The Discharge Medicines Review Service in Wales: A Mixed Methods Evaluation

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Summary

The World Health Organization aimed to halve medicines-related harm by 2022. The all-Wales Discharge Medicines Review (DMR), a community pharmacist (CP) service, aims to reduce these risks for patients discharged from any care setting. To improve CP access to the discharge medicines information needed to complete a DMR, the DMR referral system (DMRRS) was developed to provide electronic access. The DMRRS provides CP with access to this electronic information if the patient was either pre-registered for the DMR service or referred from the hospital. Despite the evidence supporting the role of the DMR in patient safety, its uptake is limited. Therefore, this thesis used mixed methods to develop recommendations to optimise the DMR's use by integrating the results of five studies.

Study one undertook a literature review and key informant interviews, contrasting the DMRRS with similar technologies in England to highlight areas of good practice. Study two undertook sixteen focus groups to explore hospital pharmacy professionals' engagement with the DMR service. Studies 3-5 involved secondary analysis of all ten years of DMR consultation data to describe the provision of the service and factors affecting its delivery and outcomes.

The integrated findings highlighted low awareness of the DMR, its benefits and processes. Additionally, the results suggest limited collaboration between care settings and inconsistency uptake of the DMR service. Further work must investigate this inconsistent uptake by exploring CPs' views of the service. Considerable investment in IT is required to optimise the DMRRS to improve engagement with it, and to complete its implementation. Furthermore, cross-sector collaboration and promotion of the DMR are required to increase awareness and buy-in.

The results show that the DMR identifies issues that could lead to harm. Therefore, the recommendations developed from this thesis should be adopted to optimise the use of the DMR, ensuring its patient safety benefits are realised.

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List of Abbreviations

Abbreviation	Full Name
ABMUHB	Abertawe Bro Morgannwg University Health Board
ABUHB	Aneurin Bevan University Health Board
AHSN	Academic Health Science Network
AIC	Akaike Information Criterion
ATC	Anatomical Therapeutic Chemical
AWQPSG	All-Wales Quality and Patient Safety Group
BIC	Bayesian Information Criteria
BCUHB	Betsi Cadwaladr University Health Board
BPMH	Best possible medicines history
CCG	Clinical Commissioning Group
CCPS	Clinical Community Pharmacy Service
ChP	Choose Pharmacy
CPW	Community Pharmacy Wales
CSPPS	Cardiff School of Pharmacy and Pharmaceutical Sciences
CTMUHB	Cwm Taf Morgannwg University Health Board
CVUHB	Cardiff and Vale University Health Board
DMR/DMR1/DMR2	Discharge Medicines Review/part one/part two
DMS	Discharge Medicines Service
(d)MUR	(discharge) Medicines Use Review
(d)NMS	(discharge) New Medicines Service
EDA	Exploratory data analysis
(e)DAL	(electronic) Discharge advice letter
EHC	Emergency Hormonal Contraception Service
EPV	Events per variable
GLM	Generalised linear model
GP	General practitioner
GPhC	General Pharmaceutical Council
HCP	Healthcare professional
HDUHB	Hywel Dda University Health Board
HFH	Help for Harry
HPP	Hospital pharmacy professional
HRA	Health Research Authority
ICC	Intra-class correlation
IT	Information technology
LHB	Local Health Board
Lowess	Locally weighted scatterplot smoothing
MAR	Medicines administration record
MCA	Multicompartment compliance aid
MRC	Medical Research Council
MRH	Medicines-related harm
MRP	Medicines-related problem
MTeD	Medicines Transcribing and Electronic Discharge
NECAF	National Electronic Claim and Audit Forms
NHS	National Health Service
NICE	National Institute for Health and Care Excellence
NSAID	Non-steroidal anti-inflammatory drug
NWIS	NHS Wales Informatics Service
NWSSP	NHS Wales Shared Services Partnership
(P:)DaHW	(Pharmacy:) Delivering a Healthier Wales
PCP	Primary care pharmacist

Abbreviation	Full Name
PhT	Pharmacy Technician
PIL	Participant information leaflet
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PSNC	Pharmaceutical Services Negotiating Committee
PTHB	Powys Teaching Health Board
R&D	Research and development
RPS	Royal Pharmaceutical Society
R_s	Spearman's correlation coefficient
RTP	Refer-to-Pharmacy
SBUHB	Swansea Bay University Health Board
SFV	Seasonal Flu Vaccination service
SOP	Standard operating procedure
UK	United Kingdom
VIF	Variance inflation factor
WCP	Welsh Clinical Portal
WHO	World Health Organization

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Chapter 1. Introduction

1.1. Chapter Introduction

This chapter provides the context for the work undertaken in this thesis, evaluating the Discharge Medicines Review (DMR), a national community pharmacy service in Wales. Introduced in 2011, the DMR aims to reduce the risks of preventable medicines-related harm (MRH) associated with patient discharge from hospitals, prisons, or care homes. Before describing the DMR in detail, this chapter describes its context, namely medicines safety, care transitions and interventions undertaken to reduce MRH.

1.2. Medicines Safety and Medicines-Related Problems

Medicines are the most commonly used intervention in healthcare and the leading cause of avoidable harm (World Health Organization [WHO] 2017). MRH varies in severity from mild symptoms like headaches to more severe symptoms like falls and even mortality (Parekh et al. 2018). These harms can increase the utilisation of healthcare services, causing emergency department attendance, hospital admissions and increased hospital length of stay (Elliott et al. 2021). The WHO (2017) have approximated the annual global cost of MRH at $42 billion. Figure 1.1 defines the differing types of medicines-related problems (MRPs), some innocuous, whilst others can lead to MRH (WHO 2019; Alqenae et al. 2020; Weir et al. 2020).

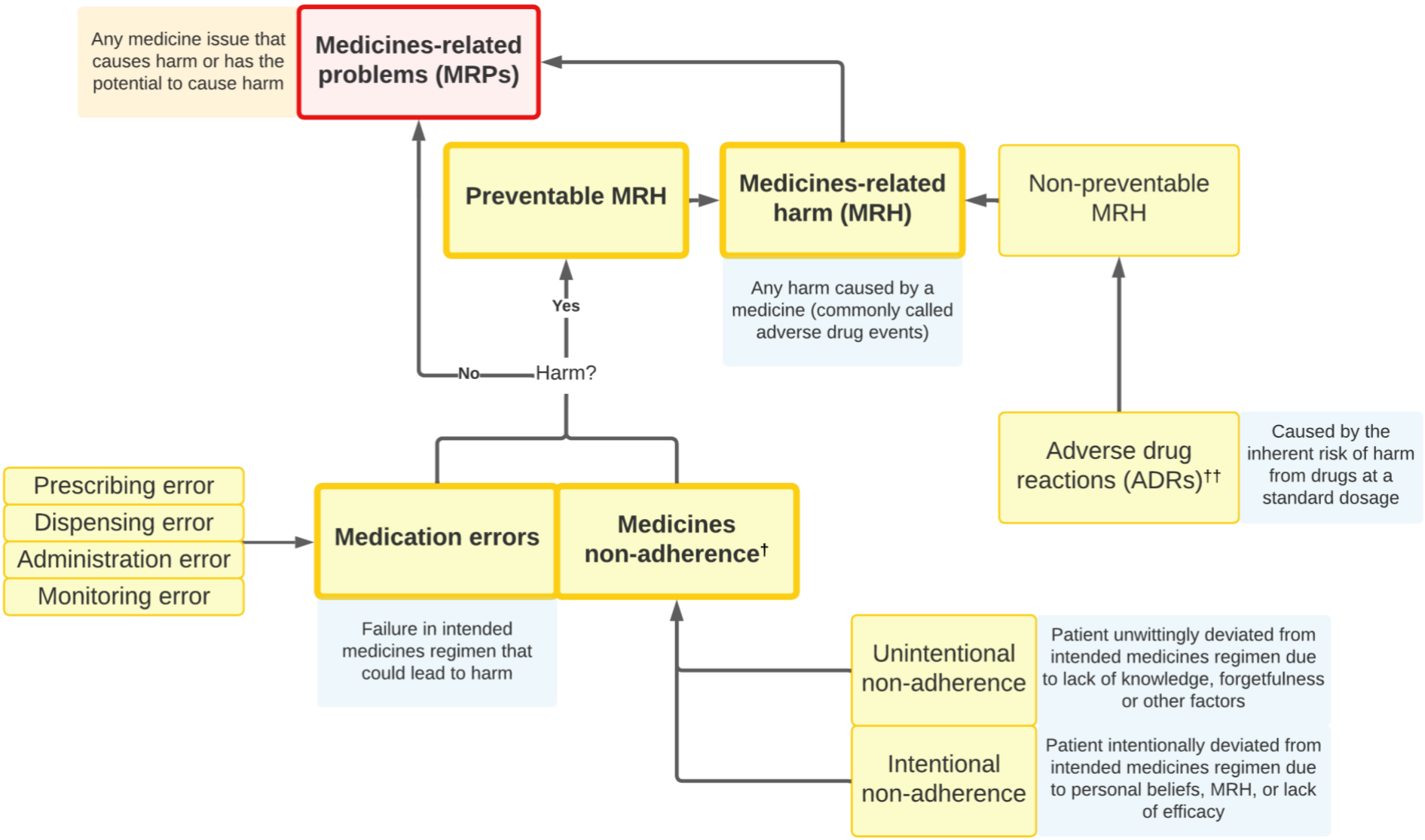


Figure 1.1: Types of Medicines-Related Problems (MRPs)

†Not all non-adherence is preventable, but the figure describes it as such for simplicity.

††ADR definitions vary in the literature, some including preventability. However, this figure uses the WHO (2019) definition.

Sheikh et al. (2019) estimated that 2% to 10% of interactions between patients and healthcare professionals (HCPs) resulted in medication errors, which are a source of preventable MRH. Due to their associated burden, the WHO (2017) set a global challenge to halve preventable MRH by 2022 in their *Medication Without Harm* report, highlighting several healthcare systems attributes (Table 1.1) of focus to reach this aim.

Table 1.1: Healthcare System Attributes Contributing to Medicines Safety

System Attributes	**System-Related Factors (WHO 2017)**	**Specific Factors Associated with Medicines-Related Harm (Asaad Assiri et al. 2018; Laatikainen et al. 2022)**
Patients and the public	May not be informed and empowered to contribute to medicines safety.	• Paediatric and elderly patients. • Medicines dispensed into a Multicompartment Compliance Aid (MCA); adherence-support containers where medicines are dispensed in morning, afternoon, evening, and night slots. • Multiple health conditions and regular medications. • Poor adherence.
Medicines	Characteristics of medicines can cause errors, such as similar packaging or names.	• Medicines with similar names. • High-risk medicines (anticoagulants, anti-inflammatories, diuretics, opioids, and beta-blocking agents).
HCPs	Errors can be caused by the way HCPs prescribe, supply, or administer medicines.	• More than one HCP is involved in the patient's care. • A lack of HCP training. • HCP fatigue.
Systems and practices of medication	The way that medicines are managed can be dysfunctional, leading to errors.	• The lack of available information regarding the patient's care. • The lack of routine processes to optimise safety. • The transfer of responsibility for a patient's care between HCPs (care transition), particularly between care settings.

The WHO (2019) highlighted care transitions as high-risk situations for preventable MRH, particularly when patients move between care settings. Primary care settings include general practitioner (GP) and dental surgeries, community pharmacies, and optometrists[1]. Alternatively, secondary care is any healthcare service, typically hospital care, that requires an initial referral from a primary care professional (NHS Digital 2022). Hospital discharge is a care transition commonly associated with MRH since the responsibility for medicines management is transferred between care settings, risking discontinuity of medicines (WHO 2019). Additionally, patients are often unwell in the hospital, requiring medicine regimen changes, increasing the risk of MRPs. Figure 1.2 presents an overview of medicines management through a patient's hospital journal, highlighting its complexity (WHO 2019).

[1]This thesis only discusses GP surgeries and community pharmacies since dental practices and optometrists are not typical DMR stakeholders.

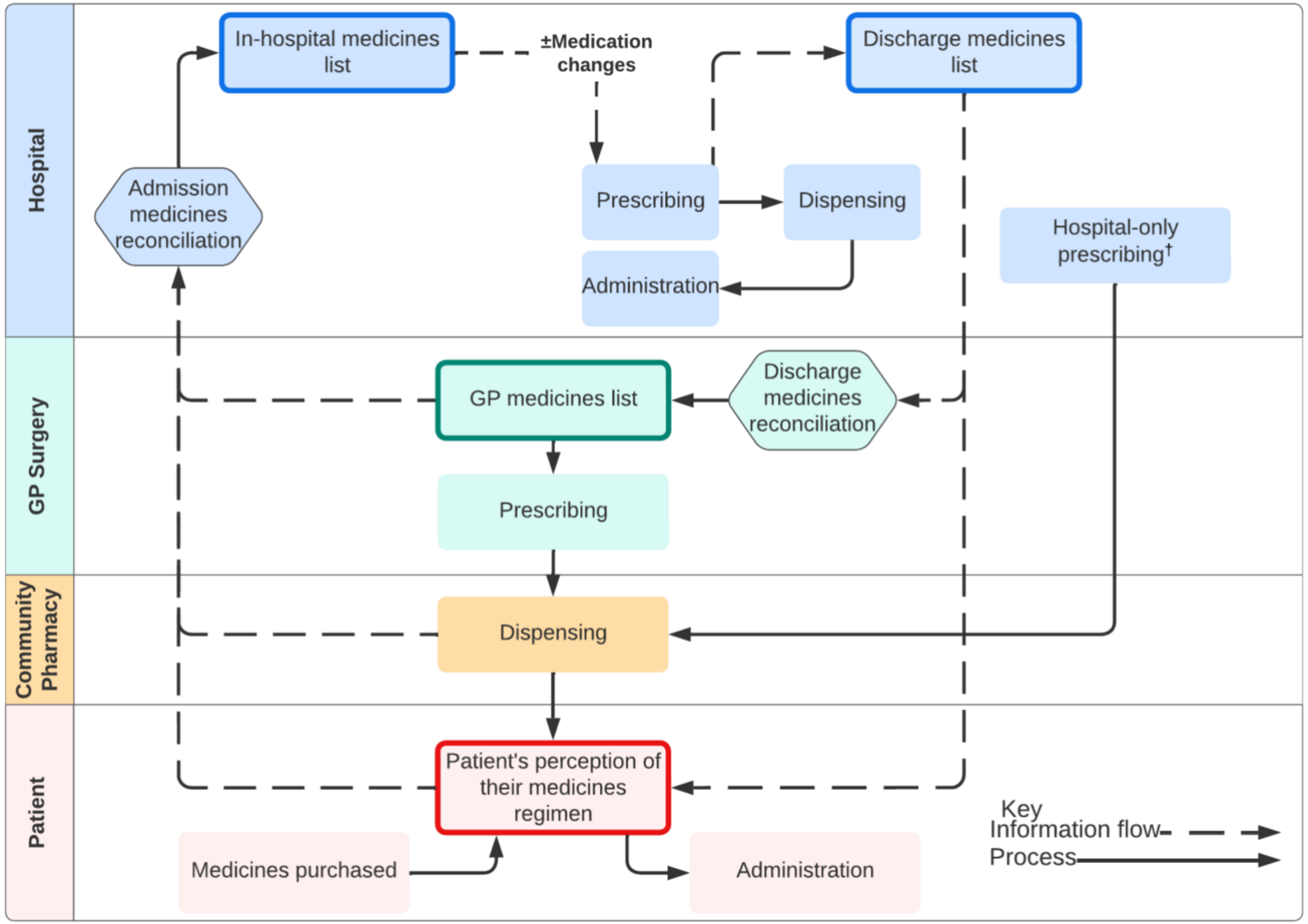


Figure 1.2: Overview of Medicines Management Through Transitions of Care

†Some medicines prescribed from hospitals are supplied directly to the patient via homecare services (Royal Pharmaceutical Society [RPS] 2013).

The following subsections describe the United Kingdom (UK) medicines management processes at home, in the hospital and post-discharge, highlighting system vulnerabilities that can lead to MRPs.

1.2.1. Medicines Management at Home

Patients usually have the majority of their medicines prescribed in their GP surgery. These could be prescribed by a GP or other qualified prescribers, e.g., nurses and pharmacists (Lim et al. 2022). Most patients manage their medicines themselves, but some may have assistance from a carer[2] who may provide support by liaising with HCPs, administering medicines and monitoring supplies (Francis et al. 2006). Each GP surgery holds a record of medicines they have prescribed for their patients. However, the medicines the patient takes at home may vary from this record, as detailed in Table 1.2 (All Wales Medicines Strategy Group 2013).

Table 1.2: Medicines Sources in Primary Care

Deviation From GP Surgery Medicines Record	Description
Medicines from a hospital prescriber.	Some patients have medicines prescribed from the hospital if they attend an outpatient specialist service or emergency department. While the responsibility for prescribing some of these medicines can be transferred to the patient's GP surgery, some are hospital-only.
Medicines from other primary care prescribers.	As described above, other professional groups can qualify as prescribers. These non-medical prescribers may prescribe from primary care settings other than the GP surgery, e.g., community pharmacies.
Medicines/herbal products purchased.	A patient may purchase medicines for self-treatment. These could be over-the-counter or herbal medicines, which may or may not be under the direction of an HCP.
Non-adherence.	The patient may be non-adherent (intentionally or non-intentionally) to medicines prescribed by their GP surgery.

Prescribed medicines can be for short-term (acute) or long-term (repeat medicines) use. To obtain an ongoing supply of repeat medicines from prescribers outside of GP surgeries, the patient must request prescriptions from them directly. For medicines prescribed in the GP surgery, a patient can use their repeat prescription form[3] to request a prescription (typically 28-56 days' supply) (All Wales Medicines Strategy Group 2013). When a patient is stable on a medication, the GP may authorise a set number of prescriptions for supply without further review, known as repeat authorisation. However, prescribers must generate and sign each prescription (RPS 2021). In contrast, repeat dispensing is where a prescriber provides an authorised batch of prescriptions so the patient can have the medicines dispensed at set intervals.

[2]Carers are individuals who routinely care for a patient, either a friend, family member or someone employed to provide such services.

[3]A repeat prescription form is a list of all repeat medicines that the GP surgery has responsibility for ongoing prescribing.

Paper prescriptions are usually presented to community pharmacies[4], by a patient or representative, for dispensing, or the patient's pharmacy may collect them from the GP surgery (RPS 2021). Electronic transfer of prescriptions from GP surgeries to community pharmacies has been implemented in England since 2017 (Hibberd et al. 2017), with implementation in Wales starting in 2023 (Digital Health and Care Wales [DHCW] 2022a).[5] Once a prescription has been dispensed, the patient or carer can collect the medicine. Alternatively, some pharmacies offer a delivery service, typically for patients who cannot attend in person, e.g., housebound patients.

Although most patients administer their medicines themselves with no support, pharmacies may provide additional adherence support when needed. This support may include MCAs or medicines administration record (MAR) charts. MAR charts are paper records designating when a carer has administered each dose of a patient's prescribed medicines (National Institute of Health and Care Excellence [NICE] 2017).

1.2.2. Medicines Management in Hospital

When patients are admitted to the hospital, their medicines are usually managed on-site by the HCPs on the ward. To ensure accurate medicines management in the hospital, HCPs must obtain an accurate representation of the patient's home medicines regimen, known as the *best possible medicines history* (BPMH). The HCP then transcribes the BPMH onto the inpatient medicines chart, a process called admission medicines reconciliation (All Wales Medicines Strategy Group 2017). Obtaining the BPMH can be challenging, considering that patients may take medicines from several sources. To overcome these challenges, HCPs often use various sources of medicines information, such as an electronic patient record, the patient or carer themselves, a repeat prescription from their GP, or medicines that the patient brought into the hospital that they were taking at home (All Wales Medicines Strategy Group 2017). Without accurate reconciliation, there may be an unintentional discrepancy between the pre-hospital and in-hospital medicines lists, a type of medication error that can cause MRH (Belda-Rustarazo et al. 2015). These discrepancies can be propagated post-discharge unless they are rectified during the patient's hospital admission. An example of a discrepancy leading to MRH is the unintentional omission of a repeat medicine, which could lead to therapeutic failure. In contrast, an unintentional change in the brand of most medicines is unlikely to cause harm (Belda-Rustarazo et al. 2015).

[4]Some patients may have their prescriptions dispensed in their GP surgery if they live in a rural area more than one mile from the nearest pharmacy (Dispensing Doctors' Association 2021).
[5]DHCW is the organisation responsible for developing and managing healthcare IT in Wales. This thesis uses their previous name, NHS Wales Informatics Service (NWIS), when referring to dates before DHCW was established (April 2021).

Hospitals encourage patients to bring their pre-admission medicines into the hospital, not only as a source of medicines information but also to circumvent the need for on-site supplies (All Wales Medicines Strategy Group 2017). If the patient did not bring their medicines into the hospital, they are prescribed and dispensed on-site. Hospitals prescribe on paper charts unless the ward uses electronic prescribing, which is in the early pilot stages in Wales (DHCW 2022a). In England, individual hospitals started implementing diverse electronic prescribing systems in 2013. However, their uptake is variable, and no national system exists (Department of Health and Social Care 2022). The prescription chart also facilitates supervision and recording of medicines administration by an HCP.

Patients are typically admitted to the hospital only if they cannot be appropriately managed in primary care, such as for acute illness or elective surgery. Therefore, it is unsurprising that medication changes are common, with Viktil et al. (2012) identifying an average of 4.4 changes per patient during their hospital stay. Best practice suggests that HCPs communicate these changes with the patient or their carer before discharge. However, this may not always happen due to HCP time constraints. Additionally, patients may not retain this information if they are unwell (Tobiano et al. 2019).

When a patient nears discharge, a discharge advice letter (DAL) is prepared for the attention of the GP surgery. The DAL should contain accurate clinical information about the hospital stay and the patient's discharge medicines (Bullock et al. 2017). The HCP preparing the DAL should be adequately trained to complete a legible and accurate record of the intended post-discharge medicines regimen, including what changes were made in the hospital and why (WHO 2019). At discharge, the hospital transmits a copy of the DAL to the patient's GP surgery, typically by post, fax, or electronically. When a patient has an insufficient supply of medicines after discharge, such as with new medicines, the hospital pharmacy prepares a small quantity to take home, typically for 7-14 days (Bullock et al. 2017).

1.2.3. Post-Discharge Medicines Management

Once a patient has been discharged, they (or their carer) are responsible for managing their medicines and must obtain ongoing prescriptions from their GP before exhausting their discharge supply. GP surgeries must reconcile medicines before they provide the first post-discharge prescription but delayed DAL availability and suboptimal quality can make timely reconciliation challenging. In particular, medication changes and their rationale are often omitted from the DAL (Weetman et al. 2021). Unless medicines are reconciled accurately and promptly after discharge, it can lead to unintentional discrepancies; Alqenae et al. (2020) reported that such discrepancies

affect between 11.0% and 93.5% of patients post-discharge. Examples of post-discharge discrepancies are the omission of medicines initiated in the hospital, differences in the dosage prescribed, or restarting medicines stopped in the hospital (Mekonnen et al. 2016a).

To complicate post-discharge medicines management further, Viktil et al. (2012) identified an average of 3.4 intentional changes[6] per patient after discharge made by the GP surgery. The immediate post-discharge period can be confusing for patients since they typically delegate responsibility for their medicines while in the hospital and may not have been involved in discussions regarding any changes made to them (Ozavci et al. 2021). This lack of knowledge of changes can lead to anxiety and unintentional non-adherence (Daliri et al. 2019). Therefore, it is unsurprising that medicine non-adherence is prevalent after discharge, with 38.7% to 43.7% of patients being non-adherent to at least one of their medicines (Coleman et al. 2005; Weir et al. 2020).

Post-discharge MRPs may be inconsequential, whilst others can lead to MRH. Parekh et al. (2018) identified an MRH prevalence of 37.0% in a cohort of 1,116 older patients in the UK within eight weeks of hospital discharge. Of the patients with MRH, 21.1% [n=87] had a medicines-related hospital readmission. Medication errors contributed to 19 (4.6%) cases of MRH, and non-adherence contributed to 93 (22.5%). The cumulative healthcare cost from the MRH was £225,747, of which 93% was attributable to hospital readmissions.

1.3. Interventions Designed to Reduce Medicines-Related Problems

Internationally, many interventions have been trialled to reduce the risks of post-discharge MRPs. Table 1.3 summarises the interventions described in the WHO (2019) *Medication Safety in Transitions of Care* report.

[6]These post-discharge changes are often described as intentional discrepancies between the in-hospital and post-discharge medicines lists.

Table 1.3: Interventions to Reduce Medicines-Related Problems (MRPs) During Care Transitions

Intervention	Characteristics	Description
Engagement with patients, families, and carers	Informed patients and patient tools	Educating patients on medication safety and encouraging them to be active partners in their care.
	Patient-held medication list	Providing a medication list to patients before each care transition, like DALs. These lists can be paper or electronic.
	Provision of specific medicines information	Providing written or verbal information (counselling) regarding medicines and their changes.
	Support around discharge	Follow-up contact after the patient has been discharged to discuss medicines-related issues.
Improvement in information quality and availability across transitions	Reliable information sources	Several information sources should support the BPMH.
	Electronic health records	Where available, HCPs should use electronic health records to access medicines information in hospitals and primary care.
	Tools and technology to facilitate medicines reconciliation	Interoperable systems that support medicines reconciliation by transferring medicines information across care settings.
Medicines reconciliation	Health workforce and skill mix considerations	HCPs should be appropriately trained for medicines reconciliation, which should be completed by the most appropriate professional. Particular attention has been given to pharmacy professionals.
	Medicines reconciliation toolkits and resources	Implementing guidance or toolkits to support medicines reconciliation.
Discharge and post-discharge interventions	These interventions vary in complexity and which HCP provides them, including medicines reconciliation and review, electronic tools to facilitate information transfer, and sharing of discharge information with HCPs. Particular attention has been given to community pharmacists to provide these interventions.	

There is extensive literature studying the outcomes of these interventions, of which a comprehensive review is outside the scope of this chapter. However, recent systematic reviews have identified conflicting evidence of the benefits of medicines reconciliation and counselling (Mekonnen et al. 2016a; Mcnab et al. 2018). Additionally, the evidence for electronic DALs (eDALs) shows they are timelier and more complete than paper DALs, with greater satisfaction from GPs and patients (Newnham et al. 2017; Kattel et al. 2020).

One limitation of the evidence base is the heterogeneity of outcome measures, including hospital readmission, adherence, discrepancies, and MRH (Daliri et al. 2021). The evidence of benefit is more robust for identifying discrepancies and improving adherence but less for clinical outcomes such as readmission and MRH (Tomlinson et al. 2020a; Daliri et al. 2021). Although these individual interventions have a limited evidence base, recent reviews have supported using *complex interventions*[7] involving multiple components, e.g., medicines reconciliation and counselling (Tomlinson et al. 2020a; Daliri et al. 2021).

[7]Complex interventions are services or systems that require specific skills to implement and span multiple settings (Skivington et al. 2021).

1.4. Reducing Post-Discharge Medicines-Related Problems in the UK

Parekh et al. (2018) estimated the annual cost of preventable post-discharge MRH in the UK as £243 million. However, the actual yearly costs are likely higher because the paper's authors only included older adults (>65 years old) in their calculations. UK policymakers have focused on improving care continuity and reducing post-discharge MRH to reduce this economic cost and patient burden. The umbrella organisation responsible for UK healthcare is the National Health Service (NHS). However, healthcare is devolved to each constituent nation, so policies are determined independently by NHS England, Wales and Scotland, or Health and Social Care (Northern Ireland) (Doheny 2015). This thesis focuses on Wales since the DMR is a national service. Contrasts are made only with healthcare in England rather than Scotland and Northern Ireland because England had similar community pharmacy post-discharge services at the time of writing (see Section 1.4.4). Table 1.4 presents the healthcare policy context of England and Wales, described in the NHS England (2019) *Long Term Plan* and the Welsh Government (2018) *A Healthier Wales* agenda.

Table 1.4: Healthcare Policy Context in England and Wales

Policy Goal	**Description**	**Relationship With Medicines-Related Problems**
Care closer to home	The healthcare systems aim to treat patients in primary care, avoiding preventable hospital admissions where possible.	Since MRPs can cause hospital readmissions, this goal encompasses reducing these risks.
Diverse primary care workforce	Primary care should include diverse professional groups to optimise patient care in the community. Particular attention has been given to the role of pharmacists in patient care, in community pharmacies and through the expansion of their role in GP surgeries.	Pharmacists have a vital role in medicines management, including services that address post-discharge MRPs.
Integrated patient-centred care	Patients should be able to access care seamlessly across healthcare settings. Rather than traditional siloed ways of working, healthcare settings should collaborate to optimise patient care.	Care transitions carry a high risk for MRPs due to the lack of communication across care settings.
Using technology to enable seamless care	This goal relates to using technology to ensure HCPs can access the information required to provide optimal care, regardless of organisational boundaries.	Developing a BPMH, and thus accurately reconciling medicines across care transitions, requires timely access to a patient's medicines information.

As healthcare is devolved to each member state, the interventions employed to reduce MRPs vary across the UK. Some of these developments vary within Wales since local healthcare services are delivered by seven Local Health Boards (LHBs) and two NHS Trusts:

- Aneurin Bevan University Health Board (ABUHB).
- Betsi Cadwaladr University Health Board (BCUHB).
- Cardiff and Vale University Health Board (CVUHB).

- Cwm Taf Morgannwg University Health Board (CTMUHB).
- Hywel Dda University Health Board (HDUHB).
- Powys Teaching Health Board (PTHB).
- Swansea Bay University Health Board (SBUHB).
- Velindre NHS Trust (national specialist cancer services and the Welsh Blood Service).
- Welsh Ambulance Service NHS Trust (national emergency services).

Despite these variations, several policies aiming to reduce MRH exist which apply to all of Wales, including the NICE (2015) Medicines Optimisation guidance and the All Wales Medicines Strategy Group (2017) Medicines Reconciliation guidance. Additionally, there is the national community pharmacy DMR service, the focus of this thesis (see Section 1.5). The following subsections, each titled based on the WHO (2019) intervention types (Table 1.3), describe how healthcare organisations in Wales have attempted to address post-discharge MRPs.

1.4.1. Engagement With Patients, Families and Carers

National guidance and each LHB's discharge processes include counselling patients or their carers on medicine use before discharge and providing printed discharge information (NICE 2015; All Wales Medicines Strategy Group 2017; Healthcare Inspectorate Wales 2018). In an evaluation of hospital discharge processes, Healthcare Inspectorate Wales (2018) found that only approximately half of discharged patients received a copy of their DAL, highlighting a lack of consistent provision.

1.4.2. Improvement in Information Quality and Availability Across Transitions

Guidance on medication reconciliation upon hospital admission suggests that HCPs use multiple information sources to develop the BPMH (NICE 2015; All Wales Medicines Strategy Group 2017). NHS Wales Informatics Service (NWIS) developed the Welsh Clinical Portal (WCP), an all-Wales shared patient record between primary and secondary care (DHCW 2021a). With patient consent, secondary care HCPs can access the GP medicines list and hospital clinical letters, which may include information about hospital-only prescribing, through WCP. Therefore, WCP provides increased availability of patients' medicines information for hospital HCPs to reconcile medicines upon hospital admission.

Guidance is also available on transferring medicines information to primary care following hospital discharge. The NICE (2015) guidance specifies that the DAL should be transmitted electronically and be available to the patient's GP surgery within 24 hours of discharge. Traditionally, DALs were sent to the GP surgery by post or fax. Some LHBs in Wales independently developed electronic discharge systems to facilitate the timely transmission of an accurate eDAL to the patient's GP surgery (Healthcare Inspectorate Wales 2018). Working towards Welsh Government's integrated technology aims, NWIS introduced the national electronic discharge system, Medicines

Transcribing and electronic Discharge (MTeD), in 2012, which automatically transmits an eDAL to the patient's GP surgery immediately after discharge, in keeping with the NICE guidance (Mantzourani et al. 2017). The incremental rollout of MTeD started in limited wards in hospitals within two LHBs and has since been rolled out fully in two LHBs, and partially in four LHBs (Way 2019). Although the national plan was to implement MTeD in all hospitals in Wales, ABUHB has not adopted it, choosing to retain the system they developed (Healthcare Inspectorate Wales 2018). For an electronic discharge system to transmit the DAL, a hospital practitioner must first transcribe the intended list of discharge medicines into the system. For MTeD, the patient's pre-admission medicines list can be imported directly from WCP to overcome this transcription process and then amended to reflect any changes made throughout their hospital stay (DHCW 2021a). The MTeD eDAL contents meet the minimum contents suggested by the NICE (2015) guidance:

- Details of the patient, their GP surgery, and the HCP completing the DAL.
- Clinical information regarding the hospital stay.
- Medicines and their strength, dose, route of administration, and formulation.
- Medication changes and their rationale.
- Recommendations for ongoing management, e.g., duration, reviews needed, and adherence support.
- Information provided to the patient or carer.

Although the use of electronic discharge systems is widespread across Wales, it is not unusual for DALs to be delayed or for critical information to be missing (Healthcare Inspectorate Wales 2018). The Healthcare Inspectorate Wales (2018) report highlighted that junior (trainee) doctors are usually responsible for completing DALs; they are not always trained for this role or involved in the decision-making process for medication changes. Consequently, the DAL quality varies, and information regarding why medicines were changed is often omitted. To mitigate some of these quality issues, hospital pharmacy professionals (HPPs) verify the medicines information on the DAL before discharge (Healthcare Inspectorate Wales 2018).

1.4.3. Medicines Reconciliation

NICE (2015) suggests that a trained HCP, like a doctor or HPP, reconcile medicines within 24 hours of admission. Although admission reconciliation with an HPP is standard practice in Wales, adherence to 24 hours varies because of suboptimal staffing levels (Healthcare Inspectorate Wales 2018). GP surgeries should reconcile medicines within seven days of discharge and before they generate any post-discharge prescriptions (NICE 2015). Each GP surgery will have a different post-discharge reconciliation process. However, it is usually delivered by their prescription clerk, GPs, or primary care pharmacy professionals (Hodson et al. 2014a; Spencer et al. 2019).

The introduction of pharmacy professionals (pharmacists and pharmacy technicians [PhTs]) in GP surgeries is a recent development. Some are employed by primary care organisations and rotate around multiple GP surgeries whilst others are directly employed by the GP surgery. However, not every GP surgery has a pharmacy professional available (Bartlett et al. 2021).

1.4.4. Discharge and Post-Discharge Interventions

Medicines review after discharge with a trained HCP, particularly pharmacists, is recommended by the NICE (2015) guidance. Although community pharmacists' role has typically been dispensing medicines, increasing interest has been given to their role in post-discharge support (Cooper 2020). Since community pharmacies are private organisations providing contracted NHS services, their post-discharge role is realised through commissioned community pharmacy services. The community pharmacy contract governs these services, which differs in England and Wales (Department of Health and Social Care 2019; Welsh Government 2021). However, these services are optional, and contractors must apply to their local healthcare organisation (LHB or NHS Trust) to register for them. Additionally, each pharmacist must be accredited for each service they intend to provide. Pharmacist service accreditation requires additional training, which is usually delivered online.

In their recent rapid review, Nazar et al. (2021) identified several post-discharge community pharmacy services available in England: the Medicines Use Review (MUR)[8], New Medicines Service (NMS) and Discharge Medicines Service (DMS). The MUR was introduced in 2005 and aimed to support patient adherence through a discussion with a patient (Pharmaceutical Services Negotiating Committee [PSNC] 2013a). From 2011, contractors had to provide at least half of their annual limit of 400 MURs to high-risk patients, which included:

- Patients taking high-risk medicines (cardiovascular or anti-inflammatory drugs).
- Patients taking certain respiratory medicines.
- Patients recently discharged from a hospital.

The discharge MUR (dMUR) had to be provided within eight weeks of discharge, but ideally within four. dMURs were associated with improved clinical care and associated cost savings when provided to elderly patients (Ramsbottom et al. 2018). However, the MUR was decommissioned in 2020 (PSNC 2021a). The NMS was introduced in 2011 to improve adherence to certain new medicines, including those used to treat asthma, diabetes (type 2) and hypertension (PSNC 2013b). Since medicines changes are common during hospital admission, the NMS has been used to support patients post-discharge (dNMS). The DMS was commissioned in 2021 to replace and

[8]The MUR was commissioned in Wales but was not often used post-discharge due to the availability of the DMR (Welsh Government 2021).

improve the dMUR and dNMS, consisting of post-discharge medicines reconciliation and a follow-up community pharmacist or PhT adherence support service (NHS England and NHS Improvement 2021).

The RPS (2014) published a report titled *"hospital referral to community pharmacy: An innovators' toolkit to support the NHS in England"*, highlighting several good practices for hospital referrals to facilitate post-discharge community pharmacy services. Several of these practices used electronic systems to transmit discharge medicines information to a designated community pharmacy and notify them that their patient had been discharged from the hospital. Examples included Refer-to-Pharmacy (RTP), Help for Harry (HFH) and PharmOutcomes. Referrals with some of these systems are associated with reductions in hospital readmissions when combined with post-discharge services but are not national solutions, limited to specific localities in England (Sabir et al. 2019; Wilcock et al. 2020).

In Wales, the national community pharmacy post-discharge service is the DMR, which is the focus of this thesis. The following section describes the DMR, its evaluation and developments over time.

1.5. The Discharge Medicines Review

Before the WHO (2017) published their *Medication Without Harm* report and the community pharmacy services described above were introduced in England, the Welsh Government recognised the MRPs associated with hospital discharge. Consequently, they commissioned the national community pharmacy DMR service in 2011 to mitigate these issues (Community Pharmacy Wales [CPW] 2011). The pharmacist must be accredited to provide the DMR, and the pharmacy premises must be registered. In 2011, for pharmacists to accredit to provide the DMR, they had to complete a competency assessment encompassing the MUR[9] (CPW 2011). Figure 1.3 illustrates the 2011 process for the DMR from when it was first introduced, a complex intervention involving several stages across multiple settings. The DMR can be described as a complex intervention since it requires co-ordination between several stakeholders across several care settings. This contrasts with complicated interventions which are a stable and linear arrangement of individual elements (Cohn et al. 2013).

[9]From 2020, to accredit for DMRs, a pharmacist must complete generic competency assessments on the national clinical services accreditation portal (NHS Wales 2022).

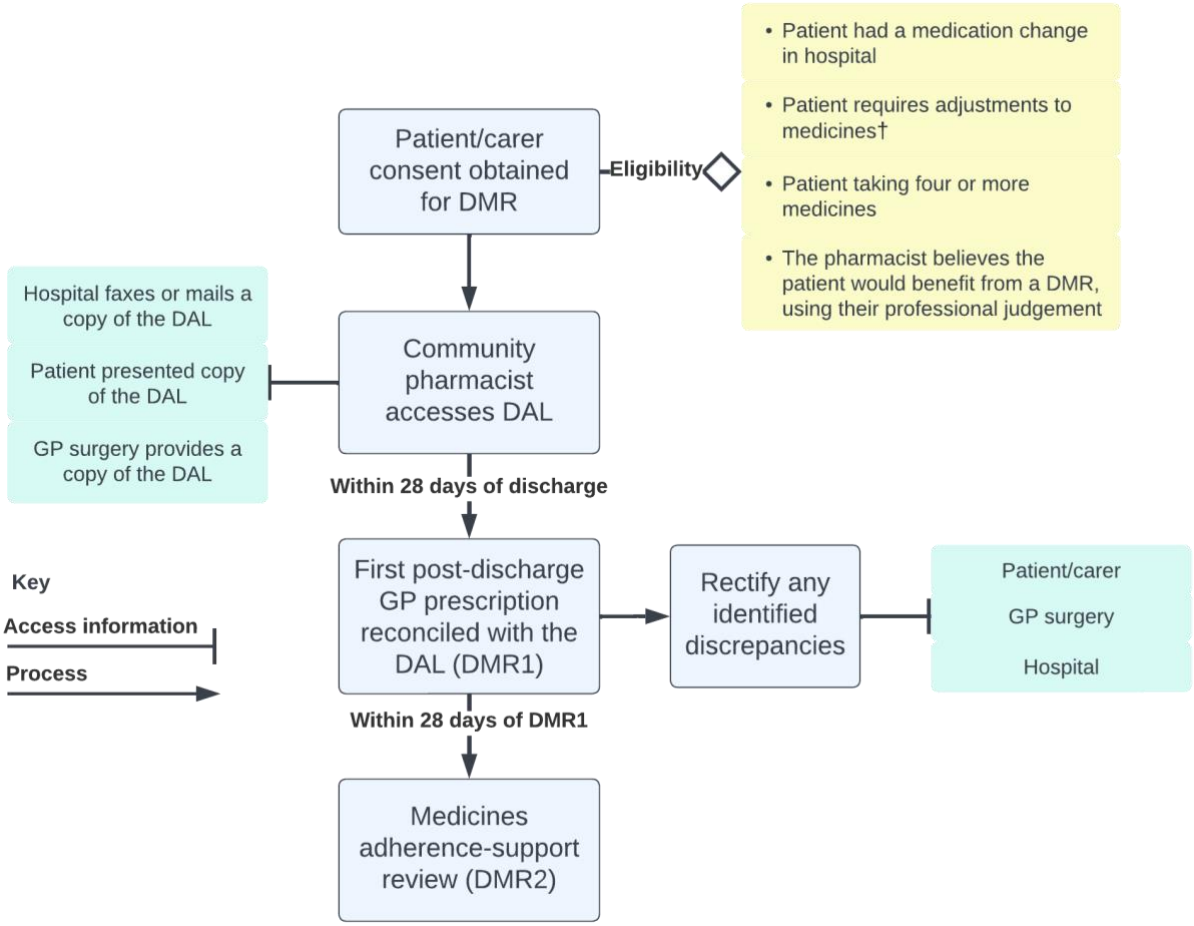


Figure 1.3: The DMR Service in 2011

†Adjustments may include MCAs or MAR charts.

A community pharmacist can complete a DMR with (CPW 2011):

- the patient in the pharmacy (with or without their carer),
- a carer in the pharmacy,
- the patient in their home,
- the patient by telephone.

When the DMR was introduced, the pharmacist completed a paper form documenting the consultation and its outcomes. They then transcribed a limited subset of that information into National Electronic Claim and Audit Forms (NECAF)[10], thus claiming payment for the service and electronically documenting some of the consultation-related information, such as patient age. The information about each medicine documented on the paper form was not transcribed into NECAF. However, the number and type of discrepancies identified during the service were recorded from the following native options:

- Medicines restarted in the community.
- Medicines discontinued in the community after discharge.
- Medicines continued but at the wrong dose.

[10]NECAF is an online service for documenting and claiming payment for community pharmacy services in Wales, managed by NHS Wales Shared Services Partnership (NWSSP).

- Medicines continued but at the wrong strength.
- Medicines continued but in the wrong formulation.
- Medicines duplicated (e.g., prescribed by brand and generic name).
- Medicines discontinued by the patient.
- Other (NECAF did not provide an opportunity to elaborate on this discrepancy type).

NECAF was not configured to distinguish between intentional and unintentional discrepancies. Additionally, it had no interoperability with other healthcare records; therefore, the only way to inform the patient's GP or other HCPs of the DMR's outcomes was for the pharmacist to provide them with a copy of the paper service record in person or by mail. Each community pharmacy was commissioned to provide up to 140 DMRs per year (paid £37 per completed service) (Hodson et al. 2014a); however, this cap was removed in April 2021 (CPW 2021).

The Welsh Government initially commissioned the DMR up until March 2014. Further funding was subsequently secured following its evaluation (Hodson et al. 2014a).

1.5.1. The 2013 Evaluation of the DMR Service

The evaluation consisted of several sections: a description of DMR provision and its outcomes, economic evaluation, and stakeholder perceptions of the service (Hodson et al. 2014a). Many pharmacies [n=224, 30.1%] provided no DMRs from November 2011 to December 2013, whilst few [n=26, 3.0%] provided over 100 per year. Although the evaluation found inconsistent service uptake, it established the value of the DMR in improving patient safety; on average, the service identified 1.3 discrepancies between the DAL and the first post-discharge prescription. The economic analysis compared the cost of stakeholder time and service remuneration with cost-savings associated with the DMR through reductions in medicines waste, emergency department attendance and probable hospital readmissions, as determined by an expert panel. The outcome of this analysis was that an average of £3 was returned to the health economy for every £1 invested in the service.

Table 1.5 summarises the next section of the 2013 evaluation, investigating stakeholder perspectives of the DMR service (Hodson et al. 2014a).

Table 1.5: Stakeholder Perspectives From the 2013 DMR Evaluation

Evaluation Feature	Stakeholder Group			
	Community Pharmacists	**Hospital Pharmacists**	**GPs**	**Patients**
Employed method [number of participants]	Interviews [n=7] and surveys [n=143]	Interviews [n=6] and surveys [n=94]	Interviews [n=5]	Interviews [n=6]
Identified barriers to DMR engagement	• Onerous paperwork for the service. • Lack of time and capacity to provide the service. • Lack of awareness that their patients have been in the hospital. • Lack of access to discharge information.	• Lack of DMR awareness and enthusiasm. • Lack of knowledge regarding whom to refer. • Gaining patient consent for referrals. • Lack of time and capacity to refer patients for the service.	• Lack of knowledge of the service.	
Identified facilitators for DMR engagement	• Having a good relationship with GPs. • Enthusiasm for and enjoyment of the DMR.	• None noted.	• Positive opinions of the service.	• Positive relationship with the pharmacist. • Pharmacist availability compared with GPs.
Suggestions for improving the DMR	• Electronic access to the DAL. • Improving the engagement of other stakeholders. • Streamlining service paperwork. • Automatically informing community pharmacists of patient discharge.	• Investment in staff to create capacity. • Electronic referrals. • Better promotion of the service to patients. • Availability of regular feedback from referrals.	• Better promotion of the service.	• None noted.

Following these findings, NWIS aimed to use technology to address community pharmacist barriers to DMR engagement. These developments included the DMR module on Choose Pharmacy (ChP) and the DMR referral system (Mantzourani et al. 2017). ChP is Wales' national online community pharmacy service platform, which NWIS developed to facilitate the electronic logging of pharmacy services and their payment claims (DHCW 2021b). Although ChP was initially piloted for the Common Ailments Scheme (a community pharmacy service in Wales), NWIS has since added modules for several services, including the DMR. Each pharmacy and pharmacist registering for a ChP account is assigned a unique account number to facilitate system access. Although NWIS implemented ChP incrementally, it is now available in 97% of pharmacies in Wales, whilst the remaining 3% of pharmacies do not meet the ChP registration requirement of a private consultation area (DHCW 2021b). Figure 1.4 presents the standard process for delivering a service through ChP.

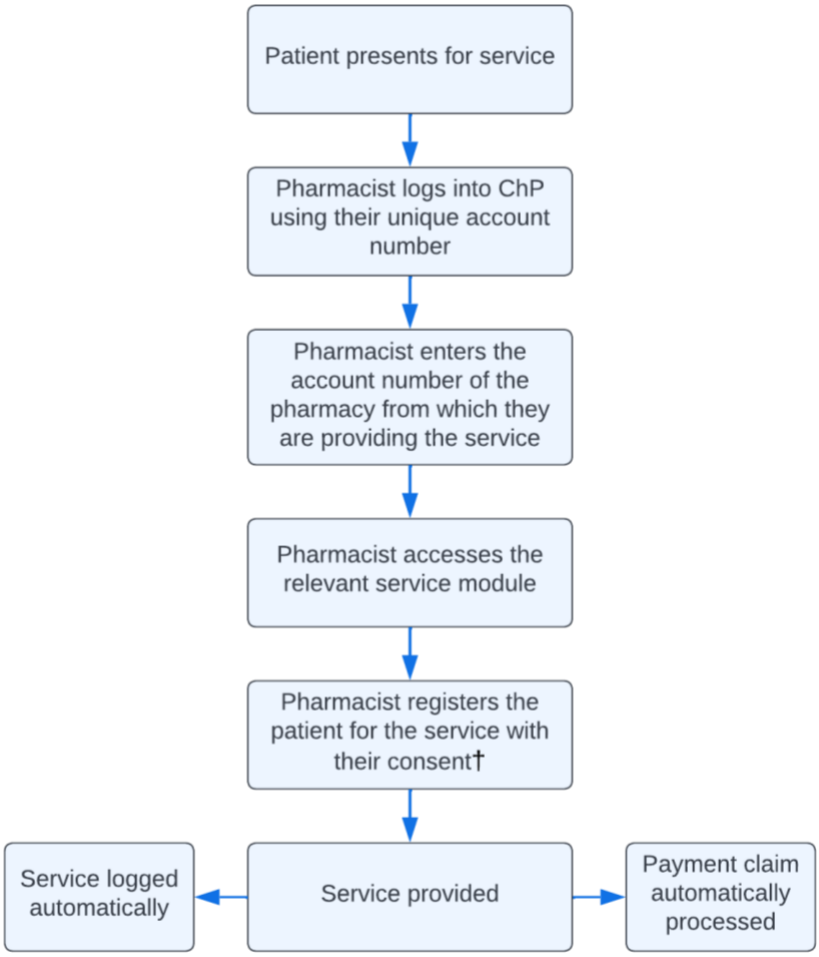


Figure 1.4: Community Pharmacy Service Delivery Through ChP

†A patient can choose to change their registered pharmacy by providing consent for a new pharmacy to access their record. The registered pharmacy may access records for any previous ChP service (DHCW 2022b).

1.5.2. Development of the DMR Module

NWIS piloted the ChP DMR module in April 2015 and rolled it out across Wales incrementally (DHCW 2021b). NECAF remained active through November 2020 since not all pharmacies had immediate access to ChP. Consequently, DMRs could be recorded in either system from April 2015 to November 2020.

The DMR module aimed to streamline the paperwork required to complete the service. Unlike NECAF, pharmacists did not have to initially document the service on paper, instead contemporaneously recording all service details on ChP, which automatically claimed for service payment (DHCW 2022b). Consequently, the DMR data collected in NECAF and ChP varied. Section 5.2 describes these differences in detail, but the key differences are how they log discrepancies and the extent of their medicines-related data collection. NECAF records no information regarding individual medicines but records the number of each discrepancy type and total discrepancies per service. In contrast, ChP records each individual medicine and whether it was associated with a discrepancy. However, ChP can only log a single discrepancy per item, whilst NECAF recorded the

total number of discrepancies per DMR. ChP has explanatory free-text boxes when the pharmacist selects the 'other' option for discrepancy type, method of DMR delivery (e.g., with the patient by telephone), and the reason DMR2 was not completed (DHCW 2022b). NECAF has 'other' options for these variables but no free-text explanatory boxes.

1.5.3. Development of the DMR Referral System

In addition to the reduced paperwork burden, the DMR module introduced interoperability with MTeD, the national electronic discharge system. This interoperability enabled community pharmacists to access eDALs for their patients and notifies the pharmacist of patient discharges (DHCW 2022b). To determine the eDAL contents, Mantzourani et al. (2014) surveyed community pharmacies in Wales, investigating what information pharmacists considered essential for completing a DMR. Patient and medication details (including changes) were considered essential, whilst clinical information like the patient's diagnosis or medication recommendations were only considered desirable, not essential. Consequently, the eDAL only contains medicines-related information alongside patient demographics (DHCW 2022b).

For a patient's eDAL to be made available for a community pharmacist to access, the patient must be registered, with their consent, for DMRs on ChP for that pharmacy. This registration may be completed by the community pharmacy proactively before hospital admission or after discharge. Additionally, hospital HCPs may register patients for a DMR using the inbuilt ChP functionality in MTeD to register a patient's consent for the referral and enter their chosen community pharmacy. For this thesis, hospital registrations will be named DMR referrals. Once a registered patient is discharged from a hospital ward using MTeD, an Electronic NHS Alert System anonymised notification is sent to the NHS email address of the pharmacy designated to receive it. This email prompts the pharmacist to access the eDAL available through ChP (DHCW 2022b). ChP provides a visual reminder of available eDALs within the DMR module, but the pharmacist must log into ChP and the DMR module to view these. When an eDAL is available for the DMR, medicines information is automatically imported into the DMR form on ChP, requiring little manual input from community pharmacists. Where no eDAL is available, the pharmacist must input the data manually (DHCW 2022b). Figure 1.5 summarises the DMR referral process using this system.

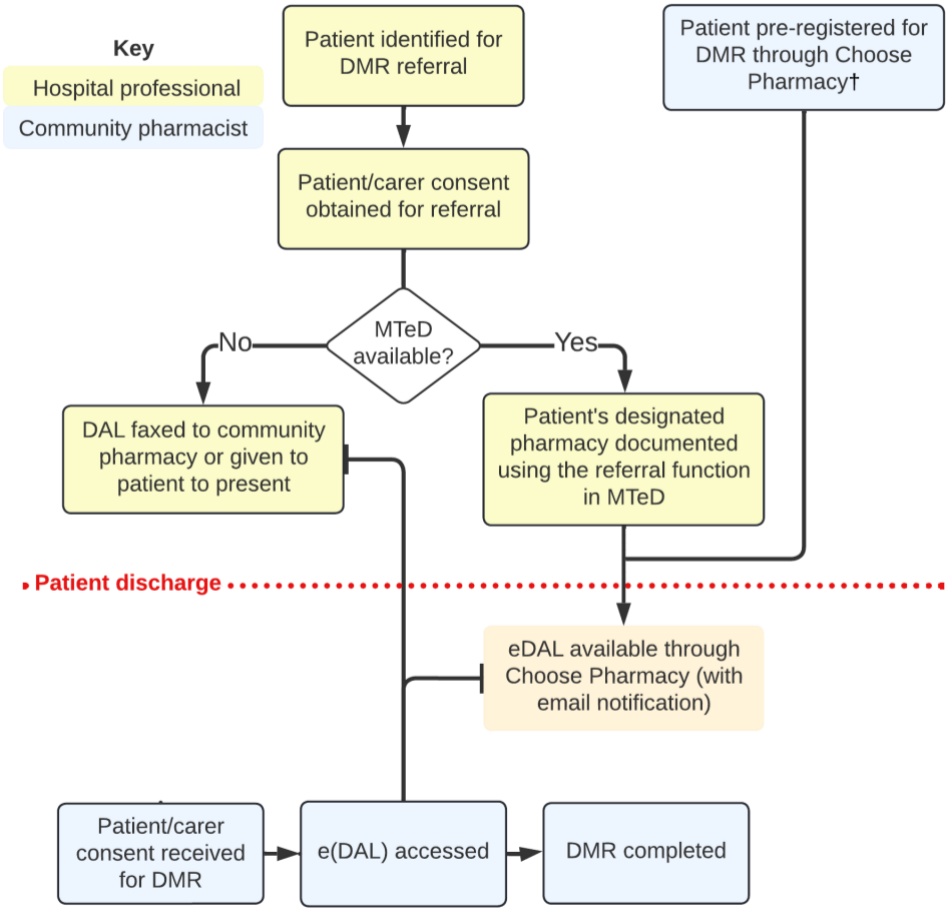


Figure 1.5: DMR Referral System Process

†Pre-registration precipitates a discharge notification and eDAL availability without a DMR referral.

1.5.4. Further DMR Evaluation and Thesis Aim

Mantzourani et al. (2017) interviewed community pharmacists for their views on the DMR ChP module. The pharmacists described a lessened paperwork burden and timelier identification of discharged patients when an eDAL was available. However, they suggested that they rarely received notification of patient discharges and perceived this was because the hospitals were not referring patients or did not have access to MTeD.

In a brief analysis of DMR provision, Hodson et al. (2018) found that the average number of identified discrepancies per service was 1.14, a slight decrease from the 1.3 described in the original evaluation (Hodson et al. 2014a). Although the authors found that the average number of monthly DMRs per pharmacy had increased slowly over time, there was still considerable inter-pharmacy variability, and only 0.7% of all commissioned DMRs (of the annual limit of 140 per pharmacy) were being undertaken. This suboptimal uptake is despite the system developments described above and the alignment of the DMR with the objectives of the national policy *A Healthier Wales* (Welsh Government 2018). Despite the evaluations outlined above, there are critical gaps in the contemporary knowledge of the DMR and its referrals. The following subsections highlight these knowledge gaps, culminating in the thesis objectives.

1.5.4.1. Description of Transfer of Care Systems

The DMR referral system facilitates community pharmacy access to an eDAL to complete a DMR. Despite NWIS's aims, the introduction of this system has not rectified the suboptimal DMR engagement. Section 1.4.4 outlined several similar systems used in localities in England: RTP, HFH, and PharmOutcomes. Understanding the implementation and attributes of these systems could highlight areas of good practice which could optimise DMR referral system use, hence DMR uptake.

1.5.4.2. Factors Affecting Stakeholder Engagement with DMRs

Stakeholder DMR engagement barriers and facilitators must be understood to optimise its uptake. A lack of engagement from community pharmacists or patients could explain the low DMR uptake. Alternatively, it could be explained by the lack of eDAL availability, precipitated by a lack of hospital HCP engagement with DMR referrals. Although it would be valuable to explore the views of all stakeholder groups, it was not possible in the thesis' time and resource constraints. Table 1.6 considers the necessity of exploring each stakeholder group's views.

Table 1.6: Considerations for Exploring DMR Stakeholders' Views

Stakeholder Group	Relevant DMR Changes Since the 2013 Evaluation	Considerations for Further Research
GPs	No changes to the DMR service or its referral process are likely to have influenced their engagement with the service.	It is unlikely that patient or GP DMR engagement barriers will have changed as much as other stakeholder groups.
Patients		
Community pharmacy	The introduction of ChP and the DMR referral system addressed community pharmacist barriers to service engagement.	Mantzourani et al. (2017) explored community pharmacy views of the DMR module in ChP. Therefore, these views are less likely to be outdated than the other groups.
Hospital pharmacy professionals	DMR referrals have significantly changed since the previous evaluation with the implementation of MTeD and the introduction of the DMR referral system.	The considerable DMR referral changes may have changed the factors affecting HPP engagement, justifying further exploration.

Furthermore, since the hospital can be considered the start of the DMR referral system, it was logical to focus on HPPs. Although any HCP could refer patients for a DMR, Section 1.2.2 outlined how HPPs usually manage medicines in hospitals. Therefore, the researcher focused on HPPs in this thesis to investigate DMR referrals. Since the original evaluation identified several barriers to DMR referrals (Hodson et al. 2014a), this work could also explore whether these have changed because of the introduction of the DMR referral system.

1.5.4.3. Recent Evaluation of DMR Provision

Since the 2013 DMR evaluation described service provision, there have been considerable changes to the DMR and its referrals. An up-to-date evaluation of DMR provision would develop a

contemporary understanding of its value and how and where it has been delivered, highlighting potential factors influencing stakeholder engagement. Additionally, one of the criticisms of the original DMR evaluation was the lack of explanation of the 'other' discrepancy type, DMR delivery method and the reason why DMR2 was not completed (Hodson et al. 2014a). Unlike NECAF, ChP collects these data (see Section 1.5.2) and an expanded range of medicines-related data. Therefore, the availability of ChP necessitates an up-to-date evaluation of the DMR to provide a more detailed description of its provision and outcomes.

Although there is literature describing factors affecting the uptake of some community pharmacy services, such as the MUR and NMS (Hann et al. 2017), literature is sparse for the DMR. Identifying such factors and how they have changed over time would provide evidence for community pharmacy barriers to DMR engagement. This evidence could support the targeting of support for DMR engagement to those pharmacies with characteristics associated with lower DMR delivery volume.

1.5.4.4. Factors Affecting DMR Outcomes

Hospital pharmacists described the lack of evidence-based criteria for DMR referrals as an engagement barrier in the original evaluation. Although considerable literature describes predictive factors for hospital readmissions to target post-discharge support, their utility has been highly variable (Zhou et al. 2016). Consequently, Nazar et al. (2019) completed a consensus study to determine appropriate referral criteria for hospital inpatients to be offered a post-discharge service. The authors concluded that further empirical research was needed to assess which patient characteristics convey better outcomes from post-discharge services. Therefore, evidence is required to describe the factors influencing the DMR's outcomes to develop prioritisation criteria. Not only could recommendations from these criteria improve DMR referral engagement but targeting the patients most likely to benefit could maximise the service's cost-effectiveness.

The researcher considered which DMR outcome would be the most appropriate to investigate, first considering the relationship between the DMR and hospital readmissions. However, Mantzourani et al. (2020) published such evidence during the development of the thesis methods. The authors found an association between receiving a DMR and a decreased rate of 40-day hospital readmissions. This study included factors affecting the association between the DMR and hospital readmission as secondary outcomes, concluding that 40 to 79-year-old patients had the greatest benefit from the DMR. However, further analyses were limited by the low frequency of hospital readmissions. Unlike readmissions, discrepancies are the primary outcome of the DMR; therefore, they are recorded for every service delivered. Despite not distinguishing between

intentional and unintentional discrepancies nor commenting on their clinical significance, the researcher chose discrepancies as a proxy for patient safety because their routine longitudinal collection from 2011 should provide sufficient data to describe factors influencing the outcomes of the DMR.

1.6. Thesis Objectives

As described above, this thesis aims to develop recommendations to optimise the DMR's use.

From the literature gaps identified above, the following objectives were developed:

1. Identify areas of good practice from similar UK transfer of care systems and their implementation to optimise DMR referral system use.
2. Explore hospital pharmacy professionals' engagement with DMR referrals.
3. Describe DMR provision from November 2011 to January 2021.[11]
4. Describe the pharmacy-related factors affecting DMR delivery volume over time.
5. Describe the factors affecting DMR discrepancy identification.
6. Synthesise findings to develop recommendations for optimising DMR provision.

1.7. Chapter Summary

This chapter summarised the international patient safety issues associated with care transitions and interventions developed to mitigate them, including the DMR service in Wales. The chapter concluded by describing the development of the DMR, its evaluation and the current gaps in knowledge that this thesis aims to address. Chapter 2 provides an overview of methodological considerations for this thesis and its employed approach.

[11]The dates span from the inception of the DMR to the date that the DMR data were accessed (see Section 5.2).

Chapter 2. Methodology

2.1. Chapter Introduction

Methodology broadly describes the study of research methods and the underpinning principles that influence them. Before outlining the methods chosen to address the thesis objectives, this chapter outlines their underpinning principles: the researcher's philosophical and personal beliefs, the influence of theory and stakeholders, and research governance considerations.

2.2. Research Philosophy and Reflexivity

Fundamentally, a thesis employs a specific methodology to create new knowledge. The choice of methodology is underpinned by the researcher's philosophical beliefs about what can be known (ontology) and what is worth knowing (epistemology) (Creswell and Creswell 2018). There are two main opposing ontologies: relativism and realism. Relativism suggests that reality is flexible and relative to the observer. However, the researcher aligns with realism, that reality is objective (Creswell and Creswell 2018). The two principal opposing epistemologies are positivism and constructionism. Positivists believe that reality can be measured objectively through the scientific method. In contrast, constructivists argue that knowledge is socially constructed. Pragmatism rejects this dichotomy, asserting that obtaining perfect knowledge is impossible. The researcher aligns with this view; therefore, they employ methods for their utility in addressing the thesis objectives rather than their philosophical underpinnings (Creswell and Creswell 2018).

There is considerable discussion in the literature regarding how a researcher's experiences and preconceptions may influence the research process, including method development, execution, and interpretation (Clark et al. 2021). Some may have personal or professional experience, which may infer a risk of bias or advantage due to their unique contextual understanding (Flick 2018). Therefore, researchers must be reflexive, a process involving reflections on how their personal experiences may influence the research (Tufford and Newman 2012). Some researchers state they acknowledge their preconceptions and put them to one side, conducting the research process free of their influence, known as bracketing (Tufford and Newman 2012). However, the researcher agrees with Laverty (2003), who suggested that removing the influence of one's preconceptions is impossible. Therefore, the researcher kept a reflexive diary (Appendix 2.1), a document containing reflections on how their background and experiences may have affected the research process (Tufford and Newman 2012). The reflexive entries for each empirical study (Appendices 2.1.1 to 2.1.3) will help the reader separate the researcher's personal views from the findings.

2.3. Theoretical Framework and Stakeholder-Informed Design and Dissemination

The Medical Research Council (MRC) suggest that the evaluation of complex interventions should expand beyond simple measures of effectiveness, describing their feasibility, implementation, and the factors or context affecting their delivery and outcomes (Moore et al. 2015). By making more holistic process evaluations, interventions may be optimised across various contexts. The MRC process evaluation framework suggests evaluating three concepts:

- Implementation: How and where was the intervention delivered? Was it delivered as intended? What adaptations have been made to the intervention?
- Mechanisms of impact: What was the intervention's effect, and what factors influenced it?
- Context: What external factors influenced its implementation or outcomes?

In line with optimising the DMR's use, the researcher framed the thesis objectives using this MRC process evaluation framework, as presented in Table 2.1.

Table 2.1: Medical Research Council (MRC) Complex Intervention Process Evaluation Concepts

Thesis Objective	**Applicable MRC Framework Concept**
1. Identify areas of good practice from similar UK transfer of care systems and their implementation to optimise DMR referral system use.	• Context
2. Explore hospital pharmacy professionals' (HPPs') engagement with DMR referrals.	• Implementation • Context
3. Describe DMR provision from November 2011 to January 2021.	• Implementation • Mechanisms of impact
4. Describe the pharmacy-related factors affecting DMR delivery volume over time.	• Implementation • Context
5. Describe the factors affecting DMR discrepancy identification.	• Mechanisms of impact • Context
6. Synthesise findings to develop recommendations for optimising DMR provision.	N/A

Since this thesis aimed to develop evidence-based recommendations to optimise DMR use, the researcher considered the role of stakeholders in the research design. In a recent iteration of the MRC framework, Skivington et al. (2021) described how stakeholder input to research design was essential for evaluating complex interventions. Stakeholder input during evaluation ensures the research findings are important to the research population, which could create actionable outcomes and overcome practical barriers to evaluation. Furthermore, Greenhalgh et al. (2016) suggested that the co-creation of research with stakeholders assists in implementing subsequent research findings into healthcare policy. Therefore, several stakeholders were involved in the research design, as described in Table 2.2. The researcher also disseminated research findings to these groups. The overall dissemination strategy, explained in full in Section 10.4, was extensive,

involving joining working groups and founding DMR special interest groups. A dissemination framework was considered but not employed. Although frameworks can increase the rigour of the dissemination process, they are primarily for research investigating methods of dissemination (Baumann et al. 2022). Therefore, the researcher used these frameworks as a guide but developed the dissemination strategy organically through the research process and through engagement with stakeholder groups.

Table 2.2: Stakeholder Groups Involved in the Thesis Design and/or Dissemination

Group Name	Group Description	Nature of Involvement
Research team	The core team that contributed to the research in this thesis: • the researcher, • KH and EM (thesis supervisors), • AE (Welsh Government, Chief Pharmaceutical Officer), • CW (NWIS).	NWIS partly funded the thesis after consulting AE (Welsh Government), who expressed interest in DMR service research. Therefore, the researcher discussed the overall thesis design with AE and CW, ensuring it would meet their goals. They suggested that describing factors affecting DMR outcomes was their priority, influencing the development of Thesis Objective 5.
All-Wales Chief Pharmacists' Quality and Patient Safety Group (AWQPSG)	A subgroup of Local Health Board (LHB) Chief Pharmacists who focus on hospital patient services and medication safety issues across Wales.	AWQPSG supported the method development to address Thesis Objective 2, detailed in Section 4.2.
NWIS Delivery Board	A working group focusing on IT delivery across NHS Wales, including ChP.	Dissemination only.
Choose Pharmacy (ChP) Clinical Reference Group	A working group that provides clinical oversight to ChP developments.	
Pharmacy: Delivering a Healthier Wales (P:DaHW) Delivery Board	A board that focuses on meeting the outcomes of the vision document on the future of the pharmacy profession in Wales, P:DaHW (Welsh Pharmaceutical Committee 2019).	
P:DaHW Digital Medicines Management subgroup	A subgroup of the P:DaHW Delivery Board that focuses on how digital systems can be used to meet the outcomes of P:DaHW.	
CVUHB Pharmacy Delivery Board	A working group to deliver the LHB's aims. They specifically asked the researcher to disseminate the thesis findings to them.	

Transdisciplinary research describes this iterative process of stakeholder-informed research design, reflection, and dissemination (Garton et al. 2022). Such approaches are novel for healthcare research but considered effective for constructing actionable findings for implementing or sustaining complex healthcare systems, such as the DMR and its referrals (Garton et al. 2022). Aligning with the researcher's pragmatic approach, it was important for the dissemination of research findings to be timely to optimise the use of the DMR, thus realising its benefits for

patients and the wider health economy. Rapid dissemination is underpinned by a rapid approach to the research, pragmatically balancing the utility of the findings with respect to their timeliness and robustness (Vindrola-Padros et al. 2021).

2.4. Research Governance

NICE defined research governance as *"the broad range of regulations, principles and standards of good practice that ensure high-quality research"* (Jonsson and Bouvy 2018, p3). Within research governance processes are considerations of research ethics and their associated study approvals. Researchers must consider the ethical implications of their research and abide by the requirements for informed consent and independent ethical review (Health Research Authority [HRA] 2021). Participant consent for research may involve patients or healthcare professionals (HCPs) if they are the intended research participants. To fulfil the criteria for informed consent, participants must read a participant information leaflet (PIL), a document outlining essential information about the study, and complete a consent form (Flick 2018). Where relevant throughout this thesis, the researcher used the HRA (2021) guidance to draft all PILs and consent forms.

All PILs developed for this thesis contained details of the study alongside specific information, such as how participants were selected to participate and why they were essential to achieving the study's aims (HRA 2021). The PILs also contained standardised statements to encompass how participant data were protected (Cardiff University 2019). Researchers have an ethical obligation to protect the data of study participants to prevent untoward harm, which is enshrined in legislation in The Data Protection Act and General Data Protection Regulation (Rumbold and Pierscionek 2017). Table 2.3 describes how the researcher protected data using the Cardiff University (2019) data protection guidelines.

Table 2.3: Data Protection Considerations

Data Protection Consideration	Researcher's Actions to Protect Data
Management of identifiable data	All identifiable data was anonymised as soon as practicable.
Data retention	The researcher deleted data and consent forms two years after collection.
Data security	The researcher kept digital data on their password-protected laptop and an encrypted external hard drive. They kept consent forms in a locked cabinet.
Data access	Only the researcher and their supervisors had data access.

After reading the PIL, if the invitee decides to participate in the study, they must complete a consent form. For this thesis, the consent forms contained several mandatory statements, e.g., that they had read the PIL and acknowledged the study's expected anonymity (HRA 2021).

Additionally, several non-compulsory statements were included, such as consenting for audio recording and the use of anonymised quotations for this thesis and academic publications.

The NHS stipulates that all research projects involving patients or staff require NHS ethical approval. These requirements only apply to research projects, not service evaluations. The HRA (2020) considers a study as 'research' if it deviates from usual care and uses strict procedures such as randomisation. In contrast, a service evaluation does not alter standard care but describes or explores current provision. The researcher considered whether each study in this thesis was research or a service evaluation using the above criteria and the HRA (2020) decision support tool. All LHBs and NHS Trusts in Wales require researchers to register service evaluations with their respective Research and Development departments, provided they agree with its classification. With these considerations in mind, Figure 2.1 summarises the researcher's approval considerations for studies involving NHS employees.

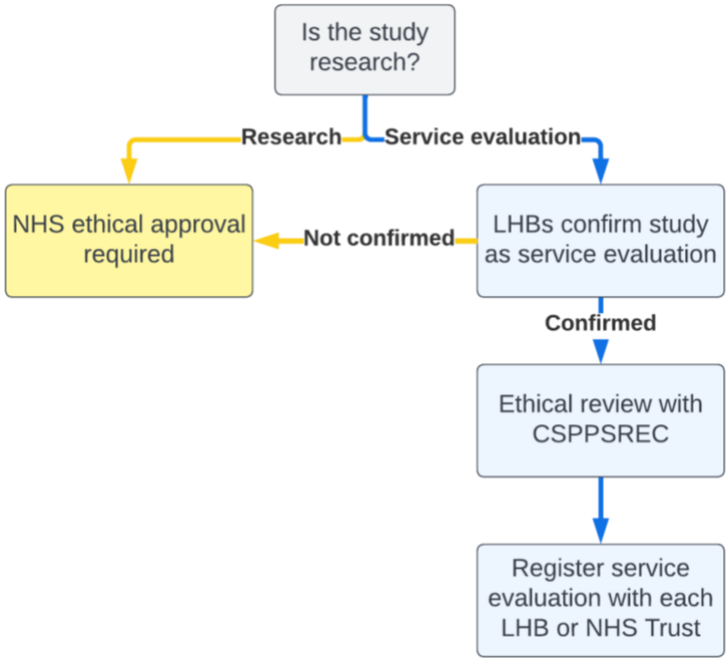


Figure 2.1: Summary of Approval Process for Studies Involving NHS Wales Employees
CSPPSREC = Cardiff School of Pharmacy and Pharmaceutical Sciences Research Ethics Committee

Independent ethical oversight is good practice for all studies involving human participants, even service evaluations that do not require NHS ethical approval. Therefore, the researcher sought approval from CSPPSREC for all empirical studies in this thesis. Each relevant chapter will present specific information on ethical considerations and study approvals.

2.5. Overview of Methodologies

There are three principal research methodologies: quantitative, qualitative, and mixed methods. Qualitative and quantitative research have long divided academic discourse, which could be

explained by the fundamental differences in their aims (Creswell and Creswell 2018). Quantitative research typically collects numerical data to describe a phenomenon and generalise the results to the entire population. The explanatory nature of quantitative research lends itself to descriptive objectives, like Thesis Objectives 3-5, describing DMR provision over time and factors influencing DMR volume and discrepancies. Qualitative research typically collects data as words rather than numbers, aiming to develop a rich understanding of the phenomenon (Creswell and Creswell 2018). Instead of generalisability, qualitative researchers refer to transferability, a concept describing the extent to which the results can be transferred outside of the study participants (Flick 2018). The exploratory nature of qualitative research lent itself to addressing Thesis Objective 2: explore HPPs' engagement with DMR referrals.

Mixed methods research rejects the divide between qualitative and quantitative, integrating both approaches to best address the research aims (Creswell and Creswell 2018). In contrast, multimethod research uses multiple methods to supplement each other but does not integrate their findings (Anguera et al. 2018). As there is justification for using qualitative and quantitative research in this thesis, the researcher considered mixed methods and multimethod approaches. The researcher chose mixed methods for the thesis design because there is justification for integrating qualitative and quantitative research, as presented in Table 2.4 (Rao and Shiyanbola 2022).

Table 2.4: Legitimations for Mixed Methods Use

Legitimation Type	Description	Relevance to Thesis
Weakness minimisation	The strength of one method compensates for the weakness of another.	The overlap between methodologies may improve the credibility of the qualitative results and provide context to the quantitative results.
Paradigmatic mixing	The ontological or epistemological beliefs that methodologies can be mixed.	As described in Section 2.2, the researcher is a pragmatist, which lends to methodological mixing.
Commensurability	Meta-inferences reflect a mixed worldview.	The DMR and its referrals are complex interventions spanning multiple care settings. Noyes et al. (2019) suggested that synthesising qualitative and quantitative evidence is a powerful method for informing guidance on complex interventions.
Multiple stakeholders	Addressing all stakeholder interests.	Since the DMR and its referrals involve multiple stakeholders, the research must be able to address multiple perspectives.
Pragmatic	The research aims to produce actionable results.	The thesis is conducted through a pragmatic paradigm, aiming to produce actionable recommendations for DMR use.

Although the researcher chose mixed methods for the overall thesis design, they used multimethods for chapters (see Table 2.11) with a rationale to combine qualitative and quantitative research but not to integrate their findings.

2.6. Research Designs

All methodologies have associated research designs denoting the overall approach and the lens through which the data are interpreted (Creswell and Creswell 2018). This section critically compares qualitative, quantitative, and mixed methods research designs, justifying the most appropriate to address the thesis objectives.

2.6.1. Quantitative Research Designs

There are two main designs of quantitative research: experimental and non-experimental, the use of which had to be appropriate and practical to address the descriptive research objectives. Experimental designs aim to describe the effect of an intervention on an outcome, using randomisation and control groups to make causal statements of an intervention's effect (Creswell and Creswell 2018). Experimental research requires prospective data collection, and its strict procedures are associated with considerable time and resource commitments (Creswell and Creswell 2018). Since the researcher balanced the value of each method with its ability to rapidly generate knowledge for dissemination, they excluded prospective research since establishing causation was not required for the thesis' objectives, especially not when balanced against its considerable time and resource commitments.

Non-experimental designs do not involve a prospective intervention and instead describe the phenomenon (descriptive design) or the relationships between variables (correlational design) (Creswell and Creswell 2018). As the quantitative objectives for this thesis were to describe DMR provision and factors affecting both service outcomes and uptake, non-experimental designs were considered appropriate.

2.6.2. Qualitative Research Designs

Qualitative research designs describe the lens through which a researcher views and conducts the study and include Grounded Theory, Ethnography, Narrative Research, Phenomenology, and Generic Qualitative Approaches (Flick 2018). Since Thesis Objective 2 centres on HPPs' perceptions of DMR referrals, the researcher chose a design reflecting this focus. As narrative research focuses on stories told by participants rather than their perceptions, other designs were considered more appropriate (Creswell and Creswell 2018). Grounded Theory can construct a rich understanding of participant perceptions and feelings, but data must be collected and analysed free from preconceptions (Flick 2018). Therefore, the researcher excluded Grounded Theory because their professional experience (see Appendix 2.1) precluded preconception-free research. Ethnography involves observing or interacting with participants within their natural environment, generating

rich and context-specific data (Flick 2018). However, it was not feasible in the context of a mixed methods PhD thesis because of its considerable time and resource burdens.

Generic qualitative approaches do not claim allegiance to a single design but often contain hues of different designs (Sandelowski 2000; Kahlke 2014). Although this flexibility is a strength of generic qualitative designs, it attracts criticism from methodological purists, stating a lack of robust theoretical foundations (Kahlke 2014). Two subtypes of generic qualitative designs are qualitative description and interpretation. These overlapping approaches to generic qualitative research are suitable where the research aims to provide a vivid description of a phenomenon, with or without interpretation (Kahlke 2014). Researchers use generic qualitative approaches for studies that aim to describe, understand, or interpret a phenomenon, especially where other approaches are unsuitable (Kahlke 2014).

Since phenomenology is concerned with studying a phenomenon through the lens of participants with relevant lived experiences, the researcher considered it suitable to address Thesis Objective 2 (Creswell and Creswell 2018). Interpretivist research, including phenomenological designs, has been used to disseminate barriers and facilitators from the participants' perspective to policymakers (Greenhalgh et al. 2016). Specifically, the researcher chose hermeneutic phenomenology because it aligns with their view that no research is interpretation-free.

2.6.3. Mixed Methods Research Designs

Mixed methods research has one of four designs: exploratory, explanatory, embedded and convergent (Creswell and Creswell 2018). Exploratory and explanatory are sequential, with two distinct phases containing qualitative or quantitative research. Exploratory designs begin with a qualitative arm, confirming and generalising findings with a quantitative arm (Creswell and Creswell 2018). In contrast, explanatory designs begin with a quantitative arm to describe or explain the phenomenon. Areas of interest are then explored further with a qualitative arm. Embedded designs are where researchers use qualitative and quantitative methods in the same study but prioritise the importance of one type of data (Creswell and Creswell 2018). A commonality with these designs is that qualitative and quantitative methods supplement each other to achieve a common objective. The researcher considered these approaches unsuitable considering the overall thesis design, with each objective lending itself to a qualitative or quantitative approach. Therefore, a convergent design was chosen, where quantitative and qualitative data are collected separately but analysed or interpreted together (Creswell and Creswell 2018). This design allowed the researcher to use the most appropriate method to address each objective but integrate and interpret their results together in the final thesis chapter.

2.7. Overview of Research Methods

A research method, e.g., interviews and surveys, refers to how the researcher collected the data required for the study. Qualitative and quantitative methods vary because of their differing aims and concepts of quality. Quantitative researchers consider that for their results to reflect the truth, they must have internal validity, meaning they have eliminated alternative explanations for their findings (Creswell and Creswell 2018). Therefore, quantitative researchers view bias as unacceptable and try to observe the data free of interpretation, allowing them to generalise their findings. In contrast, qualitative researchers are more intertwined with data collection in typical methods like interviews and focus groups (Flick 2018). Although qualitative researchers may try to minimise bias, they typically accept that data collection and interpretation are inherently biased and limit their findings' generalisability (Creswell and Creswell 2018). Therefore, quality in qualitative research typically refers to trustworthiness or credibility. There are several methods to convey credibility, including combining multiple data sources (triangulation) and independent data analysis by multiple researchers (member-checking) (Flick 2018). The researcher used indicative quotations to support this thesis' results since they increase the credibility of qualitative research (Flick 2018). Additionally, they used the Standards for Reporting Qualitative Research as a guide for reporting all qualitative methods to promote rigour and transparency (O'Brien et al. 2014).

This section considers primary and secondary data, population and sampling, and participant recruitment, followed by a critical comparison of qualitative and quantitative methods and literature reviews, considering their suitability for this thesis.

2.7.1. Considerations for Using Primary and Secondary Data

Primary data are collected explicitly to address the research aims and objectives; therefore, the researcher controls the data they collect and its quality (Hox and Boeije 2005). In contrast, secondary data have already been collected for alternative purposes like other research or routine data collection. Since the researcher has no control over the contents or quality of secondary data, it often requires significant cleansing and transformation (Hox and Boeije 2005). Despite these challenges, secondary data have several advantages: increased timeliness, reduced participant and researcher burden and lower associated research costs (Thomas 2020).

Although secondary data do not require data collection, the researcher must define a research population, identify an appropriate dataset to address the research aims, and access it (Thomas 2020). Similarly, researchers must define a research population when they consider collecting primary data. However, they must also consider how they intend to recruit participants. The following subsections describe population and sampling, then recruitment considerations.

2.7.1.1. Population and Sampling

Before comparing qualitative and quantitative sampling, this section describes the concepts of populations and sampling for context. A population is a set of objects with similar characteristics, usually referring to humans in healthcare research (Creswell and Creswell 2018). Recruiting all population members to participate (i.e. a census) is uncommon due to the cost and time burden (Field 2018). Sampling is where the researcher only identifies some population members to participate, which can introduce bias if the sample is not representative of the population (Flick 2018). A sampling frame is a source from which a potential sample can be drawn, such as using the electoral roll to access participants in the general population (Flick 2018). When the study population does not have a suitable sampling frame, researchers may consider gatekeepers to help identify and recruit suitable participants (McFadyen and Rankin 2016).

Table 2.5 compares quantitative and qualitative sampling approaches, whilst specific methods employed in this thesis are described in the relevant chapters.

2.7.1.2. Participant Recruitment

Participant recruitment is a recognised challenge for HCPs such as pharmacists, who often suggest that a lack of time is a significant barrier to research engagement (Awaisu and Alsalimy 2015). Two common methods for study recruitment are by letter or email (Clark et al. 2021). Some studies suggest that the former has better response rates, whilst the latter is more time and cost-efficient. However, both methods rely on researchers having up-to-date contact information for their participants. Gatekeepers may enable population access when this information is unavailable (McFadyen and Rankin 2016). Researchers must carefully design recruitment materials to optimise participant recruitment. They may include evidence-based design principles such as explaining the study's importance and why the participants are essential to its outcomes (Clark et al. 2021). Limiting the length of study documentation may also help recruitment, alongside sending reminder letters or emails if participants have not responded (Flick 2018).

Table 2.5: Sampling Considerations for Quantitative and Qualitative Research

Sampling Consideration	Quantitative Research	Qualitative Research
Sampling approach (Green and Norris 2015; Flick 2018)	Probability sampling methods aim to minimise bias, ensuring findings are generalisable. A key tenet of probability sampling is that participants are randomly selected from a pre-determined list (see below).	Non-probability sampling methods are commonly used to ensure participants have sufficient experience to facilitate rich data collection regarding the study topic. In non-probability sampling, population members are not randomly selected.
Examples of sampling types (Green and Norris 2015; Flick 2018)	Simple random sampling is where the sampling frame is randomised, and participants are sampled from this list. This method is time and resource-intensive but minimises the risk of sampling bias.	Purposive sampling is where researchers recruit population members based on their characteristics, such as job role, gender, or age.
		Convenience sampling selects participants who are easy to contact. Although this method is simple to employ, it is balanced against a considerable risk of sampling bias.
	Stratified sampling splits the sampling frame into several strata, each containing participants with specific characteristics of interest. A set quota of participants is sampled from each stratum.	Quota sampling involves recruiting a pre-specified number of participant subgroups based on their characteristics, e.g., two men and two women. Researchers may use quota sampling if different participant groups have alternative perspectives of the study phenomenon.
Sample size (Creswell and Creswell 2018).	Relatively large to ensure the sample is representative so that the findings are generalisable.	Relatively small because qualitative research does not aim to be generalisable, and data collection and analysis are time and resource intensive.
Sample size pre-determination	Sample sizes are typically pre-determined to ensure it is adequate to achieve the study's aims (Green and Norris 2015).†	Some qualitative researchers pre-determine sample size by considering *information power*, a concept that selects an appropriate sample size based on the study objectives (Malterud et al. 2016): • Small samples may be appropriate if participants have rich experiences relevant to the study aims. • Larger samples may be appropriate for broad aims and participants with diffuse experience. Some researchers do not pre-determine sample size, collecting data until no new information is generated, a theoretical point named data saturation (Malterud et al. 2016).

†Sample sizes are rarely pre-determined when using secondary data because the quantity of data is pre-determined.

2.7.2. Quantitative Methods

Section 2.5 justified using quantitative research to address Thesis Objectives:

3. Describe DMR provision from November 2011 to January 2021.
4. Describe the pharmacy-related factors affecting DMR delivery volume over time.
5. Describe the factors affecting DMR discrepancy identification.

To describe DMR provision, the researcher considered using surveys and quantitative observation to collect data for all community pharmacies in Wales. Surveys are a relatively timely method of collecting large quantities of data to describe a phenomenon across a population (Creswell and Creswell 2018). However, Green and Norris (2015) highlighted that non-response is a threat to the

quality of pharmacy practice survey research, leading to non-response bias, i.e., responders would likely be more interested in the DMR than non-responders. Therefore, surveys were excluded for these objectives since they could lead to a small and unrepresentative sample, unsuitable for a broad description of DMR provision. Quantitative observation involves observing the phenomenon of interest and quantifying related activities (Creswell and Creswell 2018). For example, the provision of the DMR could be described by observing a community pharmacy and counting the number of DMRs, noting when discrepancies were identified. The researcher excluded this method since it would require years of data collection across all pharmacies in Wales, which was not feasible.

Secondary data analysis was considered for the thesis' descriptive objectives because the ChP and National Electronic Claims and Audit Forms (NECAF) systems routinely collect DMR data, which could be made available for analysis. The researcher consulted with NWIS and NWSSP, the data processors for ChP and NECAF, to better understand the data contents (see Section 5.2 for comprehensive details). On review, the researcher considered these data suitable to address Thesis Objectives 3-5. One advantage of using healthcare service datasets is that they typically provide whole-of-population coverage, thus avoiding the non-response bias associated with primary data sources (Thomas 2020). However, since routine data collection is designed to optimise workflow rather than analysis, it may not contain all variables of interest and does not contain any information about the outcomes of patients who did not receive the service. Therefore, data linkage is often required to facilitate comparisons with patients who did not receive the service (Thomas 2020). Despite these limitations, the researcher decided that secondary data analysis was the most appropriate approach for the quantitative thesis objectives, as summarised in Table 2.6.

Table 2.6: Justification for Using Secondary Data Analysis

Thesis Objective	**Justification for Using Secondary Data Analysis**
3. Describe DMR provision from November 2011 to January 2021.	Addressing this objective required significant longitudinal data to describe DMR provision over time, which NECAF has collected since 2011. Considerable time would be needed to collect similar quantities of primary data, which would have been infeasible given the time constraints of a PhD thesis.
4. Describe the pharmacy-related factors affecting DMR delivery volume over time.	These objectives are concerned with describing relationships between variables, but establishing causation is unwarranted since they are descriptive objectives (Curtis et al. 2016). Therefore, the advantage of primary data analysis, which can establish causal relationships, was irrelevant (Hox and Boeije 2005).
5. Describe the factors affecting DMR discrepancy identification.	

Evaluating complex interventions involves providing a detailed description of how the intervention was implemented and its outcomes. ChP routinely logs free-text data regarding 'other'

discrepancies and delivery methods (see Section 1.5.2). Analysis of these data could provide a better understanding of DMR provision and its outcomes than secondary data analysis alone. Therefore, the researcher employed a multimethod approach for Thesis Objective 3, including secondary data analysis and a supplemental qualitative method. A qualitative description design was the most appropriate since its strengths aligned with generating a rich description of DMR provision (Kahlke 2014).

2.7.3. Qualitative Methods

The researcher considered the most appropriate qualitative method to facilitate the analysis of the free-text DMR data. Content analysis (research method) uses secondary qualitative data, such as videos, text documents and routinely collected unstructured data to address the research aims and objectives (Hsieh and Shannon 2005). Depending on its implementation, content analysis can be considered quantitative, relying on quantifying phrases or themes, or qualitative, reducing text to categories with a shared meaning (Elo and Kyngås 2008). The researcher used content analysis for the supplemental qualitative method due to its strength in extracting meaning from secondary datasets, enabling a detailed description of DMR provision (Hsieh and Shannon 2005).

Section 2.5 presented the justification for using qualitative methods to address Thesis Objective 2: explore HPPs' engagement with DMR referrals. The researcher considered several methods to achieve this objective: participant observation, interviews, and focus groups.

2.7.3.1. Participant Observation

Participant observation involves immersion in the phenomenon of interest and collecting data using field notes and audio recordings (Flick 2018). This method could collect rich data regarding HPPs' DMR referral processes. However, the researcher considered that the alternative qualitative methods described below could generate data with similar utility in achieving the thesis objectives with a lessened time and resource burden, facilitating rapid dissemination of the findings to stakeholders (Flick 2018).

2.7.3.2. Interviews and Focus Groups

Interviewing has a long history in qualitative research, involving a one-to-one discussion with a participant with expertise in the phenomenon of interest (Flick 2018). Qualitative researchers are highly involved in interviewing, using an interview schedule to question and prompt the participant. These schedules can be unstructured or semi-structured, with the former involving one or two prompts and an open-ended discursive style. Semi-structured interviews include more focused questioning but still the opportunity to elaborate and prompt (Flick 2018). In contrast, structured interviews are typically considered a quantitative method where the researcher collects

answers to specific, rigid questions. Interviews are especially suitable where the participant's perception of the phenomenon is a focal point of the research (Clark et al. 2021). Group interviews are a convenient method of quickly collecting large amounts of qualitative data by interviewing multiple participants simultaneously.

Focus groups are a type of group interview where discussion between participants is encouraged (Clark et al. 2021). The researcher takes less of a focal point in focus groups than in interviews, using the focus group schedule as a series of prompts, allowing participants to discuss the phenomenon among themselves (Clark et al. 2021). Focusing exercises are common in focus groups where participants perform activities such as sorting cards, drawing pictures, or making lists (Flick 2018). These exercises can help prompt discussion and provide data in their own right. Researchers can complete interviews and focus groups face-to-face, by telephone or video call. Telephone interviews are more time and cost-effective than face-to-face. However, the researcher cannot observe participants' body language, leading some researchers to describe them as impersonal and rigid. Additionally, some consider their findings less rich than face-to-face or video interviews (Clark et al. 2021).

The choice between focus groups and interviews can be challenging. However, interviews are more suitable when individual experiences are the focal point of the research or where the phenomenon may be too sensitive to discuss in a group setting. Qualitative researchers often use focus groups where the interaction between participants adds value to the data, such as organisational research (Flick 2018). Recruitment can be more challenging for focus groups than interviews since multiple participants must agree on a shared time and location (Clark et al. 2021).

Focus groups and interviews are suitable for exploring participant perceptions; therefore, both were appropriate for this thesis. The researcher first considered semi-structured interviews to address Thesis Objective 2 (HPPs), following the methods used by Hodson et al. (2014a) to explore hospital pharmacist engagement with DMR referrals. However, the researcher considered the benefits of focus group interactions since Hann et al. (2017) and Jacobs et al. (2018) describe how organisational characteristics affect technology and pharmacy service adoption. Additionally, the original DMR evaluation suggested that hospital pharmacists were unaware of the DMR (Hodson et al. 2014a). To the best of the researcher's knowledge, there was no subsequent campaign to increase awareness amongst hospital staff. In a focus group, participant discussions could contextualise DMR referrals with daily working practices, which would not be possible in one-to-one interviews. Webb and Kevern (2001, p. 800) proposed that focus groups are incompatible with phenomenology since participants cannot contribute in an *"uncontaminated way".* However,

hermeneutic phenomenology rejects this idealism and does not aim to describe uncontaminated phenomena, reflexively interpreting them instead. Therefore, researchers have applied hermeneutic phenomenology to focus groups, suggesting that individual experiences can be maintained or expanded (Laverty 2003; Bradbury-Jones et al. 2009). Despite the mixed views of perceived incompatibility, the researcher chose focus groups over interviews to facilitate sharing of knowledge and context between participants and explore organisational characteristics affecting DMR referrals.

2.7.4. Literature Reviews

Literature reviews identify, combine, and synthesise literature to evaluate or generate theory. Although literature reviews are common for developing theory before primary research, structured approaches are recognised as independent research methods due to their systematic approach (Tricco et al. 2017). A complete understanding of each system, similar to the DMR referral system, was essential to appraise their attributes critically to fulfil Thesis Objective 1. The researcher chose a literature review to achieve this since they are an efficient method for synthesising and interpreting information (Tricco et al. 2017).

Structured literature reviews include realist, systematic, and rapid reviews. Realist reviews focus on the authentic reality of complex interventions, using a purposive search strategy, stopping when the research team perceives that they have achieved information saturation (Tricco et al. 2017). However, the researcher identified a paucity of systems literature through scoping searches; therefore, they excluded realist reviews because their purposive sampling strategy may limit the identification of sufficient literature. Table 2.7 compares the characteristics of systematic and rapid reviews (Tricco et al. 2017; Waffenschmidt et al. 2019).

Table 2.7: Comparison of Systematic and Rapid Review Characteristics

Literature Review Characteristic	Systematic Review	Rapid Review
Timeframe	Six months to two years.	Less than six months.
Sources	The researcher uses a wide range of sources.	The range of sources is often narrower.
Grey literature[†]	Usually included.	Only included if there is an explicit purpose in line with the aims of the search.
Search strategy	Explicitly defined strategy.	Explicitly defined strategy.
Literature screening	The title and full text are screened for the full inclusion criteria.	Usually, only the titles and abstracts are screened for the full inclusion criteria.
Appraisal of literature	A rigorous critical appraisal of the literature using standardised tools.	Critical appraisal is sometimes absent.
Number of reviewers	More than one.	One or more.
Inferences	Robust evidence-base.	Cautious interpretation of findings.

[†]Grey literature is any literature source not published by a commercial academic publisher, such as videos or government white papers (Benzies et al. 2006).

Although a systematic review would have been the most comprehensive method, healthcare policy researchers often use rapid reviews because they produce similar outcomes with a lessened time burden, allowing rapid knowledge dissemination and integration into policy (Tricco et al. 2017). Chapter 3 presents the employed rapid review method, including details of the synthesis of the literature retrieved.

2.8. Overview of Data Analysis Methods

Data analysis is a systematic process of converting data into units useful for interpretation (Creswell and Creswell 2018). Analysis techniques are broadly inductive, deductive, or a combination of both. Quantitative researchers typically use deductive data analyses, which address a priori hypotheses using the data. In contrast, qualitative researchers typically use inductive analyses, which construct meaning and hypotheses from the data (Creswell and Creswell 2018). This section provides an overview of data analysis approaches and justifies their use to address each of the thesis objectives.

2.8.1. Quantitative Data Analysis

Table 2.8 describes several concepts of quantitative data preparation, which are often required before analysis (Taleb et al. 2015). Primary data typically requires less cleansing and transformation than secondary data because the researcher has control of the data collection (Thomas 2020). However, data preparation requirements will depend on the individual data and study aims. Since this thesis employed secondary analysis of DMR data, extensive preparation was required (see Chapter 5).

Table 2.8: Overview of Quantitative Data Preparation

Data Processing Concept	Description	Rationale	Example
Data linkage	Combination of multiple datasets before analysis.	Linking multiple datasets may provide additional benefits for addressing the research question.	The linkage of DMR data and hospital readmission data facilitated the calculation of the association between DMR1 on hospital readmissions (Mantzourani et al. 2020).
Data cleansing	Correcting errors in data entry or transcription	Removing or correcting erroneous entries improves the reliability of the data.	Changing a data entry for an impossible patient age value. For example, 999 years.
Data transformation	Changing the format or structure of data.	Transforming data may improve the interpretability of the results.	Grouping age into categories. For example, 0-20 years and 21-40 years.
Data reduction	Combining data entries that represent the same entity but differ due to colloquialisms, phrasing, or typographical errors.	There is little merit in analysing the same entity differently based on typos or colloquialisms.	Combining entries for *"paracetamol 500mg tablets"* and *"paracetamol 500mg tabs"*.

Quantitative data analysis often involves statistical analyses. This section provides an overview of these approaches, which were employed to address Thesis Objectives 3-5, including inferential, exploratory, and descriptive analyses (Field 2018).

2.8.1.1. Inferential Statistical Analysis

Inferential analyses describe statistical differences and relationships between variables, allowing the researcher to generalise results from a sample to a broader population (Field 2018). Although the DMR data may constitute a population (all DMRs), this thesis aimed to develop recommendations for service optimisation. Therefore, the results must be inferred to a wider population (future patients or healthcare professionals) to which the recommendations apply (Thomas 2020). Therefore, the researcher considered inferential statistical analysis appropriate.

Since these methods make assumptions about a population, there is uncertainty about the results, which can be minimised by using a large and representative sample (Field 2018). However, researchers must make statements regarding their confidence in the results. *Statistical significance* encompasses this, providing the level of certainty that the test reflects the actual result (Field 2018). Probability values (p-values) are a standard measure of certainty, representing the probability that the result is due to chance alone (type 1 error). A common threshold set to show statistical significance (alpha value) is <0.05 (Field 2018). Some researchers have described p-values as uninformative and instead recommend confidence intervals, which are maximum and minimum values within which the actual value lies, defined by a given alpha value (Field 2018). A result is statistically significant if the confidence interval does not cross the value associated with

no effect (null hypothesis).

Univariate tests, such as t-tests and ANOVA, describe the relationship between one predictor and the outcome variable, e.g., pharmacy type and the number of discrepancies per DMR (Field 2018). Multivariate tests, such as regression analysis, describe the relationship between multiple predictors and the outcome variable. Since Thesis Objectives 4 and 5 describe factors affecting DMR volume and discrepancy identification, the researcher considered all relevant routinely collected data variables as predictors, providing the rationale for using regression analyses. Chapter 7 presents the specific regression methods employed in this thesis. Since regression methods are contingent on understanding the data, it was essential first to present the DMR data and its preparation (Chapter 5).

2.8.1.2. Exploratory Data Analysis (EDA)

EDA involves systematically summarising data to generate hypotheses regarding relationships and trends. EDA is not a single method but an approach to discovering data insights, usually relying on data visualisation techniques like frequency distributions, scatter graphs, and dot plots (Komorowski et al. 2016). The procedures are similar to descriptive analyses but focus on identifying and managing outliers[12] and describing potential relationships between variables. There must be compelling reasons to alter the values for outliers in a dataset since they often represent valid data values. For example, it may be appropriate to delete outliers caused by data entry errors (determined using subject knowledge) (Field 2018).

EDA is frequently used to prepare for inferential data analysis, particularly for large datasets and where there is little published literature (Komorowski et al. 2016). The researcher used EDA to support the inferential data analysis in achieving Thesis Objectives 4 and 5 since the DMR data were large and such analyses were novel to the DMR literature. Chapter 7 discusses this rationale in more detail.

2.8.1.3. Descriptive Statistical Analysis

Descriptive analyses involve a basic quantification and description of the data, with no inferences about a wider population or relationships between variables (Field 2018). Time series analysis is a specific example of descriptive analysis, focusing on how frequencies or proportions of a given variable have changed over time. Table 2.9 summarises approaches to descriptive statistical analysis by variable type (Field 2018).

[12]An outlier is a data point distant from the other data, often defined as any data point more than 3.29 standard deviations from the mean (z-score>3.29) (Field 2018).

Table 2.9: Summary of Descriptive Statistical Analysis Methods

Concept	Variable Type	
	Numerical	**Categorical**
Definition	A variable consisting of a measurable number, e.g., the number of DMRs.	A variable consisting of a limited number of discrete values, e.g., gender. A dichotomous variable is a categorical variable which may only represent one of two values, e.g., yes or no.
Descriptive analysis	Summary statistics to describe the central tendency† (mean, mode, and median), variance (range, interquartile range, and standard deviation), and shape (skewness) of the data.	Frequency and proportion.
Variable visualisation	Frequency distribution.	Bar charts and pie charts.
Time-series visualisation	Line graph of mean values over time.	Line graph of proportions over time.

†The median is often used instead of the mean for skewed data or small sample sizes since it is more robust to extreme values (Field 2018).

Since Thesis Objective 3 was to describe DMR provision over time and all DMR data were available (i.e., a census), inferences were not needed. Therefore, the researcher chose descriptive statistical analysis as the most appropriate quantitative analytical approach to fulfil this objective.

2.8.2. Qualitative Data Analysis

Qualitative data are usually spoken word or textual. Spoken word data are collected by audio or video recording of interviews and focus groups (Field 2018). These recordings are sometimes accompanied by supplemental notes, which may be unstructured or involve a pre-determined structure to increase consistency (Field 2018). Textual data may include field notes from observational methods or free text data from clinical patient healthcare records (Lindsey and Pattison Rathbone 2022).

Recorded data must be prepared for analysis by transcription, an action of converting spoken words into a written account (Flick 2018). Transcribing can be performed ad verbatim, although due to its associated time burden, some researchers may choose to transcribe the crucial sections of data (Flick 2018). Professional transcription services can mitigate this time burden, although some qualitative researchers suggest transcription is integral to the analysis process (Flick 2018). Transcriptions can be supplemented with additional detail to add depth, including word emphasis and laughter and non-verbal communication like pauses and gesturing. Since the choice of transcription method partly depends on the study's aims, the researcher's approach is explained in each relevant chapter.

A common feature of qualitative analysis methods is assigning a description of the meaning behind data sections, known as coding (Flick 2018). Depending on the research aims, coding can

be completed line-by-line or paragraph-by-paragraph with a trade-off between depth of analysis and time burden (Flick 2018). The researcher used NVivo® (v11) qualitative analysis software to assist in coding for qualitative analyses in this thesis. Qualitative data analysis methods include grounded theory, narrative, thematic, content, interpretative phenomenological (IPA), and framework analyses (Flick 2018). The researcher did not consider Grounded Theory Analysis or narrative analysis since they support Grounded Theory and narrative designs, excluded in Section 2.6.2. The other analysis methods are considered further in this section.

2.8.2.1. Framework Analysis

Framework analysis is a highly structured approach to qualitative data analysis, indexing data into a framework (Gale et al. 2013). These frameworks may apply relevant background theory or can be developed by coding a data sample. Once the researcher has decided on an appropriate framework, they chart all data into it. This method is beneficial for analysing large quantities of qualitative data or ensuring that the analysis is theoretically driven (Gale et al. 2013; Flick 2018). However, choosing an appropriate framework can be challenging for novel research areas. The researcher considered applying an implementation science framework, such as the normalisation process theory (Ferguson et al. 2018), to focus on DMR referral implementation for Thesis Objective 2. However, they excluded framework analyses since they may be too restrictive, excluding non-implementation factors such as behavioural change.

2.8.2.2. Interpretative Phenomenological Analysis (IPA)

IPA is an inductive technique that focuses on the perception and experiences of participants. Exploratory notes are used to code the data, describing shared meaning and perspectives, known as emergent themes, that are reviewed and abstracted where appropriate (Flick 2018). IPA provides rich results regarding participant perspectives but is time-consuming and thus difficult to apply to larger sample sizes (Flick 2018). Since the researcher used a phenomenological approach for Thesis Objective 2 (HPPs' engagement with DMR referrals), they considered using IPA. However, previously identified hospital pharmacist barriers to referrals merited deductive investigation (Hodson et al. 2014a), contradicting IPA's inductive approach.

2.8.2.3. Thematic and Content Analyses

Thematic and content analyses are similar, outlining procedures for constructing themes or categories by grouping codes that share underlying meaning (Flick 2018), detailed in Table 2.10.

Table 2.10: An Overview of Thematic and Content Analyses

Analysis Attribute	Thematic Analysis	Content Analysis
Overall aim	To develop a rich understanding of the underlying meaning of the data.	To *"identify what was said"* by developing a coding frame to group the data (Lindsey and Pattison Rathbone 2022, p426).
Inductive process	Braun and Clarke (2022) outlined the process for inductive thematic analysis: 1. familiarisation with the data, 2. generating initial codes, 3. searching for themes, 4. reviewing themes, 5. defining and naming themes, 6. producing the report.	Elo and Kyngås (2008) described the inductive content analysis process: 1. familiarisation with the data, 2. inductive coding, 3. creation of a coding sheet outlining all codes constructed from data, 4. grouping of codes, 5. categorisation of groups, 6. abstraction of categories, 7. creation of the model, conceptional system, conceptual map, or categories.
Deductive process	Initial codes are indexed into *a priori* themes developed from the literature (Braun and Clarke 2022).	The data are indexed into *a priori* codes or frameworks (Elo and Kyngås 2008).
Combined approaches	Braun and Clarke (2022) recently introduced *reflexive thematic analysis,* a flexible approach using inductive and deductive analyses to meet the study aims.	Hsieh and Shannon (2005) suggest using *summative content analysis* if the study aims to understand and quantify the data. A deductive analysis is followed by inductive analysis, categorising data that did not fit into the deductive framework.

Although some scholars have criticised thematic analysis for lacking underpinning theory, it is a flexible method to analyse data from qualitative research designs and methods (Flick 2018). The researcher chose thematic analysis for the focus groups since they aimed to develop a rich understanding of HPP perceptions of DMR referrals. Specifically, reflexive thematic analysis was selected because inductive and deductive analyses would facilitate the exploration of HPPs' perceptions and the investigation of previously identified barriers to DMR referrals, respectively.

Due to its structured approach, content analysis lends itself to descriptive objectives and larger qualitative datasets than thematic analysis (Elo and Kyngås 2008). Since the datasets were large, containing data for all DMRs, the researcher chose content analysis to analyse the free-text DMR data (see Section 1.5.2) for Thesis Objective 3. Since the most appropriate content analysis approach depends on the underlying data, the researcher describes the specific methods used in Chapter 6 after the data were accessed and prepared in Chapter 5.

2.8.3. Mixed Methods Data Integration

Data integration describes the procedures for combining qualitative and quantitative data, a centrepiece of mixed methods research (Creswell and Creswell 2018). The most common data integration method is triangulation; however, its methods are often poorly reported. Farmer et al. (2006) developed the triangulation protocol to address these issues, a specific integration method

involving data sorting into meta-themes and describing theme convergence or contradiction. Multiple experienced researchers must repeat these steps to complete the triangulation protocol and calculate the consensus between themes. Although the triangulation protocol may have been suitable, involving multiple researchers would decrease the timeliness of data integration and thus delay the dissemination of findings to stakeholders. Therefore, the researcher considered alternative methods of integration.

Another method for integrating data is mixed methods matrices, a table including each study on one axis and the results of each study on the other. The matrix is then filled to describe the level of integration of the results across each study (Moseholm and Fetters 2017). This process involves quantising qualitative data, e.g., reducing qualitative themes to a yes or no, and counting the number of occurrences in each study. The researcher discounted this method as they believed that reducing qualitative themes would sacrifice the depth of information and strength of its narrative (Moseholm and Fetters 2017).

Moseholm and Fetters (2017) described joint display methods as a side-by-side visualisation of data to facilitate the construction of new meta-insights. These methods improve the transparency of the data integration process. Johnson et al. (2019) established the Pillar Integration Process (PIP) in response to their observation that joint display methods were poorly defined. In PIP, the data are listed, matched, checked, and then abstracted into meta-categories (pillar-building) (Johnson et al. 2019). Joint display methods, specifically PIP, were chosen as most appropriate due to the equal weighting of qualitative and quantitative data and the flexibility of creating meta-categories. PIP has been used to integrate mixed methods data to evaluate community pharmacy services (Gauly 2020). Each empirical chapter presents its findings separately, but Chapter 10 employs PIP to integrate all results and develop recommendations to optimise the DMR's use.

2.9. Chapter Conclusions and Thesis Roadmap

This chapter provided this thesis' underlying philosophical and methodological considerations, justifying using convergent mixed methods and research methods to address each thesis objective. Table 2.11 summarises these methods, providing a roadmap for the thesis.

Table 2.11: Thesis Roadmap

Chapter Title	Chapter Contents	Planned Methodology	Planned Research Design	Planned Method	Planned Analysis Approach
Chapter 3: A Critical Comparison of UK Technology-Supported Transfer of Care Systems†	An empirical chapter addressing Thesis Objective 1 (identify areas of good practice from similar transfer of care systems and how they were implemented).	Literature review	Literature review	Rapid review	N/A
Chapter 4: Factors Affecting Hospital Pharmacy Professionals' Engagement with DMR Referrals	An empirical chapter addressing Thesis Objective 2 (explore hospital pharmacy professionals' engagement with DMR referrals).	Qualitative	Hermeneutic phenomenology	Focus groups	Reflexive thematic analysis
Chapter 5: Introduction to the Secondary Data Analysis of DMR Data	The identification and preparation of routinely collected DMR data for the secondary data analysis to address Thesis Objectives 3-5.	N/A	N/A	N/A	N/A
Chapter 6: A Descriptive Analysis of Routinely Collected DMR Data from 2011 to 2021	An empirical chapter addressing Thesis Objective 3 (describe DMR provision from November 2011 to January 2021).	Multimethod	Generic qualitative approach and non-experimental	Content and secondary data analyses	Descriptive statistical and content analyses
Chapter 7: Regression Analysis Methods	A description of the regression analysis approach used to address Thesis Objectives 4 and 5.	N/A	N/A	N/A	N/A
Chapter 8: Describing the Pharmacy Characteristics Affecting DMR Delivery Volume	An empirical chapter addressing Thesis Objective 4 (describe the pharmacy-related factors affecting DMR delivery volume over time).	Quantitative	Non-experimental	Secondary data analysis	Exploratory and inferential statistical analyses
Chapter 9: Describing the Factors Affecting the DMR Discrepancy Identification	An empirical chapter addressing Thesis Objective 5 (describe the factors affecting DMR discrepancy identification).				
Chapter 10: Mixed Methods Data Integration and Discussion	A chapter addressing Thesis Objective 6 (synthesise findings to develop recommendations for optimising the use of the DMR) by integrating the findings from Chapters 3, 4, 6, 8 and 9.	Mixed methods	Convergent mixed methods	Pillar integration process	N/A

†The researcher deviated from the initially planned method. Chapter 3 describes the justification for the multimethod approach (literature review and key informant interviews).

Chapter 3. A Critical Comparison of UK Technology-Supported Transfer of Care Systems

3.1. Chapter Introduction

To reduce the risks of post-discharge medicines-related harm (MRH), the WHO (2019) outlined several interventions, including improving information quality and availability across care transitions and post-discharge interventions. Although the DMR meets the latter criteria in Wales, its original evaluation identified that the lack of access to the discharge advice letter (DAL) was a barrier to service uptake (Hodson et al. 2014a). Therefore, in 2015, NWIS developed the DMR referral system, enabling healthcare professionals (HCPs) to refer patients for a DMR after discharge from the hospital. This referral system notifies community pharmacists that their patients have been discharged from the hospital and provides access to an electronic DAL (eDAL) to facilitate the DMR.

In England, several Clinical Commissioning Groups (CCGs)[13] introduced similar systems: Refer-to-Pharmacy (RTP), PharmOutcomes and Help for Harry (HFH) (RPS 2014). Each of these systems enables community pharmacists' access to a patient's DAL to facilitate post-discharge services, like the discharge Medicines Use Review (dMUR) and New Medicines Service (dNMS). All of these systems are supported by technology, in line with the healthcare policy focus in England and Wales towards technology-based solutions, reducing risk and freeing healthcare staff time. This chapter defines these systems as *"technology-supported transfer of care systems"*, which is used interchangeably with *"systems"* for ease of reading.

This thesis aims to develop recommendations to optimise the DMR service, which is supported by the DMR referral system. Learning from these systems' implementation and attributes is imperative, but there is a paucity of literature comparing them. Therefore, this chapter addresses Thesis Objective 1, identifying areas of good practice from similar systems and how they were implemented. The following objectives were developed to achieve this aim:

1. Describe each UK system's referral process.
2. Describe the unique attributes of each UK system.
3. Explore the implementation of each UK system.
4. Critically compare and contrast UK systems' processes, attributes, and implementation.

3.2. Chapter 3 Methods Overview

A rapid review was the chosen method to address Thesis Objective 1, but it identified limited published information. Therefore, the researcher added a targeted grey literature search and supplemental key informant interviews to ensure the chapter met its objectives (see Figure 3.1).

[13]CCGs are the equivalent NHS organisations in England to Local Health Boards.

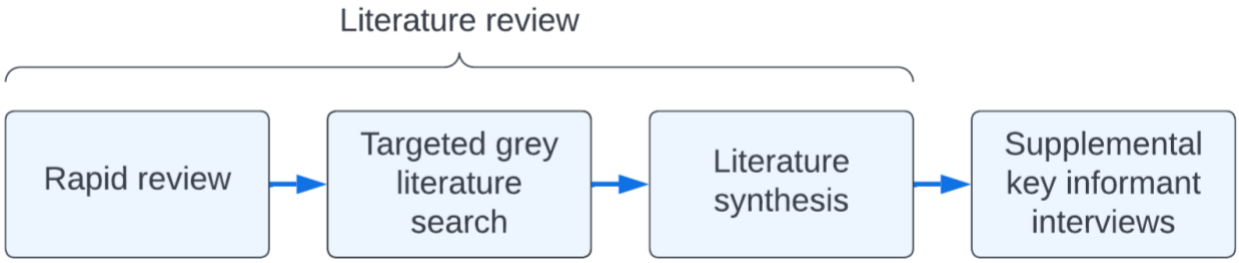


Figure 3.1: Chapter 3 Methods Overview

This chapter chronologically presents the overall multimethod approach, starting with the literature review and synthesis. Then the chapter presents the key informant interview methods and results before discussing all findings in the context of the wider literature.

3.3. Rapid Review Method

When designing the rapid review, the researcher considered two opposing criteria: sensitivity, the likelihood that the search will index all relevant literature, and precision, the likelihood that the search will only include relevant literature (Livoreil et al. 2017). These considerations were vital for this chapter since there was a paucity of systems literature but considerable literature regarding care transitions. Since achieving the chapter's objectives depended on a detailed description of each system, the researcher prioritised search sensitivity rather than precision. Table 3.1 describes the inclusion criteria chosen to ensure the findings would be relevant to modern UK systems.

Table 3.1: Rapid Review Inclusion Criteria

Inclusion Criterion	Rationale
Published between January 2009 and November 2018†	The review aimed to index UK systems literature while excluding the extensive unrelated literature regarding care transitions. The DMR was commissioned in 2011 and was the first UK post-discharge community pharmacy service (Hodson et al. 2014a). Therefore, the researcher restricted the publication date to the last ten years† to include contemporary related services and systems and their implementation whilst excluding many outdated and irrelevant sources.
Published in English	The researcher considered that it would be unlikely for publications regarding UK systems to be in languages other than English.
Relates to UK technology-supported transfer of care systems	The chapter objectives involved describing and comparing UK technology-supported transfer of care systems.
Any literature type	Since the researcher considered it likely that there would be a paucity of literature, they included all types of literature to maximise yield. Although grey literature has a high risk of bias, Benzies et al. (2006) suggested that modern healthcare system details are often published in reports, white papers, and commentaries. Since the researcher aimed to optimise search sensitivity, they included grey literature in the rapid review.††

†The dates reflect that the rapid review began in November 2018.
††The rapid review included grey literature, and then there was a distinct targeted grey literature search.

The researcher followed guidance by Cooper et al. (2018), searching Medline, Embase and Cumulative Index to Nursing and Allied Health Literature databases since they index healthcare

interventions literature. Scopus and ProQuest were searched because they index grey literature, such as conference proceedings and dissertations.

3.3.1. Development of Rapid Review Search Terms

Although the researcher focused on search sensitivity for this review, they developed search terms to optimise precision, reducing the time burden associated with screening many irrelevant findings (Atkinson and Cipriani 2018). Scoping searches started with free-text phrases such as "transfer of care" and "community pharmacy", but these required refining due to low precision. Table 3.2 describes the search terms used to optimise the search strategy and the rapid review's final search terms.

Table 3.2: Rapid Review Search Terms

Search Term Type	Description	Relevant Example	Rationale
Medical Subject Headings (MeSH)	Standardised phrases encompassing related terminology (Atkinson and Cipriani 2018).	The MeSH for "transfer of care" was "care transition".	To increase search sensitivity.
Boolean operators	Searches for combinations of different search terms (Atkinson and Cipriani 2018): • *'AND'* indexes literature containing both search terms. • *'OR'* indexes literature containing either of the two search terms.	"Care transition" AND "community pharmacist".	To increase the search precision.
Adjacent word terms	Searches for the combination of two phrases within three adjacent words: • *'w/3'* (Scopus and ProQuest). • *'adj3'* (Medline, Cumulative Index to Nursing and Allied Health Literature and Embase).	"Care adj3 transfer" (searches for any literature containing "care" and "transfer" within three words of each other).	To increase the search sensitivity.
Wildcard	An asterisk (*) searches for multiple characters.	Pharmac* (searches for pharmacy and pharmacists).	To increase the search sensitivity.
Literature field (Scopus and ProQuest only)	General search term describing the literature's field.	"Medicine", "health professions", "social sciences".	To increase the search precision.

Databases Searched	Final Search Terms
Medline	• "Patient transfer" OR "Care adj3 transfer" OR "Care adj3 transition" OR "Hospital discharge" OR "Information adj3 transfer" AND • "Pharmac*"
Cumulative Index to Nursing and Allied Health Literature	
Embase	
Scopus	• "Care w/3 transfer" OR "Hospital discharge" OR "Information transfer" AND • "pharmac*"
ProQuest	• Including only literature indexed under the 'nursing', 'health professions', 'medicine', 'psychology', 'social sciences', and 'economics' categories.

3.3.2. Screening Rapid Review Literature

The researcher used the export function of each database to transfer the indexed literature into the Mendeley® reference management software (v1.19.8). Duplicates were removed using the software's inbuilt duplicate checker and then manually checked to ensure that there were no further duplicates.

Systematic reviews screen literature twice for the full inclusion criteria, a title and abstract screening and full-text screening (Waffenschmidt et al. 2019). In contrast, rapid reviews typically use single screening protocols. Although single screening protocols are timelier than double screening, they are less sensitive. Therefore, the researcher compromised between the two approaches, screening titles and abstracts with broader criteria (relevance to transfer of care) and then screening the resulting full text for the full inclusion criteria when available. Published abstracts do not have full text, but they were included if they met the inclusion criteria.

This chapter employed a rapid review rather than a systematic review to increase timeliness, facilitating rapid dissemination of findings to policymakers (see Section 2.7.4). Following this rationale, the researcher screened the literature independently in contrast to requiring multiple researchers, a common method for rapid reviews (Tricco et al. 2017). The references of the included literature were then screened for the inclusion criteria.

3.4. Targeted Grey Literature Search Method

In addition to including grey literature in the rapid review, a targeted search was completed in grey literature sources not comprehensively indexed in the databases already searched. This search is a recognised method to increase the yield of relevant healthcare systems literature (Benzies et al. 2006). Identical inclusion criteria to the rapid review were used for consistency, except for including literature from January 2009 to December 2018 (search completed in December 2018). Table 3.3 describes the searched grey literature sources, constituting organisations known for publishing pharmacy service information.

Table 3.3: Databases Included in the Targeted Grey Literature Search

Grey Literature Databases	Rationale for Search
International Pharmaceutical Federation	The research team knew from personal experience that these sources index literature regarding community pharmacy services and systems.
NICE	
Royal Pharmaceutical Society (RPS)	
Pharmaceutical Services Negotiating Committee (PSNC)	
Community Pharmacy Wales (CPW)	
The Pharmaceutical Journal	Although the rapid review databases index these sources, the research team knew their indexing was rarely comprehensive. Therefore, they were included in the targeted search.
Clinical Pharmacist	
YouTube®	The rapid review findings suggested that these sources may include pertinent system literature.
East Lancashire NHS Trust	

These databases had less advanced search capabilities than academic databases, specifically lacking the functionality to use Boolean operators, wildcards, and adjacent word terms. Therefore, the researcher used specific search terms to increase precision: *"hospital discharge Refer-to-Pharmacy"*, *"hospital discharge PharmOutcomes", "hospital Discharge Medicines Review",* and *"hospital discharge Help for Harry".* The rapid review identified each system's name for inclusion in these search terms.

Unlike the rapid review databases, the grey literature databases had no method to export indexed literature to reference management software. Therefore, the researcher hand-searched indexed literature and screened a pre-defined number of titles for the inclusion criteria (Livoreil et al. 2017). During scoping searches, there were few relevant hits for each database; therefore, references were screened in blocks of ten. If none of the latter halves of those blocks met the inclusion criteria, the researcher stopped the search. Although this screening method may have reduced the search sensitivity, it was time-efficient, considering the scoping searches indexed hundreds of irrelevant literature sources. Like the rapid review, references of indexed literature were screened and included if they met the inclusion criteria.

3.5. Critical Appraisal and Literature Synthesis

Systematic reviewers typically use formal critical appraisal tools before including a study in the synthesis (Tricco et al. 2017). In contrast, many rapid reviewers omit this assessment, resulting in a timelier synthesis than systematic reviews, albeit with a greater risk of bias (Tricco et al. 2017). The researcher did not complete a critical appraisal since it would exclude grey literature, negating the rationale for the targeted grey literature search.

The researcher synthesised the resulting literature from both searches to describe and contrast each system's generic process, attributes, and implementation. This synthesis method can be described as narrative but critical, a common method for rapid reviews (Tricco et al. 2017). The

researcher considered employing the better reporting of interventions: template for intervention description and replication (TIDieR) checklist to increase the transparency and replicability of the description of each system (Hoffmann et al. 2014). However, this checklist was excluded because it does not consider the implementation of each intervention in detail, a key consideration for this chapter. To facilitate timely literature synthesis, the researcher completed it independently but frequently discussed findings with two experienced researchers (KH and EM) to ensure robust conclusions (Tricco et al. 2017).

3.6. Literature Review Findings

3.6.1. Rapid Review Findings

The rapid review was completed between October 8th and November 25th 2018, identifying 11 relevant results for inclusion. Figure 3.2 describes the screening of indexed literature, represented by a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram to improve transparency (Atkinson and Cipriani 2018).

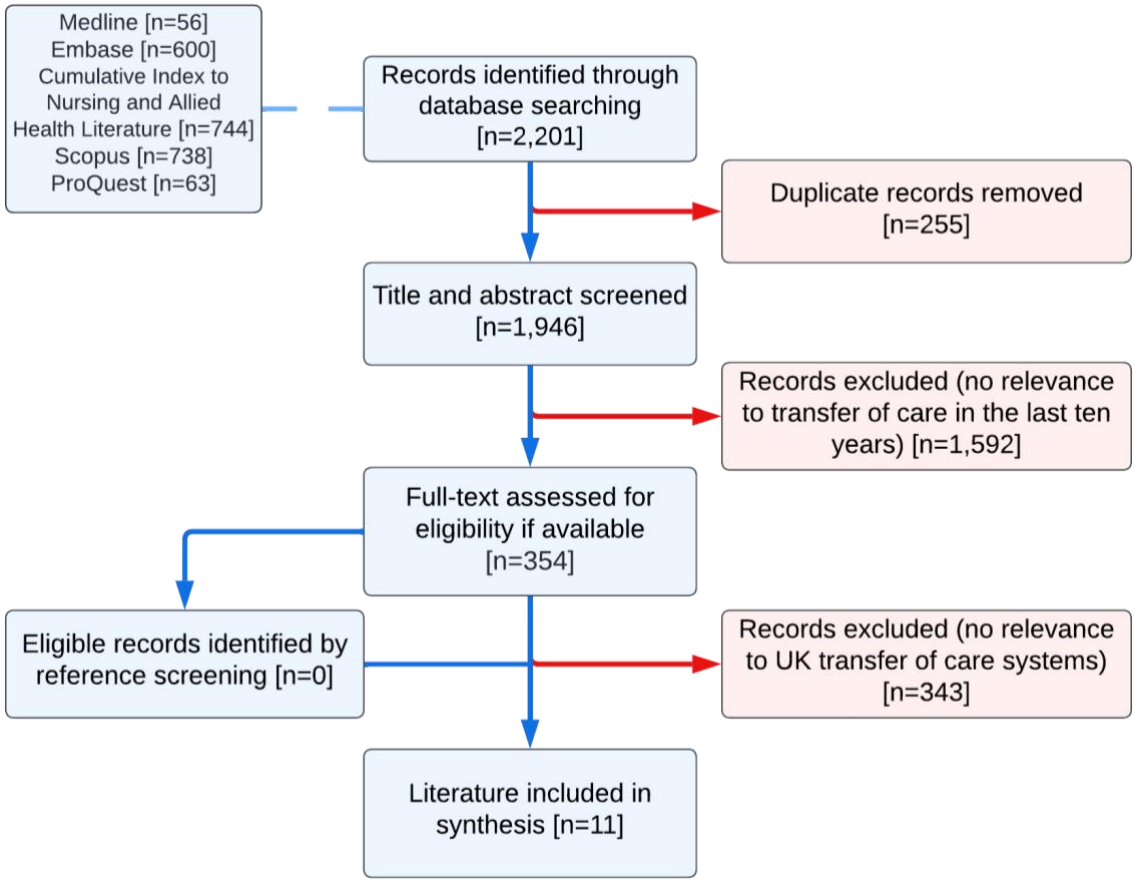


Figure 3.2: PRISMA Flow Diagram for the Screening of Rapid Review Literature

Table 3.4 summarises the 11 literature sources from the rapid review that met the inclusion criteria.

3.6.2. Targeted Grey Literature Search Findings

The researcher conducted the targeted grey literature search between November 30th and December 12th, 2018, screening 360 literature sources for inclusion. Fourteen literature sources were identified from the search, and one from reference screening. Table 3.5 summarises these 15 literature sources.

Table 3.4: Summary of Rapid Review Findings (Presented in Alphabetical Order)

Author(s)	Publisher (Literature Type)	Literature Title	Summary
Ferguson et al. (2016)	International Journal of Pharmacy Practice (abstract)	Seamless transfer of medicines information from hospital to community: Implementation lessons from two case studies	Background information about RTP and an exploration of hospital pharmacy professionals' (HPPs') perceptions of its implementation.
Ferguson et al. (2018)	BMC Health Services Research (paper)	Refer-to-pharmacy: A qualitative study exploring the implementation of an electronic transfer of care initiative to improve medicines optimisation following hospital discharge	Background information about RTP and an exploration of HPPs' and community pharmacists' perceptions of RTP.
Gray (2015a)	British Journal of Hospital Medicine (paper)	Electronic referrals from hospital bedsides to community pharmacies	Background information about the need for transfer of care systems and details about RTP.
Gray (2015b)	Pharmacy (paper)	Refer-To-Pharmacy: Pharmacy for the Next Generation Now! A Short Communication for Pharmacy	A brief description of how RTP works in practice.
Hodson et al. (2014b)	International Journal of Pharmacy Practice (abstract)	Evaluation of the Discharge Medicines Review Service in Wales: community and hospital pharmacists' views	Background information about the DMR and an exploration of community and hospital pharmacist perceptions of the DMR.
Hodson et al. (2014c)	International Journal of Pharmacy Practice (abstract)	Evaluation of the Discharge Medicines Review Service in Wales: Content analysis of Discharge Medicines Reviews	Background information about the DMR and a description of its uptake and impact on patient safety and the health economy.
Hodson et al. (2018)	International Pharmaceutical Federation Congress (abstract)	A four-year evaluation of the discharge medicines review service provision across all of Wales	A description of DMR provision between 2014 and 2018.
Mantzourani et al. (2017)	Integrated Pharmacy Research and Practice (paper)	Does an integrated information technology system provide support for community pharmacists undertaking Discharge Medicines Reviews? An exploratory study	Background information about the DMR referral system and the perspectives of community pharmacists who have used it.
Nazar et al. (2016)	British Medical Journal (paper)	New transfer of care initiative of electronic referral from hospital to community pharmacy in England: a formative service evaluation	Background information about the PharmOutcomes system and describing the effect of PharmOutcomes referrals with a dNMS on hospital readmission rates.
RPS (2014)	RPS (report)	Hospital referral to community pharmacy: An innovators' toolkit to support the NHS in England	A description of several UK technology-supported systems, including PharmOutcomes, RTP and HFH.
Wilcock et al. (2018)	Pharmacoepidemiology and Drug Safety (paper)	Growing the evidence base for transfer of care to community pharmacy	Background information about the PharmOutcomes system and describing the association between PharmOutcomes referrals and hospital readmissions.

Table 3.5: Summary of Targeted Grey Literature Search Findings (Presented in Alphabetical Order)

Author(s)	Publisher (Literature Type)	Literature Title	Summary
Gray (2016)	YouTube® (video)	Refer-to-Pharmacy hospital demo featuring the new Hospital Admission Notification message	A demonstration of the RTP hospital admission notification system.
Gray (2017a)	YouTube® (video)	Refer-to-Pharmacy Community Pharmacy training film February 2017	A demonstration of how RTP referrals are processed in community pharmacies.
Gray (2017b)	YouTube® (video)	Refer-to-Pharmacy hospital pharmacy training film February 2017	A demonstration of RTP referrals.
Gray (2017c)	YouTube® (video)	Refer to Pharmacy presentation and demo February 2017	A background and demonstration of RTP.
Hodson et al. (2014a)	CPW (report)	Evaluation of the Discharge Medicines Review service	An extensive service evaluation for the DMR, including its background and stakeholder perceptions.
Leeson (2018)	Pharmaceutical Journal (article)	Post-discharge medicines scheme is underutilised, study suggests	A description of the underutilisation of the DMR.
NWIS (2018)†	CPW (report)	Choose Pharmacy user guide version 7.0	A description of the DMR referral system process.
Pinnacle Health Partnership LLP (2018)	PharmOutcomes (webpage)	PharmOutcomes. Delivering evidence	A detailed description of PharmOutcomes, including information about its development, provision, and user-support guides.
Pinnacle Media (2018)	PharmOutcomes (webpage)	PharmOutcomes Media	Multiple videos demonstrating how to refer patients through PharmOutcomes, and action a referral in community pharmacy.
PSNC (2013a)	PSNC (webpage)	Medicines Use Review	A description of the MUR, including its use post-discharge.
PSNC (2013b)	PSNC (webpage)	New Medicines Service	A description of the NMS, including its use post-discharge.
Roberts (2017)	YouTube® (video)	PharmOutcomes instructional video	A demonstration of community pharmacy processes for completing a PharmOutcomes referral.
Staffs & Stoke Pharmacies (2018)	YouTube® (video)	PharmOutcomes introduction V2	A demonstration of PharmOutcomes referrals.
The Eastern Academic Health Science Network (2018)	YouTube® (video)	PharmOutcomes	A demonstration of PharmOutcomes referrals.
Yorkshire & Humber Academic Health Science Network (2018)	YouTube® (video)	Connect with Pharmacy: Medicines Support after Hospital	A description of the local implementation of PharmOutcomes in West Yorkshire (named Connect with Pharmacy).

†Identified by reference screening.

3.6.3. Literature Synthesis

This section presents the narrative synthesis of the 26 indexed literature sources. Section 3.6.3.1 presents an overview of each system, followed by a comparison of their attributes in Section 3.6.3.2.

3.6.3.1. Systems Overview

All systems were developed to notify community pharmacists of a patient's discharge from the hospital and provide access to discharge information. By providing this information, the systems aimed to prompt community pharmacists to provide post-discharge support services (RPS 2014; Mantzourani et al. 2017). Figure 3.3 summarises each system's referral process (Hodson et al. 2014a; RPS 2014; Gray 2017b; Mantzourani et al. 2017; Roberts 2017; NWIS 2018; Pinnacle Media 2018).

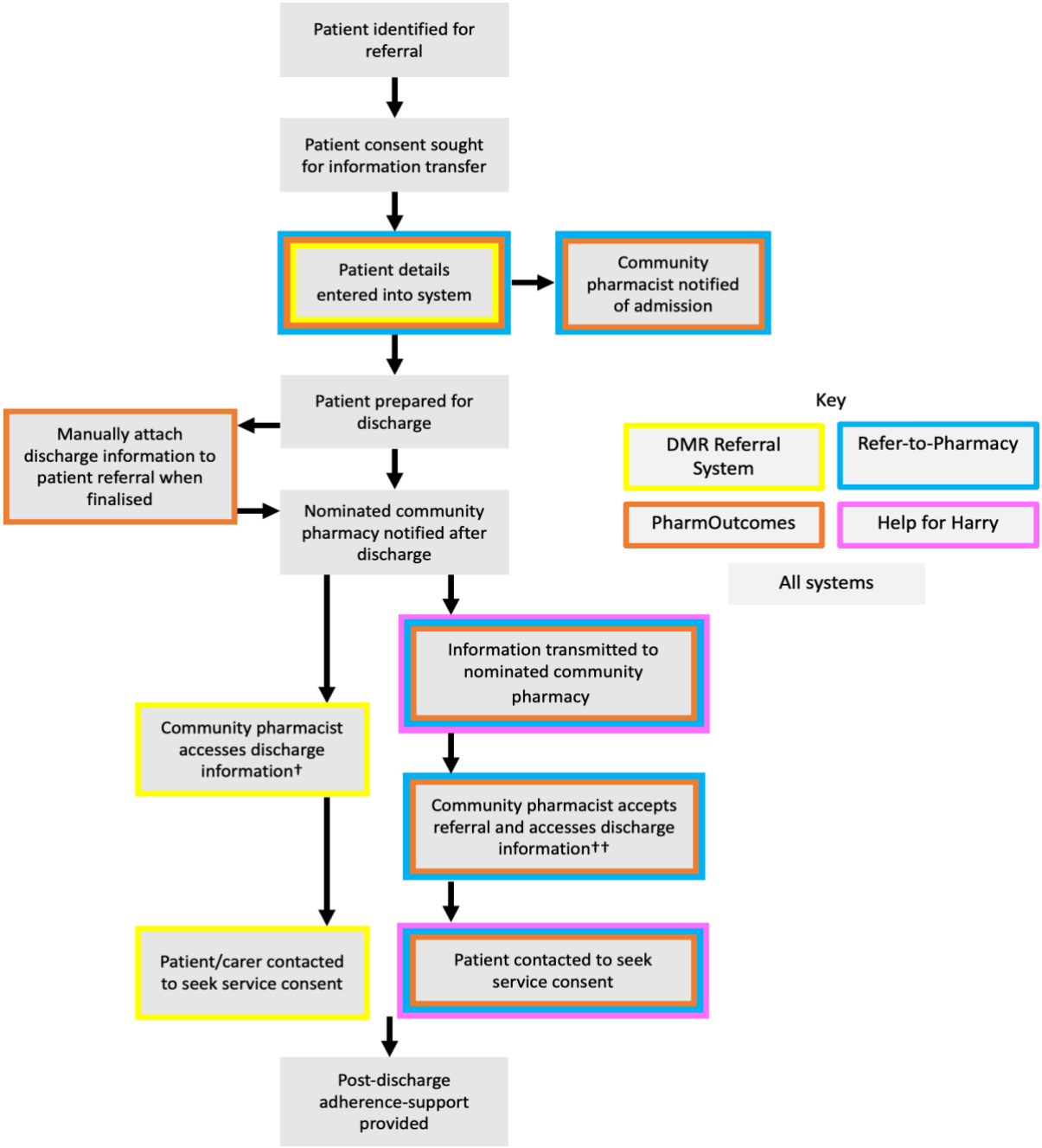


Figure 3.3: Process Map for UK Technology-Supported Transfer of Care Systems

†Discharge information is stored within the Welsh Care Records Service and accessed via Choose Pharmacy (ChP). Only the nominated pharmacy is notified of discharge, but any pharmacist can access discharge information with patient consent.

††Information is only available to the nominated pharmacy.

3.6.3.1.1. The DMR Referral System

NWIS developed the DMR referral system to provide community pharmacists electronic access to a patient's discharge information, specifically to provide a DMR. The system was developed between the hospital discharge software, Medicines Transcribing and electronic Discharge (MTeD), and the shared community pharmacy services platform, ChP (Mantzourani et al. 2017). Therefore, only hospital wards using MTeD have access to the DMR referral system. HCPs can complete the referral at any stage of the patient's hospital stay once they have obtained patient

consent. The referral consists of completing an onscreen consent statement and specifying the patient's designated community pharmacy. Provided the patient has been referred (or pre-registered on ChP for the DMR service), the system notifies the nominated community pharmacy when the patient has been discharged from the hospital, prompting them to access the discharge information in ChP (NWIS 2018).

3.6.3.1.2. PharmOutcomes

PharmOutcomes is like ChP, an online platform that facilitates the delivery, claims, and data collection for community pharmacy services (Pinnacle Health Partnership 2018). In some local geographic areas, local CCGs have developed schemes to promote the use of PharmOutcomes referrals, such as *'Connect with Pharmacy'* in West Yorkshire (Yorkshire & Humber Academic Health Science Network 2018).

A PharmOutcomes referral can be completed at any stage of the patient's hospital stay by documenting patient consent and completing the referral form, including the patient's designated community pharmacy and reason for the referral (Roberts 2017). Although referring HCPs can suggest a commissioned post-discharge service, such as the dMUR or dNMS, they may recommend other support like smoking cessation advice or medicines reconciliation. However, Figure 3.4 shows that the community pharmacist can provide whichever service they feel is appropriate (Roberts 2017).

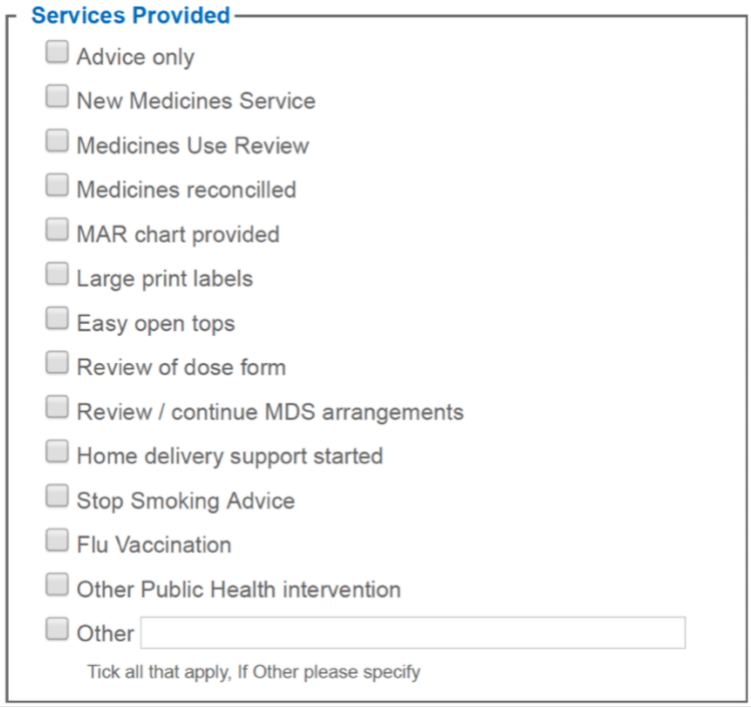


Figure 3.4: Screenshot of PharmOutcomes Post-Discharge Support Data Entry
MAR = Medicines Administration Record, MDS = Monitored Dosage System (Multicompartment Compliance Aid)

Although a referring practitioner can complete the referral form at any point during the patient's hospital stay, they must attach the finalised discharge information before discharge (Pinnacle Health Partnership 2018).

3.6.3.1.3. Refer-to-Pharmacy (RTP)

RTP is an online platform designed to facilitate eDAL transmission to a nominated community pharmacy (Gray 2017b). When an HCP deems a patient eligible for a referral at any point during their hospital stay, they must gain patient consent. To support the consent process, RTP has two unique features; a patient-facing video to explain the need for referral, and pre-written consent statements for patients to approve, which can be translated into several languages (Gray 2017b). Like PharmOutcomes, the practitioner may specify various referral reasons, including commissioned adherence support services, illustrated in Figure 3.5 (Gray 2017b). The referring practitioner must then select the patient's nominated pharmacy, supported using the system's inbuilt map, which highlights the location of local pharmacies (Gray 2017b). After completing the referral, the discharge information is transmitted automatically after discharge.

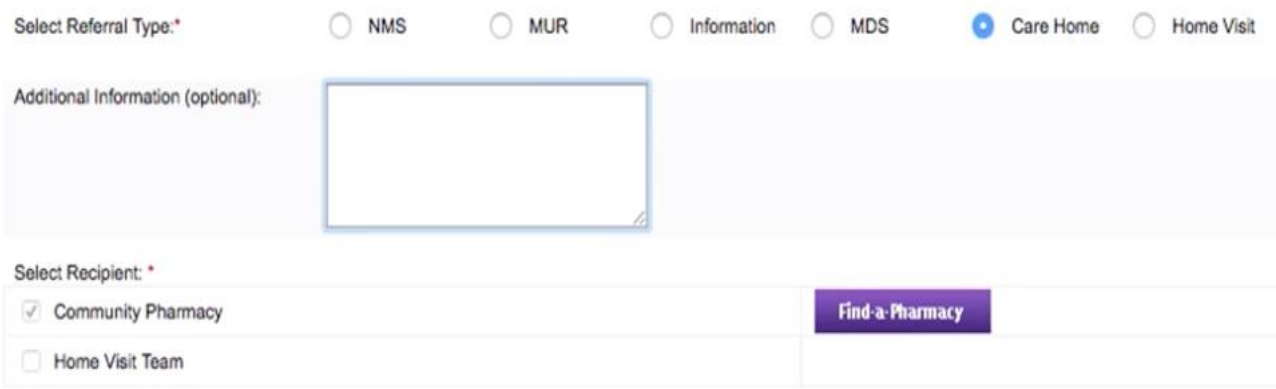


Figure 3.5: Screenshot of the Refer-to-Pharmacy Referral Form

3.6.3.1.4. Help for Harry (HFH)

HFH is a referral system involving fax transmission of the DAL to a nominated community pharmacy to facilitate the provision of a dMUR or dNMS. Referring practitioners identify a patient for referral and obtain their consent, then manually fax the discharge information to the community pharmacy once it has been finalised (RPS 2014).

3.6.3.2. Identifying System Similarities and Differences

3.6.3.2.1. System Implementation

The requirements for system implementation in hospitals and community pharmacies vary. Since the DMR referral system was developed nationally using existing NHS Wales IT infrastructure, any hospital ward using MTeD automatically has access (Mantzourani et al. 2017). In contrast, for hospitals to use PharmOutcomes or RTP, their local NHS Trust or CCG must organise access

(including payment) with Pinnacle and Webstar Health, respectively (RPS 2014; Roberts 2017). There are no formal requirements for hospitals to use HFH since it is a fax transmission of the DAL (RPS 2014). For RTP, PharmOutcomes, and the DMR referral systems, the community pharmacist and pharmacy must register for an account to gain access (Gray 2017c; Roberts 2017; NWIS 2018). No information was available regarding community pharmacy requirements to receive HFH referrals. Table 3.6 presents an overview of system development and uptake.

Table 3.6: Comparison of UK Technology-Supported Transfer of Care System Implementation

System Feature	DMR Referral System	RTP	PharmOutcomes	HFH
Location (Hodson et al. 2014a; RPS 2014; Gray 2015a; Pinnacle Health Partnership 2018)	Wales (only available from hospital wards that use MTeD)	East Lancashire and Blackburn with Darwen CCG	Devon, Hampshire and Isle of Wight, North of Tyne, Thames Valley, Buckinghamshire, Cornwall and Isles of Sicily, West Yorkshire CCGs	Derbyshire NHS Trust
Implementation starting date (RPS 2014; Mantzourani et al. 2017)	April 2015	December 2015	July 2014	Data unavailable
System developers (RPS 2014; Gray 2015a; NWIS 2018; Pinnacle Health Partnership 2018)	NWIS	Webstar Health, in conjunction with East Lancashire CCG	Pinnacle Health Partnership LLP	Derbyshire NHS Trust
Funding for IT infrastructure (Hodson et al. 2014a; RPS 2014; Pinnacle Health Partnership 2018)	Unknown ChP costs funded centrally by the Welsh Government†	Annual cost of £3600-£4800 funded between the CCG and NHS Trust	Annual cost from £4145 per year (additional payments for extra system functionality) paid by CCG†	Negligible cost of fax machine upkeep
Community pharmacy uptake (at the time of the study) (NWIS 2018; Pinnacle Health Partnership 2018)	628 contractors (85% of pharmacies in Wales)	Data unavailable	432 contractors (3.7% of pharmacies in England)	Data unavailable

†These systems are used for several community pharmacy services; therefore, their costs are not borne by the transfer of care functionality alone.

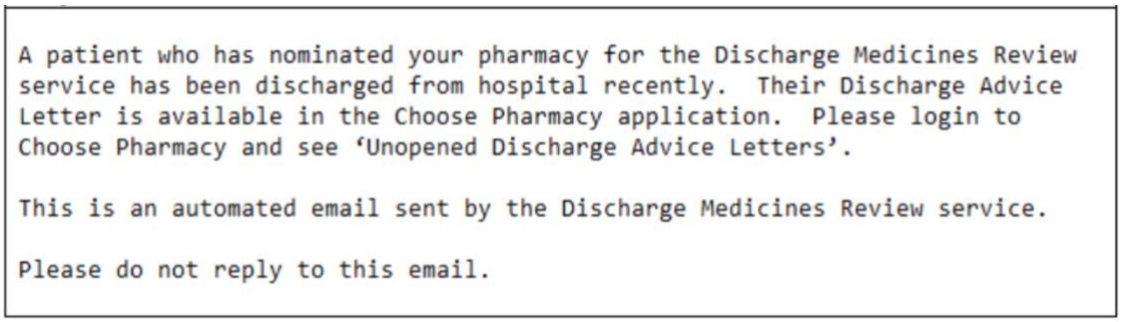
3.6.3.2.2. Nature of Communication and Notifications

Figure 3.3 highlighted differences in system-enabled communication between hospitals and community pharmacists. The DMR referral system and HFH involve unilateral communication from the hospital to the community pharmacy at discharge. They notify the community pharmacy of their patient's discharge and prompt them to provide specific commissioned post-discharge services (RPS 2014; NWIS 2018). In contrast, referring practitioners using PharmOutcomes and RTP specify a reason for their referral, which could be a commissioned service, such as dMUR or dNMS, or other services (Gray 2017a; Roberts 2017). The nominated community pharmacy receives the referral form before discharge, notifying them that their patient has been admitted to the hospital and allowing them to reject the referral if inappropriate (Gray 2016; Gray 2017a; Roberts 2017).

The referring practitioner may forward a rejected referral to a different pharmacy with the patient's consent. If the community pharmacist accepts the referral, the system automatically notifies them of hospital discharge and provides access to discharge information.

The contents of available discharge information vary by system, with RTP sending the whole DAL, including clinical information, and the DMR referral system and PharmOutcomes sending only medicines information (Gray 2017a; Roberts 2017; NWIS 2018). Since HFH transmits information by fax, its contents are not standardised; therefore, it could vary by the referring practitioner (RPS 2014).

The DMR referral system sends discharge notifications to the designated pharmacy's ChP account and the NHS email address used to register the pharmacy with ChP (see Figure 3.6) (NWIS 2018). A pharmacist must log into either ChP or the designated email address to access the notification. The system generates these notifications automatically when a patient is discharged from a ward using MTeD if the hospital refers them or if the patient was pre-registered for the DMR on ChP (NWIS 2018). However, a patient's DAL may still be accessed through ChP if the patient provides DMR consent after discharge without hospital referral or pre-registration.


A patient who has nominated your pharmacy for the Discharge Medicines Review service has been discharged from hospital recently. Their Discharge Advice Letter is available in the Choose Pharmacy application. Please login to Choose Pharmacy and see 'Unopened Discharge Advice Letters'.

This is an automated email sent by the Discharge Medicines Review service.

Please do not reply to this email.

Figure 3.6: DMR Referral System Email Discharge Notification

RTP and PharmOutcomes send admission and discharge notifications through NHS email and personal email addresses, whichever was associated with the pharmacy during account setup (Gray 2017a; Roberts 2017). RTP can notify by text message if the pharmacy registers this preference (Gray 2017a). Pinnacle has developed the *pharmalarm*® for pharmacies using PharmOutcomes, a USB device that notifies of incoming referrals using a flashing light. Pharmacies or CCGs must opt-in to use this device and pay an additional fee; therefore, its uptake is variable.

3.6.3.2.3. Commissioned Post-Discharge Services

Table 3.7 compares the three commissioned post-discharge services associated with the systems: the DMR, dNMS, and dMUR.

Table 3.7: Specification of Commissioned Post-Discharge Community Pharmacy Services

Service Attribute	DMR (Hodson et al. 2014a)	dNMS (PSNC 2013b)	dMUR (PSNC 2013a)
Description	Medicines reconciliation (DMR1) and an adherence-support consultation (DMR2).	Adherence-support consultation for new medicines.	Adherence-support consultation.
Eligibility criteria (one of the following)	• Medication change(s) in the hospital. • The patient takes four or more medicines. • The patient requires adjustment to their medicine. • Pharmacist's professional judgement.	• The patient is taking a new medication for type 2 diabetes, chronic obstructive pulmonary disorder, asthma, hypertension, or anticoagulation.	• The patient takes two or more medicines. • Medication change(s) in the hospital.
Service modality	Face-to-face or by telephone.	Face-to-face or by telephone.	Face-to-face or by telephone.
Face-to-face service location	Pharmacy or in the patient's home with Local Health Board (LHB) permission.	Pharmacy or in the patient's home with CCG permission.	Pharmacy or in the patient's home with CCG permission.
The person receiving the review	Patient or carer.	Patient only.	Patient only.
Community pharmacy reimbursement per service	£37 (on completion of DMR1 and DMR2)	£28	£20 - £28 (graduated cost per service that increases with the number of services provided)
Annual limit of commissioned post-discharge services	140	400	1% of the annual number of dispensed prescriptions, e.g., 100 services for a pharmacy that dispensed 10,000 prescriptions.

Once a community pharmacist accesses a patient's discharge information through RTP, PharmOutcomes or HFH, they can immediately provide an adherence-support service. The DMR service specification suggests that the adherence-support component (DMR2) should be completed within 28 days of DMR1, which may have been provided up to 28 days from discharge (Hodson et al. 2014a). Therefore, there is a potential delay in adherence support facilitated by the DMR referral system.

Since ChP and PharmOutcomes are platforms designed to support the provision and claiming of advanced community pharmacy services, payment claims for any commissioned post-discharge services are automated (NWIS 2018; Pinnacle Health Partnership 2018). In contrast, any commissioned services resulting from RTP or HFH referrals must be claimed in separate systems (RPS 2014; Gray 2017c).

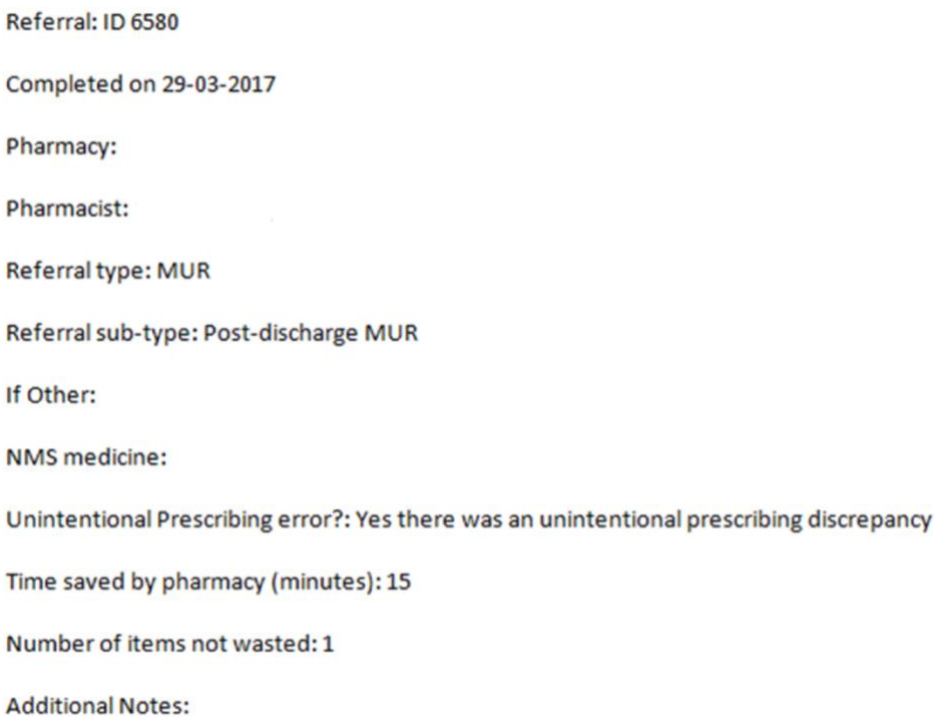
3.6.3.2.4. Patient Referral Eligibility and Screening

As described above, each system can refer to commissioned post-discharge services. Unlike the DMR referral system and HFH, RTP and PharmOutcomes facilitate referrals for several non-

commissioned support services (see Section 3.6.3.1). The referral criteria for these services are locally agreed upon (Gray 2017b; Roberts 2017). Patients referred for a commissioned adherence-support service, like dMURs, should meet their eligibility criteria (see Table 3.7). Since the DMR referral system may only refer to the DMR, of which one eligibility criterion is the pharmacist's professional judgment, no patients are excluded from referrals. When referring a patient through RTP for a dMUR or dNMS, the referring practitioner must select the patient's eligibility criteria from a drop-down menu before they can complete the referral (Gray 2017b). Although PharmOutcomes does not provide such eligibility screening, it describes the dMUR and dNMS eligibility criteria onscreen (Pinnacle Health Partnership 2018). Neither the DMR referral system nor HFH has integrated screening tools for post-discharge service eligibility criteria (RPS 2014).

3.6.3.2.5. Referral Outcomes and Feedback

When a community pharmacist accesses discharge information through the DMR referral system, the only option is to complete a DMR using the designated form (NWIS 2018). The system autocompletes most of the DMR form, including patient details. The community pharmacist must state whether each medication was associated with a post-discharge discrepancy and its nature (NWIS 2018). When actioning an RTP referral, the community pharmacist records the nature of post-discharge support provided, e.g., medicines reconciliation, dMUR or information only, and its outcomes. RTP returns these outcomes to the referring practitioner by email, as shown in Figure 3.7 (Gray 2017b). This RTP feedback was not available from system implementation but was introduced later in 2016 due to stakeholder feedback (Gray 2016).


Referral: ID 6580

Completed on 29-03-2017

Pharmacy:

Pharmacist:

Referral type: MUR

Referral sub-type: Post-discharge MUR

If Other:

NMS medicine:

Unintentional Prescribing error?: Yes there was an unintentional prescribing discrepancy

Time saved by pharmacy (minutes): 15

Number of items not wasted: 1

Additional Notes:

Figure 3.7: Refer-to-Pharmacy Automated Feedback to Referring Practitioner

Similarly, PharmOutcomes collects data regarding post-discharge support and outcomes, describing whether the referral prevented discrepancies and whether the patient suffered any side effects from their medicines (Pinnacle Health Partnership 2018). Referring practitioners may access these referral outcomes on PharmOutcomes, but these are not automatically returned like on RTP (Pinnacle Media 2018). Uniquely, PharmOutcomes will send a copy of the outcomes to the patient's GP surgery if they have an email address registered on the system (Pinnacle Media 2018). Neither the DMR referral system nor HFH facilitates referring practitioner access to outcomes from the referrals.

3.6.3.2.6. System Evaluation

Only PharmOutcomes has peer-reviewed evidence of system benefit, including an association with reducing hospital readmission and the number of bed-days (Nazar et al. 2016; Wilcock et al. 2018). This evidence is for PharmOutcomes referrals culminating in a dNMS. Published audit results on the RTP website indicate reductions in readmissions compared to the background rate. Additionally, RTP saved time and costs from the cessation of community pharmacy prescription dispensing while the patient was in the hospital (Gray 2015b).

The DMR referral system and RTP were the only systems with published service evaluations regarding community and HPP perceptions. HPPs felt that RTP implementation was effective because of strong leadership and the ease of integrating it into working practices (Ferguson et al. 2018). Compared with traditional fax transmission to community pharmacies, HPPs felt that RTP referrals were quick and easy (Ferguson et al. 2018). Community pharmacists' barriers to actioning RTP referrals were difficulties managing workload and a lack of managerial support (Ferguson et al. 2018). Interviewed community pharmacists perceived the DMR referral system to improve workload and patient identification compared with fax transmission of discharge information. However, they suggested a barrier was the scarcity of referrals (Mantzourani et al. 2017).

3.7. Key Informant Interview Methods

This chapter aimed to address Thesis Objective 1, identifying areas of good practice from similar UK transfer of care systems and their implementation to optimise DMR referral system use, which was dependent on a detailed description of the systems. The literature review described the system process and identified three broad contrasting concepts: implementation, system attributes, and stakeholder engagement. However, the paucity of literature limited the description of system implementation and optimising stakeholder engagement. Therefore, the researcher added a supplemental qualitative method, which they considered suitable to generate a detailed description of the systems, adding depth and context to the literature review findings (Flick 2018).

The researcher first considered a phenomenological design, but the study's aims were not to study perceptions of the phenomenon, a crucial tenet of this design (Flick 2018), but to describe and compare the systems. Therefore, a generic qualitative design was most appropriate due to its flexibility and strengths in developing a rich description (see Section 2.6.2).

Since the chapter's focal point was to describe each system thoroughly rather than consider interactions between participants, the researcher chose interviews over focus groups. Semi-structured were more appropriate than unstructured interviews for this study since the literature review had generated specific areas for investigation (Clark et al. 2021). As participants would need sufficient system oversight and knowledge to provide a detailed description, key informant (participants with specialist knowledge of the subject of enquiry) interviews were considered the most appropriate method (Clark et al. 2021).

3.7.1. Population and Sampling

The researcher defined the population as individuals involved in developing or implementing a UK system. Information power (see Table 2.5) outlines that specific aims with knowledgeable participants require smaller sample sizes. Therefore, one population member was purposively sampled per system. One population member was known to the research team for their role in developing the DMR referral system, whilst informants for the other systems were identified from the literature review. Table 3.8 presents a brief overview of the identified key informants' characteristics.

Table 3.8: Characteristics of Identified Key Informants

Key Informant Feature	DMR Referral System	RTP	PharmOutcomes	HFH
Role	System development and implementation.	System development and implementation.	Implementation of PharmOutcomes in a local area (West Yorkshire) and developing a protocol for its use (called "Connect with Pharmacy").	System development and implementation.
Employer	NWIS	East Lancashire NHS Trust	Community Pharmacy West Yorkshire	Derbyshire NHS Trust
Employer description	The organisation responsible for the development of the DMR referral system.	The NHS Trust that implemented RTP.	The community pharmacy organisation responsible for implementing PharmOutcomes in West Yorkshire CCG.	The NHS Trust that implemented HFH.

3.7.2. Study Approvals and Recruitment Strategy

Using the HRA (2020) guidance, the researcher defined this study as a service evaluation rather than research because it aimed to describe current practice rather than alter it. Since NHS ethics was not required, the CSPPSREC provided ethical approval for the interviews (reference: 1819-11).

The researcher invited the four informants to participate by email (Appendix 3.1) rather than mail recruitment because of convenience and associated cost savings (Creswell and Creswell 2018). The literature identifying three key informants contained their contact email addresses, and the research team knew the DMR informant's email address from previous collaborations. The researcher employed evidence-based methods when designing the recruitment email and participant information leaflet (PIL) to encourage participation. These design considerations included explaining the study's background and aims, emphasising why the informants had been selected, and the importance of their contribution to patient care (Awaisu and Alsalimy 2015). Appendices 3.2 and 3.3 present the study's PIL and consent form, which were attached to each email for the participants' perusal. Non-responders were emailed (Appendix 3.1) after two weeks prompting them to respond, providing ample opportunity to read the documentation, which was attached again for their convenience. Further contact to recruit participants was not planned if they did not respond to the reminder email within one week.

Since the DMR, RTP and HFH informants were NHS employees, the researcher considered whether the study needed registration with their employer's Research and Development (R&D) department. Once informants responded to the recruitment emails, the RTP and DMR informants were asked to contact their respective R&D departments to confirm whether study registration was required. The RTP informant described that their employing NHS Trust did not require any study approvals. In contrast, Velindre NHS Trust (the organisation that hosted NWIS) R&D department required study registration which they subsequently approved after reviewing the standardised documentation as completed by the researcher. As the PharmOutcomes informant was not a member of NHS staff, they were asked to forward the study details to their employing organisation, which confirmed that no further steps were required. The HFH informant declined to participate due to a change in job role, so they did not contact their R&D department. No alternative informants could be identified due to the lack of HFH literature. Once the study gained all the necessary approvals and participants had returned the consent form, the researcher organised the date and method for the interview via email.

3.7.3. Data Collection Method

Despite the perception that face-to-face interviews improve rapport-building, the researcher considered telephone interviews more practical for busy professionals and feasible within the limited resources of a PhD project (Clark et al. 2021). Therefore, participants were offered whichever method was most convenient for them. The researcher spent time before each interview building a rapport with participants by exchanging emails and making small talk, a

recognised method of improving the perceived anonymity of telephone interviews (Trier-Bieniek 2012).

The interview schedule (see Appendix 3.4) included ten open-ended questions, with additional prompts where needed. These questions aimed to explore and further describe and explore the contrasting concepts: implementation, system attributes and stakeholder engagement. Interview data were collected by audio-recording (Phillips DPM6700).

3.7.4. Data Preparation and Analysis

Audio recordings were transcribed ad verbatim to prepare the data for analysis. By personally transcribing all interviews, the researcher grounded themself in the data, allowing for a more thorough analysis than professional transcription services (Flick 2018). Transcriptions were quality assured by listening to the audio recordings and making necessary corrections. All interviews were transcribed and prepared before data analysis to limit preconceptions about the data, ensuring coding was applied consistently.

Section 2.8.2 contrasted the qualitative data analysis methods: interpretive phenomenological (IPA), content, thematic, and framework analyses. The researcher excluded IPA for the interviews because they focused on system description rather than participant perceptions. Framework analysis was unsuitable since it required considerable background theory, which was absent for the systems (Gale et al. 2013). Thematic analysis was chosen over content analysis since the researcher added the supplemental method to develop a rich understanding of the systems rather than creating a conceptual map (Elo and Kyngås 2008). The key informant interviews aimed to explore and describe the literature reviews' contrasting concepts. Therefore, the researcher chose reflexive thematic analysis because deductive and inductive analyses are appropriate for descriptive and exploratory aims, respectively (Braun and Clarke 2022).

Deductive analysis was completed first, coding data under the contrasting concepts of implementation, system attributes and stakeholder engagement. The researcher then analysed each transcript inductively, using the procedure outlined by Braun and Clarke (2022) to encompass any data not included in the deductive analysis. To promote the credibility of the findings, the researcher presented themes using indicative quotations and asked two research team members (KH and EM) to independently analyse the data to ensure coding consistency (Flick 2018).

3.8. Key Informant Interview Results

Table 3.9 details the dates, methods, and lengths of the three completed interviews.

Table 3.9: Key Informant Interview Details

Informant	Interview Date	Interview Method	Interview Length (Minutes)
DMR Referral System	29/05/2019	Face-to-face	68
RTP	14/06/2019	Telephone	75
PharmOutcomes	08/07/2019	Telephone	45

Three themes were developed deductively: implementation, stakeholder engagement and system attributes. No further themes were constructed from the inductive analysis, but it facilitated the organisation of the deductive themes into subthemes. Neither KH nor EM developed different themes in their independent analysis, indicating the credibility of the findings. Figure 3.8 presents an overview of the constructed themes and subthemes, which this section describes in detail.

Theme 1: Implementation	Theme 2: System Attributes	Theme 3: Stakeholder Engagement
1.1 Piloting 1.2 Community Pharmacy Engagement 1.3 Marketing Strategies 1.4 Collaboration 1.5 Dedicated Implementation Staff	2.1 IT Interoperability 2.2 Referral Prompts 2.3 Referral to Other Healthcare Services 2.4 Outcome Measures 2.5 Community Pharmacy Notifications	3.1 Accountability for Referrals 3.2 Responsiveness to Stakeholder Feedback 3.3 Feedback to Referring Practitioners 3.4 Staff Training 3.5 Patient Consent Support

Figure 3.8: Key Informant Interview Themes and Subthemes

3.8.1. Theme 1: Implementation

Implementation describes how each system was taken from conception to its current use. This process varied considerably between systems.

3.8.1.1. Piloting

Although all key informants discussed piloting methods, these varied across the systems. The initial implementation of PharmOutcomes in West Yorkshire CCG was only for patients who had their medicines dispensed into a Multicompartment Compliance Aid (MCA). This method was perceived as appropriate because the transmission of discharge information was already common practice in this patient population, albeit by fax. PharmOutcomes was implemented in all West Yorkshire CCG simultaneously rather than piloting incrementally by location.

RTP did not have an initial pilot, but it was implemented across all East Lancashire CCG

simultaneously for all patients. The RTP informant felt this lack of piloting was beneficial for increasing referral availability:

> *"If you were to pilot [a system] on a single ward, the chance of the pharmacy that you've lined up to do the pilot, one of their patients rocking up [one of their patients arriving] while you're doing a pilot is very, very low".*

In contrast to RTP and PharmOutcomes, NWIS piloted the DMR referral system geographically in approximately 42 pharmacies across three LHBs and then slowly rolled it out to the rest of Wales. Simultaneously, NWIS progressively rolled out MTeD in hospital wards across Wales.

3.8.1.2. Community Pharmacy Recruitment

Informants for RTP and PharmOutcomes discussed the importance of community pharmacist engagement during system implementation, ensuring they could use the system and accept referrals. The RTP informant described how persistence was needed when engaging with some community pharmacies during the implementation period:

> *"There were some people [community pharmacists] who, again human factors, took a few phone calls to say, 'please fill the form in', 'oh yeah, we'll do it now, we'll do it now'. Of course, they didn't, so we had to phone them back".*

The DMR informant did not discuss specific community pharmacist engagement strategies during system implementation.

3.8.1.3. Marketing Strategies

The RTP informant described a pre-determined marketing strategy to ensure that stakeholders were aware of the system, perceiving that it facilitated stakeholder engagement through the extensive dissemination of information.

> *"I wanted to create some sort of marketing strategy, so I got onto speakers circuits at various conferences. I started sending out a newsletter to interested parties to keep them informed of [system] developments, and that helped sort of create an awareness of what we were actually doing".*

In contrast, the PharmOutcomes and DMR referral system informants did not describe pre-determined marketing strategies. The DMR informant suggested they "*fell down a bit [partly failed] selling it to hospital pharmacists*", perceiving that the lack of marketing for the system was a barrier to its implementation.

3.8.1.4. Collaboration

All key informants discussed the importance of collaborating with local professional organisations to engage with community pharmacists. These organisations included local pharmaceutical councils (LPCs) and CPW. The RTP and DMR informants said that professional organisations

disseminated information to stakeholders. The PharmOutcomes informant described closer collaboration by directly showing pharmacy contractors how to use the system.

3.8.1.5. Dedicated Implementation Staff

All informants discussed the importance of staff dedicated to ensuring system implementation and engagement. The PharmOutcomes informant described how they were employed in Yorkshire CCG specifically to facilitate system implementation, which was beneficial.

> *PharmOutcomes informant: "…well that [funding] paid for me, which really helped sort the meetings at the hospital, ring the pharmacies, develop guides, develop the PharmOutcomes platform cos [sic] all that takes time really".*

The RTP informant described their extensive involvement in system implementation and emphasised the need for time and staff to ensure engagement. The DMR informant did not recount using dedicated staff for widespread system implementation. However, they explained how a single hospice employee organised system implementation because they perceived it as beneficial. Although the hospice was not a planned site for implementation, the DMR informant described how the employee overcame these barriers because *"where there's a will, there's a way".*

3.8.2. Theme 2: System Attributes

System attributes describe each system's variable functionalities: IT interoperability, referral prompts, referral to other healthcare services, outcome measures, and notifications.

3.8.2.1. IT Interoperability

All key informants discussed the importance of system interoperability for system engagement. The DMR informant described the extensive interoperability between the system and hospital and community pharmacy software, perceiving an improved workflow and reduced barriers to engagement.

> *DMR Informant: "It [DMR referral system] populates the [DMR] form for you. That saves them [community pharmacists] time as well […] I think it's probably removed a number of the barriers".*

The RTP informant shared a similar sentiment, suggesting that the system integration improved workflow, promoting engagement. In contrast, the PharmOutcomes informant perceived that a lack of interoperability with hospital software was a barrier to system engagement:

> *"It's [referrals] still an extra step for them [referring practitioners] I think. It'd be better if it was integrated into the hospital IT system somehow. Cos [sic] we use a web-based platform, and although it's a quicker system than using a fax it's still a lot of logging in and that's what they said, they'd use it if it was integrated".*

3.8.2.2. Referral Prompts

RTP prompts practitioners to refer eligible patients when recording the patient's drug history at admission, which was perceived to promote referral engagement. The other key informants did not describe similar features in their systems.

> *RTP informant: "It [RTP] prompts to make a referral if they're a blister pack [MCA] patient or a care home resident, so we're pretty good at making those referrals".*

3.8.2.3. Referral to Other Healthcare Services

Referring practitioners using RTP and PharmOutcomes can refer to other post-discharge healthcare services.

> *RTP informant: "We also send referrals to what we called a medicines support team, so a domiciliary pharmacy support service for people from [CCG name]. So that's to arrange home visits for people who are housebound or can't easily access community pharmacy services".*

The PharmOutcomes informant described how added functionality in West Yorkshire CCG allowed patient referrals to local warfarin clinics and mental health teams. However, this function was associated with added costs. The DMR informant suggested that expanding the system beyond community pharmacy referrals was not planned, as they have limited capacity and alternative priorities.

RTP and PharmOutcomes informants perceived that these alternative referrals were beneficial for promoting patient-centred care by optimising communication between the hospital and primary care providers.

3.8.2.4. Outcome Measures

The systems vary by the way that outcomes are measured and captured. The DMR informant described that the system collects data regarding individual medication discrepancies between the patient's discharge information and the first prescription received from the GP. The PharmOutcomes informant explained that their system records discrepancies and where they occurred, such as whether it was a discrepancy with the discharge information or medicines. However, PharmOutcomes records data on a patient-level compared to the individual medication-level seen with the DMR referral system. RTP collects outcome data from the community pharmacist when they complete the referral, inputting whether the referral saved or cost time, saved or cost medication waste, and prevented a discrepancy.

3.8.2.5. Community Pharmacy Notifications

All informants said the systems notified community pharmacists when the hospital discharged their patients. The RTP and PharmOutcomes informants explained how their systems also notified

pharmacists when their patients had been admitted to the hospital, which they perceived to be beneficial for reducing waste.

> *PharmOutcomes informant: "We can make hospital admission notifications so if it's a blister pack [MCA] patient then we can let them [community pharmacy] know they've [patient] been admitted to hospital. So, they can save the dispensary's time and waste while the patient is in hospital".*

The DMR informant said they had received requests to include admission notifications. However, they suggested it was challenging to implement.

3.8.3. Theme 3: Stakeholder Engagement

All participants discussed engagement with stakeholders to optimise system use, including accountability for referrals, responsiveness to stakeholder feedback, feedback to referring practitioners, staff training and patient consent support.

3.8.3.1. Accountability for Referrals

The PharmOutcomes and RTP informants described that designated HCPs create weekly reports highlighting referrals that community pharmacies had not actioned. The HCP then contacts these pharmacies to prompt them to contact the patient and provide support where needed. Both informants considered referral accountability a facilitator for system engagement.

> *PharmOutcomes informant: "I've seen some of the other systems go live, and they've had no support for community pharmacists. If you've got no-one pulling down a report to see which pharmacies are doing it, it just gets forgotten about. The pharmacists don't know how to use the system, and then it just falls apart".*

The RTP informant described similar methods to keep HPPs accountable for referring eligible patients. They perceived that providing feedback when HPPs discharged eligible patients without a referral encouraged system engagement.

> *RTP informant: "…they [HPPs] are being monitored, so they get quick feedback so 'ooh that patient was eligible why didn't you do that'. I think it's actually driving behavioural change".*

The DMR informant did not describe methods to keep stakeholders accountable for referrals. However, they suggested that hospital pharmacists were not engaging with the system because they were only held accountable for admission processes, not discharge.

3.8.3.2. Responsiveness to Stakeholder Feedback

The RTP informant discussed adapting stakeholder engagement strategies based on feedback, such as adding a quiz to improve knowledge of patient eligibility criteria:

> *"I thought I'll do a Refer-to-Pharmacy quiz and that'll be used by the staff to get them understanding why someone is eligible for referral. Despite the fact that when they go live, they have that training, it's obviously not embedding so we're looking at strategies to try and raise awareness of eligibility".*

The DMR informant described how NWIS developed the DMR referral system in response to feedback from both community and hospital pharmacists that fax transmission was onerous and unreliable. The PharmOutcomes informant did not describe facilitating engagement by responding to feedback.

3.8.3.3. Feedback to Referring Practitioners

RTP generates automated and routine feedback to referring practitioners by email describing its outcomes, such as discrepancies identified and costs saved. In contrast to the RTP automated feedback, the PharmOutcomes informant explained how referring practitioners had to log into the system to access referral outcomes. To provide routine feedback, the PharmOutcomes informant described how they organised regular hospital pharmacy meetings to share high-level information, which they felt generated enthusiasm and engagement:

> *"We have regular meetings with the hospital as well, so they can see what the pharmacy is doing. Y'know [sic], it's not just going into the ether like a fax was. They can see all the feedback and they're loving seeing all the data that pharmacy's doing and they're like 'let's keep going, let's send more referrals'".*

The DMR informant described how the system did not facilitate referring practitioner access to referral outcomes, automatically or otherwise. However, the informant suggested that the DMR form would soon be routinely uploaded to the all-Wales shared patient record, Welsh Clinical Portal (WCP), which they perceived would improve referral engagement. Although these outcomes would be accessible by HPPs, there would be no routine feedback from referrals.

3.8.3.4. Staff Training

Only the RTP informant described specific HPP training for system use. As described in Section 3.8.3.2, this training was expanded to include referral criteria quizzes targeted at stakeholder feedback.

3.8.3.5. Patient Consent Support

The different systems have different methods to support practitioners in gaining patient consent. RTP has patient-facing videos to describe the benefits of the service, which the informant perceived as helpful in gaining patient consent. The RTP informant described that the system could translate referral consent statements into multiple languages:

> *"…we've had it [consent statement] translated into multiple common local languages. So, at the click of a button if you know someone speaks Urdu or Polish or whatever, you can click a button and show whatever language on the screen, so they can read whatever we're trying to do".*

The RTP and DMR informants described how leaflets were developed to advertise the system to patients, distributed from hospital wards and community pharmacies. The PharmOutcomes informant did not recount any supporting material to support patient consent.

3.9. Discussion

This chapter used a multimethod approach to describe, compare, and contrast UK technology-supported transfer of care systems. Following a discussion of the chapter's strengths and limitations, system differences will be discussed in the context of wider literature to highlight potential areas of good practice for optimising DMR referral system use, addressing the chapter's aim. To the best of the researcher's knowledge, this chapter presents the first detailed comparison of UK systems.

3.9.1. Strengths and Limitations

The literature review employed several methods associated with rapid reviews, including omitting critical appraisal and literature screening by only the researcher (Tricco et al. 2017). Although these choices increased the risk of bias, they were pragmatic decisions made to improve the timeliness and yield of relevant literature. If the researcher had used a critical appraisal tool, much of the grey literature would likely have been excluded, and the findings would have been far less descriptive. Furthermore, the supplemental key informant interviews effectively provided depth and context, expanding on areas absent from the review. The researcher recruited one key informant per system based on their domain expertise. Although some researchers may consider the small sample a limitation, it was appropriate for the supplemental aims. Two interviews were conducted by telephone rather than face-to-face. Although this may have limited the richness of the interview, the researcher minimised this through rapport-building (see Section 3.7.3). On reflection, each key informant was enthusiastic about the topic area, providing vivid accounts of their respective systems, evidenced by the considerable interview length. However, the inability to recruit an HFH informant limited its description and comparisons. Although the key informants had different backgrounds and involvement with their respective systems, they provided similarly descriptive accounts of each aspect of the system implementation, attributes, and stakeholder engagement.

The following section supports the potential areas of good practice using wider literature. However, there is no direct evidence linking these findings to improved system engagement; therefore, they should be cautiously interpreted. Chapter 10 integrates results from all empirical thesis chapters, which may support these findings further.

3.9.2. Relevance to Wider Literature

This study highlights the different methods by which systems were implemented in their locality. The results show that the employment of dedicated staff was considered essential for RTP and PharmOutcomes implementation for engaging with stakeholders and disseminating information. A recent systematic review of the factors affecting the implementation of electronic interventions in healthcare supports this view (Ross et al. 2016). It concluded that implementation should be pre-planned and dedicated system 'champions' should be employed to implement and sustain technology use. LHBs should consider hiring a dedicated staff member to promote the DMR referral system by supporting HPPs to use it and understand its benefits. These staff could also keep community pharmacists and HPPs accountable for DMR referrals, as suggested by RTP and PharmOutcomes informants. These methods of accountability are supported by the Hawthorne Effect, which describes how observed individuals are more likely to enact a behaviour (McCambridge et al. 2014). This effect has been observed in many populations, including HCPs. Referral accountability could also change stakeholder perceptions of referrals, framing them as a perceived societal norm. The Theory of Planned Behaviour states that if staff perceive referrals as the societal norm, the intention to refer will increase (Williams et al. 2015). Therefore, stakeholders should consider implementing methods to keep community and hospital pharmacists accountable for referrals to optimise DMR referrals and provision.

The key informants considered that collaboration between hospital and community pharmacy professional organisations was essential for successful system engagement. Jeffries et al. (2021) highlighted the importance of developing a collaborative network of multiple stakeholders to support the local implementation of PharmOutcomes referrals in Salford (England). Therefore, community and hospital pharmacy organisations should consider close collaboration in Wales to promote cross-sector engagement with the DMR referral system.

For a system to effectively facilitate post-discharge support, patients vulnerable to the risk of post-discharge medication management issues must be eligible. All systems refer to commissioned post-discharge adherence support services, which differ depending on their UK location. These services need flexible eligibility criteria to allow a wide range of patients to access the support. Elderly patients are at higher risk of post-discharge medicines discrepancies but frequently cannot access community pharmacy services if they are housebound (Coleman et al. 2005; Ramsbottom et al. 2016). Although community pharmacists can provide DMR and dMUR services to patients in their homes (with local health authority permission), Hodson et al. (2014a) found that domiciliary DMRs were rare because of staffing and financial constraints. At the time of this study,

pharmacists in England could only provide the dNMS and dMUR to patients, not their carers. However, the dNMS was expanded in September 2019 to allow provision to carers (PSNC 2021b). Since the completion of this study, another change was the decommissioning of the dMUR in England in April 2021. This change restricts commissioned post-discharge services from RTP, PharmOutcomes and HFH to the dNMS and the new Discharge Medicines Service (DMS), introduced in February 2021 (NHS England and NHS Improvement 2021). The DMS allows service provision for carers and has broader eligibility criteria, expanding the patient demographics who can receive the support facilitated by these systems. Although post-discharge service eligibility is widening, some patients who do not meet these criteria will be excluded from post-discharge support. The DMR referral system in Wales could adopt the broader referral reasons described for RTP and PharmOutcomes, allowing referrals for other appropriate services, such as smoking cessation advice. These referral reasons would enable practitioners to adapt post-discharge support to address the patient's individual needs. Additionally, they could improve system engagement by accommodating patients who are unsuitable for a DMR but would benefit from other support.

NHS England (2019) prioritised increasing IT utilisation for care continuity in their long-term plan. Subsequently, the commissioned Topol Review (2019) was published, recommending increased IT provision and integration in the NHS. Although there is limited research surrounding the benefits of IT interoperability, this study suggests that referrals via systems without it disrupted workflow. The non-adoption, abandonment, scale-up, spread, and sustainability (NASSS) framework asserts that technology is less likely to be adopted if it disrupts workflow (Greenhalgh et al. 2017). The DMR referral system has extensive interoperability with MTeD and community pharmacy IT systems. However, MTeD implementation is not uniform across Wales, with partial implementation within hospitals in most LHBs, and none in ABUHB (see Section 1.4.2). Therefore, the roll-out of MTeD in Wales should be accelerated to increase the availability of the DMR referral system, potentially increasing DMR uptake. Alternatively, DHCW could consider developing interoperability between other electronic discharge systems and ChP, although this would oppose the Welsh Government's (2018) 'Once for Wales' approach of a single national system.

The extent of information transmission was different across the systems. In contrast to the DMR referral system and PharmOutcomes, RTP transmitted the entire DAL, including clinical information. Alongside information governance considerations, NWIS developed the DMR eDAL contents through interviews with community pharmacists who suggested that clinical information

would be helpful but not essential (Mantzourani et al. 2014). In contrast, Luetsch et al. (2021) proposed, from a realist synthesis of post-discharge medicines reviews, that community pharmacists perceived that access to clinical information allowed them to identify more significant discrepancies than medicines information alone. Therefore, commissioners should consider collaborating with DHCW to widen information access for the DMR referral system to promote DMR uptake. Including clinical information would align with the new Independent Prescribing Service in Wales, also provided through ChP (DHCW 2022b).

Patient consent was previously identified as a barrier to the DMR and its referrals during the original evaluation (Hodson et al. 2014a). The evidence for using multimedia consent aids to assist the patient consent process in healthcare is growing (Mawhinney et al. 2019). Therefore, it would be prudent to adopt video consent aides, like those identified in RTP, to support the consent process. DHCW could adopt multilingual consent statements like those found in RTP, as they may help address health inequalities by removing language barriers. Robinson et al. (2022a) suggested that such barriers often reduce non-English speakers' healthcare service engagement; therefore, adoption may improve DMR engagement.

Hodson et al. (2014a) described the lack of awareness of patient hospital admission as a DMR provision barrier for community pharmacists. DMR referral system adoption of admission notifications like RTP and PharmOutcomes could remove such barriers, promoting DMR engagement and reducing medicines waste. Another consideration for notification systems was their modality. The DMR referral system notifies by NHS email and ChP, requiring practitioners to log into these respective systems to access notifications. Self-determination theory states that behaviours with fewer barriers are more likely to be adhered to (Patrick and Williams 2012), providing the rationale for adapting system notifications to enable access. The DMR referral system could adopt methods used by PharmOutcomes, such as notification transmission to the pharmalarm® system. Since the completion of this study, Jeffries et al. (2021) evaluated the process of PharmOutcomes referrals. Community pharmacists interviewed for this study suggested that the pharmalarm® helped improve notification visibility, speeding up their access to referrals, supporting this chapter's recommendation for its use.

Before RTP implemented feedback, interviewed hospital pharmacists stated that they would like feedback from referrals or it would be like referring into a *"black hole"* (Ferguson et al. 2018). Similar feedback was obtained from hospital pharmacists referring to the DMR (Hodson et al. 2014a). Although NWIS developed the DMR referral system to address stakeholder barriers to DMR engagement, they did not address the previously identified hospital pharmacist barriers,

namely the absence of feedback. As of April 2020, each DMR's outcomes are automatically uploaded to WCP, providing referring practitioners access to referral outcomes (DHCW 2022b). Since this feedback is not direct to the referring practitioner, it is unclear whether busy professionals will access this information unless required for ongoing healthcare provision. Normalisation Process Theory describes how innovation implementation and embedding are more likely when stakeholders can reflect on its effectiveness (May and Finch 2009). The RTP automated feedback to referring practitioners could facilitate this reflection since they provide information regarding the referral's outcome. Therefore, integrating this feedback modality into the DMR referral system should be considered since it could motivate practitioners to refer patients.

3.9.3. Potential Areas of Good Practice

Error! Reference source not found. summarises the potential areas of good practice identified from this chapter's findings once contextualised with the wider literature.

Table 3.10: Summary of Findings from Chapter 3

Potential Areas of Good Practice	Associated System(s)
Employing a dedicated staff member to champion system use, including ensuring pharmacy staff can use it and understand its benefits.	• RTP • PharmOutcomes
Collaboration between local professional organisations to promote system use.	• RTP • PharmOutcomes • DMR referral system
Holding community and hospital pharmacy staff accountable for system referrals.	• RTP • PharmOutcomes
Interoperability between the referral system and hospital IT systems.	• RTP • DMR referral system†
Interoperability between the referral system and community pharmacy IT systems.	• DMR referral system
System community pharmacy notifications upon patient hospital admission and discharge from the hospital.	• RTP • PharmOutcomes • DMR referral system (discharge only) • HFH (discharge only)
Flexible community pharmacy notification modalities such as USB device alerts.	• RTP (personal email accounts and text messages) • PharmOutcomes (USB device and personal email accounts)
System-enabled routine feedback to referring practitioners regarding the outcomes of the referral.	• RTP (automated feedback by email) • PharmOutcomes (referring practitioners can log into the platform to see outcomes)
Enhanced information access with referrals, including clinical information.	• RTP
System-enabled support for obtaining patient consent for referral.	• RTP (multilingual consent statement and an educational video)

†Only when the referring hospital ward uses MTeD.

3.10. Conclusions and Dissemination

This chapter achieved Thesis Objective 1, using literature reviews and key informant interviews to identify areas of good practice from similar UK transfer of care systems and their implementation. Once integrated with other thesis findings in Chapter 10, the areas of good practice will form the basis of recommendations to optimise the DMR referral system, hopefully increasing DMR uptake. Further research is needed to determine factors affecting stakeholder engagement with systems. The next chapter builds that evidence, exploring HPPs' engagement with DMR referrals.

As detailed in Section 2.3, the researcher disseminated research outcomes to multiple stakeholder groups: the ChP Clinical Reference Group, NWIS Delivery Board, AWQPSG, P:DaHW Delivery Board and DMR subgroup. Additionally, the contents of this chapter were published as a journal article and several abstracts:

- James, R., Mantzourani, E., Way, C., Gray, A., Burnley, M. and Hodson, K. 2021. Using Technology-Supported Transfer of Care Systems: Informing Good Practice Recommendations. *Pharmacy* 9(1), 36. doi: 10.3390/pharmacy9010036.
- James, R., Hodson, K., Mantzourani, E., Way, C., Gray, A. and Burnley, M. 2020. Improving the discharge medicines review service in Wales: learning from the comparison of technology-supported UK transfer of care systems. *International Journal of Pharmacy Practice*, 28(S1), 30. [HSRPP Oral presentation].
- James, R., Hodson, K., Mantzourani, E., Way, C., Gray, A. and Burnley, M. 2019, Nov-19. Improving the DMR Service in Wales: Learning from the Comparison of Technology-supported UK Transfer of Care Systems. Poster presented at the *RPS Medicines Safety Conference 2019*, London.

Chapter 4. Exploring Hospital Pharmacy Professionals' Engagement with DMR Referrals

4.1. Chapter Introduction

Community pharmacists interviewed for the original DMR evaluation described several barriers to service uptake, including a lack of awareness of patient discharge and a lack of access to the patient's discharge advice letter (DAL) (Hodson et al. 2014a). NWIS aimed to address these issues by introducing the DMR referral system in April 2015, which aligns with the WHO (2017) recommendations to reduce the risk of preventable medicines-related harm (MRH) at care transitions: improving the quality and availability of information and enabling post-discharge interventions. However, in late 2015, community pharmacists interviewed [n=17] about the DMR module in Choose Pharmacy (ChP) suggested they rarely received referrals from hospitals; therefore, DAL access was still a barrier to DMR provision (Mantzourani et al. 2017). Optimising DMR referrals, a complex intervention, would improve DAL availability, reducing community pharmacist barriers to DMR provision. The MRC framework for evaluating complex interventions proposes investigating to what extent an intervention has been implemented and the contextual factors influencing its implementation (Moore et al. 2015). Therefore, this chapter addresses Thesis Objective 2: explore hospital pharmacy professionals' (HPPs') engagement with DMR referrals (the intervention).

During the original service evaluation, hospital pharmacists described a lack of awareness about the DMR and felt left 'out of the loop' in service design and implementation (Hodson et al. 2014a). Consequently, many hospitals had not developed DMR referral processes. To the best of the research team's knowledge, there have been no attempts to improve HPPs' DMR awareness since the evaluation. Therefore, it was unlikely that there were defined processes for DMR referrals across Wales. Understanding the context of hospital processes for transmitting information to community pharmacies was essential to contextualise HPPs' views of DMR referrals and the subsequent service. Hence, the chapter's objectives were to:

1. Describe hospital pharmacy processes for transmitting discharge information to community pharmacies across Wales.
2. Explore HPPs' perceived barriers and facilitators to DMR referral engagement.

4.2. Chapter 4 Methods Overview

Section 2.5 justified using a qualitative methodology with a hermeneutic phenomenology design to address Thesis Objective 2. In line with recommendations in the MRC framework, the researcher involved stakeholders to ensure the study's design was feasible and that the findings would be relevant for influencing policy (Skivington et al. 2021). As detailed in Table 2.2, the All Wales Quality and Patient Safety Group (AWQPSG) assisted in the study design for this chapter, a subgroup of Local Health Board (LHB) Chief Pharmacists overseeing patient service and medicines

safety issues in hospitals across Wales. The group's chair (DD) volunteered to contribute to study development and regularly met with the research team to discuss optimal study design. This chapter will highlight any specific stakeholder contributions to the study design.

Section 2.7.3.2 described that focus groups were chosen for this chapter to encourage participant interactions, allowing participants to prompt each other when answering questions and to provide information regarding team dynamics (Flick 2018). This section describes considerations for the employed focus group method.

4.2.1. Population and Sampling

This section justifies this chapter's employed population and sampling approach, as summarised in Figure 4.1.

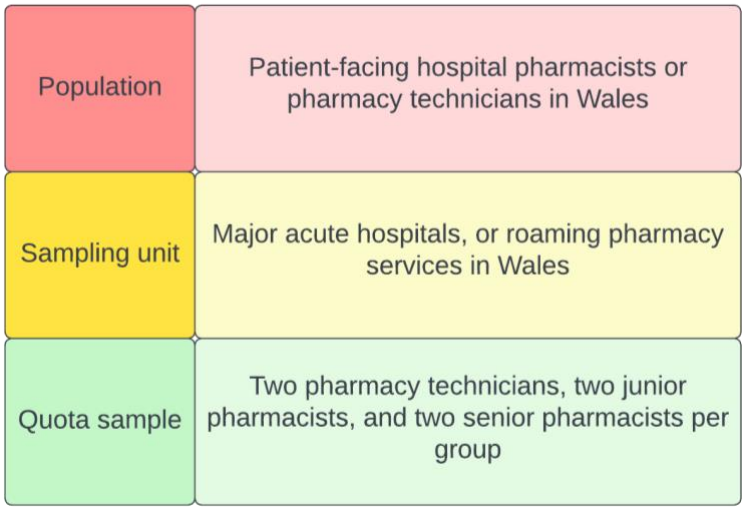


Figure 4.1: Summary of Focus Group Sampling Strategy

To address the study's aims, the researcher had to define a population that included staff involved in DMR referrals on an all-Wales basis, representing all LHBs. Since DD suggested that pharmacists and pharmacy technicians (PhTs) are directly involved with the discharge process and could provide insight into DMR referrals, patient-facing HPPs working in secondary care in Wales were chosen as the most appropriate research population.

Hospitals were used as a sampling unit, ensuring that each group would contain participants employed by the same hospital. Rather than completing a focus group in every hospital in Wales, e.g., acute and community hospitals, the researcher restricted the population to major acute hospitals (hospitals containing an emergency department). This categorisation represents a diverse range of hospitals, including multiple hospitals within each LHB (NHS Wales [no date]). However, PTHB (an LHB serving a rural population) does not have any major acute hospitals and has a team of HPPs that travels around the region's district hospitals where needed. This roaming

pharmacy service was added as a further sampling unit to explore their views. Therefore, the total number of sampling units, thus, focus groups attempted was 17.

The researcher aimed to recruit six participants per group to allow individual group members to share their experiences, in line with recommendations from Krueger and Casey (2014) of six to eight participants. Consequently, the overall study sample size [n=102] is large in the context of qualitative literature. However, the sample size was appropriate in the context of a broad all-Wales approach, in keeping with the principle of information power (see Table 2.5).

Since DD suggested including pharmacists and PhTs due to their unique roles and perspectives, the focus groups could have been homogenous (six PhTs) or heterogeneous. Section 2.7.3.2 theorised how organisational culture could affect DMR referral engagement. Therefore, the researcher used heterogeneous focus group compositions to allow participants to interact in their usual multidisciplinary environment. Previous research into engagement with DMR referrals identified low awareness of the DMR amongst hospital pharmacists (Hodson et al. 2014a). Therefore, the researcher included senior pharmacists (band 8+) in the same focus group as junior pharmacists (band 6-7) and PhTs to increase the likelihood of a focus group member recalling the initial DMR implementation. These participants could then provide insight and context to the others. NHS agenda for change pay bandings were used to define the seniority of the pharmacists because it often reflects their level of responsibility and years of experience (Jankovic 2019). Power disparities in focus groups could discourage honest discourse from the less senior group members (Clark et al. 2021). Nevertheless, the researcher considered that the advantages of heterogeneous focus groups for achieving this chapter's objectives outweighed this potential risk. Participants were offered one-to-one interviews if they were uncomfortable participating in their colleagues' presence or wanted to participate but could not attend the group.

Since the skill mix was crucial for data collection, the researcher chose a quota sampling method to ensure a balanced representation of participant characteristics (Flick 2018). This quota included two PhTs, two junior pharmacists and two senior pharmacists in each focus group.

4.2.2. Focus Group Study Approvals

Using the HRA (2020) guidance, the researcher defined this study as a service evaluation rather than research since it did not intervene in standard practice nor use randomisation. As a service evaluation, the study did not require NHS ethics approval. Therefore, the researcher obtained approval from CSPPSREC (reference: 1819-24).

Since the chapter involved NHS employees, each LHB had to confirm the study as a service evaluation and register it, thus allowing their respective staff to participate. The Research and Development (R&D) department for each LHB [n=7] confirmed that the study was a service evaluation. Due to process variation, it was challenging to identify the registration process for each of the seven LHBs. Some R&D departments took immediate responsibility for service evaluations, and the researcher completed a simple form for registration. Other R&D departments suggested that the pharmacy clinical directorate was responsible for study registration, which was challenging to identify for a researcher unfamiliar with the hospital staff. One LHB requested the researcher obtain a research passport and a letter of access, documents required to conduct research projects on NHS premises, despite ratifying the project as a service evaluation (HRA 2019). Despite these challenges and associated time commitments (ten weeks), the necessary approvals to complete the focus groups were obtained in each LHB.

4.2.3. Recruitment Strategy

Recruitment of healthcare professionals (HCPs) for research is a recognised challenge, with hospital pharmacists identifying that time is a significant barrier to research engagement (Awaisu and Alsalimy 2015). Additionally, recruitment for focus groups has unique logistical challenges compared to other qualitative methods because of the need to coordinate the attendance of multiple participants. The researcher carefully designed study documentation and used gatekeepers for recruitment to overcome these challenges.

4.2.3.1. Study Documentation Considerations

The researcher employed evidence-based study documentation design principles (see Section 2.7.1.2) to optimise engagement, including explaining the study's importance to potential participants and limiting the length of correspondence. Although the evidence for the effect of a figure of authority's endorsement on response rate is mixed, some studies have shown a positive impact on survey research responses (Ngune et al. 2012). Therefore, the researcher included a sentence describing how Wales' Chief Pharmaceutical Officer (a research team member) supported the study. These design principles were applied to this study's recruitment email (Appendix 4.1) and participant information leaflet (PIL) (Appendix 4.2). The researcher chose recruitment emails over letters because of their lower associated costs and availability since every HPP in Wales has a designated email address (Clark et al. 2021; DHCW 2022a).

After reading the PIL, participants had to sign the consent form (Appendix 4.3) before participating. The researcher included a consent form clause obliging participants to keep discussions confidential because anonymity cannot be guaranteed in focus groups.

4.2.3.2. The Role of the Gatekeepers

Since the researcher did not have HPPs' contact details, they involved gatekeepers to facilitate recruitment. DD suggested that this role could be fulfilled by an AWQPSG member employed by the hospital for each planned focus group. The researcher described the study's background and aims to the volunteering members and defined their role in recruitment: to distribute study materials, organise the time and location of the focus groups, and act as recruitment champions. The latter role involved encouraging potential participants to engage with the research process during staff meetings, an established method of increasing response rates for healthcare research (Ngune et al. 2012). The gatekeepers were asked to identify and supply any DMR referral standard operating procedures (SOPs) for their employing hospital or LHB. These SOPs allowed the researcher to become familiar with the LHB procedure and use them as a prompt for participants when completing the focusing exercise, which required them to describe their hospital processes (see Section 4.2.4.3).

Each gatekeeper sent the recruitment email (with attached PIL and consent form) to all patient-facing HPPs working in their respective hospital. The researcher aimed to recruit the first two participants of each participant type that returned the consent form. After two weeks, the gatekeeper distributed a reminder email (Appendix 4.1) to prompt participation. If recruitment was suboptimal after distributing the reminder email, the gatekeeper encouraged recruitment in staff meetings, targeting specific participant groups if they were missing from the quota. The gatekeeper organised the focus group's timings during this process, distributing the details by email.

4.2.4. Focus Group Conduct

This section describes the researcher's considerations for focus group conduct: moderators, location, room layout, and structure.

4.2.4.1. Moderator and Assistant Moderators

Focus groups require the participation of a skilled moderator and assistant moderator to facilitate discussion. The moderator leads each group, facilitating the discussion by ensuring it stays on-topic and that each group member can contribute, prompting quieter group members (Clark et al. 2021). The assistant moderator is responsible for taking notes regarding interesting conversation sections and non-verbal language (Krueger and Casey 2014). The researcher moderated each group, and two undergraduate pharmacy students undertaking their masters' dissertations were assistant moderators (research passports and letters of access were obtained for the assistant moderators for the LHB that requested them). Table 4.1 describes the responsibilities of focus

group moderators and assistant moderators and the methods employed to meet these responsibilities (Krueger and Casey 2014; Clark et al. 2021).

Table 4.1: Focus Group Moderator and Assistant Moderator Responsibilities

Moderator Responsibility	**Employed Methods**
Skilled moderation	The researcher read extensive research methods literature to ensure they were knowledgeable and confident in focus group moderation. Additionally, they participated in three focus groups (unrelated to this thesis) as an assistant moderator for the experience.
Keeping the discussion on the topic	The researcher used the focus group schedule to guide the discussion (see Section 4.2.4.3).
Exploring emerging areas of interest	The researcher used verbal ("why?", "can you explain that a bit further?") and non-verbal prompts (nodding) alongside silence to encourage participants to continue their trail of thought where appropriate.
Avoiding influencing participants	The researcher remained neutral and did not express opinions on the participants' views.
Enforcing ground rules	Participants were asked not to talk over each other to avoid obscuring the audio recording and to prevent more extroverted personalities from dominating the discussion. When this did not adequately enforce the ground rules, the researcher made eye contact with quieter participants and turned toward them.
Assistant Moderator Responsibility	**Employed Methods**
Skilled assistant moderation	The assistant moderators completed extensive literature reviews regarding the DMR and focus group methods to ensure they understood their roles and responsibilities.
Notetaking (see Appendix 4.4 for an example)	The assistant moderators kept notes to supplement the audio recording, demonstrating whether opinions were isolated or shared by the group. These notes included participant characteristics, laughter, and non-verbal interactions like eye-rolling or nodding.
Consistency	Some qualitative researchers suggest using the same assistant moderator for all focus groups in a study to increase consistency. To mitigate the use of multiple assistant moderators, the research team met before the first focus group to discuss an agreed format for notetaking. Additionally, both assistant moderators attended the first two focus groups, after which the researcher provided feedback on their moderation skills and notetaking.

4.2.4.2. Location and Room Layout

When deciding on the focus group locations, the researcher considered the differences between face-to-face and online focus groups. Although online methods would have been more cost-effective and convenient, the researcher completed the focus groups face-to-face to generate richer data with fewer participant distractions (Clark et al. 2021). The focus groups were completed on each respective hospital's premises since Clark et al. (2021) propose that participants may be more forthcoming with information in familiar surroundings. Additionally, organising focus groups in the participants' hospital minimised their time away from work. Whilst each focus group was conducted in a different location, Table 4.2 presents the researcher's considerations for ensuring consistency, and Figure 4.2 provides an example (Clark et al. 2021).

Table 4.2: Considerations for Focus Group Room Setup

Focus Group Room Characteristic	Rationale
Gatekeepers were asked to choose a quiet and private room.	To limit distractions and ensure recording fidelity.
The participants and researcher sat around the table, facing each other.	To maximise participant interactions and mitigate any perceived power disparity between the researcher and participants.
The audio-recording device (Phillips DPM6700) was placed in the centre of the participants.	To ensure the recording fidelity of all participants.
The assistant moderator(s) sat back from the discussion.	To ensure they could observe the whole group and make notes in a non-obstructive manner.

Figure 4.2: Example of Focus Group Room Setup

4.2.4.3. Focus Group Structure

Before beginning the focus group, the researcher welcomed participants, explained the ground rules, and made small talk to make them feel comfortable, facilitating open discussions (Krueger and Casey 2014). The researcher developed the focus group schedule with feedback from DD and supervisors, ensuring it was suitable to address the study aims. Table 4.3 presents the schedule, including the rationale for the inclusion of each item. The researcher was flexible with the focus group schedule, as is common in qualitative research, altering questions and prompts where appropriate to highlight the participants' unique experiences (Flick 2018).

Table 4.3: Contents of the Focus Group Schedule and the Rationale for Their Inclusion

Focus Group Schedule Item	Rationale
If everyone is ok with getting started, I'll start the recording now [start recording]. To make it easier for the researchers to identify everyone on tape when transcribing, could we go around the room and say your name and job role?	To enable transcribers to distinguish participants and to provide context for their contributions (Clark et al. 2021).
I'll summarise the DMR process for you [describe the nature of the DMR and its referrals]. Do you have any questions about the DMR process before we start?	To ensure participants understood the DMR before the discussions began.
I would like you, as a group, to make a flow chart of the process of referring a patient for a DMR in your hospital. • What does the DMR policy for the hospital say? [prompt] • What staff members are involved in referring a patient for a DMR? [prompt] • What patients would you refer for a DMR? [prompt]	Focusing exercises are well-established in focus group research to promote discussion, act as an icebreaker, and unveil some group dynamics (Clark et al. 2021). Any SOPs supplied by the gatekeeper were used as prompts.
Please take a few minutes to read through the document in front of you. It is an excerpt from an RPS report stating how transfers of care should be implemented. • I'd like to begin by discussing how well each of these four core principles reflects the practice in your workplace. • How well do you feel your organisation meets each of their responsibilities in this document?	The RPS (2012, p. 16) document '*Keeping patients safe when they transfer between care providers – getting the medicines right'* excerpt highlights principles for professionals and organisations to provide exemplary transfer of care. The document prompted discussions regarding organisational perspectives surrounding care transitions and DMR referrals.
What are your thoughts and feelings on the DMR? • What do you think are the current barriers to referrals for the DMR? [prompt]	Open-ended questions help facilitate discussions in focus groups (Flick 2018), which could prompt discussions about referral barriers and facilitators.
Previous evaluation of the DMR stated that hospital pharmacists felt it was difficult to determine whom to refer for a DMR and felt they did not get enough feedback about the service. We have already discussed personal, organisational, and service-level issues with the DMR service. I'd like you to consider each of those levels individually for a moment.	To facilitate discussions around previously identified referral barriers (Hodson et al. 2014a), determine their current relevance or any facilitators that have mitigated them.
What changes would you make to improve engagement with DMR referrals?	To allow participants to reflect on the discussions and suggest any areas for improvement to optimise referrals.
• Does anyone have anything to add that we have not covered in our discussion? • The participant debrief [the researcher summarised the fundamental areas of discussion, allowing participants to clarify, correct or add any further comments].	Participant debriefs confirm that the researcher's perception of the key discussions was congruent with the participants' views (Krueger and Casey 2014).

4.2.5. Data Preparation and Analysis

The audio recordings were transcribed *ad verbatim* by the researcher [n=6], assistant moderators [n=7] and professional transcription services [n=2]. The researcher quality assured each transcript by listening to the audio recording and making necessary corrections, then stripping them of identifying information. Finally, the transcripts were annotated using the assistant moderators' supplementary notes.

The researcher chose reflexive thematic analysis (assisted with NVivo® v11) as the most appropriate analytical approach to address this chapter's aim (see Section 2.8.2.3), starting with inductive analysis. Then the data were analysed deductively to identify processes for information transmission to community pharmacies and the previously identified barriers for referrals: DMR referral feedback and the perceived need for referral criteria (Hodson et al. 2014a). The researcher checked for differences in themes and subthemes across participant groups, hospitals and LHBs.

4.3. Focus Group Results

The researcher conducted 15 focus groups in major acute hospitals in Wales and one with the roaming pharmacy service in PTHB. One major acute hospital did not participate due to low recruitment. Two participants from this hospital agreed to participate in interviews but subsequently declined due to a lack of time. Due to time constraints, the researcher made no further attempts to organise a focus group in this hospital. Table 4.4 describes each focus group's details, composition, and whether each gatekeeper identified an SOP for DMR referrals. Appendix 4.5 outlines each focus group's participant characteristics.

Table 4.4: Details of the Completed Focus Groups

LHB	Focus Group (FG)	Pharmacy Technicians (PhT)	Junior Pharmacists (JP)	Senior Pharmacists (SP)	Time (Hours: Minutes)	Date	SOP Availability
LHB1	LHB1-FG1	1	2	2	1:38	29/10/19	LHB SOP available.
LHB2	LHB2-FG1	1	2	2	1:53	17/10/19	No SOP identified.
	LHB2-FG2	2	2	2	1:43	17/10/19	
	LHB2-FG3	2	1	2	1:46	05/11/19	
LHB3	LHB3-FG1†	1	2	4	1:19	21/11/19	Out-of-date LHB SOP (last updated January 2012).
	LHB3-FG2	2	2	2	0:58	07/11/19	
LHB4	LHB4-FG1	2	0	1	1:24	20/11/19	Out-of-date LHB SOP (last updated February 2012).
	LHB4-FG2	2	2	2	1:41	19/11/19	Hospital SOP available.
	LHB4-FG3	2	2	1	1:33	06/11/19	Out-of-date LHB SOP (last updated February 2012).
LHB5	LHB5-FG1††	2	2	2	1:00	14/11/19	No SOP identified.
	LHB5-FG2	2	2	2	1:28	13/11/19	
	LHB5-FG3	2	2	2	1:16	26/11/19	
	LHB5-FG4†	2	1	3	1:30	25/11/19	
LHB6	LHB6-FG1†	3	4	1	1:32	05/12/19	No SOP identified.
LHB7	LHB7-FG1	2	1	2	1:36	12/11/19	LHB SOP available.
	LHB7-FG2†	3	2	2	1:35	26/11/19	
Total	16 FGs	31	30	31	23:52	N/A	

†Extra participants who had not registered their interest in advance attended the focus groups. The researcher decided it would be worth including these participants since they had shown interest.
††One senior and junior pharmacist who agreed to participate did not attend due to unforeseen work commitments. Consequently, this group did not have a junior pharmacist.

Few up-to-date DMR referral SOPs were identified, most of which applied to the LHB rather than the specific hospital, other than LHB4-FG2. Due to practical recruitment difficulties, the focus groups frequently deviated from the planned quota (two senior pharmacists, junior pharmacists, and PhTs). However, given the overall sample size, the researcher considered that it was acceptable to deviate from the quota for each focus group if each participant type was represented.

The researcher constructed six themes inductively and two deductively. Rather than presenting the themes according to the analysis procedure (inductive then deductive), they are interwoven to ensure narrative flow and avoid unnecessary repetition. Figure 4.3 presents the eight themes, with deductive themes italicised. Most variation in theme distribution existed between hospitals rather than LHBs and professional groups. However, the results highlight these differences where they exist.

Theme 1: Familiarity with the DMR and its Referral Process	***Theme 2: Processes for Information Transmission to Community Pharmacies***	**Theme 3: Intra-professional and Inter-professional Collaboration**	**Theme 4: Integration of DMR Referrals into the Workflow**
1.1 DMR Awareness 1.2 Awareness of DMR Benefits 1.3 Familiarity with the DMR Referral Process	*2.1 DMR Referral Processes* *2.2 Information Transmission for Ongoing Medicines Supply* *2.3 Patient Consent for Referrals* *2.4 Electronic Discharge Systems*	3.1 Familiarity With the Community Pharmacy Sector 3.2 Collaborative Culture 3.3 Perceived Benefits of Information Exchange 3.4 Post-Discharge Liaisons	4.1 Workload Capacity for DMR Referrals 4.2 Optimising Patient Identification 4.3 Sustaining DMR Referrals
Theme 5: The Role of Pharmacy Professionals in Post-Discharge Support	***Theme 6: Previously Identified DMR Referral Barriers***	**Theme 7: Electronic Discharge System Uniformity**	**Theme 8: Training and Education Requirements**
5.1 Dedicated Time 5.2 Comprehensiveness of Post-Discharge Support 5.3 Business Orientation 5.4 Personal Relationships 5.5 Intra-professional Communication 5.6 Service Consistency and Continuity	*6.1 DMR Referral Feedback* *6.2 Perceived Need for Referral Criteria*	7.1 Barriers to MTeD Adoption 7.2 System Uniformity Operational Issues 7.3 Shared Care Records	8.1 Dissemination of Information 8.2 Staff Induction Training 8.3 Integrated Training 8.4 Educating Other Stakeholders

Figure 4.3: Focus Group Constructed Themes and Subthemes

MTeD = Medicines Transcribing and electronic Discharge.

4.3.1. Theme 1: Familiarity with the DMR and its Referral Process

One of the main DMR referral barriers identified in all focus groups was the lack of awareness of the DMR, its benefits, and how to refer to it.

4.3.1.1. DMR Awareness

LHB4-FG2 participants were knowledgeable about the DMR. However, most participants in all other focus groups lacked awareness of the DMR, a clear barrier to referrals.

> *LHB7-FG1-JP1: "I've been here for eighteen months, so I've not been here a long time, but I wasn't even aware it [the DMR] was a thing".*

Senior pharmacists and other experienced HPPs were more aware of the DMR than other professional groups. This difference could be explained by previous projects to increase DMR referral awareness, which waned over time.

> *LHB4-FG2-PhT1: "We used to do it [DMR referrals]. I'm talking years ago now […] and then that just went by and by, so there's now a whole cohort of new people that come in that probably wouldn't, it wouldn't even register".*

Many participants had misconceptions about the service specification and scope, mainly that the DMR involved making clinical decisions about a patient's care. This misconception generated a barrier to DMR referrals for some pharmacists because they were sceptical of the community pharmacist's confidence and competence with clinical services. Another misconception described by many participants was that the DMR could not recruit elderly or housebound patients, including those who had medication collected on their behalf.

> *LHB6-FG1-PhT1: "Some of my patients that I think it [a DMR] might be useful for, you then discover 'oh I get my medicines delivered', so they never actually step foot in the community pharmacy".*

When the researcher informed these participants that pharmacists could provide telephone DMRs, many suggested that these would be inferior to a face-to-face consultation, especially if the patient were hard of hearing. Many participants thought patients should receive post-discharge support in their homes because they would be more at ease, and the practitioner could remove unnecessary medicines. However, many participants thought domiciliary DMRs were infeasible. This view was grounded in their perceptions that community pharmacists were often lone workers that could not leave the pharmacy because of the responsible pharmacist regulations.[14] Many participants were unaware that DMRs could be provided to a carer, but most agreed it was a facilitator once informed.

[14]The Medicines (Pharmacies) (Responsible Pharmacist) Regulations (2008) prevent pharmacies from completing regulated activities (such as dispensing) unless there is a pharmacist on-site.

4.3.1.2. Awareness of DMR Benefits

Participants in all focus groups (except LHB4-FG2) lacked knowledge of DMR benefits, stating they would not prioritise referring patients to a service they did not perceive as valuable. Only two senior pharmacists were familiar with the published evidence of DMR benefits; therefore, it was clear that there was no effective evidence dissemination.

> *LHB1-H3-SP1: "Maybe they [HPPs] are not aware of the [DMR association with readmission] data, cos [sic] I have not heard of that specific data being quoted otherwise I think otherwise [sic] I would think post-discharge MUR [DMR] is a good thing".*

Although unfamiliar with the evidence, some participants, especially pharmacists with community pharmacy experience, perceived the DMR as valuable. These participants suggested that the DMR would improve patient safety by reducing discrepancies and hospital readmissions. In contrast, a few pharmacists remained sceptical of the DMR benefits, even when the researcher described the evidence. Some of this scepticism was borne from misunderstandings about the service and doubts about community pharmacists' role in post-discharge support, elaborated upon in Section 4.3.5.

4.3.1.3. Familiarity With the DMR Referral Process

Participants in all focus groups, except LHB4-FG2, lacked familiarity and confidence with DMR referrals, including who and how to refer. In the hospitals using MTeD, most participants did not know how to refer patients electronically using the ChP functionality, and some did not associate it with the DMR service. Consequently, a few participants had been using the ChP functionality regularly without understanding that it gave electronic DAL (eDAL) access to community pharmacists. Additionally, a few PhTs and junior pharmacists were unaware of the existence of the functionality. In hospitals that used MTeD, some participants were unaware that electronic DMR referrals automatically notified community pharmacists of patient discharge, suggesting it should be considered to improve engagement.

Many participants were unaware of the eDAL contents and when the information was available to the community pharmacist post-discharge, which was a referral barrier.

> *LHB5-FG3-PhT2: "I feel like I'm a little bit afraid to use Choose Pharmacy just because I don't know what it looks like. Do you get that? You don't know what the system is like and what it entails and how to use it".*

Participants in one focus group felt that knowing the eDAL contents would be helpful because they could improve the quality of information they enter at discharge.

4.3.2. Theme 2: Processes for Information Transmission to Community Pharmacies

During the focussing exercise, the researcher asked participants to map out their hospital's DMR referral process and any processes for transmitting discharge information to community pharmacies for other purposes.

4.3.2.1. DMR Referral Processes

Most hospitals did not routinely refer for DMRs, and participants were unaware of any existing SOP, even when one existed. Senior pharmacists were more likely to be aware of the existence of SOPs but often stated how they were not up-to-date. Only LHB4-FG2 participants identified a routine process for DMR referrals, summarised in Figure 4.4. An up-to-date SOP documented this process, with which all participants were familiar.

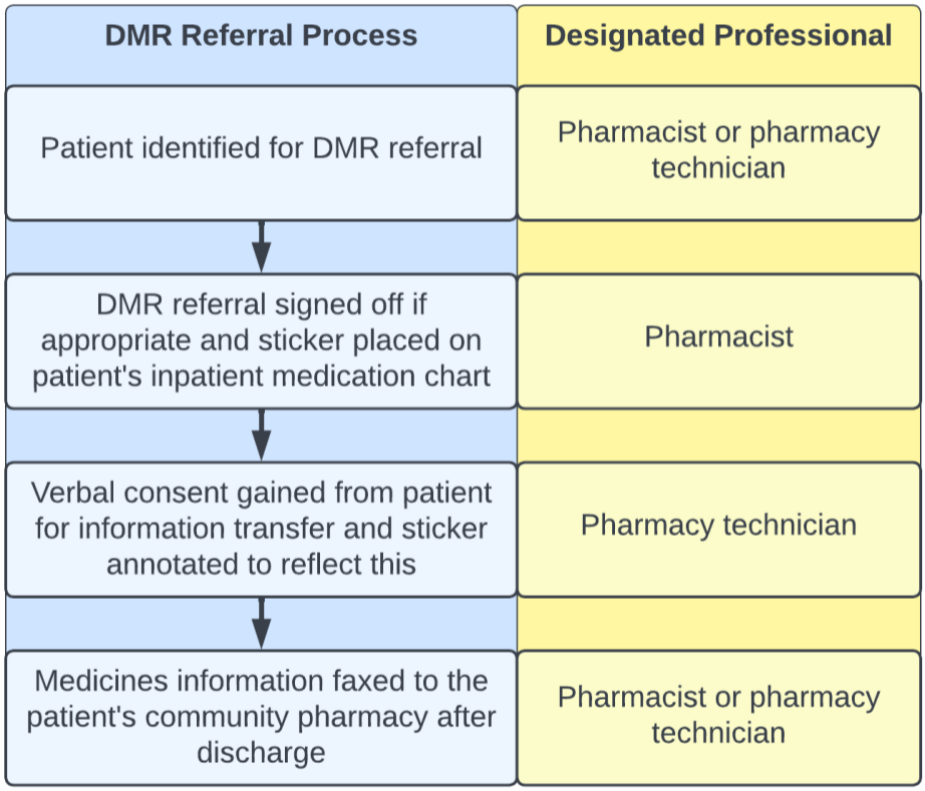


Figure 4.4: DMR Referral Process for LHB4-FG2

The eligibility criteria for DMR referrals in LHB4-FG2 were patients who:

- had a medication change during admission,
- took four or more medicines,
- had medicines dispensed into a Multicompartment Compliance Aid (MCA),
- were newly initiated on high-risk medications, i.e., anticoagulants,
- were newly initiated on inhalers or had poor inhaler technique,
- were frequent hospital attendees.

The participants in this focus group discussed how they felt that strict eligibility criteria could exclude some patients from being DMR referrals who could benefit from the service. Although

many were not in active use, the SOPs from other hospitals allowed referrals using the practitioner's professional judgement.

LHB1-FG1 participants described that their electronic discharge system automatically printed off a DAL for the patient's community pharmacist. Discharging practitioners routinely placed the DAL in each patient's medicines bag in an envelope marked *"to be taken to your community pharmacy"*. Participants in other focus groups discussed how their hospital had previously used similar letters to encourage patients to attend their community pharmacy for a DMR. However, they were uncertain whether these letters were still available.

As described in Figure 4.4, the LHB4-FG2 DMR referral process required a pharmacist to sign the patient off as appropriate for a DMR referral. However, PhTs could flag them for the pharmacist to review, which pharmacists in this group described as essential for the feasibility of referrals.

> *LHB4-FG2-JP2: "I mean, if it wasn't for the technicians [PhTs] taking up the bulk of it [DMR referrals], I don't think many would be done at all because I don't think anybody has the time".*

In one focus group, participants discussed how PhTs could not refer for DMRs because they did not have access to the electronic discharge system. One pharmacist explained that they did not have a PhT on their ward; therefore, they would have to identify all eligible DMR referral patients. In a few focus groups, participants suggested that ward pharmacists and PhTs would identify and refer patients for DMRs, unlike those working in the dispensary.

> *LHB2-FG1-JP1: "If I'm the ward pharmacist for that patient, then I will know that patient quite well, and I will have done a really good job of their discharge. If I'm in the dispensary dealing with ten discharges that have come down from the ward that's got no cover today, I know **none** of these patients".*

4.3.2.2. Information Transmission for Ongoing Medicines Supply

Unlike DMR referrals, participants in all focus groups discussed robust processes for transmitting discharge information for patients who have their medication dispensed into MCAs. Fax transmission of discharge information was used if the discharging ward did not have the facility for electronic transmission. Hospital wards with the facility for electronic transmission typically used fax because it was more suitable for patients who needed an MCA prepared before discharge.

Only LHB3 routinely used electronic transmission for MCA patients, except in their mental health wards and admission units, which did not have this functionality. Figure 4.5 describes typical processes for MCA patient information transmission to community pharmacies electronically and by fax. A pharmacist or PhT may complete each stage.

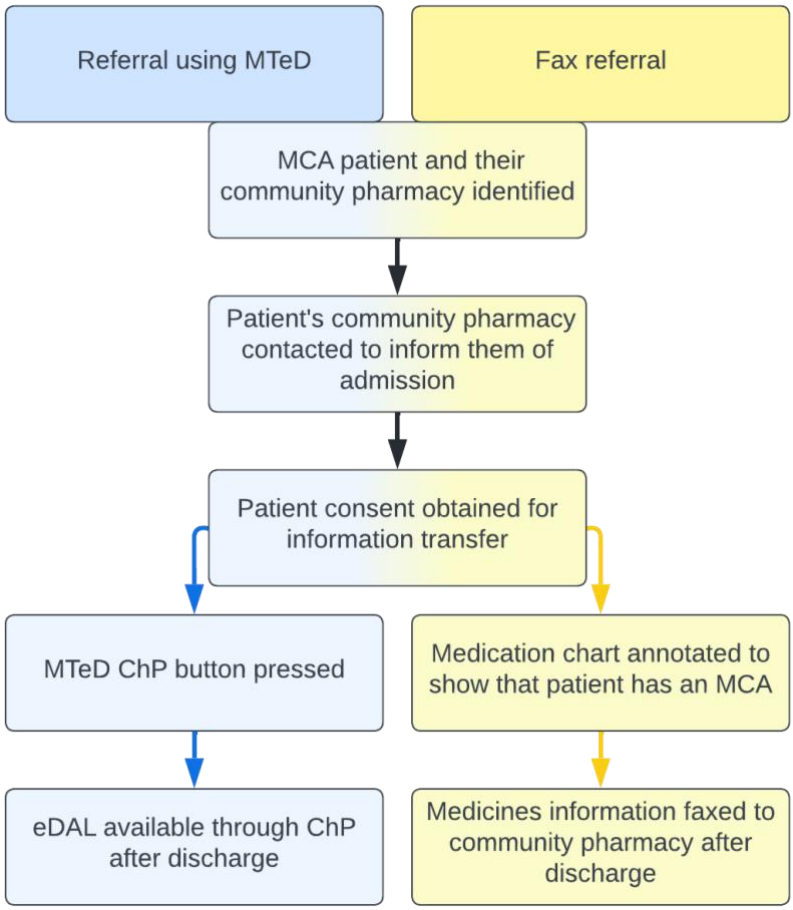


Figure 4.5: Typical Information Transmission Processes for Multicompartment Compliance Aid (MCA) Patients

Identification of MCA patients was opportunistic, with the HPP identifying them as requiring information transmission to the community pharmacy whilst they reconciled their medicines at admission. In some LHBs, participants described how admission medicines reconciliation was primarily a PhT's role. In other LHBs, participants suggested that some wards did not have a PhT; therefore, a pharmacist would be responsible.

Participants in all focus groups discussed how there was routine communication with community pharmacies for other patient populations, including those with restricted medicines supply or that receive a Medicines Administration Record chart. Communication at admission would also allow HPPs to gather information about when the patient last had a medication supply.

4.3.2.3. Patient Consent for Referrals

The extent to which participants sought patient consent for discharge information transmission varied. LHB4-FG2 participants took formal consent for every DMR referral after they had counselled the patient about the DMR and referrals, supported by educational leaflets. LHB3 participants who used the ChP functionality discussed how they would explain the need to transfer the discharge information and ask for consent.

Participants in most focus groups felt formal consent was a referral barrier because it was time-consuming, especially since they perceived low patient awareness of the DMR. Some participants suggested that patients were surprised when they asked for consent to transmit information because they assumed it was automated.

> *LHB3-FG2-JP1: "I think patients **assume** that's what happens [information transfer to community pharmacy], they assume they've got a record that everyone can see".*

PhTs in two focus groups disagreed that consent was a barrier. They proposed that consent for electronic information transfer would not take much time since they already ask patients for consent to access their GP records at admission.

Many participants described taking a *"pragmatic"* approach to consent for MCA patients, telling them they were transmitting the information and allowing them to object. Although most of these participants acknowledged that this was not the correct way to approach consent, it removed the barrier, allowing them to complete the task they considered essential. Many participants lacked awareness about the legality of consent, including how long it was valid and what processes required consent. For example, one senior pharmacist suggested that consent was unnecessary for DMR referrals because the ChP functionality had the option to override consent in the patient's best interests.

A few participants with community pharmacy experience were critical of the consent laws themselves, proposing that community pharmacists should not need explicit consent to access discharge information.

> *LHB2-FG1-SP2: "One of the barriers to the transfer of information are the consent laws […] It's a bit different than sending them to the person who manages the local Lidl [UK supermarket chain] or something, because they're [community pharmacist] involved with the patient's care".*

Many participants felt that it would be beneficial to document consent to prevent work duplication. LHB4-FG2 staff documented consent by attaching a sticker to the medication chart, which was ticked when they obtained consent. A few senior pharmacists described how HPPs used a similar method when they had previously referred patients for the DMR. Participants in one focus group suggested adding a consent box for DMR referrals to the electronic discharge system, which they felt would help document consent.

4.3.2.4. Electronic Discharge Systems

Participants in all groups discussed using electronic discharge systems in their respective hospitals, identifying four distinct systems across Wales. All systems facilitated eDAL transmission to GP surgeries after discharge, but only MTeD could facilitate community pharmacist access. MTeD

implementation varied across the hospitals, with a few using it exclusively. Most hospitals had partial implementation alongside other electronic discharge systems, whilst one LHB did not use MTeD. Participants in many groups discussed how lacking the ChP functionality in MTeD was a referral barrier because the alternative (fax transmission) was too time-consuming to refer routinely. Participants frequently shared frustrations about fax and paper DAL transmission.

LHB2-FG2-JP1: "If they're [doctor completing discharge summary] just sort of like faintly running a gel pen across the top then obviously nothing transfers through the bottom, and then every copy underneath is completely worthless".

In contrast, all participants perceived electronic discharge systems were safer than paper discharges due to improved legibility, timeliness, and completeness. In two hospitals without MTeD, participants expressed frustration that the DAL would not be transmitted electronically to the GP unless the discharging doctor had signed it off. Many pharmacists perceived that electronic discharge systems improved information governance compared to fax transmission, which they considered a data security threat.

LHB4-FG3-JP2: "That's what always scares me about faxes, if you've typed slightly wrong, typed the wrong number in, it [the DAL] could end up in some office in London" [all participants laugh].

Although most wards across Wales used electronic discharge systems, others did not have the facility; therefore, they relied on paper DALs. These were typically admission wards that did not have resources to facilitate change due to their fast patient turnaround. Participants in one focus group described how their surgical wards still used paper discharges because the doctors were reluctant to adopt an electronic system. This delay created tension between HPPs and the ward doctors since paper discharges were considered a patient safety risk.

Participants in LHB3 discussed how their hospitals stopped using fax machines, forcing them to engage with electronic discharge systems. However, participants in LHB3-FG1 described that fax machine decommissioning in wards without an electronic discharge system forced them to revert to posting paper DALs.

4.3.3. Theme 3: Intra-Professional and Inter-Professional Collaboration

Through the focus groups, it was clear that there was limited collaboration between HPPs and their colleagues in community pharmacies, which was a barrier to DMR referrals.

LHB4-FG3-JP2: "There's just a massive difference between hospital and community isn't there? There's a lot of things that can change, but it's there's still that us and them […] that's a community issue, or that's a hospital issue, isn't it?".

Discussions in the focus groups included familiarity with the community pharmacy sector, collaborative culture, the need for information exchange and post-discharge liaisons.

4.3.3.1. Familiarity With the Community Pharmacy Sector

Most participants, except those with community pharmacy experience, were unfamiliar with the community pharmacy sector, which was a barrier to collaboration. This lack of familiarity included what services community pharmacists could provide, their professional limitations, and to what information they have access. PhTs were typically less familiar with these concepts than pharmacists, especially to which information community pharmacists had access.

Some participants were reluctant to refer patients who needed specific clinical post-discharge support because they were unsure whether it was within the community pharmacist's role. This perception was underpinned by the misunderstanding that the DMR is a clinical service (see Section 4.3.1).

> *LHB7-FG2-JP2: "…if we'd started a blood pressure tablet, and we wanted them [patient] to be monitored in the next week, I wouldn't know if their community pharmacy could do blood pressure monitoring. Then, if the patient's blood pressure did come back really low, then would the community pharmacist be able to solve that?"*

Many participants were unaware of which services each pharmacy was registered to provide and whether individual pharmacists had the appropriate service accreditation for the DMR. Some PhTs shared experiences where they had tried to refer for a DMR, but the community pharmacy could not provide it. Participants in most focus groups suggested that many community pharmacists would not be able to provide DMRs. Therefore, they were reluctant to refer because it would be a wasted effort. Many participants perceived that large chain pharmacies were less likely to provide DMRs than independently owned pharmacies.

4.3.3.2. Collaborative Culture

Four LHB's participants implied an apparent culture of disinterest or lack of prioritisation of tasks surrounding discharge. This culture appeared to be more prolific among pharmacists compared to PhTs. A few participants proposed that referrals were not their responsibility since they did not benefit them, unlike the community pharmacy, which would be remunerated. However, some participants clarified that referrals were not a priority compared to what they perceived to be their role.

> *LHB1-FG1-SP1: "The reason it's [DMR referrals] low down in our priority list there is that community pharmacists aren't going to come in and see the acute patients for us personally; […] if I've only got X amount of time, I need to do my work before what I perceive to be **their** work".*

Only the participants from LHB4-FG2 (the hospital that routinely referred for DMRs) discussed how referrals were their responsibility since adequate post-discharge care was essential to continue their work.

LHB4-FG2-SP1: "I think seeing the discharge as the beginning of something rather than the end [...] it's the beginning of whatever intervention we've done as a hospital for the patient going forward in the community. So, if you think of it that way, it becomes very, very important".

4.3.3.3. Perceived Benefits of Information Exchange

Despite mixed opinions on the DMR's value, most participants felt that community pharmacists should be aware when their patients are admitted to the hospital. Participants considered this essential for MCA patients; otherwise, they could have erroneous dispensing and delivery of pre-admission MCAs. To prevent this, they contact community pharmacies by telephone when an MCA patient is admitted to the hospital (see Figure 4.5). Most participants felt that community pharmacists should also have access to all their patients' discharge medicines information for reference, even if not for DMRs. Two senior pharmacists disagreed with this, suggesting community pharmacists would not benefit from information about acute medicines.

LHB5-FG4-SP3: "Say there was a discharge on like an antibiotic that was due to be stopped like an antibiotic course or like painkillers, does the chemist [community pharmacist] need to know?".

Many participants said that for a DMR referral to be meaningful and improve communication, they should be able to stipulate a referral reason.

LHB4-FG2-JP2: "The whole point of this [DMR referrals] is to promote the communication [...] but if we can't even write a note as to what we want them [community pharmacists] to specifically look at, then it diminishes the value of it".

Participants in two focus groups had used the additional medicines free-text box available in MTeD to include extra information about specific follow-ups for GPs, primary care pharmacists (PCPs), and community pharmacists despite not being the box's intended purpose. One electronic discharge system had a specific free-text box for additional information, which participants considered beneficial for communication.

There was considerable discussion in all focus groups regarding community pharmacists' access to clinical information. Many participants considered accessing clinical information, such as treatment indications, necessary for a meaningful DMR.

LHB7-FG2-JP2: "From the pharmacist's point of view, they have no idea why they're [patients] on these medications, so it seems a bit pointless".

In contrast, a few participants thought clinical information was irrelevant since the DMR was primarily about medicines reconciliation. A few PhTs perceived confidentiality issues with community pharmacist access to clinical information, especially in a traditional village pharmacy where the staff were likely to know their patients. Senior pharmacists in one group suggested that

it was not their responsibility to provide clinical information access to community pharmacists and that patients would not consent.

Several participants proposed that community pharmacists should receive access to Welsh Clinical Portal (WCP, the all-Wales shared patient record). They argued that this would provide access to clinical and discharge medicines information and hospital admission status. If community pharmacists could access discharge information, participants perceived this would make DMR referrals redundant.

4.3.3.4. Post-Discharge Liaisons

In a few focus groups, the pharmacists discussed how a primary care liaison role could improve collaboration between sectors. This individual could identify appropriate patients for a DMR upon receiving their DAL and refer them to their community pharmacy. Participants felt this role would save them time since they could refer all patients to one professional rather than having to refer them to separate pharmacies. Participants considered this as a role for PCPs. This level of intra-professional collaboration was perceived to have the potential to improve the quality of post-discharge care.

4.3.4. Theme 4: Integration of DMR Referrals into the Workflow

Many participants suggested they did not consider DMR referrals because it was not part of their usual workflow and processes, nor was it normalised. Participants felt that integrating referrals into their work processes would be a facilitator.

> *LHB4-FG1-SP1: "… maybe somebody who looked at the way we work and made it [DMR referrals] an easy part of your day, not an extra thing. I think if somebody saw it as 'you want me to do this as well?' then it doesn't get done".*

4.3.4.1. Workload Capacity for DMR Referrals

One of the main DMR referral barriers was the participants' workload. There were contrasting views on whether HPPs had the workload capacity to refer patients. In hospitals without ChP functionality, many participants stated lack of time as a significant referral barrier. In contrast, participants who had referred electronically suggested that the lack of workflow integration was the barrier, not time, since the act of referring was quick. When participants were short on time or staff, they felt DMR referrals were not a priority since they did not consider them valuable compared with other tasks. The extent of this perception varied across hospital sites. For example, LHB4-FG1's participants felt they were far too busy to refer patients, whilst LHB4-FG2's participants routinely referred for DMRs, despite not having ChP functionality. Participants discussed how insufficient capacity meant they were restricted to core functions, often designated by management.

LHB4-FG3-PhT1: "…we are quite understaffed, and then we're being told by senior members of staff that our priority is to see these new patients to do our discharges and that's all you can do".

Participants in many focus groups discussed how suboptimal staffing levels, such as on weekends and out-of-hours, reduced the capacity for DMR referrals. Many participants specified that ward pharmacy staffing was the critical factor for DMR referrals since they perceived dispensary staff could not refer because they lacked input into that patient's care. One group's participants discussed a recent pilot for a dedicated pharmacist and PhT on their ward. They perceived this pilot as the ideal staffing level to facilitate additional service provisions, such as DMR referrals.

4.3.4.2. Optimising Patient Identification

Participants discussed the most appropriate time during hospitalisation to refer patients electronically for a DMR. Most participants suggested that referring at admission could easily be integrated into the current admission processes. In contrast, they perceived referring at discharge as an extra task when staff are busy. A few participants discussed potential issues with performing the referral at admission rather than discharge. These issues included inappropriate referrals since the patient's circumstances may change during admission, or they may change pharmacy or residence. PhTs in a few groups were optimistic about integrating DMR referrals into their workflow since they could ask for referral consent at the same time as consent to access their GP record. Some participants submitted that every patient must be referred to effectively integrate DMR referrals into admission processes. They elaborated that choosing appropriate patients would increase the time burden of referrals and perhaps require pharmacist input, removing the task from PhTs' workflow.

LHB4-FG1-SP1: "If it became a chore of this one [patient] you can refer, this one you can't, it would take it away from the techs [PhTs] to do it, and then it would have to come back to the pharmacist […] I don't have time".

However, some participants felt it was inappropriate to refer every patient because some may not benefit from a DMR. Therefore, referring would be a waste of time and resources. In contrast, a few participants suggested that all patients require post-discharge reconciliation; otherwise, their in-hospital medicines changes would not be continued. Many participants were concerned that community pharmacists would not have adequate capacity if the hospital committed to referring every patient. Therefore, some participants thought there needed to be a method for community pharmacists to prioritise 'high risk' referrals. Participants in a few focus groups recommended adding such prioritisation methods to MTeD to allow community pharmacists to triage referrals effectively. Some of these participants further discussed that they would need evidence-based prioritisation criteria.

4.3.4.3. Sustaining DMR Referrals

Senior pharmacists in most groups discussed an initial concerted effort to promote DMR referrals when the service was introduced. However, the hospital management did not sustain these efforts, so interest waned over time. These efforts to promote referrals were often led by an individual undertaking post-graduate study or whose role involved working with the electronic discharge systems.[15]

> *LHB2-FG3-SP2: "…there was a specific technician [PhT] dedicated to work on MTeD to roll it out and so on [LHB2-FG3-PhT1: 'and she was good'] and then it fizzled out".*

Participants in one group discussed how having a champion to take control of DMR referrals for their hospital would facilitate engagement. Another group discussed how they had an HPP who functioned as a referral champion and was effective at promoting engagement.

4.3.5. Theme 5: The Role of Pharmacy Professionals in Post-Discharge Support

Many participants doubted the value of community pharmacists providing post-discharge support compared with PCPs. Four LHB's participants described their extensive collaboration with PCPs, whom they perceived as the most appropriate group to provide post-discharge support.

> *LHB2-FG3-SP1: "…we have really good links to the practice pharmacist who visits the GP surgeries […] I would probably more contact the pharmacist who goes into the GP surgery to follow something up than [LHB2-FG3-PhT1: 'that's what I do'] the community pharmacy".*

Pharmacists in many groups discussed how they would preferentially refer patients to PCPs for post-discharge support since referring to both was considered unnecessary work duplication. These referrals would often be ad-hoc by email, telephone, or using a free-text notes section in the electronic discharge system.

A few senior pharmacists felt strongly that the PCP could provide more effective post-discharge support than the DMR, suggesting that the DMR should be decommissioned. The participants who held this view were also sceptical of the DMR's value and held negative opinions of the business orientation of community pharmacists.

4.3.5.1. Dedicated Time

Participants felt that it was important that a practitioner had dedicated time to provide a thorough post-discharge review. Many submitted that this would be infeasible in community pharmacies since they must balance service provision with a busy retail environment unless they had two pharmacists. Participants stated they would not refer patients if community pharmacists had insufficient capacity to complete a DMR because it would be a wasted effort. A few participants

[15]Most hospital pharmacists undertake a clinical diploma in their early careers.

disagreed with this sentiment, stating that their perceptions of community pharmacist capacity were not a reason to withhold discharge information. In contrast to participants' perceptions of community pharmacists, they felt PCPs had dedicated time to undertake thorough and timely post-discharge reviews.

LHB3-FG2-PhT1: "I would choose a primary care pharmacist [for post-discharge support] because I feel like they would follow up promptly, rather than a business that can squeeze it in".

Some participants suggested that community pharmacy capacity for DMRs could be improved by employing more PhTs. They proposed that PhTs could complete DMRs themselves or release pharmacist capacity by accuracy-checking prescriptions. Additionally, a few participants perceived that many pharmacists were locums; therefore, PhTs were a more consistent workforce.

4.3.5.2. Comprehensiveness of Post-Discharge Support

Many participants considered that PCPs would be able to identify any discrepancies within the GP surgery, providing a safety net before the prescription reached the community pharmacy.

LHB5-FG3-SP2: "…by the time it [prescription] gets to community pharmacy then, it should all be all sorted from that point of view because the practice pharmacist should've seen it, they would've highlighted any discrepancies".

Many participants perceived PCPs could rectify discrepancies more efficiently than community pharmacists because they had closer working relationships with GPs and were more likely to be independent prescribers. Some participants suggested that PCPs had superior clinical skills and access to the GP record; therefore, they provided broader post-discharge support. These participants would preferentially refer to PCPs since they could provide DMR-like services and clinical follow-ups like blood pressure and therapeutic drug monitoring. In contrast to these perceptions of PCPs' clinical roles, a few participants had traditional views of community pharmacist roles, primarily dispensing.

4.3.5.3. Business Orientation

In most groups, participants discussed how community pharmacists prioritise their business commitments over patient care, more so for multiple pharmacies than independents. This perception existed on a spectrum, with most participants being somewhat sceptical of the motives behind community pharmacy services. Participants from two LHBs felt more strongly about business orientation than others, stating that community pharmacists would provide DMRs to uncomplicated patients to meet service targets.

LHB7-FG1-SP2: "So my concern, if cynical, is that community pharmacies aren't going to pick up the ones [DMRs] needed, they're going to pick up the ones that are quick wins for money".

For some PhTs, this perception was grounded in community pharmacy experience, where they had seen pharmacists deliver inappropriate Medicines Use Reviews (MURs) to meet targets. A few participants with community experience suggested that the managers or the quantity-driven model of the community pharmacy contract prevented pharmacists from providing optimal patient care. In contrast to participants' views of community pharmacists, they perceived PCPs as patient centred.

> *LHB3-FG2-PhT1: "Primary care [pharmacists] work for the NHS, whereas community pharmacists work for a **business.** […] If you found out one of your patients had come out of hospital, you'd be like 'yes we can do a DMR, that's like £25 or £50 for the business', whereas primary care pharmacists are thinking about the aftercare".*

4.3.5.4. Personal Relationships

Participants who had experience collaborating with PCPs cited their relationships as influential in referring to them preferentially. This personal relationship facilitated better communication and instilled accountability for actioning referrals. Participants in some groups described how PCPs were often trained in hospitals, meaning they belonged to the same peer group with shared experience and capabilities.

> *LHB2-FG2-JP2: "I think because we **know** the practice pharmacists, quite a lot of them have gone from the hospital background, they get it. We speak the same language with the practice pharmacists … and we know what they're able to do".*

In contrast, participants in a few groups did not consider themselves in the same peer group as community pharmacists, referring to them as 'chemists' rather than pharmacists. These participants also held sceptical views about community pharmacy and the benefits of the DMR. Participants in all groups discussed how they lacked a strong working relationship with community pharmacists, which was a referral barrier.

> *LHB4-FG1-SP1: "…if you can put a face to the voice you're speaking to, or a name to the person you know, I think that would improve the working relationship".*

Some participants suggested that the quality of their working relationship was variable, depending on the pharmacy or pharmacist.

4.3.5.5. Intra-Professional Communication

Many participants described it as time-consuming to find a community pharmacy's contact details, even when using MTeD, which did not reliably include them. In contrast, some participants stated it was straightforward to find PCPs' contact details.

> *LHB4-FG3-JP1: "I think primary care are more contactable as well [all participants: 'yeah'], if you can't get hold of them that day, you can go find their email somewhere […] I've never emailed a community pharmacy I wouldn't know where to start looking for their email, or whether they check emails".*

Many participants preferred emailing professionals for post-discharge support over other methods like fax because of increased accountability and audit trail.

4.3.5.6. Service Consistency and Continuity

Participants held mixed views regarding community pharmacy continuity. Many participants suggested that the DMR's value was underpinned by the community pharmacist's rapport with their patients. In contrast, participants from a few groups perceived community pharmacies lacked continuity since they relied on locum pharmacists, who were unlikely to know the patient and action DMR referrals. Some participants proposed that referring the patient to a named community pharmacist would mitigate the impact of staff discontinuity, a method employed by LHB4-FG2 (see Section 4.3.2.1).

Participants from some focus groups collaborated more closely with PCPs than others, highlighting their lack of role uniformity across Wales. Participants in two focus groups said there were no PCPs in their area; therefore, community pharmacies provided more consistent post-discharge support. However, participants felt it was easier to identify PCPs to provide post-discharge support than community pharmacists because patients must be registered with a GP surgery. Many participants shared frustrations when they could not identify the patient's regular pharmacy, relying on patients' vague descriptions.

LHB2-FG2-PhT2: "If you get a prescription in pharmacy, and there's nothing written on there on the medicine chart or where the community pharmacy is, then finding that information online is impossible".

LHB2-FG3-SP1: "Yeah, it's the one on the corner".

LHB2-FG2-PhT1: "Yeah, it's the one just down my road".

LHB2-FG3-SP1: "Your heart sinks, doesn't it?" [all participants laugh].

Some participants discussed that identifying the pharmacy would be easier if patients had to register with a pharmacy for their care, as they must for their GP surgery.

4.3.6. Theme 6: Previously Identified DMR Referral Barriers

The researcher asked participants about the current relevance of the previously identified DMR referral barriers: referral feedback and the perceived need for referral criteria.

4.3.6.1. DMR Referral Feedback

Participants from all focus groups agreed that there was still no DMR referral feedback, and most felt this was a barrier.

LHB1-FG1-SP1: "I agree that we probably still feel it's [DMR referrals] going into a black hole, why would we bother doing that?".

In contrast, two participants suggested that they were not concerned about feedback from the DMR and that it would not motivate them to engage with referrals. There was considerable debate across the groups about what feedback would be helpful or appropriate. Conversations around feedback encompassed three areas: asserting the DMR's value, how referrals could be improved, and demonstrating that community pharmacists are actioning referrals.

To assert the DMR's value, participants in all groups discussed how there should be feedback mechanisms for its outcomes, which their hospital or LHB should disseminate. Many participants emphasised that they wanted outcome feedback to be patient-centred, focusing on hospital readmission rates and improvements in adherence and adverse drug reaction rates. However, they considered that feedback about cost-savings would encourage hospital management to prioritise referrals. Participants in most groups felt that feedback presented as case studies would encourage them to refer more patients.

> *LHB5-FG3-JP2: "…if there was like a case study [of a DMR] it would be quite nice, because then you could see a very specific example of the difference it's making. Numbers are great, and they do push us, but I always like a nice, specific, feel-good example of how we've helped someone".*

Participants discussed individualised feedback in all groups, such as automated emails describing each referral's outcome. This feedback was a contentious topic, with most groups lacking consensus on whether it would encourage referral engagement. Those who supported this feedback mechanism suggested it would assure them that each referral had value. Several participants specified that individual feedback might be helpful in specialities whose patients are frequently readmitted because it would improve follow-up. In contrast, some participants felt that automated feedback would not be meaningful. Junior pharmacists expressed concerns in a few groups that receiving such feedback would mean they maintain responsibility for the patient's care.

> *LHB2-FG1-JP1: "If I've referred to a fellow healthcare professional, I then entrust them to do their job and follow that up" [some participants nod in agreement].*

All participants agreed that the DMR form should be uploaded to WCP, allowing other practitioners to see its outcomes when providing care to that patient and preventing work duplication. Some participants added that the DMR form would be a valuable information source for medicines reconciliation if the patient was readmitted, which would also normalise DMRs.

Participants in most groups discussed how they would like feedback to improve referral information content, including any trends in medication discrepancies or errors. As many participants were concerned about their referrals not being actioned in the community, they suggested feedback regarding the proportion of completed referrals.

LHB1-FG1-PhT2: "If we had referred 100 patients a month, it would be nice for us to find out how much value was in referring that one hundred. Did 99 uptake, which means that the value's there? Or did we refer 100 out and now one up took? [one DMR was completed]".

Additionally, these participants wanted feedback from community pharmacists stating they wanted more DMR referrals. Some wanted automated feedback to show that the community pharmacist acknowledged their referral via email or a read receipt integrated into the electronic discharge system.

Some participants felt that feedback on the percentage of referred patients at discharge would be encouraging because it would create competition between hospitals. One participant disagreed because many of their patients attended dispensing doctors' practices rather than community pharmacies; therefore, they were ineligible for DMRs.

4.3.6.2. Perceived Need for Referral Criteria

Most participants suggested strict referral criteria would not be required to facilitate referrals since they knew which patients to refer using their professional judgement. Participants from many groups discussed how strict referral criteria would prevent some patients from receiving a DMR, even if they may benefit.

LHB7-FG1-JP1: "I always get worried with really prescriptive things [referral criteria] cos [sic] it might be the one [patient] on an inhaled corticosteroid just for asthma, and she will never be picked up, even though her compliance is paramount".

Some participants felt new staff members or PhTs might benefit from referral criteria to aid their judgement. Although the need for referral criteria was disputed in most groups, most participants agreed that non-prescriptive guidance would be helpful.

4.3.7. Theme 7: Electronic Discharge System Uniformity

There was a lack of electronic discharge system uniformity across Wales. Most hospitals had multiple discharge systems in use. This lack of uniformity existed on a spectrum, with LHB2 using the same system on most wards in contrast to one hospital, which used three different systems concurrently. Many participants suggested that the lack of system uniformity limited DMR referrals because they could not be ingrained into daily routines when not all wards used MTeD.

LHB5-FG3-PhT2: "We don't always use that discharge system [MTeD] for all of the wards […] that's why I haven't used it because I thought well the next ward down isn't going to be able to use it".

4.3.7.1. Barriers to MTeD Adoption

As described in Section 4.3.2.4, MTeD implementation varied across the hospitals. Some participants did not want to adopt MTeD, despite its support from Welsh Government and being

the only system capable of providing community pharmacist eDAL access. These participants were reluctant to adopt MTeD because they perceived it as less user-friendly than their current electronic discharge system.

> *LHB2-FG2-SP1: "The [electronic discharge] systems need to be slick and quick because as I alluded to before, MTeD is incredibly cumbersome and clunky".*

Since most discharge systems could not provide eDAL access to community pharmacists, organisations attempted to find workarounds like emails or integrating their discharge system with ChP. Senior pharmacists in these groups discussed how these ideas were not receiving support due to the availability and national support for MTeD.

Participants from two LHBs were waiting for full MTeD implementation, but unknown external barriers were preventing this from happening. These participants were frustrated that the implementation timeline had not been communicated to them, discouraging them from engaging with DMR referrals since system changes would make their processes obsolete. One senior pharmacist felt that NWIS had not prioritised them for MTeD implementation since their hospital had developed its electronic discharge system.

> *LHB2-FG2-SP1: "I think because we had [electronic discharge system] here, that's why MTeD got rolled out in the other sites first. They had nothing and then basically, they [NWIS] haven't got resource to implement it on this site as well, so there's [participant exaggerates a sigh] … it's political" [all participants laugh].*

Participants in two groups suggested that some wards had not adopted an electronic discharge system because implementation was infeasible in an under-resourced department.

4.3.7.2. System Uniformity Operational Issues

Participants described issues caused by the lack of discharge system uniformity. For example, data would have to be input twice if a patient was transferred between wards using different systems. Participants in a hospital bordering on several LHBs described processing a patient transfer from a ward using MTeD as easier than other systems because they could access the patient's discharge information at the source rather than requiring fax transmission.

4.3.7.3. Shared Care Records

Although all participants agreed that electronic systems improved information transmission at discharge, many suggested that a shared care record would be more impactful for patient safety and a facilitator of the DMR. Participants conceptualised this as a single patient care record to which all practitioners would have read-write access. They felt a single patient record would reduce the need for reconciliation between care settings and circumvent DMR referrals since community pharmacists would have access to the patient's up-to-date medication list.

4.3.8. Theme 8: Training and Education Requirements

It was clear from the focus groups that there was a lack of formalised training about the DMR and its referrals. Participants felt this was a major barrier to engaging with referrals because it limited HPPs' knowledge of the service, its referrals, and how to refer for it.

4.3.8.1. Dissemination of Information

Without formalised training, participants gained most of their knowledge about the DMR and its referral process through personal community pharmacy experience or word of mouth. Some HPPs knew about electronic DMR referrals since their role included working with MTeD. However, there was no routine dissemination of this information to other staff. Discussions in one group exemplified this lack of communication, with one participant informing the others that the ChP functionality was not operational in their hospital.

> *LHB4-FG3-SP1: "The fact that none of us actually **know** any of this [ChP not functioning] is actually quite hard cos [sic] obviously I was using it not knowing".*

4.3.8.2. Staff Induction Training

The lack of DMR referral training at induction contributed to low awareness and created the impression that DMR referrals were not one of the organisation's priorities.

> *LHB1-FG1-SP1: "…because it's [DMR referrals] not included in things like the induction, [...] so it's not really flagged as an important thing from a hospital perspective cos [sic] we're trying to do all the other things".*

LHB4-FG2 included DMR referrals in their PhT training module. The participants in this group were far more knowledgeable and optimistic about the DMR than other groups, despite the hospital lacking the capacity for electronic referrals. Although this shows the benefit of DMR referral modules in PhT training, participants described how it would be inadequate since PhTs who trained elsewhere would not receive that training. These participants concluded that induction training should include DMR referrals.

4.3.8.3. Integrated Training

Participants unfamiliar with the community pharmacy sector described how integrated training would help raise their awareness, improving cross-sector collaboration such as DMR referrals. A few participants suggested an event HPPs could meet those working in community pharmacies to share experiences and learn about their roles. Some participants felt the recent development of cross-sector training opportunities in Wales would help familiarise HPPs with other sectors.

> *LHB7-FG1-SP1: "Hopefully when we go to this multisector working, things will be a little bit different and hopefully a little bit more communication between everybody cos [sic] everyone will have an idea of how each area works".*

PhTs in one group described not being afforded the same opportunities to work across sectors as pharmacists.

4.3.8.4. Educating Other Stakeholders

Participants in all groups described how it was essential to educate other stakeholders about the DMR and its referrals to optimise its uptake. Some participants acknowledged that other professional groups could refer to DMRs, proposing they should be promoted to nurses and GPs.

Pharmacists in all groups discussed patient involvement in DMR referrals. Many participants thought patients knew little about community pharmacy services, including the DMR. They suggested that patients would not engage with the DMR if they did not understand its value.

> *LHB2-FG3-SP1: "We need to sell it [the DMR] to the patients […] they need to see the point of it because if I see the point of it that's fine, and the community pharmacy sees the point of it. But if the patient doesn't, then they don't really engage".*

Numerous patient advertising methods were discussed, including TV adverts, posters in GP surgeries, or speaking with the patient to describe the service and its benefits. Participants in one focus group suggested creating leaflets and videos to 'sell' the service to patients while in the hospital.

4.4. Summary of Main Findings

The chapter's results described the different hospital pharmacy processes for information transmission to community pharmacists across Wales and the barriers and facilitators to DMR referral engagement. Although processes varied, there were few differences in the factors affecting engagement across hospitals, LHBs and professional groups. The main differences included workload capacity for DMR referrals, familiarity with the DMR, and the uniformity of electronic discharge systems. Only one hospital routinely referred patients for DMRs. However, all transmitted information to community pharmacists to enable ongoing MCA supply.

Table 4.5 summarises the identified DMR referral barriers and facilitators alongside suggested areas for improvement.

Table 4.5: Summary of Findings from Chapter 4

DMR Referral Barriers and Facilitators	Suggested Areas for Improvement
Lack of awareness of the DMR and its referrals.	Integrating the DMR and its referrals into staff training.
Scepticism of the DMR's benefits.	Discussion of DMR outcomes in staff meetings.
	Community pharmacy organisations could share educational material to showcase their role in patient care, including the DMR.
	Regular dissemination of the DMR's outcomes to HPPs on an LHB and hospital basis.
	Hospital pharmacy leads should consider routinely disseminating fundamental research to frontline staff.
The DMR was considered less comprehensive than PCP post-discharge support.	Consider the future of DMR in the context of wider system developments to avoid potential work duplication.
	Consider expanding DMR information access to include clinical information.
DMR referrals were not integrated into HPPs' workflow.	Hospital pharmacy management could optimise SOPs to integrate DMR referrals seamlessly into hospital workflow.
	Non-prescriptive evidence-based referral criteria could be developed to aid patient identification where required.
Lack of awareness of community pharmacy roles.	Cross-sector training for pharmacists and PhTs.
	Collaborative meetings between hospital management and community pharmacy organisations.
Lack of electronic discharge system uniformity.	Acceleration of MTeD implementation.
Electronic DMR referrals were useful.	
MTeD was considered difficult to use.	MTeD could be adapted to improve its usability relative to other electronic discharge systems.
HPPs did not consider DMR referrals part of their core role.	Helping support patients after discharge could be integrated as a key part of HPPs' role.

4.5. Discussion

This chapter presented the first national study exploring HPPs' views of a post-discharge community pharmacy service and its referrals. Subsequently, published studies have explored hospital pharmacy views of referrals to community pharmacies in England but are limited to local healthcare organisations (Jeffries et al. 2021; Khayyat et al. 2021a). This section presents the chapter's strengths and limitations and then discusses its findings within the context of the wider literature.

4.5.1. Strengths and Limitations

This chapter presents a qualitative study; therefore, it did not aim for generalisable findings. However, the relatively large sample size and all-Wales representativeness may enable stakeholders to transfer the findings to hospitals across Wales cautiously. Using focus groups was a considerable strength, generating discussion between participants about their employing organisation and their processes. As theorised, the senior pharmacists contextualised DMR referrals, which helped involve participants unfamiliar with the service. The focusing exercise

generated rich discussions, often lasting up to 60 minutes. Since the focusing exercise successfully generated discussion, some later questions in the schedule were unnecessary. However, these questions were valuable prompts for further discussion in these areas where required.

The participants were self-selecting; therefore, the results are subject to selection bias since population members interested in the DMR may have been more likely to participate than those uninterested (Flick 2018). However, given the lack of DMR awareness in most focus groups, the researcher considers that selection bias was limited. Gatekeepers may have introduced bias, preferentially recruiting some participants with whom they had personal relationships. However, the researcher mitigated this risk of recruitment bias by guiding gatekeepers to encourage all population members to participate equally (see Section 4.2.3.2). Recruiting senior managers as gatekeepers was a strength for this study since they controlled staff allocation, mitigating challenges to organising six busy NHS workers to attend a single meeting. However, poor gatekeeper engagement contributed to failed recruitment for one group. This variability in the impact of gatekeepers is well documented in the literature, suggesting that gatekeepers can either be positive or negative influences on recruitment (McFadyen and Rankin 2016). On reflection, it may have been helpful for the researcher to provide more explicit instructions for the gatekeepers.

Section 4.2.1 described the potential pitfalls of heterogeneous focus groups, namely that the power disparity would prevent honest discourse from the less senior participants. Although this effect cannot be dismissed, PhTs and junior pharmacists were typically the most engaged participants, describing their roles and perspectives in considerable detail.

4.5.2. Relevance to Wider Literature

This study's results demonstrated that HPPs rarely communicated with community pharmacists unless the patient had their medicines dispensed into an MCA. This finding was previously described by community pharmacists interviewed by Urban et al. (2013) in England. A major contributing factor to the lack of DMR referrals was the lack of awareness of the DMR service. This finding is reflected in its original evaluation, which suggested that hospital pharmacists felt 'out of the loop' with service development (Hodson et al. 2014a).

The original evaluation also identified the lack of feedback from referrals as a significant barrier (Hodson et al. 2014a). This study indicates that this barrier has not changed, with participants suggesting they could not reflect on the DMR's outcomes. A systematic review by Ross et al. (2016) supports this view, concluding that for successful implementation and embedding of technologies, stakeholders must be able to reflect on their effectiveness and value. Specifically,

many focus group participants suggested that ChP should upload DMR outcomes to WCP, which DHCW (2022b) have subsequently implemented. Although this is a positive development, some participants felt that understanding outcomes on a case study, hospital or LHB-level would improve referral engagement. Discussing patient cases in team meetings is common, but it could influence behavioural change by shifting perceptions of social norms and providing feedback (Johnson and May 2015). Some participants suggested benchmarking DMR referrals to increase motivation. A systematic review and meta-analysis by Cotterill et al. (2020) described how such methods that influence social norms modestly affect behaviour. However, there may be concerns surrounding inappropriate target-driven behaviour.

The original DMR evaluation (Hodson et al. 2014a) suggested that hospital pharmacists needed criteria to guide their referrals. However, this chapter's results suggested that most HPPs could confidently refer patients based on professional discretion. Abuzour et al. (2021) interviewed HPPs in England to investigate how they prioritise patients for pharmaceutical care, including medicines reconciliation. The authors concluded that HPPs rarely used formal tools but used professional judgment to decide whom to prioritise for services. Using similar judgement for referrals would suit the DMR since community pharmacists can recruit any patient they believe would benefit (CPW 2011).

As identified in the previous DMR evaluation, this study suggests that obtaining consent for referrals was a barrier (Hodson et al. 2014a). Participants described using informal 'pragmatic' consent approaches to circumvent this barrier when they thought it was necessary, such as for MCA patients. Although this pragmatic approach overlooked the legal requirement for informed consent, it demonstrated that consent was not a significant barrier to processes the participants considered essential. Some participants shared frustrations that community pharmacists required patient consent to access the information they considered critical to care for their patients. Opt-out consent, such as that used for organ donation in Wales (Human Transplantation (Wales) Act 2013.), could be considered for DAL access for community pharmacists. Although this could reduce the consent burden, data protection legislation (the Data Protection Act and General Data Protection Regulation) prevents the transfer and processing of personal data without explicit consent from the data subject (Rumbold and Pierscionek 2017). However, patient consent is not currently required to transfer discharge information to the patient's GP surgery, indicating that NHS organisations may consider GP post-discharge support essential to patient care in contrast to community pharmacies. It would be prudent to initiate a dialogue with patients and health authorities to ensure that the consent requirements for community pharmacist DAL access are

optimal for DMR engagement but within boundaries set by legislation and patient willingness.

This study's results demonstrated that HPPs were sceptical of the DMR's benefits, which led to their lack of prioritisation of referrals. The perception has not changed since the previous evaluation, where hospital pharmacists described how they had not been 'sold' the benefits of the service (Hodson et al. 2014a). Although the evidence base supporting the DMR has expanded, nobody communicated this to frontline staff. The research-practice gap is common in healthcare but could be mitigated by strategically planning evidence dissemination (Robinson et al. 2020). Therefore, researchers could work alongside hospital pharmacy management to plan evidence dissemination to frontline staff to ensure they understand the value of the DMR and other services.

Participants' misunderstandings about the DMR's scope may partly explain their scepticism of its benefits. For example, many participants thought that the DMR involved the community pharmacist making clinical decisions about the patient's care, for which they felt community pharmacists were ill-equipped. Although community pharmacists are undertaking an increasing range of clinical services, the DMR's specification is strictly for medicines reconciliation and adherence support; therefore, these concerns were unfounded (CPW 2011). Participants also believed that elderly or housebound patients could not access the DMR. Research investigating discharge MURs (dMUR) and discharge New Medicines Service feasibility in England supports this view, concluding that these patients are difficult to recruit (Elson et al. 2017; Lam et al. 2019). Although the data are not current, the original DMR evaluation described that 2.1% of DMRs were conducted in the patient's home and 33.7% over the phone, demonstrating that these delivery methods are feasible (Hodson et al. 2014a).

Another explanation for participants' scepticism of the DMR was their perception that community pharmacists would prioritise business commitments over patient-centred care. This perceived difference in professional values could be a barrier to collaboration and referrals since inter-professional collaboration can depend on shared values and vision (Aunger et al. 2022). Concerns about target-driven community pharmacy services are not unfounded since Latif et al. (2011) found that community pharmacists in England chose less clinically complex patients for MURs to meet managerial targets. Secondary data analysis of MUR provision partly supports this view, describing a negative association with local long-term health condition prevalence (Hann et al. 2017). However, this has not been demonstrated for the DMR. In their recent systematic review of pharmacists' and GPs' views of community pharmacy services, Hindi et al. (2019a) identified similar scepticism about the business-orientation of community pharmacists by GPs. These views

contrast with the new Community Pharmacy Contract for Wales, which outlines the vision for community pharmacists to provide an expanded range of services to support patient care (Welsh Government 2021). Altman et al. (2019) described intra-professional tension within the pharmacy profession. Hospital pharmacists viewed community pharmacists primarily as dispensers in contrast to their clinical role, considering hospital and community pharmacy as almost two different professions. This chapter's results reflect these findings, with some participants reluctant to accept community pharmacists' extended roles, referring to their community colleagues as chemists instead of pharmacists. Waring and Latif (2018) described how these views represent the opinion that hospital pharmacists are 'more professional' than community pharmacists, contributing to poor collaboration. Participants' perception of community pharmacists as less professional may be explained by their lack of familiarity with community pharmacist roles and responsibilities. Professional role clarification is essential to facilitate inter-professional collaboration (Karam et al. 2018). This lack of familiarity was not surprising when placed in the context of UK pharmacist and PhT training, which trainees have traditionally completed in one sector (General Pharmaceutical Council [GPhC] 2021).

Broad (2017) interviewed pre-registration pharmacists in Wales [n=6] regarding their perceptions of a multisector training pilot, who felt that multisector training might improve collaboration between sectors and reduce animosity. Following this pilot, the Welsh Government have supported multisector pre-registration[16] places (Bartlett et al. 2022). It will be interesting to see whether this improves the appreciation of the community pharmacist's role by those pharmacists working in other sectors. Since PhTs engage in DMR referrals, multisector training could be extended to all HPPs to improve cross-sector collaboration.

In contrast to participants' perceptions of community pharmacists, they felt PCPs were the most appropriate professionals to provide post-discharge support. This preference was multifaceted but partly described by the perception that PCPs were less business-oriented and could rectify identified discrepancies, providing better patient service. A survey in England supports participants' views, describing that 91% [n=185] of PCPs regularly performed post-discharge reconciliation (Alshehri et al. 2021). Theoretically, this work duplication could reduce the DMR's effectiveness because the PCP would identify discrepancies before the community pharmacist received the prescription. However, there is not currently a pharmacist employed by every GP surgery in Wales, and little evidence regarding PCP post-discharge support services, in contrast to

[16]The researcher acknowledges that pre-registration training has been renamed foundation training since completing this chapter. These changes are discussed in Section 10.3.2.3.

the DMR (Hodson et al. 2014a; Mantzourani et al. 2020). There is evidence that commissioners are redistributing pharmacy services across the workforce, with NHS England (2019) decommissioning the MUR and replacing it with PCP-led structured medication reviews. However, the Discharge Medicines Service was recently commissioned in England, suggesting that there is still national support for community pharmacist-led post-discharge services (NHS England and NHS Improvement 2021). The national support for the DMR in Wales is highlighted through its ongoing commissioning through the Covid-19 pandemic in contrast to other suspended services and its continuation in the new Community Pharmacy Contract for Wales (Evans 2020; Welsh Government 2021). As pharmacy professional roles continue to develop in GP surgeries and community pharmacies, the DMR and its benefits must be continually evaluated.

To integrate referrals into the hospital workflow, hospital pharmacy management must decide who is responsible for DMR referrals and which patients to refer. There is justification for referring all patients since the WHO (2017) recommends that HCPs reconcile medication at every care transition. However, participants were reluctant to refer for DMRs because they perceived community pharmacists would not complete them. One underpinning reason for this barrier was the participants' perceptions that the pharmacy would not be registered for the DMR service or the on-duty pharmacist would not be accredited. A small study investigating dMUR provision supports this view because regular pharmacist unavailability led to the pharmacy rejecting four (of nine) patients who requested the service (Lam et al. 2019). Currently, there is no available data to describe what proportion of DMR referrals community pharmacists complete. However, the DMR is available in 703 of the 715 pharmacies in Wales, and 97% of pharmacies have access to ChP (DHCW 2021b). Therefore, most pharmacies can receive electronic DMR referrals.

HPPs felt that community pharmacists would not feel confident in providing DMRs or would not be motivated to complete them. However, in the original DMR evaluation, community pharmacists suggested that they would like more referrals because they enjoyed the service and felt it was a good use of their skills (Hodson et al. 2014a). This view had not been disseminated to HPPs; therefore, the perceptions remain unchallenged. The engagement of community pharmacy leads with hospital managers could partly help address this issue by describing the community pharmacy sector's willingness to engage with referrals.

The results demonstrated an apparent disinterest in discharge-related activities relative to admission-related activities. HPPs felt that treating inpatients was their core function, whilst DMR referrals were additional non-essential work. This culture of 'their work' and 'our work' contrasts with the national vision in Wales to integrate care across settings, described in the Welsh

Government (2018) vision document, A Healthier Wales. There is no doubt that healthcare needs to put patients at the centre, with numerous reports describing the negative impact of poor collaboration on patient care. For example, the Kirkup (2015) report partly attributed patient deaths in University Hospitals of Morecambe Bay NHS Foundation Trust to a *"toxic us and them culture"*. Focus groups with hospital pharmacists identified that they often have external management pressures that prevented them from engaging with discharge counselling, prioritising inpatient services instead (Watson et al. 2016). This prioritisation indicates that the silo working culture could be management-driven. To rectify this, managers must understand the benefits of DMR referrals and promote them in their departments. The managers in this situation would act as a champion, a prolific role in implementation science literature for aiding innovation implementation and sustainability (Bonawitz et al. 2020).

The lack of management engagement with DMR referrals is evidenced by the lack of up-to-date SOPs and processes. Only one hospital had developed a process for DMR referrals, and participants in this group typically had a better understanding of the service and how to refer. The results suggest that DMR referrals felt like an additional task because they were not part of the workflow. Management must work to integrate referrals seamlessly with the workflow to avoid disrupting current tasks, thus creating a considerable time burden. Ergonomic approaches comparing the hospital pharmacy workflow with the DMR referral process could allow management to integrate processes effectively. Although ergonomics is uncommon in healthcare, similar approaches have been used in the United States to integrate technology into community pharmacy workflow (Jahn and Caldwell 2018). This study's results can guide hospital management to establish process inefficiencies and frustrations for transferring information to community pharmacies, allowing them to create and document a seamless and efficient workflow whilst engaging with DMR referrals.

Lack of HPP time and capacity was a barrier for DMR referrals. While some participants acknowledged that time would not be a barrier once referrals were integrated into the workflow, some wards and hospitals lacked the capacity to implement new technology and processes effectively. The NASSS framework describes how an organisation's capacity to implement innovations is essential for successful implementation (Greenhalgh et al. 2017). A lack of organisational capacity to innovate is a function of low staff availability and management that does not encourage innovation (Greenhalgh et al. 2017). This framework supports the barriers identified in this study, including suboptimal staffing levels, absence of managerial support and encouragement for DMR referral engagement. Bednall et al. (2021) recently developed a

workforce calculator to optimise pharmacy ward services. Managers could use similar workforce planning to optimise staffing levels to integrate DMR referrals into the workflow, providing the department with the capacity to innovate alongside actively encouraging engagement.

The results make a compelling argument for utilising the PhT workforce to support DMR referrals. PhTs were confident of their ability to perform DMR referrals and were well-placed in the admission workflow to integrate DMR referrals into their working practices. Workforce surveys of PhTs support these results by describing how hospital PhTs are often involved in admission medicines reconciliation and assisting with discharge planning (Boughen and Fenn 2020). There were suggestions of community PhTs providing the DMR themselves. Interviews with four community PhTs in Wales described how they were confident they could support community pharmacy services with appropriate training, including the DMR (Chamberlain et al. 2020). However, these aspirations of PhT involvement are limited by technology because PhTs have limited access to MTeD and no access to ChP. Commissioners and information governance bodies should consider making these systems available to PhTs to facilitate their engagement.

Participants considered electronic discharge systems facilitators for DMR referrals compared with paper and fax transmission methods. Interviewed community pharmacists and GPs agreed with the sentiment that electronic information transmission methods were timelier and more accurate than paper (Mantzourani et al. 2017; Spencer et al. 2019). Evidence supports these perceptions, showing that electronic discharges contain more comprehensive and accurate discharge information than paper discharges (Lehnbom et al. 2014). Despite these universal benefits, only MTeD could provide eDAL access to community pharmacists. Since MTeD was not available in all hospital wards, eDAL availability was inconsistent across Wales. Results from community pharmacist interviews support the assertion that eDAL availability was inconsistent and a barrier to DMR provision (Mantzourani et al. 2017). The staggered implementation of MTeD in hospital wards across Wales led to system non-uniformity, associated operational issues and frustration for HPPs. Ahmed et al. (2018) found that the lack of electronic prescribing system uniformity in England caused similar issues, leading to decreased confidence in using any one system. DHCW and the seven LHBs in Wales should closely collaborate to prioritise the acceleration of MTeD implementation to overcome these issues since ABUHB do not currently use MTeD, and its implementation is variable across the other LHBs (see Section 1.4.2). Many participants described how they were reluctant to engage with MTeD any further than perceived essential functions because they found it difficult to use. HPPs were reluctant to change systems when the hospital used an electronic system before MTeD implementation. Greenhalgh et al. (2017) suggest that the

sustained use of technology depends on users considering the technology worth adopting compared to their current processes. DHCW could consider taking good practice recommendations from staff who use alternative systems to improve the perceived value of MTeD adoption.

This study shows that misconceptions and lack of familiarity underpin many identified referral engagement barriers. Providing specific education and training could help address some of these barriers, improving DMR referral engagement. This education should encompass the benefits of the DMR, how to refer, and the community pharmacist's role. Participants made several suggestions for effective staff training, emphasising the importance of hospital induction. Participants suggested that patient awareness of pharmacy services is low, supported by focus groups with members of the public in Wales (Kember et al. 2018) and a review of public perspectives of post-discharge services in England (Khayyat et al. 2021b). Fylan et al. (2018) explored post-discharge medicines management strategies by patients and their carers, concluding that they are an underutilised source of system resilience which should be harnessed. Not only could patient involvement improve safety, but it aligns with the principles of patient-centred care. Since DMR referrals are automatically generated if a community pharmacist has pre-registered a patient for a DMR on ChP, community pharmacy staff should consider engaging patients before hospital admission to describe the merits of the DMR. Ward HPPs could also explain the DMR to suitable patients, encouraging them to consent for referrals and attend the pharmacy for the service.

One of the aims of P:DaHW is to optimise seamless and collaborative medicines management in Wales, ensuring care is patient-centred rather than siloed (Welsh Pharmaceutical Committee 2019). DMR referrals enable HPPs to meet these aims by referring to the DMR, an evidence-based service. To align with P:DaHW, HPPs and their organisations should work to integrate DMR referrals into their workflow and address the barriers outlined in this study.

4.6. Conclusions and Dissemination

This study successfully addressed Thesis Objective 2 by exploring HPPs' engagement with DMR referrals. These factors varied between hospitals but rarely between LHBs and professional groups. Once integrated with other thesis findings, these results will form recommendations to improve engagement with DMR referrals, hence optimising DMR uptake. The chapter's results have been disseminated through all groups detailed in Table 2.2, and the research team is drafting an academic publication relating to this chapter's findings.

Chapter 5. Introduction to the Secondary Data Analysis of DMR Data

5.1. Chapter Introduction

The MRC framework for evaluating complex interventions, like the DMR, suggests investigating how and where the intervention was delivered and the contextual factors affecting its implementation (Moore et al. 2015). The original DMR evaluation described the provision of the DMR service and its outcomes between 2011 and 2013 (Hodson et al. 2014a). The authors found inconsistent service delivery; many pharmacies [n=224, 30.1%] provided no DMRs and few [n=26, 3.0%] provided over 100 per year. The evaluation identified several barriers to community pharmacists engaging with the DMR, namely, lack of knowledge of a patient being discharged from the hospital and the lack of access to the discharge advice letter (DAL). In April 2015, NWIS developed the DMR module in Choose Pharmacy (ChP) and the DMR referral system to address these community pharmacist DMR engagement barriers. However, as previously described, Hodson et al. (2018) found that DMR uptake was still suboptimal despite these developments. Therefore, given the absence of current literature (see Section 1.5.4.3), an up-to-date description of DMR provision was justified, alongside describing the contextual pharmacy-related factors impacting DMR delivery volume. Therefore, the researcher developed Thesis Objectives:

3. Describe DMR provision from November 2011 to January 2021.
4. Describe the pharmacy-related factors affecting DMR delivery volume over time.

One attribute of the MRC framework is to describe the intervention outcomes and the factors influencing them (Moore et al. 2015). An average of 1.3 discrepancies were identified per DMR in the original evaluation, most of which were medicines discontinued or restarted after discharge or 'other' discrepancy types (Hodson et al. 2014a). Subsequent research by Mantzourani et al. (2020) showed the association between DMR1 and reduced hospital readmissions. While these outcomes are positive, several stakeholders, including the Welsh Government and AWQPSG, have requested information regarding which patient groups to prioritise for DMRs. This feedback led the researcher to develop Thesis Objective 5: describe the factors affecting DMR discrepancy identification.

As previously outlined, each DMR is documented routinely. This was initially through National Electronic Claim and Audit Forms (NECAF) and latterly through ChP. Given that NWIS implemented ChP incrementally, the use of the two systems overlapped (see Figure 5.1).

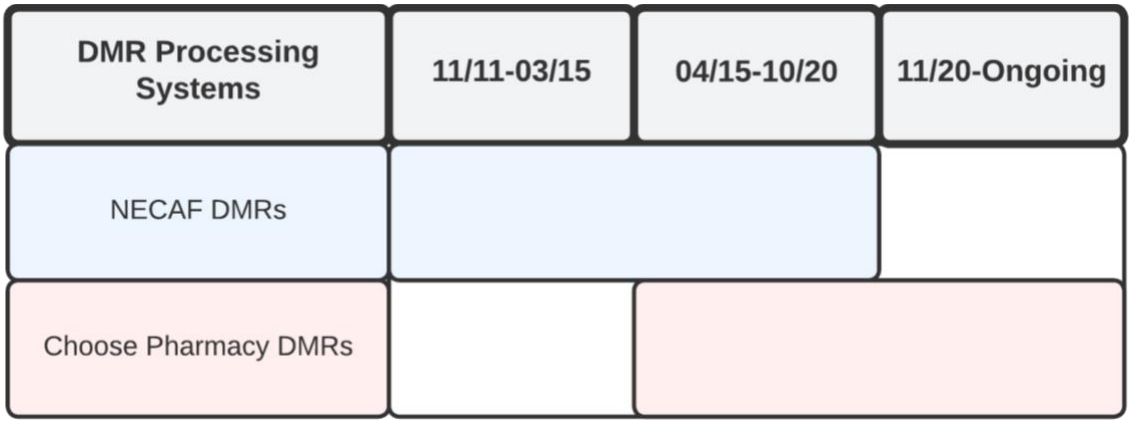


Figure 5.1: Timescales for DMR Processing Systems Use

These databases provided an opportunity for a secondary data analysis of all DMRs undertaken.[17] This chapter describes the DMR datasets, the study approvals obtained to use them for analysis and employed data preparation procedures.

5.2. Description of DMR Datasets

The first consideration for secondary data analysis is what data are available to address the objectives. Table 5.1 describes the routinely collected DMR data variables, highlighting whether they are collected in ChP or NECAF. The systems use the following data input types:

- Free-text: the pharmacist types a response.
- Drop-down: the pharmacist selects one of the presented options in a list.
- Click-box: the pharmacist selects one or more of the presented options.
- Pre-populated: the system fills in the information automatically.
- Pre-populated (eDAL): pre-populated only if the eDAL was available, else free-text.

[17]See Section 2.7.2 for the justification for using secondary data analysis to address these objectives.

Table 5.1: Description of the Routinely Collected DMR Data

Variable	NECAF	ChP	Data Entry Type and Further Information
Discharge-Related Data			
Discharge date	✓	✓	Pre-populated (eDAL) in ChP, free-text in NECAF
Discharge information provider	✓	✓	Drop-down: • Patient • Other • Carer • Hospital • GP
Discharge place	✓	✓	Drop-down: • Welsh hospital • English hospital • Prison • Other care settings • Care home
Discharging hospital	✓	✓	Free-text
eDAL availability		✓	Drop-down: yes or no
Service-Related Data			
DMR ID		✓	Pre-populated (unique identifier)
Eligibility criteria	✓	✓	• Click-box: Medication change(s) in hospital • Patient takes four or more medicines • Patient requires adjustment to medicines • Pharmacist's professional judgement
Further action required after DMR2		✓	Drop-down: Yes or no
Further action after DMR2 details		✓	Free-text (available when further action required after DMR2 = yes)
DMR1 delivery method	✓	✓	Drop-down: • With patient at pharmacy (with carer) • With patient at pharmacy (without carer) • With patient by telephone • With carer at pharmacy (without patient) • With patient at home/care home† • Other
Other DMR1 delivery methods		✓	Free-text (available when DMR1 delivery method = other)
DMR2 delivery method	✓	✓	Drop-down: • With patient at pharmacy (with carer) • With patient at pharmacy (without carer) • With patient by telephone • With carer at pharmacy (without patient) • With patient at home • Other†
DMR1 and DMR2 dates	✓	✓	Pre-populated (the date that the DMR was entered into the system). However, this can be manually changed.
DMR2 incompletion reason	✓	✓	Drop-down: • Patient withdrew consent • Patient deceased • Patient admitted to hospital • Patient did not attend the appointment(s) • Patient moved home or pharmacy • Other
Other DMR2 incompletion reason description	✓		Free-text (available when DMR2 incompletion reason = other)

Table 5.1 (continued)

Variable	NECAF	ChP	Data Entry Type and Further Information
Patient-Related Data			
Gender		✓	Pre-populated (male or female)
Age	✓	✓	Pre-populated (calculated from the date of birth, which is pre-populated in ChP, free-text in NECAF)
Pharmacy-Related Data			
Contractor ID	✓	✓	Pre-populated (unique pharmacy identifier)
Contractor name	✓	✓	Pre-populated
Pharmacy address	✓	✓	Pre-populated
GPhC number	✓		Free-text (GPhC number of the pharmacist that claimed service payment)
GPhC numbers for DMR1 and DMR2		✓	Pre-populated (only collected after January 2018)
Medicines-Related Data			
Number of medicines on DAL	✓	✓	Free-text
Number of medicines patient found to be taking	✓	✓	Free-text
Item description		✓	Pre-populated (eDAL) (item name, strength, and formulation).
Dose description		✓	Free-text
Outcome-Related Data			
DMR1 and DMR2 number of discrepancies and each discrepancy type	✓		Free-text
Item discrepancy		✓	Drop-down: Yes or no
Item discrepancy type		✓	Drop-down: • Medicines restarted in the community • Medicines discontinued in the community after discharge • Medicines continued but at the wrong strength • Medicines continued but in the wrong formulation • Medicines duplicated • Medicines discontinued by the patient • Medicines continued but at the wrong dose • Other
'Other' discrepancy description		✓	Free-text (available if item discrepancy type = other)
Action to resolve the discrepancy		✓	Drop-down: • Seek resolution with the GP • Seek resolution with the hospital • Resolve with the patient • Other
'Other' action to be taken description		✓	Free-text (available if action to resolve the discrepancy = other)
Item discrepancy resolution		✓	Drop-down: Yes or no

†Only available in NECAF.

Although most variables are collected in both NECAF and ChP, Table 5.2 describes the subtle differences concerning how each system logs medications and discrepancies (DHCW 2022b).

Table 5.2: Summary of the Differences between NECAF and ChP Data

Data Feature	NECAF	ChP
Logging of medication items	The system records the total number of medication items for a given DMR.	The system logs the details of each medication item.
Logging of discrepancy	The system logs the total number of discrepancies (and discrepancy types) identified for a given DMR.	The system logs whether each medication was associated with a discrepancy (and its type).
Limit on recording the number of discrepancies	The system imposes no limit since the number of discrepancies is free-typed for a consultation.	The system imposes a limit of one discrepancy per item.

Figure 5.2 and Figure 5.3 present screenshots of NECAF and ChP DMR discrepancy data collection entries, respectively (DHCW 2022b).

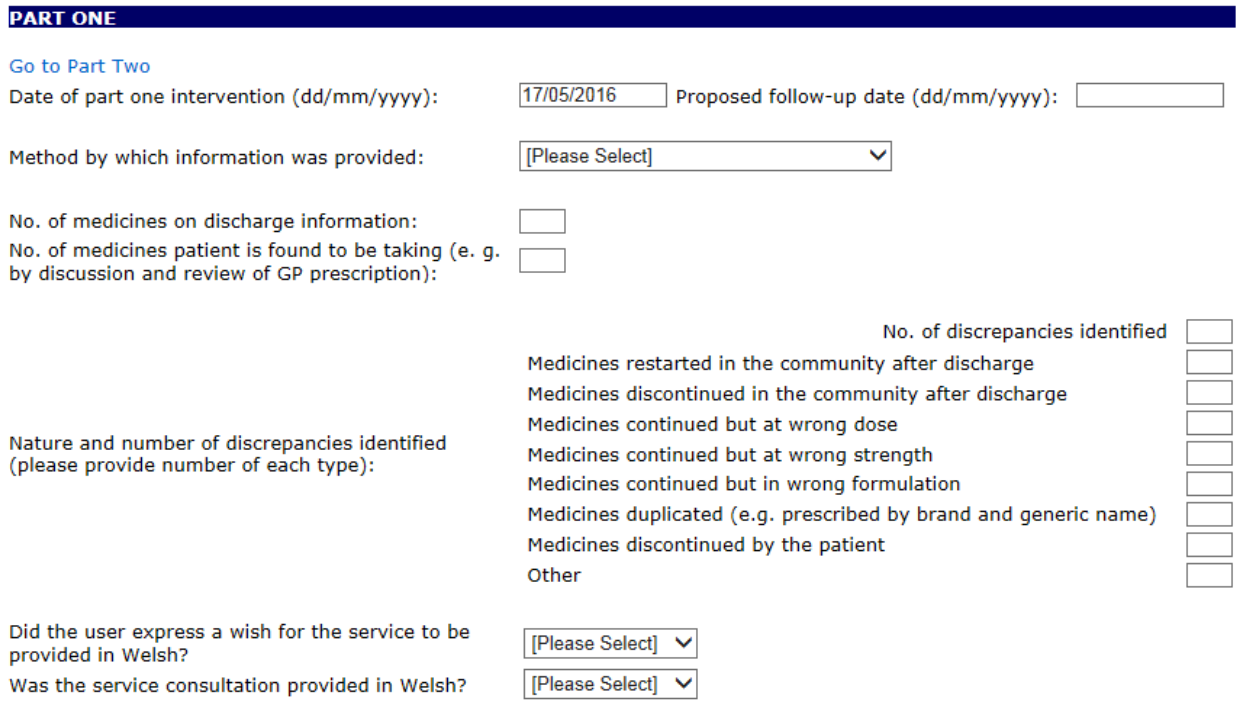


Figure 5.2: Discrepancy Data Entry for NECAF DMRs

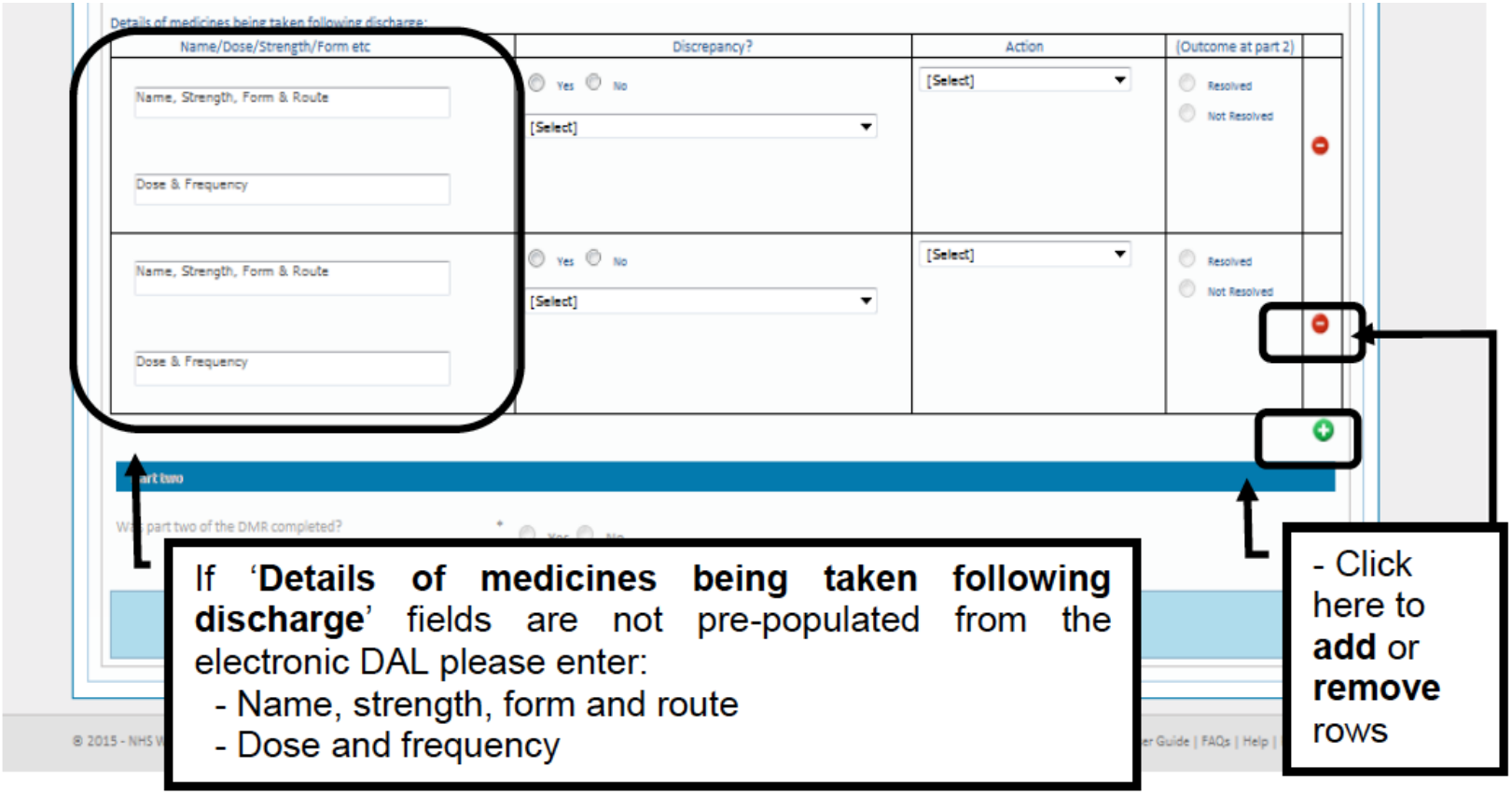


Figure 5.3: Discrepancy Data Entry for ChP DMRs

The DMR data from ChP and NECAF were both considered essential to address Thesis Objectives 3-5. ChP contained detailed medication-related data and explanatory free-text data categories (e.g., 'other' DMR1 delivery method), whilst NECAF contained more longitudinal data necessary to describe DMR provision over time.

5.3. Study Approvals and Data Access

The researcher considered the study approvals required to analyse the DMR data and how to access it. Although some ethics committees do not require approval for the analysis of anonymised secondary data (Phillips et al. 2017), the researcher sought and obtained it from CSPPSREC (reference: 1920-20) because the study was part of their PhD. As part of the routine consent for the DMR, patients must consent to the recording and use of the data for service evaluation and audit (Mantzourani et al. 2020). Therefore, no additional patient consent was needed to use the data.

Further study approvals were considered because the respective ChP and NECAF data processors, NWIS and NWSSP, were NHS organisations. In line with the HRA (2020) guidance, the researcher defined the secondary analysis as a service evaluation rather than research because it aimed only to evaluate the DMR and not change patient care. Velindre University NHS Trust, the hosting organisation for NWIS, agreed with the service evaluation designation and registered the study. In contrast, NWSSP did not require study registration.

Formal data access requests were submitted to NWIS and NWSSP. NWIS provided the ChP DMR data in two related datasets, one containing the details of each consultation and the other with details of each medication entered on the DMR form. NWSSP provided one dataset containing all DMRs recorded in NECAF or ChP. Figure 5.4 summarises the structure and contents of the three datasets provided.

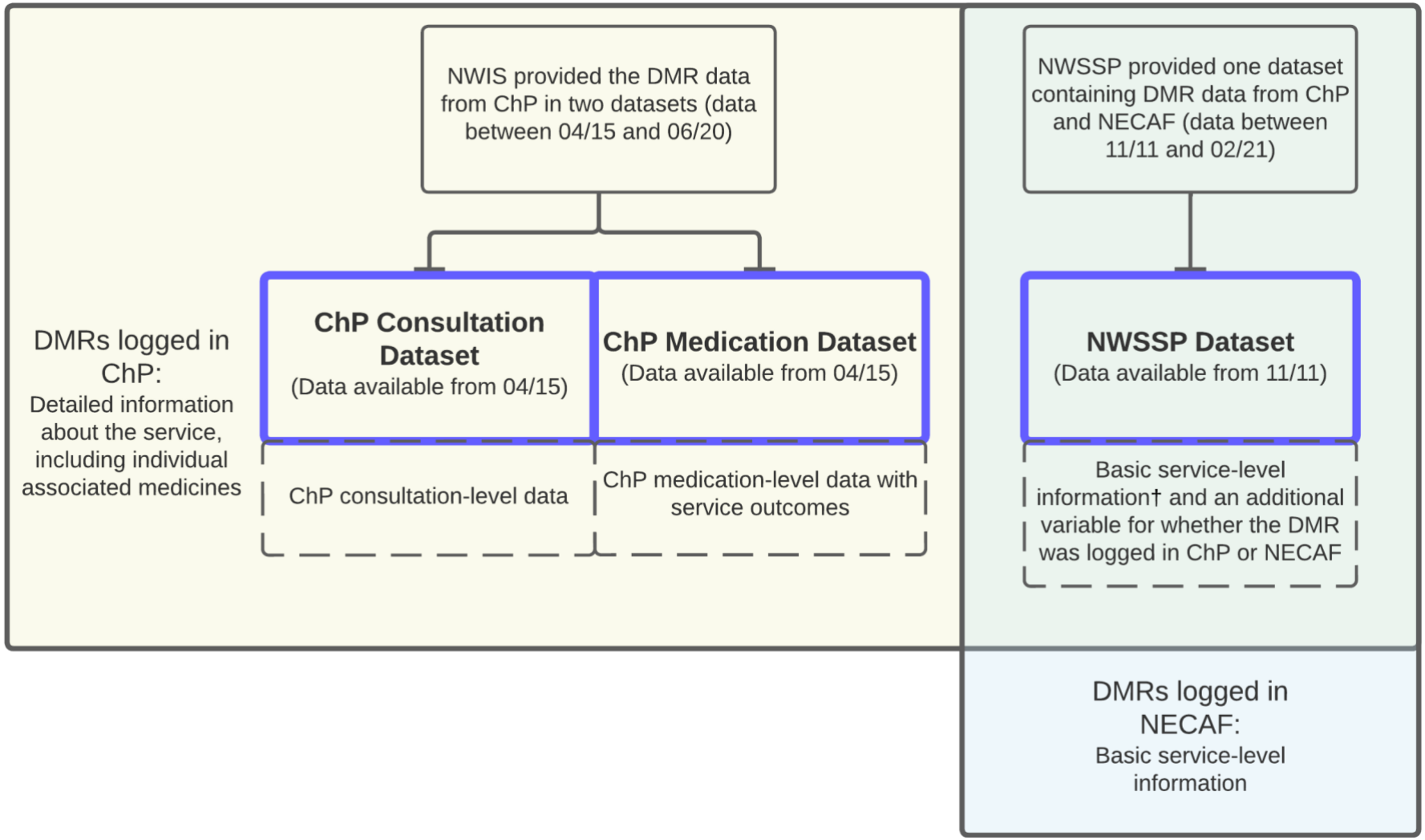


Figure 5.4: Overview of DMR Dataset Extraction and Contents

†The NWSSP dataset contains the same variables as those collected in NECAF (see Table 5.1).

5.4. Data Preparation Method

Section 2.8.1 outlined the general processes involved in data preparation: cleansing, reduction, and transformation. This section presents the researcher's specific data preparation methods, using Microsoft Excel® (v16.6), to structure the data for secondary data analysis.

5.4.1. Data Cleansing

The researcher checked each of the three datasets for erroneous values and considered whether to use pairwise (delete only the erroneous value) or listwise deletion (delete the whole data entry) (Thomas 2020). Pairwise deletion conserves more data than listwise but is more liable to bias during inferential statistics. Therefore, listwise deletion was only used where the erroneous value indicated that the entry did not represent a legitimate DMR. The patient age variable was checked for zero values because data entry and database errors often default to zero (false zeroes) (Blasco-Moreno et al. 2019). Table 5.3 details this process for the ChP consultation and NWSSP datasets. These identified false zeroes were deleted (pairwise) since they likely represented data entry errors. The researcher considered using medicines-related data to identify DMRs with medications unlikely to be associated with 0-year-old patients. However, this method was excluded because it would have required extensive assumptions due to the lack of access to each patient's medical record.

Table 5.3: Identification of False Zeroes in the Patient Age Variable

Variable	Categories Indicating a False Zero	Rationale	Number of Identified Zeroes (NWSSP/ChP Consultation Datasets)
DMR1 delivery method	With the patient at the pharmacy (without a carer)	0-year-old patients could not engage with the DMR without assistance from a carer.	92/0
	With the patient by telephone		2/0
DMR2 delivery method	With the patient at the pharmacy (without a carer)		77/0
	With the patient by telephone		5/0
Discharge information provider	Patient		18/0
Discharging hospital	Care home	0-year-old patients are unlikely to reside in care homes.	1/0
Total number of identified false zeroes			97†/0

†The total number of false zeroes was less than the number added from each variable because there was considerable overlap, i.e., many patients had the same delivery method for DMR1 and DMR2.

Table 5.4 summarises all further identified erroneous values and the deletion method employed. Once the researcher had completed the considerable data cleansing processes, the NWSSP and ChP consultation datasets contained 85,573 and 28,099 DMRs, respectively. The ChP medication dataset contained 269,699 items.

Table 5.4: Identification and Processing of DMR Data Erroneous Values

Data Source	Variable	Description of Erroneous Entry	Management Method	Number of Erroneous Values
ChP consultation dataset	Date of discharge	The discharge date was before the DMR commissioning date, e.g., *"27/03/1900"*.	Pairwise deletion	21
	Contractor ID	The entry was not a valid contractor ID, e.g., *"NULL"*. These entries did not have values for the contractor's name.	Listwise deletion†	10
	Discharging hospital	The entry was *"test"*, indicating that it was not a legitimate DMR.	Listwise deletion†	7
ChP medication dataset	DMR ID	An item description was entered in the DMR ID field, indicating that the entry was erroneously transcribed.	Listwise deletion†	1
	Item description	Many item descriptions did not describe a distinct item, often summarising that the patient had no medication changes or discrepancies. Appendix 5.1 describes these entries in more detail.	Pairwise deletion	1,679

†Listwise deletion was used because the entry did not correspond with a legitimate DMR.

5.4.2. Data Reduction

Section 5.2 described that many DMR variables were free-text, including the discharging hospital, pharmacy contractor name and item descriptions. These variables could not be analysed directly because the data contained colloquialisms and typos, commonly described as 'dirty data', a recognised challenge for analysing secondary healthcare data (Manogaran et al. 2017). Therefore, the researcher reduced the data, removing typos and colloquialisms to ensure that each data subject was represented by a single value (Taleb et al. 2015). In addition to the free-text variables, the researcher reduced the 'contractor ID', a unique value for a pharmacy and associated contractor. This value changes if a given pharmacy changes ownership; therefore, it was unsuitable to describe the consistency of the DMR across Wales because it did not describe an individual pharmacy. Figure 5.5 provides an overview of the data reduction processes.

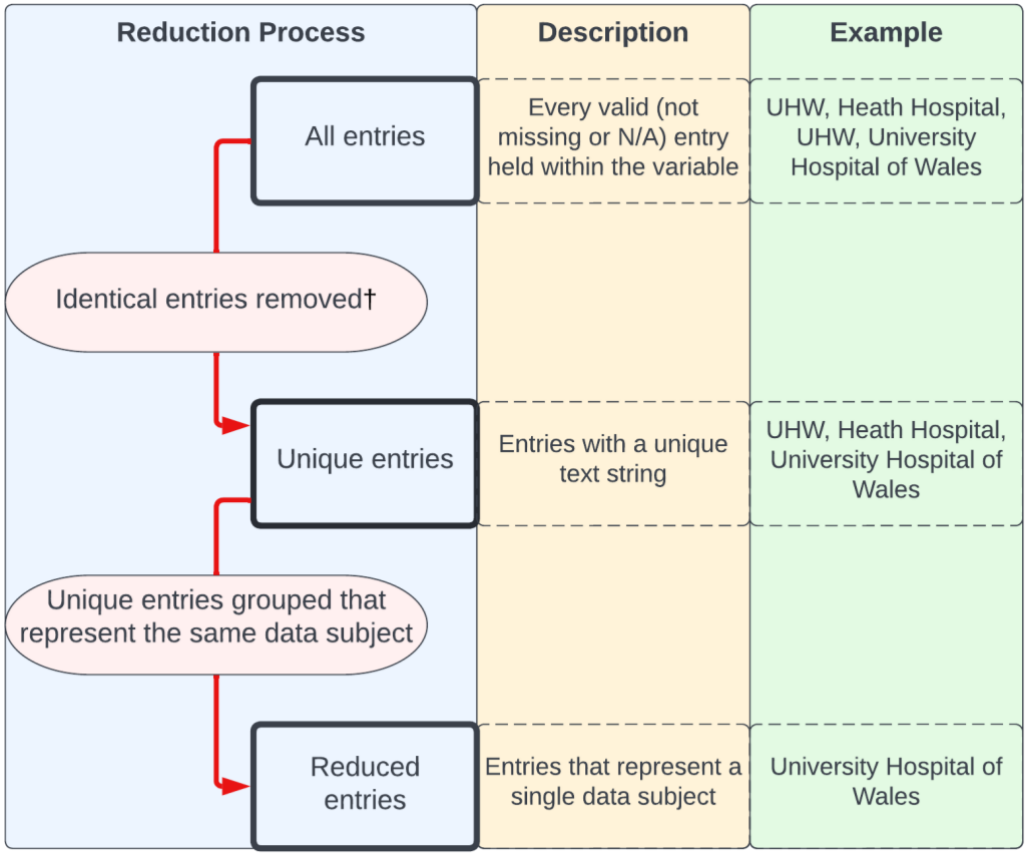


Figure 5.5: DMR Data Reduction Process

†Using the Microsoft Excel 'remove duplicates' function.

Once the researcher completed this process, they substituted all entries for their reduced counterparts. Table 5.5 summarises each data reduction process and its associated challenges.

The contractor ID variable only accounted for pharmacies that had provided at least one DMR during the data collection period (November 2011 to January 2021). The researcher developed the *pharmacy dataset* using publicly accessible dispensing and services data for Wales to ensure all pharmacies were accounted for in the analyses (NWSSP 2021). The dispensing and services dataset included monthly data for each pharmacy that had dispensed at least one NHS prescription (between April 2012 and January 2021), including:

- pharmacy name, address, postcode, and contractor ID,
- NHS prescription dispensing data,
- service delivery volume, e.g., the monthly number of Medicine Use Reviews (MURs).

The researcher reduced contractor IDs using the pharmacy name and postcode, ensuring each new reduced contractor ID corresponded with a single pharmacy premises. These pharmacies included all in Wales that had provided DMRs and all those that provided none, which was essential for describing pharmacy-related factors affecting DMR delivery volume (Thesis Objective 4).

Table 5.5: Overview of Employed Data Reduction Processes for DMR Data

Data Source	Data Category [Number of Entries]	Challenges With Reduction	Number of Unique Entries	Unique Data Entry Examples	Number of Reduced Entries	Reduced Data Entry Example
NWSSP dataset	Contractor ID [n=85,573]	The NWSSP dataset only contained the contractor ID for pharmacies that had provided a DMR. It was essential to include all pharmacies (even those that provided no DMRs) to address Thesis Objective 4, describing the factors affecting DMR delivery volume over time. The researcher developed a separate dataset to reduce the contractor ID (see previous page).	900	*"602080K" and "602080J"* (contractor IDs with the same postcode and pharmacy address)	721	Pharmacy 200
	Contractor name† [n=85,573]	The systems stored many different names for the same pharmacy contractor. The contractors were assigned a number for anonymity.	410	*"Boots", "My Local Boots", and "Boots Ltd"*	251	Contractor 150 (a false number was assigned here for anonymity)
	Discharging hospital† [n=85,573]	Pharmacists frequently entered ward names rather than the hospital name, necessitating extensive online searches to determine the corresponding hospital (NHS Wales [no date]).	254	*"Abblett Unit" and "Ysbyty Glan Clwyd"*	126††	Ysbyty Glan Clwyd
	Other DMR2 incompletion reason [n=2,117]	None noted.	531	*"Too long time elapsed" and "Too long elapsed"*	457	Too much time elapsed
ChP consultation dataset	Other DMR1 delivery method [n=2,278]	Pharmacists frequently entered superfluous information, requiring a considerable time to reduce.	798	*"Husband by phone" and "Husband telephone"*	412	Husband by telephone
	Further action required after DMR2 [n=1,605]	The large number of unique entries was time-consuming to review.	1,600	*"Patent [sic] admitted to hospital" and "patient readmitted to hospital"*	1,380	Patient readmitted to the hospital

Table 5.5 (continued)

Data Source	Data Category [Number of Entries]	Challenges With Reduction	Number of Unique Entries	Unique Data Entry Examples	Number of Reduced Entries	Reduced Data Entry Example
ChP medication dataset	Item description [n=268,020]	Although each entry generally included generic medicine name, strength, and formulation, many only had some of this information. The researcher replaced any missing features with "unknown". For example, '*amoxicillin capsules'* was grouped into '*amoxicillin capsules unknown'*.	14,101	*"Apixaban 2,5mg tablets" and "apixiban [sic] 2.5 tablets"*	3,424	Apixaban 2.5mg tablets
	Other DMR1 discrepancy type [n=9,682]	The large number of unique entries was time-consuming to review.	6,080	*"Missing from GP Rx" and "Missing from GP prescription"*	5,781	Missing from GP prescription
	Other actions taken to rectify the discrepancy [n=2,086]	The large number of unique entries was time-consuming to review.	1,026	*"Antibiotic course complete" and "Antibiotic course finished"*	860	Antibiotic course complete

The variables subjected to content analysis are coloured yellow.

†Data reductions were performed in the NWSSP dataset and then exported to the ChP consultation dataset.††Although the databases named the variable 'discharging hospital', it also contained the names of other care settings like care homes, prisons and when the discharging hospital was unknown.

5.4.3. Data Transformations

Data transformation involves changing the data structure to optimise analysis. The researcher added additional variables from external data sources if they were relevant for addressing Thesis Objectives 4 and 5 (describing factors affecting DMR delivery volume and discrepancy identification). Table 5.6 summarises all employed data transformations, but further explanations of each transformation are provided below.

Table 5.6: Summary of Employed DMR Data Transformations

Variable Descriptor	Starting Variable [Number of Groups]	Transformed Variable [Number of Groups]	Applicable Dataset
Pharmacy-related	Reduced Contractor ID [n=721]	Pharmacy ID [n=712]	Transformed in the pharmacy dataset and then exported to the NWSSP† and ChP consultation datasets.
		Pharmacy type [n=5]	
		Rural-urban classification [n=6]	
		Social deprivation quartile [n=4]	
		GP co-location status [n=2]	
	GPhC number for DMR1/DMR2 [n=824/794]	Same pharmacist for DMR1/DMR2 [n=2]	Transformed in the ChP consultation dataset.††
Discharge-setting-related	Discharging hospital [n=126]	Discharging healthcare organisation [n=16]	Transformed in the NWSSP dataset and then exported to the ChP consultation dataset.
Service-related	Dates for discharge, DMR1 and DMR2 [numerical]	Associated month and year [numerical]	Transformed in the NWSSP and ChP consultation datasets, respectively.
		Weekend status [n=2]	
		Number of days between dates [numerical]	
	DMR delivery method [n=6]	DMR pharmacy status [n=3]	Transformed in the NWSSP dataset and then exported to the ChP consultation dataset.
		DMR carer involvement [n=3]	
Medicines-related	Item description [n=3,424]	Anatomical Therapeutic Chemical (ATC) level 1 [n=16]/level 2 [n=87]/level 4 [n=418]	Transformed in the ChP consultation dataset.††
		Broad high-risk drug classification [n=13]	
		Narrow high-risk drug classification [n=33]	
		Condensed item description [n=1,144]	
		Controlled drug status [n=2]	
		Dosage form [n=58]	
		Route of administration [n=24]	
		Incomplete item description [n=2]	
	Dosage direction [n=50,857]	As-directed dosage feature [n=2]	
		When-required dosage feature [n=2]	
		Change after discharge dosage feature [n=2]	

†As previously described, the NWSSP dataset contained DMRs from November 2011, whilst the pharmacy dataset only had data from April 2012. Therefore, the researcher made the assumption that these variables had not changed before this date for a given pharmacy.

††These variables were only available in the ChP consultation dataset.

5.4.3.1. Pharmacy-Related Variables

5.4.3.1.1. Pharmacy ID

The 721 reduced contractor IDs represented all pharmacies in Wales that had dispensed at least one NHS prescription. When describing the number of DMRs per pharmacy, it was essential to remove pharmacies that were not registered to provide the DMR and thus could not engage with the service (see Section 1.5). Therefore, the researcher removed the nine non-registered pharmacies from the pharmacy dataset using registration data requested from and supplied by NWSSP. However, the only available data was a list of DMR-registered pharmacies in January 2021; therefore, it did not account for any changes in registration status over time. *Pharmacy IDs* (e.g., pharmacy 105) were assigned to the 712 DMR-registered pharmacy premises, which were added to the NWSSP and ChP datasets.

5.4.3.1.2. Pharmacy Type

Previous research has described how pharmacy type influences the uptake of community pharmacy services, including the DMR (Hodson et al. 2014a; Hann et al. 2017). The researcher used the Hodson et al. (2014a) definitions of pharmacy type:

- independent (the contractor owns one pharmacy),
- small chain (the contractor owns 2-4 pharmacies),
- medium-sized multiple (the contractor owns 5-25 pharmacies),
- large-sized multiple (the contractor owns >25 pharmacies),
- supermarket (the pharmacy is in a supermarket).

Appendix 5.2 provides further detail regarding calculating the number of pharmacies owned per contractor. The researcher manually changed entries for pharmacy type if they changed over time because the contractor purchased or sold a pharmacy. For example, if an independent contractor purchased another pharmacy on 1st March 2015, the researcher changed the pharmacy type for entries related to this contractor after this date to a small chain. The pharmacy type was then exported to the ChP consultation and NWSSP datasets.

5.4.3.1.3. Rural-Urban Classification and Social Deprivation Quartile

The inverse care law infers that the availability of good medical care will be lower in areas of greater need, such as socially deprived areas (Mercer et al. 2021). In contrast, Todd et al. (2015) described a positive pharmacy care law in England, that pharmacy access is greater in areas of social deprivation. Bradley et al. (2008) found that Medicines Use Review (MUR) provision was lower for pharmacies in rural or deprived areas. Therefore, the researcher added rurality and social deprivation measures, described in Table 5.7, to investigate their effect on DMR provision.

Table 5.7: Chosen Measures of Rurality and Social Deprivation

Chosen Measure	Description
Social deprivation quartile (Welsh Government 2019)	A statistical quartile from a ranked list of social deprivation by LSOA (see below), defined by the Welsh Index of Multiple Deprivation (the 2019 iteration). Quartile 1 described the most deprived areas, whilst quartile 4 described the least deprived.
Rural-urban classification	An Office for National Statistics (2016) relative rurality and population density measure, defined for a given LSOA (see below). The six groups include: • City & town (not sparse) • Town & fringe (not sparse) • Villages (not sparse) • City & town (sparse) • Town & fringe (sparse) • Villages (sparse)
Lower Super Output Area (LSOA)	An Office for National Statistics (2016) measure that describes a geographic area with an approximate population of 1,600. The researcher assigned an LSOA to each pharmacy ID (using their postcode) and then used it to assign the social deprivation and rurality measures. As there were no pharmacy LSOA changes over time, there were no changes in social deprivation status or rural-urban classification.

5.4.3.1.4. GP Co-location Status

A systematic review of factors affecting collaboration between GPs and community pharmacists identified that physical distance between the professions might impact collaboration (Bollen et al. 2019). Since the DMR involves collaboration with GP surgeries, the researcher theorised that pharmacy co-location could influence DMR provision. There is no standard definition of pharmacy co-location. However, Jenkins et al. (2016) described it as co-location within the same building. The researcher decided that this definition may not be appropriate because it would exclude pharmacies adjacent to GP surgeries. Therefore, the researcher used Google Maps® to find a walking distance cut-off between pharmacies and their nearest GP surgery that would only encompass pharmacies within GP surgeries and those adjacent. KH and the researcher reviewed these distances and found that the most appropriate cut-off was 150 yards, under which pharmacies were co-located (see Figure 5.6). If the pharmacy changed its address during the data collection period, the researcher checked for changes in co-location status. The co-location status was changed in all datasets for the pharmacies with co-location changes [n=28] after the change date.

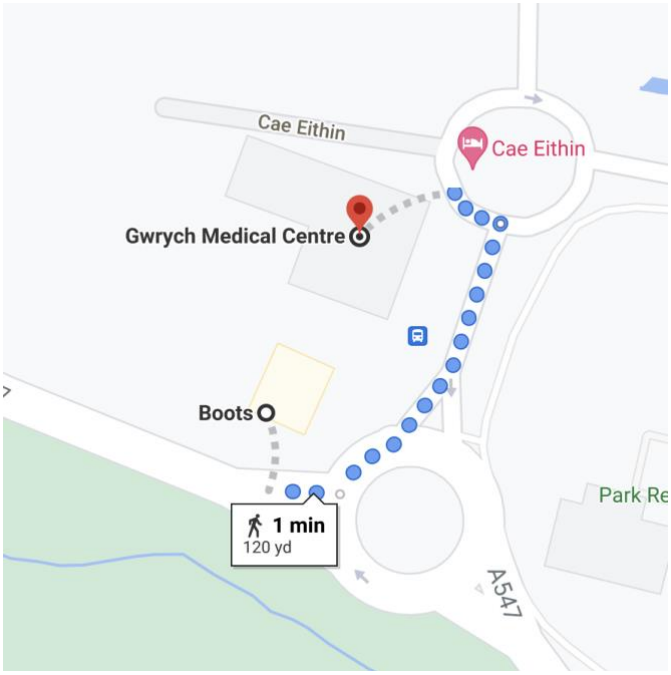


Figure 5.6: Example of a Co-located Pharmacy

5.4.3.1.5. Same Pharmacist for DMR1 and DMR2

The researcher created a new binary variable to describe whether the same pharmacist (using their GPhC number) completed DMR1 and DMR2:

- 'Yes' represented matching GPhC numbers logged for DMR1 and DMR2.
- 'No' represented when the GPhC number did not match.

Where there was no entry for the pharmacist completing DMR2 (DMR2 was not completed), the value was left blank because the variable was not applicable.

5.4.3.2. Discharge-Related Variables

The researcher transformed the 126 unique 'discharging hospitals' into 16 *discharging healthcare organisations*. For hospitals in Wales, the discharging healthcare organisation was their Local Health Board (LHB) or Velindre NHS Trust. Data entries in the 'discharging hospital' variable that described alternative care settings were grouped by the type of setting. For example, 'discharging hospital' entries describing a care home were coded as 'care home' for the discharging healthcare organisation.

Abertawe Bro Morgannwg University Health Board (ABMUHB) was renamed SBUHB in April 2019, other than the Princess of Wales, Maesteg General and Glanrhyd hospitals. Instead, these hospitals merged with CTMUHB (The Local Health Boards (Area Change) (Wales) (Miscellaneous Amendments) Order 2019). The researcher manually changed the discharging healthcare organisation for ABMUHB when the patient discharge date was after March 2019.

5.4.3.3. Service-Related Variables

5.4.3.3.1. Dates for Discharge, DMR1 and DMR2

The discharge, DMR1 and DMR2 dates (dd/mm/yyyy) were transformed to months and years (mm/yy) to analyse DMR provision and outcomes over time. Since healthcare literature has described lower service provision and poorer outcomes on weekends (Chen et al. 2019), the researcher added a binary variable for each date describing whether they fell on the weekend.

The DMR specification suggests that pharmacists complete DMR1 within 28 days of discharge and DMR2 within 28 days of DMR1 (CPW 2011). The NICE (2015) guidance recommends that medicines be reconciled within seven days of discharge. Therefore, the researcher created two variables for comparison with guidance, calculating the number of days between patient discharge and DMR1, and between DMR1 and DMR2. Upon quality assuring these new variables, there appeared to be erroneously large values. For example, the maximum value for the number of days between discharge and DMR1 in the NWSSP dataset was 2,196. These large values are likely to represent when the pharmacist did not contemporaneously record the DMR in NECAF or ChP and entered the date they logged the service rather than when they completed it. Alternatively, the pharmacist may have entered the wrong date when recording the service. Nonetheless, the researcher considered managing these erroneous values by removing statistical outliers, defined as any values with a z-score over 3.29.[18] However, since there were considerable numbers of DMRs with large numbers of days, the z-score threshold values for these variables were relatively large (minimum threshold of 120 days). Therefore, this method was excluded at this stage because it was not a meaningful cut-off, including many values that are likely to be erroneous. The researcher did not remove any values at this stage, deciding how to manage them in each respective data analysis chapter depending on their aims.

5.4.3.3.2. DMR Delivery Method

Patients who delegate responsibility for medications, e.g., to carers, may be at higher risk of post-discharge discrepancies (Tomlinson et al. 2020b). The researcher transformed the DMR delivery method variable into two variables (see Table 5.8), describing whether the DMR had carer involvement and if it was completed in the pharmacy.

[18]A z-score is the distance (number of standard deviations) of a data point from the mean (Field 2018).

Table 5.8: Transformation of the DMR Delivery Method Variable

DMR Delivery Method Groups	Transformed Variables	
	Carer Status Groups	Pharmacy Status Groups
With patient by telephone	No carer present	Not in pharmacy
With patient at home		
With patient at pharmacy (without carer)		In pharmacy
With carer at pharmacy (without patient)	Carer present	
With patient at pharmacy (with carer)		
Other delivery method	Unknown	Unknown

5.4.3.4. Medicines-Related Variables

5.4.3.4.1. Medicine Therapeutic Classification

The researcher considered how to condense the item description entries whilst retaining the information of interest, the therapeutic class. The first consideration was using the British National Formulary classes, which are organised by organ system; hence medicines may appear in multiple classes (Joint Formulary Committee 2022). Therefore, the ATC classification was used because it describes the therapeutic activity, so medicines only appear in a single class (WHO Collaborating Centre for Drug Statistics Methodology 2021). The researcher deviated from the ATC classification for codeine tablets because it classifies them as cough suppressants when their everyday use is as analgesics (Joint Formulary Committee 2022). Table 5.9 introduces the ATC levels, using codeine as an illustrative example.

Table 5.9: Examples of Anatomical Therapeutic Chemical (ATC) Classification Levels

ATC Level	Rationale for Inclusion	Classification of Codeine	
		Original Classification	Adapted Classification
ATC1	Variables were added for ATC1 [16 groups] and ATC2 [87 groups] to provide broad therapeutic descriptions of medicines.	Respiratory system	Nervous system
ATC2		Cough and cold preparations	Analgesics
ATC3	ATC3 groups were not added as a variable because many are identical to ATC2 groups.	Cough suppressants, excluding combinations with expectorants.	Opioids
ATC4	Variable added for ATC4 [418 groups] to provide a specific categorisation of therapeutic effect.	Opium alkaloids and derivatives	Natural opium alkaloids

5.4.3.4.2. High-Risk Medicine Classification

Descriptive analysis of the DMR data would allow the identification of the frequency of high-risk medicines associated with DMRs. Howard et al. (2007) identified certain 'high-risk' medicines classifications associated with medication-related hospital admissions. The researcher did not use these classifications because there have been significant developments since their publication, such as novel anticoagulant drugs (Joint Formulary Committee 2022). More recent classifications by Lin et al. (2017) were used because they were up-to-date and provided broad and narrow classifications, providing flexibility. One variable each was generated for broad (13 groups,

including non-steroidal anti-inflammatory drugs [NSAIDs]) and narrow (33 groups, including non-selective NSAIDs) classifications, respectively. Within these variables, item descriptions that did not fall within one of the high-risk classifications were defined as *'not high-risk'*.

5.4.3.4.3. Condensed Item Descriptions

Since the item description had many categories [n=3,424], the researcher considered that meaningful analysis would be challenging. Therefore, they created a new variable to group item descriptions by medication and route of administration. For example, 'paracetamol 500mg tablets' and 'paracetamol tablets unknown' were categorised as 'paracetamol oral'. When different medicine strengths conferred a different ATC group, these were classified separately. For example, since *'aspirin 300mg tablets'* and *'aspirin 75mg tablets'* are in different ATC groups, the researcher classified them as *'aspirin high dose'* and *'aspirin low dose'*, respectively (WHO Collaborating Centre for Drug Statistics Methodology 2021). All subsequent analyses used condensed item descriptions rather than the original item descriptions.

5.4.3.4.4. Controlled Drug Status

Controlled drugs, as defined by the Misuse of Drugs Act (1971), are not an eligibility criterion for the DMR. However, they are for England's recently introduced Discharge Medicines Service (NHS England and NHS Improvement 2021). Since stakeholders wanted to know patient criteria for DMR referrals, the researcher wanted to explore whether controlled drugs were more likely to be associated with discrepancies. Therefore, a binary variable (yes/no) was added describing whether each item was a controlled drug (all schedules). The researcher manually changed entries for pregabalin and gabapentin because they changed from non-controlled to controlled drugs after 30th March 2019 (Misuse of Drugs Act 1971).

5.4.3.4.5. Dosage Form, Route of Administration, and Incomplete Item

Two variables were generated from the item descriptions, detailing the item's route of administration [n=24] and dosage form [n=58] according to the Food and Drug Administration (2017) data standards. For example, *'paracetamol 500mg tablets'* was categorised as an *'oral'* route of administration and a *'tablets'* dosage form. Table 5.5 described that some item description entries were missing dosage form information. For these entries, the route of administration and dosage form variables were defined as 'unknown'. A further binary variable, *'incomplete item'*, was generated to describe item description entries with missing strength or dosage form information.

5.4.3.4.6. Dosage Directions

ChP captures the dosage directions of each medication item, which the researcher considered categorising to describe dosage descriptions associated with the DMR and associated with discrepancies. These data would have required considerable reduction as there were 50,857 unique values, including typos and differences in phrasing for a given dose direction. For example, *"take one dose daily"* was also entered as *"one daily"* and *"1 od",* among many others. Reducing these data would have taken considerable time, which was not feasible in the context of a PhD thesis. For timeliness, the researcher generated three binary variables describing the presence of specific features: 'when-required', 'as-directed', and planned dose changes after discharge. The researcher chose these categories as they reflected where the dose of the medication was not clearly defined and could theoretically create ambiguity after discharge. Following a method used by Tate et al. (2011) to extract phrases from free-text clinical data, a combination of word fragments was used to encompass common phrasing and typos. Appendix 5.3 describes this process in more detail. Due to the considerable quantity of data, it was not practicable to quality assure all entries. Therefore, the researcher quality assured a sample constituting approximately 10% [n=5,100] of unique entries, in line with recommendations for coding clinical data (Sarkar and Seshadri 2014).

5.5. Data Reflections and Conclusions

This chapter presented the extensive work undertaken to prepare the DMR data for analysis, including data cleansing, reduction, and transformation. Although these processes took several months, this extensive preparation coincides with common limitations of secondary data analysis (Hox and Boeije 2005). In part, these limitations can be explained by the design of the DMR data systems to optimise community pharmacist workflow rather than analysis. The time taken to prepare the data was inflated by the large DMR datasets, encompassing over 85,000 consultations and almost 270,000 medication items.

The extensive data preparation procedures were justified for the data analyses' aims but are liable to the researcher's human error, which could introduce bias. An example of these errors would be misclassification, where a data entry was incorrectly categorised (Verheij et al. 2018). However, the researcher took care to quality assure each data preparation stage to minimise these risks. Furthermore, the descriptive analysis in Chapter 6 and the exploratory data analysis (EDA) undertaken before regression for Chapters 8 and 9 provided further opportunities for error detection. Another potential source of error is that much of the DMR data were manually entered by pharmacists (see Table 5.1). Manually-entered data have an inherent risk of inaccuracy, which

could be considerable given the context of a busy healthcare environment (Verheij et al. 2018). Although these characteristics of the DMR data are limitations, they are common for secondary data, where the researcher cannot control the quality of the data inputted (Hox and Boeije 2005).

Data preparation may be assisted by machine learning and natural language processing developments, providing timely and semi-automated solutions (Koleck et al. 2019). Rather than using distinct categories for data entry, Lockery et al. (2019) suggested that type-to-text data entry (typing free-text provides suggested entries) improved data collection consistency. This approach was especially effective when the authors routinely updated the type-to-text algorithm to include free-text data such as common colloquialisms, brand names, or typos. Improved data consistency would make future analyses timelier and facilitate the complete analysis of 'dirty data'.

The data prepared in this chapter are used to support the secondary data analyses addressing Thesis Objectives 3-5. Chapter 6 presents the first of these analyses, a multimethod description of DMR provision from November 2011 to January 2021.

Chapter 6. Describing DMR Provision from November 2011 to January 2021 Using Routinely Collected Data

6.1. Chapter Introduction

The thesis introduction (Section 1.5.4.3) presented the rationale for describing the provision of the DMR over time. This process is considered essential for evaluating complex interventions, specifically for investigating how and where the intervention was delivered, any factors influencing its implementation, whether any adaptations were made, and the intervention's effect (Moore et al. 2015). Describing the outcomes of the DMR will build on the previous evidence for the service in preventing medication errors and potential medicines-related harm (MRH).

The original service evaluation used data extracted only from National Electronic Claim and Audit Forms (NECAF) since NWIS had not yet developed the Choose Pharmacy (ChP) DMR module (Hodson et al. 2014a). ChP collects more detailed data than NECAF, providing the opportunity to describe DMR features that have not been previously available. As detailed in Section 5.2, these previously unavailable features included explanatory free-text boxes for 'other' discrepancy types, DMR delivery methods, and the details of any further action required after DMR2. ChP also records data regarding each DMR medication item. The increased availability of detailed DMR data justifies the need for an up-to-date service description. Trends in DMR provision and outcomes can also be calculated due to the availability of almost ten years of longitudinal data in the NWSSP dataset. Expanding and updating the original DMR evaluation, this chapter addresses Thesis Objective 3, describing DMR provision from November 2011 to January 2021. This chapter's objectives are to:

1. Describe the discharge-related factors associated with the DMR.
2. Describe the patient-related factors associated with the DMR.
3. Describe the medicines-related characteristics of DMR recipients.
4. Describe the DMR consultation-related factors.
5. Describe the identification of DMR discrepancies and their resolution.
6. Explore further action required after DMR2.

This chapter does not aim to identify factors affecting the number of DMRs provided per pharmacy or the number of discrepancies because these are addressed in Chapters 8 and 9, respectively.

6.2. Chapter 6 Methods

This chapter employed a multimethod approach, including a descriptive analysis of the DMR data in the NWSSP dataset (approximately ten years of data) and content analysis of the available free-text explanatory boxes (see Section 2.7). This approach provides a detailed description of how the DMR was delivered, its outcomes, and whether any adaptations had been made to the service in line with the MRC framework (Moore et al. 2015). Table 6.1 presents the variables used for

Chapter 6, which were selected if they aligned with the MRC framework, describing how and where the DMR was provided and its outcomes.

Table 6.1: DMR Data Used for Chapter 6

Variable Descriptor	Variable	Number of Valid/Missing Entries†		
		NWSSP Dataset [n=85,573]	ChP Consultation Dataset [n=28,099]	ChP Medication Dataset [n=269,699]
Discharge-setting-related	Discharge place	85,573/0	N/A	N/A
	Discharging healthcare organisation	85,573/0	27,567/532	N/A
	Discharge information provider	85,573/0	28,099/0	N/A
Patient-related	Patient age	83,127/2,446	22,881/5,218	N/A
	Patient gender	N/A	28,099/0	N/A
	Eligibility criteria	85,573/0	28,099/0	N/A
Pharmacy-related	Pharmacy ID	85,573/0	28,099/0	N/A
	Contractor name	85,573/0	28,099/0	N/A
	Pharmacy type	85,573/0	28,099/0	N/A
	Pharmacist providing DMR	N/A	22,881/5,258	N/A
	Same pharmacist for DMR1 and DMR2	N/A	18,379/4,212	N/A
	Rural-urban classification	85,573/0	28,099/0	N/A
	Social deprivation quartile	85,573/0	28,099/0	N/A
	Co-location status	85,573/0	28,099/0	N/A
Service-related	Days between discharge and DMR1	85,523/50	27,899/200	N/A
	DMR1 weekend status	85,573/0	28,099/0	N/A
	DMR1 delivery method	85,573/0	28,088/11	N/A
	Other DMR1 delivery methods description	N/A	2,278/0	N/A
	DMR2 incompletion reason	14,690/0	5,508/0	N/A
	Other DMR2 incompletion reason description	2,117/0	N/A	N/A
	Days between DMR1 and DMR2	70,883/0	22,591/0	N/A
	DMR2 weekend	70,883/0	22,591/0	N/A
	DMR2 delivery method	70,883/0	22,591/0	N/A
	DMR processing method	85,573/0	N/A	N/A
	Electronic discharge advice letter (eDAL) availability	N/A	28,099/0	N/A
Medicines-related	Number of patient medicines	85,567/6	28,083/16	N/A
	Number of medicines on the DAL	85,571/2	28,097/2	N/A
	Anatomical Therapeutic Chemical (ATC) 1/2/4 groups	N/A	N/A	268,020/1,679
	Route of administration	N/A	N/A	268,020/1,679

Table 6.1 (continued)

Variable Descriptor	Variable	Number of Valid/Missing Entries		
		NWSSP Dataset [n=85,573]	ChP Consultation Dataset [n=28,099]	ChP Medication Dataset [n=269,699]
Outcome-related	DMR1 number of discrepancies	85,491/82	N/A	N/A
	DMR1 number of discrepancy types	85,491/82	N/A	N/A
	DMR2 number of discrepancies	70,812/71	N/A	N/A
	DMR2 number of discrepancy types	70,812/71	N/A	N/A
	Discrepancy occurrence	N/A	N/A	269,576/123
	Discrepancy type occurrence	N/A	N/A	269,575/124
	Other discrepancy type description	N/A	N/A	9,682/0
	Actions taken to rectify discrepancy	N/A	N/A	28,488/0
	Other actions taken to rectify discrepancy description	N/A	N/A	2,086/0
	Discrepancy resolution	N/A	N/A	25,851/2,637
	Further action required after DMR2	N/A	22,591/0	N/A
	Further action required after DMR2 description	N/A	1,605/0	N/A

Free-text variables are coloured yellow.

†The researcher deleted the missing values in each dataset pairwise rather than listwise to maximise the available data. This benefit was weighed against the greater risk of bias with pairwise deletion, which was less critical because this chapter did not use inferential statistics (Thomas 2020).

6.2.1. Content Analysis Methods

Section 2.8.2.3 justified using content analysis (analysis technique) for this chapter. This section describes the specific method employed: inductive, deductive, or summative. While completing data reduction (see Table 5.5), the researcher noted that the entries for some variables (other DMR1 delivery method and action taken to rectify the discrepancy) were less detailed than the others. Therefore, different content analysis approaches were employed for each variable, as described in Table 6.2 (Gale et al. 2013). The researcher analysed all data entries rather than a sample since understanding the provision of the DMR and its outcomes was vital for the chapter's aims (Elo and Kyngås 2008). Lindsey and Pattison Rathbone (2022) suggest independent content analysis by multiple researchers to ensure the credibility of the findings. However, the researcher considered this impractical given the considerable time commitment for the content analysis of a large dataset. Therefore, they completed the content analyses by themself, but KH and EM reviewed the constructed categories to enhance credibility.

Table 6.2: Overview of DMR Free-Text Variables Analysed with Content Analysis

Free-Text Variable [Number of Reduced Entries]	Chosen Content Analysis Method	Deductive Framework
Other DMR2 incompletion reason [n=457]	• The free-text data was explanatory, so the analysis aimed to understand its underlying meaning. • Inductive content analysis was chosen since it facilitates a richer understanding of data than other approaches.	N/A
Further action required after DMR2 [n=1,380]		
Other DMR1 discrepancy type [n=5,781]		
Other DMR1 delivery method [n=412]	• The native categories had a clear structure, so the researcher aimed to categorise the data into this format. • Deductive was appropriate because it facilitates categorising free-text data into a framework. • The deductive frameworks were developed by following the structure of the native categories. • However, the researcher chose summative content analysis (deductive then inductive) to ensure data could be categorised even if it did not fit within the deductive framework.	*"With whom the service was provided" - "the location where the service was provided".*
Actions taken to rectify the discrepancy [n=860]		*"Resolve with whomever the pharmacist intends to resolve the discrepancy with".*

6.2.2. Descriptive Statistical Analysis Methods

Section 2.8.1.3 outlined the rationale for using descriptive statistical analysis to describe DMR provision, primarily that inferences were not needed because all DMR data were available. Microsoft Excel® (v16.6) was used for data descriptions, such as summary statistics, frequencies, and proportions, and visualisations, such as frequency distributions for numerical variables and pie or bar charts for categorical variables (Field 2018). This chapter does not compare the number of DMRs or discrepancies across variables, e.g., the average number of DMRs or discrepancies per independent pharmacy vs supermarket pharmacy, because Chapters 8 and 9 explore these relationships.

The researcher used DMR dates to describe service provision and its outcomes over time. Monthly proportions or mean values were calculated and plotted for categorical and numerical data, respectively. The researcher used linear and fractional polynomial regression lines to visualise linear and non-linear changes over time, using the Microsoft Excel® inbuilt functionality. The researcher also used fractional polynomial lines for time series with considerable inter-month variability to improve the visualisation of changes over time, known as smoothing methods (Ledolter 2008). Given the large quantity of data, it would be impractical to include results for changes over time for all variables. Therefore, the researcher visualised the data but only presented notable findings.

Since the NWSSP dataset contained all DMRs logged in NECAF or ChP, data linkage was not necessary to describe DMR provision over time. However, the ChP medication dataset contained

medicines-related data but no consultation data such as DMR dates. Therefore, the researcher decided to perform data linkage between the ChP consultation and medication datasets. The researcher linked these datasets using DMRiD, the unique ChP DMR reference (see Table 5.1), generating the *ChP combined dataset*. Of the 29,318 unique DMRiDs in the ChP medication dataset, 28,073 were successfully linked with the consultation dataset (corresponding with 267,311 items).

6.3. Chapter 6 Results

Although different methods, this section integrates content analysis and descriptive analysis findings to aid flow and interpretation. For example, the content analysis results for 'other' discrepancy types will be presented with the descriptive analysis of discrepancy types. The researcher added *ad verbatim* comments to facilitate category description and enhance the credibility of results (Lindsey and Pattison Rathbone 2022). The content analysis results are presented in tables unless they require a more detailed description, in which case they are presented narratively.

The first results section provides an overview of the number of DMRs over time, followed by subsections regarding discharge, patient, pharmacy, service, medicines, and outcome-related data. Unless stated otherwise, the analyses used the NWSSP dataset.

6.3.1. Overview of DMR Provision

There was a total of 85,573 DMR claims, most [n=70,883, 82.8%] of which included DMR2. Most DMR1s [n=79,526, 92.9%] and DMR2s [n=64,708, 91.3%] were provided on a weekday. Figure 6.1 describes monthly DMRs over time.

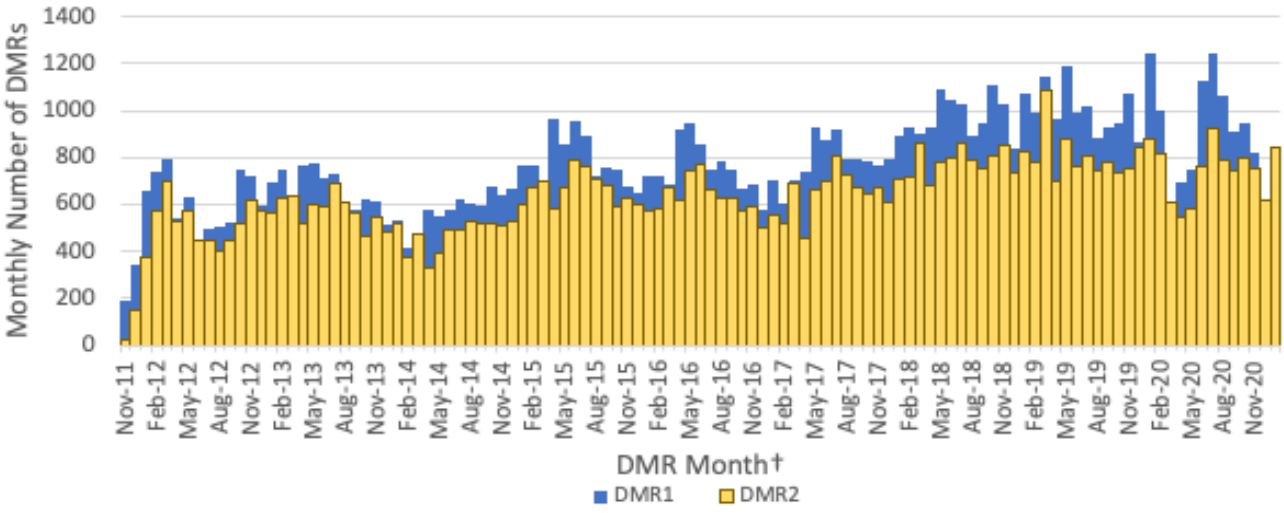


Figure 6.1: Frequency Distribution of the Number of Monthly DMRs Over Time

†Data are calculated monthly, but the x-axis labels are presented quarterly to improve readability.

The monthly number of DMRs increased over time. There were three notable decreases in monthly DMRs, in March 2014, 2017, and 2020. The maximum number of DMRs undertaken per month was 1,248 (January 2020) and 1,083 (March 2019) for DMR1 and DMR2, respectively. Figure 6.2 presents the percentage of total DMR1s (from 2012 to 2019) completed in each calendar month. The years 2011 and 2020 were excluded to remove the effects of partial years (2011) and Covid-19 (2020).

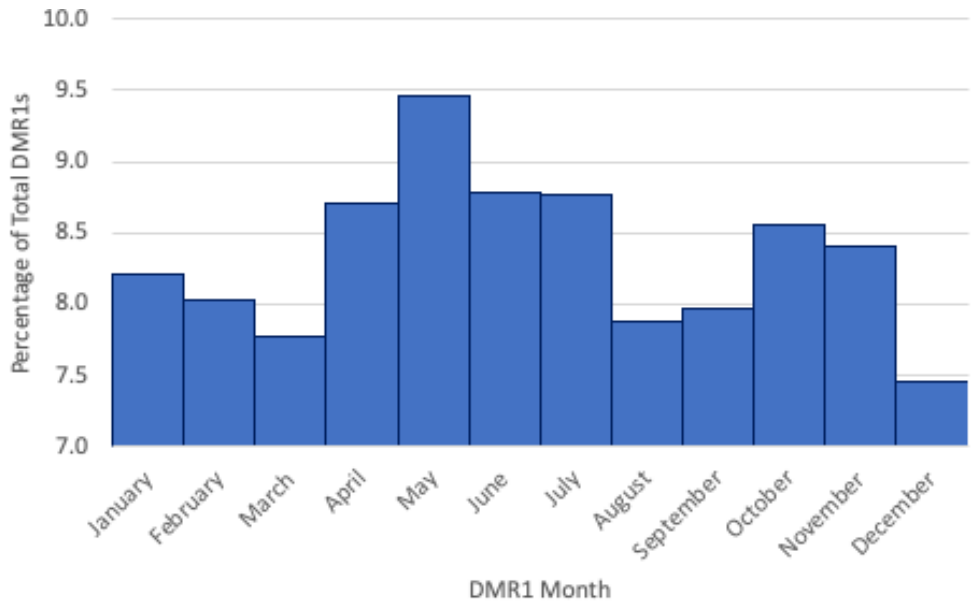


Figure 6.2: Percentage of Total DMR1s Completed Each Calendar Month (2012-2019)

Table 6.3 describes the reasons chosen for why DMR2 was not completed.

Table 6.3: Frequency and Percentage of DMR2 Incompletion Reasons

DMR2 Incompletion Reason	Frequency [n=14,690]	Percentage of Total
Patient admitted to hospital	7,806	53.1%
Other incompletion reason	2,117	14.4%
Patient deceased	2,095	14.3%
Patient did not attend appointment(s)	1,822	12.4%
Patient moved home and/or pharmacy	524	3.6%
Patient withdrew consent	326	2.2%

The 'other' category had a free-text explanatory category which the researcher explored with inductive content analysis. Eight categories were developed from these 2,117 entries. Self-explanatory categories are presented only in Table 6.4, whilst those requiring further description are detailed below.

Table 6.4: Categories Developed Inductively from Other DMR2 Incompletion Reasons

Category [n=2,117]	Subcategories [Frequency]	Description with Indicative Comment
Unknown reason for DMR2 incompletion [n=4]	No subcategories	The comment stated that DMR2 was not completed, with no further explanation. *"Part 2 did not take place".*
Patient deceased [n=3]†	No subcategories	The pharmacist could not provide DMR2 because the *"patient died".*
Patient readmitted to hospital [n=5]†	No subcategories	The patient was readmitted to hospital. *"Patient took a turn for the worse and was consistently in and out of hospital".*
No patient consent for DMR [n=5]	No subcategories	The patient did not provide any initial consent for the DMR. *"Failed to sign consent form".*
Patient moved home and/or pharmacy [n=601]†	The patient moved home and/or pharmacy [n=545]	The pharmacist could not complete DMR2 because the patient moved home or pharmacy, but no further explanation was provided. *"Patient went to Boots".*
	The patient moved to a hospice [n=2]	The pharmacist felt they could not complete DMR2 because *"patient admitted to hospice".*
	The patient moved to a residential care facility [n=54]	As above, but for residential care facilities. *"Patient in nursing home. Not able to do".*
Patient did not attend appointment(s) [n=1,331]	Failed attempt(s) to contact patient [n=1,295]	Described in detail below table.
	Patient too unwell to attend [n=36]	
Pharmacy failed to follow up [n=91]	Too much time elapsed [n=87]	
	Lack of pharmacy capacity [n=4]	
DMR2 not appropriate [n=77]	No discrepancies identified [n=20]	
	Patient delegates responsibility for medicines [n=18]	
	Ongoing medication changes [n=23]	
	Communication issues [n=16]	

†Native data category in ChP.

6.3.1.1. Patient Did Not Attend the Appointment(s)

This category describes comments where the pharmacist could not provide DMR2 because the patient did not attend the appointment. *'Failed attempt(s) to contact patient'* represents comments where the pharmacist attempted to contact the patient to no avail.

"Patient did not attend first appointment and could not be contacted".

Many comments described how the pharmacist could not complete DMR2 because the patient was too unwell to attend. The subcategory *'patient too unwell to attend'* was constructed to encompass these comments.

6.3.1.2. Pharmacy Failed to Follow Up

This category reflects comments where the pharmacy did not follow up with the patient after DMR1. The subcategory *'too much time elapsed'* encompassed comments where the pharmacist judged that they could not provide DMR2 because too much time had elapsed since DMR1. For

some of these comments, the pharmacist did not promptly follow up because the pharmacist who completed DMR1 was a locum or left the store.

"Locum pharmacist started part 1. Regular pharmacist not aware in time".

'Lack of pharmacy capacity' describes comments explaining that the pharmacy did not complete the DMR because they were too busy. Some of these comments specified that increased workload associated with the Christmas period or Covid-19 caused this lack of capacity.

6.3.1.3. DMR2 Not Appropriate

This category reflects comments describing how the pharmacist had purposely not provided DMR2. *'No discrepancies identified'* describes where the pharmacist had not identified discrepancies in DMR1 and therefore did not think DMR2 was needed.

'Patient delegates responsibility for medicines' describes that the pharmacist felt they could not provide DMR2 because the patient delegated medication management to a carer.

"Patient's medicines are administered by carers. Patient's understanding is poor".

'Ongoing medication changes' describes comments where the pharmacist suggested medication changes had occurred since DMR1, making DMR2 unnecessary or inappropriate. Usually, this was where the GP had stopped the patient's medications, or ongoing changes meant the ongoing regimen was unclear.

"Patient's medication supplied by psychiatric ward as not stabilised at home".

'Communication issues' represents comments describing how the pharmacist could not adequately provide DMR2 because the patient had communication or competency issues.

"Phoned and spoke to patient twice; too deaf and confused to proceed with review".

6.3.2. Discharge-Setting-Related Variables

6.3.2.1. Discharging Place and Healthcare Organisation

Most [n=82,916, 97.0%] DMRs were provided to patients discharged from a hospital in Wales. In contrast, relatively few were provided to patients discharged from hospitals in England [n=2,008, 2.4%], care homes [n=234, 0.3%], prisons [n=31, 0.0%] and other care settings [n=384, 0.5%]. Table 6.5 describes the number and percentage of DMRs by the discharging healthcare organisation and the average percentage of discharged patients that received a DMR.

Table 6.5: Number and Percentage of DMRs by Discharging Healthcare Organisation

Discharging Healthcare Organisation	Total Number of DMRs [n=85,573] (Percentage)	Average Percentage of Discharged Patients Receiving a DMR†
BCUHB	17,337 (20.3%)	1.13%
CVUHB	14,869 (17.4%)	1.22%
ABUHB	14,718 (17.2%)	0.97%
CTMUHB	13,032 (15.2%)	1.55%
ABMUHB	11,365 (13.3%)	0.96%
HDUHB	9,227 (10.8%)	0.93%
SBUHB	1,702 (2.0%)	0.82%
PTHB	319 (0.4%)	0.70%
English hospital	2,008 (2.4%)	Discharge data unavailable.
Unknown	577 (0.7%)	
Care home	234 (0.3%)	
Velindre University NHS Trust	127 (0.2%)	
Prison	31 (0.0%)	
Private	16 (0.0%)	
Hospice	11 (0.0%)	

Maximum and minimum values in each column are coloured green and red, respectively.
†Calculated using the average yearly number of discharged patients per Local Health Board (LHB) (DHCW 2020).

Figure 6.3 visualises the trend of monthly DMRs by associated discharging LHB over time. The monthly number of DMRs increased over time for all discharging LHBs, except ABMUHB, since it was re-named SBUHB in 2019 (see Section 5.4.3.2). Monthly DMRs associated with HDUHB did not appreciably increase over time until 2019. The number of ABUHB and BCUHB-associated DMRs decreased after peaking in 2018.

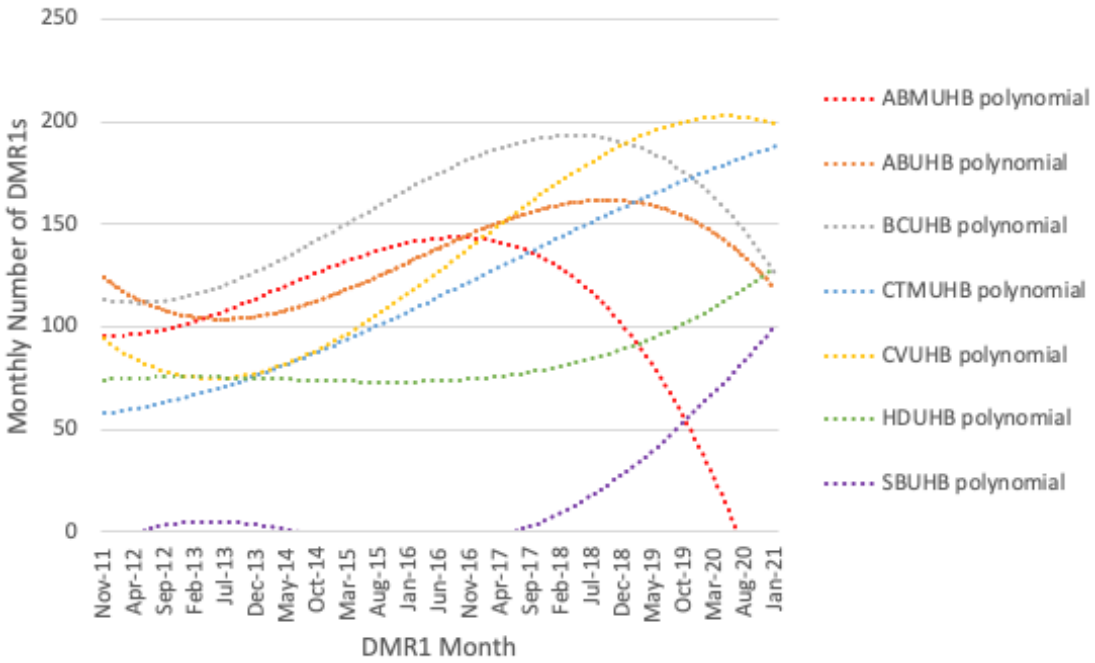


Figure 6.3: Number of Monthly DMRs Over Time by Discharging LHB (Fitted Polynomial)

6.3.2.2. Discharge Information Provider

Table 6.6 describes the DMR discharge information providers for all DMRs in the NWSSP dataset. From this dataset, DMRs logged in ChP and NECAF are presented separately. The hospital was the primary source of discharge information, which was more pronounced in ChP than in NECAF DMRs. The percentage of DMRs where the hospital provided discharge information increased from 59.2% (2016) to 68.9% (2020) for NECAF DMRs, but 62.9% to 82.5% for ChP DMRs.

Table 6.6: Number and Percentage of DMRs by Discharge Information Provider

Discharge Information Provider	Number of DMRs (Percentage)		
	All DMRs [n=85,573]	NECAF DMRs [n=49,372]	ChP DMRs [n=36,201]†
Hospital	56,927 (66.5%)	29,517 (59.8%)	27,410 (75.7%)
Patient	11,812 (13.8%)	7,587 (15.4%)	4,225 (11.7%)
Carer	8,598 (10.1%)	5,794 (11.7%)	2,804 (7.8%)
GP	6,691 (7.8%)	5,354 (10.8%)	1,337 (3.7%)
Other sources	1,545 (1.8%)	1,120 (2.3%)	425 (1.2%)

†There were lower frequencies for ChP DMRs because they were unavailable before April 2015.

From 2015 to 2020, the percentage of DMRs where the hospital provided discharge information increased for CVUHB (58.6% to 97.2%), CTMUHB (44.6% to 93.7%) and HDUHB (73.7% to 92.4%). However, it did not increase for ABUHB (52.2% to 52.1%). These increases correspond with the phased roll-out of the DMR referral system, given that ABUHB has not implemented it.

6.3.3. Patient-Related Variables

6.3.3.1. Patient Age and Gender

The mean patient age was 74.0 and 73.6 for DMR1 and DMR2, respectively. The median value for both DMR parts was 77. Figure 6.4 presents a frequency distribution for patient age. The frequency distribution shows a negative skew, with few patients under 50 receiving a DMR but many between 50 and 90 years of age.

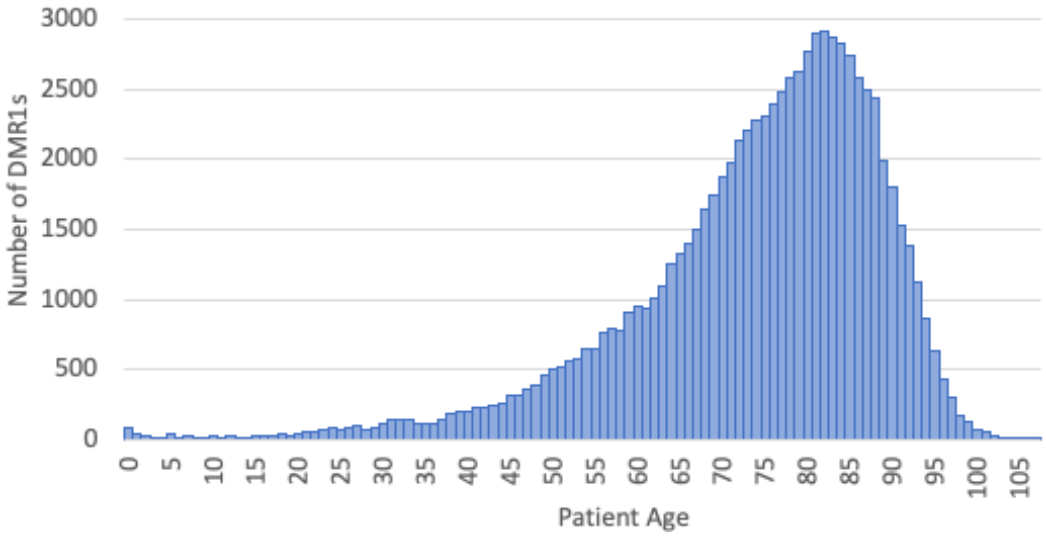


Figure 6.4: Frequency Distribution of the Number of DMR1s by Patient Age [n=83,127]

Data on DMR patient gender was available in the ChP consultation dataset. Of the 28,099 DMRs, 14,861 (52.9%) recipients were female, and 13,238 (47.1%) were male.

6.3.3.2. Eligibility Criteria

Table 6.7 describes the number of DMRs associated with each eligibility criterion. Since the mean number of selected eligibility criteria per DMR was 2.0, the total number of eligibility criteria exceeds the number of DMRs.

Table 6.7: Number and Percentage of DMRs Associated with Each Eligibility Criterion

Eligibility Criteria	Number of DMR1s with Each Eligibility Criterion [n=170,161]	Percentage of DMRs [n=85,573]
Patient taking four or more medicines	68,795	80.4%
Medicines changed during admission	61,725	72.1%
Patient requires adjustment to medicines	24,791	29.0%
Pharmacist's professional discretion	14,850	17.4%

The percentage of one eligibility criterion (patient requires adjustment to medicines) decreased over time while the others increased (see Figure 6.5).

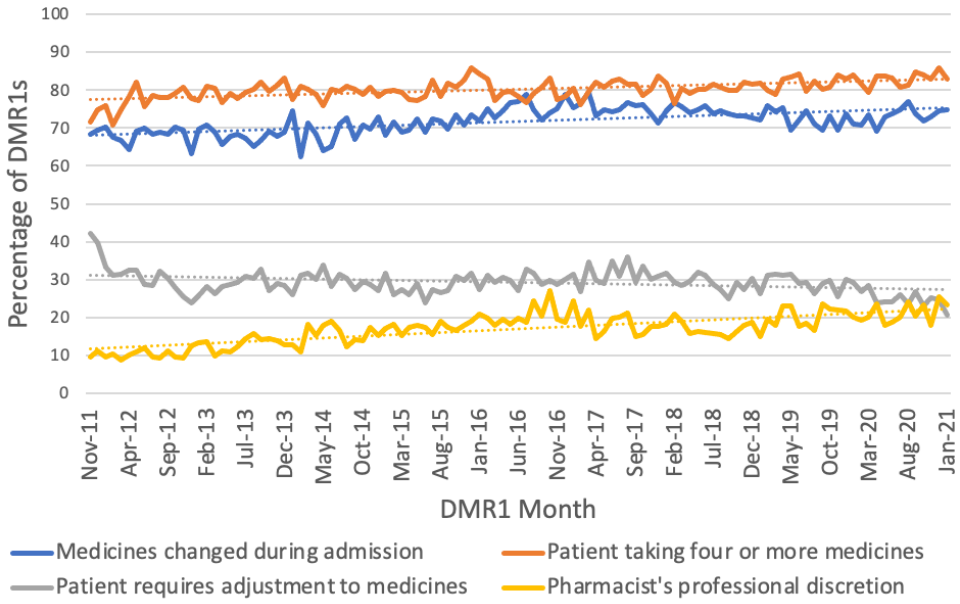


Figure 6.5: Percentage of Monthly DMRs Over Time Associated with Each Eligibility Criterion

6.3.4. Pharmacy-Related Variables

6.3.4.1. Pharmacy Premises and Contractors

As described in Section 5.4.3.1.1, 712 DMR-registered pharmacies were active (dispensed at least one NHS prescription) during the data collection period. These pharmacies were owned by 243 contractors (a pharmacy may have had several contractors over time due to changes in ownership). Of these 712 pharmacies, 679 (95.7%) and 678 (95.2%) had provided at least one DMR1 and DMR2, respectively. During the data collection period, the maximum number of DMRs delivered by a single pharmacy was 1,156 (1.4%) and 1,002 (1.1%) for DMR1 and DMR2. The

annual limit of 140 commissioned DMRs was exceeded 33 times; 18 pharmacies exceeded the limit at least once. Figure 6.6 illustrates that most pharmacies provided few DMRs.

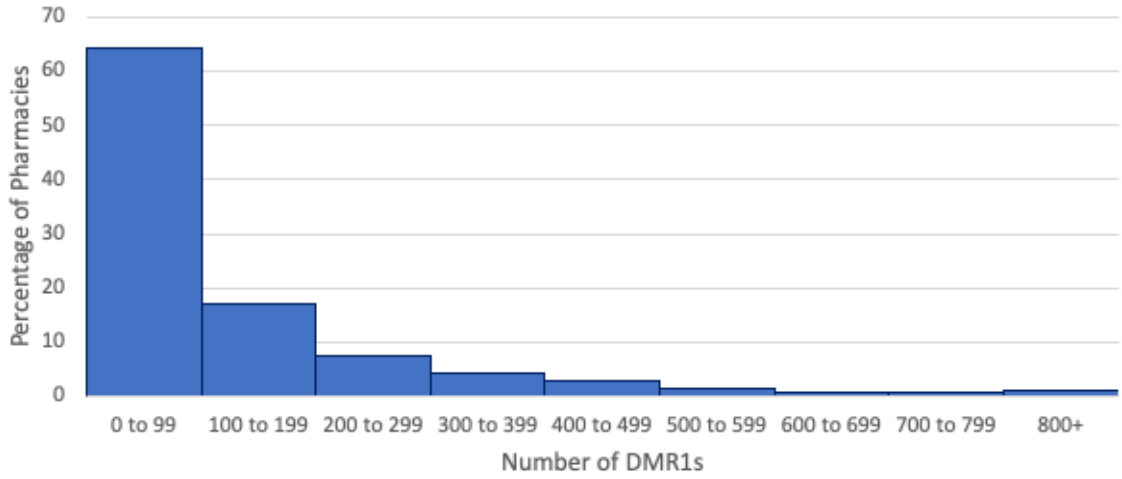


Figure 6.6: Percentage of Pharmacy Premises by Number of DMR1s

Figure 6.7 describes the proportion of pharmacies that completed at least one DMR each month over time.[19] The maximum monthly percentage of pharmacies completing at least one DMR was 43.8% (June 2020), demonstrating that most pharmacies did not provide a DMR every month. However, there did appear to be an increasing trend over time.

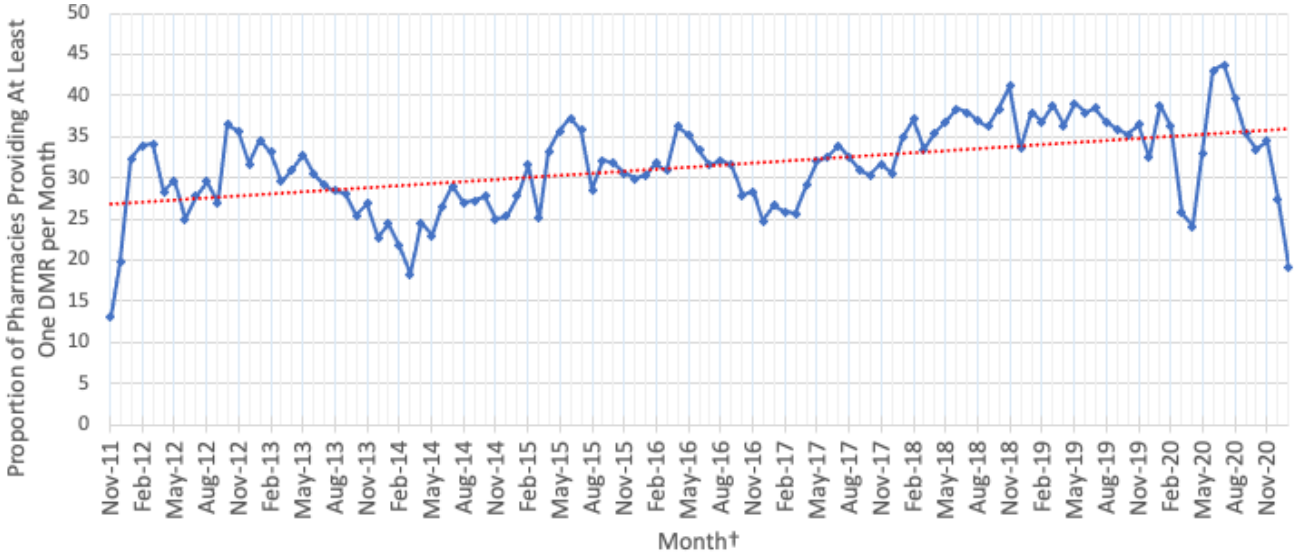


Figure 6.7: Percentage of Pharmacy Premises Providing At Least One Monthly DMR Over Time

†Data are calculated monthly, but the x-axis labels are presented quarterly to improve readability.

Table 6.8 presents summary statistics for the five contractors that provided the most DMRs. These contractors provided 58.8% of all DMR1s. There was considerable variability within these contractors, with some pharmacies providing many DMRs and others providing few.

[19]Calculated using the total number of monthly pharmacy IDs from the pharmacy dataset (see Section 5.4.3.1.1).

Table 6.8: Summary Statistics for the Five Contractors That Provided the Most DMR1s

Contractor	Number of DMR1s [n=85,573]		
	Total per Contractor (Percentage)	Minimum/Maximum per Pharmacy	Median
Contractor 1	22,095 (25.8%)	13/1,156	142
Contractor 2	8,970 (10.5%)	55/816	225
Contractor 3	7,708 (9.0%)	0/306	55
Contractor 4	6,733 (7.9%)	0/485	48
Contractor 5	4,838 (5.7%)	1/303	69

6.3.4.2. Pharmacist Providing DMR

ChP only collected data regarding the pharmacist who delivered the DMR from March 2018. From this date, 824 and 794 pharmacists had provided at least one DMR1 and DMR2, respectively, with the maximum number of DMR1s delivered by a pharmacist being 418. Three pharmacists provided, on average, more than ten DMR1s per month, and 598 provided less than one DMR per month. Of the 18,379 completed DMRs with valid GPhC numbers, 16,709 (90.9%) had DMR1 and DMR2 provided by the same pharmacist.

6.3.4.3. Pharmacy Type and Co-location Status

Table 6.9 describes the number and proportion of DMRs by pharmacy type.

Table 6.9: Number and Percentage of DMRs by Pharmacy Type

Pharmacy Type	Number of DMRs (Percentage)	
	DMR1 [n=85,573]	DMR2 [n=70,883]
Large-sized multiple	51,687 (60.4%)	41,918 (59.1%)
Independent	17,006 (19.9%)	14,690 (20.7%)
Small chain	9,611 (11.2%)	8,252 (11.6%)
Medium-sized multiple	6,722 (7.9%)	5,564 (7.9%)
Supermarket	547 (0.6%)	459 (0.7%)

Large-sized multiples provided most DMRs, with fewer than 1% provided by supermarket pharmacies. The monthly percentage of DMRs provided by large-sized multiples increased over time until 2014, when it decreased relative to other pharmacy types (see Figure 6.8).[20]

Co-located pharmacies provided 28,994 (33.8%) and 24,496 (34.6%) DMR1s and DMR2s, respectively.

[20]The large differences in provision could be explained by the differences in the number of pharmacies within each group, which Chapter 8 explores.

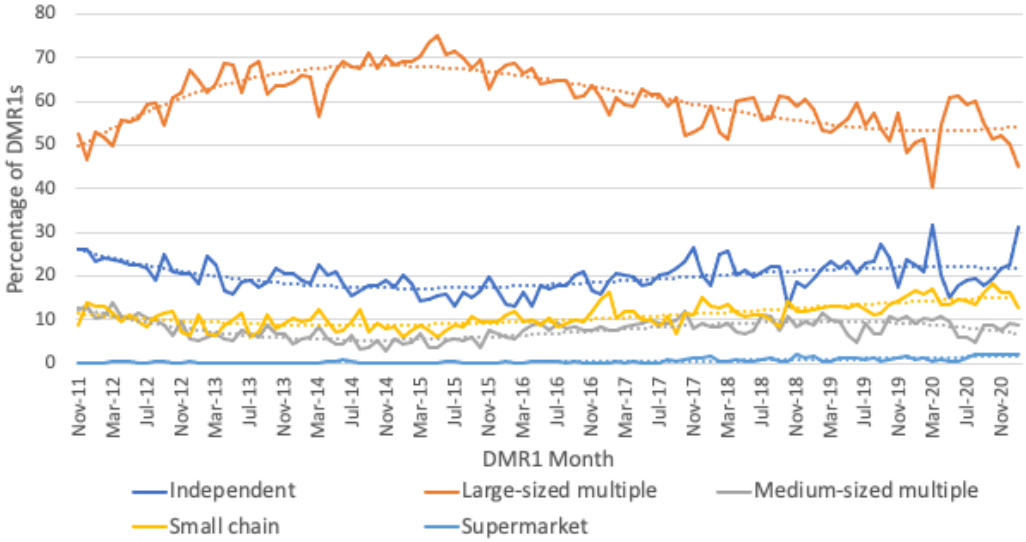


Figure 6.8: Percentage of Monthly DMR1s Over Time by Pharmacy Type

6.3.4.4. Rural-Urban Classification and Social Deprivation Quartile

Table 6.10 describes the number and percentage of DMRs provided by pharmacies in each rural-urban classification and social deprivation quartile.

Table 6.10: Number and Percentage of DMRs by Rural-Urban Classification and Social Deprivation Quartile

Rural-Urban Classification	**Number of DMRs (Percentage)**	
	DMR1 [n=85,573]	**DMR2 [n=70,883]**
City and town (not sparse)	59,977 (70.1%)†	49,233 (69.5%)
Town and fringe (not sparse)	12,728 (14.9%)	10,652 (15.0%)
Town and fringe (sparse)	7,783 (9.1%)	6,574 (9.3%)
City and town (sparse)	3,353 (3.9%)	2,943 (4.2%)
Villages (sparse)	1,374 (1.6%)	1,166 (1.6%)
Villages (not sparse)	358 (0.4%)†	315 (0.4%)
Social Deprivation Quartile	**Number of DMRs (Percentage)**	
	DMR1 [n=85,573]	**DMR2 [n=70,883]**
Quartile 2	28,961 (33.8%)	24,169 (34.1%)
Quartile 1 (most deprived)	28,459 (33.3%)	23,699 (33.4%)
Quartile 3	16,024 (18.7%)	13,115 (18.5%)
Quartile 4 (least deprived)	12,129 (14.2%)	9,900 (14.0%)

†The large differences in provision could be explained by the differences in the number of pharmacies within each group, which Chapter 8 explores.

6.3.5. Service-Related Variables

6.3.5.1. Days Between Discharge, DMR1 and DMR2

Figure 6.9 describes a frequency distribution for the days between discharge and DMR1, and between DMR1 and DMR2. As described in Section 5.4.3.3.1, there were many large and potentially erroneous values for these variables. The figure groups values over 337 since the frequency decreased considerably [n=158 and 17 above 337 days for discharge to DMR1, and DMR1 to DMR2, respectively].

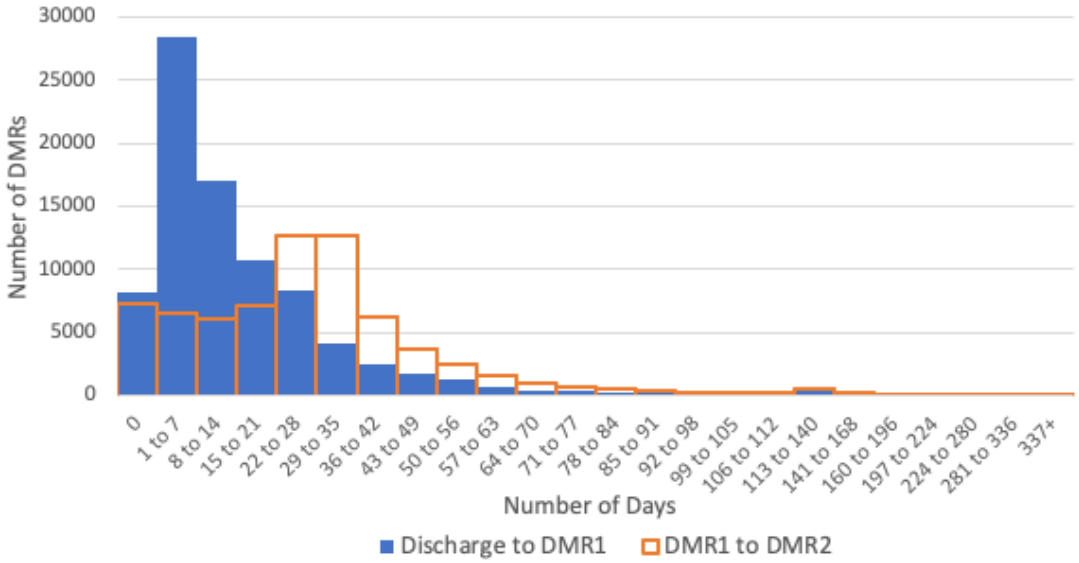


Figure 6.9: Frequency Distribution of the Number of Days Between Discharge and DMR1 [n=85,523], and Between DMR1 and DMR2 [n=70,883]

Pharmacists provided 42.8% of DMR1s within seven days of discharge and 85.0% within 28 days. The large proportion of zeroes indicates that many pharmacists actioned DMRs immediately after discharge. Figure 6.10 describes the mean days between discharge and DMR1 and DMR2 over time.

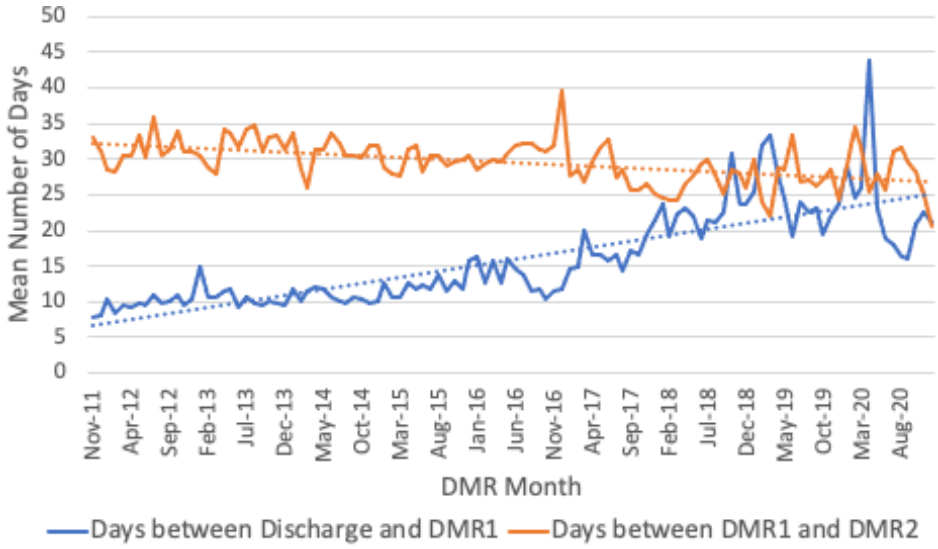


Figure 6.10: Mean Number of Days Between Discharge and DMR1, and DMR1 and DMR2 Over Time

The mean number of days decreased between DMR1 and DMR2 but increased between discharge and DMR1. The latter showed a spike in April 2020, corresponding with delayed DMRs during the Covid-19 pandemic. Table 6.11 describes these variables, with summary statistics for NECAF and ChP DMRs from the NWSSP dataset. The mean and median days between discharge and DMR1 were larger for DMRs processed through ChP than NECAF, in contrast to days between DMR1 and DMR2. Therefore, the introduction of ChP DMRs in 2015 could explain the trends noted in Figure 6.10.

Table 6.11: Summary Statistics for Days Between Discharge and the DMR, and Between DMR1 and DMR2

Summary Statistics	Days Between Discharge and DMR1		Days Between DMR1 and DMR2	
	NECAF [n=49,364]	ChP [n=36,159]	NECAF [n=41,868]	ChP [n=29,015]
Mean†	10.3	24.5	31.0	26.1
Median†	7	16	27	13
Minimum/maximum	0/2,196	0/1,478	1/753	0/1,467
Percentage within 28 days	94.6	71.8	43.9	61.8

†The mean and median were calculated after removing all entries above 337, as per Figure 6.9, since they could skew the measures of central tendency.

There was little difference in the mean number of days between discharge and DMR1 for DMRs with eDAL availability (15.5) and those without (15.4) for those DMRs logged in the ChP consultation dataset.

6.3.5.2. DMR Delivery Method

Since NECAF and ChP have slightly different categories for DMR delivery methods, they were analysed separately using the NWSSP and ChP consultation datasets, as shown in Table 6.12.

Table 6.12: Number and Percentage of DMRs by the DMR Delivery Method

Category	Number of NECAF DMRs (Percentage)		Number of ChP DMRs† (Percentage)	
	DMR1 [n=49,372]	DMR2 [n=41,868]	DMR1 [n=28,088]	DMR2 [n=22,591]
With patient by telephone	16,484 (33.4%)	19,965 (47.7%)	9,781 (34.8%)	10,853 (48.0%)
With carer at pharmacy (without patient)	15,878 (32.2%)	9,707 (23.2%)	9,080 (32.3%)	6,468 (28.6%)
With patient at pharmacy (without carer)	11,302 (22.9%)	8,701 (20.8%)	6,010 (21.4%)	4,455 (19.7%)
With patient at pharmacy (with carer)	4,292 (8.7%)	2,467 (5.9%)	939 (3.3%)	537 (2.4%)
With patient at home/care home	818 (1.7%)	544 (1.3%)	N/A††	278 (1.2%)
Other delivery method	598 (1.2%)	484 (1.2%)	2,278 (8.1%)	N/A††

Maximum and minimum values in each column are coloured green and red, respectively.
†From the ChP consultation dataset. ††Category unavailable in ChP (see Table 5.1).

The most common delivery method was 'with patient by telephone' for DMR1 and DMR2, whilst 'with patient at home/care home' was much less common. The 'other' delivery method from the ChP consultation dataset had a free-text explanatory variable, which was analysed by summative content analysis. The researcher developed 20 categories by deductive analysis, mapping data onto the framework *"with whom the service was provided - the location where the service was provided".* This framework follows the structure of the native categories from NECAF and ChP, e.g., with patient by telephone. Two categories were then inductively developed from the 76 comments that did not fit into the deductive framework. Table 6.13 presents all categories with indicative comments.

Table 6.13: Categories Developed from the Content Analysis of the Other DMR1 Delivery Method Free-Text Variable

Deductive Category [n=2,202]	**Subcategory [Frequency]**	**Indicative Verbatim Comment(s)**
With carer [n=1,710]	With carer by telephone [n=1,335]	• *"With care home manager over the phone"* • *"Patients wife via telephone"*
	With carer at unknown location [n=212]	• *"Nursing home staff"*
	With carer at pharmacy [n=127]	• *"Patient's daughter at pharmacy"*
	With carer at patient's home [n=36]	• *"At home with wife"*
With patient [n=125]	With patient at patient's home [n=119]	• *"With patient at home"*
	With patient at the pharmacy [n=1]	• *"Via a discussion with patient at [name] pharmacy"*
	With patient by telephone [n=4]	• *"With patient by telephone"*
	With patient at an unknown location [n=1]	• *"With patient"*
With patient (and carer) [n=46]	With patient (and carer) at patient's home [n=28]	• *"With patient and carer at home"*
	With patient (and carer) at pharmacy [n=2]	• *"Mum and baby in pharmacy"*
	With patient (and carer) by telephone [n=14]	• *"On phone with patient's husband who was communicating with patient"*
	With patient (and carer) at unknown location [n=2]	• *"Patient and daughter"*
With GP surgery staff [n=79]	With GP surgery staff at unknown location [n=38]	• *"Colleague spoke with practice pharmacist"*
	With GP surgery staff by telephone [n=41]	• *"Surgery over the phone"*
With hospital [n=49]	With hospital at unknown location [n=33]	• *"With hospital pharmacist as patient on trays"*
	With hospital by telephone [n=16]	• *"Hospital pharmacy by phone"*
With unknown person [n=193]	With unknown person at patient's home [n=128]	• *"At patient's home"*
	With unknown person at pharmacy [n=7]	• *"[name] at pharmacy"*
	With unknown person by telephone [n=4]	• *"Facetime/phone"*
	With unknown person at unknown location [n=54]	• *"[name]"*
Inductive Category [n=76]	**Subcategory [Frequency]**	**Subcategory Description with Indicative Verbatim Comment**
Pharmacy-only DMR [n=74]	Service description [n=46]	The pharmacist completed the service without the patient. *"New prescription checked against discharge".*
	Consent obtained [n=23]	The pharmacist completed the DMR without consulting the patient but obtained consent. *"By pharmacist, consent obtained via delivery driver".*
	No explicit consent obtained [n=5]	The pharmacist completed the DMR without obtaining consent. *"Acting in patient's best interest as unable to contact".*
No DMR completed [n=2]	No subcategories	The pharmacist did not complete the DMR. *"No consultation completed due to inactive DMR".*

A key observation was that pharmacists often consulted patients' family members for the DMR but logged the delivery method as 'other' rather than 'with carer'. Many comments encompassed by 'pharmacy only DMR', 'with hospital' and 'with GP surgery staff' described no formal consultation with the patient or carer, indicating that the pharmacist completed DMR1 using information from other sources.

This section now describes DMR provision using the transformed DMR delivery methods, whether the pharmacist delivered the service with a carer or in the pharmacy (see Section 5.4.3.3.2). Using the content analysis results in Table 6.13, the researcher re-categorised the ChP consultation dataset transformed variables. For example, 'with GP surgery staff by telephone' was categorised as 'not in pharmacy' and 'without carer' (see Appendix 6.1 for full re-categorisation). Table 6.14 describe the frequencies and proportions of the re-categorised DMR delivery methods.

Table 6.14: Number and Percentage of ChP Consultation Dataset DMR1s by the DMR Delivery Method

DMR1 Delivery Method	**Category**	**Number of ChP DMRs (Percentage)**	
		DMR1 [n=28,088]	**DMR2 [n=22,591]**
DMR carer involvement	No carer involvement	16,170 (57.5%)	15,586 (69.0%)
	Carer involvement	11,775 (41.9%)	7,005 (31.0%)
	Unknown carer involvement	143 (0.5%)	N/A
DMR pharmacy status	Service in pharmacy	16,166 (57.5%)	11,466 (50.7%)
	Service not in pharmacy	11,653 (41.5%)	11,131 (49.3%)
	Unknown if service in pharmacy	269 (1.0%)	N/A

Figure 6.11 shows that the percentage of DMRs with carer involvement and in the pharmacy decreased over time, and then there was a large decrease after February 2020, in line with the Covid-19 pandemic.

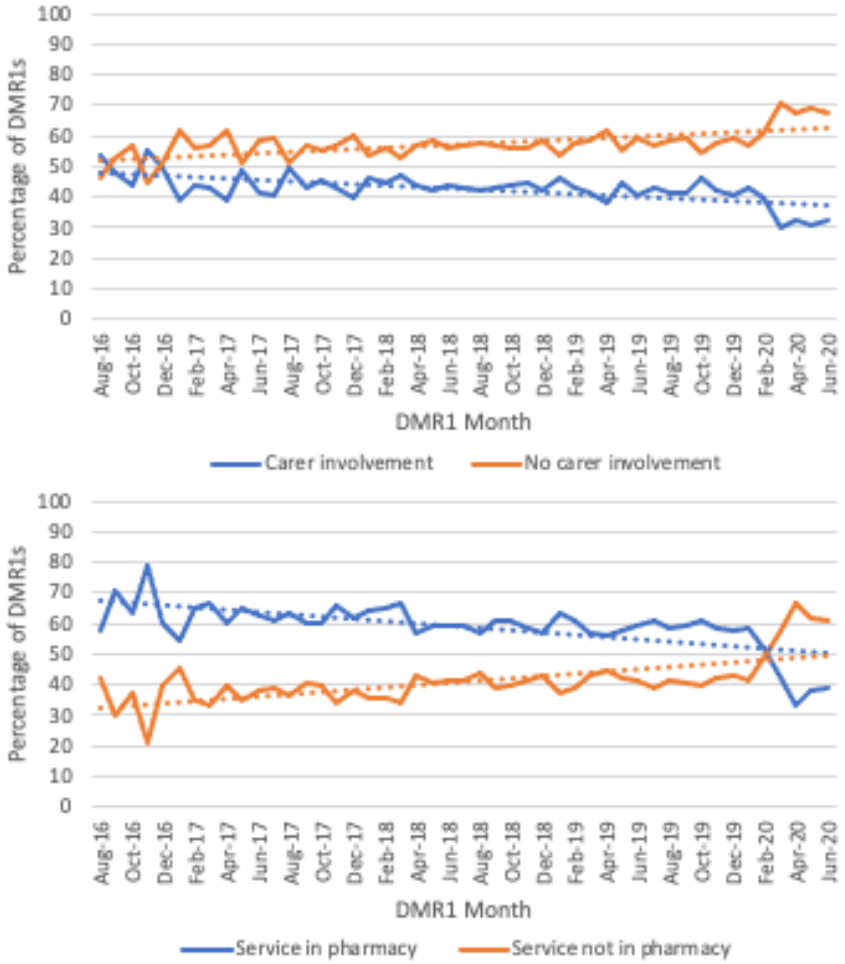


Figure 6.11: Percentage of Monthly DMR1s in the Pharmacy and with Carer Involvement Over Time

6.3.5.3. DMR Processing Method and Electronic Discharge Advice Letter Availability

Figure 6.12 describes the percentage of DMRs processed through ChP and NECAF over time. It illustrates that DMRs processed via NECAF decreased over time after NWIS introduced the ChP module in 2015, eventually approaching 0%.

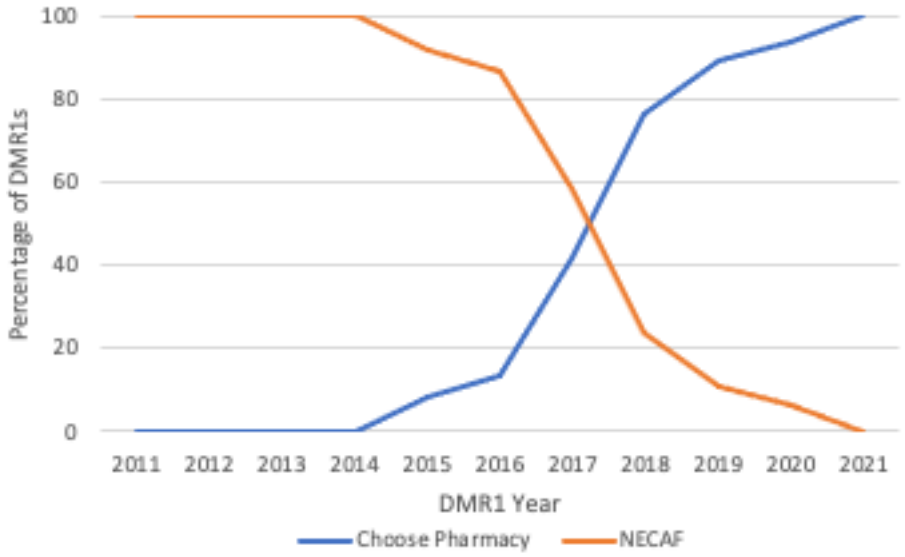


Figure 6.12: Percentage of Yearly DMR1s by Processing Method Over Time [n=85,573]

Of the 28,099 DMRs in the ChP consultation dataset, 13,811 (49.2%) had an eDAL available and 14,288 (50.8%) did not. As visualised in Figure 6.13, eDAL availability increased over time until December 2019, after which it sharply decreased during the Covid-19 pandemic.

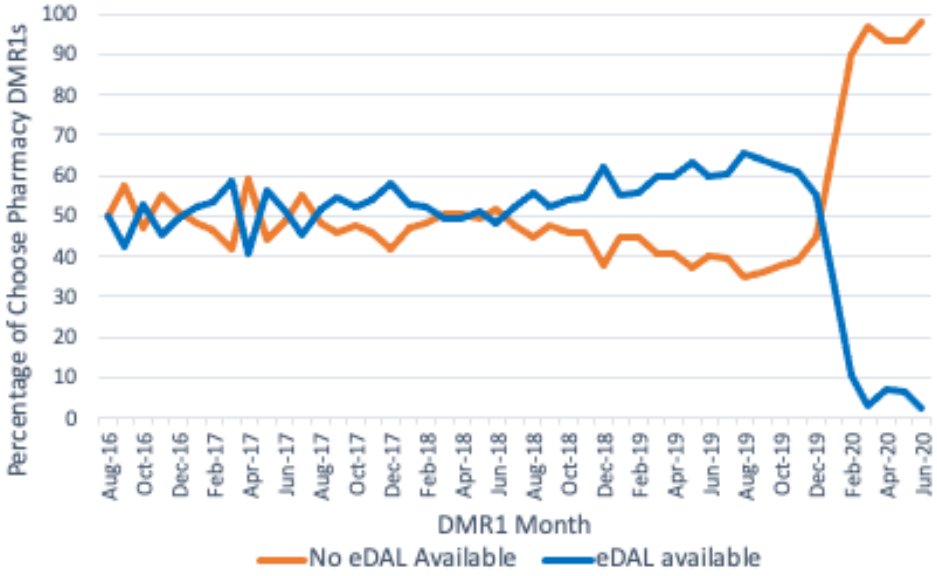


Figure 6.13: Percentage of ChP DMRs with eDAL Availability Over Time

Figure 6.14 describes the percentage of DMRs with eDAL availability by the discharging healthcare organisation over time. Only six organisations (in a restricted date range) were presented in this figure because the others had low monthly frequencies. Consequently, their calculated percentages of eDAL availability had large inter-month variability and were difficult to interpret.

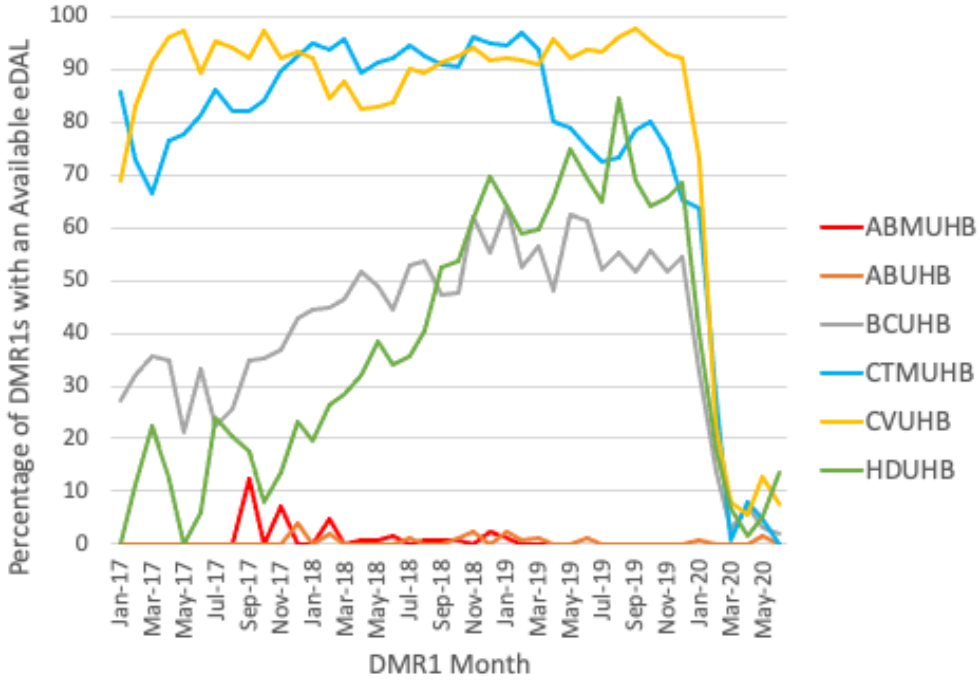


Figure 6.14: Percentage of ChP DMRs with eDAL Availability Over Time by Discharging Healthcare Organisation

The availability of eDALs for patients discharged from HDUHB and BCUHB increased over time while it remained high throughout for CTMUHB and CVUHB until the Covid-19 pandemic. ABUHB had very few associated DMRs using eDALs, as expected, given that it has not implemented Medicines Transcribing and electronic Discharge (MTeD, the only electronic discharge system that facilitates eDAL availability to ChP).

6.3.6. Medicines-Related Variables

6.3.6.1. Medicine Quantities

The mean number of medicines on the DAL and that the patient was taking was 9.34 and 9.29, respectively. For both quantities of medicines, the median, minimum and maximum were nine, zero and 38, respectively. In the ChP consultation dataset, the mean number of DAL and patient medicines were larger for services with eDAL availability (10.07 and 10.38) than those without (9.15 and 9.20).

6.3.6.2. Anatomical Therapeutic Chemical (ATC) Classification and Route of Administration

The ChP medication dataset contained information on the specific medicines entered in the DMR form, which may have been imported from the eDAL (if available). The pharmacist may have also manually added medicines from the DAL, the first post-discharge prescription, or that the patient was taking that were missing from other sources. In these data, there were 16, 87 and 418 ATC groups of levels one, two and four, respectively. Table 6.15 describes the frequency and percentage of items by ATC group. All ATC1 groups are presented, with the five most frequent level two and four classes.

Table 6.15: Number and Percentage of ChP DMR Items by Anatomical Therapeutic Chemical (ATC) Classification

ATC1 Groups	**Frequency [n=268,020] (Percentage)**	**Most Frequent Condensed Items in ATC Group**	
Cardiovascular system	63,084 (23.5%)	Bisoprolol [n=9,243]	Atorvastatin [n=7,812]
Alimentary tract and metabolism	56,228 (21.0%)	Omeprazole oral [n=7,213]	Lansoprazole [n=5,937]
Nervous system	50,548 (18.9%)	Paracetamol oral [n=10,373]	Morphine oral [n=2,953]
Blood and blood-forming organs	29,674 (11.1%)	Aspirin low dose [n=6,332]	Clopidogrel [n=4,408]
Respiratory system	22,161 (8.3%)	Salbutamol inhaled [n=6,516]	Carbocisteine [n=1,909]
Systemic hormonal preparations, excluding sex hormones and insulins	9,631 (3.6%)	Levothyroxine [n=5,327]	Prednisolone oral [n=3,158]
Musculoskeletal system	7,344 (2.7%)	Alendronic acid [n=2,065]	Allopurinol [n=1,645]
Anti-infectives for systemic use	7,071 (2.6%)	Doxycycline [n=1,068]	Co-trimoxazole [n=761]
Genito urinary system and sex hormones	6,226 (2.3%)	Tamsulosin [n=2,067]	Finasteride [n=1,220]
Dermatological	6,107 (2.3%)	Emollients [n=3,405]	Barrier cream [n=416]
Sensory organs	5,490 (2.1%)	Carbomer ophthalmic [n=888]	Latanoprost [n=648]
Various	2,010 (0.8%)	Nutrition supplement [n=1,236]	Non-medicated dressings [n=317]
Antineoplastic and immunomodulating agents	1,649 (0.6%)	Letrozole [n=285]	Methotrexate oral [n=24]
Appliances†	614 (0.2%)	Needles/testing strips [n=419]	Spacer [n=178]
Antiparasitic products, insecticides, and repellents	177 (0.1%)	Hydroxychloroquine [n=172]	Atovaquone [n=1]
No ATC code	6 (0.0%)	Vernagel [n=2]	Arnica [n=1]
ATC2 Groups	**Frequency [n=268,020] (Percentage)**	**Most Frequent Condensed Items in ATC Group**	
Antithrombotic agents	21,605 (8.1%)	Aspirin low dose [n=6,332]	Clopidogrel [n=4,408]
Analgesics	21,269 (7.9%)	Paracetamol oral [n=10,373]	Morphine oral [n=2,953]
Drugs for acid-related disorders	18,259 (6.8%)	Omeprazole oral [n=7,213]	Lansoprazole [n=5,937]
Drugs for obstructive airway diseases	16,727 (6.2%)	Salbutamol inhaled [n=6,516]	Tiotropium [n=1,817]
Lipid-modifying agents	13,789 (5.1%)	Atorvastatin [n=7,812]	Simvastatin [n=4,405]
ATC4 Groups	**Frequency [n=268,020] (Percentage)**	**Most Frequent Condensed Items in ATC Group**	
HMG-CoA reductase inhibitors	13,156 (4.9%)	Atorvastatin [n=7,812]	Simvastatin [n=4,405]
Platelet aggregation inhibitors, excluding heparin	11,479 (4.3%)	Aspirin low dose [n=6,332]	Clopidogrel [n=4,408]
Anilides	10,566 (3.9%)	Paracetamol oral [n=10,373]	Paracetamol suppositories [n=150]
Beta-blocking agents, selective	10,285 (3.8%)	Bisoprolol [n=9,243]	Atenolol [n=702]
Sulfonamides, plain	8,770 (3.3%)	Furosemide oral [n=7,039]	Bumetanide [n=1,308]

†ATC classifications do not include appliances, so a specific group was generated for them.

Over 60% of the items entered on the DMR form were the 'cardiovascular system', 'nervous system' and 'alimentary tract and metabolism' ATC groups. Twenty-four routes of administration were associated with at least one DMR. Appendix 6.2 describes the number and proportion of all routes. The three most frequent routes were oral [n=223,427, 83.4%], inhaled [n=16,476, 6.2%], and topical [n=7,939, 3.0%].

6.3.7. Outcome-Related Variables

This subsection describes service outcomes for DMRs recorded in NECAF and ChP DMRs. These data are analysed separately because of their different methods for describing discrepancies and their resolution (see Table 5.1). Namely, NECAF recorded the number of discrepancies identified per DMR1 and then the number identified in DMR2. In contrast, ChP logged each medication item on the DMR form and whether it was associated with a discrepancy. At DMR2, ChP records whether each discrepancy was resolved and whether further action was needed after the service.

6.3.7.1. NECAF Outcome-Related Variables

From the 49,321 NECAF DMR1s with non-missing discrepancy data, pharmacists identified 56,706 discrepancies (mean = 1.15). For the 41,285 DMR2s with non-missing discrepancy data, 2,865 (mean = 0.07) discrepancies were identified. However, the median and mode for both were zero, demonstrating that most DMRs identified no discrepancies. The maximum number of discrepancies identified for a single DMR1 was 37. Figure 6.15 visualises these features with a frequency distribution.

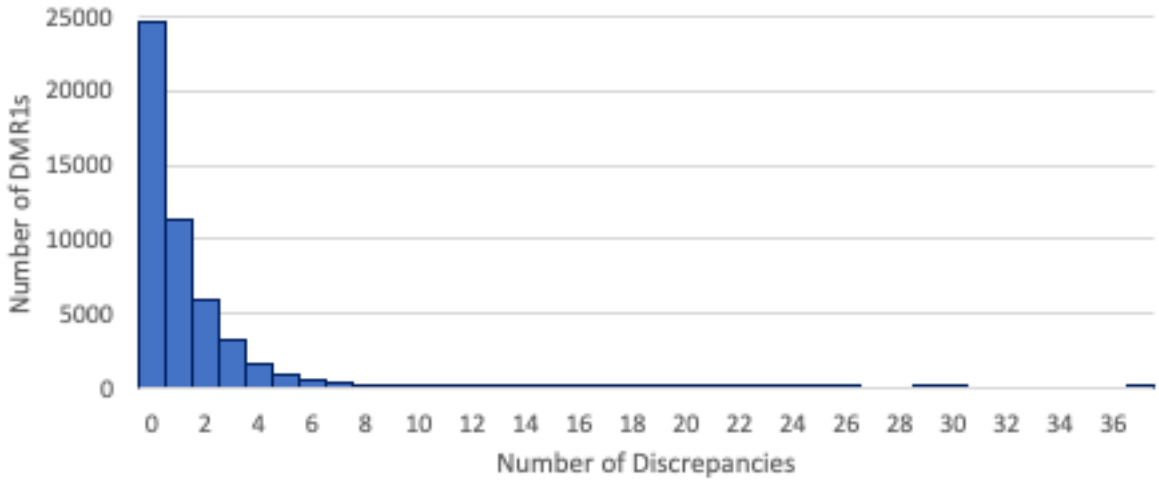


Figure 6.15: Frequency Distribution for the Number of DMR1 Discrepancies

Of the 49,321 DMR1s, 594 (1.2%) had more identified discrepancies than the number of patient medicines, indicating that multiple discrepancies were identified for each item. Figure 6.16 describes the mean number of discrepancies per DMR over time.

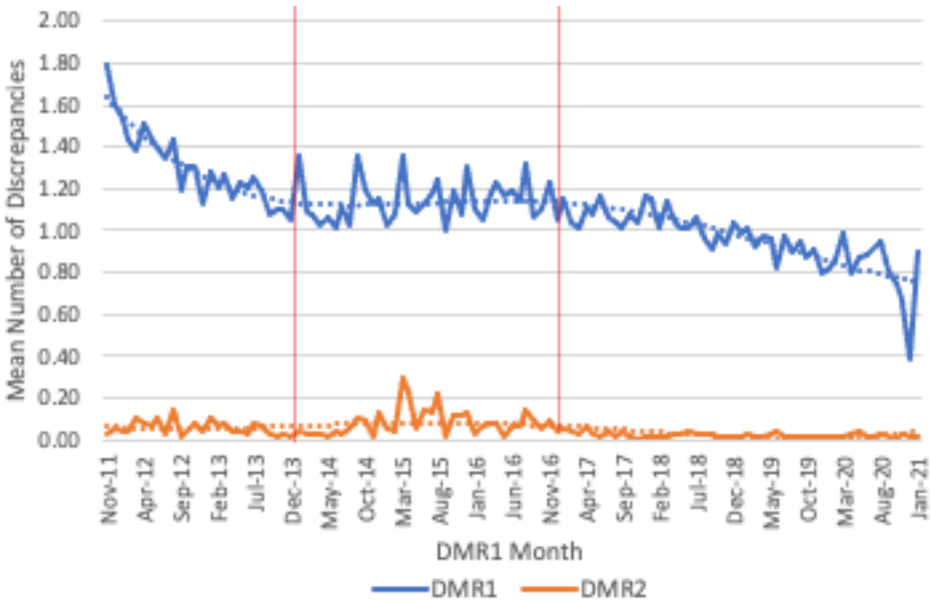


Figure 6.16: Mean Number of NECAF DMR1 Discrepancies Over Time

Upon visual inspection, the DMR1 discrepancy time series appears to have three phases: a decrease until late 2013, a plateauing from 2014 to 2016, and a subsequent decrease. Most discrepancies for DMR1 [n=43,211, 76.2%] were medicines restarted or discontinued after discharge or 'other' (Figure 6.17).

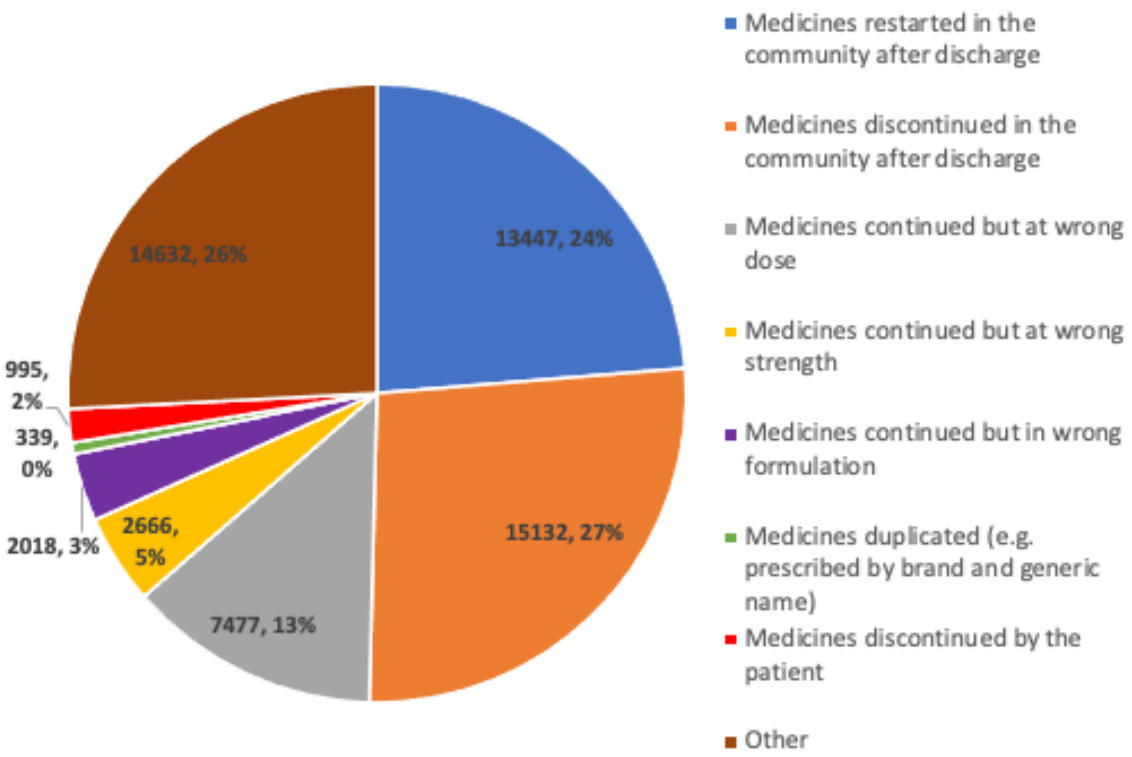


Figure 6.17: Number and Percentage of DMR1 Discrepancy Types

Figure 6.18 describes changes in the monthly average number of each discrepancy type over time using a fitted polynomial function.

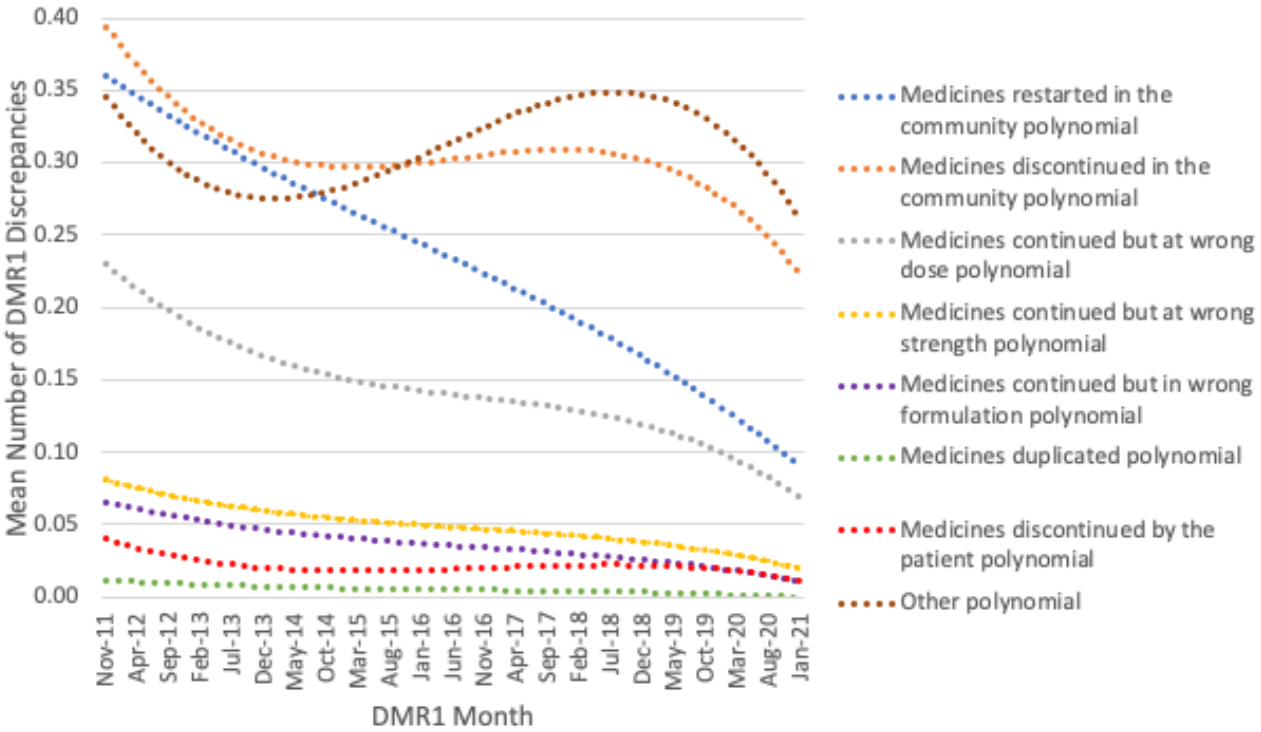


Figure 6.18: Mean Number of Each Discrepancy Type Over Time (Fitted Polynomial)

6.3.7.2. Choose Pharmacy Outcome-Related Data

6.3.7.2.1. Item Discrepancy Occurrence

Of the 269,576 items with non-missing discrepancy data, 28,488 (10.6%) were associated with a discrepancy. Figure 6.19 shows that the item discrepancy proportion decreased over time.

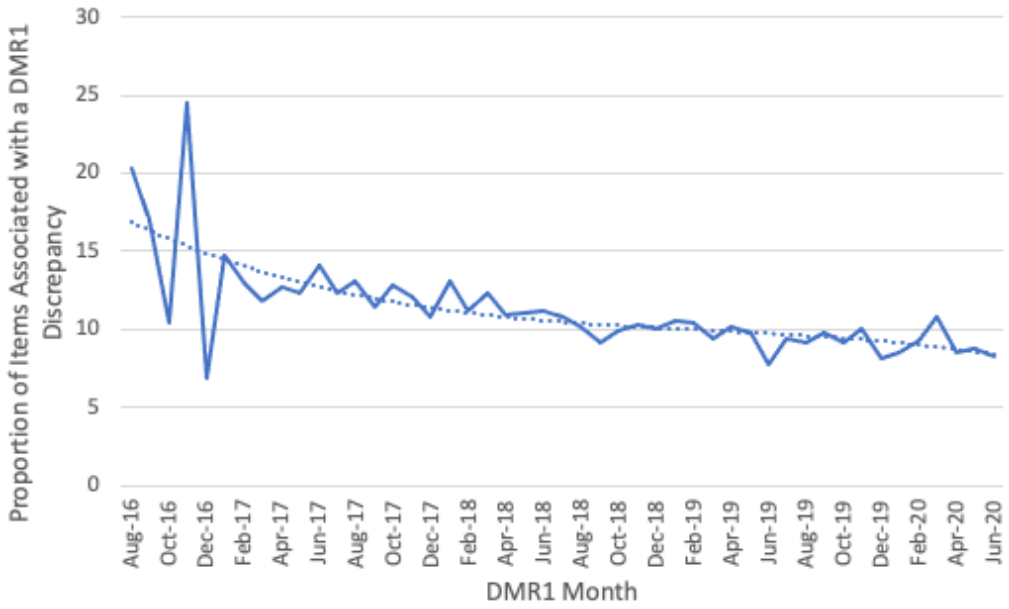


Figure 6.19: Proportion of Items Associated with a Discrepancy Over Time

Of the 25,851 discrepancies where DMR2 was completed, 880 (3.4%) were left unresolved after DMR2. Table 6.16 describes the frequency and proportion of item discrepancy types (DMR1).

Table 6.16: Number and Percentage of Identified ChP DMR1 Discrepancy Types

Discrepancy Type	Frequency [n=28,488] (Percentage)	Percentage of Items [n=269,575]
'Other' discrepancy type	9,682 (34.0%)	3.6%
Discontinued in the community after discharge	8,483 (29.8%)	3.1%
Restarted in community	4,003 (14.1%)	1.5%
Continued but at wrong dose	3,546 (12.4%)	1.3%
Continued but at wrong strength	1,239 (4.3%)	0.5%
Continued but at wrong formulation	800 (2.8%)	0.3%
Medications discontinued by patient	663 (2.3%)	0.2%
Duplicated (prescribed by brand and generic name)	72 (0.3%)	0.0%

The 'other' discrepancy type was the most frequent, and its explanatory free-text variable was analysed with inductive content analysis. Table 6.17 summarises the 50 subcategories developed from the 5,781 reduced free-text entries[21]. Infrequent categories are described only in Table 6.17, whilst those requiring further description are presented below the table.

[21]Table 5.5 described how the 9,682 entries were reduced (removed typos and colloquialisms) to 5,781 unique entries.

Table 6.17: Categories Developed from the Content Analysis of the 'Other' Discrepancy Type Free-Text Variable

Category [n=9,717]†	**Subcategories [Frequency]**	**Subcategory Description with Indicative Verbatim Comment**
Insufficient information to categorise as a discrepancy [n=501]	Incomplete information [n=110]	There was insufficient information to determine whether it was a discrepancy. *"On new prescription post discharge".*
	Multiple items listed [n=55]	The item's discrepancy referred to multiple other medication items. *"Haven't entered other items as same as previous recent DMR".*
	Changes actioned appropriately [n=28]	The post-discharge prescription accurately reflected the DAL. *"On increasing dose until patient taking 150mg twice a day. Rx had increasing dose".*
	Entry unrelated to item [n=308]	The entry did not provide coherent information. *"Yes".*
Continued but at wrong quantity [n=123]	No subcategories	The GP prescribed an insufficient quantity for the intended prescription duration. These comments were usually associated with in-hospital dosage changes. *"Dosage of two a day but only 28 prescribed for the month".*
Continued but at wrong strength†† [n=70]	Different strength provided [n=53]	There was a difference between the strength on the DAL and the prescription. *"Still at 45mg from surgery".*
	No strength titration [n=17]	The GP surgery did not titrate the strength after discharge as intended. *"Rivaroxaban should have been titrated up to 20mg post-discharge but had remained at 15mg".*
Continued but at wrong formulation [n=111]	Different brand provided [n=45]	The brand on the first GP prescription differed from that on the DAL. *"Tildiem 120 with twice a day dose prescribed by GP, intervention made and Slozem 120mg capsules prescribed" [different brand of medicines with differing clinical effect].*
	Different formulation provided†† [n=66]	The formulation was different on the first GP prescription compared to the DAL. *"Should have given the Modified-Release capsules instead of the Standard Release tablets".*
Item duplicated [n=124]	Duplicated (brand and generic)†† [n=23]	The GP prescription duplicated the item by brand and generic. *"Duplicated by hospital (brand and generic)".*
	Duplicated by dose, strength, or formulation [n=19]	The GP prescription included the item twice at different doses, strengths, or formulations. *"Dose reduced by hospital, but prescription came over with both 30mg and 10mg tablets".*
	Multiple drugs of the same class [n=82]	The prescription included multiple drugs, creating therapeutic duplication. *"Both contain long-acting beta 2 agonists. Should not be on both".*
Medication discontinued by patient†† [n=106]	Patient reversed medication changes [n=28]	The patient reverted to the pre-admission regimen. *"Patient has Zapain [paracetamol and codeine] at home that he takes"* [paracetamol discrepancy].
	Patient stopped the item for a clinical reason [n=27]	The patient discontinued the item because they suffered side effects or perceived a lack of efficacy. *"Constipation vs codeine - patient refusing to take codeine".*
	Patient discontinued item [n=51]	The patient discontinued the item, but no further information was provided. *"Patient doesn't want it".*

Table 6.17 (continued)

Category [n=9,717]†	**Subcategories [Frequency]**	**Subcategory Description with Indicative Verbatim Comment**
Continued but at wrong dose [n=287]	Different dose provided†† [n=146]	There was a difference in dose between the DAL and the first post-discharge prescription, but no further information was provided. *"DAL apply bd [twice a day], prescription apply tds [three times a day]".*
	Dose missing or incomplete [n=25]	The prescription omitted the dose, or it was incomplete. *"Dosage to include to 'right eye' as per DAL".*
	Dose incompatible with Multicompartment Compliance Aid (MCA) [n=10]	The prescribed dose was different from the DAL and incompatible with placement in the patient's MCA. *"Added to MCA in hospital when required dose given on prescription from surgery".*
	Different dose timings [n=106]	The dosage timings differed between the DAL and the prescription. *"Directions differ, prescription one daily, discharge specifies night-time".*
Discontinued in the community [n=1,423]	Item discontinued after discharge†† [n=1,235]	Described in detail overleaf.
	Not restarted after withheld [n=14]	
	Insufficient information from hospital [n=25]	
	Item discontinued but on repeat [n=18]	
	Different drug prescribed [n=131]	
Restarted in community [n=350]	Item not on DAL [n=168]	
	Item restarted in community†† [n=103]	
	Discontinued item on repeat [n=36]	
	Exceeded limited course [n=29]	
	Item not withheld [n=14]	
Intentional discrepancy [n=2,291]	Change since discharge [n=592]	
	Consolidation [n=152]	
	DAL incorrect [n=234]	
	Formulary substitution††† [n=84]	
	Limited course complete [n=545]	
	Item not needed [n=369]	
	Item ordered when needed [n=26]	

Table 6.17 (continued)

Category [n=9,717]†	**Subcategories [Frequency]**	**Subcategory Description with Indicative Verbatim Comment**
Intentional discrepancy (continued)	Item supplied elsewhere [n=215]	Described in detail overleaf.
	Item supply issue [n=12]	
	Item withheld subject to review [n=62]	
Pharmacist intervention [n=644]	Intervention due to an adherence issue [n=297]	
	Intervention due to a clinical issue [n=226]	
	Patient did not order item [n=57]	
	Patient requests change [n=30]	
	Prescription synchronisation [n=34]	
Pre-empted prescription [n=3,687]	Discrepancy with existing prescription [n=185]	
	Incongruent information [n=146]	
	Different to pre-admission [n=706]	
	Insufficient information about item [n=129]	
	Administration issue [n=607]	
	Inform GP of further actions [n=1,914]	

†There were 35 entries that described more than one discrepancy. ††Native ChP category.

†††A formulary is a list of the medicines that can be prescribed from each care setting (McLean 2015).

6.3.7.2.1.1. Discontinued in the Community

This category reflected comments describing item discontinuation after discharge. For many comments within this category, it was unclear why it was designated 'other' rather than the native category since the pharmacist provided no further information. *'Items discontinued after discharge'* was constructed to represent these comments.

'Different drug prescribed' describes where the GP surgery discontinued the item but prescribed a similar item in its place. However, it was unclear whether this was intentional.

Lansoprazole discrepancy: "Omeprazole 20mg daily prescribed by GP".

'Insufficient information from hospital' describes where the GP surgery discontinued the item because they had not received sufficient information from the hospital at discharge.

"No prescription, hospital discharge letter was only page 1/2. Informed surgery".

'Item discontinued but on repeat' describes where the item was not present on the first GP prescription but included on the patient's repeat prescription.

The researcher constructed *'not restarted after withheld'* for comments describing where the item was withheld temporarily in the hospital. However, the GP did not restart it on the first prescription. These comments illustrated ambiguity regarding whether the omission was intentional.

"Changed from pregabalin 25mg capsules 1 bd [twice a day] but 75mg withheld during admission, no indication that it has been stopped but not on GP script [prescription]".

6.3.7.2.1.2. Restarted in Community

Some of these comments, designated *'item restarted in community'*, reflected discrepancies where the GP surgery restarted the item on the first GP prescription after discontinuation in the hospital but provided no further information.

'Exceeded limited course' describes comments where the GP continued an item after hospital discharge despite the DAL describing that it was only for a limited course.

"Discharge suggested limited course but it's on repeat with GP".

'Item on prescription but not on DAL' was constructed for comments where the item was present on the first GP prescription despite its absence from the DAL. It is unclear whether these are intentional discrepancies.

"Missed off discharge and prescription issued".

'Item not withheld' reflects comments describing where the GP restarted the item despite the DAL instructing them to withhold it.

"Due blood tests to confirm if continuing but added onto prescription by GP prematurely".

Some comments described where an item was present on the patient's repeat prescription after discharge despite the DAL describing it as stopped. *'Item on repeat when intended to stop'* was constructed to represent these comments. However, whether the item was present on the GP prescription was unclear.

"Left on repeat with potential to be restarted by patient".

6.3.7.2.1.3. Intentional Discrepancy

This category describes where the pharmacist decided that the discrepancy did not need actioning because it was an intentional post-discharge change. *'Change since discharge'* describes intentional post-discharge changes by a prescriber.

"Blood pressure elevated at review appointment with GP so dose increased".

The researcher constructed *'consolidation'* to represent comments describing how the GP changed the item to consolidate to a simpler medicine regimen.

"Community prescription states one and a half gliclazide 80 instead of one 80mg tablet and one 40mg tablet".

'DAL incorrect' describes comments where the pharmacist perceived the DAL was incorrect; therefore, the discrepancy was appropriate.

Latanoprost discrepancy: "Should have been Latanoprost + timolol !! patient advised to continue using same drops as before admission".

Some post-discharge changes were intentional because of differences between the GP surgery and hospital formularies. The subcategory *'formulary substitution'* describes these comments.

Apixaban discrepancy: "Note formulary substitution from rivaroxaban".

'Limited course of item' reflects comments describing how a GP surgery intentionally discontinued an item because it was for a limited course length. Most of these discrepancies were identified with antibiotics.

'Item not needed' describes where the GP surgery omitted the item from the first prescription because the patient had sufficient supply.

"Not required by patient at the time of new prescription".

Some comments described where the GP surgery intentionally omitted an item because their policy was only to prescribe it when the patient explicitly requested it. *'Item ordered when needed'* encompasses such comments.

"GTN [glyceryl trinitrate] sprays not regularly repeat unless needed".

'Item supplied elsewhere' describes when the GP surgery intentionally omitted the item because it was to be supplied elsewhere, either from a hospital clinic or a pharmacy.

"Started on smoking cessation programme at pharmacy to continue".

'Supply issue' describes where the GP prescribed an alternative item because of supply problems with the item specified on the DAL.

'Item withheld subject to review' describes when the GP intentionally discontinued the item subject to review.

"Missing from script pending blood tests".

6.3.7.2.1.4. Pharmacist Intervention

These discrepancies describe where the pharmacist intervened based on the first prescription information. *'Intervention due to a clinical issue'* describes where the pharmacist intervened because of a potential clinical issue. For example, a discrepancy with methotrexate injections was described as *"Query as on flucloxacillin, advised to not give methotrexate injection whilst on antibiotic".*

'Intervention due to an adherence issue' describes where the pharmacist identified an adherence issue, some of which they rectified.

"Patient doesn't want to cut in half, so we are doing it, putting tabs in the blister pack and doing weekly".

'Patient requests change' describes where the patient requested a change to the item, and the pharmacist attempted to facilitate this where appropriate.

'Intervention for prescription synchronisation' describes where the GP surgery had not synchronised the item with the patient's other medication leading to potential difficulties for adherence or MCA preparation.

The researcher developed *'item not ordered'* to describe where the pharmacist intervened because the patient had not ordered the item since discharge.

6.3.7.2.1.5. Pre-Empted Prescription

This category describes where the pharmacist had performed DMR1 before they received the first post-discharge prescription from the GP. The constructed subcategories describe the reasons for this deviation from the service specification.

'Administration issue' describes where the pharmacist pre-empted the first prescription because the item's administration would not be possible as described on the DAL.

"Care staff not had training on use of buccolam yet, therefore if patient had seizure they are not able to give it- for urgent review".

Some of these comments described where the item was subject to an ongoing manufacturing supply problem, or the hospital supplied an insufficient quantity for ongoing supply.

"Patient is MCA and needed script issued and trays changed to continue treatment".

'Item different to pre-admission' describes where the DAL directions differed from those taken before hospital admission. The pharmacist perceived that clarifying whether the differences were intentional was appropriate.

Codeine discrepancy: "Patient has Zapain [codeine and paracetamol tablets] in community and hospital initiated separate therapies".

Many of these comments described how pre-admission items were missing from the DAL without indicating if the hospital stopped them.

'Discrepancy with existing prescription' reflects where the pharmacist identified a discrepancy between the DAL and a pre-admission prescription. Most of these comments described pre-prepared MCAs.

"Stopped by hospital and hospital did not give discharge meds as patient knew a script was waiting. Removed from tray in line with DAL".

'Incongruent information' describes where the pharmacist required further clarification regarding the patient's intended post-discharge medication regimen because of conflicting information sources. For some comments, one of the conflicting sources was the patient's perception of their medication regimen.

"Patient seems to think this was stopped in hospital but says continue on discharge letter - query with GP".

'Insufficient information about item' describes where the pharmacist had to clarify information about the item to ensure the intended regimen was continued post-discharge.

"Unclear from DAL if to be continued, and if so, who responsible for Rx [prescription]. Phoned hospital, to be seen by alcohol services -discussed with patient, appointment made, GP to Rx until seen again".

'Inform GP of further actions' describes where the pharmacist performed DMR1 before the first prescription and informed the GP surgery of the changes, ensuring the first prescription was correct.

Edoxaban discrepancy: "New item as warfarin has stopped - GP to put on regular repeat".

6.3.7.2.2. Actions Taken to Rectify the Discrepancy

Table 6.18 describes the frequency and proportion of actions taken to rectify discrepancies.

Table 6.18: Frequency and Percentage of Actions Taken to Rectify Discrepancies

Actions Taken to Rectify the Discrepancy	Frequency [n=28,488] (Percentage)
Seek resolution with GP	20,018 (70.3%)
Resolve with patient	5,768 (20.2%)
Other action taken to rectify the discrepancy	2,086 (7.3%)
Seek resolution with hospital	616 (2.2%)

The researcher used summative content analysis to analyse the 2,086 explanatory comments for other actions to rectify discrepancies. Table 6.19 presents the 12 deductive subcategories, developed by mapping the data onto the deductive framework: *"resolve with whomever the pharmacist intends to resolve the discrepancy with"* (see Table 6.2).

Table 6.19: Categories Developed from the Deductive Content Analysis of the Other Actions Taken to Rectify the Discrepancy Free-Text Variable

Deductive Category [n=598]	Deductive Subcategories [Frequency]	Indicative Verbatim Comment
Resolve with patient [n=38]	No subcategories	*"Confirm with patient still taking".*
Resolve with other community practitioners [n=9]	Resolve with nurse [n=6]	*"Resolve with district nurse".*
	Resolve with community mental health team [n=3]	*"Care home to sort prescription with mental health team".*
Resolve with carer [n=378]	Resolve with family member [n=56]	*"Discuss with wife".*
	Resolve with care home staff [n=322]	*"Speak to nursing home".*
Resolve with GP surgery staff [n=84]	Resolve with GP or receptionists [n=64]	*"Will review with GP to see if it's suitable".*
	Resolve with practice pharmacist [n=20]	*"Resolve with practice pharmacist".*
Resolve with discharging care setting [n=12]	Resolve with hospital [n=10]	*"Informed patient and contacted hospital to get the up-to-date discharge letter".*
	Resolve with prison [n=2]	*"Prison".*
Resolve with multiple sources [n=28]	No subcategories	*"Carer and surgery reception".*
Resolve in pharmacy [n=43]	No subcategories	*"Not on latest Rx [prescription] - pharmacist to check at next prescription".*
Resolve with unknown source [n=6]	No subcategories	*"Stopped in hospital, due to start warfarin, but self-discharged. Query as to whether needs to restart".*

Table 6.20 describes the five inductive categories developed from the 1,488 comments that could not be categorised using the deductive framework.

Table 6.20: Inductive Categories Developed from the Content Analysis of the Other Action Taken to Rectify Discrepancy Free-Text Variable

Inductive Category [n=1,488]	**Inductive Subcategory [Frequency]**	**Subcategory Description with Indicative Verbatim Comment(s)**
Patient/carer to resolve [n=64]	Patient/carer to resolve for unknown reason [n=32]	The patient or carer was tasked with resolving the discrepancy, but the comment did not provide further information. *"Care home to sort prescription with GP".*
	Patient/carer to resolve if required [n=5]	The patient or carer needed to resolve the discrepancy only if required. *"Carer to speak to palliative care team if needed".*
	Patient will resolve during clinical review [n=27]	The patient required a clinical review or test to rectify the discrepancy. *"Patient has appointment with consultant and wishes to discuss issues".*
Discrepancy already resolved [n=579]	Discrepancy resolved with the patient/carer [n=231]	The discrepancy was already resolved with the patient or their carer. *"Checked with patient - not needed this month".*
	Discrepancy resolved with GP surgery staff [n=109]	The GP, prescription clerk, or practice pharmacist resolved the discrepancy. *"Checked with pharmacist at surgery".*
	Discrepancy resolved by the pharmacy [n=95]	The community pharmacy staff resolved the discrepancy themselves. *"Arranged for prescription as soon as possible so that MCA could be sent out immediately. Surgery had not received discharge information so faxed them copy to facilitate this".*
	Discrepancy resolved with multiple sources [n=24]	The discrepancy was resolved with multiple individuals. *"Discussion with practice pharmacist and patient/carers".*
	Discrepancy resolved with other community practitioners [n=7]	A nurse or community healthcare team resolved the discrepancy. *"Nurse has directed a change in dose to assist patient and increase compliance".*
	Discrepancy resolved with unknown source [n=113]	An unknown individual resolved the discrepancy. Often these comments included a name which had been redacted. *"[name] initiated reducing dose after patient home visit".*
Discrepancy did not require resolution [n=401]	Post-discharge change actioned as per DAL [n=317]	The item was changed as per DAL instructions, so there was no discrepancy to resolve. *"No action required short course only".*
	Discrepancy not clinically relevant [n=84]	The pharmacist thought the discrepancy did not require resolution because it was not clinically relevant. *"Same medication different brand".*

Table 6.20 (continued)

Inductive Category [n=1,488]	**Inductive Subcategory [Frequency]**	**Subcategory Description with Indicative Verbatim Comment(s)**
Resolution not possible [n=18]	Entry was not an individual medication [n=10]	The pharmacist could not rectify the discrepancy because the item description entry was a note rather than an individual item. *"Entry disregarded as not medication".*
	Patient readmitted to hospital [n=6]	The patient was readmitted to the hospital before the discrepancy could be actioned. *"Patient readmitted to hospital before able to query".*
	GP surgery would only communicate with the patient/carer [n=2]	The pharmacist could not resolve the discrepancy because the GP surgery wanted to resolve them with the patient or carer. *"Tried contacting surgery. Surgery asked for home to liaise with them".*
Unsure if action needed [n=426]	Further explanation of discrepancy [n=72]	The pharmacist provided further information about the discrepancy rather than describing their plan to resolve it. *"Capsules prescribed instead of tablets".*
	No coherent information [n=354]	The comments did not provide any coherent information. *"F"*

Like Section 6.3.5.2, these results show that some pharmacists did not consider family members 'carers'. Many comments reflected how the pharmacist believed the discrepancy did not require further resolution because it was intentional or already resolved. Pharmacists consulted many professional groups to rectify discrepancies, including practice pharmacists, nurses, and community mental health teams. GP surgery administrative staff, such as prescription clerks and receptionists, were similarly consulted. Other comments suggested that the pharmacist intended to resolve the discrepancy themselves.

6.3.7.2.3. Discrepancy Resolution

Of the 24,971 items with discrepancies subject to DMR2, 880 (3.4%) were unresolved. The percentage of unresolved discrepancies increased from 3.1% in 2016 to 5.1% in 2020. There was a notable increase between February (4.0%) and May (6.6%) of 2020, corresponding with the Covid-19 pandemic. The percentage of unresolved discrepancies was largest for 'medication discontinued by patient' (6.5%) discrepancies and the smallest for 'continued at wrong quantity' (0.9%).

6.3.7.2.4. Further Action Required After DMR2

Of the 22,591 ChP consultation dataset DMR2s, 1,605 (7.1%) required further action and 20,986 (92.9%) did not. The researcher developed seven categories from the explanatory free-text comments for DMRs requiring further action. Some comments were associated with more than one subcategory; therefore, the total frequency was 1,855 (from 1,605 entries). Self-explanatory categories are described only in Table 6.21, whilst those requiring more extensive explanation are presented below.

Table 6.21: Categories Developed from Content Analysis of the Further Action Required After DMR2 Free-Text Variable

Category [n=1,855]	Subcategories	Subcategory Description with Indicative Verbatim Comment
Admitted to care setting to follow up [n=38]	No subcategories	The patient was readmitted, and the pharmacist intended to follow them up after discharge. *"Patient has been readmitted and discharged again and seen cardiac nurse at home".*
Discrepancy still to be resolved [n=419]	Responsibility for ongoing prescribing [n=12]	The pharmacist needed to clarify where the patient was to obtain an ongoing supply of one of their medications. *"Patient has been referred back to consultant as GP will not prescribe this item as he/she feels it is hospital only".*
	Dose, formulation, and quantity discrepancy [n=194]	An identified discrepancy that had not yet been resolved. *"Amlodipine reduced to 5mg on hospital follow up visit - needed GP script to be changed".*
	Generic discrepancy [n=46]	The comment alluded to a discrepancy but did not describe its nature. *"Prescription back to GP for amendment".*
	Medication to be synchronised [n=35]	The prescription items were out of synchronisation. *"Carbimazole increased to 4 daily so interim script generated to synchronise tablets".*
	Medication erroneously discontinued or restarted [n=132]	The GP surgery unintentionally discontinued or restarted the item after discharge, which was still unresolved. *"Tablets missing from repeat prescription. Emergency supply issued to patient to cover over the bank holiday weekend".*
No details of further action [n=422]	Describing medication change [n=396]	The comments describe changes in the patient's medication in the hospital or post-discharge. *"As suggested Indapamide was discussed with surgery pharmacist and changed to morning dose".*
	Service context [n=26]	The comment provided information about the delivery of the DMR itself. *"Carer by telephone for above ... no option to select".*
	Unintelligible entry [n=4]	Insufficient context was available to understand the comment. *"Dementia guidelines".*
Change to be requested [n=77]	Requesting a change for a clinical reason [n=33]	The pharmacist intended to request medication changes for a clinical reason such as treatment efficacy, side effects or clinical appropriateness. *"Patient request to order co-codamol as patient said paracetamol are not controlling his pain".*
	Requesting a change to improve adherence [n=30]	The pharmacist intended to request changes, such as formulation or dose, to improve the patient's adherence. *"Is it possible to have soluble paracetamol as difficulty swallowing tablets? Will speak to GP".*
	Requesting a change due to supply issues [n=14]	The pharmacist requested a change because of medicine supply issues. *"Change haloperidol to liquid due to shortage of solid dosage forms".*

Table 6.21 (continued)

Category [n=1,855]	Subcategories	Subcategory Description with Indicative Verbatim Comment
Other healthcare support provided [n=35]	No subcategories	Described in detail overleaf.
Adherence support [n=453]	Alteration in compliance aid [n=155]	
	Medication counselling [n=72]	
	Medication delivery [n=11]	
	Disposal of old medicines [n=11]	
	Monitoring medication regimen [n=128]	
	Adherence issue identified [n=61]	
	Dose schedule change [n=15]	
Review needed [n=407]	Clinical review [n=209]	
	Treatment monitoring [n=186]	
	Generic review needed [n=18]	

6.3.7.2.4.1. Adherence Support

The researcher constructed this category to encompass comments explaining how the pharmacist identified potential issues with patient adherence. *'Adherence issues identified'* represents comments that provided no further information.

> *"Serious concern issue raised with GP regarding [name] ability to cope and her opiate use".*

The other six subcategories describe the nature of the adherence support provided. *'Alteration in compliance aid'* was constructed to describe comments where a patient's compliance aid status was changed to facilitate their adherence, such as supplying or ceasing an MCA.

Comments describing pharmacist adherence support counselling were categorised as *'medication counselling'*.

> *"I will contact him [patient] in one week's time. He admitted he is not taking his tablets. I asked him why and impressed upon him if he doesn't take his blood pressure tablets, he could have a heart attack or stroke".*

'Medication delivery' reflects comments describing that the pharmacist assisted the patient's adherence by delivering the medication to their home.

'Disposal of old medicines' encompasses comments where the pharmacist organised the removal of old medicines from the patient's home to aid adherence.

> *"Old medication that had been discontinued still at home. Liaised with carer & GP to arrange removal".*

Some comments, categorised as *'dose schedule change'*, described how the pharmacist changed the patient's dosing schedule to optimise adherence to the intended post-discharge regimen.

> *"Need to amend MDS [MCA] night-time medicines to teatime as no care package at night".*

'Monitor medication regimen' describes where the pharmacist monitored the patient's medication regime, ensuring any changes were actioned appropriately, such as stopping medication after a limited course.

> *"Excess stock of Tramadol at home trying not to take too many - don't order any this month with blister pack - ring next month to check situation".*

6.3.7.2.4.2. Other Healthcare Support Provided

This category encompasses comments where the pharmacist advocated for and supported the patient in optimising aspects of their healthcare unrelated directly to the DMR. Some of these comments included formal support, such as smoking cessation services. Others described less formal support, such as alcohol reduction advice and helping patients book appointments with the GP to monitor health conditions.

"Patient was unsure whether she had missed an appointment for a blood test. I have referred her to the surgery, and I will inform the surgery of this conversation".

6.3.7.2.4.3. Review Needed

This category represents comments describing further review requirements for the patient, with healthcare professionals such as GPs, practice pharmacists and consultants. The pharmacist supported these patients in accessing an appropriate review or indicated that the review was conditional based on further monitoring. Some of these comments were unclear why the review was needed and categorised as *'generic review needed'*. Two other subcategories describe the reasons for further review: *'clinical review'*, where the pharmacist identified a clinical issue like medication interactions or side effects, or *'treatment monitoring'*, where the pharmacist identified that the patient required a review of their treatment efficacy or necessity.

"Condition is deteriorating, carer wants answers as to where to go. Signposted to MIND [mental health charity] and making note on record. I also spoke to [name] over the phone around a week ago, and she seems to have deteriorated based on phone call. To follow up" ['clinical review' indicative comment].

6.3.8. Summary of Main Findings

As identified in the original DMR evaluation, the results showed that DMR provision is still inconsistent, with a small number of pharmacies engaging far more than the majority. Pharmacists are still identifying discrepancies between the DAL and first GP prescription showing the DMRs value. However, the discrepancy rate has decreased over time from 1.37 discrepancies per DMR in 2012 to 0.97 in 2019 (NECAF DMRs). Unique to this study, the researcher found that pharmacists were using the DMR as an opportunity to provide patient-centred care outside of the service specification. Additionally, pharmacists collaborated with different professional groups to ensure seamless transfer of care. Table 6.22 summarises the chapter's main findings relevant to optimising the DMR.

Table 6.22: Summary of Findings from Chapter 6

Finding	Relevance to Optimising the DMR
DMR provision was inconsistent, with few pharmacies and pharmacists engaging more than the majority.	No change since the original DMR evaluation; therefore, low providers could be targeted for support and further investigation.
Pharmacists provided patient care outside of the DMR specification.	The value of such support is not routinely captured; therefore, the DMRs value may be underestimated.
The discrepancy occurrence per DMR/item decreased over time.	The perceived value of the DMR may decrease according to its routine data collection. A cyclical and broader analysis of DMR outcomes may better evidence its value.
Community pharmacists collaborated with many professionals to provide post-discharge support, including primary care pharmacists.	The place of the DMR needs to be considered concerning the wider primary care workforce to optimise post-discharge patient support.
Many pharmacists completed DMR1 before they received the first post-discharge prescription.	The data collection may not accurately capture the value of these DMRs since there is no opportunity for discrepancies to occur.
Some in-hospital changes, such as changed brands or where pre-admission medicines were missing from the DAL, often required community pharmacists to seek clarification, even if the changes were intentional.	The eDAL information may be insufficient to support the DMR.

6.4. Discussion

This chapter used a multimethod approach to achieve its aim by providing a detailed description of DMR provision and its outcomes for all DMRs completed since its inception (November 2011). This study was unique in providing a description of DMR and outcomes over such an extensive period, almost encompassing ten years of data. These findings elaborate on those found in the original DMR evaluation (encompassing two years of data) (Hodson et al. 2014a) because of the availability of the medication-related data in ChP and free-text explanatory categories. Before discussing the specific findings in the context of the wider literature, it is essential to consider the strengths and weaknesses of the study design.

6.4.1. Strengths and Limitations

The chapter successfully used the routinely collected DMR data to meet its aim, describing DMR provision from November 2011 to January 2021. Such secondary analysis has many advantages, e.g., timeliness. However, its challenges were apparent in this study, such as the extensive content analysis required to extract meaning from the free-text data. This challenge reflects that researchers do not have control over the quality of secondary data. Many DMR data variables were manually entered by the pharmacists, which can be a source of bias and inaccuracies, particularly where there is a lack of understanding of the data (Verheij et al. 2018). These misunderstandings were exemplified by many pharmacists miscategorising discrepancies as 'other' when a native discrepancy type was suitable.

The results outlined considerable deviations from the DMR specification, such as completing DMR1 before receiving the first post-discharge prescription. Although the content analysis successfully identified these deviations, their true frequency is unclear because some pharmacists may not have entered this information into the free-text boxes.

There has likely been an underestimation of discrepancy occurrence in the ChP data analysis. Approximately 1% of NECAF DMRs had more identified discrepancies than medicines. Furthermore, the content analysis of 'other' discrepancies identified 35 comments that described more than one discrepancy. Although these entries were infrequent, some pharmacists may have logged a single discrepancy using the native categories when other discrepancies were also present, considering that the ChP DMR form can only log one discrepancy per item.

Acknowledging that DMR routine data collection was not designed considering future analysis (see Section 5.5), the results have highlighted potential areas for improvement, which would improve subsequent analysis. For example, due to the lack of context, the entered data for 'other' discrepancies were often difficult to categorise. Lindsey and Pattison Rathbone (2022) suggested this is a common limitation when using content analysis of routinely collected data and proposed overcoming the lack of context by checking the underlying meaning with participants. However, checking meaning with participants would not have been practical for this study due to the scale of the data analysed. The categories developed from the content analysis could inform ChP adaptations to optimise data collection. For example, DHCW could add 'intentional discrepancy' and 'continued at wrong quantity' as native discrepancy types, facilitating consistent discrepancy documentation and timelier future analysis.

6.4.2. Relevance to Wider Literature

The monthly number of DMRs has increased over time. However, numbers decreased in 2014, when the Welsh Government decided whether to continue DMR commissioning and in 2020 due to Covid-19. There seems to be some seasonality with DMR completion; for example, numbers were lower between December and March. This seasonality contrasts with the Medicines Use Review (MUR), with Hann et al. (2017) finding that provision dropped in December but increased considerably between January and March. They postulated that this was because the UK financial year, thus the deadline for completing annual commissioned services, was at the end of March. Perhaps the number of DMRs decreased because pharmacists focused on achieving the maximum number of annual commissioned MURs (400) (PSNC 2013a).

In the original evaluation, approximately 68% [n=712] of pharmacies averaged one or fewer monthly DMRs (Hodson et al. 2014a), compared to 63.6% completing one or fewer DMR1 per

month in this chapter. A descriptive statistical analysis of MUR provision three years after its implementation noted a similar finding, with few pharmacies providing many services but most providing very few (Bradley et al. 2008). This chapter also identified that 824 pharmacists had completed at least one DMR1, but there is no accessible list of community pharmacists in Wales for comparison. However, Health Education and Improvement Wales [HEIW] (2019) recently completed a workforce survey for community pharmacies, describing that 1,604 pharmacists were actively working in the sector. This value is only an approximation since the number of active pharmacists may have changed over time when considering newly qualified and retiring pharmacists. Nonetheless, using this approximation with the chapter results suggests that 49% of pharmacists in Wales have not provided a DMR. According to the Diffusions of Innovations theory, pharmacies or pharmacists that are slow and reluctant to adopt innovations can be described as laggards (Makowsky et al. 2013). Whilst these results could characterise some pharmacies as 'DMR laggards', further work is needed to identify the causes, be they a lack of DMR referral to those pharmacies, pharmacists' motivation, or other contributory factors. It should also be acknowledged that the study results identified that the same pharmacist usually completes both parts of the DMR. The content analysis showed that some DMR2s were not completed because the pharmacist who completed DMR1 did not follow up. Given these findings, perhaps pharmacists are reluctant to initiate a DMR if they are unlikely to be able to complete both parts, such as locum pharmacists. Further research could elucidate this theory by investigating community pharmacy barriers to DMR provision in high and low DMR providers.

The pharmacies in the two quartiles of highest social deprivation provided 67% [n=85,573] of all DMRs. These findings contradict the inverse care law, which states that healthcare utilisation is lower in areas of greater need, such as socially deprived areas (Mercer et al. 2021). The pharmacy care law states that pharmacy access is greater in areas of social deprivation, which could explain these findings (Todd et al. 2015). Pharmacies in 'city and town' classifications provided 74% of all DMRs, supporting Bradley et al. (2008) that MUR provision was lower in rural areas than urban ones. Although these findings for social deprivation and rurality agree with pharmacy services research, this chapter did not consider the DMR provision per pharmacy. Chapter 8 controls these factors, describing the effect of pharmacy-related factors, such as rural-urban classification and social deprivation, on DMR volume.

The average age of a patient receiving a DMR (74.0) exceeds the average age of a patient in Wales that received a full consultant episode[22] (61.0) (DHCW 2020). This comparison indicates that older patients may be more likely to be eligible for the DMR or that pharmacy staff are targeting older patients for the DMR and its referrals. Previous research has identified that hospital communication with community pharmacies during discharge is primarily for patients who have medicines dispensed into an MCA (Urban et al. 2013). However, the results suggest that this may be changing, as the proportion of patients who met the eligibility criterion 'patient requires adjustment to medicines' decreased over time. What is unknown is whether the needs of MCA patients are decreasing or patients are being recruited for different reasons because pharmacy staff better understand the DMR. The availability of individual medication-level data collected in ChP facilitated the first description of the types of medicines that DMR patients take. Most medicines (over 60%) were from the cardiovascular, alimentary tract, metabolism, and nervous system ATC1 groups. This finding is unsurprising given that they are Wales' most commonly prescribed therapeutic drug classes (StatsWales 2021). Further work could describe the differences between prescribing data in Wales and the DMR data in granular detail to explore whether certain medications are being 'targeted' for DMRs.

The NICE (2015) guidance and DMR service specification state that medicines reconciliation should be completed within seven and 28 days of discharge, respectively. The results showed that pharmacists often took over seven days to complete the DMR (42.8% of total), but most completed it within 28 days (85.0% of total). Despite DMRs frequently deviating from the guidance, it is important to remember that timeliness of DMR1 provision is dependent on the presentation of the first GP prescription, so it may be out of the pharmacist's control. The timing for DMR1 and DMR2 has changed over time (Figure 6.10), showing that pharmacists usually complete DMR1 later than originally and leave little time before DMR2. This finding could be explained by increasing workload pressures, especially during Covid-19, but further exploration is required.

NWIS developed the DMR referral system in response to community pharmacist feedback that they rarely had access to timely discharge information (Mantzourani et al. 2020). The results describe that this development has been successful since the relative proportion of hospital discharge information availability has increased over time, coinciding with the rollout of MTeD and ChP. Therefore, stakeholders could inform subsequent system developments through regular

[22]A full consultant episode is the time a patient spends in the continuous care of one consultant within one NHS provider (DHCW 2020).

evaluation. This cyclical process of evaluation and improvements (action research) could be used for DMR referral system development, requiring close collaboration between researchers and system users, developers, and funders (Cordeiro and Soares 2018).

Section 6.3.6.1 showed that the average number of logged discharge medicines was greater for ChP than NECAF DMRs, especially for those with eDAL availability (mean number of DAL medicines = 10.07) compared to those without (mean = 9.15). These findings support literature which describes that electronic discharge systems have increased the completeness and comprehensiveness of discharge information (Mehta et al. 2017). Mantzourani et al. (2017) interviewed community pharmacists with experience using eDALs for the DMR, who perceived that the eDAL provided more comprehensive discharge information than paper or faxed DALs.

The Covid-19 pandemic changed the way that pharmacists provided the DMR. During the initial lockdown in the UK (March 2020), the monthly DMRs decreased, and there was an increased mean time elapsed between DMR1 and DMR2. The Chief Pharmaceutical Officer for Wales continued funding the DMR during the pandemic, unlike other pharmacy services like the MUR (Evans 2020). However, increased workloads could explain the decreased DMR volume during this period (Welsh Government 2021). Fewer patients had their discharge information provided by the hospital and eDALs available after discharge. These changes could be explained by the impetus to discharge patients quickly in the first few months of the pandemic. The Welsh Government (2020a) formalised this strategy in their *'Covid-19 Hospital Discharge Service Requirements'* report. The focus group participants (Chapter 4) described how DMR referrals were not a priority, which the impetus to discharge patients quickly may have compounded. The decreased eDAL availability could explain the reduced DMR provision since the lack of eDAL availability and knowledge of patient discharge are known community pharmacist engagement barriers (Hodson et al. 2014a; Mantzourani et al. 2017). During Covid-19, more DMRs were provided by telephone, as could be expected with stay-at-home orders legislated by the Welsh Government. Decreased healthcare service provision and increased telephone consultations have been noted internationally (Moynihan et al. 2021). During this period, video consultations were enabled to support pharmacy services and have subsequently been added to a recent iteration of the DMR specification (Welsh Government 2020b; NHS Wales 2022). Although there was no indication in the data of pharmacists using video consultations to provide the DMR, its availability may change future service provision.

In previous DMR evaluations, the average discrepancy rate ranged from 1.15 to 1.3 (Hodson et al. 2014a; Hodson et al. 2018). The average discrepancy rate for NECAF DMRs has now reduced to

0.97 and 0.79 in 2019 and 2020, respectively. Despite these decreases over time, approximately half (49.9%) of patients had at least one discrepancy in 2020, demonstrating the value of the DMR in reducing potential MRH. This discrepancy rate is within the literature range of 14-82% for unintentional discrepancies (Alqenae et al. 2020). The proportion of discrepancy types identified during the DMR has not appreciably changed since the original DMR service evaluation (Hodson et al. 2014a). The vast majority encompassed where medicines were discontinued or restarted after discharge and 'other' discrepancies. The 'other' discrepancy type content analysis provided a detailed description of issues rectified by pharmacists after discharge, including GP surgeries continuing medicines in the wrong quantity and duplicating the therapeutic medication classes.

Interestingly, many pharmacists categorised many discrepancies as 'other' despite fitting within the definition of native discrepancy types within ChP. The DMR delivery method content analysis also demonstrated that pharmacists often input data inaccurately, not selecting 'with carer' when the DMR was completed with a family member. These examples highlight the need for pharmacist training and education to ensure data are entered correctly.

There are several explanations for reducing discrepancy rates, including improved accuracy of discharge information or more comprehensive post-discharge reconciliation by GP surgeries. Section 1.4.3 described the development of primary care pharmacist (PCP) roles in GP surgeries in Wales. These roles have become more commonplace since being endorsed in P:DaHW (Welsh Pharmaceutical Committee 2019). PCPs often undertake post-discharge medicines reconciliation (Wilcock and Bearman 2019). Although their uptake is not uniform and their roles are inconsistent, increasing PCP availability could explain the decreasing DMR discrepancy rate.

The content analysis results described how community pharmacists liaised with PCPs to support medicines reconciliation or rectify identified discrepancies.[23] The overlap between the PCP post-discharge role and the DMR could be considered unnecessary work duplication, as suggested by the focus group participants (Chapter 4). However, the results show that the DMR is still identifying discrepancies which may be clinically significant. Since healthcare aims to be patient-centred, all sectors should consider collaborating to optimise the workflow for post-discharge support, involving colleagues in community, hospital, and GP surgeries.

The average DMR2 identified very few discrepancies (mean = 0.07), which is unsurprising given that most were identified during DMR1. However, the preparation and analysis of the data highlighted the lack of scrutiny given to how patient safety is influenced by DMR2, which aims to

[23]See examples in Sections 6.3.5.2 and 6.3.7.2.4.

improve post-discharge medicines adherence, a recognised cause of MRH (Laatikainen et al. 2022). Perhaps this lack of focus has led to the DMR incompletion rates reported in this chapter, with one in five (17.2%) DMRs only including part one. Consequently, many patients could be missing the benefits of DMR2, considering that recent reviews of post-discharge services have highlighted how multi-component interventions are more effective at reducing MRH than medicines reconciliation or review alone (Tomlinson et al. 2020a; Daliri et al. 2021). Whilst Mantzourani et al. (2020) described the association of DMR1 with a reduced risk of hospital readmissions; the study should be repeated, investigating whether there are any additive patient safety benefits from DMR2.

A considerable proportion of 'other' discrepancies indicated that the discrepancies were intentional. The value of pharmacist follow-up for these discrepancies may be limited; hence many studies evaluating post-discharge service effectiveness consider unintentional discrepancies (Alqenae et al. 2020). Within intentional discrepancies, some pharmacists described how the GP was reversing medication changes made in the hospital, such as formulary substitutions and consolidating dosage forms. The pharmacists considered few of these changes clinically significant since many were brand swaps due to hospital stock availability but spent time clarifying the intentions for ongoing prescribing. Additionally, Daliri et al. (2019) interviewed patients who described brand swaps as confusing and affected post-discharge adherence. LHBs should consider adopting suggestions by McLean (2015) to use joint formularies between primary and secondary care to prevent such changes.

Although detailed descriptions of post-discharge community pharmacist interventions are rare, Ensing et al. (2017) explained that Dutch pharmacists often intervened in drug-drug interactions and contraindications. However, this service did not have a well-defined specification; therefore, the clinical interventions were not outside its scope. In contrast, the content analysis findings showed that community pharmacists provided patient-centred care outside the DMR specification. For example, they intervened in clinical issues and advised patients on their medical conditions and lifestyles. Similarly, Cooper and Tsoneva (2017) interviewed community pharmacists who suggested they would capitalise on the routine interactions from a public health programme to provide medicines reviews and general clinical support, despite being outside of the service scope. A recent meta-analysis of community pharmacist medicines reviews described clinically significant patient outcome benefits, including improvements in blood pressure and diabetes control (Al-babtain et al. 2022). The DMR form does not routinely capture these outcomes, so Hodson et al. (2014a) could not include them in their cost-effectiveness calculations.

NHS service commissioning is based on the principles of value-based healthcare, providing the best value for money within limited budgetary constraints (Hurst et al. 2019). If service value is not accurately captured, its cost-effectiveness may be understated, risking decommissioning. DHCW developed a platform to collect patient-reported outcome measures (PROMs) data to capture service values accurately (Withers et al. 2021). These data are widely collected across secondary care in Wales, with patients routinely completing surveys regarding managing their medical conditions and associated symptoms. Further work could link the PROMs data with DMR data, which could describe the effect of the DMR on post-discharge management of several health conditions, e.g., the effect of the DMR on blood pressure management and adherence to the medication regimen. Such holistic appraisal of service value would ensure that service commissioning decisions are made with the best evidence.

Another example of pharmacists' deviation from the DMR specification was how they frequently completed DMR1 before receiving the first GP prescription, often on the day of discharge and informing the GP of the changes, ensuring the first post-discharge prescription reflected the DAL. The focus group participants (Chapter 4) perceived that the DMR would not be timely for MCA patients. These results reflect this sentiment, with many pharmacists completing DMRs before the first prescription because of MCA issues. Similarly, Latif et al. (2016) found that pharmacists in England would alter the New Medicines Service to circumvent pharmacy service specifications for patient and workflow benefits. The NASSS framework suggests that the ability to adapt technologies to meet a need is essential for long-term sustainability (Greenhalgh et al. 2017). If pharmacists cannot provide the service to suit their needs, it may be a barrier to engagement. Although pre-empting the prescription is proactive, it may lead to the under-reporting of discrepancies since it is impossible to determine whether a discrepancy would have been generated without this intervention. However, this proactive approach demonstrates a commitment to reducing MRH and providing patient-centred and seamless care, all of which are principles outlined in P:DaHW (Welsh Pharmaceutical Committee 2019).

6.5. Conclusions and Dissemination

This chapter addressed Thesis Objective 3 by describing DMR provision from November 2011 to January 2021. Systematic and detailed data collection facilitated this description, but inconsistencies with data entry partly limit its use. This analysis is built upon in Chapters 8 and 9 by further exploring the data to facilitate inferential analysis to determine factors associated with the number of DMRs and their outcomes.

The researcher has disseminated the chapter's findings to the AWQPSG and the DMR Promotional Material Working Group. The latter dissemination involved the researcher providing expert advice regarding the DMR outcomes and required areas of community pharmacist education to inform the development of educational videos about the DMR (see Section 4.6). Further dissemination is planned to the other groups introduced in Table 2.2.

Chapter 7. Regression Analysis Methods

7.1. Chapter Introduction

Although Chapter 6 described DMR service provision across Wales, extensive stakeholder engagement identified a need to describe the pharmacy-related factors that affect DMR provision and which patients to target for a DMR. Such information could be utilised to optimise the use of the DMR by attempting to increase its uptake. Additionally, targeting the patients most likely to benefit from the service could maximise its cost-effectiveness. Thesis Objectives 4 and 5 were developed to encompass these aims:

4. Describe the pharmacy-related factors affecting DMR delivery volume over time.
5. Describe the factors affecting DMR discrepancy identification.

Chapter 5 has already explained the preparation of the DMR data, which contained many variables which could be considered for addressing these objectives. Therefore, the researcher undertook regression analysis, using Stata® (v17), to address Thesis Objectives 4 and 5 since it can describe the influence of several predictor (dependent) variables and an outcome (independent) variable (Field 2018).[24] For example, describing the effect of patient age and pharmacy type (predictors) on the number of identified discrepancies (outcome).

This chapter provides a general overview of regression analyses before describing the pertinent considerations for addressing the thesis objectives. Chapters 8 and 9 present the specific regression methods employed for each objective and their results. The researcher consulted with experienced colleagues from Cardiff University Schools of Mathematics and Social Sciences for statistical support, who confirmed that the methods for each chapter were suitable.

7.2. Regression Overview

Figure 7.1 illustrates the various components that make a regression model, which this section describes in further detail (Field 2018).

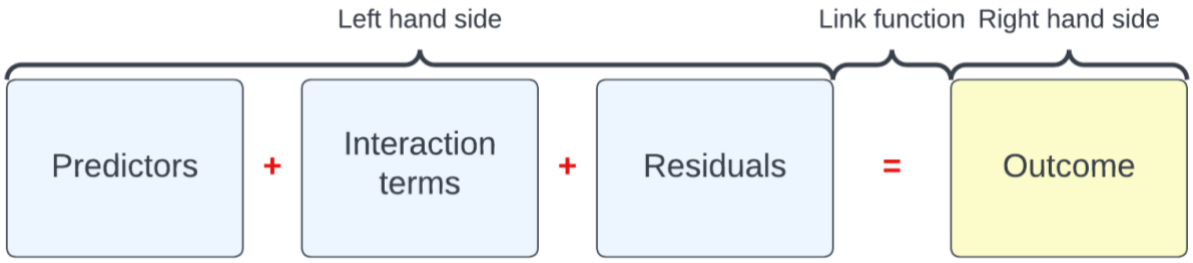


Figure 7.1: Visualisation of Regression Models

Table 7.1 provides an overview of the outcome variables used for this thesis' regression analyses.

[24]See Section 2.8.1.1 for the full rationale for using regression analysis.

Table 7.1: Outcome Variables Used for Regression

Thesis Objective	Outcome Variable	Dataset	Rationale
4. Describe the pharmacy-related factors affecting DMR delivery volume over time.	The annual number of DMRs per pharmacy (numerical)	Pharmacy dataset (monthly data for all DMR-registered pharmacies from April 2012 to January 2021)	• Using the annual number of DMRs per pharmacy facilitates the description of the factors affecting the volume of DMRs delivered and whether they have changed over time. • The pharmacy dataset was used since it included all pharmacies in Wales, not just those that had provided DMRs, such as in the NWSSP and ChP datasets. • The number of DMRs per pharmacy was exported from the NWSSP dataset since it contained more longitudinal data than the ChP consultation dataset.
5. Describe the factors affecting DMR discrepancy identification.	Number of discrepancies identified per DMR (numerical)	NECAF dataset (a subset of the NWSSP dataset containing all DMRs logged in NECAF)	• Discrepancies are logged differently in ChP and NECAF, so they must be analysed separately (see Table 5.2). • Although regression was not needed for both variables since they describe similar concepts, the researcher considered them both in Chapter 9. • For the chapter's results to form part of meaningful recommendations to optimise DMR use, the researcher focused on total discrepancies since they were more frequent than individual discrepancy types, e.g., medicines discontinued after discharge.
	Item discrepancy occurrence (binomial)	ChP combined dataset (all DMRs logged in ChP from April 2015 to June 2020)	

ChP = Choose Pharmacy. NECAF = National Electronic Claim and Audit Forms.

Since the DMR datasets represent a population (containing all DMRs completed during the data collection period), the researcher considered whether inference was required because it typically applies to generalising findings from a sample to a wider population (Field 2018). However, since the regression results are used to develop recommendations, they must be inferred to a wider population (future patients or healthcare professionals) to which the recommendations may apply (Thomas 2020).

7.2.1. Predictors and Interaction Terms

All variables must be numerical rather than text to undertake a regression analysis. Therefore, when including a categorical predictor, the text must be transformed into numerical data (encoding) (Hosmer et al. 2013). Dummy encoding is the most common method, which Table 7.2 details.

Table 7.2: Description of Dummy Encoding

Encoding Step	Description (Hosmer et al. 2013)	Example Using Social Deprivation Quartile
1	• Select one categorical predictor group to function as a baseline reference. • Usually, researchers choose the most frequent group or a specific group to aid the interpretation of results.	Social deprivation quartile 1 was chosen as the baseline reference since it is the most deprived; therefore, it is easier to interpret findings.
2	• Create a new dummy predictor for each predictor group except the baseline reference.	Three new dummy predictors are created for quartiles 2, 3, and 4.
3	• The value for each dummy predictor equals one for data observations where its related predictor group is present. • All dummy predictors must be included in the model instead of the original predictor.	For the quartile 2 dummy predictor: • The value equals one when the data observation is from quartile 2. • The value equals zero when the data observation is from other quartiles. This process is repeated for quartiles 3 and 4 dummy predictors. All three dummy predictors are included in the model, replacing the original predictor.

The regression model treats each dummy predictor as binary and compares it with the baseline reference. The researcher chose dummy encoding since it is easy to implement. However, the results can be challenging to interpret if the predictor has many groups (high cardinality) (Moeyersoms and Martens 2015).

Predictors can either be included in a model as a fixed or a random effect. A fixed effect assumes that the effect of each predictor on the outcome is constant for all observations (Hoffmann 2016). Table 7.3 illustrates two data characteristics that violate this assumption.

Table 7.3: Data Characteristics That Limit Fixed-Effects Use

Data Characteristic	Description (Hoffmann 2016)	Theoretical Example
Autocorrelation	Repeated measures from the same data subject may be associated with each other.	The number of DMRs provided by a pharmacy in 2020 could be related to the number it provided in 2019.
Panel data	Observations are clustered into distinct data subjects, across which the measurement of the outcome variable may vary systematically.	The recording of discrepancies could vary in different pharmacies.

These characteristics can be described as intra-subject variability, which, if unaccounted for, will cause inaccurate regression coefficients. Including the data subject as a random effect accounts for this variability by allowing coefficients to vary, in contrast to a fixed effect (Hoffmann 2016). For example, Green et al. (2020) included pharmacy ID as a random effect in a model describing drug misuse service provision over time to control for repeated measures. When researchers consider including a predictor as a random effect, they typically calculate the intra-class correlation (ICC), which expresses the extent of outcome variability across data subjects. ICC is

calculated by constructing a model with only the random effect and outcome, with values over 10% suggesting the random effect should be accepted (Huang 2018).

Interaction effects describe where a relationship between predictor and outcome is contingent on another predictor, e.g., if the effect of patient age on the number of identified discrepancies depended on the number of medicines prescribed (Field 2018). An interaction term combines these predictors to encompass these marginal effects.

Each predictor and interaction term has an associated regression coefficient, which describes its relationship with the outcome variable while controlling for other predictors' effects (Field 2018). Each coefficient has a corresponding value denoting statistical significance, either a p-value or a confidence interval.

7.2.2. Residuals

As with any statistical test, regression models are associated with inherent errors because they approximate a complex relationship between predictors and outcomes. Such errors between the regression model and the data are named residuals (Field 2018). Since models are never perfect, researchers often discuss the principle of parsimony: the simplest (fewest predictors) model that achieves the study's objectives should be selected (Box et al. 2005). Smaller models are easier to interpret and reduce the risk of overfitting (Vittinghoff et al. 2012).[25] Events per variable (EPV) is a rule-of-thumb to avoid overfitting that varies in the literature, stating that the ratio of the observations to predictors (and interaction terms) should not exceed between 10 and 50 (Vittinghoff et al. 2012). The researcher chose the conservative value of 50 to reduce the risks of overfitting and improve the interpretability of the models.

7.2.3. Link Function

The link function describes the relationship between the regression model's left- and right-hand sides (Vittinghoff et al. 2012). For example, linear regression uses a linear link function, whereas logistic regression uses a binomial link function (Field 2018). Although linear regression is the simplest model to interpret, it is also the most stringent, as the data must meet several assumptions (see Table 7.4).

[25]Overfitting describes where the model accounts for noise in the data rather than the variability explained by the predictors (Vittinghoff et al. 2012).

Table 7.4: Assumption Checks for Linear Regression

Regression Assumption	Description of Assumption	Checking Assumption	Consequences of Violation	Methods to Mitigate Violation
Absence of multicollinearity (Field 2018)	There should be minimal multicollinearity (correlation between predictors).	• Variance inflation factor (VIF) is a measure for each predictor that describes the degree of correlation with other predictors. • Johnston et al. (2018) describe various cut-offs for acceptable VIF values, including <10, <5 and <2.5. • Since the DMR data had many variables, which increases the risk of multicollinearity, the researcher chose the conservative value of <2.5.	P-values/confidence intervals are inaccurate for correlated predictors.	Remove one of the correlated predictors.
Normal distribution of residuals† (Field 2018)	The regression residuals should approximately follow a normal distribution.	• Visualise whether the residuals follow a normal distribution using a quantile-quantile plot. • Quantile-quantile plots visualise the residuals vs the predicted quantiles of the residuals if they followed a normal distribution. • The plotted values should follow a normal distribution (diagonal line).	Regression coefficients will be inaccurate.	Using an alternative link function.
Homoscedasticity† (Field 2018)	Regression residuals should not vary by the value of the outcome variable.	• Scatterplot of residuals vs fitted values. • Residual variances should be consistent across all fitted values.	Regression coefficients will be inaccurate.	Data transformation of the outcome variable (commonly log transformation) or using an alternative link function.
Linear and additive relationships (Field 2018)	The relationship between predictor and outcome variables should be linear and additive.	• Scatterplot between predictor and outcome variable. • Plotted points following a straight line represent a linear and additive relationship.	Regression coefficients will be inaccurate.	Using an alternative link function.
Independence of observations (Vittinghoff et al. 2012)	Observations should be independent, e.g., not systematically correlated (see Section 7.2.1).	• Using domain-specific knowledge or knowledge of the data, researchers logically consider whether the data may be autocorrelated.	Regression coefficients will be inaccurate.	Include the data subject as a random effect.

†Regression residuals are calculated by first fitting a linear regression model with all predictors (and interactions).

Although researchers should avoid assumption violations, they should consider regression models holistically, weighing accuracy, parsimony, and the interpretability of the findings (Field 2018). A potential remedy to assumption violations is to use an alternative link function in a *generalised linear model* (GLM), summarised in Table 7.5 (Hoffmann 2016; Field 2018).

Table 7.5: Overview of Common Generalised Linear Models (GLMs)

Model Type	Suitability
Logistic regression	Suitable for binomial (yes/no) outcome variables.
Poisson regression	Suitable for data skewed towards zero. However, Poisson models assume equidispersion (variance = mean) of the outcome variable.
Zero-inflated Poisson regression	As above, but for zero-inflated data (a numerical variable with excessive zeroes relative to a normal distribution).
Negative binomial regression	Suitable for data skewed towards zero but does not assume equidispersion of the outcome variable.
Zero-inflated negative binomial regression	As above, but for zero-inflated data.
Hurdle model (logistic and negative binomial)†	Suitable for zero-inflated count data when the researcher suspects that the factors influencing the outcome variable being non-zero differ from those affecting its overall value.

†Hurdle regressions construct two consecutive models: a logistic regression model, which describes the factors affecting the likelihood of the outcome being over zero, and a negative binomial model describing the value of the outcome variable over zero (Hoffmann 2016).

Although using GLMs relaxes some assumptions from linear regression, the data should still lack multicollinearity, and observations should be independent (Hoffmann 2016).

7.3. Regression Model Construction Methods

Figure 7.2 provides an overview of regression model construction to guide the reader through this section.

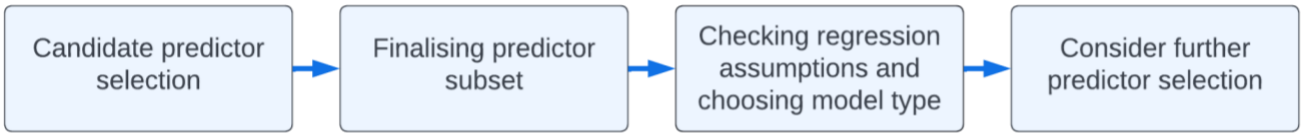


Figure 7.2: Process for Constructing Regression Models

7.3.1. Candidate Predictor Selection

The researcher did not aim to include all available DMR variables since they could make the model difficult to interpret or violate EPV (Heinze et al. 2018). Therefore, they aimed to use candidate predictor selection methods, which can be knowledge-driven using domain-specific knowledge or related literature, or data-driven, using characteristics of the datasets (Heinze et al. 2018).

7.3.1.1. Knowledge-Driven Candidate Predictor Selection

The researcher initially used domain-specific knowledge to choose all variables from the relevant DMR datasets that could be related to the outcome variable. Further predictors from external

datasets were considered if there was a theoretical basis for their relationship with community pharmacy service volume or discrepancies (Heinze et al. 2018), e.g., the number of Medicines Use Reviews (MURs) provided by the pharmacy.

7.3.1.2. Data-Driven Candidate Predictor Selection Methods

A common data-driven method for predictor selection is to complete univariate statistical tests (e.g., ANOVA) between each potential candidate predictor and the outcome variable. Any variables with a statistically significant result from this test are included in the model (Heinze et al. 2018). Although this *univariate prefiltering* is simple to implement, including variables in a model based solely on its statistical significance can lead to inaccurate inferences because repeated statistical tests increase the probability of finding a statistically significant result by chance (Heinze et al. 2018). Therefore, the researcher followed recommendations by Chatterjee and Hadi (2012), using exploratory data analysis (EDA) to guide predictor selection, investigate interaction effects, and check regression assumptions. The employed EDA processes, using Microsoft Excel® and Stata® (v17), included univariate and bivariate data exploration.

Univariate data exploration describes several outcome variable characteristics, such as their central tendency (mean, mode and median) and spread (Komorowski et al. 2016). The researcher visualised these characteristics for numerical outcomes using a frequency distribution to provide information for subsequent regression model building. For example, heavily skewed data may be more suited to negative binomial rather than linear models (Vittinghoff et al. 2012). For the binomial outcome variable (item discrepancy occurrence), the proportion of items with a discrepancy was calculated (Komorowski et al. 2016).

The researcher visualised the bivariate relationship between DMR variables and the outcome variable and quantified their magnitude (effect size). From these investigations, the researcher chose any DMR variables that appear to influence the outcome variable as candidate predictors. If the EDA highlighted the presence of interaction effects, these were investigated and considered for inclusion as interaction terms. Figure 7.3 presents the specific EDA methods employed to explore these relationships, which are described in detail below (Schäfer and Schwarz 2019). These methods varied for binomial and numerical outcome variables.

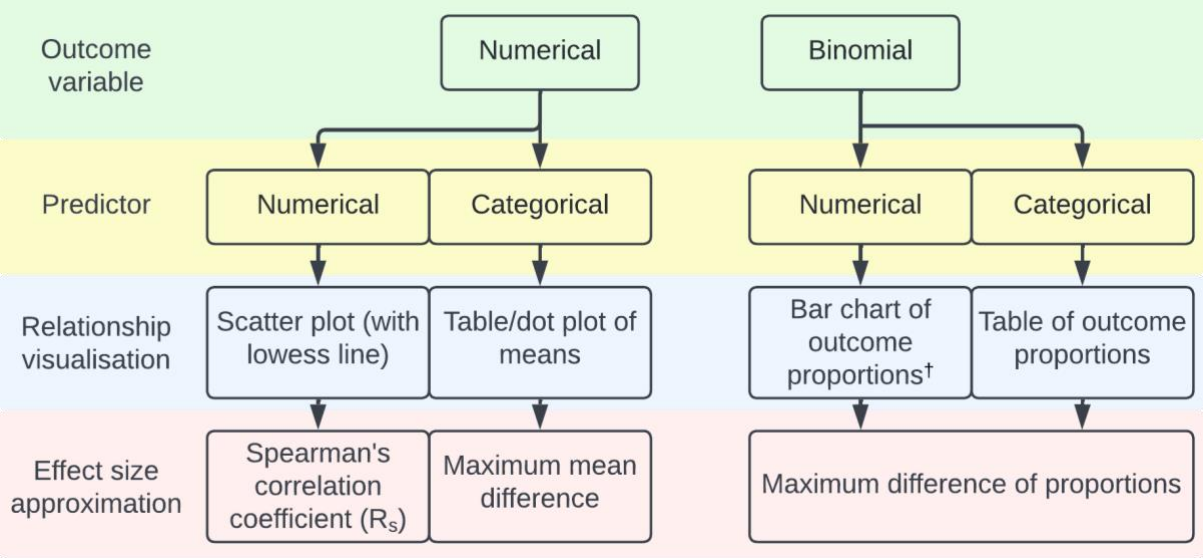


Figure 7.3: Summary of Exploratory Data Analysis (EDA) Bivariate Relationship Exploration
†Numerical predictors are categorised into groups.
Lowess= Locally weighted scatterplot smoothing.

7.3.1.2.1. Bivariate Relationship Exploration with Numerical Outcome Variables

Chapter 6 showed that the number of identified discrepancies and DMRs per pharmacy were skewed towards zero, characteristic of 'count data' (Hoffmann 2016). Although medians are more robust measures of central tendency for skewed data than means (Field 2018), the researcher chose a mean difference as the most appropriate effect size measure because the EDA aimed to inform regression analysis, which uses the mean (Vittinghoff et al. 2012). Although many researchers used standardised mean differences[26] to compare effect sizes across different outcome variables (Schäfer and Schwarz 2019), this was not required since a single outcome variable was to be used per chapter. Therefore, the researcher used the maximum mean difference due to the simplicity of its interpretation. The data were then tabulated for visualisation unless the predictor had high cardinality, which was instead visualised on a dot plot.

For numerical predictors, Spearman's correlation coefficient (Rs) was used to describe the effect size for bivariate relationships. Correlation coefficients range between -1 (perfect negative correlation) and 1 (perfect positive correlation), with 0 representing no relationship (Field 2018). Field (2018) describes that correlation coefficients of 0.1, 0.3, or 0.5 are weak, moderate, and strong relationships, respectively. Pearson's correlation coefficient represents the strength and direction of a linear relationship, whilst Rs describes a monotonic relationship (Field 2018). Chapter 6 showed that the number of DMRs and discrepancies skewed toward zero. Therefore, the researcher chose Rs because it is more suitable for non-normal data and their typical non-linear relationships (Field 2018). The researcher visualised relationships using scatterplots with an

[26]Cohen's d is a common standardised mean difference, representing group differences in terms of the number of standard deviation differences.

overlaid lowess line, a best-fit line commonly used to visualise scatterplot relationships (Vittinghoff et al. 2012). For example, a straight lowess line would indicate a linear relationship, whilst a curved line would suggest a curvilinear relationship. However, if the data points are distant from the line, it suggests a poor fit.

7.3.1.2.2. Bivariate Relationship Exploration with Binomial Outcome Variables

For binomial outcome variables, the researcher used the difference in proportion to approximate effect size (Vittinghoff et al. 2012). Numerical variables were categorised into discrete groups for this process to ensure large enough group sizes to avoid outliers that could skew the relationships. The data were tabulated or plotted on a bar chart to visualise proportion differences to compare across variable groups.

7.3.2. Finalising Predictor Subset

Once the researcher had selected candidate predictors using the EDA results, they considered whether any explained the same concept and would therefore be at risk of multicollinearity, thus violating a regression assumption. For example, including the 'contractor name' and 'pharmacy ID' in the same model may not be appropriate because they describe overlapping concepts created from the same data source (contractor ID). When there were multiple overlapping initial predictors, the researcher decided which of these was most appropriate to include. Table 7.6 summarises the rationale for these choices (Hosmer et al. 2013).

Table 7.6: Predictor Selection Considerations

Predictor Selection Consideration	Description
Cardinality	Including high cardinality categorical predictors in the model may violate EPV when dummy encoding. Additionally, interpreting the regression results would be challenging.
Explanatory power	The predictor with the most explanatory power (largest effect size) would be appropriate to choose.
Actionable results	In line with the principles of parsimony, the researcher considered that including predictors that could form actionable recommendations was more important than those that could not.

A further consideration for selecting the final predictor subset was the proportion of missing data (blank or N/A values). The two main methods for managing missing data are deletion and imputation (replacing the data entry with another value) (Thomas 2020). Imputation conserves more data than deletion, which can be essential for smaller datasets to conserve statistical power, which is dependent on sample size. However, such methods are resource-intensive and complex, with incorrect imputation methods biasing results (Thomas 2020). The researcher deleted rather than imputed missing values because data conservation was unnecessary since the DMR datasets were large [n=269,699 for the ChP medication dataset]. Specifically, listwise deletion (delete the

whole entry) was chosen because it has a lower bias risk than pairwise, which can generate inaccurate inferences (Thomas 2020). Since dataset entries were to be deleted to manage missing data, including predictors with lower proportions of missing data was preferable to those with larger proportions to preserve statistical power.

Once the researcher had selected the predictors, they considered how to include them in the model, considering random effects, choosing reference categories for dummy encoding and whether any further transformations would improve interpretability or model stability. Domain-specific knowledge and the EDA results informed these transformations (Hosmer et al. 2013). For numerical predictors with non-linear relationships with the outcome or where there was a considerable proportion of missing data, the researcher considered categorising data into discrete groups (Bennette and Vickers 2012). The researcher combined groups based on domain-specific knowledge (semantic grouping) for high cardinality categorical predictors. By reducing the number of groups before dummy encoding, the researcher reduced the resulting number of predictors, increasing interpretability and model stability, aligning with the principles of parsimony (Hosmer et al. 2013). Although this method reduces the number of groups to facilitate dummy encoding, there is an inherent risk of information loss and is contingent on a logical way to combine groups (Moeyersoms and Martens 2015).

KH and the researcher independently chose the predictors and agreed on the final subset before proceeding to the next stage, checking regression assumptions, and selecting the model type.

7.3.3. Checking Regression Assumptions and Choosing Model Type

The researcher first checked the data for multicollinearity, described by predictors with variation inflation factor (VIF)>2.5. If the data violated this assumption, correlated predictors were removed, and the VIF was calculated again to ensure the multicollinearity had resolved. The researcher checked linear regression assumptions for numerical outcome variables since it is the simplest model to interpret (Field 2018). They considered GLMs if the data violated any linear regression assumptions, then chose the most appropriate by constructing a model for each and comparing their goodness of fit. Table 7.7 describes several goodness of fit tests, all of which describe how well the model fits the data (Field 2018).

Table 7.7: Goodness of Fit Tests

Goodness of Fit Test	Description	Interpretation
R^2 (coefficient of determination)	Describes the proportion of the outcome variability explained by the model. R^2 is only applicable to linear models.	Values of 1 and 0 represent a perfect fit and no fit, respectively.
Pseudo R^2	An alternative test for R^2, which is suitable for GLMs.	Larger values indicate better model fit. Hosmer et al. (2013) suggest that 0.2 to 0.4 indicates a good fit.
Akaike Information Criterion (AIC)	Describes the outcome variability explained by the model but penalises for an increasing number of predictors. The AIC is suitable for any model type.	It cannot be used to assess goodness of fit objectively but can be used to compare between models. Smaller values indicate better model parsimony.
Bayesian Information Criterion (BIC)	As for AIC but it penalises more for an increasing number of predictors.	

The researcher chose BIC as the most appropriate test to choose between model types since it penalises larger models, optimising model parsimony.

7.3.4. Considerations for Further Predictor Selection

Despite the above processes to select candidate predictors, big datasets may still contain too many predictors concerning interpretability or their Events Per Variable (EPV). The researcher considered whether further predictor selection was needed for interpretability and calculated the EPV, carrying forward all candidate predictors to the next stage of regression modelling if there were no issues. All predictor selection processes are associated with biased results, but larger EPV datasets mitigate this effect (Hosmer et al. 2013). Table 7.8 details common predictor selection methods. Since interaction terms were preselected, the researcher added them after these predictor selection processes (details of this are provided in Chapters 8 and 9).

Table 7.8: Further Predictor Selection Methods

Selection Method	Starting Predictors	Iterative Model Development	Model Stopping Criteria
Forwards stepwise (Field 2018)	Starts with no predictors.	The predictor with the smallest p-value† is added to the model.	Stopped when all statistically significant predictors† have been included.
Backwards stepwise (Field 2018)	Selected by univariate prefiltering (see Section 7.3.1.2).	The predictor with the largest model p-value is removed.	Stopped when all statistically non-significant predictors have been removed.
Purposive (Hosmer et al. 2013)		The predictor with the largest p-value is removed from the model and excluded from future iterations if the change-in-estimate†† for other predictors was less than 20%.	Stopped when all statistically non-significant predictors have been removed, except those whose removal changes any other regression coefficient (change-in-estimate) by more than 20%.
Augmented backwards (Dunkler et al. 2014)	Chosen by knowledge-based criteria or EDA.		

†Determined through univariate testing between each predictor and the outcome variable.

Although stepwise and purposive selection methods using significance criteria can be easily automated, the researcher excluded them since they have similar inference inaccuracy to

univariate prefiltering (Hosmer et al. 2013). Therefore, they chose augmented backwards selection for further predictor selection to maintain inference accuracy and to ensure confounding effects were considered. To confirm improvement in model parsimony across model iterations, the researcher calculated BIC and chose the model subset with the smallest value. Once the researcher had finalised the predictors, they added interaction terms in a preliminary model but only retained them if they were statistically significant (determined using the 95% confidence interval), in keeping with the principles of parsimony.

7.4. Interpreting Results

Regression results can be grouped into test statistics and regression coefficients. Test statistics describe how well the model fits the data, and regression coefficients represent the relationship between each predictor and the outcome (Field 2018). Since regression coefficients can be challenging to interpret for GLMs, researchers often present them as risk ratios. Table 7.9 describes regression test statistics and risk ratios with their interpretation (Vittinghoff et al. 2012).

Table 7.9: Regression Test Statistics and Coefficients

Test Statistic	**Model Type**	**Interpretation**
F-statistic	Linear	A statistically significant finding demonstrates that the model fits the data better than the null model (no predictors).
Chi-square probability	All models	
Chi-square likelihood ratio	Mixed-effects model (contains fixed and random effects)	A statistically significant finding demonstrates that the random effect improves model fit.
R^2	Linear	Provides objective information on model goodness of fit (see Table 7.7).
Pseudo-R^2	All models	
Risk Ratios	**Model Type**	**Interpretation**
Odds ratio	Logistic	A value of 2 describes doubled odds of the outcome for each unit increase of the predictor, whilst a value of 0.5 describes halved odds (1 describes no effect).
Incidence rate ratio	Linear, Poisson and negative binomial	As above, but incidence rate instead of odds.
Marginal mean	All models	A value of 20 describes a predicted mean increase of 20 for each unit increase of the predictor, whilst a value of 0 describes no effect.

The Chapter 8 and 9 regression models results will include relevant test statistics and risk ratios. Since odds and incidence rate ratios describe the average effect of numerical predictors on the outcome, the researcher also plotted marginal mean values on graphs to visualise their effect accurately (Field 2018).

7.5. Chapter Summary

This chapter provided an overview of the multistage regression approach employed in Chapters 8 and 9. These chapters address Thesis Objectives 4 and 5, describing factors affecting DMR volume and discrepancy identification, respectively.

Chapter 8. Describing the Pharmacy Characteristics Affecting DMR Delivery Volume

8.1. Chapter Introduction

This chapter describes the pharmacy-related factors affecting DMR volume over time (Thesis Objective 4) using the regression analysis approach presented in Chapter 7. By understanding these factors, a strategy can be developed to optimise DMR uptake across Wales and, if necessary, target pharmacies with characteristics associated with lower service volume.

8.2. Chapter 8 Methods Overview

The pharmacy dataset was used to describe the pharmacy-related factors affecting DMR volume over time, with the annual number of DMR1s per pharmacy as the numerical outcome variable. This dataset contained monthly services data (from April 2012 to January 2021) for all DMR-registered pharmacies in Wales, including those that had not provided DMRs. The researcher combined monthly entries for each pharmacy in this dataset into annual data to create the annual number of DMRs outcome variable. Table 8.1 summarises that characteristics of these data that could confound the results. The researcher removed these data; therefore, the final dataset included the 702 DMR-registered pharmacies in Wales open from 2013 through 2019.

Table 8.1: Potential Chapter 8 Data Issues

Potential Data Issue	Data Affected	Description of Confounding
Some pharmacies were not open for the whole data period	Ten pharmacies	These pharmacies would not have had the opportunity to provide as many DMRs as others, potentially confounding the results.
Partial years of data	2012 and 2021	The pharmacy dataset data did not capture the entire years for 2012 and 2021.
Covid-19 pandemic	2020 and 2021	Specific effects on DMR provision created by the Covid-19 pandemic may confound results, limiting their generalisability.

The regression coefficients for each predictor, chosen in the following section, describe the factors affecting DMR1 volume. To describe the change in these factors over time, the researcher included the year (numerical) as a predictor and considered including interaction terms between the year and other predictors (Vittinghoff et al. 2012). These year interaction terms described the marginal change in predictor effect size over time and whether that change was statistically significant.

The following subsections describe the choices employed to complete this chapter's regression analysis, following the processes outlined in Section 7.3: candidate predictor selection, finalising predictor subset, checking regression assumptions and choosing the model type, and considerations for further predictor selection.

8.3. Candidate Predictor Selection

Initial candidate predictor selection was based on knowledge-driven approaches, which were further assessed using exploratory data analysis (EDA) (data-driven approach).

8.3.1. Knowledge-Driven Predictor Selection

For this chapter, the researcher used literature to identify pharmacy-related predictors in the pharmacy dataset that have evidence to show they may influence community pharmacy service provision (Table 8.2).

Table 8.2: Knowledge-Driven Predictor Selection for Chapter 8 With Rationale

Variable	Rationale
Contractor name†	• Organisational factors such as pharmacy type influence the provision of community pharmacy services (Hodson et al. 2014a; Hann et al. 2017).
Pharmacy type	
Pharmacy rural-urban classification	• Bradley et al. (2008) concluded that rurality and increasing social deprivation reduced Medicines Use Review (MUR) delivery volume.
Social deprivation quartile	
Pharmacy co-location status	• Bollen et al. (2019) described that the physical distance between GP surgeries and pharmacies influences collaboration. • The working relationship between community pharmacists and GPs influences service provision (Moecker et al. 2021). • The researcher defined a co-located pharmacy as one within 150 yards of a GP surgery (see Section 5.4.3.1.4).
The annual number of MURs	• Diffusion of innovations theory suggests that organisations follow one of several adoption patterns of new practices: innovators, early adopters, late adopters, and laggards (Makowsky et al. 2013). • The researcher included other pharmacy service provisions as variables, theorising that the uptake of the DMR may be associated with the uptake of other services. • The Common Ailments Scheme was not included because it was commissioned in 2014; therefore, it did not apply to 2013 data.
The annual number of Seasonal Flu Vaccination services (SFVs)	
The annual number of Emergency Hormonal Contraception services (EHCs)	
The annual number of prescription forms and items	• The number of dispensed prescription forms and items are associated with the number of MURs and New Medicines Services (NMSs) (Bradley et al. 2008; Hann et al. 2017).

†The contractor's name (e.g., Boots) refers to the pharmacy owner rather than a specific pharmacy premises. However, for anonymity, these names were replaced with numbers (e.g., Contractor 150).

Section 5.4 presented extensive transformations of the DMR data to prepare it for analysis. However, further transformations were warranted (Table 8.3) since this chapter used a different dataset (pharmacy dataset) and because further data characteristics were unveiled in the description of the DMR data in Chapter 6. The researcher explored transformed variables alongside the original variables to determine which to include in the regression model.

Table 8.3: Chapter 8 Variable Transformation Processes

Variable	Variable Groups	Transformed Groups	Transformed Variable Name	Rationale for Transformation
The annual number of MURs, EHCs and SFVs	Numerical	No services provided	Dichotomised MUR, EHC and SFV provision	• The annual number of services is 'count data', which are often skewed and challenging to include in regression models (Hoffmann 2016).
		At least one service provided		
		Number of additional available services (0-3)		• To further explore the relationship between service-related predictors and the number of DMRs.
Rural-urban classification	City and town	Urban	Dichotomised rural-urban classification	• Section 6.3.4 outlined that some rural-urban classifications (villages) and pharmacy types (supermarkets) had provided few DMRs. • Small predictor group sizes can be challenging to interpret and limit statistical power (Vittinghoff et al. 2012). • Hann et al. (2017) used dichotomised rural-urban classification and pharmacy type when describing pharmacy service volume determinants.
	Town and fringe	Rural		
	Villages			
Pharmacy type	Large-sized multiple	Multiple	Dichotomised pharmacy type	
	Medium-sized multiple			
	Supermarket			
	Small chain	Non-multiple		
	Independent			
Number of prescription items	Numerical	Number of prescription items/1000 (divided by 1000)		• The number of prescription items was large (up to 400,000), which would generate small regression coefficients, which would be difficult to interpret. • Therefore, the researcher divided each value by 1000 to ease interpretation.

8.3.2. Exploratory Data Analysis (EDA)

Chapter 7 described how the researcher employed EDA to inform predictor and interaction term selection and check regression assumptions. There were no missing data in the dataset; therefore, the researcher did not consider missing data management. Since this chapter's outcome variable was numerical, it was explored using summary statistics.

Figure 8.1 summarises this chapter's methods for exploring bivariate relationships. The rationale for these choices is explained in Section 7.3.1.2.2. Differences in effect size (maximum mean difference and Spearman's correlation coefficient [R_S]) were calculated between 2013 and 2019 to explore changes in influencing factors over time. These calculations informed the inclusion of year interaction terms in the model. Therefore, data are presented for 2013 and 2019, respectively, to calculate changes over time and all years (2013 to 2019) to calculate the overall effect size.

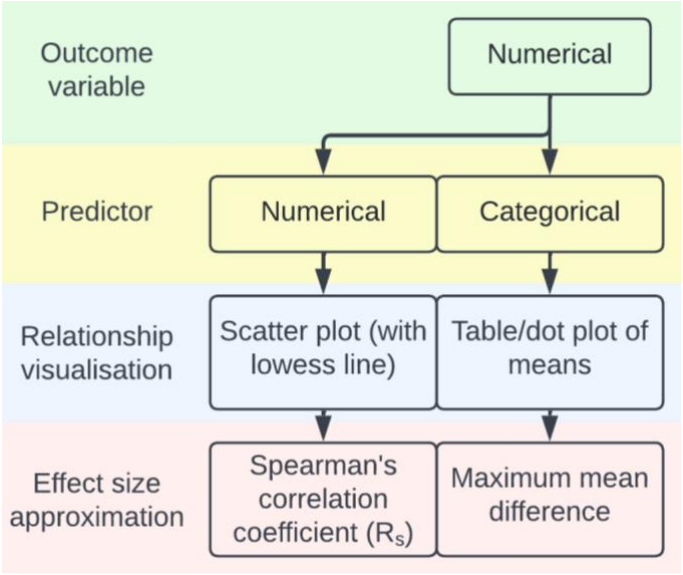


Figure 8.1: Chapter 8 Exploratory Data Analysis (EDA) Bivariate Relationship Exploration
Lowess = Locally weighted scatterplot smoothing.
Maximum mean difference = the maximum difference in mean values between groups.

8.3.2.1. Univariate Data Exploration of Outcome Variable

Table 8.4 describes summary statistics for all years of data and the difference over time. The number of DMRs was heavily skewed, indicated by a larger mean than the median and a mode of zero. The mean and median number of DMRs increased over time, as did the inter-pharmacy variability illustrated by the increased standard deviation and interquartile range.

Table 8.4: Summary Statistics for the Number of DMRs per Pharmacy

Summary Statistics	**Number of DMRs**			**Difference Over Time (2019-2013)**
	All Years [n=4,914]	**2013 Only [n=702]**	**2019 Only [n=702]**	
Mean	13.52	11.34	17.23	+5.89
Mode	0	0	0	0
Median	4	2	7	+5
Standard deviation	23.99	19.72	26.83	N/A
Minimum/maximum	0/220	0/167	0/189	0/+22
Interquartile range	16	15	20	+5

Most pharmacies provided no DMRs in 2013 and 2019, a data pattern known as zero inflation, which is common in count data and often violates linear regression assumptions such as linearity of relationships and homoscedasticity (Vittinghoff et al. 2012). Therefore, the researcher considered alternative link functions in generalised linear models (GLMs) more suitable for count data, such as negative binomial and hurdle regression (see Section 7.2.3 for an overview of GLMs).

8.3.2.2. Bivariate Relationship Exploration

8.3.2.2.1. Contractor Name and Pharmacy Type

The mean number of DMRs varied between contractors, with a maximum mean difference of 95 for all DMRs. Although the predictor's approximate effect size is large, the notable cardinality (large number of contractors) may make it unsuitable for inclusion in the regression model.

Specifically, 197 predictors would be generated from dummy encoding of the 'contractor name' variable, making the results challenging to interpret (see Section 7.2.1 for details of dummy encoding).

The maximum mean difference between contractors was 121 in 2013 and 173 in 2019, which Figure 8.2 visualises in dot plots, with each dot representing a contractor's mean number of DMRs. Since the maximum mean difference increased (+52) over time, the researcher considered including a year interaction term for this variable.

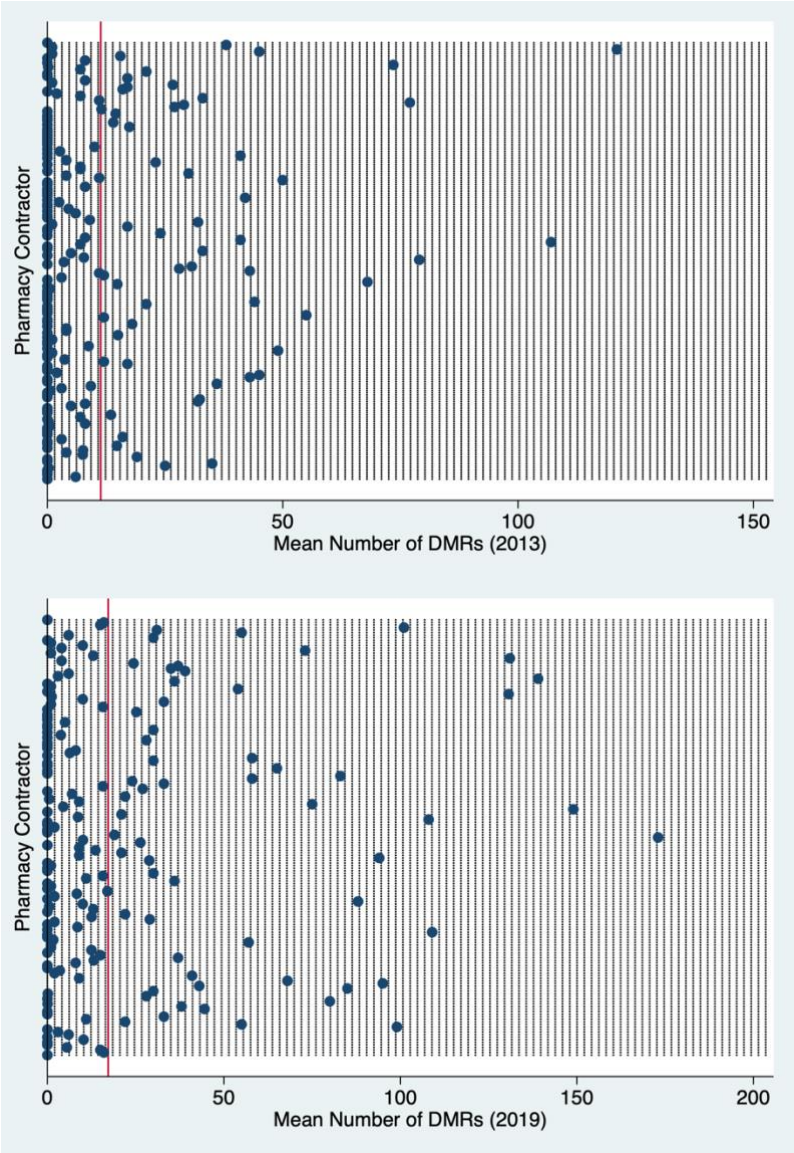


Figure 8.2: Dot Plot Showing the Mean Number of DMRs per Contractor (2013 and 2019) and the Population Mean (Red Line)

Table 8.5 describes the mean number of DMRs by pharmacy type over time. DMR provision varied by pharmacy type, with small chains providing the most per pharmacy on average. In 2013, independent pharmacies had the greatest mean, but small chain pharmacies had a greater increase over time and therefore had the largest mean number in 2019. Non-multiple pharmacies consistently provided more DMRs over time, on average, than multiples. Although the

dichotomised variable had a smaller effect size, it may be more suitable for inclusion in the regression model because of its smaller number of groups, making it easier to interpret when dummy encoded. The maximum mean difference for pharmacy type increased over time, inferring a year interaction effect, which was considered for inclusion in the model.

Table 8.5: Mean Number of DMRs per Pharmacy Over Time by Pharmacy Type

Pharmacy Type	**Mean Number of DMRs per Pharmacy [Group Frequency]**			**Difference Over Time (2019-2013)**
	All Years [n=4,914]	**2013 Only [n=702]**	**2019 Only [n=702]**	
Small chain	15.55 [n=608]	11.74 [n=85]	23.14 [n=87]	+11.40
Independent	14.13 [n=796]	12.54 [n=126]	20.07 [n=105]	+7.53
Large-sized multiple	14.04 [n=2,902]	12.06 [n=407]	16.30 [n=418]	+4.24
Medium-sized multiple	10.92 [n=419]	8.19 [n=57]	14.94 [n=65]	+6.75
Supermarket†	2.12 [n=189]	0.37 [n=27]	6.93 [n=27]	+6.56
Maximum mean difference	13.43	12.17	16.21	+4.04
Dichotomised Pharmacy Type	**Mean Number of DMRs per Pharmacy [Group Frequency]**			**Difference Over Time (2019-2013)**
	All Years [n=4,914]	**2013 Only [n=702]**	**2019 Only [n=702]**	
Non-multiple (independent or small chain)	14.75 [n=1,404]	12.22 [n=211]	21.46 [n=192]	+9.24
Multiple (medium, large-sized multiples and supermarket)	13.03 [n=3,510]	10.97 [n=491]	15.63 [n=510]	+4.66
Maximum mean difference	1.72	1.25	5.83	+4.58

Maximum and minimum values in each column are coloured green and red, respectively.
†The mean could be skewed by the small group frequency.

8.3.2.2.2. Rural-Urban Classification

Table 8.6 presents the variation in the mean number of DMRs per pharmacy by rural-urban classification. On average, pharmacies in rural areas provided fewer DMRs than those in urban areas. Since the mean number of DMRs per pharmacy varied by rural-urban classification, the predictors were considered for inclusion in the model. The maximum mean difference for rural-urban classification increased over time; therefore, a year interaction term was included in the model.

Table 8.6: Mean Number of DMRs per Pharmacy Over Time by Rural-Urban Classification

Rural-Urban Classification	Mean Number of DMRs per Pharmacy [Group Frequency]			Difference Over Time (2019-2013)
	All Years [n=4,914]	2013 Only [n=702]	2019 Only [n=702]	
City and town (sparse)†	20.29 [n=126]	14.22 [n=18]	33.83 [n=18]	+19.61
City and town (not sparse)	13.70 [n=3,220]	11.52 [n=460]	17.71 [n=460]	+6.19
Town and fringe (sparse)	13.70 [n=686]	11.18 [n=98]	15.68 [n=98]	+4.50
Town and fringe (not sparse)	12.43 [n=686]	11.14 [n=98]	13.83 [n=98]	+2.69
Villages (sparse)†	10.16 [n=126]	6.78 [n=18]	16.72 [n=18]	+9.94
Villages (not sparse)†	8.00 [n=70]	9.70 [n=10]	14.40 [n=10]	+4.70
Maximum mean difference	12.29	7.44	20.00	+12.56
Dichotomised Rural-Urban Classification	**Mean Number of DMRs per Pharmacy [Group Frequency]**			**Difference Over Time (2019-2013)**
	All Years [n=4,914]	**2013 Only [n=702]**	**2019 Only [n=702]**	
Urban (city and town)	13.94 [n=1,568]	11.62 [n=478]	18.32 [n=478]	+6.70
Rural (town and fringe, or villages)	12.61 [n=3,346]	10.75 [n=224]	14.90 [n=224]	+4.15
Maximum mean difference	1.33	0.87	3.42	+2.55

Maximum and minimum values in each column are coloured green and red, respectively.
†The mean could be skewed by the small group frequency.

8.3.2.2.3. Social Deprivation Quartile and Co-location Status

Table 8.7 describes the mean number of DMRs per pharmacy by social deprivation quartile and co-location status. The mean number of DMRs varied by both variables; therefore, they were considered for inclusion as predictors.

Table 8.7: Mean Number of DMRs per Pharmacy Over Time by Social Deprivation and Co-location Status

Social Deprivation Quartile	Mean Number of DMRs per Pharmacy [Group Frequency]			Difference Over Time (2019-2013)
	All Years [n=4,914]	2013 Only [n=702]	2019 Only [n=702]	
Quartile 3	14.15 [n=1,443]	12.25 [n=206]	18.59 [n=206]	+6.34
Quartile 2	13.80 [n=1,512]	10.63 [n=216]	16.76 [n=216]	+6.13
Quartile 1 (most deprived)	13.35 [n=1,301]	11.69 [n=186]	16.77 [n=186]	+5.08
Quartile 4 (least deprived)	11.81 [n=658]	10.29 [n=94]	16.20 [n=94]	+5.91
Maximum mean difference	2.34	1.96	2.39	+0.43
Co-location Status	**Mean Number of DMRs per Pharmacy [Group Frequency]**			**Difference Over Time (2019-2013)**
	All Years [n=4,914]	**2013 Only [n=702]**	**2019 Only [n=702]**	
Co-located	14.14 [n=3,122]	12.80 [n=251]	18.52 [n=259]	+5.72
Not co-located	13.16 [n=1,792]	10.53 [n=451]	16.47 [n=443]	+5.94
Maximum mean difference	0.98	2.27	2.05	-0.22

Maximum and minimum values in each column are coloured green and red, respectively.

Although DMR volume was smallest on average for pharmacies in the least deprived quartile, it was not the largest for the most deprived quartile. The mean number of DMRs increased over time for all quartiles, as did the variable maximum mean difference. In contrast, the effect size for co-location status decreased over time. Therefore, the researcher considered including year interaction terms for each predictor.

8.3.2.2.4. Number of Prescription Forms and Items

Figure 8.3 presents scatterplots with lowess lines to visualise the relationships between the number of DMRs (all DMRs) and the number of prescription forms and items, respectively. The R_S values indicated weak positive relationships for both variables, and the lowess line indicated these relationships were approximately linear (straight lines), suggesting that the data may be suitable for a linear regression model. However, the considerable data distribution around the line indicated notable variability from the linear relationship. The researcher considered including the number of prescription items rather than the number of forms because the effect size was larger.

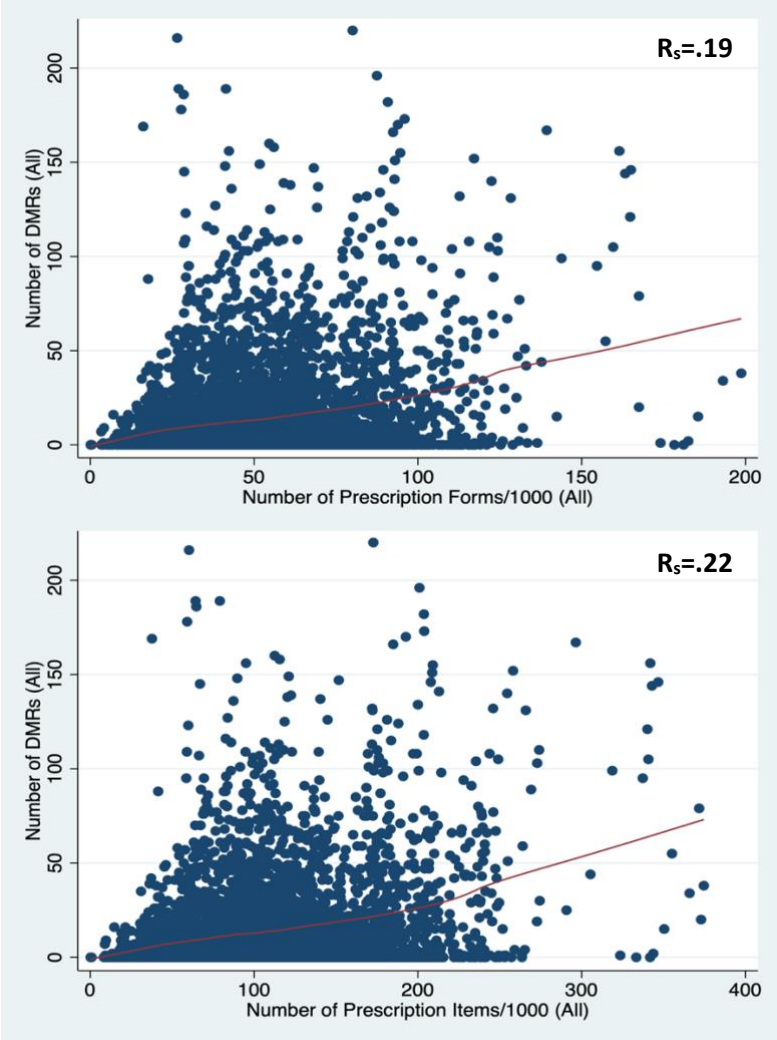


Figure 8.3: Scatter Plots Showing the Relationship Between the Number of Prescription Forms and Items (/1000), and the Number of DMRs (All Years)

The effect size did not change over time for prescription forms (R_S = 0.16 for 2013 and 2019), but there was a minimal change for prescription items, which increased from 0.18 in 2013 to 0.19 in 2019 (+0.01).[27] Therefore, the researcher considered including a year interaction term for prescription items.

[27]See Appendix 8.3 for the scatter plots for 2013 and 2019 data.

8.3.2.2.5. Provision of Other Services

Table 8.8 presents the mean number of DMRs for the dichotomised service variables. Since each variable appeared to affect the mean number of DMRs provided, the researcher considered them all suitable for inclusion as predictors. Pharmacies providing these services were consistently associated with greater average DMR volume than those which did not. In 2013, the MUR provision had the largest effect on DMR volume, whilst in 2019, the EHC provision did. Those pharmacies that provided no MURs or SFVs saw greater mean increases from 2013 to 2019 than those that had provided at least one service. There were notable changes in effect size over time, necessitating the inclusion of year interaction terms with these variables.

Table 8.8: Mean Number of DMRs by Dichotomised Service Provision

MUR Provision	**Mean Number of DMRs [Group Frequency]**			**Difference Over Time (2019-2013)**
	All Years [n=4,914]	**2013 Only [n=702]**	**2019 Only [n=702]**	
At least one MUR	14.19 [n=4,629]	12.28 [n=643]	17.31 [n=680]	+5.03
No MURs†	2.59 [n=285]	1.15 [n=59]	14.68 [n=22]	+13.53
Maximum mean difference	11.60	11.13	2.63	-8.50
SFV Provision	**Mean Number of DMRs [Group Frequency]**			**Difference Over Time (2019-2013)**
	All Years [n=4,914]	**2013 Only [n=702]**	**2019 Only [n=702]**	
At least one SFV	16.63 [n=2,814]	16.37 [n=200]	17.59 [n=589]	+1.22
No SFVs	9.34 [n=2,100]	9.34 [n=502]	15.63 [n=113]	+6.29
Maximum mean difference	7.29	7.03	1.96	-5.07
EHC Provision	**Mean Number of DMRs [Group Frequency]**			**Difference Over Time (2019-2013)**
	All Years [n=4,914]	**2013 Only [n=702]**	**2019 Only [n=702]**	
At least one EHC	16.02 [n=3,736]	14.21 [n=486]	18.82 [n=589]	+4.61
No EHCs	5.58 [n=1,178]	4.90 [n=216]	8.92 [n=113]	+4.02
Maximum mean difference	10.44	9.31	9.90	+0.59

Maximum and minimum values in each column are coloured green and red, respectively.
†The mean could be skewed by the small group frequency, which decreased over time.

Figure 8.4 visualises the relationship between the number of additional services and DMRs. The relationship appeared approximately linear, which the R_s indicated as moderate strength. Therefore, the researcher considered including the number of additional services as a predictor. The R_s decreased from 0.38 in 2013 to 0.22 in 2019 (-0.16), supporting the inclusion of a year interaction term.[28]

[28]See Appendix 8.4 for the scatter plots for 2013 and 2019 data.

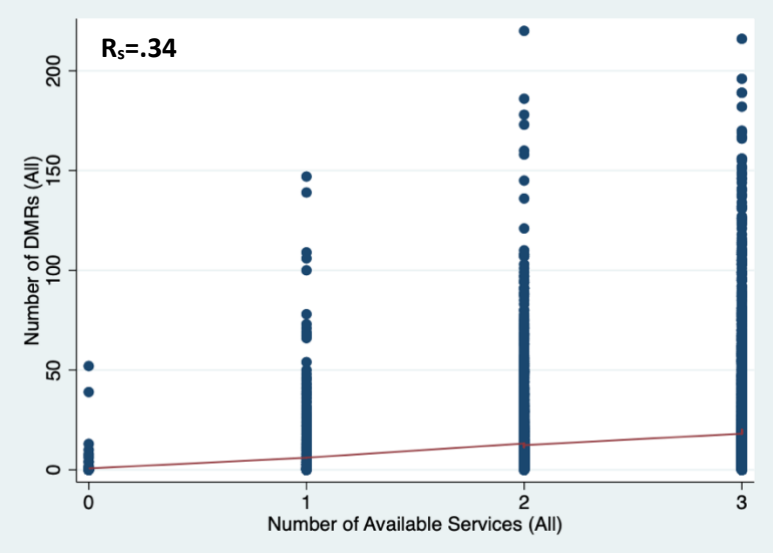


Figure 8.4: Scatter Plot Approximating the Relationship Between the Number of Additional Services and DMRs (All Years)

Figure 8.5 presents a scatterplot with a lowess line to approximate the relationship between the annual number of MURs and DMRs per pharmacy (all DMRs). The R_s indicated a moderate strength relationship; therefore, the researcher considered including the number of MURs as a predictor. Furthermore, the lowess line appears approximately linear, suggesting the number of MURs may be suitable for inclusion in a linear regression model. The R_s value decreased from 0.34 in 2013 to 0.28 in 2019 (-0.06), supporting the inclusion of a year interaction term.[28]

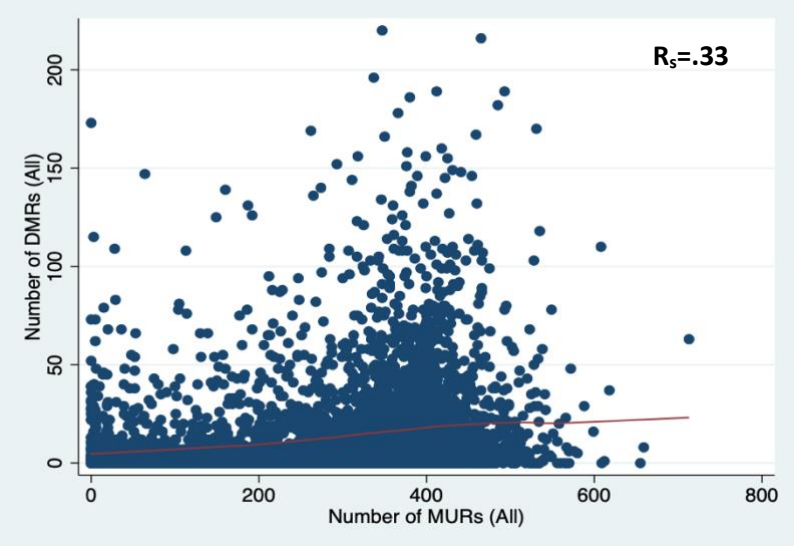


Figure 8.5: Scatter Plot Approximating the Relationship Between the Number of MURs and DMRs (All Years)

Figure 8.6 presents a scatterplot to visualise the relationship between the number of SFVs and DMRs. The R_s value indicated a weak positive relationship, supporting the inclusion of the number of SFVs as a predictor.

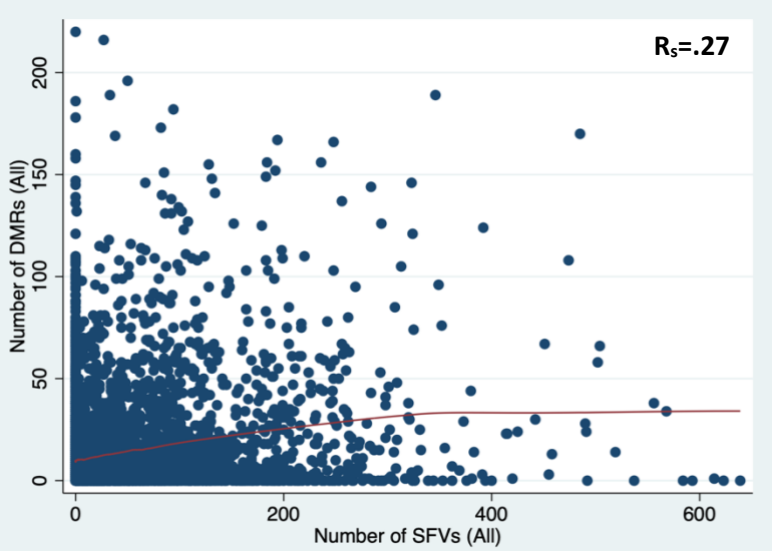


Figure 8.6: Scatter Plot Approximating the Relationship Between the Number of SFVs and DMRs (All Years)

However, the lowess line appears non-linear with an initial increase followed by an apparent plateau, likely caused by the presence of zero-inflation. Therefore, the number of SFVs may be difficult to include in a linear regression model, requiring consideration of transformations or alternative link functions in a GLM. The R_s values decreased slightly over time, from 0.21 in 2013 to 0.20 in 2019 (-0.01).[29] However, the larger R_s value for the data from all years suggests that the relationship was stronger between 2013 and 2019. Therefore, the researcher considered including a year interaction term.

Figure 8.7 presents the relationship between the number of DMRs and the number of EHCs, which appears complex showing an initial positive relationship followed by a plateau.

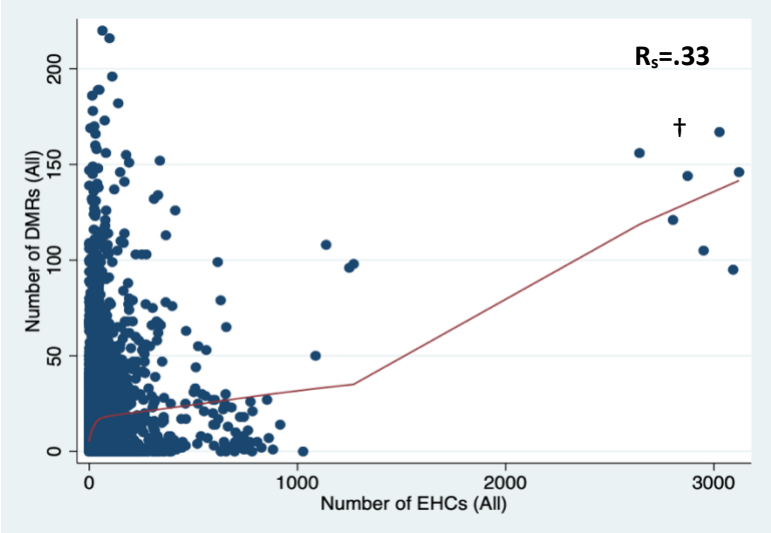


Figure 8.7: Scatter Plot Approximating the Relationship Between the Number of EHCs and DMRs (All Years)
†Influential point(s)

[29]See Appendix 8.5 for the scatter plots for 2013 and 2019 data.

A cluster of influential points corresponds with a single pharmacy that provided many EHCs. These points created a further positive relationship after the plateau. A considerable distribution of points around the lowess line suggests it is a poor predictor of the relationship. However, the R_s suggests a moderate strength relationship, supporting the inclusion of the number of EHCs as a predictor. However, the notable zero-inflation and presence of outliers would make including the variable in a linear model challenging.

Similar to the scatter plots for all years, the relationships for 2013 and 2019 were also complex, further evidencing the need to consider GLMs. The R_s weakened from 0.35 in 2013 to 0.26 in 2019 (-0.09), supporting the inclusion of the year interaction term.[29]

8.3.3. Summary of Candidate Predictor Selection

Although the magnitudes of some effect sizes were small, the researcher considered all variables suitable for inclusion as predictors since they may have confounding effects unaccounted for by the EDA. Furthermore, year interaction terms were included for all predictors since their effect sizes changed over time. Table 8.9 summarises these findings (all years) from the EDA.

Table 8.9: Summary of Relationships Between Predictors and the Number of DMRs (All Years)

Categorical Predictor [Number of Groups]	**Group With Minimum Mean Number of DMRs**	**Group With Maximum Mean Number of DMRs**	**Effect Size (Maximum Mean Difference)**	**Change in Effect Size Over Time (2019-2013)**
Contractor name† [n=198]	Forty contractors had a mean number of DMRs of zero, e.g., Contractor 138.	Contractor 300	95.00	52.00
Pharmacy type [n=5]	Supermarket	Small chain	13.43	4.04
Rural-urban classification [n=6]	Villages (not sparse)	City and town (sparse)	12.29	12.56
MUR provision [n=2]	No MURs	At least one MUR	11.60	-8.50
EHC provision [n=2]	No EHCs	At least one EHC	10.43	0.59
SFV provision [n=2]	No SFVs	At least one SFV	7.29	-5.07
Social deprivation quartile [n=4]	Quartile 4	Quartile 3	2.33	0.43
Dichotomised rural-urban classification [n=2]	Rural	Urban	1.34	2.55
Dichotomised pharmacy type [n=2]	Multiple	Non-multiple	1.72	4.58
Co-location status [n=2]	Not co-located	Co-located	0.99	-0.22
Numerical Predictor	**Nature of Relationship**		**Effect Size (Spearman's Correlation Coefficient [R_s])**	**Change in Effect Size Over Time (2019-2013)**
Number of additional services	Positive, approximately linear relationship.		0.34	-0.16
Number of MURs	Positive, approximately linear relationship.		0.33	-0.06
Number of EHCs	Non-linear, complex relationship with a rapid increase followed by a slower increase at approximately EHC=50. Then a plateau followed by a rapid increase at approximately EHC=1300 due to a cluster of influential points.		0.33	-0.09
Number of SFVs	Positive, approximately linear relationship until approximately SFV=350, where it appears to plateau.		0.27	-0.01
Number of prescription items/1000	Positive, approximately linear relationship.		0.22	0.01
Number of prescription forms/1000	Positive, approximately linear relationship.		0.19	0.00

Maximum and minimum values in each column are coloured green and red, respectively.

†Anonymous contractor numbers were assigned to preserve their identity (see Table 5.5).

8.4. Finalising Predictor Subset

Table 8.10 describes the researcher's choices from overlapping predictors (see Section 7.3.2), a process undertaken to avoid multicollinearity and construct a parsimonious model. Since each of the chosen predictor's effect sizes changed over time, all the year interaction terms were included.

Table 8.10: Chapter 8 Choice of Overlapping Predictors

Predictor Descriptor	Considered Predictors	Rationale
Organisational characteristics	Contractor name	• 'Contractor name' described the most variability since it had the largest effect size. However, as there was high cardinality, dummy encoding would not be easy to interpret. • Although dichotomising a predictor sacrifices information, the researcher chose the dichotomised pharmacy type because dummy encoding would generate fewer predictors, making the model easier to interpret.
	Pharmacy type	
	Dichotomised pharmacy type	
Rural-urban classification	Rural-urban classification	• Some rural-urban classifications had few pharmacies; therefore, there would be minimal data loss through dichotomisation whilst requiring fewer predictors.
	Dichotomised rural-urban classification	
EHC provision	Number of EHCs	• The relationship between the number of EHCs and DMRs was complex, with many zero values for both services, and the lowess lines do not appear to describe the relationship well. • The researcher chose the dichotomised predictors because including the number of EHCs in the regression model would be challenging.
	Dichotomised EHC provision	
SFV provision	Number of SFVs	• Rationale as per EHC provision variables.
	Dichotomised SFV provision	
MUR provision	Number of MURs	• In contrast to EHC and SFV, the relationship was clear and should be simple to include in models.
	Dichotomised MUR provision	
Prescription dispensing	Number of prescription items/1000	• Relationships were visually similar, but prescription items had a larger correlation coefficient, suggesting a stronger relationship with the number of DMRs.
	Number of prescription forms/1000	

The chosen predictors are coloured yellow.

Table 8.11 describes the researcher's chosen reference categories for the dummy encoding of categorical predictors.

Table 8.11: Reference Categories for Predictor Dummy Encoding

Predictor	Reference Category	Rationale
Dichotomised rural-urban classification	Urban	Larger group sizes and ease of interpretation
Dichotomised pharmacy type	Multiple	
Social deprivation quartile	Quartile 1 (most deprived)	Ease of interpretation
Co-location status	Not co-located	
Dichotomised EHC provision	No EHCs provided	
Dichotomised SFV provision	No SFVs provided	

8.5. Checking Regression Assumptions and Choosing Model Type

After selecting the predictor subset to include in the model, the next stage was to check the data for linear regression assumptions. These assumptions included the independence of observations, multicollinearity, homoscedasticity, normal distribution of residuals, and linearity (Field 2018).

One issue with analysing repeated measurement data, like the annual number of DMRs per pharmacy over time, is that it violates the independence of observations assumption. For example, the number of DMRs provided by a pharmacy in 2013 probably influences the number they provided in 2019. To account for this intra-subject variability, the researcher considered including the pharmacy ID as a random effect (see Section 7.2.1). The intra-class correlation (ICC)[30] for the pharmacy ID was calculated as 58.8%, supporting its inclusion as a random effect.

Table 8.12 presents each predictor's Variance Inflation Factor (VIF), a measure of multicollinearity. The number of available services, EHC provision and SFV provision were the only predictors with a VIF over 2.5, indicating multicollinearity.

Table 8.12: Predictor Variance Inflation Factors (VIFs)

Predictor	Group	Variance Inflation Factor (VIF)	Adjusted VIF†
Number of available services	N/A	18.0	N/A
EHC provision	EHC provided	6.6	1.2
SFV provision	SFV provided	7.9	1.4
Number of MURs	N/A	1.6	1.4
Dichotomised pharmacy type	Non-multiple	1.2	1.2
Dichotomised rural-urban classification	Rural	1.1	1.1
Co-location status	Co-located	1.1	1.1
Social deprivation quartile	Quartile 2	1.6	1.6
	Quartile 3	1.6	1.6
	Quartile 4	1.4	1.4
Number of years	N/A	1.2	1.2
Number of prescription items/1000	N/A	1.2	1.2

†Recalculated VIF value once the 'number of available services' predictor was removed.

The researcher removed the 'number of available services' predictor to rectify the multicollinearity since it was less informative than EHC and SFV provision. Once removed, all remaining predictors had a VIF under 2.5.

Figure 8.8 presents a residual vs fitted value plot to assess homoscedasticity and a quantile-quantile plot to evaluate the normality of residuals.

[30]ICC values describe the proportion of outcome variability accounted for by a predictor. ICC>10% indicates that the predictor should be included as a random effect (Huang 2018).

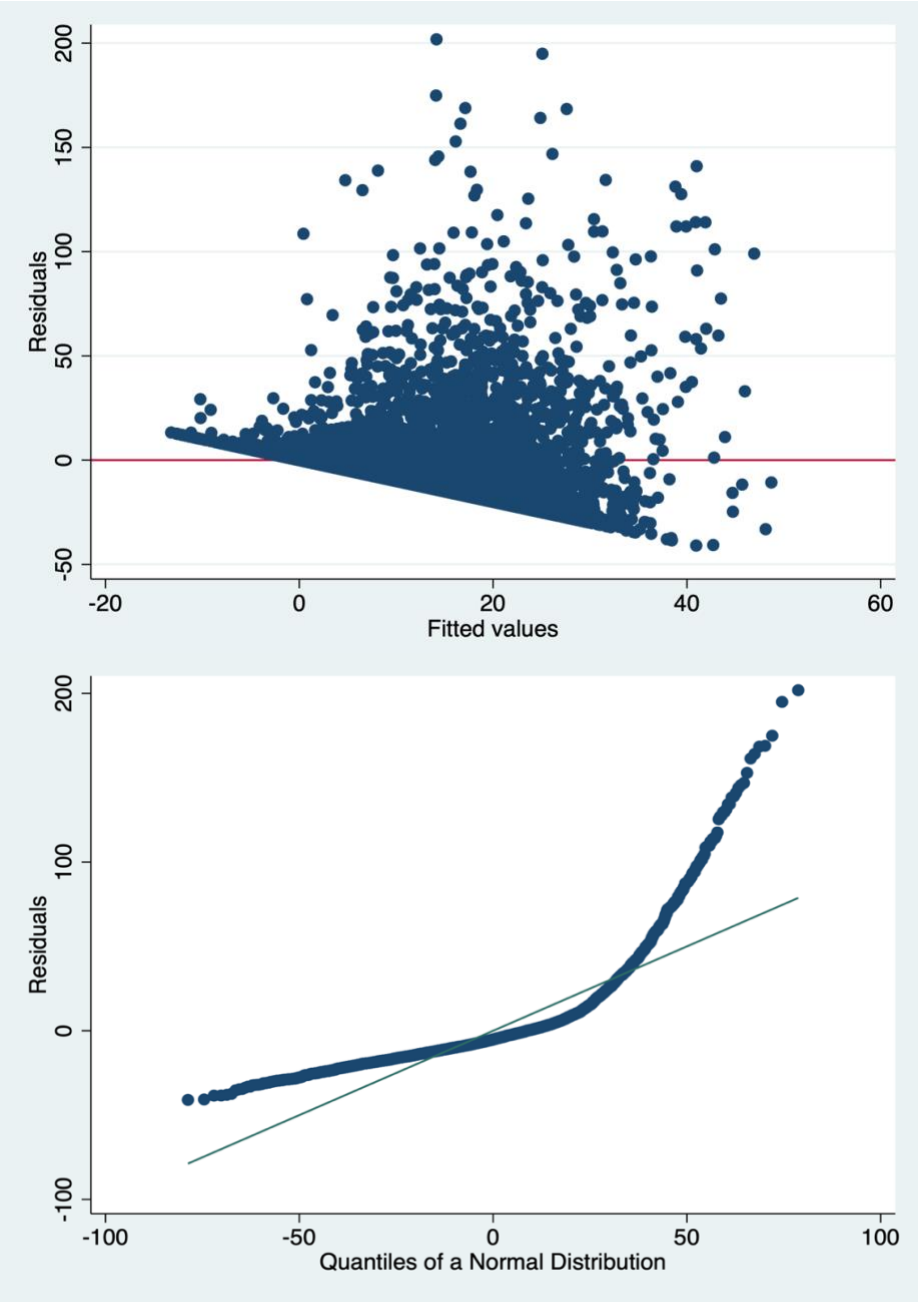


Figure 8.8: Residual and Quantile-Quantile Plots to Assess Homoscedasticity and Residual Uniformity

The plot of residuals vs fitted values demonstrated how the data violated the homoscedasticity linear regression assumption due to the increased variance of residuals over the range of fitted values, which can lead to inaccurate regression coefficients (see Section 7.2.2). Additionally, there were considerable deviations from residual normality (deviations from the diagonal line) in the quantile-quantile plot, especially for the largest and smallest residual values, a common feature of count data (Hoffmann 2016). A linear model using these data would poorly predict small and large numbers of DMRs due to the pattern of deviations.

The EDA results suggested that some predictors had non-linear relationships with the number of DMRs, violating the linear and additive assumption. Given the several violations of assumptions, the researcher decided that using an alternative link function in a GLM was more appropriate for

reliable results. Section 7.2.3 outlined several suitable GLMs for skewed count data, like the number of DMRs: Poisson, zero-inflated Poisson, negative binomial, zero-inflated negative binomial, and hurdle regressions. Poisson models were unsuitable because they assume equidispersion (variance = mean) of the outcome variable (Hoffmann 2016). Table 8.4 shows that the number of DMRs violates this assumption since the mean was smaller than the standard deviation, which is always smaller than the variance (Field 2018).

To decide between the remaining GLMs, the researcher constructed a model for each and calculated their fit using Bayesian Information Criteria (BIC). The BIC values for negative binomial, zero-inflated negative binomial, and hurdle models were 31,052, 25,606, and 24,991, respectively. Since the hurdle model had the smallest BIC value, indicating a better fit, the researcher selected it as the most appropriate for the data. Table 8.13 describes the interpretation of the hurdle regression, which consists of two consecutive models.

Table 8.13: Interpretation of Hurdle Model Components

Model Designation	Model Type	Outcome Variable	Interpretation
Model 1	Logistic	Yes [n=3,198]/no [n=1,716] outcome describing whether the pharmacy provided at least one DMR.	Describing the factors affecting DMR provision (the likelihood of a pharmacy providing at least one DMR).
Model 2	Negative binomial	The number of DMRs provided (>0) [n=3,198].	Describing the factors affecting DMR volume (in pharmacies that provided at least one DMR).

8.6. Considerations for Further Predictor Selection

The researcher considered whether any further predictor selection procedure was required to optimise the model stability or interpretability. The events per variable (EPV) was calculated as a guide, with fewer than 50 EPV indicating that further selection may be required. EPV refers to the number of 'events' for logistic regression rather than the number of observations for other models (Vittinghoff et al. 2012). Models 1 and 2 contained 3,198 events (DMRs >0) and observations, respectively. Therefore, each model could support a maximum of 64 (3,198/50) predictors based on the EPV rule of 50. The initial models met this rule of thumb since they had 21 predictors, including year interaction terms. Since the overall number of predictors was interpretable and met the EPV rule-of-thumb, the researcher did not undertake further selection procedures.

The researcher then considered whether the interaction terms would be included in the final model since they only aimed to include those with a statistically significant effect on the outcome to maintain model parsimony. Therefore, preliminary models were fit for Models 1 and 2 with all predictors and interaction terms. Appendices 8.1 and 8.2 describe the regression coefficients for

these preliminary models, containing all interaction terms. Consequently, only the SFV provision and number of MURs year interaction terms were included for Model 1, and none were included for Model 2.

8.7. Regression Results

Models 1 and 2 had chi-square probability values <0.001, showing that the model fit the data significantly better than the null model (no predictors). Similarly, both models had a chi-square likelihood ratio test probability value <0.001, showing that the mixed effect model (with random effect) fit the data significantly better than the fixed effect model. However, the Pseudo R^2 was 0.144 and 0.018 for Models 1 and 2, respectively, showing poor model fit.[31] The following subsections present the regression coefficients for Models 1 (odds ratios) and 2 (incidence rate ratios).

8.7.1. Model 1 Regression Coefficients

Table 8.14 presents the odds ratios for Model 1 (likelihood of a pharmacy providing at least one DMR), and Figure 8.9 visualises these findings in a forest plot.

Table 8.14: Chapter 8 Model 1 Adjusted Regression Coefficients

Predictor	Group	Odds Ratio [95% Confidence Interval]	
		Main Effect	Year Interaction Effect†
Number of years	N/A	1.153 [1.047 to 1.270]	N/A
Social deprivation quartile	Quartile 1 (most deprived)	Reference	Reference
	Quartile 2	1.314 [0.870 to 1.986]	Not included
	Quartile 3	1.562 [1.029 to 2.371]	Not included
	Quartile 4 (least deprived)	1.526 [0.908 to 2.564]	Not included
Dichotomised rural-urban classification	Urban	Reference	Reference
	Rural	1.081 [0.768 to 1.522]	Not included
Dichotomised pharmacy type	Multiple	Reference	Reference
	Non-multiple	1.729 [1.229 to 2.435]	Not included
Number of prescription items/1000	N/A	1.006 [1.002 to 1.009]	Not included
Number of MURs	N/A	1.006 [1.005 to 1.007]	1.000 [0.999 to 1.000]††
EHC provision	No EHCs provided	Reference	Reference
	At least one EHC provided	3.340 [2.546 to 4381]	Not included
SFV provision	No SFVs provided	Reference	Reference
	At least one SFV provided	1.524 [1.091 to 2.129]	1.119 [1.019 to 1.230]
Co-location status	Not co-located	Reference	Reference
	Co-located	1.111 [0.801 to 1.542]	Not included
Constant	N/A	0.035 [0.019 to 0.063]	N/A

Positive and negative statistically significant predictors are coloured green and red, respectively.
†The only statistically significant year interaction terms in Preliminary Model 2 were SFV provision and the number of MURs (see Appendix 8.1).
††0.99967 [0.99937 to 0.99997] to five decimal places.

[31]Poor fit relative to the literature 'good fit' values of 0.2-0.4 (Hosmer et al. 2013).

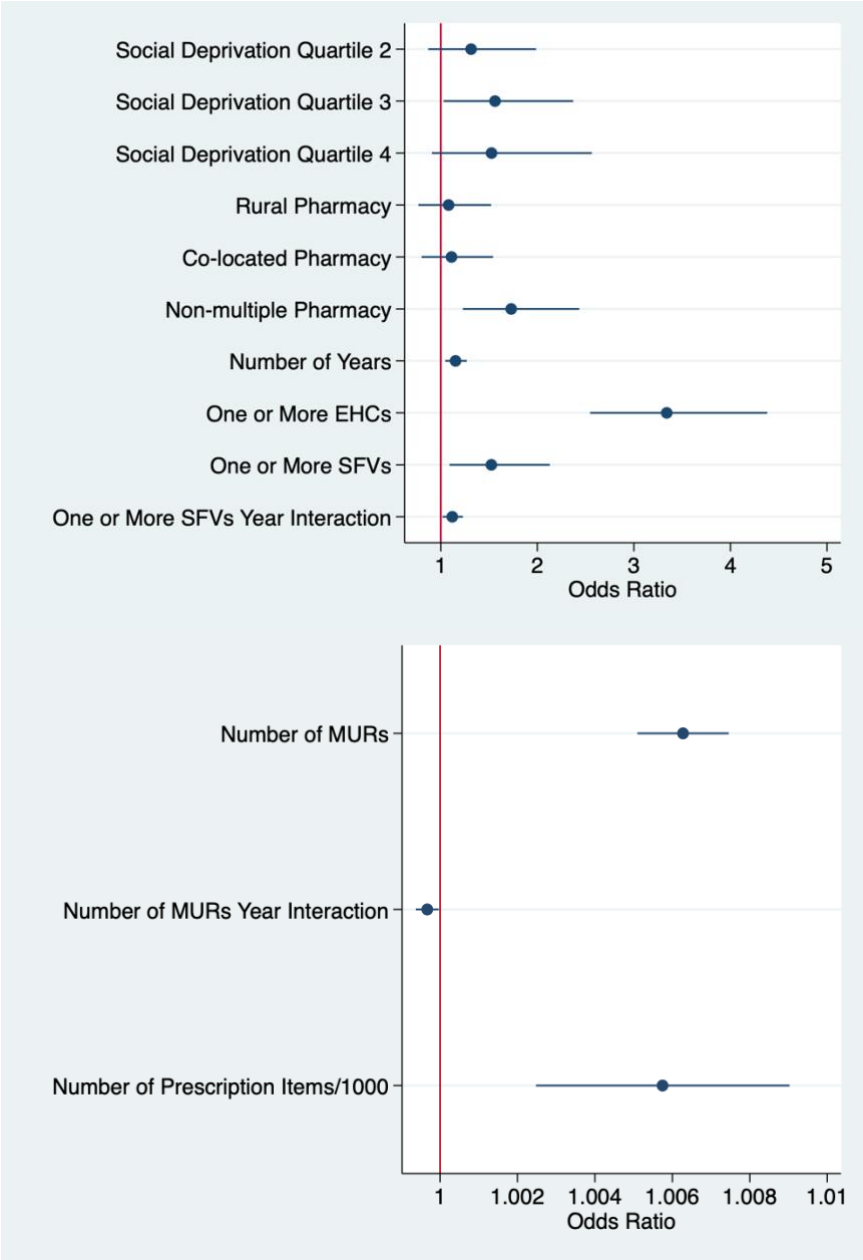


Figure 8.9: Chapter 8 Model 1 Odds Ratio Forest Plots

The results for Model 1 show that the non-multiple pharmacies, those in social deprivation quartile 3 and those which provided at least one EHC and SFV were more likely to have provided at least one DMR. The figure also shows that the odds of delivering at least one DMR increased over time (DMR year predictor), and with an increased number of MURs and prescription items dispensed.

Since the odds ratio only provides an average effect for numerical predictors, Figure 8.10 presents the marginal probability of a pharmacy providing at least one DMR by Model 1's numerical predictors, the number of MURs and prescription items/1000. The probability of providing at least one DMR increased with the number of MURs and prescription items, although these effects were relatively small. For example, the probability of providing at least one DMR was approximately 50% and 75% for pharmacies providing 100 and 400 annual MURs, respectively.

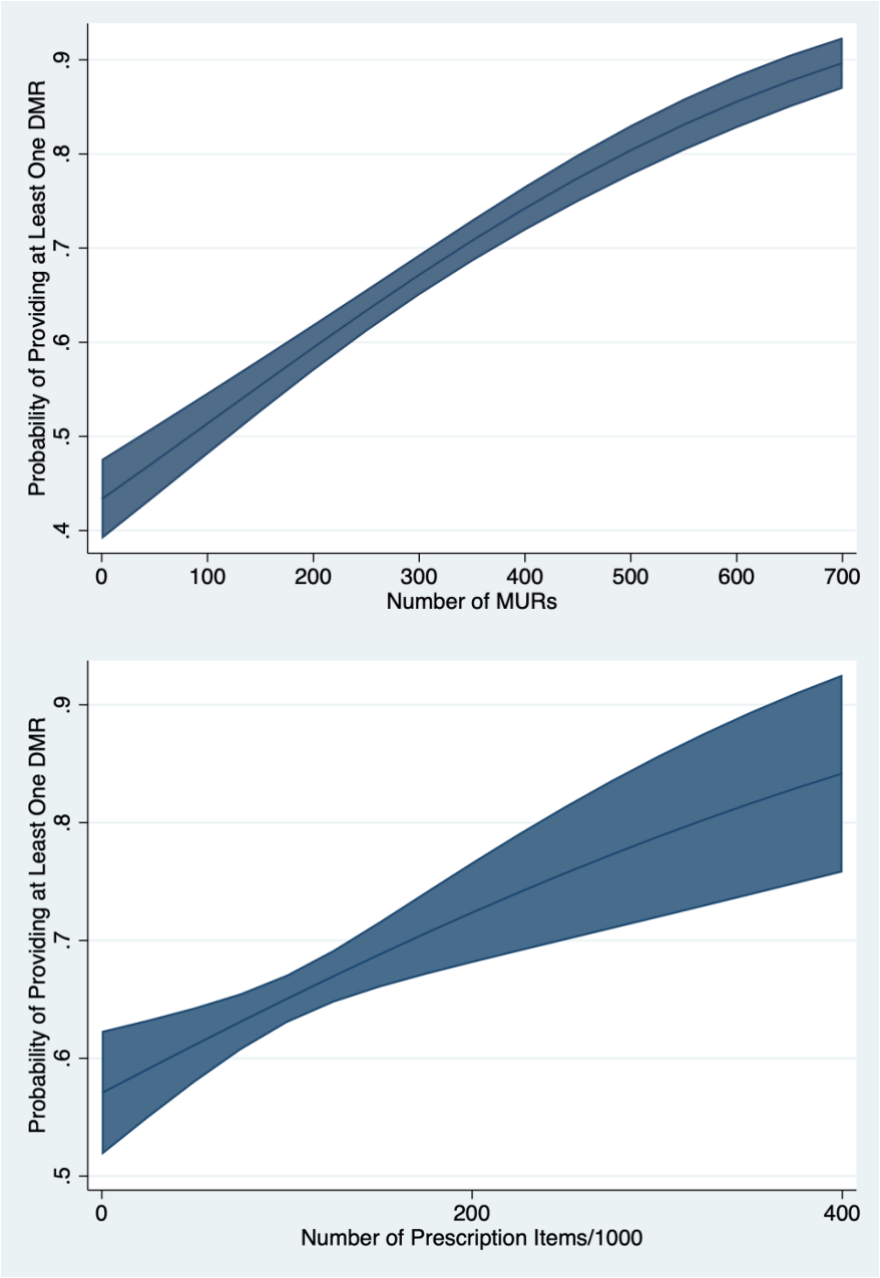


Figure 8.10: Chapter 8 Model 1 Numerical Predictor Marginal Effects

The only statistically significant year interaction terms were SFV provision, where the odds ratio increased over time, and the number of MURs, where the odds ratio decreased. Figure 8.11 visualise these changes in relationship over time by representing the probability of a pharmacy providing at least one DMR over time.

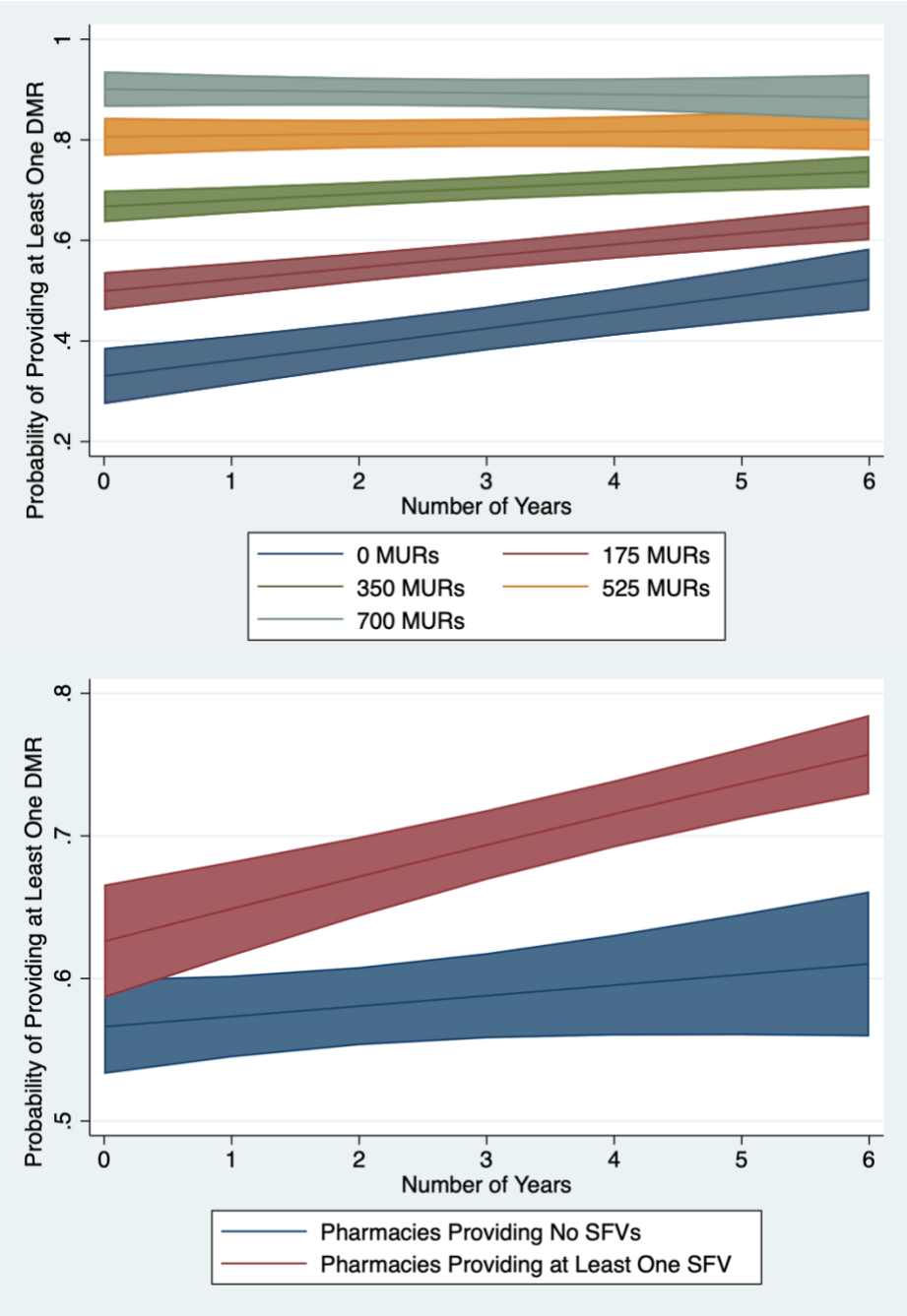


Figure 8.11: Chapter 8 Model 1 Marginal Effects of the Year Interactions with Seasonal Flu Vaccination Service Provision and the Number of MURs

The probability of a pharmacy providing at least one DMR stayed consistent over time for pharmacies providing large numbers of MURs. However, it increased over time for those that provided few. In contrast, the probability of providing at least one DMR increased over time for pharmacies providing at least one SFV more than those providing none (approximate difference of increase in the probability of 10%).

8.7.2. Model 2 Regression Coefficients

Table 8.15 details the incidence rate ratios for Model 2 (the incidence rate for the number of DMRs (>0) per pharmacy), and Figure 8.12 visualises these findings in a forest plot. Pharmacies providing at least one EHC and SFV provided more DMRs than those which did not. Non-multiple pharmacies provided more DMRs than multiples, which was the largest effect size. The number of DMRs increased over time, and there was a positive relationship between the number of MURs and prescription items and DMRs.

Table 8.15: Chapter 8 Model 2 Regression Coefficients

Predictor	**Group**	**Incidence Rate Ratios [95% Confidence Interval]**	
		Main Effect	**Year Interaction Effect†**
Number of years	N/A	1.020 [1.004 to 1.037]	N/A
Social deprivation quartile	Quartile 1 (most deprived)	Reference	Reference
	Quartile 2	0.922 [0.760 to 1.117]	Not included
	Quartile 3	0.997 [0.820 to 1.213]	Not included
	Quartile 4 (least deprived)	0.955 [0.749 to 1.217]	Not included
Dichotomised rural-urban classification	Urban	Reference	Reference
	Rural	1.048 [0.895 to 1.228]	Not included
Dichotomised pharmacy type	Multiple	Reference	Reference
	Non-multiple	1.560 [1.335 to 1.824]	Not included
Number of prescription items/1000	N/A	1.006 [1.005 to 1.008]	Not included
Number of MURs	N/A	1.002 [1.001 to 1.002]	Not included
EHC provision	No EHCs provided	Reference	Reference
	At least one EHC provided	1.259 [1.102 to 1.437]	Not included
SFV provision	No SFVs provided	Reference	Reference
	At least one SFV provided	1.242 [1.135 to 1.359]	Not included
Co-location status	Not co-located	Reference	Reference
	Co-located	0.894 [0.772 to 1.035]	Not included
Constant	N/A	2.406 [1.866 to 3103]	N/A

Positive statistically significant predictors are coloured green.

†No year interaction terms were statistically significant in Preliminary Model 2 (see Appendix 8.2).

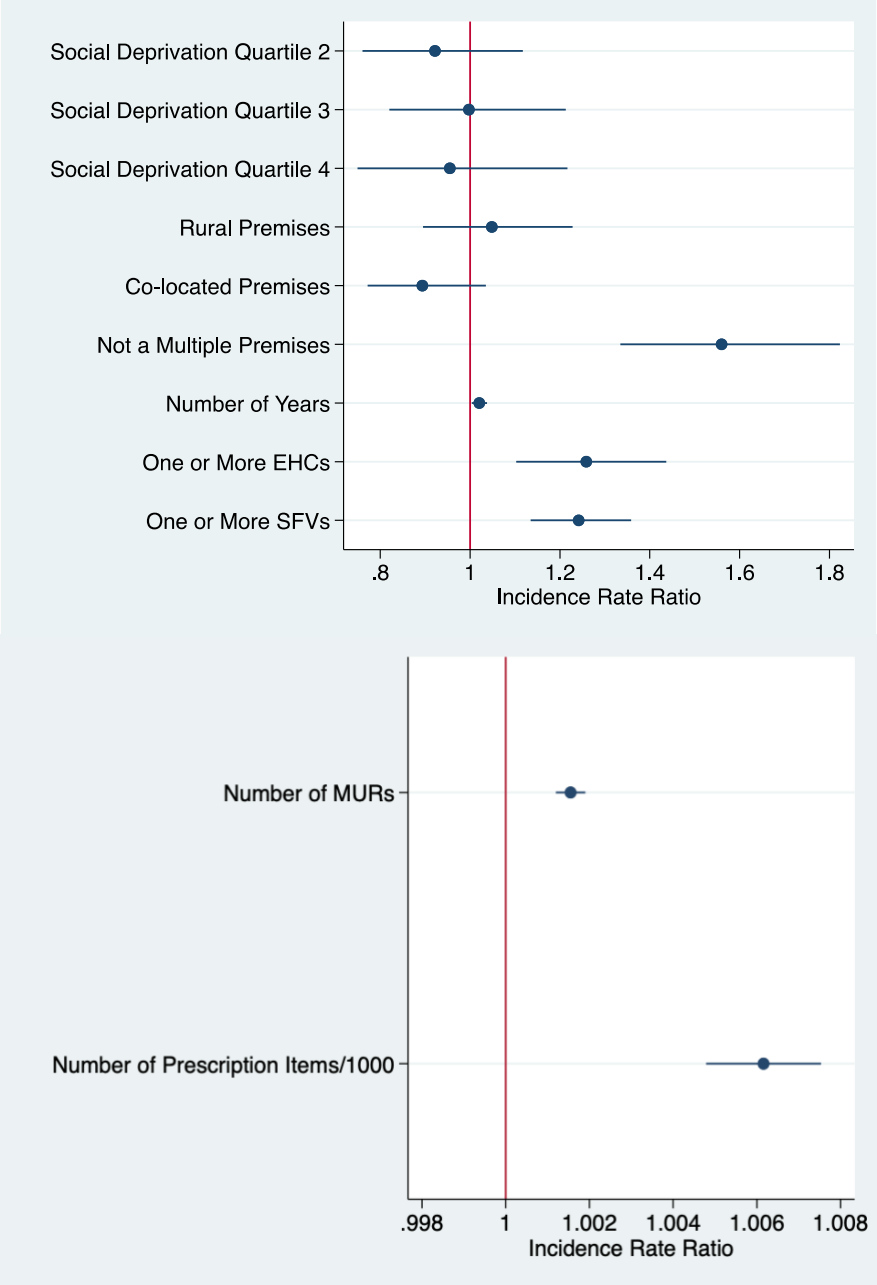


Figure 8.12: Chapter 8 Model 2 Incidence Rate Ratios Forest Plots

Since incidence rate ratios provide only an average effect for numerical predictors, the researcher visualises the marginal mean effects in Figure 8.13 for numerical predictors, the number of MURs and prescription items/1000. There was a positive relationship between the number of MURs and prescription items with DMR volume. However, the effect of the number of MURs was relatively small. For example, the predicted number of DMRs was approximately 12 and 22 for pharmacies providing 0 and 400 annual MURs, respectively. The positive relationship appears to increase at larger values of MURs and prescription items in contrast with Model 1, where the relationship decreased at larger values.

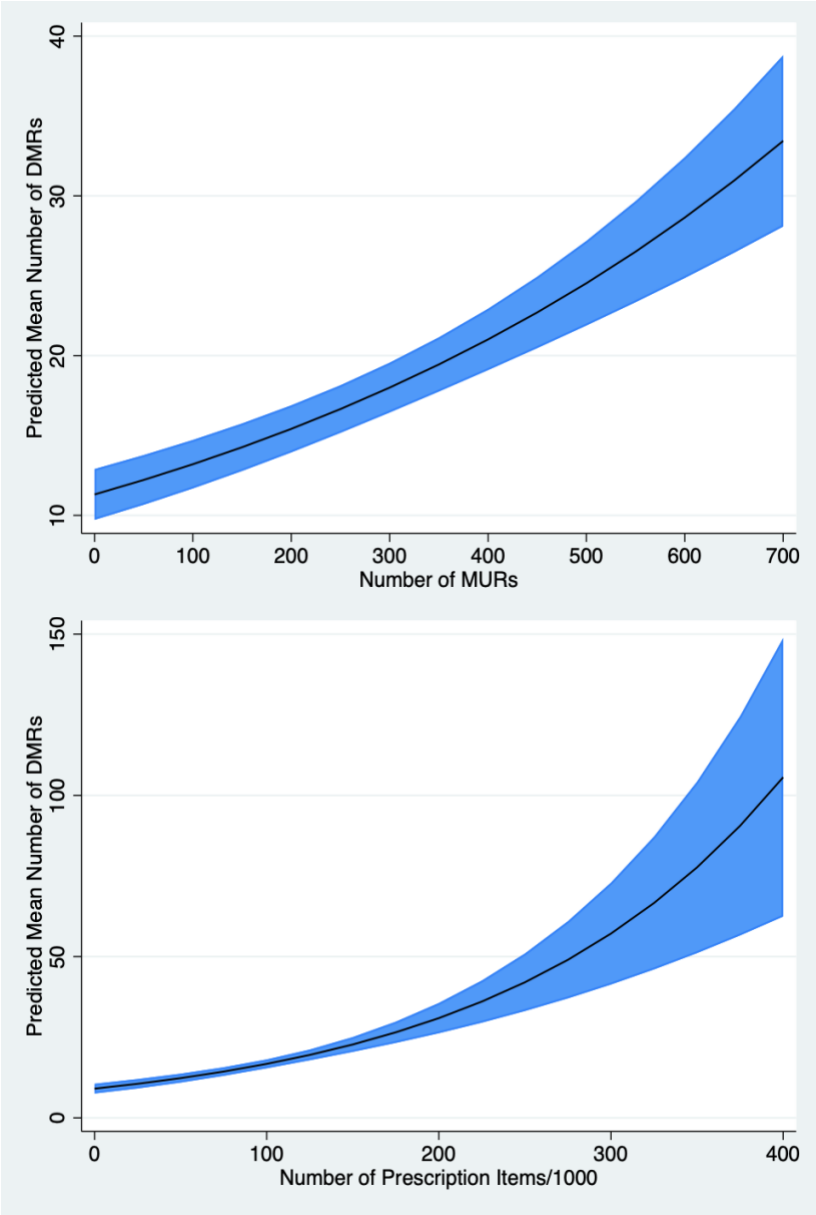


Figure 8.13: Chapter 8 Model 2 Numerical Predictor Marginal Effects

8.7.3. Summary of Main Findings

The two regression models identified several pharmacy-related factors influencing DMR provision and volume, but the calculated pseudo R^2 was 0.144 and 0.018 for Models 1 and 2, respectively, indicating poor model fit. These factors have changed over time, but few of these changes were statistically significant. Table 8.16 describes the factors affecting DMR provision (Model 1) and DMR volume (Model 2).

Table 8.16: Summary of Chapter 8 Model Results

Predictor	Group	Regression Coefficient [95% Confidence Interval]	
		Model 1 Odds Ratio	Model 2 Incidence Rate Ratio
Number of years	N/A	1.153 [1.047 to 1.270]	1.020 [1.004 to 1.037]
Social deprivation quartile	Quartile 1 (most deprived)	Reference	Reference
	Quartile 2	1.314 [0.870 to 1.986]	0.922 [0.760 to 1.117]
	Quartile 3	1.562 [1.029 to 2.371]	0.997 [0.820 to 1.213]
	Quartile 4 (least deprived)	1.526 [0.908 to 2.564]	0.955 [0.749 to 1.217]
Dichotomised rural-urban classification	Urban	Reference	Reference
	Rural	1.081 [0.768 to 1.522]	1.048 [0.895 to 1.228]
Dichotomised pharmacy type	Multiple	Reference	Reference
	Non-multiple	1.729 [1.229 to 2.435]	1.560 [1.335 to 1.824]
Number of prescription items/1000	N/A	1.006 [1.002 to 1.009]	1.006 [1.005 to 1.008]
Number of MURs	N/A	1.006 [1.005 to 1.007]	1.002 [1.001 to 1.002]
Number of MURs year interaction	N/A	1.000 [0.999 to 1.000]	Not included
EHC provision	No EHCs provided	Reference	Reference
	At least one EHC provided	3.340 [2.546 to 4.381]	1.259 [1.102 to 1.437]
SFV provision	No SFVs provided	Reference	Reference
	At least one SFV provided	1.524 [1.091 to 2.129]	1.242 [1.135 to 1.359]
SFV provision year interaction	N/A	1.119 [1.019 to 1.230]	Not included
Co-location status	Not co-located	Reference	Reference
	Co-located	1.111 [0.801 to 1.542]	0.894 [0.772 to 1.035]

Positive and negative statistically significant predictors are coloured green and red, respectively.

The probability of a pharmacy providing at least one DMR increased over time, as did the volume of DMRs. Non-multiple pharmacies had greater odds of delivering at least one DMR and greater incidence of DMRs (>0) alongside the service-related predictors: the number of prescription items/1000, number of MURs, EHC and SFV provision. Pharmacies in social deprivation quartile 3 had greater odds of providing at least one DMR than those in quartile 1 (most deprived), whilst other quartiles did not significantly differ. Pharmacy rurality nor co-location status had a statistically significant effect on DMR occurrence or volume.

8.8. Discussion

This chapter successfully achieved its aim by describing the pharmacy-related factors affecting DMR provision over time. To the best of the researcher's knowledge, the multistage quantitative analysis approach (EDA and regression) was unique in pharmacy services literature, necessary because of the unusually large dataset. This section discusses the chapter's strengths and limitations and describes the relationship between these results with the wider literature.

8.8.1. Strengths and Limitations

The quantity of longitudinal pharmacy data available was a strength of this study, increasing statistical power and facilitating the inclusion of many predictors. However, since many pharmacy services have developed through the data collection period, further work could repeat this analysis whilst including new services once sufficient data have been collected. For example, the researcher would ideally have included the Common Ailments Scheme in the model if it had been available for the whole data collection period (see Table 8.2). Despite the benefits of having many variables to consider as predictors, this did make the predictor selection process challenging. However, using EDA before regression was helpful because it facilitated a rich understanding of the data, their relationships, and interactions, ensuring the construction of the most appropriate model with relative ease.

Although the researcher did not plan to use a hurdle model from the chapter's outset, it provided additional information, splitting inferences into those for DMR provision and the DMR volume (>0). The pharmacy dataset used in this chapter only included DMR-registered pharmacies, but the data used to determine registration status was only accurate as of January 2021 (see Section 5.4.3.1.1). Therefore, a pharmacy that became DMR-registered in 2020 would not have been registered between 2013 and 2019. The data did not account for this, instead assuming that the pharmacy was DMR-registered for the whole data collection period. However, another advantage of using a hurdle model was that this potential limitation could only affect Model 1 (probability of a pharmacy providing at least one DMR) since Model 2 (incidence of DMRs >0) excluded any pharmacies that provided no DMRs.

Table 8.1 presented the rationale for excluding data from 2020 and 2021 in this chapter to remove specific confounders from the Covid-19 pandemic, increasing the generalisability of the findings. However, this study would not account for any permanent changes in the pharmacy-related factors affecting DMR volume caused by Covid-19.

8.8.2. Relevance to Wider Literature

The suboptimal model fit suggests that there were predictive factors of DMR provision that the models did not include, despite including many predictors with evidence to support their relationships with pharmacy service provision. Although this finding was unexpected, it shows the complexity of DMR provision and the need for further research. Individual pharmacist-related factors could influence DMR delivery, which seems plausible considering that Chapter 6 estimated that only 51% of pharmacists in Wales had completed a DMR between March 2018 and June 2020. In their systematic review investigating the adoption of community pharmacy innovations, Weir et

al. (2019) concluded that pharmacists are more likely to adopt services that they find personally or professionally rewarding. In the original DMR evaluation, Hodson et al. (2014a) surveyed 116 community pharmacists in Wales to describe their views of the service, with 79 (68%) agreeing or strongly agreeing with the statement *"in general, I am enthusiastic about the service"*. Also, 92 agreed or strongly agreed that *"a DMR allows me to apply my clinical knowledge and skills to my practice"*. Although these findings suggest personal and professional satisfaction from the DMR, the authors acknowledged that their 20% survey response rate made their results vulnerable to non-responder bias.

Given that eight years have passed since this work, it should be repeated to explore and describe community pharmacists' personal factors affecting DMR provision. However, optimising the survey response rate should be prioritised to ensure the findings are generalisable. To optimise community pharmacy survey response rates in England, Veeren (2019) provided financial incentives and engaged professional organisations like the RPS and PSNC to advertise the project on social media. However, the authors only achieved an estimated 2.3% response rate. Perhaps using local recruitment champions to encourage survey completion could improve the response rate for future research, considering that gatekeepers effectively recruited focus group participants in Chapter 4. Collaboration with the newly appointed (in April 2021) Community Pharmacy Cluster Leads could provide a convenient method of networking within the community pharmacy sector in Wales for this purpose (Welsh Government 2021).[32]

Despite the suboptimal model fit, this chapter did identify organisational factors that affected DMR delivery volume. In contrast to previous research describing that multiple pharmacies provide more MURs (Bradley et al. 2008; Hann et al. 2017), this chapter showed that multiple pharmacies had lower DMR incidence than non-multiples.[33] Table 8.5 showed that the mean number of DMRs per supermarket pharmacy (2.1) was considerably smaller than large-sized (14.0) and medium-sized (10.9) multiples, which could have confounded the result. However, considering that the supermarket group frequency was much smaller than the other pharmacy types, it is unlikely to have notably influenced the findings. Therefore, there could be inherent differences in how multiple and non-multiple pharmacies engage with the DMR compared with MURs. Previous research has identified that pharmacists, especially those working in large-sized multiples, often felt pressured to reach MUR volume targets to maximise reimbursement (Latif et

[32]Primary care clusters are local groups of primary care professionals that organise primary care service delivery in their geographic area.

[33]Multiple pharmacies were supermarket, large or medium-chain pharmacies, whilst non-multiples were independents or small chains.

al. 2011). Perhaps multiples are not providing DMR targets, in contrast to MURs, because it is less financially viable to do so. Although contractors received £37 for each DMR compared to £28 for an MUR (CPW 2011; PSNC 2013a), 90.5% [n=115] of surveyed community pharmacists in the original evaluation agreed that *"a DMR takes longer than an MUR",* and 42.4% agreed that *"the reimbursement by the commissioner is not proportional to the input needed"* (Hodson et al. 2014a).

In contrast to research suggesting that the co-location of GP surgeries and community pharmacies increases collaboration between the two professions (Bollen et al. 2019), this chapter showed no significant effect of co-location on DMR provision. The original DMR evaluation supports this finding showing that 47% [n=115] of surveyed community pharmacists stated proximity to other healthcare providers as 'not a barrier at all' to DMR provision (Hodson et al. 2014a).[34] Lam et al. (2019) found that 35% [n=23] of patients who declined a dMUR suggested they would prefer to see their doctor for post-discharge medicines support. Interestingly, Veeren (2019) found that 24.5% [n=495] of surveyed community pharmacists felt they were the most appropriate professionals to provide post-discharge support, compared with 6.3% for GPs, and 27.5% for GP surgery pharmacists. If patients and community pharmacists prefer post-discharge support in GP surgeries, DMR engagement could be reduced in co-located pharmacies, ameliorating any collaboration benefits conveyed by co-location.

The researcher thought pharmacies in socially deprived areas would provide fewer DMRs because of the inverse care law, which infers that healthcare service utilisation is inversely related to need, which is higher in socially deprived areas (Mercer et al. 2021). The findings do not support this hypothesis for the DMR since there was no significant relationship between the social deprivation quartile and DMR volume. However, Model 1 showed increased odds of a pharmacy providing at least one DMR with decreasing social deprivation, although only quartile 3 significantly differed from quartile 1. This finding mirrors research describing the factors affecting MUR and SFV delivery volume, which also found no relationship with social deprivation (Evans et al. 2016; Hann et al. 2017). The pharmacy positive care law states that pharmacy access is higher in areas of social deprivation (Todd et al. 2015). Perhaps the law holds for pharmacy access but not pharmacy services.

The provision of other services positively influenced DMR provision and volume, with the largest effect noted for EHCs. The different effects of different services suggest that service-specific

[34]On a scale of barriers to DMR provision, where one represented 'not a barrier at all' and five represented a major barrier.

factors could influence delivery volume. Interestingly, interviewed community pharmacists who provided SFVs in Wales indicated that they would reduce the provision of other services, such as the MUR, to facilitate SFV provision (Evans et al. 2016). Therefore, the finding of a positive relationship between SFV and DMR provision was unexpected. Perhaps pharmacists do not deprioritise the DMR for SFV as suggested for the MUR, or this effect is offset by associated factors such as the employment of multiple pharmacists, which the interviewees described as essential for SFV provision.

Of the surveyed community pharmacists from the original DMR evaluation, 64.7% stated that workload was a barrier to engagement (Hodson et al. 2014a).[35] Qualitative research investigating factors affecting community pharmacy service provisions, such as the MUR and NMS, identified that this workload primarily constitutes prescription dispensing volume (Jacobs et al. 2018; Hindi et al. 2019a). Therefore, the positive relationship between prescription volume and DMR delivery identified in this chapter is surprising. Hann et al. (2017) reported a similar relationship between prescription volume and MUR delivery. However, they found that it was contingent on increased staffing hours and skill mix, variables not included in this chapter. Perhaps these factors could also explain the relationships between the DMR and the provision of other services. The Consolidated Framework for Implementation Research supports this theory, describing how innovations are more likely to be adopted in organisations with adequate capacity, denoting their "readiness for implementation". Weir et al. (2019) considered this important for community pharmacy service implementation. Therefore, researchers should consider collecting additional pharmacy-related variables like skill mix and staffing hours if they repeat this study. Hann et al. (2017) undertook an initial survey to collect these variables, which could be adopted to improve model fit. The All Wales Pharmacy Database (AWPD) is a centralised national source for pharmacy data, including facilities and available services (NHS Business Services Authority 2022). As part of the Quality & Safety scheme, pharmacy contractors are renumerated for validating the information by AWPD bi-annually. Widening AWPD data collection to include workforce information such as skill mix and pharmacist full-time equivalents would facilitate more in-depth and routine analysis of DMR provision, amongst other services.

The relationship between community pharmacy service provision is clearly interlinked and complex. Additionally, the new Welsh Community Pharmacy Contract restructured advanced pharmacy service commissioning. From April 2022, the Common Ailments Scheme, Emergency

[35]Responded with a four or five on a scale of barriers to DMR provision, where one represented 'not a barrier at all' and five represented 'a major barrier'.

Medicines Supply service, SFV, and EHC were combined into a single commissioned service, the Clinical Community Pharmacy Service (CCPS) (Welsh Government 2021). Pharmacies must now agree to provide all four services in the CCPS, or they will be unable to provide any. The contract also decommissioned the MUR service in Wales following its suspension during the Covid-19 pandemic and its decommissioning in England in 2021 (Evans 2020; PSNC 2021a). Since this chapter's results describe an association between DMR and other service provisions, these contractual developments could increase DMR provision by increasing the provision of other services. Although the DMR is commissioned in the new contract as a 'clinical service', it is not included in the CCPS (Welsh Government 2021). Therefore, these changes could reduce DMR provision in pharmacies with lower service capacity because of the focus and funding surrounding other services. Adequate workforce planning with an optimised skill mix could mitigate these potential issues. Regardless, further work must evaluate the influence of the new contract on engagement with the DMR. Since this chapter demonstrated the complexity of the relationships between community pharmacy services, further work should not only evaluate the influence of the new contract on DMR engagement but explore the relationship between community pharmacy services.

8.9. Conclusions and Dissemination

This chapter achieved Thesis Objective 4 by describing pharmacy-related factors influencing DMR provision over time: pharmacy type, prescription dispensing volume, and the provision of other services. The findings provide an excellent evidence base to support further work, necessary due to the suboptimal regression model fit, to describe community pharmacy and pharmacist factors affecting DMR engagement, and to explore the complex relationship between the provision of community pharmacy services.

The researcher has disseminated this chapter's findings to stakeholder groups directly involved in community pharmacy services, such as the P:DaHW DMR subgroup and DMR Promotional Material Working Group (see Table 2.2). Since these groups aim to optimise the use of the DMR in community pharmacies, this chapter's findings will assist in targeted interventions to improve engagement, particularly in multiple pharmacies and those providing few community pharmacy services.

Chapter 9. Describing the Factors Affecting DMR Discrepancy Identification

9.1. Chapter Introduction

In the original DMR evaluation, one of the previously identified hospital pharmacist barriers to DMR referrals was the lack of evidence-based referral criteria (Hodson et al. 2014a). The researcher often communicated with the AWQPSG during the design of Chapter 4 and the dissemination of its results. When providing their views of DMR referrals, they repeatedly asked which patients would benefit most from the DMR so they could target them for referrals. However, the opinions of hospital pharmacy professionals (HPPs) in Chapter 4 were mixed. Some felt that referral criteria would help them integrate referrals into their working practices, whilst others suggested they were confident knowing whom to refer. Irrespective of whether the HPPs perceived it as a barrier, they felt that the development of criteria was necessary for use as a referral guide for themselves and for community pharmacists to prioritise patients for a DMR. Therefore, this chapter describes the factors affecting DMR discrepancy identification (Thesis Objective 5) employing the regression analysis approach presented in Chapter 7.

9.2. Chapter 9 Methods Overview

As described previously, two outcome variables were considered for use in this chapter, the number of identified discrepancies and item discrepancy identification. Table 9.1 highlights the differences between these variables and the datasets that contain them. Although regression was not required for both variables since they describe similar concepts, the researcher completed the exploratory data analysis (EDA) for both to choose the dataset that would construct the most optimal and representative model.

Table 9.1: Datasets Used for Chapter 9

Dataset Name	Dataset Description	Data Entries	Discrepancy Recording	Outcome Variable
ChP combined dataset (April 2015 to June 2020).	All DMRs logged in ChP.	269,699 medication items.	One discrepancy can be recorded for a given medication item.	Discrepancy occurrence for a given item.
NECAF dataset (November 2011 to November 2020).	The subset of the NWSSP dataset that was recorded in NECAF.	49,372 NECAF DMRs.	The total number of discrepancies is recorded per DMR service since NECAF does not collect information regarding individual medicines.	The number of discrepancies identified for a given DMR.

ChP = Choose Pharmacy. NECAF = National Electronic Claim and Audit Forms.

The researcher listwise deleted data at this stage to ensure the dataset used for selection was representative of the data that would be included in the regression model.[36] Specifically, they removed entries from the NECAF [n=51] and ChP combined [n=123] datasets that did not have a

[36]Section 7.3.2 describes the rationale for using listwise deletion (delete all entries) in regression.

valid entry for discrepancy occurrence, leaving 49,321 and 269,576 entries, respectively. Additional entries with missing data were deleted from the ChP combined dataset. These entries included item descriptions that did not correspond with a single medication item [n=1,678] (see Section 5.4.2) and those with missing consultation-level data due to unsuccessful data linkage [n=2,293] (see Section 6.2.2). Therefore, the final ChP combined dataset contained 265,605 entries.

9.3. Candidate Predictor Selection

Since this chapter aims to develop recommendations for targeting DMRs to those patients who would benefit most from one, regression model interpretability was an essential consideration. Steyerberg (2019) recommended using smaller models for developing clinical guidelines in keeping with the principles of parsimony. When selecting predictors for inclusion, the researcher prioritised those that could form actionable recommendations, i.e., they could be practically used to identify patients at high risk of discrepancies. However, if non-actionable predictors had relationships with the outcome, they were considered for inclusion to control for their effects (Steyerberg 2019).

The researcher considered knowledge-driven and data-driven approaches (EDA) to select candidate predictors for the regression model. Since this is the first study investigating factors affecting DMR discrepancy identification, there was no appropriate literature to choose between the variables available in the DMR datasets. However, since the chapter considered discrepancies identified at DMR1, variables relating to DMR2 were excluded, e.g., the DMR2 delivery method. The researcher included all other variables in the EDA, which aimed to facilitate regression model construction by choosing between candidate predictors and checking regression assumptions. Inferential statistics were not used for predictor selection (univariate prefiltering) because they cause inaccurate regression inferences (Heinze et al. 2018).

The EDA involved univariate exploration of the outcome variables, using summary statistics and frequency distributions for the number of NECAF discrepancies (numerical) and proportions for ChP item discrepancy occurrence (binomial). Figure 9.1 summarises the researcher's methods for visualising bivariate relationships and approximating their effect size. Section 7.3.1.2.2 provides the rationale for these choices.

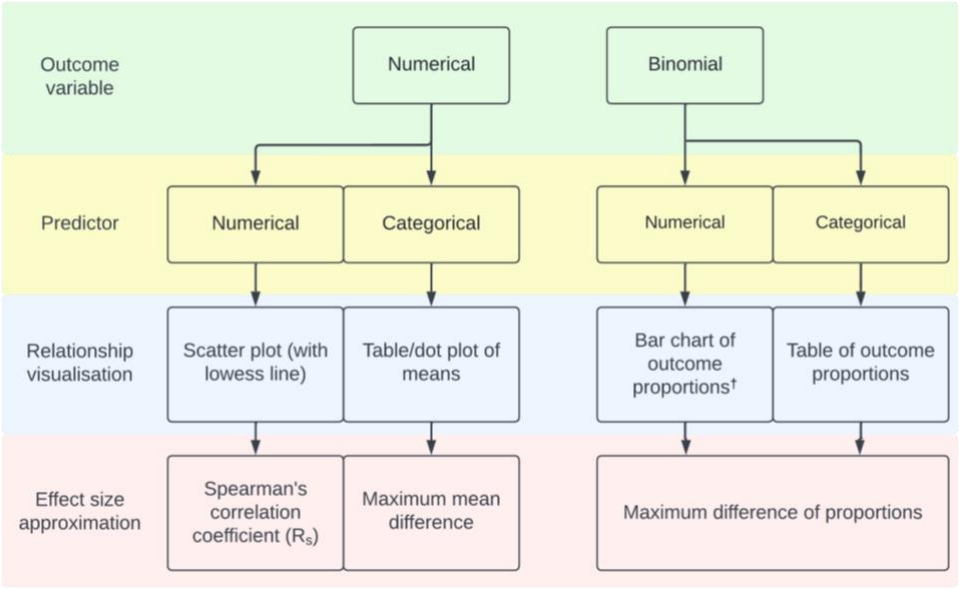


Figure 9.1: Chapter 9 Exploratory Data Analysis (EDA) Bivariate Relationship Exploration
Lowess = Locally weighted scatterplot smoothing.
Maximum mean difference = the maximum difference in mean values between groups.
†Numerical predictors were categorised into groups.

The researcher used maximum mean differences to approximate effect size for categorical predictors since regression analyses use the mean as a measure of central tendency. However, since the mean is sensitive to extreme values, the researcher only used subgroups with n≥100 (Field 2018). Spearman's correlation coefficient (Rs) was used to approximate the effect size for numerical predictors because NECAF discrepancies were skewed (Field 2018).

9.3.1. Univariate Exploration of Outcome Variables

The total number of discrepancies in the NECAF dataset was 56,706 from 49,321 DMRs (mean = 1.15). The median and mode number of discrepancies were zero. These statistics show that fewer DMRs identify discrepancies than not. The standard deviation (1.87) was larger than the mean, indicating considerable variability between DMRs. Figure 9.2 presents a frequency distribution for the number of DMRs to further investigate this distribution. The number of discrepancies had many zero values (zero inflation), with far fewer entries with larger values, characteristic of count data. The considerable data skew would make constructing a linear regression model challenging, perhaps requiring an alternative link function in a generalised linear model (GLM).

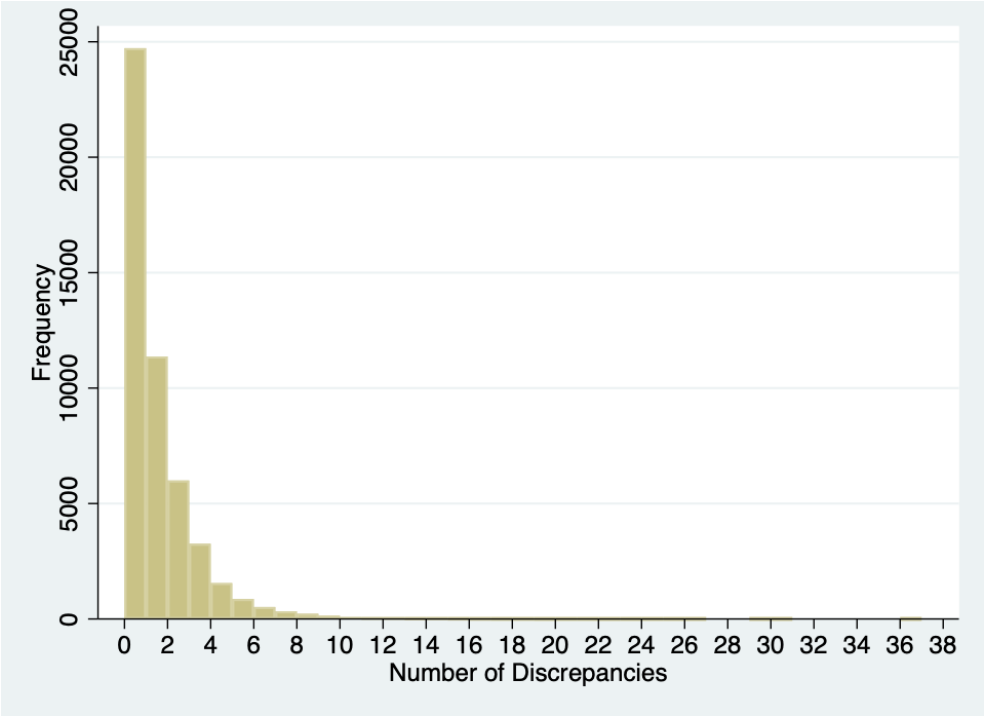


Figure 9.2: Frequency Distribution for the Number of Discrepancies

For ChP DMRs, the number of item discrepancies was 27,392 (10.31%). Therefore, most items were not associated with a discrepancy. Since the outcome is binary, a linear regression model would be unsuitable compared with logistic regression.

9.3.2. Bivariate Relationship Exploration

This section outlines the bivariate data exploration between the number of identified discrepancies (NECAF) and item discrepancy occurrence (ChP) with discharge-setting-related, patient-related, pharmacy-related, service-related, and medicines-related variables.

9.3.2.1. Discharge-Setting-Related Variables

9.3.2.1.1. Discharging Hospital and Healthcare Organisation

The maximum mean difference for discharging hospitals [n≥100] was 1.92. For ChP DMRs, the maximum item discrepancy proportion for a discharging hospital [n≥100] was 22.64%, and the minimum was 3.85% (maximum difference = 18.79%).

Table 9.2 describes the variation in discrepancy occurrence by the discharging healthcare organisation. There was a greater variation in discrepancy occurrence by the discharging hospital than by the discharging healthcare organisation. However, its cardinality would make interpreting the results challenging if included in the regression model.

Table 9.2: Discrepancy Occurrence by Discharging Healthcare Organisation

Discharging Healthcare Organisations With n≥100	Mean Number of NECAF Discrepancies [DMR Frequency = 49,321]	Item Discrepancy Proportions [Item Frequency = 265,605]
CVUHB	1.34 [n=6,793]	10.20% [n=66,305]
English hospital	1.25 [n=1,286]	16.69% [n=1,989]
ABUHB	1.23 [n=11,748]	11.85% [n=19,030]
BCUHB	1.18 [n=9,023]	12.87% [n=54,639]
Unknown	1.15 [n=336]	14.35% [n=5,157]
CTMUHB	1.14 [n=4,918]	8.65% [n=60,025]
HDUHB	1.10 [n=5,296]	9.76% [n=29,338]
PTHB	1.06 [n=177]	13.91% [n=1,107]
ABMUHB	0.91 [n=9,444]	7.60 [n=17,834]
Care home	0.82 [n=176]	5.98% [n=117]
Velindre NHS Trust	N/A [n=62]	13.60% [n=566]
SBUHB	N/A [n=13]	6.44% [n=9,450]
Maximum difference [n≥100]	0.52	10.71%

Maximum and minimum values in each column are coloured green and red, respectively.

9.3.2.1.2. Discharge Information Provider and Electronic Discharge Advice Letter (eDAL) Availability

Table 9.3 describes the discrepancy occurrence by the discharge information provider, which seemed to influence the occurrence of discrepancies, justifying its inclusion in the regression model. However, the researcher considered combining these groups since some ('other' and 'GP' providers) had low frequencies.

Table 9.3: Discrepancy Occurrence by Discharge Information Provider

Discharge Information Provider	Mean Number of Discrepancies [DMR Frequency = 49,321]	Item Discrepancy Proportions [Item Frequency = 265,605]
Other	1.62 [n=1,116]	15.18% [n=2,754]
Patient	1.24 [n=7,579]	12.75% [n=25,313]
Hospital	1.13 [n=29,485]	9.52% [n=210,202]
Carer	1.11 [n=5,791]	14.21% [n=19,757]
GP	1.05 [n=5,350]	12.27% [n=7,579]
Maximum difference	0.57	5.66%

Maximum and minimum values in each column are coloured green and red, respectively.

The percentage of items associated with a discrepancy was 9.53% [n=148,891] when an eDAL was available and 11.31% [n=116,714] when one was not. Since the discrepancy proportion difference (1.78%) indicated a relationship with eDAL availability, the variable was considered for inclusion.

9.3.2.2. Patient-Related Variables

9.3.2.2.1. Patient Age and Gender

The NECAF and ChP combined datasets had 2,252 and 48,244 missing values for the patient age, leaving 47,069 and 217,361 valid entries, respectively. Figure 9.3 visualises the relationship between patient age and the number of discrepancies, with Spearman's correlation coefficient (R_s) to describe its effect size. The correlation coefficient described a negative but very weak

relationship, which the lowess line suggested was non-linear, showing a curvilinear relationship with discrepancies peaking at age 60-70 instead.

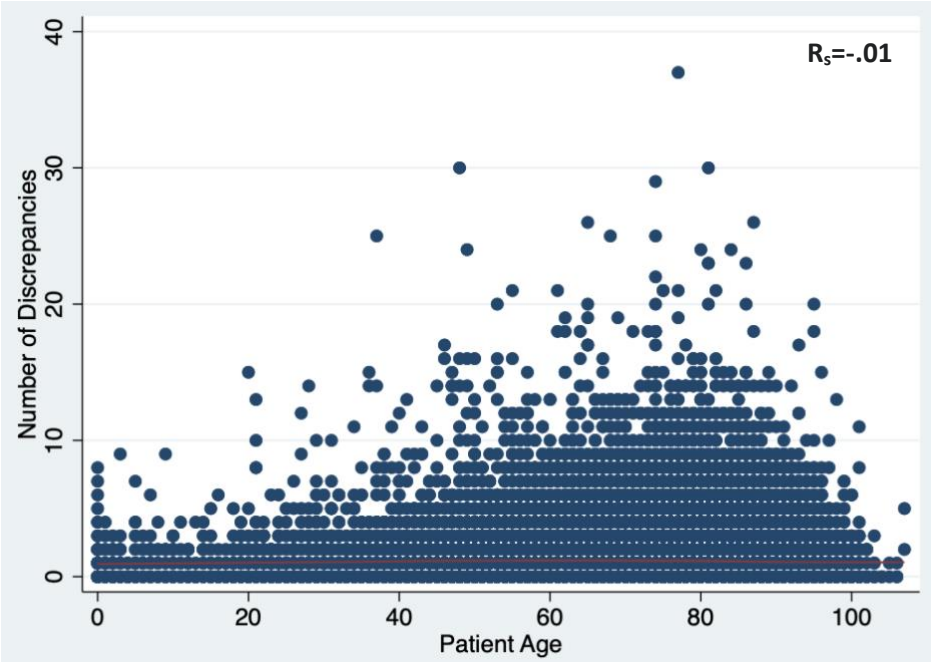


Figure 9.3: Scatter Plot Approximating the Relationship Between Patient Age and the Number of Discrepancies

Figure 9.4 describes how item discrepancy proportions have the opposite curvilinear relationship, with the maximum rates at the lowest and highest patient age groups. The maximum difference in discrepancy proportion was 17.22%. Nonetheless, the researcher considered including patient age as a candidate predictor since it appeared to affect discrepancy occurrence in both datasets.

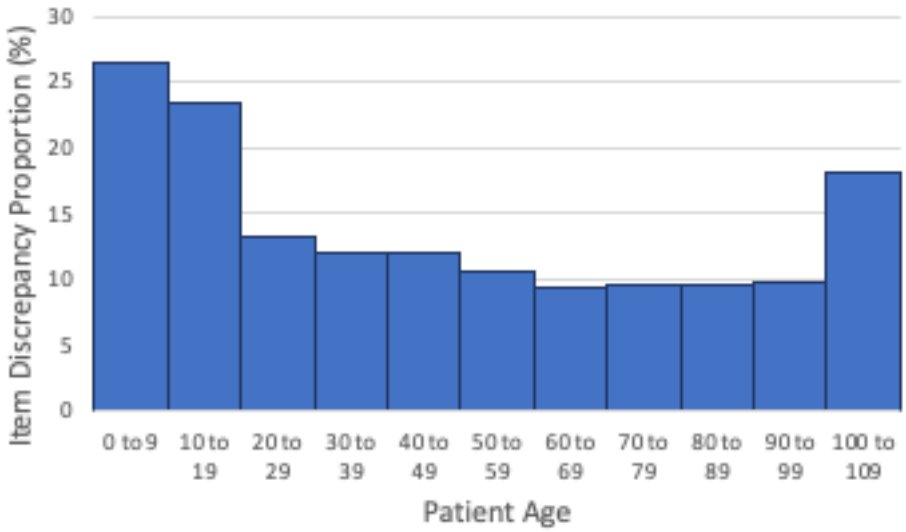


Figure 9.4: Item Discrepancy Proportion by Patient Age

The contrast between the item discrepancy proportions and the mean number of discrepancies suggests that there may be an interaction effect between patient age and the number of medicines, which Figure 9.5 explores.

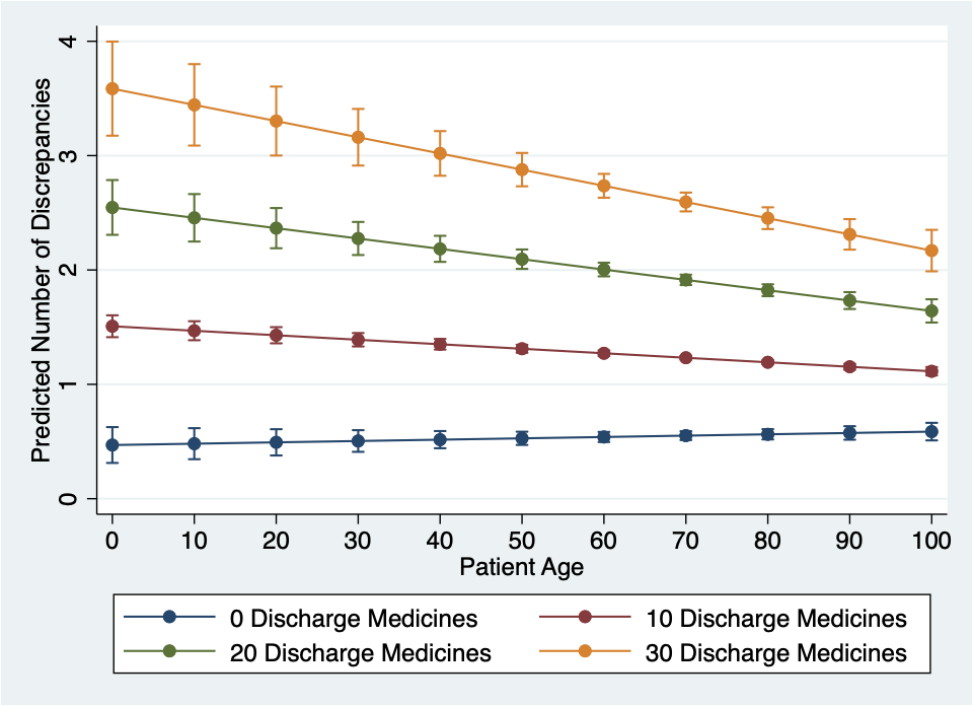


Figure 9.5: Effect of the Number of Discharge Medicines on the Relationship Between Patient Age and the Number of Discrepancies

As theorised, the number of discharge medicines moderates the relationship between patient age and the number of discrepancies. For patients with no discharge medicines, there appears to be a small positive relationship between patient age and the number of discrepancies. Since there were no medicines on the discharge advice letter (DAL), these discrepancies are likely to be omissions. The positive relationship decreased with increased numbers of discharge medicines. Therefore, the researcher considered including an interaction term between discharge medicines and patient age.

The item discrepancy proportion was 10.10% [n=123,174 items] for males and 10.50% [n=142,431] for females. Since patient gender (ChP dataset only) appeared to influence item discrepancy proportions, it was considered for inclusion as a predictor.

9.3.2.2.2. Eligibility Criteria

For each eligibility criterion, the mean number of discrepancies was larger when they were present. In contrast, item discrepancy proportions were lower for DMRs where the patient took four or more medicines or required adjustments. Table 9.4 describes the relationships between the chosen eligibility criteria and discrepancy occurrence.

Table 9.4: Discrepancy Occurrence by Chosen Eligibility Criteria

Eligibility Criterion	**Mean Number of Discrepancies [DMR Frequency = 49,321]**	**Item Discrepancy Proportion [Item Frequency = 265,605]**
Medicines changed during admission	1.30 [n=35,560]	11.79% [n=192,328]
Medicines not changed during admission	0.77 [n=13,761]	6.45% [n=73,277]
Maximum difference	0.53	5.34%
Patient taking four or more medicines	1.18 [n=38,538]	10.13% [n=234,073]
Patient not taking four or more medicines	1.04 [n=10,783]	11.71% [n=31,532]
Maximum difference	0.14	1.58%
Patient requires adjustment to medicines	1.20 [n=14,703]	10.01% [n=84,795]
Patient does not require adjustment to medicines	1.13 [n=34,618]	10.45% [n=180,810]
Maximum difference	0.07	0.44%
Pharmacist's professional judgement	1.36 [n=7,278]	12.41% [n=53,840]
No professional judgement	1.11 [n=42,043]	9.78% [n=211,765]
Maximum difference	0.25	2.63%
Number of Chosen Eligibility Criteria	**Mean Number of Discrepancies [DMR Frequency = 49,321]**	**Item Discrepancy Proportion [Item Frequency = 265,605]**
4	1.65 [n=2,328]	12.83% [n=13,885]
3	1.39 [n=10,691]	11.40% [n=74,090]
2	1.16 [n=18,423]	10.87% [n=109,619]
1	0.94 [n=17,879]	7.72% [n=68,011]
Maximum difference	0.71	5.11%

Maximum and minimum values in each column are coloured green and red, respectively.

For ChP and NECAF, the 'medicines changed during admission' criterion had the greatest difference, whilst 'patient requires adjustment to medicines' had the least. Discrepancy occurrences increased with the number of eligibility criteria fulfilled for both datasets. Therefore, all variables were considered for inclusion in the regression model.

9.3.2.2.3. Numbers of Medicines (NECAF Dataset Only)

Figure 9.6 describes the relationships between discrepancies and the number of medicines on the DAL and that the patient was taking. Respectively, these variables had two and six missing values; therefore, they had 49,319 and 49,315 valid entries. The lowess lines suggest approximately linear relationships between the number of patient and DAL medicines with the number of discrepancies. However, the distribution of values around the line suggests a poor fit and the correlation coefficients indicated weak relationships for both variables. Including these variables in the regression model may be challenging owing to their notable zero inflation, requiring consideration of alternative link functions in a GLM.

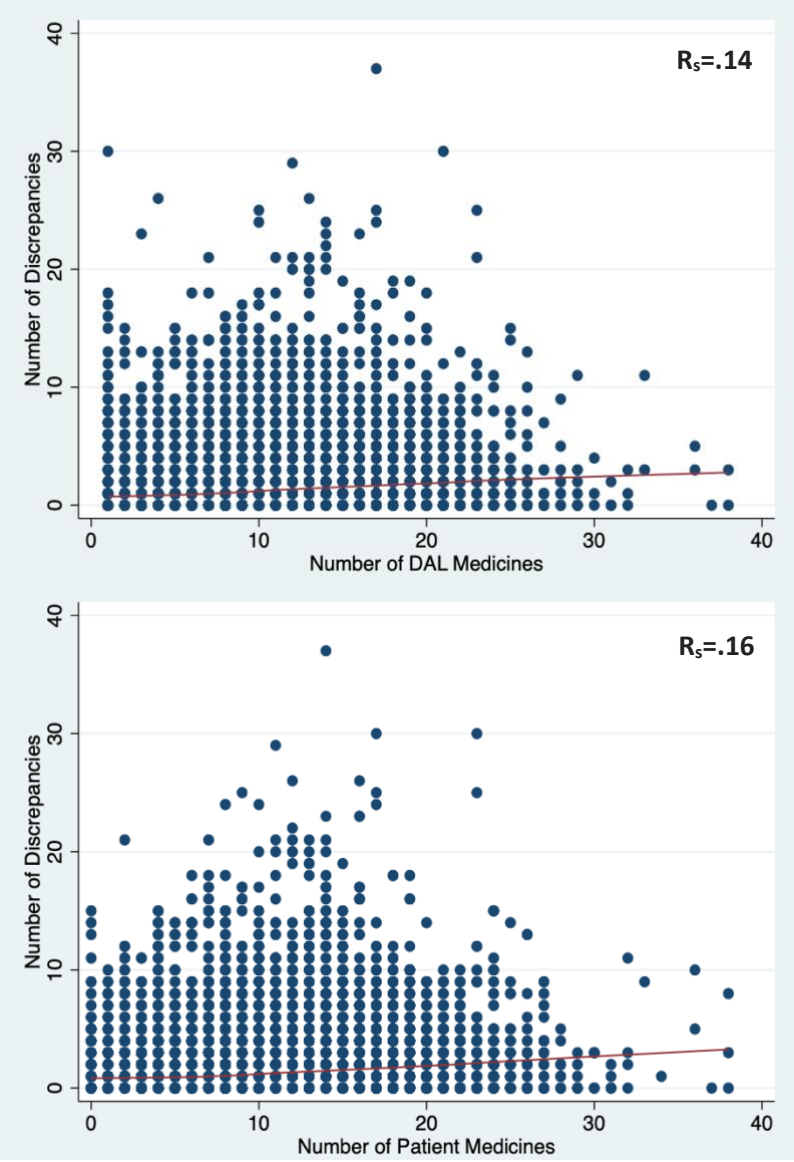


Figure 9.6: Scatter Plot Approximating the Relationship Between the Number of Medicines and Discrepancies

9.3.2.3. Pharmacy-Related Variables

9.3.2.3.1. Pharmacy, Contractor, and Pharmacist

The pharmacy ID and contractor variables had no missing values in NECAF and ChP datasets; therefore had 49,321 and 265,605 valid entries, respectively. For the NECAF dataset, the maximum mean difference [n≥100] in discrepancies for pharmacies and contractors was 6.74 and 6.81, respectively. Figure 9.7 visualises the mean number of discrepancies per pharmacy, with a reference line for the population mean. A similar distribution of values was noted for contractors.

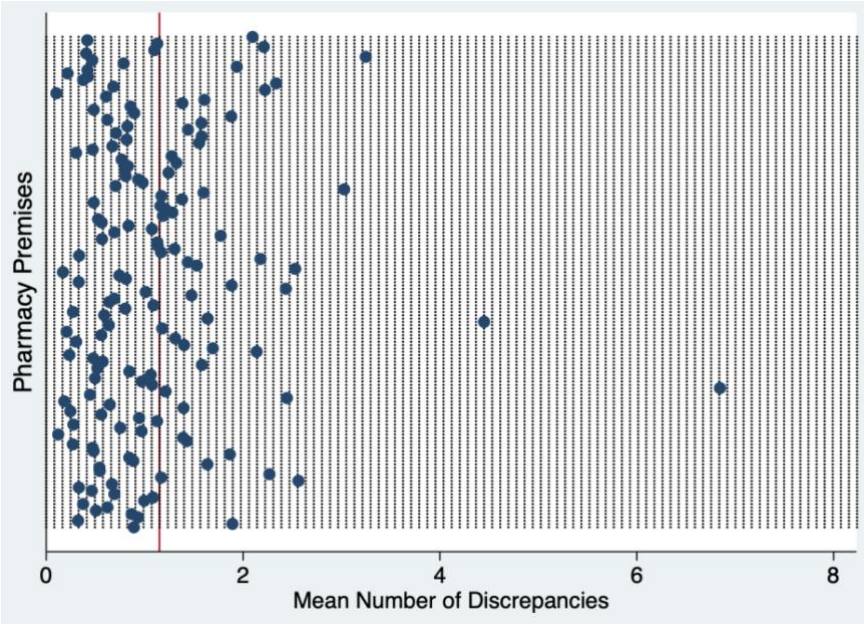


Figure 9.7: Dot Plot for the Mean Number of Discrepancies by Pharmacy ID

In the ChP combined dataset, the maximum difference in item discrepancy proportions [n≥100] for pharmacies and contractors was 78.00% and 34.83%, respectively. Data regarding the pharmacist who provided the DMR was only available in the ChP combined dataset. This variable had 48,248 missing values, leaving 217,357 valid entries. The item discrepancy proportion also varied among pharmacists, with a maximum mean difference [n≥100] of 100%. The variability in item discrepancy proportion is greatest for pharmacists, followed by pharmacy ID and contractors. However, this is associated with greater cardinality (number of groups) and lower group frequencies, which would be challenging to interpret in a regression model. Additionally, the pharmacist variable had a large proportion of missing data, leading to considerable data loss by listwise deletion. Therefore, the researcher considered the pharmacy ID more suitable for inclusion in the model.

9.3.2.3.2. Pharmacy Type

Table 9.5 describes the variation in discrepancy occurrence by pharmacy type. The maximum difference in mean and proportion of discrepancies are smaller for pharmacy type than pharmacy ID. Therefore, since the pharmacy type could not form an actionable result (as patients could not be targeted for a DMR based on the pharmacy they attend), the researcher considered it less suitable for inclusion in the model than the pharmacy ID.

Table 9.5: Discrepancy Occurrence by Pharmacy Type

Pharmacy Type	**Mean Number of Discrepancies [DMR Frequency = 49,321]**	**Item Discrepancy Proportion [Item Frequency = 265,605]**
Small chain	1.32 [n=5,134]	11.50% [n=35,686]
Independent	1.26 [n=10,025]	8.27% [n=50,950]
Large-sized multiple	1.09 [n=30,077]	10.76% [n=156,610]
Medium-sized multiple	1.07 [n=3,951]	9.08% [n=19,597]
Supermarket	0.93 [n=134]	16.26% [n=2,762]
Maximum difference	0.39	7.99%
Dichotomised Pharmacy Type	**Mean Number of Discrepancies [DMR Frequency = 49,321]**	**Item Discrepancy Proportion [Item Frequency = 265,605]**
Non-multiple (independent or small chain)	1.28 [n=15,159]	9.60% [n=86,636]
Multiple (medium, large-sized multiples and supermarket)	1.09 [n=34,162]	10.66% [n=178,969]
Maximum difference	0.19	1.06%

Maximum and minimum values in each column are coloured green and red, respectively.

9.3.2.3.3. Rural-Urban Classification, Co-location Status and Social Deprivation

Table 9.6 describes the difference in discrepancy occurrence by rural-urban classification, co-location status, and social deprivation quartile.

Table 9.6: Discrepancy Occurrence by Rural-Urban Classification, Co-location, and Social Deprivation Quartile

Rural-Urban Classification	**Mean Number of Discrepancies [DMR Frequency = 49,321]**	**Item Discrepancy Proportion [Item Frequency = 265,605]**
Villages (not sparse)	2.05 [n=237]	11.99% [n=1,051]
City and town (sparse)	1.27 [n=1,839]	16.17% [n=11,902]
Town and fringe (sparse)	1.22 [n=3,919]	14.95% [n=23,211]
City and town (not sparse)	1.17 [n=35,804]	9.82% [n=184,804]
Town and fringe (not sparse)	0.95 [n=6,859]	8.56% [n=39,916]
Villages (sparse)	0.93 [n=663]	6.46% [n=4,721]
Maximum difference	1.12	9.71%
Dichotomised Rural-Urban Classification	**Mean Number of Discrepancies [DMR Frequency = 49,321]**	**Item Discrepancy Proportion [Item Frequency = 265,605]**
Urban (city and town)	1.18 [n=37,643]	10.20% [n=196,706]
Rural (town and fringe, or villages)	1.06 [n=11,678]	10.62% [n=68,899]
Maximum difference	0.12	0.42%
Co-location Status	**Mean Number of Discrepancies [DMR Frequency = 49,321]**	**Item Discrepancy Proportion [Item Frequency = 265,605]**
Co-located	1.17 [n=16,454]	8.09% [n=79,761]
Not co-located	1.14 [n=32,867]	11.27% [n=185,844]
Maximum difference	0.03	3.18%
Social Deprivation Quartile	**Mean Number of Discrepancies [DMR Frequency = 49,321]**	**Item Discrepancy Proportion [Item Frequency = 265,605]**
Quartile 1 (most deprived)	1.44 [n=17,032]	11.28% [n=89,295]
Quartile 3	1.14 [n=8,908]	11.84% [n=50,038]
Quartile 2	0.94 [n=16,560]	9.04% [n=86,222]
Quartile 4 (least deprived)	0.94 [n=6,821]	8.99% [n=40,050]
Maximum difference	0.50	2.85%

Maximum and minimum values in each column are coloured green and red, respectively.

Discrepancy occurrence varied with pharmacy rural-urban classification. Although the dichotomised variable had a smaller effect size, its lower cardinality and larger group size would make it easier to interpret in the model. Additionally, discrepancy occurrence differed between the social deprivation quartiles and co-location status, supporting their inclusion as predictors.

9.3.2.4. Service-Related Variables

9.3.2.4.1. DMR Year, Discharge and DMR Weekend Status

Figure 9.8 describes the relationship between discrepancy occurrence and DMR1 year. Neither NECAF nor ChP combined datasets had missing values for the DMR1 year, so they had 49,321 and 265,605 valid entries, respectively. Since the ChP combined dataset only had 15 entries in 2015, they were grouped into 2016 to ease interpretation.

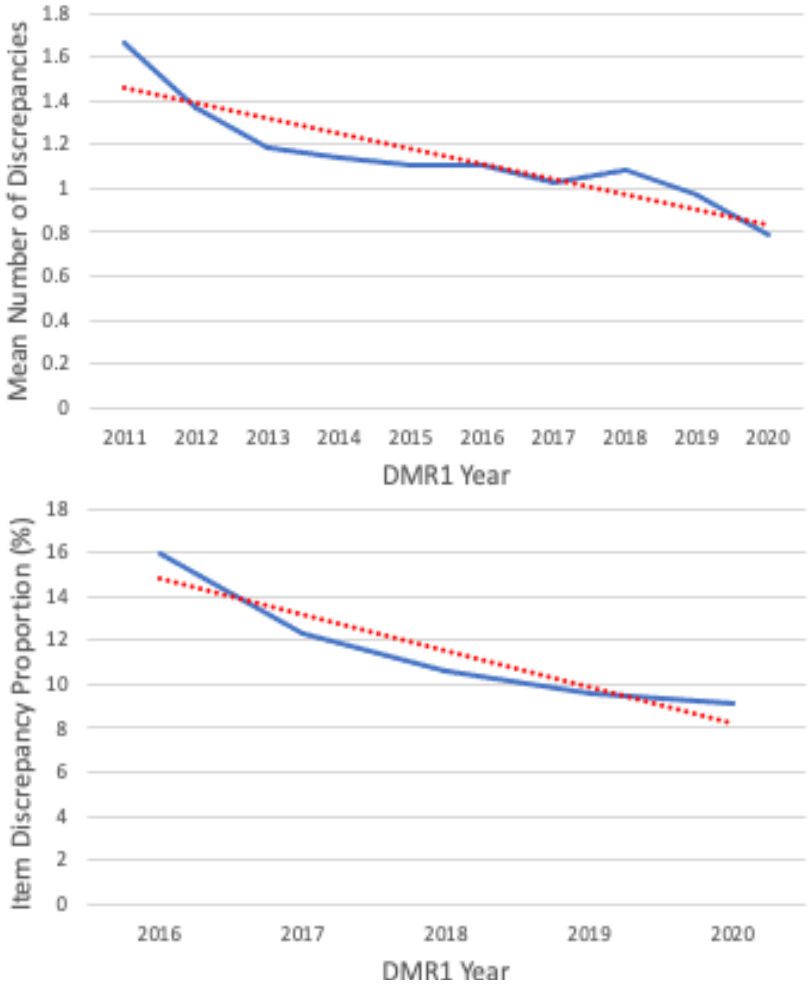


Figure 9.8: Line Plot Showing Discrepancy Occurrence by DMR1 Year

There is a clear difference in discrepancy occurrence over time, with a maximum mean difference of 0.88 for NECAF DMRs, and a maximum difference in item discrepancy proportion of 6.90% for ChP DMRs. These relationships appear approximately linear, so they are likely suitable for inclusion as numerical predictors. Table 9.7 describes the discrepancy occurrence by discharge and DMR1 weekend status.

Table 9.7: Discrepancy Occurrence by Weekend Status

Discharge Weekend Status	**Mean Number of Discrepancies [DMR Frequency = 49,313†]**	**Item Discrepancy Proportions [Item Frequency = 265,447††]**
Weekday	1.15 [n=46,660]	10.20% [n=249,385]
Weekend	1.13 [n=2,653]	12.04% [n=16,062]
Maximum difference	0.02	1.84%
DMR1 Weekend Status	**Mean Number of Discrepancies [DMR Frequency = 49,321]**	**Item Discrepancy Proportions [Item Frequency = 265,605]**
Weekday	1.15 [n=46,499]	10.24% [n=242,888]
Weekend	1.07 [n=2,822]	11.12% [n=22,717]
Maximum difference	0.08	0.88%

Maximum and minimum values in each column are coloured green and red, respectively.
†Eight missing values. ††158 missing values.

For NECAF DMRs, discrepancy occurrence was lower for patients discharged on the weekend compared to ChP DMRs, which were higher, but these differences were small. The researcher considered including the discharge weekend status in the subsequent model since the results would be actionable, i.e., patients could be targeted for DMR referrals if discharged on the weekend.

9.3.2.4.2. Number of Days Between Discharge and DMR1

In the NECAF and ChP combined datasets, the 'days between discharge and DMR1' variable had eight and 158 missing values, respectively. Section 6.3.5.1 described the maximum number of days between discharge and DMR1 as 2,196. The researcher identified and removed statistical outliers for the EDA; otherwise, data visualisation would be challenging.[37] Respectively, there were 147 and 1584 statistical outliers in the NECAF and ChP combined datasets (number of days >125 or >120), leaving 49,166 and 263,863 entries.

Figure 9.9 describes the relationship between the number of discrepancies (NECAF) and the days between discharge and DMR1. The lowess line showed a complex relationship between the days between discharge and DMR1 and the number of discrepancies. The correlation coefficient suggested that this relationship was very weak.

[37]Defined using z-score>3.29, as described in Section 5.4.3.3.1.

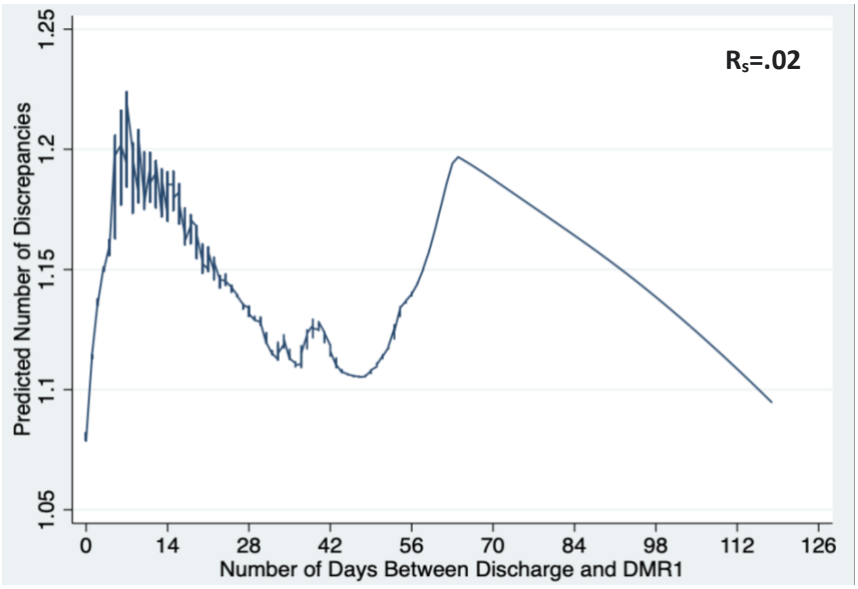


Figure 9.9: Lowess Line Approximating the Relationship Between the Predicted Number of Discrepancies and Number of Days Between Discharge and DMR1

Figure 9.10 describes a similar initial relationship for ChP DMRs between 0 and 56 days. After 56 days, the proportion of item discrepancies increased. The maximum proportion difference for the discretised number of days between discharge and DMR1 was 8.04%.

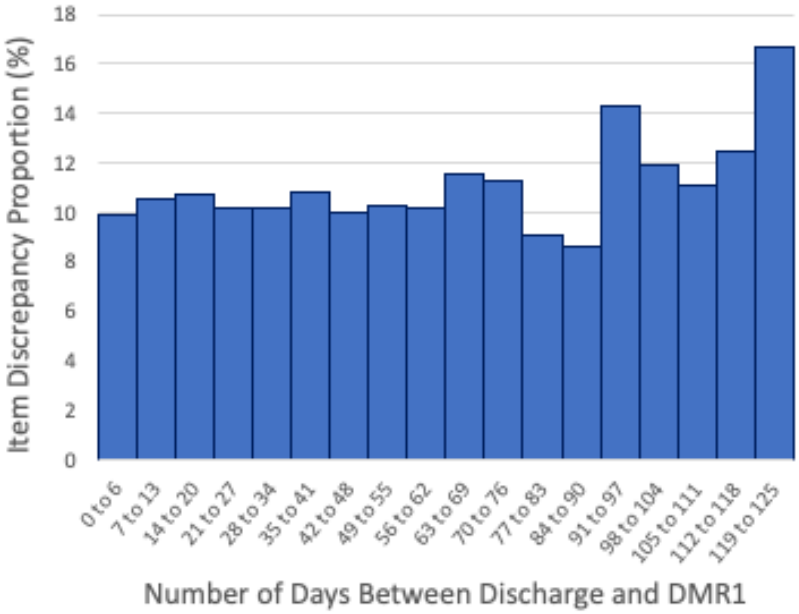


Figure 9.10: Relationship Between the Item Discrepancy Proportion and the Number of Days Between Discharge and DMR1

Although there appears to be a relationship between the outcome variables and the number of days between discharge and DMR, the complex relationship and presence of outliers may make it challenging to include as a predictor. Although inclusion in the model was desired as a control, the researcher considered transformations such as categorising into discrete groups.

9.3.2.4.3. DMR Delivery Method

Table 9.8 describes the discrepancy occurrence by the DMR1 delivery method. In contrast to ChP,

NECAF DMRs with carer involvement and those conducted in the pharmacy appear to have lower discrepancy rates than those without carer involvement and distant from the pharmacy. Since discrepancy occurrence varied by each measure of DMR1 delivery methods, they were all considered for inclusion as predictors. However, the original DMR1 delivery method predictor had missing values, and the derived predictors may be more actionable, i.e., identifying patients for DMRs who have a carer.

Table 9.8: Discrepancy Occurrence by the DMR1 Delivery Method

DMR1 Delivery Method	**Mean Number of Discrepancies [DMR Frequency = 49,321]**	**Item Discrepancy Proportion [Item Frequency = 265,560†]**
With patient at pharmacy (with carer)	1.23 [n=4,288]	11.93% [n=8,600]
With patient by telephone	1.22 [n=16,463]	9.98% [n=98,571]
Other	1.19 [n=598]	10.13% [n=22,479]
With carer at pharmacy (without patient)	1.12 [n=15,863]	10.31% [n=87,449]
With patient at home/care home	1.09 [n=815]	Not available in ChP
With patient at pharmacy (without carer)	1.07 [n=11,294]	10.80% [n=48,461]
Maximum difference	0.16	1.95%
DMR1 Carer Involvement	**Mean Number of Discrepancies [DMR Frequency = 49,321]**	**Item Discrepancy Proportion [Item Frequency = 265,605]**
Unknown carer involvement	1.19 [n=598]	5.86% [n=1,468]
No carer involvement	1.15 [n=28,572]	10.20% [n=150,834]
Carer involvement	1.14 [n=20,151]	10.52% [n=113,303]
Maximum difference	0.05	4.66%
DMR1 Pharmacy Status	**Mean Number of Discrepancies [DMR Frequency = 49,321]**	**Item Discrepancy Proportion [Item Frequency = 265,605]**
Service not conducted in pharmacy	1.21 [n=17,278]	10.01% [n=117,466]
Unknown if conducted in pharmacy	1.19 [n=598]	9.15% [n=2,514]
Service conducted in pharmacy	1.12 [n=31,445]	10.58% [n=145,625]
Maximum difference	0.09	1.43%

Maximum and minimum values in each column are coloured green and red, respectively.
†45 missing values.

9.3.2.5. Medicines-Related Variables (ChP Combined Dataset Only)

9.3.2.5.1. Incomplete Item Description

The item discrepancy proportion was 18.88% [n=1,414] when the item description was incomplete (see Section 5.4.3.4.5) and 10.27% [n=264,191] when complete. The maximum difference in discrepancy proportion was 8.61%, showing the relationship between discrepancies and incomplete item descriptions. Therefore, the researcher considered including this variable as a regression predictor.

9.3.2.5.2. Anatomical Therapeutic Chemical (ATC) Classification and High-Risk Criteria

Table 9.9 describes the item discrepancy proportion by ATC classification, presenting all ATC1 groups alongside the five ATC2 and ATC4 groups with the highest and lowest discrepancy proportions.

Table 9.9: Item Discrepancy Rate by Anatomical Therapeutic Chemical (ATC) Classification

ATC1 Groups with n≥100 [n=265,605]	**Item Discrepancy Proportion**	**Item with the Largest Discrepancy Proportion†**
Various [n=1,975]	19.65%	Nutrition supplements (21.74%)
Anti-infectives for systemic use [n=7,007]	16.20%	Clarithromycin (21.32%)
Nervous system [n=50,024]	11.89%	Nicotine transdermal (30.39%)
Dermatological [n=6,076]	11.45%	Clotrimazole (18.38%)
Alimentary tract and metabolism [n=55,980]	11.19%	Magnesium (26.32%)
Appliances [n=607]	11.04%	Needles/testing strips (13.64%)
Antineoplastic and immunomodulating agents [n=1,642]	10.60%	Azathioprine (16.07%)
Cardiovascular system [n=62,430]	9.82%	Amiodarone (16.18%)
Musculoskeletal system [n=7,137]	9.15%	Naproxen (22.71%)
Blood and blood-forming organs [n=29,236]	8.93%	Dalteparin (19.51%)
Respiratory system [n=22,052]	8.08%	Cyclizine oral (16.89%)
Sensory organs [n=5,475]	7.96%	Chloramphenicol (20.18%)
Systemic hormonal preparations, excluding sex hormones and insulins [n=9,589]	7.57%	Dexamethasone oral (22.26%)
Genito urinary system and sex hormones [n=6,196]	6.08%	Estriol topical (14.41%)
Antiparasitic products, insecticides, and repellents [n=175]	3.43%	Hydroxychloroquine (2.91%)
Maximum difference	16.22%	N/A
ATC2 Groups with n≥100 [n=265,605]	**Item Discrepancy Proportion**	**Item with the Largest Discrepancy Proportion†**
Five ATC2 Groups with the Largest Item Discrepancy Proportions		
Antivirals for systemic use [n=299]	22.74%	Aciclovir (16.31%)
Anti-inflammatory and antirheumatic products [n=592]	21.62%	Naproxen (22.71%)
General nutrients [n=1,465]	20.61%	Nutrition supplements (21.74%)
All other therapeutic products [n=212]	25.47%	No items with ≥100 entries.
Antiemetics and antinauseants [n=281]	19.93%	Ondansetron oral (22.78%)
Five ATC2 Groups with the Smallest Item Discrepancy Proportions		
Lipid-modifying agents [n=13,633]	5.36%	Atorvastatin (6.12%)
Endocrine therapy [n=636]	5.19%	Letrozole (3.91%)
Antigout preparations [n=1,731]	4.91%	Colchicine (19.23%)
Antiprotozoals [n=174]	3.45%	Hydroxychloroquine (2.91%)
Thyroid therapy [n=5,475]	3.27%	Carbimazole (10.76%)
Maximum difference [n≥100]	19.47%	N/A

Table 9.9 (continued)

ATC4 Groups with n≥100 [n=265,605]	Item Discrepancy Proportion	Item with the Largest Discrepancy Proportion†
Five ATC4 Groups with the Largest Item Discrepancy Proportions		
Drugs used in nicotine dependence [n=965]	28.39%	Nicotine transdermal (30.39%)
Neuraminidase inhibitors [n=100]	27.00%	No items with ≥100 entries.
Magnesium [n=213]	25.82%	Magnesium (26.32%)
Potassium [n=286]	24.48%	Potassium chloride oral (24.82%)
Propionic acid derivatives [n=449]	22.49%	Naproxen (22.71%)
Five ATC4 Groups with the Smallest Item Discrepancy Proportions		
Gonadotropin-releasing hormone analogues [n=110]	3.64%	No items with ≥100 entries.
Aromatase inhibitors [n=351]	3.42%	Letrozole (3.91%)
Fibrates [n=238]	3.36%	Fenofibrate (4.19%)
Thyroid hormones [n=5,306]	3.00%	Levothyroxine (2.98%)
Aminoquinolines [n=172]	2.91%	Hydroxychloroquine (2.91%)
Maximum difference [n≥100]	25.48%	N/A

†The condensed item with the highest discrepancy rate (where n≥100) is presented for context.

There are considerable differences in item discrepancy proportion by ATC classification, the largest for ATC4 groups and the smallest for ATC1. Although this would suggest including ATC4 in the regression predictor subset, the cardinality would make the results difficult to interpret. Therefore, the researcher considered including ATC2 and transforming the predictors. Table 9.10 describes item discrepancy proportions by high-risk criteria defined by Lin et al. (2017) (see Section 5.4.3.4.2).

Table 9.10: Item Discrepancy Rate by High-Risk Criteria

High-Risk Criteria Broad Criteria with n≥100 [n=265,605]	**Item Discrepancy Proportion**	**Item with the Largest Discrepancy Proportion†**
Non-steroidal anti-inflammatory drugs (NSAIDs) [n=540]	22.41%	Naproxen (22.71%)
Narcotics [n=8,438]	17.01%	Codeine (22.93%)
Diuretics [n=12,046]	13.97%	Indapamide (16.07%)
Benzodiazepines/Z-hypnotics [n=3,707]	12.95%	Lorazepam (18.76%)
Anti-arrhythmics [n=2,276]	10.54%	Amiodarone (16.18%)
Antihypertensives [n=27,809]	10.34%	Sacubitril/valsartan (15.45%)
None [n=165,996]	10.14%	Nicotine transdermal (30.39%)
Antipsychotics [n=2,312]	10.12%	Lithium carbonate (12.06%)
Anticonvulsants [n=4,868]	9.65%	Valproic acid (11.03%)
Anticoagulants [n=4,509]	9.09%	Dalteparin (19.51%)
Diabetic agents [n=10,626]	8.91%	Insulin isophane (14.81%)
Antiplatelets [n=11,588]	8.21%	Aspirin high dose (22.08%)
Antidepressants [n=10,890]	6.59%	Venlafaxine (11.13%)
Maximum difference [n≥100]	15.82%	N/A
High-Risk Criteria Narrow Criteria with n≥100 [n=265,605]	**Item Discrepancy Proportion**	**Item with the Largest Discrepancy Proportion†**
Five Narrow High-Risk Criteria with the Largest Item Discrepancy Proportions		
Non-selective NSAIDs [n=521]	23.03%	Naproxen (22.71%)
Strong narcotics [n=3,360]	17.05%	Morphine oral (17.87%)
Weak narcotics [n=5,078]	16.98%	Codeine (22.93%)
Class 1 and 3 anti-arrhythmics [n=472]	16.31%	Amiodarone (16.18%)
Low-ceiling diuretics [n=1,069]	15.53%	Indapamide (16.07%)
Five Narrow High-Risk Criteria with the Smallest Item Discrepancy Proportions		
Antiplatelets [n=11,588]	8.21%	Aspirin high dose (22.08%)
Other antidepressants [n=2,292]	7.46%	Mirtazapine (7.43%)
Serotonin and norepinephrine reuptake inhibitor [n=1,289]	6.44%	Venlafaxine (11.13%)
Alpha-blockers [n=138]	5.80%	No items with ≥100 entries.
Selective serotonin reuptake inhibitors [n=4,943]	4.94%	Sertraline (5.56%)
Maximum difference [n≥100]	18.09%	N/A

†The condensed item with the highest discrepancy rate (where n≥100) is presented for context.

Broad high-risk criteria described much less variability than the narrow criteria, in which non-selective NSAIDs had a higher discrepancy rate than the other groups. Although these criteria had a relationship with discrepancy occurrence, the effect size was smaller than for the ATC classifications. Therefore, the researcher considered the ATC classifications more suitable for inclusion in the model, although this must be weighed against their increased cardinality.

9.3.2.5.3. Controlled Drug Status, Route of Administration and Dosage Form

The discrepancy proportion for controlled drugs was 15.32% [n=15,758], contrasted with 10.00% [n=249,847] for non-controlled drugs, indicating a relationship between controlled drug status and discrepancy rate. Therefore, controlled drug status was considered for inclusion in the regression model.

Table 9.11 describes the variation in item discrepancy rate by route of administration and dosage form. The variability in discrepancies was greater for dosage form than route; however, its associated cardinality would make results challenging to interpret.

Table 9.11: Item Discrepancy Rate by Route of Administration and Dosage Form

Route of Administration with n≥100 [n=265,605]	**Item Discrepancy Proportion**
Intravenous [n=319]	19.75%
Dressings [n=322]	17.70%
Transdermal [n=2,161]	17.17%
Rectal [n=204]	16.67%
Oropharyngeal [n=668]	13.62%
Subcutaneous [n=4,952]	13.13%
Parenteral indistinct [n=305]	12.79%
Topical [n=7,824]	11.80%
Auricular [n=100]	11.00%
Device [n=646]	10.84%
Oral [n=221,422]	10.41%
Intramuscular [n=956]	9.52%
Nasal [n=910]	7.91%
Ophthalmic [n=5,336]	7.81%
Sublingual [n=2,863]	7.51%
Inhaled [n=16,421]	7.24%
Maximum difference [n≥100]	12.51%
Dosage Form with n≥100 [n=265,605]	**Item Discrepancy Proportion**
Five Dosage Forms with the Largest Item Discrepancy Proportions	
Testing strips [n=117]	22.22%
Unknown [n=642]	21.18%
Dressing [n=230]	17.39%
Cutaneous patch [n=162]	17.28%
Transdermal patch [n=2,161]	17.17%
Five Dosage Forms with the Smallest Item Discrepancy Proportions	
Eye drops [n=4,375]	7.36%
Sublingual spray [n=2,638]	7.13%
Pressurised inhalation [n=9,185]	6.37%
Inhaler unknown [n=117]	5.98%
Asthma devices [n=182]	4.40%
Maximum difference [n≥100]	17.82%

9.3.2.5.4. Dosage Direction Features

Table 9.12 describes the item discrepancy rate by dosage direction features.

Table 9.12: Item Discrepancy Rate by Dosage Direction Features

Dosage Direction Feature [n=265,605]	Item Discrepancy Proportion
When-required dosage feature [n=25,830]	12.08%
No when-required dosage feature [n=239,775]	10.12%
Maximum difference	1.96%
As-directed dosage feature [n=255,192]	10.33%
No as-directed dosage feature [n=10,413]	9.89%
Maximum difference	0.44%
Change after discharge dosage feature† [n=5,594]	17.09%
No change after discharge dosage feature [n=260,011]	10.17%
Maximum difference	6.92%

†A dosage direction describing planned changes in medicine dose or strength after discharge.

Discrepancy proportions were larger for items that include 'when-required' and 'change after discharge' dosage direction features in contrast to 'as-directed' features, which had lower proportions. 'Change after discharge' represented the largest effect size for all features, while 'as-directed' represented the smallest. Nonetheless, all features were considered for inclusion in the model since they have relationships with discrepancy occurrence.

9.3.3. Summary of Candidate Predictor Selection

The researcher analysed both NECAF and ChP DMRs for EDA but did not consider both necessary for regression because they described similar concepts. The ChP combined dataset contained more granular discrepancy information, including individual medicines, which was considered essential for developing actionable guidance for DMR prioritisation. The EDA showed how the number of discrepancies had considerable zero inflation and complex relationships with other predictors, e.g., patient age. Therefore, the researcher chose item discrepancy occurrence (ChP combined dataset) as the most appropriate outcome variable.

Table 9.13 summarises the EDA results. Since all variables appeared to have relationships with item discrepancy occurrence, the researcher considered them all appropriate for inclusion in the model. The researcher included an interaction term between the 'patient age' and the 'number of medicines' predictors since Section 9.3.2.2.1 indicated the presence of an interaction effect.

Table 9.13: Summary of Relationships Between Item Discrepancy Proportion and Candidate Predictors

Predictor Descriptor	Categorical Predictor [Number of Groups]	Group with Largest Item Discrepancy Proportion [n≥100]	Group with Smallest Item Discrepancy Proportion [n≥100]	Maximum Difference in Proportions [n≥100]	Missing Values (%)
Discharge-setting-related	Discharging hospital [n=105]	Princess Royal Hospital	Ysbyty Ystrad Fawr	18.8%	0.0%
	Discharging healthcare organisation [n=15]	English hospital	Care home	10.7%	0.0%
	Discharge information provider [n=5]	Other provider	Hospital	5.7%	0.0%
	eDAL availability [n=2]	eDAL not available	eDAL available	1.8%	0.0%
Patient-related	Medicines changed during discharge [n=2]	Yes	No	5.3%	0.0%
	Number of eligibility criteria [n=4]	Four criteria	One criterion	5.1%	0.0%
	Pharmacist's professional judgement [n=2]	Yes	No	2.6%	0.0%
	Patient taking four or more medicines [n=2]	No	Yes	1.6%	0.0%
	Patient requires adjustment to medicines [n=2]	No	Yes	0.4%	0.0%
	Patient gender [n=2]	Female	Male	0.4%	0.0%
Pharmacy-related	Pharmacist providing DMR [n=824]	Pharmacist 12	Pharmacist 76	100.0%	18.2%
	Pharmacy ID [n=580]	Pharmacy 486	Pharmacy 566	78.0%	0.0%
	Contractor [n=116]	Contractor 21	Contractor 4	34.8%	0.0%
	Rural-urban classification [n=6]	City and town (sparse)	Villages (sparse)	9.7%	0.0%
	Pharmacy type [n=5]	Supermarket	Independent	8.0%	0.0%
	Social deprivation quartile [n=4]	Quartile 3	Quartile 4	2.9%	0.0%
	Co-location status [n=2]	Not co-located	Co-located	3.2%	0.0%
	Dichotomised pharmacy type [n=2]	Multiple	Non-multiple	1.1%	0.0%
	Dichotomised rural-urban classification [n=2]	Rural	Urban	0.4%	0.0%
Service-related	DMR1 year [n=5]	2016	2020	6.9%	0.0%
	DMR1 with carer [n=3]	Carer involvement	Unknown carer involvement	4.7%	0.0%
	DMR1 delivery method [n=5]	With patient at pharmacy (with carer)	With patient by telephone	2.0%	0.0%
	Discharge weekend status [n=2]	Weekend	Weekday	1.8%	0.1%
	DMR1 in pharmacy [n=3]	Service conducted in pharmacy	Unknown if conducted in pharmacy	1.4%	0.0%
	DMR1 weekend status [n=2]	Weekend	Weekday	0.9%	0.0%

Table 9.13 (continued)

Predictor Descriptor	Categorical Predictor [Number of Groups]	Group with Largest Item Discrepancy Proportion [n≥100]	Group with Smallest Item Discrepancy Proportion [n≥100]	Maximum Difference in Proportions [n≥100]	Missing Values (%)
Medicines-related	ATC4 groups [n=413]	Drugs used in nicotine dependence	Aminoquinolines	25.5%	0.0%
	ATC2 groups [n=87]	Anti-inflammatory and antirheumatic products	Thyroid therapy	19.5%	0.0%
	Narrow high-risk drug classification [n=33]	Non-selective NSAIDs	Selective serotonin reuptake inhibitors	18.1%	0.0%
	Dosage form [n=58]	Testing strips	Asthma devices	17.8%	0.0%
	ATC1 groups [n=16]	Various	Antiparasitic products, insecticides, and repellents	16.2%	0.0%
	Broad high-risk drug classification [n=13]	Non-steroidal anti-inflammatory drugs	Antidepressants	15.8%	0.0%
	Route of administration [n=25]	Intravenous	Inhaled	12.5%	0.0%
	Incomplete item description [n=2]	Item discrepancy incomplete	Item discrepancy complete	8.6%	0.0%
	Change direction dosage feature [n=2]	Feature present	Feature absent	6.9%	0.0%
	Controlled drug status [n=2]	Controlled drug	Non-controlled drug	5.3%	0.0%
	When-required dosage feature [n=2]	Feature present	Feature absent	2.0%	0.0%
	As-directed dosage feature [n=2]	Feature present	Feature absent	0.4%	0.0%
Predictor Descriptor	**Numerical Predictor**	**Nature of Relationship**		**Maximum Difference in Proportions [n≥100]**	**Missing Values (%)**
Patient-related	Number of patient medicines	N/A		N/A	N/A
	Number of discharge medicines	N/A		N/A	N/A
	Patient age	Curvilinear relationship with maximum item discrepancy occurrence at 0-19 years and 100-109 years.		17.2%	18.2%
Service-related	Number of days between discharge and DMR1	Curvilinear relationship with a positive relationship between days 0 and 28, then a negative.		8.0%	0.1%

Maximum and minimum values in each column are coloured green and red, respectively.

9.4. Finalising Predictor Subset

Several overlapping predictors, e.g., the discharging hospital and healthcare organisation, would likely be collinear and thus violate regression assumptions. Therefore, the researcher chose between these overlapping variables using the EDA results (Table 9.14).

Table 9.14: Chapter 9 Choice of Overlapping Candidate Predictors

Variable	Considered Predictors	Rationale
Pharmacy-related	Pharmacy ID	• The 'pharmacist providing DMR' variable had the largest effect size but had a considerable proportion (18.2%) of missing data. • Pharmacy ID was considered because it had the next largest effect size without being limited by missing data.† • Including pharmacy ID would be challenging because of high cardinality; therefore, the researcher included it as a random effect (see Section 9.5). • The researcher did not include other pharmacy-related predictors, e.g., co-location status, since these results would not be actionable, violating parsimony principles.
	Pharmacist providing DMR	
	Contractor name	
	Rural-urban classification	
	Dichotomised rural-urban classification	
	Co-location status	
	Social deprivation quartile	
	Pharmacy type	
	Dichotomised pharmacy type	
Discharge-setting-related	Discharging hospital	• The discharging hospital had a larger effect size and cardinality than the discharging healthcare organisation. • The researcher aimed to include the discharging hospital as a random effect as above.
	Discharging healthcare organisation	
DMR delivery method	Pharmacy status	• The carer and pharmacy status predictors account for a considerable proportion of the DMR delivery method effect size whilst having lower cardinality. • Whilst the results from carer status could be actionable (targeting patients with carers for DMRs), those for pharmacy status are less-so. Nonetheless, it was included as a control.
	Carer status	
	DMR delivery method	
Weekend status	Discharge weekend status	• Discharge weekend status had a larger effect size, and its results would be more actionable than DMR1 weekend status.
	DMR1 weekend status	
Item classification	Broad high-risk classification	• ATC4 groups had the largest effect size, but the high cardinality would make it difficult to interpret when dummy encoded. • ATC2 groups were a compromise between explanatory power and cardinality. The researcher further condensed ATC2 groups to reduce cardinality (see Table 9.15).
	Narrow high-risk classification	
	ATC1 groups	
	ATC2 groups	
	ATC4 groups	
Item formulation	Route of administration	• Although the dosage form had a larger effect size, it also had greater cardinality, which would be difficult to interpret. • Therefore, the route of administration was chosen as a compromise between effect size and cardinality.
	Dosage form	

Chosen predictors are coloured yellow.

†Since the researcher chose listwise deletion of missing values for regression (see Section 7.3.2), predictors with large proportions of missing values will lead to the deletion of large quantities of data, sacrificing statistical power.

Table 9.15 presents the researcher's considerations for predictor transformations to optimise regression model interpretability.

Table 9.15: Chapter 9 Predictor Transformations

Predictor	Transformation
Days between discharge and DMR1†	• Section 9.3.2.4.2 described a complex relationship between this predictor and the outcome, which would be challenging to include in the regression model. • Dichotomisation retains some of the effect size but removes the complex relationship. • Therefore, the researcher dichotomised to 'under 28 days' and '28 days or over'. • The 28-day cut-off was chosen to reflect the recommended DMR timescale from its service specification (CPW 2011).
Discharge information provider	• Dichotomised to 'hospital' and 'not hospital' information providers. • The 'hospital' group had a much higher frequency than the other groups combined. • Since the effect size was relatively small, the researcher dichotomised the predictor to improve interpretability.
Route of administration	• Route of administration had high cardinality with small group sizes. • Groups were combined using domain knowledge (see Appendix 9.1).
ATC2 groups	• ATC2 groups had high cardinality and would be difficult to interpret. • The researcher considered combining groups whilst retaining the information about 'high-risk' drugs. • Groups outside the top 80% cumulative frequency were categorised as 'other'. The researcher made manual changes to ensure the groups included 'high-risk items and to minimise potential multicollinearity (see Appendix 9.2).
DMR1 year	• Cardinality is reduced by including the predictor as numerical. • Numerical predictors assume a linear effect on the outcome over time, but Section 9.3.2.4.1 suggested that the relationship was approximately linear. • The researcher included DMR1 year as the number of years since the first available DMR year, i.e., 2016 encoded as '0', 2017 encoded as '1'. • The DMR1 year values of 2015 [n=15] were encoded as '0'.
Patient age	• Patient age contained 18.2% missing values, leading to considerable data loss if subjected to listwise deletion. • The researcher considered grouping of patient age would be preferable to predictor exclusion or data loss. • Patient age was grouped into '0 to 39 years', '40 to 79 years', 'over 80 years', and 'unknown age' (encompassing the missing values). • The age groups were chosen to reflect the relationship with the outcome described in Section 9.3.2.2.1.

†The dichotomised predictor grouped the outliers into >28 days.

After data transformation, the only included predictors with missing data were the discharge weekend status [n=158] and the dichotomised number of days between discharge and DMR1 [n=158]. These missing values were deleted listwise to prepare the data for regression since it has lower risks of biased results than pairwise deletion (see Section 7.3.2). Therefore, 158 entries were deleted, leaving 265,447 in the dataset.

Table 9.16 describes the chosen reference categories for dummy encoding of categorical predictors.

Table 9.16: Chapter 9 Dummy Encoding Reference Categories

Predictor	Reference Category	Rationale
Dichotomised days between discharge and DMR1	Less than 28 days	Ease of interpretation.
Eligibility criteria	Criterion not met	
eDAL availability	eDAL not available	
Discharge weekend status	Not a weekend	
DMR carer status	No carer present	
ATC2 condensed	'Other'	
When-required/as-directed/change after discharge dosage features	Features not present	
Gender	Male	Ease of interpretation (the EDA indicated males had a lower discrepancy rate).
Patient age	Age 80+	Ease of interpretation (the EDA indicated age 80+ had the lowest discrepancy rate).
Discharge information provider	Hospital	Largest group size
DMR pharmacy status	DMR in pharmacy	
Route of administration	Oral	

The researcher included the interaction effect between the number of DAL medicines and patient age by generating interaction terms for each dummy predictor of patient age (0 to 39 years, 40 to 79 years, and unknown age).

9.5. Checking Regression Assumptions and Choosing Model Type

Since the outcome (discrepancy occurrence) was a binary variable, logistic regression was the most appropriate model type (Field 2018). Therefore, the researcher only considered the independence of observations and multicollinearity assumptions because logistic regression does not assume homoscedasticity or linearity of response (Hosmer et al. 2013).

Section 7.2.1 introduced the concept of intra-subject variability, which describes data where the measurement of the outcome variable (discrepancy occurrence) varies depending on the data subject, violating the independence of observations (Hoffmann 2016). Table 9.13 summarised that discrepancy identification varied considerably by pharmacy ID (maximum mean difference = 78%) and discharging hospital (maximum mean difference = 19%). To control for this variability, the researcher considered including them in the model as random effects and calculated their intra-class correlations (ICCs). The ICC was 8.3% for the discharging hospital and 22.1% for pharmacy ID. Therefore, the researcher included pharmacy ID as a random effect but did not include the discharging hospital since random effects are typically included if their ICC is over 10% (Huang 2018).

The researcher then determined multicollinearity by calculating the Variation Inflation Factor (VIF) for all predictors, with values over 2.5 indicating violations of the assumption (see Section 7.3.3). Appendix 9.3 presents all VIF values, whilst Table 9.17 presents only those with a VIF over 2.5. The

researcher theorised that removing the 'number of eligibility criteria' and 'controlled drug status' predictors would resolve the multicollinearity since they were likely to be correlated with the individual eligibility criteria and opioid analgesics (mostly controlled drugs), respectively.

Table 9.17: Variation Inflation Factor (VIF) Values for Chapter 9 Predictors

Predictor	Variance Inflation Factor (VIF)	Adjusted VIF†
Number of eligibility criteria	8,427.9	N/A
Patient requires adjustment to medicines	2,516.8	1.1
Medicines changed during admission	2,314.1	1.0
Pharmacist's professional discretion	1,872.7	1.0
Patient taking four or more medicines	1,209.8	1.0
Controlled drug status	4.7	N/A
Opioid analgesics	4.4	1.3

†VIF value once the researcher removed the 'number of eligibility criteria' and 'controlled drug status' predictors (coloured red).

Once the researcher had removed these predictors, the remaining predictors had a VIF under 2.5, showing that the data met the multicollinearity assumption.

9.6. Considerations for Further Predictor Selection

The researcher considered whether to include all of the predictor subset in the final model or to conduct further predictor selection. One consideration for this was the Events per Variable (EPV), which describes the ratio of 'events' (discrepancies) to the number of predictors, for which the researcher chose the literature threshold of at least 50 (see Section 7.2.2). Therefore, the 27,392 events in the ChP combined dataset would support a maximum of 547 (27,392/50) predictors. There were 50 chosen predictors (including the interaction terms), fulfilling the EPV rule-of-thumb.

Although the data met the EPV rule-of-thumb, the researcher considered that interpreting a model with so many predictors would be challenging, working against the principle of parsimony. Therefore, the researcher used augmented backward selection[38] for further predictor selection, in line with Steyerberg (2019), who suggested using smaller models to develop clinical guidelines. All predictors were entered into preliminary Model 1; statistically non-significant predictors ($p>0.05$) were removed iteratively, starting with the predictor with the largest p-value. If the removal of a predictor did not change any other regression coefficient (change-in-estimate) by more than 20%, it was excluded from the model. Table 9.18 presents the iterative model development for this chapter (see Appendix 9.4 for regression coefficients and their changes-in-estimate).

[38]See Section 7.3.4 for the rationale for using augmented backwards selection.

Table 9.18: Results for Chapter 9 Preliminary Model Iterations

Model Iteration	Bayesian Information Criteria (BIC)†	Statistically Non-significant Predictors	Outcome
Preliminary Model 1 (all predictors)	157,320	Pharmacist's professional judgement (p=0.066) and as-directed dosage feature (p=0.125)	• Removed the 'as-directed dosage feature' predictor for the next model iteration.
Preliminary Model 2 (all predictors except 'as-directed dosage feature')	157,310	Pharmacist's professional judgement (p=0.065)	• Excluded the 'as-directed dosage feature' predictor since the maximum change-in-estimate was 7.5% (antithrombotic agents). • Removed 'pharmacist's professional judgement' for the next model iteration.
Preliminary Model 3 (all predictors except 'as-directed dosage feature' and 'pharmacist's professional judgement')	157,301	None	• Excluded 'pharmacist's professional judgement' since the maximum change-in-estimate was 16.9% (antiepileptics). • Carried the predictor subset forward to the next model since there were no more statistically non-significant predictors.

†Lower BIC values indicate better model parsimony.

The predictor subset from Preliminary Model 3 was carried forward to the next model since it had the smallest BIC, indicating a more parsimonious model. The researcher added interaction terms between 'four or more medicines' and the 'patient age' dummy predictors (age 0-39 years, age 40-79 years, and unknown age) in preliminary model 4 (Appendix 9.4). However, only the interaction term for the 'age 0-39 years' dummy predictor was statistically significant and retained for the final model to maintain model parsimony.

9.7. Regression Results

The final model had chi-square probability and chi-square likelihood ratio test results of <0.001, showing that the final model fit the data significantly better than the null and fixed-effect models, respectively (Vittinghoff et al. 2012). The BIC (157,295) for the final model was smaller than for the preliminary models, describing an improvement in parsimony. However, the pseudo R^2 (0.034) explains that the final model had a relatively poor fit.[39] Table 9.19 describes the model regression coefficients (odds ratios), which Figure 9.11 visualises in a forest plot.

[39]Poor fit relative to the literature 'good fit' values of 0.2-0.4 (Hosmer et al. 2013).

Table 9.19: Chapter 9 Final Model Odds Ratios

Final Model Predictors	Groups	Odds Ratio [95% Confidence Interval]
Days between discharge and DMR1	28 days or less	Reference
	Over 28 days	1.082 [1.041 to 1.126]
Discharge weekend status	Weekday	Reference
	Weekend	1.155 [1.096 to 1.218]
eDAL availability	eDAL not available	Reference
	eDAL available	0.778 [0.749 to 0.807]
Discharge information provider	Hospital	Reference
	Not hospital	1.163 [1.117 to 1.212]
Medicines changed during admission	Medicines not changed during admission	Reference
	Medicines changed during admission	1.880 [1.810 to 1.953]
Patient taking four or more medicines	Patient not taking four or more medicines	Reference
	Patient taking four or more medicines	0.881 [0.842 to 0.922]
Patient requires adjustment to medicines	Patient does not require adjustment to medicines	Reference
	Patient requires adjustment to medicines	0.918 [0.888 to 0.950]
Incomplete item description status	Complete item description	Reference
	Incomplete item description	1.556 [1.339 to 1.810]
ATC2 condensed	Other	Reference
	Mineral supplements	1.341 [1.229 to 1.464]
	Drugs for acid-related disorders	1.129 [1.062 to 1.201]
	Antibacterial drugs for systemic use	1.857 [1.714 to 2.013]
	Corticosteroids for systemic use	1.361 [1.222 to 1.516]
	Calcium channel blockers	1.093 [0.991 to 1.206]
	Diuretics	1.663 [1.559 to 1.775]
	Antiepileptics	0.998 [0.910 to 1.095]
	Psycholeptics	1.342 [1.231 to 1.462]
	Psychoanaleptics	0.746 [0.688 to 0.808]
	Lipid-modifying agents	0.559 [0.513 to 0.608]
	Antithrombotic agents	0.899 [0.846 to 0.955]
	Anti-anaemic preparations	1.003 [0.939 to 1.097]
	Drugs for constipation	1.910 [1.790 to 2.038]
	Agents acting on the renin-angiotensin system	1.297 [1.204 to 1.397]

Table 9.19 (continued)

Final Model Predictors	Groups	Odds Ratio [95% Confidence Interval]
ATC2 condensed (continued)	Beta-blocking agents	1.031 [0.956 to 1.112]
	Opioid analgesics	2.257 [2.108 to 2.416]
	Non-opioid analgesics	1.481 [1.378 to 1.592]
	Cardiac glycosides	0.976 [0.822 to 1.159]
	Insulin and analogues	0.716 [0.609 to 0.843]
	Anti-inflammatory and antirheumatic products	2.597 [2.098 to 3.215]
	Drugs used in addictive disorders	3.880 [3.285 to 4.583]
	Anti-arrhythmics, class I and III	1.868 [1.437 to 2.428]
	Oral drugs used in diabetes	0.896 [0.818 to 0.982]
Route of administration	Oral	Reference
	Injections	1.714 [1.548 to 1.898]
	Inhaled	0.749 [0.697 to 0.804]
	Transdermal	0.852 [0.736 to 0.987]
	Topical	1.361 [1.256 to 1.475]
	Sublingual	0.677 [0.52 to 0.789]
	Other routes	1.325 [1.103 to 1.592]
	Device/dressing	1.522 [1.247 to 1.859]
	Ear/eye/nose	0.848 [0.767 to 0.938]
Gender	Male	Reference
	Female	1.059 [1.031 to 1.089]
Patient age	Age 80+	Reference
	Unknown age	1.007 [0.954 to 1.064]
	Age 0 to 39 years	1.804 [1.503 to 2.165]
	Age 40 to 79 years	0.968 [0.937 to 1.001]
(Age 0 to 39 years)*(patient taking four or more medicines)	N/A	0.637 [0.519 to 0.782]
DMR1 year	N/A	0.870 [0.851 to 0.889]

Table 9.19 (continued)

Final Model Predictors	Groups	Odds Ratio [95% Confidence Interval]
Carer involvement	Not with carer	Reference
	With carer	0.966 [0.932 to 1.000]
	Unknown carer involvement	1.227 [0.930 to 1.617]
Pharmacy status	In pharmacy	Reference
	Not in pharmacy	0.924 [0.891 to 0.958]
	Unknown pharmacy status	0.876 [0.742 to 1.034]
When-required feature	No when-required feature	Reference
	When-required feature	1.073 [1.022 to 1.127]
Change term feature (planned dose change after discharge)	No change term feature	Reference
	Change term feature	1.637 [1.509 to 1.777]
Constant	N/A	0.083 [0.073 to 0.095]

Statistically significant predictors increasing the risk of discrepancy occurrence are coloured green, whilst those decreasing the risk are red.

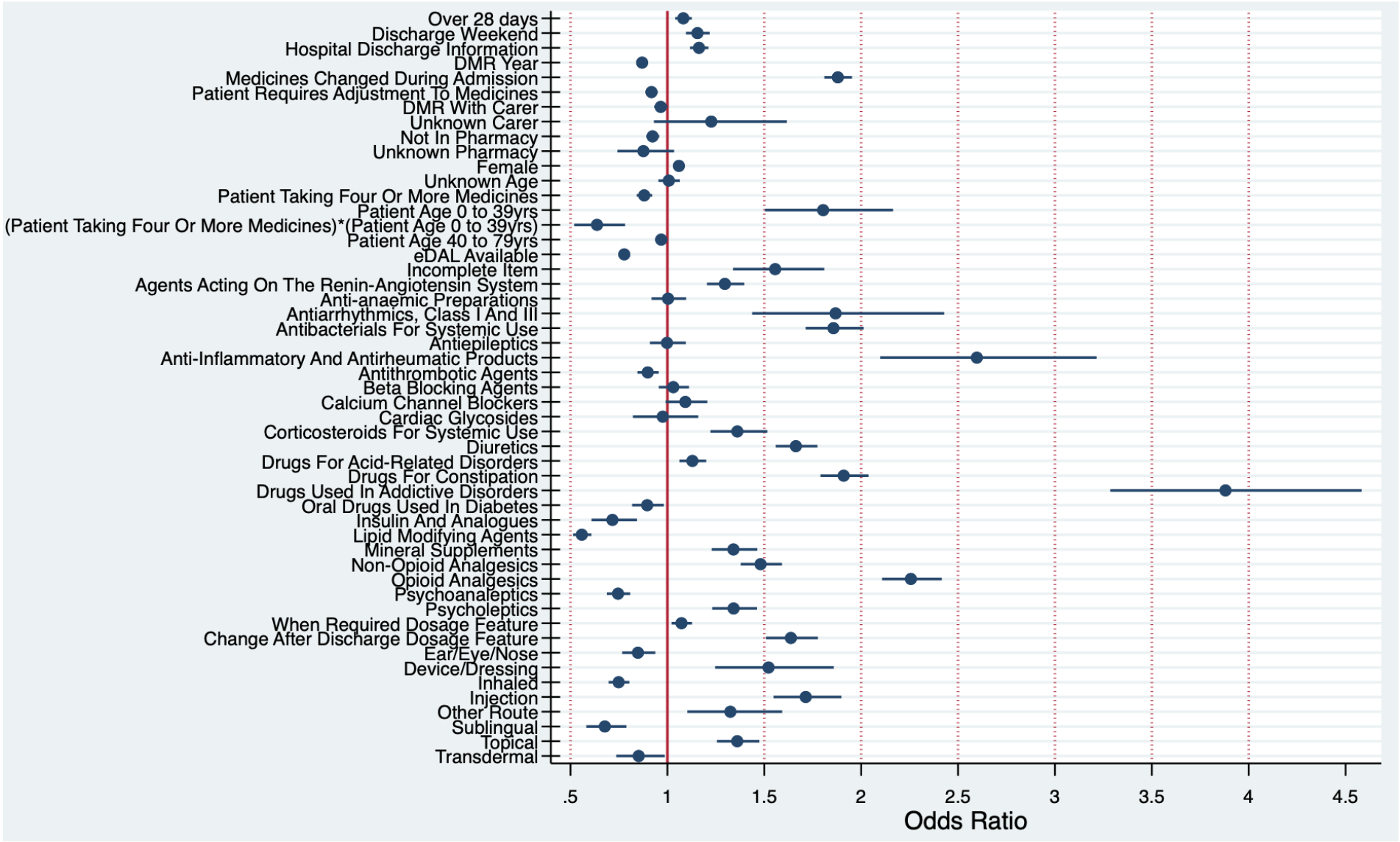


Figure 9.11: Chapter 9 Final Model Odds Ratios Forest Plot

One of the objectives of this chapter was to develop evidence-based referral criteria for the DMR by identifying factors increasing discrepancy identifications. Since some predictors (DMR year, days between discharge and DMR1, discharge information provider, and eDAL availability) were included as controls, they could not form the basis of actionable recommendations. Table 9.20 ranks the statistically significant actionable results by effect size to facilitate the creation of DMR prioritisation recommendations.

Table 9.20: Risk and Protective Factors for Discrepancy Occurrence

Risk Factor Category	**Item with Largest Discrepancy Proportion† [n≥100]**	**Odds Ratio**
Drugs used in addictive disorders	Nicotine patches	3.880
Anti-inflammatory and antirheumatic drugs	Naproxen	2.597
Opioid analgesics	Codeine	2.257
Drugs used for constipation	Docusate	1.910
Medicines change during admission	N/A	1.880
Anti-arrhythmic drugs	Amiodarone	1.868
Antibacterial drugs for systemic use	Clarithromycin	1.857
Injections	Zolendronic acid	1.714
Diuretics	Indapamide	1.663
Change after discharge dosage feature	N/A	1.637
Device/dressing	Dressings	1.522
Non-opioid analgesics	Aspirin (high dose)	1.481
Corticosteroids for systemic use	Dexamethasone	1.361
Topical	Clotrimazole	1.361
Psycholeptics	Lorazepam	1.342
Mineral supplements	Magnesium	1.341
Other route of administration	Chlorhexidine buccal	1.325
Agents acting on the renin-angiotensin system	Sacubitril/valsartan	1.297
Weekend discharge	N/A	1.155
Drugs for acid-related disorders	Magnesium hydroxide	1.129
When-required dosage feature	N/A	1.073
Age 0-39 years	N/A	1.804
Female gender	N/A	1.059
Protective Factor Category	**Item with Smallest Discrepancy Proportion† [n≥100]**	**Odds Ratio**
Lipid-modifying drugs	Ezetimibe	0.559
Sublingual	Buprenorphine sublingual	0.677
Insulin and analogues	Insulin aspart/protamine	0.716
Psychoanaleptics	Paroxetine	0.746
Inhaled	Glycopyrronium inhaled	0.749
Eye/ear/nose	Bimatoprost	0.848
Transdermal	Fentanyl patches	0.852
Four or more medicines	N/A	0.881
Oral drugs for diabetes	Saxagliptin	0.896
Antithrombotic agents	Warfarin	0.899
Patient requires adjustment to medicines	N/A	0.918

†Condensed item descriptions (see Section 5.4.3.4.3) are included for context.

From these findings, the researcher recommends identifying patients meeting the following criteria based on the ten predictors with the largest effect sizes:

1. Patients taking any of the following medication types:
    a. drugs used in addictive disorders,
    b. analgesics/anti-inflammatories,
    c. drugs used for constipation,
    d. anti-arrhythmic drugs,
    e. antibacterial drugs for systemic use,
    f. diuretics,
    g. psychoanaleptics (i.e., hypnotics and antipsychotics).
2. Patients who have had a medication change during admission.
3. Patients aged 0-39 years.
4. Patients who use any injectable medicines.
5. Patients taking any medicines with a change scheduled after discharge.

9.8. Discussion

This chapter achieved its aim by describing the factors affecting DMR discrepancy identification using a multistage quantitative analysis approach. To the best of the researcher's knowledge, this is the first study to describe factors affecting post-discharge discrepancy identification in such granular detail, specifically regarding medicines-related factors such as route of administration. This section describes the strengths and limitations of this chapter and then discusses its findings in the context of the wider literature.

9.8.1. Strengths and Limitations

The size of the DMR dataset was a strength, constituting all NECAF and ChP DMR data collected. Using large datasets is uncommon in pharmacy services research but was possible due to the routine collection of national detailed services data through the all-Wales systems. However, the DMR datasets contained many variables requiring the researcher to undertake complex predictor selection procedures. For example, the researcher removed the 'number of eligibility criteria' and 'controlled drug status' variables because they violated the regression assumption of multicollinearity. Since these variables were not included as predictors, it is uncertain whether they had a statistically significant effect on discrepancy identification. The further predictor selection procedures removed some candidate predictors, e.g., the pharmacist's professional judgement. However, these were only removed because they had no statistically significant effect on discrepancy occurrence and had no notable confounding effects (change-in-estimate <20%).

Although different subsets of predictors may have gleaned valuable results, many combinations were possible due to the data size, which was not practicable to explore in the context of a PhD

thesis. Furthermore, describing factors affecting specific discrepancy types (e.g., medicines continued but at the wrong dose) may have provided valuable results for stakeholders; however, it was outside this chapter's scope. Further work could repeat this chapter's methods for each discrepancy type if these results were valuable to stakeholders. However, since each discrepancy type had a low frequency, supporting a regression model with as many predictors as this chapter may violate EPV. Although the DMR data size was a key strength of this chapter's work, greater resources are required to maximise its use and optimise data-driven care. If this is a goal for the NHS and international healthcare organisations, they must invest appropriately in data analysts and researchers.

Section 1.5.3 described that the DMR does not distinguish between unintentional and intentional discrepancies nor determines their clinical impact. However, there is evidence that post-discharge discrepancies are associated with medicines-related harm (MRH), and DMR1 is associated with a reduction in hospital readmission (Coleman et al. 2005; Mantzourani et al. 2020). Researchers could further elucidate these relationships by associating DMR factors with hospital readmissions or post-discharge MRH. Similar pseudonymised data linkage methods to the DMR hospital readmission study by Mantzourani et al. (2020) could be employed to achieve these aims. Furthermore, the content analysis results (Chapter 6) show that pharmacists completing the DMR frequently used the 'other' discrepancy type to indicate intentional discrepancies. If the DMR form were adapted to distinguish between intentional and unintentional discrepancies, further analysis could predict factors affecting post-discharge MRH more precisely.

Section 9.5 described the rationale for including pharmacy ID as a random effect because of intra-subject variability. The pharmacist providing the DMR may have provided a better representation of pharmacy-related variability, but the researcher excluded it due to its large proportion of missing data. Additionally, there may have been intra-patient variability, which the study could not account for since the data were anonymised. Further analysis could use pseudonymised data to include a random effect for a patient ID, which could improve this chapter's model fit.

As expected with routinely collected service data, the DMR datasets only included patients that received a DMR. There may be factors affecting patient likelihood to receive a DMR which interact with the factors affecting discrepancy identification which are unaccounted for in this chapter's results as the required data were not available for analysis. Additionally, the DMR databases were not designed with analysis in mind, requiring extensive data preparation before this chapter. Although the researcher spent considerable time completing preparation and cleansing, any human error or inaccuracies may influence the reliability of the relationship between predictors

and the outcome. One such example was the transformation of free-text dosage directions into the dosage features: change after discharge, when-required, and as-directed. To the best of the researcher's knowledge, these identifiers are unique to this study, and their inclusion was only possible due to the extensive data collection in ChP. The method employed to extract these features from the >250,000 dosage direction entries (see Appendix 5.2) was a balance between accuracy and timeliness. Since the researcher only quality assured a sample of entries, this method may have under-reported the occurrence of dosage features. Future research could automate the extraction process using recent natural language programming developments to analyse free-text clinical data (Koleck et al. 2019).

9.8.2. Relevance to Wider Literature

The model fit statistics indicate suboptimal explanatory power, describing that much of the variability in discrepancy identification was not accounted for by the predictors. This suboptimal fit is not unexpected, considering the medication item variable was significantly condensed to facilitate inclusion, with the trade-off of reduced explanatory power. The absence of patient factors such as co-morbidities, the reason for hospital admission and length of hospital stay may explain the model fit since they are associated with post-discharge discrepancies (Belda-Rustarazo et al. 2015). Future research could repeat this chapter's methods whilst including such identifiable predictors to elucidate additional factors affecting DMR discrepancy identification. Although this suboptimal fit was not ideal for addressing the chapter's aim, it is a valuable result in itself, demonstrating the complexity of the factors affecting discrepancy identification and subsequent challenges with developing DMR referral criteria. Although Section 9.7 presented some guidance for DMR referrals to address barriers identified in the original DMR evaluation (Hodson et al. 2014a), few factors could constitute actionable referral criteria.

A recent consensus study by Nazar et al. (2019) found that senior pharmacists, managers, and directors agreed that medicines changed during admission should be a referral criterion for community pharmacy transfer of care services. The DMR and Discharge Medicines Service (DMS) both include medicine changes as a patient eligibility criterion; therefore, including it as a referral criterion would increase the consistency of patient recruitment across sectors (CPW 2011; NHS England and NHS Improvement 2021). Although this chapter found that the DMR service eligibility criterion 'medicines change during admission' increased the odds of discrepancy identification (odds ratio = 1.88), it may not constitute usable criteria since Viktil et al. (2012) identified that all studied patients [n=105] had at least one medication change during hospital admission. Therefore, it may be appropriate for HPPs to primarily refer patients they believe would benefit from a DMR

based on their professional judgement. Most HPPs from Chapter 4 felt this was appropriate because they were confident that they could identify appropriate patients provided they had been directly involved in their care. However, this chapter concluded that the pharmacist's professional judgement eligibility criterion did not significantly affect discrepancy identification. Although this finding seemingly precludes 'professional judgement' referrals, the eligibility criterion only applies to the community pharmacist providing the DMR service, not the practitioner referring them. Additionally, the DMR does not record the clinical consequences of discrepancies; therefore, a high risk of discrepancies may not correlate with an increased risk of MRH.

As described above, Nazar et al. (2019) used a consensus approach to develop referral criteria for post-discharge community pharmacy services. Although the study methods were appropriate for initial work, the findings may not be transferable to an all-Wales patient population due to the small sample of experts [n=10] from England only. However, such an approach could be adapted in Wales to develop similar referral criteria. As acknowledged by the study's authors, these criteria could then be empirically tested to identify whether they predict post-discharge MRH.

HPPs from Chapter 4 suggested that they transmit information to community pharmacies for patients with limited prescription medicine supplies, e.g., supervised consumption of drugs for addiction. This chapter's results concluded that 'drugs for addiction' is the factor with the greatest amplifying effect on discrepancy identification. Additionally, these drugs are associated with post-discharge MRH (Howard et al. 2007). Therefore, this patient group may be an ideal DMR referral target in line with one of the eligibility criteria for the DMS in England, drugs that could cause dependence (NHS England and NHS Improvement 2021).

Some ATC2 groups associated with a higher rate of discrepancy identification overlap with medicines associated with post-discharge MRH, including anti-inflammatories, analgesics, and antibiotics (Alqenae et al. 2020). However, some ATC2 groups contrasted with the literature findings. In this chapter, respiratory medicines and antidiabetics had lower odds of discrepancy occurrence, whilst Alqenae et al. (2020) concluded they were high-risk medicines for post-discharge MRH. The granular nature of ATC2 groups allowed more specific results than groups investigated previously, such as cardiovascular drugs, which are often implicated in post-discharge MRH (Alqenae et al. 2020). Consequently, this chapter found subcategories with differential effects. For example, diuretics and drugs affecting the renin-angiotensin system were associated with increased discrepancy identification. In contrast, calcium channel blockers, beta-blockers and anticoagulants were associated with a lower risk of discrepancy identification which could be explained by the inclusion of the 'change after discharge' feature, considering they are frequently

titrated after discharge (Joint Formulary Committee 2022). Alternatively, since these ATC2 groups are frequently implicated in post-discharge MRH, HCPs may take more care to ensure continuity after discharge, either by ensuring timely and clear communication of the DAL or targeting these patients for post-discharge reconciliation. Further work could investigate whether these factors vary for different patient populations.

In contrast to previous literature, the number of medicines did not appear to influence the odds of a discrepancy (Coleman et al. 2005). However, the measure used for medication number for this chapter's regression was the eligibility criterion 'four or more medicines', which was self-reported by pharmacists rather than automated. Since self-reported measures are less accurate than automated ones (Verheij et al. 2018), this could reduce the reliability of this result, especially considering the lack of discrepancy reporting accuracy described in the Chapter 6 content analysis results. The EDA results indicated the presence of a weak positive relationship between the number of medicines and discrepancies for NECAF DMRs. Perhaps this difference can be explained by ChP only recording one discrepancy per item, unlike NECAF, which records the overall number of discrepancies per service. Since increasing polypharmacy is associated with hospital readmissions (Pereira et al. 2021), there may be discordance between the number of identified discrepancies and their clinical impact.

Patients who have medicines dispensed into an MCA had lower odds of discrepancy identification in this chapter's results, despite their inclusion in DMR and DMS eligibility criteria (CPW 2011; NHS England and NHS Improvement 2021). Similar findings suggested older patients were at lower odds of discrepancy identification. HPPs in Chapter 4 routinely transmitted information to community pharmacies for MCA patients. They also indicated that DMR referrals might be suitable for elderly and MCA patients because they perceived them as high-risk for post-discharge discrepancies. If the patients' GP surgery perceived these patients as high-risk, the decreased discrepancy odds could be explained by increased care and attention when they reconcile the medicines post-discharge. Community pharmacist interviews by Urban et al. (2013) support this hypothesis, highlighting improved post-discharge communication between community pharmacists and GP surgeries for this patient population.

In contrast to elderly patients, the younger patient group (0-39 years) had greater odds of discrepancies after discharge, but an increasing number of medicines lessened this effect. The EDA supported these results, suggesting that patients under 20 years of age have the highest rate of discrepancy identification. In an analysis of paediatric patient charts, 26% [n=69] had more than one discrepancy, supporting the risk of discrepancies in younger patients (Gattari et al. 2015).

However, post-discharge outcomes are seldom investigated for paediatric patients, with Alqenae et al. (2020) identifying four (of 54) studies in this population during their post-discharge MRH systematic review. Mantzourani et al. (2020) excluded patients under 20 years of age from their paper investigating the association between DMR1 and hospital readmission due to infrequent DMRs and hospital readmissions. Although this could imply that the elevated risk of discrepancies was not clinically significant, McKay et al. (2015) found an elevated risk of medicines-related hospital admissions in younger patients in England, especially those between 5 and 14 years old. Therefore, further work should investigate the clinical significance of discrepancies in the under-researched younger population, including paediatrics. Considering that DMR data collection is routine, this further research could be achieved by repeating the data linkage method by Mantzourani et al. (2020) when more data are available, describing the benefits of the DMR for younger patients.

The study's results described considerable variation in discrepancy identification between pharmacies and pharmacists. For example, some pharmacies had identified no discrepancies across many DMRs, whilst others identified several per DMR. Some of these discrepancy identification rates fell outside the literature values of 14 to 82% for medicines (Alqenae et al. 2020). Although differences in patient populations could explain this, so could differential recruitment of patients for the DMR. Literature describing engagement with the Medicines Use Review (MUR) suggested that pharmacists avoided complex patients to save time and hit targets for service volume (Latif et al. 2011). A similar pressure for DMRs in some pharmacies could explain the difference in discrepancy identification if some pharmacists were recruiting non-complex patients. This variation could also be explained by pharmacists misdescribing their DMRs and discrepancies, which could be possible considering Chapter 6's findings that suggest pharmacists lacked knowledge regarding the nature of discrepancies and how to log them. The EDA results indicated that discrepancy identification rates were highest for pharmacies in the most socially deprived areas, but discrepancy identification did not linearly decrease with decreasing social deprivation. However, the social deprivation measure used in this chapter was calculated using the pharmacy address as a surrogate for the patient's social deprivation status. Considering that patients living in socially deprived areas have poorer health outcomes than those in affluent areas (Mercer et al. 2021), future research could use a patient's home address to calculate their level of social deprivation.

Section 1.4.2 outlined the development of electronic discharge systems to improve the quality and timeliness of DAL availability to GP surgeries after discharge. NWIS expanded this by integrating

MTeD with ChP to facilitate eDAL access for community pharmacists. This chapter's results show that eDAL availability reduced the odds of discrepancy identification, in keeping with findings from a systematic review by Mekonnen et al. (2016b), concluding that paper DALs had a higher discrepancy rate than eDALs. However, this chapter describes factors affecting discrepancy identification rather than discrepancy generation. This protective effect could be explained by pharmacists logging DMR medicines differently depending on whether an eDAL was available. Section 6.3.6.1 supported this explanation, showing that DMRs using an eDAL had a greater mean number of medicines than those that did not. This finding is not surprising considering the DMR form auto-completes medicines information when an eDAL is available. Therefore, eDAL availability should be optimised to improve information transmission and reduce post-discharge discrepancies, aligning with the WHO (2019) recommendations to improve information availability, ideally using electronic solutions, across care settings.

9.9. Conclusions and Dissemination

This chapter achieved Thesis Objective 5 using a multistage regression analysis process, describing factors affecting DMR discrepancy identification. The researcher disseminated this study's findings to AWQPSG to support hospital pharmacy managers in developing guidance for DMR referrals, assisting them in integrating referrals into their workflow. The researcher also discussed results with the DMR Promotional Material Working Group to support the future development of educational material for hospital and community pharmacy professionals.

Chapter 10. Mixed Methods Data Integration and Discussion

10.1. Chapter Introduction

This thesis used a mixed methods approach with five empirical studies to address the following objectives:

1. Identify areas of good practice from similar transfer of care systems and how they were implemented.
2. Explore the factors affecting hospital pharmacy professionals' (HPPs') engagement with DMR referrals.
3. Describe DMR provision from November 2011 to January 2021.
4. Describe the pharmacy-related factors affecting DMR provision over time.
5. Describe the factors affecting DMR discrepancy identification.

This chapter synthesises the findings from each empirical study to develop recommendations for optimising DMR provision (Thesis Objective 6). As described in Section 2.8.3, the researcher employs the Pillar Integration Process (PIP) for this purpose, combining results into meta-inferences known as *central pillars* (Johnson et al. 2019). These central pillars are then discussed in the context of the wider literature to develop recommendations for optimising the DMR.

10.2. Integration of Thesis Findings

10.2.1. Pillar Integration Process Methods

The PIP is a method of integrating qualitative and quantitative findings through visualisation, consisting of four stages (Table 10.1) (Johnson et al. 2019).

Table 10.1: Description of Pillar Integration Process (PIP) Stages

Pillar Integration Process Stage	Description
Listing	Qualitative and quantitative findings are listed separately.
Matching	Respectively, qualitative and quantitative findings are grouped into preliminary pillars, which describe a shared meaning.
Checking	Preliminary pillars are reviewed and quality assured.
Pillar building	Preliminary pillars are abstracted into central pillars, spanning qualitative and quantitative findings.

Although the PIP is intuitive and transparent, it was only designed to integrate two data sources. Gauly (2020) adapted the PIP to overcome this limitation, integrating several data sources to develop recommendations to optimise the provision of community pharmacy sexual and reproductive health services. Where PIP develops respective preliminary pillars for qualitative and quantitative findings, adapted PIP develops them iteratively, considering the findings of all studies. Since this thesis integrates seven data sources, the researcher used adaptive PIP, as Figure 10.1 presents (Gauly 2020).

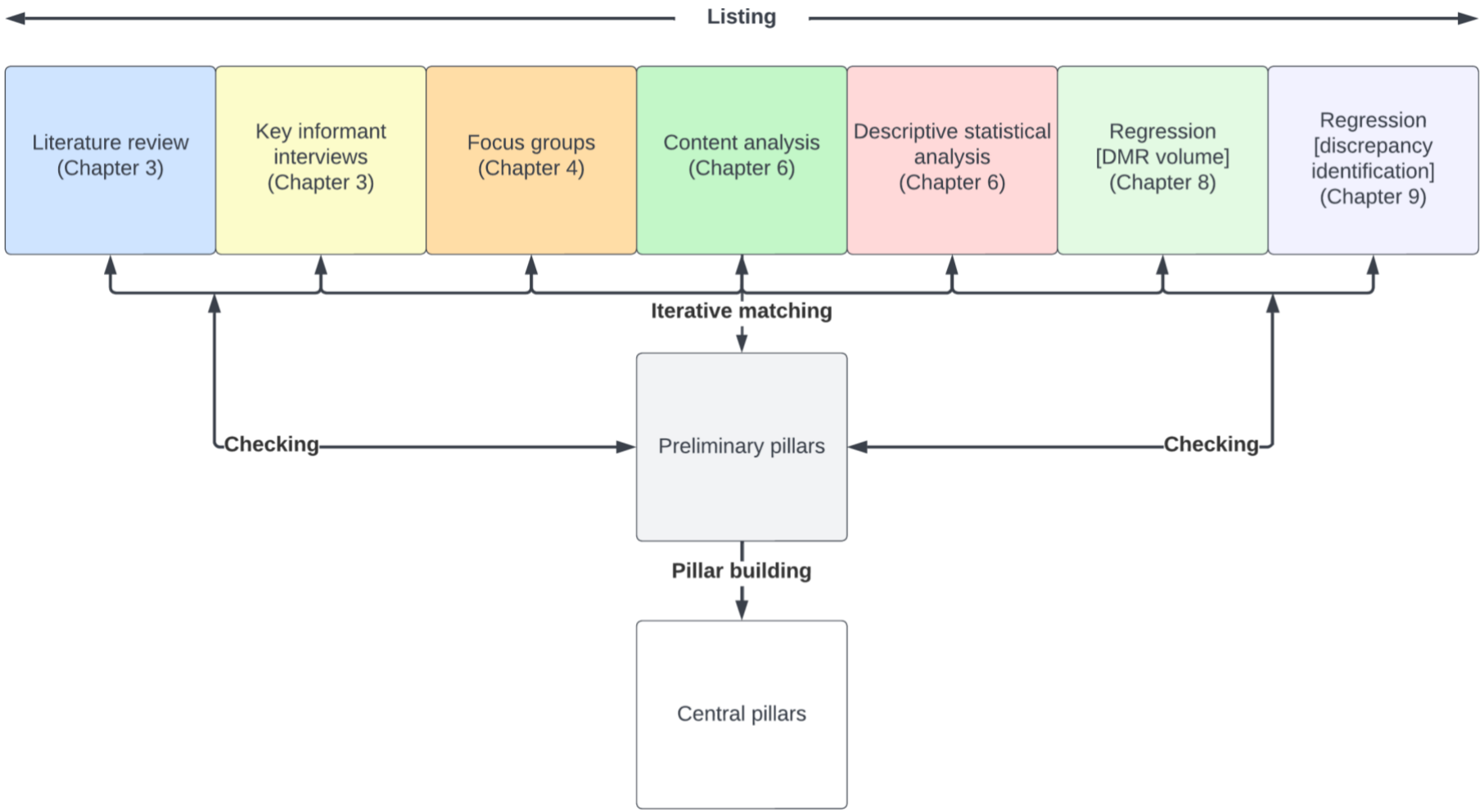


Figure 10.1: Thesis Adapted Pillar Integration Process Method

The researcher considered what results to present during "listing". PIP often presents indicative quotations for qualitative findings and raw data for quantitative (Johnson et al. 2019). Given that each empirical chapter has described its results extensively, including such detail would be unnecessarily repetitive. Therefore, qualitative and quantitative findings were summarised narratively, only using raw data when required for context. The researcher discussed the data integration with an experienced researcher (KH) during the checking and pillar-building process, iteratively developing and refining preliminary and central pillars (Johnson et al. 2019). However, KH and the researcher agreed on the suitability of the pillars, requiring no further changes, inferring the credibility of the data integration.

10.2.2. Adapted Pillar Integration Process Results

Table 10.2 presents the adapted PIP visual matrix, summarising which studies correspond with each of the nine constructed preliminary pillars. These pillars were abstracted into the three central pillars: knowledge, optimising system cohesiveness, and fitness for purpose. Appendix 10.1 outlines which thesis findings correspond with each pillar, and Section 10.3 describes each pillar in further detail in the context of the wider literature.

10.2.3. Reflections on the Integration of Findings

The PIP facilitated the integration of findings from a diverse range of research methods, including qualitative, quantitative and literature reviews. A key advantage of the PIP was its transparency, demonstrated in this chapter by the clear stages of data integration and presentation of the findings relating to each pillar (Appendix 10.1). Since mixed methods research has received recent criticism for its opacity (Creswell and Creswell 2018), researchers should endeavour to detail their integration methods as in this thesis. One potential limitation of the PIP is that it did not account for the nature of the data. For example, the convergence between the focus groups and descriptive analysis may be limited since the former describes HPPs' perceptions, and the latter describes how the DMR was provided. However, mixed methods specifically aim to converge multiple methodologies, considering diverse perspectives, a strength of the overall thesis approach (Creswell and Creswell 2018).

Once the PIP was complete, the pillars supported the structure of discussions in the context of the wider literature. Without this structure, presenting the discussion would have been challenging because of the breadth and diversity of the results.

Table 10.2: Overview of Pillars Constructed from the Thesis Findings

Central Pillar	Summary	Preliminary Pillars	Chapter 3		Chapter 4 (Focus Groups)	Chapter 6		Chapter 8 (DMR Volume Regression)	Chapter 9 (Discrepancy Regression)
			Literature Review	Key Informant Interviews		Content Analysis	Descriptive Analysis		
Knowledge	The *knowledge* central pillar reflected thesis findings identifying a profound lack of awareness of the DMR and its referral process across multiple stakeholder groups. Many HPPs and community pharmacists demonstrated gaps in their procedural knowledge of completing a DMR or referral or using their associated systems. Finally, stakeholders were unaware of the evidence demonstrating the DMR's benefits.	DMR awareness		■	■	■	■		
		Procedural knowledge	■	■	■	■			
		Knowledge of the DMR's benefits	■	■	■	■	■		■
Optimising system cohesiveness	*Optimising system cohesiveness* outlines factors affecting engagement with the DMR or its referral process. These factors broadly include how hospitals across Wales implemented the DMR referral system, the limited organisational buy-in for the DMR and its referrals, and the sparse collaboration between hospital and community pharmacy professionals.	Referral system implementation and usability	■	■	■		■		
		Buy-in and role integration	■	■	■	■	■	■	
		Collaboration		■	■			■	
Fitness for purpose	The *fitness for purpose* central pillar explores the effectiveness of the DMR and its referrals. Notably, this included the role of pharmacy professionals in post-discharge support, the suitability of DMR referrals, and how patients can access the DMR to reap its safety benefits.	Pharmacy professional post-discharge support			■	■	■		■
		The nature of DMR referrals	■	■	■	■	■		■
		Patients' access to DMRs	■		■	■	■	■	■
Table Key									
■		Pillar constructed from these findings							

10.3. Discussion in the Context of the Wider Literature and Recommendations

This section discusses the pillars in the context of the wider literature. Each central pillar is then summarised, and its related recommendations for optimising the DMR's use are presented, achieving Thesis Objective 6.

10.3.1. Knowledge

10.3.1.1. DMR Awareness

An overriding finding from the thesis is the lack of awareness of the DMR and its associated systems by pharmacy professionals and patients. Whilst patients were not included as participants, the HPPs in the focus groups felt that patient awareness of community pharmacy services, including the DMR, was poor. This lack of patient awareness led to lengthy conversations to obtain consent for referrals, influencing the HPPs' own motivation to refer future patients. Although these findings were not directly from patients, Kember et al. (2018) found low awareness of community pharmacy services during focus groups with members of the public in Wales [n=32]. Furthermore, Khayyat et al. (2021a) also found limited awareness in interviews with patients and carers [n=11] about their perceptions of post-discharge community pharmacy services in England. One carer from this study stated (Khayyat et al. 2021a, p. 6):

> *"There needs to be some kind of publicity [for community pharmacy post-discharge services]. There is a lack of knowledge in relation to this kind of system. (...) I do not think people are aware of it".*

This lack of patient awareness could explain previous findings that patients were unlikely to attend community pharmacy post-discharge services unless prompted (Luetsch et al. 2021). The thesis focus group participants suggested patient education about the DMR from the hospital and community pharmacy to improve their knowledge of the service, hopefully easing the consent process and promoting engagement. Chapter 3 showed that Refer-to-Pharmacy (RTP) has an integrated patient educational video to save HPP time in explaining community pharmacy referrals and associated services. Similar videos could be integrated into the DMR referral system to promote patient engagement with the DMR.

Hindi et al. (2018) identified several studies proposing that recommendations for community pharmacy services from GPs would encourage patients to engage with them, a finding echoed by several thesis focus group participants. However, the study authors concluded that GP awareness of community pharmacy services was poor. Similarly, the original DMR evaluation found limited GP awareness of the service (Hodson et al. 2014a). These findings may be outdated and limited by the small number of interviews undertaken with GPs [n=6]; therefore, further work should

ascertain the engagement of GP surgery staff with the DMR and their knowledge of the service. This work could include identifying optimal post-discharge processes encompassing the DMR and post-discharge support provided by pharmacy professionals working in GP surgeries (described further in Section 10.3.3.1).

Hindi et al. (2019b) investigated patient, pharmacist, and GP views of long-term condition management in community pharmacies in focus groups. All participants in this study [n=43] agreed that community pharmacy services needed a cross-sector national promotional campaign to optimise engagement, using multiple modalities like television and newspaper adverts. Participants also perceived that local promotion methods used for Seasonal Flu Vaccination (SFV) services were effective, which included regular conversations with pharmacy staff and word-of-mouth recommendations. Modern advertising methods, like social media, could be leveraged, given that some patients often use it for health advice (Crilly et al. 2019).

Recent research has shown considerable barriers to community pharmacy service access for medically underserved populations, such as black and ethnic minority patients (Robinson et al. 2022a). Therefore, all methods to promote the DMR to patients must transverse language and cultural boundaries to be truly equitable. Community pharmacy users in England have suggested co-producing services with underserved population members to promote engagement (Robinson et al. 2022b). However, recent studies investigating the effect of such interventions failed to identify a significant benefit (Latif et al. 2019). The multilingual consent statements embedded within RTP (Chapter 3) could help address language barriers. Although this may benefit patient engagement with DMR referrals, language barriers are only one of many considerations to ensure equitable access (Robinson et al. 2022a). Harries and Bryer (2021) identified limited availability of the Welsh language in their evaluation of the national strategic framework for the Welsh language in healthcare services. In line with the recommendations from this evaluation, DHCW should ensure that any patient-facing system developments, e.g., consent statements or patient education videos, include the Welsh language.

It was evident that many thesis focus group participants did not understand the DMR, with a few having never heard about it. When the Welsh Government launched the DMR, hospitals had some promotional activity, as described by the focus group participants. However, this was not sustained. Interestingly, some participants' motivation toward the scheme changed when the researcher described the DMR. Therefore, in line with the original DMR evaluation (Hodson et al. 2014a), HPPs must be made aware of the DMR and its benefits to promote their engagement with referrals.

The focus groups (Chapter 4) not only identified a lack of awareness of DMRs, but it was evident that HPPs had poor awareness of how the Choose Pharmacy (ChP) functionality in Medicines Transcribing and electronic Discharge (MTeD) was a necessary step in electronic referrals. In some hospitals with MTeD, less senior participants often perceived that the ChP functionality 'appeared out of nowhere' without explanation or instruction. Consequently, these participants did not electronically refer patients for DMRs because they did not know what the ChP button did. Staff from hospitals without complete MTeD uptake often described how they were not kept 'in the loop' with its implementation plan. Consequently, they were reluctant to integrate DMR referrals with their working practices because any system changes would negate their new referral workflow. Although NWIS communicated such information to hospital pharmacy management, the focus group results suggest this did not reach frontline HPPs. Ross et al. (2016) emphasised the importance of involving end-users and comprehensively communicating their strategy for healthcare technology implementation. This finding is in line with suggestions from the RTP informant (Chapter 3), who promoted system awareness by developing videos, attending speaker circuits and discussions in hospital team meetings. Hospital pharmacy management should adopt these suggestions to disseminate and discuss technology implementation and strategy to optimise engagement. However, this is contingent on organisational buy-in to its use (see Section 10.3.2.1 for more detail).

As well as a lack of general DMR awareness, the thesis found evidence of limited awareness of the DMR service specification. Specifically, some HPPs in the focus groups did not think the DMR could be provided to patients who rarely attended the pharmacy in person. Similarly, the content analysis of the DMR2 incompletion reasons highlighted that some pharmacists did not believe they could deliver DMR2 to patients who delegated responsibility for their medicines to a carer. In contrast to these views, the DMR specification states that the service can be completed with carers (NHS Wales 2022), and the descriptive analysis (Chapter 6) showed that approximately 40% of DMRs were completed with carer involvement and 42% were not completed in-person in the pharmacy. These misconceptions could limit DMR provision by restricting practitioners' views of patients eligible for the service. Therefore, promotional campaigns to improve DMR awareness should include educational material explaining the DMR, its referral process and patient eligibility.

The research team designed this thesis with dissemination in mind (see Section 2.3); therefore, its findings were regularly communicated with stakeholders to improve DMR awareness. One of the most impactful approaches was the researcher regularly attending the P:DaHW Delivery Board and Digital Medicines Management subgroup. Not only did this provide opportunities to

disseminate findings formally, but it facilitated routine discussion of the DMR and how to optimise its use. Due to these discussions, a CPW employee, with research team support, applied for funding from the Welsh Government to develop DMR promotional and educational videos for patients, hospital and community pharmacy professionals, and GP surgery staff. To support the development of these videos, the research team provided expert advice and established a working group, including representation from hospital pharmacy organisations, to ensure the videos would be suitable across sectors. CPW has subsequently published (in English and Welsh) the following:

- A video for patients, carers, and GP surgery staff: generic information about the DMR and its benefits (CPW. 2022. *The Discharge Medicine Review (DMR) Service - A Welsh Community Pharmacy Service*. Available at: www.youtube.com/watch?v=AgqR9eJsJGQ [Accessed: 22 Oct 2022]).
- A video for community pharmacists: information regarding how to complete a DMR, including how to access electronic discharge advice letters (eDALs) and the DMR's procedure (CPW. 2022. *How to complete a DMR - for pharmacy teams in Wales*. Available at: www.youtube.com/watch?v=uv82zewTB9I [Accessed: 22 Oct 2022]).
- A video for hospital staff: information regarding the DMR and its benefits, including the procedure for referring patients (CPW. 2022. *The Discharge Medicines Review Service - a guide for secondary care colleagues*. Available at: www.youtube.com/watch?v=TmBC2WlfAwE [Accessed: 22 Oct 2022]).

Although impromptu feedback from the promotional material has been positive, the profound lack of DMR awareness across multiple stakeholder groups necessitates a cross-sector DMR promotional campaign. Following the collaborative effort in developing the videos, community pharmacy organisations and the Welsh Government should continue collaborating to expand the campaign locally and nationally and evaluate its impact.

10.3.1.2. Procedural Knowledge

Alongside the limited awareness of the DMR described above, this pillar describes the lack of community pharmacists' and HPPs' procedural knowledge of completing a DMR or a referral. In Chapter 4, many HPPs stated that they did not know how to refer patients electronically because nobody had trained them. Additionally, the content analysis provided evidence of limited community pharmacist knowledge of completing the DMR form, including errors such as miscategorising data in National Electronic Claim and Audit Forms (NECAF) and ChP, often using the 'other' option instead of the available native categories. Although a lack of knowledge could explain this, it could also be caused by a poor fit between the native discrepancy types in the DMR form and the identified discrepancy, as previously described in the original DMR evaluation (Hodson et al. 2014a). Some of the analysed free-text comments in Chapter 6 were not interpretable due to a lack of context, a common disadvantage of using routinely collected

healthcare service databases like ChP, which were developed to optimise workflow rather than for research purposes (Hox and Boeije 2005). Although this could be explained by pharmacists haphazardly completing the DMR form because they work in a busy retail environment, it suggests that they did not understand how the data would be used for analysis. The Department of Health and Social Care commissioned Goldacre and Morley (2022) to investigate the use of NHS data for health and social care research, culminating in the *'Better, broader, safer: using health data for research and analysis'* report. One key consideration was the difficulty in using routinely collected NHS records for research, requiring extensive curation before analysis. As previously described, the DMR data reflected this consideration, requiring extensive cleaning and preparation. For routine analysis of healthcare data, including the DMR, centralised data curation and preparation should be considered to reduce its burden on researchers and work duplication. Goldacre and Morley (2022, p. 14) also recommended training healthcare managers to be *"good data customers"*. This concept describes that healthcare staff involved in data entry must have adequate training to ensure their entered data are fit for analysis.

The limited knowledge of DMR-related systems is coherent with recent research by MacLure and Stewart (2018), who explored pharmacy staff digital literacy in Scotland. This study concluded that pharmacists and support staff rarely had specific IT systems training, a barrier to their confidence and engagement. In their *'Developing a Digitally Enabled Pharmaceutical Workforce'* report, the International Pharmaceutical Federation (2021) found that formal digital education training was rare in pharmacy practice. Consequently, they recommended that all routine pharmacy training include digital education to ensure pharmacy staff have the skills to thrive in a digital healthcare age. The GPhC (2021) have actioned such recommendations in their new initial education and training standards for trainee pharmacists in the UK. A new learning outcome is that trainees must *"keep abreast of new technologies and use data and digital technologies to improve clinical outcomes and patient safety, keeping to information governance principles"* (GPhC 2021, p. 13). Although such guidance is vital for improving digital literacy, its implementation must include specific training for DMR-related systems, such as MTeD and ChP in Wales. Recent developments in international pharmacy education have included healthcare technology training using open-access software to provide hands-on experience. Early evaluations of these training programmes are promising, showing increased trainee perceived preparedness for practice, confidence, and competence (Nabovati et al. 2022). Higher education institutes in Wales offering the MPharm programme (the undergraduate pharmacy degree in the UK) could collaborate with DHCW to develop open-source versions of ChP and MTeD, providing undergraduates with hands-on

experience using these systems to improve their confidence moving into practice. Even though these systems are only used in Wales, introducing the use of electronic systems to support care transitions would be beneficial for students who choose to work in other UK member states once qualified.

Although addressing initial training is essential, this would not support the pharmacy staff currently in practice using these systems. The HPPs in Chapter 4 suggested including the DMR and its referral process in staff induction but acknowledged that this would not support current employees. The key informant interviews found that RTP and PharmOutcomes implementation involved employing dedicated champions to ensure practitioners could use the system. One recognised champion role is a 'super-user', an upskilled colleague who provides practical support for system or process use (Umstead et al. 2021). In a recent exploration of PharmOutcomes implementation, interviewed HPPs described how two colleagues had trained them to complete referrals, showing the benefits of super-users (Jeffries et al. 2021). Similarly, Gray et al. (2020) highlighted the importance of using local champions to increase engagement with referrals through RTP. Such super-users could be employed in hospital and community pharmacy organisations to support staff using DMR-related systems.

DHCW (2022b) regularly release a ChP user guide describing how to use the system and enter data. However, the content analysis highlighted many data entry errors, such as pharmacists miscategorising discrepancies. These findings suggest that pharmacists may not be accessing the user guide, which would not be surprising considering that interviewed community pharmacists suggested that onerous paperwork and a lack of time were barriers to DMR provision in the original evaluation (Hodson et al. 2014a). A systematic review by MacLure and Stewart (2016) investigated pharmacy staff digital literacy, suggesting that formal training may be helpful before staff use a system. However, this review did not include staff working in Wales; therefore, further research is warranted to establish confidence and training needs for ChP. Although mandatory training for ChP could improve pharmacist confidence and competence, policymakers must balance this with the risk of reducing overall engagement by introducing additional barriers to system access. A less time-intensive information source could be embedded educational content in the DMR ChP module, like videos or pop-ups. Virtanen et al. (2021) recommended such supportive elements in a recent systematic review of interventions to improve engagement and adherence to healthcare systems. Instructional videos supported RTP implementation (Chapter 3) by showing HPPs how to refer to community pharmacies and showing community pharmacists how to complete a referral. The DMR videos described previously included such information for

practitioners to use as a quick-reference guide. DHCW should consider integrating these videos into the ChP and MTeD interfaces to assist practitioners in completing a DMR referral or the service itself.

10.3.1.3. Knowledge of the DMR's Benefits

The DMR has evidenced-based benefits for patient care and the wider health economy, with Hodson et al. (2014a) describing how an average of 1.3 discrepancies were identified per DMR and that the service returned an average of £3 to the health economy for every £1 spent. Additionally, Mantzourani et al. (2020) found an association between the DMR1 and reduced odds of hospital readmission at 40 days. Furthermore, this thesis has built on this evidence base for the identification of discrepancies (see Section 10.3.3.1), reinforcing the value of the DMR in reducing post-discharge medicines-related problems (MRPs), which could lead to preventable medicines-related harm (MRH).

Despite the DMR's evidenced benefits, this thesis found that they had not been disseminated to multiple stakeholder groups. Some HPPs in the focus groups, primarily those with community pharmacy experience, perceived the DMR as valuable for patient care. In contrast, many were sceptical of the value of community pharmacy services, including the DMR. Since HPPs did not understand the benefits of DMRs, they did not prioritise referrals compared to tasks they perceived as valuable. Many HPPs also perceived that their management did not see the value of the DMR because they had not integrated referrals into their workflow and training. To improve their knowledge about the benefits of the DMR, HPPs felt they needed regular feedback about the DMRs outcomes to motivate them. Suggested feedback included patient-centred feedback like hospital readmission rates or reduction in MRH on a hospital or Local Health Board (LHB) level, including more granular feedback such as case studies. The focus group participants also considered DMR cost-savings important, but more so for management, which would prioritise referrals if they felt it was cost-effective. NWSSP (2021) has recently developed a data dashboard showing the extent of pharmacy service provision across Wales and their high-level outcomes. These data, including the DMR, are easily accessible and can be filtered by LHB or primary care cluster. Hospital pharmacy management, or an employed DMR champion, could regularly access these data for their relevant LHB and present it to their staff to improve appreciation of the DMR and its benefits. This feedback could form part of a wider strategy for evidence dissemination to frontline hospital staff, ensuring that the benefits of the DMR and other community pharmacy services are communicated.

Chapter 3 found that RTP had automated feedback to the referring practitioner, which included a

summary of the outcomes, including which service the pharmacist provided and a self-reported approximation of time and costs saved because of the referral. Although similar feedback would provide regular outcomes for DMR referrals, the focus group discussions presented mixed views on whether it was desirable or appropriate. Since these views were so varied, DHCW could implement automated outcomes feedback but allow HPPs to disable it if they preferred. Some focus group participants suggested that the completed DMR form be uploaded to the shared patient record, WCP, so they could access the outcomes if needed. This feedback mirrors that of PharmOutcomes and has subsequently been actioned by DHCW (2022b), who should collaborate with hospital pharmacy management to ensure frontline HPPs are aware of these changes.

The content analysis (Chapter 6) found that many 'other' discrepancies were intentional post-discharge changes, suggesting that a considerable proportion of identified discrepancies may not be clinically meaningful. However, identified discrepancies are an imperfect measure of patient benefit from the DMR since they do not consider the added value of DMR2, an adherence-support review. This step could be essential, considering Parekh et al. (2018) found that non-adherence caused approximately a quarter of UK post-discharge MRH in older adults. Although Chapter 6 found that 53% of incomplete DMRs [n=14,690] were because the patient was readmitted to the hospital, a notable proportion (21%) were because the patient did not attend the appointment, when including those identified in the content analysis of the 'other' DMR2 incompletion reason variable. This patient disengagement with DMR2 could be explained by a perceived lack of value. Furthermore, 20 comments in this content analysis described that the pharmacist did not complete DMR2 because they did not identify any discrepancies in DMR1. Although this was a small number of services, perhaps some community pharmacists consider the adherence-support component of the DMR less valuable than medicines reconciliation. This finding contrasts with community pharmacists' views of other adherence-support reviews like MURs, which they perceived as valuable for patients (Stewart et al. 2020). Perhaps this view for DMR2 has resulted from the evidence focus on DMR1 and identifying discrepancies. For example, although Mantzourani et al. (2020) described the association between the DMR and reduced odds of hospital readmission, they only considered DMR1. Therefore, further research is warranted to describe the value of DMR2 in improving patient safety. This work could repeat the analysis by Mantzourani et al. (2020) but include DMR2 completion as an additional variable to determine its impact on the relationship between the DMR and hospital readmissions.

In Chapter 4, some HPPs considered that the quality of clinical service would be better in independent pharmacies than in multiples. Although this demonstrates a misunderstanding of the

DMR, since it is not currently a clinical service, there is no evidence to support this view. Interestingly, Chapter 9 found that the mean number of discrepancies per DMR was higher for non-multiples than multiples, but not the item discrepancy occurrence. This variability was much smaller than that between individual pharmacies and pharmacists. Although this variation could be explained by differences in how the pharmacist enters the DMR data (see Section 10.3.3.1) or patient populations, it could indicate a lack of consistency in service quality. This finding is not surprising, considering no specific training is required for pharmacists to accredit for the DMR, just a declaration of competency (NHS Wales 2022). Although mandatory training could improve consistency, community pharmacists rarely have protected learning time, a perceived barrier to professional development (McMillan et al. 2022). However, HEIW is piloting such protected learning time for community pharmacy professionals, with results expected shortly (Robinson 2021). Perhaps the need for protected learning time for these services could be circumvented by integrating them into MPharm programmes meaning all pharmacists can provide them from day one of qualification. Not only could this improve the quality of services training but also the consistency of service provision, a fundamental principle of P:DaHW.

The integrated findings imply that this dissemination is required for multiple stakeholder groups. NHS England fund Academic Health Science Networks (AHSNs), a collaborative group of stakeholders from NHS secondary and primary organisations and academic institutions, aiming to develop and evaluate innovations and disseminate those findings to stakeholders (Robinson et al. 2020). Many ASHNs developed transfer of care programmes, implementing systems like PharmOutcomes (Jeffries et al. 2021). Such networks could be developed in Wales to systematise evidence dissemination to various stakeholder groups, improving knowledge of DMR benefits and future innovations. Patient-public involvement is a vital consideration for AHSNs, ensuring the patients are central during innovation development and evaluation. Understanding what evidence is important to patients could focus any future DMR evaluation, ensuring the disseminated evidence is meaningful.

10.3.1.4. Summary of the Knowledge Central Pillar and Recommendations

The WHO (2019) *Medication Safety in Transitions of Care* report suggested that post-discharge MRH can be reduced by interventions which improve:

- Information quality and availability across care transitions, like the DMR referral system.
- Post-discharge interventions, including medicines reconciliation and review, like the DMR service.

However, the knowledge central pillar identified a lack of knowledge of the DMR, its referrals and associated systems, which limits engagement with them. Therefore, the 14 recommendations developed from this pillar (see Table 10.3) aim to promote knowledge across stakeholder groups, thus optimising engagement with the DMR. The critical implication for practice is that cross-sector awareness campaigns are required to promote DMR engagement. Future service development should pre-plan the dissemination of information to avoid profound engagement barriers due to knowledge.

Table 10.3: Recommendations from the Knowledge Central Pillar (Organised by Intended Outcome)

Recommendation	Recommendation Recipient(s)	Intended Outcome(s)
A cross-sector promotional campaign for the DMR and its referrals.†	• Welsh Government • Hospital pharmacy management • Community pharmacy organisations • GP surgeries	• Improve the knowledge and awareness of the DMR, its referral process and its benefits.
Develop cross-sector educational material to describe the DMR, its benefits, and how to use the appropriate systems to facilitate them.† This material should be integrated into routine undergraduate and pharmacy professionals' training.	• GP surgeries • HEIW • Higher education institutes • Researchers • Hospital pharmacy management • Community pharmacy organisations	
Integrate patient-facing educational content into the DMR referral system for patients, ensuring it is multilingual and suitable for medically underserved populations.	• Hospital pharmacy management • DHCW	
Consider integrating HCP-facing educational material into the DMR form and referral system.	• Welsh Government • DHCW	• Increase the consistency of data entry into the DMR form and improve knowledge of the DMR referral procedure.
Explore GP surgery engagement with the DMR service across Wales.	• Researchers • GP surgeries	• Identify potential barriers and facilitators to GP surgery engagement in the DMR and its referrals.
Investigate the digital training needs and confidence of pharmacy staff in Wales.	• Researchers • HEIW	• Identify barriers, facilitators and suggested improvements for community and hospital pharmacy staff using DMR-related systems.
Employ a dedicated champion or super-user to explain to staff how to complete a DMR or referral.	• Hospital pharmacy management • Community pharmacy organisations	• Improve confidence and competence in using technology to support the DMR and its referrals.
Add specific digital healthcare skills to undergraduate training, including how to use ChP and MTeD.	• Higher education institutes • DHCW	
Patient education should be supplemented with an active recruitment strategy for DMRs from hospitals, community pharmacies, and GP surgeries.	• Hospital pharmacy staff • Community pharmacy staff • GP surgeries	• To improve patient engagement with the DMR.
Ensure system updates and indicative timescales are routinely disseminated to hospital frontline staff.	• Hospital pharmacy management • DHCW	• Improve the awareness of the DMR referral system.

Table 10.3 (continued)

Recommendation	Recommendation Recipient(s)	Intended Outcome(s)
Investigate the specific value of DMR2.	• Researchers	• To evidence DMR2's value, which could be disseminated to pharmacy professionals and patients to increase engagement.
Develop specific dissemination strategies for the DMR's benefits in hospital pharmacies. For example, structured dissemination of published evidence or community pharmacists presenting DMR case studies in staff meetings	• Hospital pharmacy management • Community pharmacy organisations • Researchers	• To improve HPPs' perceptions of the DMR's value.
Disseminate the updated DMR value to hospital and community pharmacy staff.†	• Hospital pharmacy management • Community pharmacy organisations • Researchers	
Consider enabling automated outcomes feedback to the referring practitioner and informing HPPs that ChP uploads the DMR forms to WCP.	• DHCW • Welsh Government • Hospital pharmacy management	

†The researcher and the wider team have begun implementing these recommendations (See Table 10.7).

10.3.2. Optimising System Cohesiveness

10.3.2.1. Buy-In and Role Integration

The thesis focus groups identified suboptimal buy-in for DMRs from hospital pharmacy departments across Wales. Many participants highlighted that their management had not meaningfully engaged with DMR referrals or asked staff to prioritise them. P:DaHW, the vision document for pharmacy in Wales, states that pharmacy professionals should lead hospital discharge, including facilitating post-discharge support from community pharmacists, such as the DMR (Welsh Pharmaceutical Committee 2019). Hospital pharmacy leadership must engage with DMR referrals to meet these aims; however, the original DMR evaluation concluded that HPPs were not 'sold' the service benefits (Hodson et al. 2014a). Although there are clear patient benefits, 'selling' the DMR's association with reduced hospital readmissions may be effective since it directly incentivises referrals for their workload. Groups such as AWQPSG (see Table 2.2) may be valuable conduits to promote DMR referrals to upper management to facilitate buy-in. As part of this buy-in, leaders must foster readiness for implementation in their organisations by providing the necessary resources, including adequate staffing, training, and feedback (Michel et al. 2022). However, despite the benefits of leadership engagement, individual staff members also need to buy in to promote referrals. Dedicated staff were used to increase buy-in to RTP and PharmOutcomes during implementation, a well-established method of improving the adoption of healthcare technologies (Ross et al. 2016). These staff need ongoing employment as DMR champions to promote and sustain referrals, ensuring promotional efforts are not short-lived, as was the case when DMRs were introduced in 2011. In a comparative case study analysis of healthcare service implementation in 11 US hospitals, Bonawitz et al. (2020) found that sustained employment of champions framed the service as routine care and a core part of hospital roles. Therefore, LHBs should hire ongoing DMR referral champions to prevent the experiences shared in the thesis focus groups, where efforts to promote referrals waned over time.

A DMR referral barrier identified in the thesis focus groups was the lack of integration with HPPs' working practices. Nazar and Nazar (2021) identified a similar finding from HPPs interviewed [n=4] as part of an evaluation of a post-discharge domiciliary medicines review service in England. Additionally, many focus group participants (Chapter 4) suggested that they did not perceive discharge-related activities, such as DMR referrals, as part of their core role. Without hospital management outlining DMR referrals as a core responsibility and developing standard operating procedures that seamlessly integrate them into their workflow, HPPs felt they would not engage. NHS England and NHS Improvement (2020) developed a toolkit to support hospital and community pharmacy organisations in developing procedures to integrate the Discharge

Medicines Service (DMS) into their working practices. However, such national approaches may be unsuitable for DMR referrals since Chapter 4 highlighted considerable heterogeneity of discharge processes across hospitals in Wales. In implementation science, the concept of 'context' is often discussed, outlining the specific environment and processes in which the innovation is implemented (Nilsen and Bernhardsson 2019). Given that the discharge processes vary across Wales, the hospital pharmacy management should integrate DMR referrals into the workflow for their specific hospital, given that they understand the local context.

Additionally, this thesis described the importance of accountability for the DMR and its referrals in sustaining engagement. The RTP key informant (Chapter 3) detailed how they kept HPPs accountable for referrals by following up with staff who discharged eligible patients without a referral. Similarly, they would contact community pharmacies that had received a referral but not actioned it within a reasonable timeframe. DHCW collects data regarding the percentage of eDALs available through ChP that resulted in a DMR. Approximately 11% of these eDALs resulted in DMRs in 2021, suggesting that HPPs' concerns may be founded (Jones 2022). Although these data are not published, DHCW circulates them to interested parties. HPPs indicated that such data would encourage them to refer patients since it would provide information on community pharmacy engagement. However, the eDALs available in ChP could have been precipitated by a referral from the hospital or proactive patient pre-registration for the DMR service in the community pharmacy. Furthermore, not all patients with an available eDAL will be suitable for a DMR. Therefore, these data do not provide a valid 'attrition rate'.

Hodson et al. (2014a) identified the lack of tangible feedback as a DMR referral barrier in the original evaluation. The focus group results suggest that this has not been rectified. Community pharmacists accessing RTP and PharmOutcomes referrals must accept or reject the referral, which feeds back automatically to the referring practitioner. This automated feedback shows the referring practitioner that the community pharmacist had actioned their referral. However, hospital pharmacists interviewed for a recent evaluation of a referral service using PharmOutcomes described how frequent rejections dissuaded them from referring more patients (Khayyat et al. 2021a, p. 12).

> *"Some people found it demoralising because you could send 4 or 5 and then they would always be rejected, and that's quite demoralising if you did a lot of work".*

Such feedback integrated into the DMR referral system could promote referrals only if community pharmacists adequately engage with the DMR. Interestingly, the focus group participants (Chapter 4) perceived that the community pharmacy sector did not want to engage with the DMR, which reduced their own motivation to refer patients. Chapter 6 showed considerable variability in DMR

provision, with 18 pharmacies exceeding the previous funding cap of 140 annual DMRs at least once and 33 providing no DMRs from November 2011 to January 2021. HPPs in the focus groups perceived this variability as a barrier since they did not know which pharmacies would action their referrals. In an evaluation of post-discharge services facilitated by PharmOutcomes, interviewed patients and members of the public [n=11] suggested they would not think to attend a pharmacy for post-discharge services because of this perceived inconsistency in service availability (Khayyat et al. 2021a). Hindi et al. (2019b) reported similar views in their interviews with GPs, patients, and pharmacists regarding community pharmacy management of chronic conditions. The results from the secondary analysis (Chapter 8) identified some factors that contributed to this variability, with lower DMR provision in multiple pharmacies[40] and those that provide fewer other services and lower dispensing volume. Community pharmacy professional organisations must provide targeted support to pharmacies providing few DMRs using the thesis findings. Further work could explore community pharmacists' motivation to provide DMRs. The thesis findings provide a sampling framework for this research, which could involve a quota from pharmacies providing many DMRs, and those providing none.

Leadership was identified as critically important for implementing community pharmacy services in a recent systematic review of international literature (Michel et al. 2022). However, Ferguson et al. (2018) highlighted the challenges of leadership in the community pharmacy sector when investigating the implementation of RTP. The authors suggested that creating buy-in for the system was challenging in community pharmacies because they are owned by many contractors. In contrast, RTP implementation in hospitals was perceived as straightforward since there was cohesive and centralised leadership to drive the scheme forward. The key informants for RTP and PharmOutcomes (Chapter 3) suggested local collaboration between professional organisations to promote system engagement in community pharmacies. In April 2021, contractors from each primary care cluster nominated a 'cluster lead' to represent the local interests of community pharmacies (Welsh Government 2021). The Welsh Pharmacy Contract was altered to incentivise contractors to regularly attend meetings with their cluster lead to promote local collaboration. Community pharmacy professional organisations, such as CPW, could collaborate with these cluster leads to promote DMR buy-in on a local level, permeating the sector's complex leadership structure.

Another important consideration is how to promote patient buy-in to the DMR. Lam et al. (2019) identified that methods of hospital pharmacy promotion of dMURs were rarely effective. These

[40]Multiple pharmacies included supermarket pharmacies and large-sized and medium-sized multiples.

methods included verbal encouragement and providing a leaflet regarding the service. In contrast to these approaches, Luetsch et al. (2021) concluded from a realist review of community pharmacist post-discharge services that the 'appointment' for the service be organised on the patient's behalf. Therefore, it would be prudent for healthcare professionals (HCPs) to proactively recruit patients for DMRs rather than only improving their awareness. Although community pharmacists could attempt to invite patients for a DMR after discharge, Chapter 6 described that 8.8% [n=1,293] of incomplete DMR2s were because the pharmacist could not contact the patient, despite several attempts. Some focus group participants suggested referring patients to a designated pharmacist for a post-discharge review. Perhaps HPPs could book this appointment during the referral process, using a digital appointment system integrated into the DMR referral system to ensure it does not considerably increase the referral time burden. Exploring patients' views of such a system would be valuable since Hindi et al. (2018) found that the accessibility of community pharmacies was a facilitator for patient engagement in a systematic review investigating patient perspectives of community pharmacy services. Although appointment booking systems are being considered for the Independent Prescribing Service in Wales, community pharmacists' views should be explored on extending such a system to the DMR since it could reduce their autonomy over their own workload.

10.3.2.2. Referral System Implementation and Usability

Although DHCW has promoted MTeD as an all-Wales system since 2012, its implementation has been incremental and is still incomplete. Many LHBs have developed their own electronic discharge systems during this time to improve communication with GP surgeries. The thesis focus group participants highlighted this complex range of systems, describing how many were in concurrent use across Wales, even within the same hospital. The lack of system uniformity created barriers such as a lack of practice with MTeD, the only system with the facility to refer for DMRs electronically. Ahmed et al. (2018) reported similar findings regarding electronic prescribing system uniformity in England, with participants suggesting it led to decreased perceived competence and engagement. The influence of the MTeD roll-out on DMRs can be conceptualised using the descriptive analysis results, which showed that eDAL availability increased over time but varied considerably by LHB (see Figure 6.14). For example, CVUHB DMRs had almost 100% eDAL availability in 2020, whilst ABUHB had 0%, which was expected considering ABUHB declined MTeD adoption in favour of their own electronic discharge system, Clinical Workstation (Healthcare Inspectorate Wales 2018). Without the facility to refer patients electronically for DMRs, the HPPs (Chapter 4) felt they could not integrate referrals into their working practices since alternative

paper or fax transmission methods were cumbersome.

However, the focus group participants frequently discussed how MTeD was cumbersome compared to their alternative electronic discharge systems. Similarly, CPW (2022b, p. 4) stated that pharmacy contractors *"unanimously and quite understandably view the system [ChP] as extremely slow and clunky"* and *"it [ChP] is becoming universally recognised as a barrier to service development"*. Although CPW did not provide supporting evidence of these views, it is known that poor healthcare system usability can lead to disengagement and user burnout (Melnick et al. 2020). Bloom et al. (2021) used the system usability scale, a validated scale of technology usability, to quantify the usability of various electronic health records across the UK, including WCP. They found poor usability compared with other commercial systems, like those used for online banking. Perhaps DHCW could use such a scale to iteratively develop their systems to ensure they are easy to use, promoting adoption and engagement. Additionally, DHCW and researchers could investigate and adopt the perceived advantages of alternative systems to increase engagement with MTeD, which would hopefully result in increased DMR referrals. The Chapter 3 key informants considered that responsiveness to feedback was important for system adoption. Co-design is increasingly considered essential for digital healthcare adoption (Yardley et al. 2015). However, as needs and practices change, technologies must be adapted to suit a changing environment. DHCW has mechanisms to review stakeholder feedback, including a ChP user group. However, during recent parliamentary scrutiny of DHCW, CPW (2022b) suggested that responsiveness to feedback has been slow.

These findings demonstrate the need for considerable investment in IT to accelerate MTeD implementation across Wales and to increase the capacity to implement the specific recommendations in this thesis. This investment would be significant considering the delays caused by Covid-19, given that DHCW (2021c) diverted their resources to develop the Welsh Immunisation System, a considerable achievement to facilitate data sharing for cross-sector mass vaccination. This recommendation is in line with the forward view for technology-supported healthcare in the UK, supported by the Topol Review (2019) in England and the vision document, A Healthier Wales (Welsh Government 2018). In response to the technology focus of A Healthier Wales, the Welsh Government transitioned NWIS to a new Special Health Authority, DHCW (2022a). This transition in April 2021 suggested a national commitment to delivering digital healthcare in Wales. Hopefully, this will result in increased investment into digital healthcare in Wales to optimise the provision of the DMR and other services.

There may be situations where MTeD adoption is not feasible. For example, focus group participants working in hospitals near the Wales-England border described how their patients frequently attended English hospitals, where electronic DMR referrals would not be possible. However, the descriptive analysis showed that 2.35% of all DMRs were for patients discharged from English hospitals, evidencing that community pharmacists are overcoming these barriers. In their integrated medium-term plan, DHCW (2022a) have described that they are dedicating a team to work on cross-border projects. This team should consider developing non-MTeD discharge system interoperability with ChP to ensure equitable access to electronic DMR referrals.

The implementation of electronic hospital prescribing is ongoing in Wales (Section 1.2.2). The interoperability of these systems with MTeD will have significant consequences for DMR referrals. HPPs considered seamless interoperability and ease of use essential to facilitate referrals. If electronic prescribing implementation worsens these factors, it could reduce referrals and subsequent DMR provision. Ideally, there should be one national system for Wales to ensure seamless medicines information access across care settings. However, DHCW (2022a) has provided each LHB with criteria to procure their own hospital electronic prescribing system. Although these disparate systems could threaten interoperability with other systems, such as MTeD and ChP, DHCW has specified that the procured systems must meet specific open data standards to ensure seamless transfer of information. To support the aims of DaHW, DHCW (2022a) created the digital medicines transformation portfolio, a workstream designed to digitalise medicine use in Wales, including electronic prescribing. Within this workstream, DHCW intends to develop a single centralised patient medication record, which could be accessed or amended by any professional providing that patient care. Provided this workstream ensures interoperability with ChP at discharge and staff are adequately supported in system use, realising this aim should promote DMR referrals.

10.3.2.3. Collaboration

Even with the perfect seamless referral system, HPPs must be motivated to collaborate with their colleagues in the community. Unfortunately, many thesis focus group participants cited poor relationships with their local community pharmacies, mainly driven by a lack of trust, which made them reluctant to refer for DMRs. Some participants were sceptical of community pharmacists' motives for DMR provision, citing business orientation and the quantity-driven model of the community pharmacy contract. Some with this view had personal experience working in community pharmacies, seeing a target-driven approach to MURs rather than patient-driven ones.

An extensive observational study of MUR consultations in England echoed this finding, with Latif et al. (2011) finding that community pharmacists chose less clinically complex patients for MURs to meet targets, especially those working in large chain pharmacies. However, this may not be true of the DMR, with Chapter 8 showing that non-multiple pharmacies were more likely to have provided at least one DMR (odds ratio = 1.73) and had greater DMR volume (incidence rate ratio = 1.56). There was an apparent conflict between the HPPs' (Chapter 4) views of their goals and that of primary care pharmacists (PCPs), primarily working for patient benefit and their perception of community pharmacists working for profit. Additionally, they did not trust that community pharmacists would action their referrals, especially not for complex patients, who would take more time. These views contrast with the broader agenda for community pharmacy in Wales, which is moving away from a quantity-driven contract and towards clinical services (Welsh Government 2021). Aunger et al. (2022) completed a realist review of factors affecting inter-organisational healthcare collaboration, highlighting that shared vision and trust were essential. Therefore, to change the HPPs' (Chapter 4) perceptions of community pharmacists as 'business orientated', routine collaboration may be required between grassroots community pharmacists with secondary care HCPs to sell their role and enthusiasm in post-discharge patient care. Community pharmacist inclusion in cross-sector collaborative networks like AHSN (see Section 10.3.1.3) or in groups like the AWQPSG may facilitate this routine collaboration. Additionally, community pharmacists could contribute to HPP DMR training or present case studies at staff meetings, an effective method of translating knowledge and developing shared understandings (Park et al. 2021). As part of the overall thesis dissemination strategy, the researcher has built relationships with community and hospital pharmacy organisations' employees and promoted collaborative working between them. For example, the researcher was a founding member of a DMR subgroup of the P:DaHW Delivery Board and ensured representation from the Welsh Government and hospital and community pharmacy sectors. Hopefully, these efforts will improve cross-sector communication and collaboration and optimise DMR engagement.

Some focus group participants (Chapter 4) perceived that community pharmacists were not clinically competent and did not have access to appropriate information to support such services. Therefore, they believed community pharmacists should limit their role to technical tasks like dispensing. Since the DMR specification is not a clinical service, this referral barrier was based on misinformation. The HPPs also explained their limited awareness of community pharmacy roles, which could explain their view of the clinical competence of community pharmacists. The Nazar and Nazar (2021) evaluation of a post-discharge domiciliary medicines review service identified

similar HPP referral barriers to those identified in Chapter 4, including a lack of knowledge of the service and frustration surrounding the lack of referral capacity. However, the study HPPs better understood the service after shadowing the domiciliary pharmacist and suggested they would be more likely to refer patients. Although shadowing for the DMR would be resource-intensive, these findings demonstrate the benefits of meeting cross-sector colleagues to develop a shared understanding of roles and responsibilities.

The thesis focus group participants suggested cross-sector training for pharmacists and pharmacy technicians (PhTs) to solve the lack of HPP understanding and appreciation of the community pharmacy sector. Bartlett et al. (2022) recently interviewed pharmacists [n=6] who trained during early pilots of multisector training (in 2017) to explore how the pilot affected their preparedness for practice. Most [n=5] of these participants worked in hospital pharmacies after qualification. The placement improved their understanding of community pharmacy services and the need for collaboration. Additionally, hospital pharmacists participating in post-qualification cross-sector GP surgery training better understood post-discharge medicines management processes, leading them to change their practices in the hospital (Rathbone et al. 2019). Therefore, cross-sector training may optimise collaboration between sectors and address DMR referral barriers.

Since the researcher completed Chapter 4, pharmacist pre-registration training has undergone a considerable transformation and is now named foundation training. This new training aims to better prepare trainees for the evolving nature of pharmacy practice (GPhC 2021). HEIW launched a multisector foundation training programme in response to the changing guidance and the positive response to its pilot (Bartlett et al. 2022). In this new programme, all trainee pharmacists will complete equal placements in community, hospital, and GP surgeries. Similarly, national multisector PhT training trials are underway in Scotland and Wales (Bartlett et al. 2022; NHS Education for Scotland 2022). Although this new multisector training programme may optimise DMR referrals by increasing cross-sector appreciation and understanding of roles, Bartlett et al. (2022) described some unintended consequences. These included a perceived lack of preparedness for practice once qualified owing to a reduced time in each sector relative to training in one sector. If the MPharm programmes in Wales included increased exposure to the DMR and other community pharmacy services (see Section 10.3.1.3), undergraduates could start their foundation training with an appreciation of the community pharmacist's role in post-discharge support.

It was disappointing to find a lack of collaboration between hospital and community pharmacies alongside the presence of deprecating perspectives from HPPs regarding their community

colleagues. Khayyat et al. (2021a) described the fidelity of PharmOutcomes referrals in England but did not report such strong HPP reluctance to collaborate with community pharmacy colleagues. This disparity could be explained by differences between pharmacy staff working in England or Wales or differences in the employed study methods. Reflecting on the focus groups, the participants seemed initially reluctant to share such views. However, discussions ensued once a group member described 'the elephant in the room'. Perhaps using focus groups elicited these views more strongly than interviews, as Khayyat et al. (2021a) used.

There is a plethora of literature describing such friction between secondary and primary care doctors (Johnston and Bennett 2019), but little for pharmacists. Altman et al. (2018) interviewed hospital pharmacists in England who felt that community pharmacists were holding back the profession due to their lack of role progression. Similarly, Nabhani-Gebara et al. (2020) found similar criticism of community pharmacists when interviewing GP pharmacists [n=19] about their integration into GP surgery roles. Although the study authors did not specifically ask the participants about their views of community pharmacists, they expressed negative views. One GP pharmacist in this study derogatorily described their community colleagues as *"checking monkeys"*, referring to their primary role of prescription accuracy checking (Nabhani-Gebara et al. 2020, p. 20). Kellar et al. (2021) reviewed international literature regarding pharmacists' professional identities. They concluded that hospital pharmacists often aligned with the 'clinician' identity, whilst community pharmacists aligned with the 'businessperson', although aspiring to be clinical. Additionally, pharmacists often attributed value to these identities, leading them to perceive themselves as either a clinician or 'just' a community pharmacist. In keeping with these findings, Altman et al. (2018) suggested that intra-pharmacy tensions could be explained by the differential uptake of clinical work between hospital and community pharmacists. Despite recent developments in community pharmacy clinical services, most of the community pharmacists' workload involves dispensing and checking prescriptions (Cooper 2020). The researcher suggested directly promoting the DMR to HPPs to improve their awareness and knowledge of the benefits in Section 10.3.1. However, the wider promotion of the community pharmacists' evolving clinical role in patient care could challenge the view that community pharmacists are less clinical, promoting respect and collaboration. The new community pharmacy contract exemplifies this evolving clinical role in Wales, which includes more funding for clinical services, including the Independent Prescribing Service (Welsh Government 2021).

Butcher et al. (2017) reviewed the literature regarding HCP students' experiences working in intra-professional teams. Although this study was not exclusive to pharmacy professionals, it suggested

that educators and staff create intra-professional hierarchies which impede relationships and collaboration. Chapter 4 reflected these findings, with some of the more critical participants being senior pharmacists. The Cardiff School of Pharmacy and Pharmaceutical Sciences [CSPPS] (2022) delivers most of its community pharmacy-specific content in years one and two (of four) of the MPharm degree. In contrast, they teach the 'clinical' therapeutics work later. In their PhD thesis investigating pharmacy graduate preparedness for practice, Broad (2017) interviewed 14 CSPPS academic staff. Some interviewees suggested that undergraduate students professionally diverged early in training, deciding on community or hospital pharmacy. This structure and divergence could introduce a perceived hierarchy with community pharmacy work considered 'simple'. Johnston and Bennett (2019) explored similar tensions between primary and secondary care doctors, suggesting that the structure of medical education reinforces this perceived hierarchy. For example, the CSPPS (2022) future careers website section could reinforce the view of community pharmacists as 'less clinical' since it states that graduates could get a career as a community or a 'clinical' pharmacist.

The GPhC (2017, 2021) initial education and training standards for PhTs and pharmacists state collaboration as one of the key competency areas before qualification. Within this area, one competency states that pharmacy professionals must demonstrate competence in working within multidisciplinary teams for patient-centred care. Although this is the correct direction of travel, there is no specific focus on intra-professional collaboration. MPharm programmes across the UK are likely to be undergoing a period of transformation to prepare new graduates to qualify as independent prescribers from day one of practice, which will be standard from 2026 (Lim et al. 2022). Higher education institutes should use this opportunity to follow recommendations from the study by Johnston and Bennett (2019) to critically appraise curricula, ensuring they foster mutual understanding and respect without unwittingly undermining the work of primary care professionals, such as community pharmacists.

Recent national agendas focus on integrated and collaborative care, highlighted in P:DaHW and the introduction of integrated care systems in England (NHS Digital 2022). These agendas emphasise how healthcare is moving away from silo working and towards patient-centred practice. Professionals must collaborate to achieve this shared aim. Educators and professional organisations should critically reflect on their biases and promote collaboration for the patient's benefit, including DMR referrals. Further work should investigate the sources and extent of pharmacy intra-professional tensions. Understanding these tensions will facilitate interventions to achieve cultural change and promote integrated care.

10.3.2.4. Summary of the Optimising System Cohesiveness Central Pillar and Recommendations

Table 10.4 presents this central pillar's 15 recommendations to optimise DMR use by improving the cohesiveness of the whole system, including its required collaboration, buy-in and the associated technology. The critical implications for practice are that hospital and community pharmacy organisations must engage with the DMR and its referrals, integrate it into the frontline staff's core role and 'sell' it to them. As part of this campaign, work must be done to improve the relationship between HPPs and community pharmacists through cross-sector training and routine collaboration. It is essential for the DMR and future integrated care initiatives that all sectors have a shared vision for patient-centred care.

Table 10.4: Recommendations from the Optimising System Cohesiveness Central Pillar (Organised by Intended Outcome)

Recommendation	Recommendation Recipient(s)	Intended Outcome(s)
Accelerate MTeD implementation.	• DHCW • LHBs • Welsh Government	• Enable electronic DMR referrals across Wales. • Remove issues associated with lack of system uniformity.
Ensure the interoperability between MTeD and ChP is maintained throughout any system changes, and consider developing IT interoperability with other systems where MTeD is unavailable.	• DHCW • Welsh Government	
Investigate the perceived advantages of alternative electronic discharge systems.	• DHCW • Researchers	• Improve the user experience of DMR-related systems to optimise engagement with them.
Expand DHCW capacity to action system feedback.	• DHCW • Welsh Government	
Integrate the DMR and its referrals into the community and hospital pharmacy core role and make HCPs accountable for referrals.	• Hospital pharmacy management • Community pharmacy organisations	• Normalise the DMR and its referrals.
Locally integrate DMR referrals into the workflow of HPPs.	• Hospital pharmacy management	
Ensure ward staffing is adequate to support DMR referrals.	• Hospital pharmacy management	• Increase HPP capacity to refer for DMRs.
Employ dedicated staff to champion the DMR and its referrals. These roles could include promoting buy-in to the service and supporting frontline staff during periods of system changes.	• Hospital pharmacy management • Community pharmacy organisations	• Promote the DMR and its referrals and ensure staff are confident with system use.
Explore reasons for variable community pharmacy DMR engagement and provide targeted support for those with low engagement.	• Researchers • Community pharmacy organisations	• Obtain information regarding variable community pharmacy DMR uptake. • Improve consistency of DMR provision.
Adapt the DMR referral system to provide feedback for referring practitioners indicating that referrals were actioned.	• DHCW • Welsh Government	• Change HPPs' perceptions that community pharmacists would not action DMR referrals.
Provide regular feedback to hospital pharmacy departments regarding the commitment of community pharmacists to the DMR and patient care.	• DHCW • Hospital pharmacy management • Community pharmacy organisations	
Hospital and community pharmacy professional organisations should collaborate routinely.†	• Hospital pharmacy management • Community pharmacy organisations	• Improve cross-sector understanding of roles, responsibilities and aims; hence improving working relationships and collaboration.
Cross-sector training for pharmacists and PhTs.	• HEIW • GPhC	
Adapt pharmacy education to showcase patient-centred collaboration, including the DMR.	• Higher education institutes	
Explore the intra-professional tensions in the pharmacy profession.	• Researchers	

†The researcher and the wider team have begun implementing these recommendations (See Table 10.7).

10.3.3. Fitness for Purpose

10.3.3.1. Pharmacy Professional Post-Discharge Support

These findings highlight considerations for using the whole primary care pharmacy workforce to optimise post-discharge support. The description of DMR provision in Chapter 6 built on the published evidence for the patient safety benefits of the service (Hodson et al. 2014a; Mantzourani et al. 2020), showing that pharmacists identified an average of 1.15 discrepancies during NECAF DMR1s. Similarly, for ChP DMRs, pharmacists identified discrepancies with 10.6% of medication items. The most frequent discrepancy types were medicines discontinued or restarted after discharge and 'other' discrepancies, as identified in the original DMR evaluation (Hodson et al. 2014a). Chapters 6 and 8 showed that the overall rate of discrepancies decreased over time, which could be explained by improvements in GP surgery post-discharge reconciliation. One such improvement could be the increased use of electronic discharge systems, which provide timelier access to an eDAL, which is likely more comprehensive and accurate than paper DALs (Mekonnen et al. 2016b). Alternatively, it could be explained by the employment of pharmacy professionals responsible for post-discharge medicines reconciliation into some GP surgeries (see Section 10.3.3.1).

As described in Section 10.3.1.3, HPPs (Chapter 4) were unaware of the published DMR benefits. A considerable referral barrier was their view that the DMR specification was unfit for supporting patients post-discharge. One key aspect of this was that the DMR was not comprehensive since it was not a clinical service and did not involve resolving discrepancies. However, the content analysis results for the free-text 'other' discrepancies and further action required after DMR2 variables suggested that community pharmacists provided care outside the DMRs specification. For example, intervening in the first post-discharge prescription to rectify a clinical issue and providing ongoing support after the DMR had concluded for a patient's medical condition. One illustrative comment included:

> *"Condition is deteriorating, carer wants answers as to where to go. Signposted to MIND [mental health charity] and making note on record (…) she seems to have deteriorated based on phone call. To follow up".*

The DMR form would not capture the outcomes of this additional care; therefore, the value of the DMR could be underreported.

The content analysis in Chapter 6 showed that pharmacists were pre-empting the first post-discharge prescription to stop discrepancies from occurring. Also identified in the original DMR evaluation, this method may lead to the under-reporting of discrepancies (Hodson et al. 2014a). However, it shows that pharmacists are trying to adapt the DMR to fit their workflow and provide

patient-centred care. The new DMS in England formalises this 'pre-empting' process. In contrast to DMR1, DMS part one is completed within 72 hours of discharge and compares the DAL to the patient's pre-admission medicines. Therefore, pharmacists completing the DMS can clarify medication changes before the first post-discharge prescription and alter any pre-admission prescriptions (NHS England and NHS Improvement 2021).

As a consequence of working outside the service specification, the DMR form on ChP was not fit for purpose since it did not routinely capture how pharmacists were delivering the service. For example, the content analysis results indicated that pharmacists provided several DMR modalities not encompassed by the specification, like with a carer by telephone. Additionally, pharmacists occasionally used the 'other' discrepancy type to describe multiple discrepancies for a single item, which is not otherwise possible to document on the DMR form. Blijleven et al. (2022) described similar system workarounds caused by poor process-system fit, leading to poor data quality and end-user frustration and disengagement. Consequently, the DMR form may not accurately report the DMR's provision and may cause stakeholder disengagement. Further work must describe how community pharmacists provide the DMR, which could inform the adaptation of the DMR form to accurately collect the service provision and holistic outcomes. The content analysis findings, e.g., that pharmacists often complete DMR1 before receiving the first post-discharge prescription, could inform this further work, providing a basis for research design.

The thesis focus group participants regularly referred patients to PCPs for post-discharge support; hence some perceived the DMR as unnecessary work duplication. Furthermore, some HPPs felt PCPs could provide more comprehensive post-discharge care because they could provide clinical care and rectify discrepancies themselves if they were independent prescribers, cutting out the community pharmacist 'middleman', who would have to refer to the GP. Jeffries et al. (2021) presented similar HPP views during interviews [n=6] regarding the implementation of PharmOutcomes referrals. Several upcoming changes in the pharmacy profession could reduce these views of community pharmacists. HEIW (2022) recently announced increased funding for MPharm programmes in Wales to increase the number of clinical placements, supporting pharmacists to develop the experience needed to qualify as competent independent prescribers from day one of practice (Lim et al. 2022). As the forward view is for all pharmacists in Wales to become prescribers (Welsh Pharmaceutical Committee 2019), HPPs may acknowledge that community pharmacists have met a minimal standard of clinical competency. Furthermore, prescribing community pharmacists may be able to 'action' discrepancies, especially if they have access to clinical records, reducing the 'middleman' perception. However, for community

pharmacists to undertake this role, the sector must have greater integration with the multidisciplinary primary care team to outline this responsibility. Additionally, community pharmacists would require read-write access to the GP records to document any actions adequately.

PCPs are relatively new, although their numbers have increased since their introduction in primary care clusters in 2015 (Welsh Pharmaceutical Committee 2019). Although some PCPs are employed directly by GP surgeries, others are employed by LHBs or primary care clusters and frequently rotate through different GP surgeries, so they will not be there each day. Pharmacists interviewed for their perception of a pilot training programme for working in GP surgeries in Wales highlighted considerable role heterogeneity, even if they worked in a single location (Bartlett et al. 2021). Until each GP surgery has a pharmacist or PhT who provides post-discharge support as part of their core role, post-discharge service availability will be more consistent in community pharmacies. However, this is contingent on community pharmacists engaging consistently with the DMR, which was not borne in the thesis' description of DMR provision that identified the maximum percentage of pharmacies providing at least one DMR in a given month was 44% (see Figure 6.7). Therefore, the primary care workforce should buy into consistent pharmacy professional-led post-discharge support, including the DMR.

Waring et al. (2019) described several causes of poor collaboration between secondary and primary care, including differences in professional roles and culture. This study conceptualised discharge liaison roles as 'brokers' supporting collaboration across boundaries. The focus group participants preferred communicating with PCPs because they "speak the same language", explaining that many of them used to work in hospitals. Surprisingly, Karampatakis et al. (2020, p. 6) found that community pharmacy teams appreciated the introduction of PCPs because they *"speak the same language".* The content analysis highlighted that community pharmacists sometimes collaborate with PCPs during DMRs to rectify discrepancies or clarify information. The DMS toolkit highlights the potential role overlap of PCPs and suggests local collaboration to demarcate responsibilities for each sector (NHS England and NHS Improvement 2021). Further work could explore PCP roles in post-discharge medicines management in Wales and work to optimise the provision of post-discharge services across pharmacy professionals.

The focus group participants suggested that community pharmacists may not have sufficient capacity to complete more DMRs, in keeping with identified DMR barriers from the original service evaluation (Hodson et al. 2014a). Hindi et al. (2019b) described similar barriers for other community pharmacy services in a systematic review, including the MUR and NMS in England and

the SFV in Wales. These capacity issues are worsening in the UK, with ongoing and highly publicised community pharmacy workforce shortages (Connelly 2022). Interestingly, in their investigation of stakeholder views of managing chronic conditions in community pharmacies, Alotaibi et al. (2022) interviewed one employee of a community pharmacy professional organisation who directly cited this workforce crisis as a barrier to service provision. This barrier could apply to the DMR, preventing increased community pharmacist engagement. Therefore, work must be undertaken to consider the optimal roles and skill mix in community pharmacy. HPPs in the thesis focus groups suggested that community PhTs complete DMRs to increase capacity for services and better utilise skill mix. PhT-led DMRs would have parity with the DMS in England, where a pharmacist or PhT can complete each stage (NHS England and NHS Improvement 2021). Although the thesis focus groups identified that hospital PhTs in Wales were routinely involved in medicines reconciliation and discharge planning, community PhT roles are often indistinguishable from lesser-qualified support staff (Schafheutle et al. 2017). Chamberlain et al. (2020) surveyed 83 community pharmacy PhTs to investigate their roles in Wales. Of the 40 participants who completed the whole survey, the mean percentage of time spent on accuracy checking and dispensing was 57% and 43%, respectively. Although limited by the low sample size and missing data, the participants expressed enthusiasm for extended roles in free-text responses; one response expressly referred to enthusiasm for the DMR. This enthusiasm was mirrored by some PhTs in the focus groups (Chapter 4), who were some of the strongest advocates for integrating DMR referrals into their working practices.

A critical pillar of P:DaHW is to upskill the community pharmacy workforce, enabling pharmacists to pursue clinical services and for PhTs to work to the top of their licenses. However, 35% of community pharmacies in Wales do not employ a PhT (HEIW 2019). The new Community Pharmacy Contract for Wales incentivises PhT employment to achieve an upskilled workforce and to support developing PhT roles (Welsh Government 2021). Community pharmacies should aim to employ PhTs to support service provision, and the Welsh Government should expand the DMR service specification to include PhTs.

As Table 2.2 described, the researcher disseminated the thesis findings to CVUHB, including those regarding PhT involvement in the DMR. From this dissemination, a CVUHB employee asked for academic support from the research team to support an application for Welsh Government funding to pilot and evaluate a PhT-led DMR service. Following a successful application, the researcher led the pilot evaluation, which led to a positive response from the Welsh Government, changing the DMR service specification to enable PhT-led DMRs nationally (NHS Wales 2022).

10.3.3.2. The Nature of DMR Referrals

The results from Chapter 9 support the value of electronic information exchange by identifying an association between eDAL availability and decreased odds of community pharmacists identifying discrepancies. This effect is likely due to timelier and more comprehensive information than paper or fax, a sentiment shared by the focus group participants in this thesis and interviewed community pharmacists in Wales (Mantzourani et al. 2017). The thesis' descriptive statistical analysis shows that the proportion of DMRs where the hospital provided discharge information increased over time alongside eDAL availability, suggesting that electronic transmission has improved information exchange. The content analysis results suggested further benefits for information exchange to community pharmacists since they described forwarding the information to the GP, enabling post-discharge reconciliation. However, the lack of clarity surrounding some medication changes caused difficulties for pharmacists attempting to identify discrepancies. The eDAL does include reasons for medicine discontinuation (DHCW 2022b). Still, this level of information was insufficient for situations where hospitals had changed medicine brands, or pre-admission medicines were missing from the DAL. Weetman et al. (2021) described similar findings for GPs attempting to reconcile medicines post-discharge. More extensive information on the eDAL regarding medication changes may provide clarity and ease the process of post-discharge reconciliation. Wuyts et al. (2020) reviewed international literature to develop an ideal discharge report for community pharmacists, including lists of admission and discharge medicines and reasons for changes. Interviewed Belgian community pharmacists [n=10] from this study unanimously agreed that this additional information was valuable (Wuyts et al. 2020, p. 173).

> *"I would definitely add this [medication registered at hospital admission]. This makes it clear that if medication is not on the list at discharge that they [HCP of the hospital] were aware of the medication use and the medication therapy has been stopped".*

Including such information on the eDAL could provide the context required to avoid many issues identified from the content analysis.

Section 10.3.3.2 introduced the DHCW (2022a) digital medicines transformation portfolio, aiming to develop a single patient medication record. The focus group participants suggested that a similar system would be beneficial because community pharmacists could access discharge information rather than require a DMR referral. This record could also assist the documentation of medication changes by changing the nature of admission medicines reconciliation. Instead of hospital practitioners taking a medication history and importing medicines information into MTeD, they would access and make any necessary changes to the shared record. This method may prevent the omission of pre-admission medicines from the DAL and ensure that the reasoning for

any changes is included. However, having the system enforce documentation of medication changes may not be feasible. Yemm et al. (2014) identified that junior doctors usually write DALs in the UK but were not the decision-makers in the patient's care; therefore, the DAL quality was limited. If the shared medication record enforced documentation of the rationale for changes, it could ensure documentation at the time of the change rather than waiting until discharge.

The literature review and key informant interviews (Chapter 3) highlighted the differences in the nature of each system's referrals. The DMR referral system informs a community pharmacist of their patient's discharge and provides eDAL access. In contrast, HPPs using RTP and PharmOutcomes must state a reason for the referral, which could involve several services, like medicines reconciliation, a dNMS or adherence counselling. The focus group participants discussed how such a feature would increase the perceived value of DMR referrals since they could better define any specific follow-up needed and allow community pharmacists to identify the patients considered most important by the referring practitioner. Currently, the community pharmacist cannot distinguish between DMR notifications generated by patient pre-registration or a specific hospital DMR referral. It is recommended that the system is adapted to rectify this, ensuring that community pharmacists can appropriately prioritise DMR patients if the referring practitioner has specific concerns precipitating a referral. Restructuring referrals in this manner would also facilitate accurate calculation of the attrition rate between specific DMR referrals and completed DMRs, which was identified as desirable by the HPPs in the focus groups (see Section 10.3.2.1). However, these system changes could be resource-intensive, so an alternative could be to introduce functionality for including a referral reason, i.e., a free-text box, which may make referrals more meaningful for HPPs and distinguish between pre-registered and referred patients. Allowing a broader range of post-discharge services via the DMR ChP module would be more patient-centred and could improve data collection on the benefits of community pharmacist post-discharge support (see Section 10.3.3.1).

Many focus group participants proposed that since the DMR referral system only makes the eDAL available after discharge, they are unsuitable for Multicompartment Compliance Aid (MCA) patients, who often need a reconciled MCA prepared in advance of discharge. Considering that the descriptive analysis found that 29% of DMRs were for patients who required adjustments to medicines (MCAs or MARs), this could be a significant barrier to engagement because the referring practitioners cannot use the system to meet their communication needs. In these circumstances, focus group participants were frustrated that they had to revert to less streamlined methods, like phone calls and fax. Perhaps this finding calls for a more generalised and flexible system for cross-

sector communication, where practitioners could transmit the eDAL or specific referral reasons before discharge. Secure NHS emails could achieve this since all pharmacy professionals have an account in the global inbox (DHCW 2022b). However, the focus group participants felt they would not know whom to contact since they did not have close working relationships with their community colleagues. These relationships will hopefully be improved by following the recommendations outlined in Section 10.3.2.4. Like RTP integrated a map into its referral interface to identify pharmacies, DHCW could integrate a drop-down list of pharmacists and their contact details that displays when the referring practitioner selects the patient's pharmacy. This development could be challenging since locum pharmacists, who do not have a permanent place of employment, constitute 32% of the community pharmacist workforce in Wales (HEIW 2019). However, the Welsh Government's (2018) 'Once for Wales' approach of creating national and interoperable IT systems could overcome this issue. For example, community pharmacists could be compelled to sign into ChP each working day and record their presence in a given pharmacy. These details could then populate an active database accessed through the DMR referral system. Such a database could also be helpful when considering booking systems for community pharmacy services, as discussed previously.

Most focus group participants perceived value in community pharmacists receiving access to discharge medicines information for their patients. Some thought that for meaningful post-discharge support, community pharmacists required access to clinical information regarding the patient's hospital admission. However, a few participants did not consider this necessary or appropriate. Additionally, when Mantzourani et al. (2014) surveyed community pharmacists to investigate what information to include on the eDAL, they did not consider clinical details essential. Over the last decade, there has been considerable debate regarding clinical information access for community pharmacists who argue that they require clinical information access since they provide an enhanced range of clinical services. Barriers include patient confidentiality concerns and tensions arising from GPs' autonomy over clinical information access in primary care (Goundrey-Smith 2018; Hindi et al. 2019a). However, Chapter 3 identified that RTP transmitted the whole DAL, including clinical information. PharmOutcomes has recently adopted this extent of information transmission, with interviewed community pharmacist users suggesting they valued access to the additional information because (Jeffries et al. 2021, p. 12):

> *"...when you've got the full picture of any contraindications, medical history, any medicines that were stopped and started, any that were in hospital but have then been stopped, you've got all the extra detail on […] there's no guesswork".*

These findings are supported by a realist review of post-discharge community pharmacy medication reviews, which concluded that clinical discharge information access enabled more comprehensive reviews (Luetsch et al. 2021). Additionally, the study identified that access to clinical information might encourage pharmacists to take ownership of identified issues and work to resolve them personally. These benefits to extended information access may address multiple barriers to DMR referrals identified through the focus groups, including the perceived lack of service comprehensiveness and the community pharmacist as the middleman. Consideration must be given to the patient perspective, with some members of the public in Wales expressing reluctance to community pharmacists accessing sensitive information at discharge (Rowlands et al. 2014). Since patients must consent to transmit their discharge information to their community pharmacy, they should be empowered to decide what information they are comfortable sharing and with whom. In England, patients have autonomy over their summary care records. They can provide limited access (medications and allergies) or additional access (medical history) to specific professionals (NHS Digital 2021). Providing patient autonomy over information sharing would align with the principles of patient-centred care, one of the key principles of P:DaHW (Welsh Pharmaceutical Committee 2019). DHCW should consider enabling enhanced eDAL information access for consenting patients. Since disseminating this thesis' findings, DHCW has committed to enabling access to the whole DAL through the DMR referral system, including clinical information (Way 2022).

Although increasing eDAL information access would be beneficial, there is also a national UK movement towards community pharmacist access to the GP record. NHS England has recently committed to a shared patient care record, which all HCPs involved in the patient's care may access (Department of Health and Social Care 2022). This commitment includes providing information access to community pharmacists by March 2025, including medicines-related information and medical history. In Wales, DHCW (2022b) has enabled limited GP record access through several ChP modules, such as the Emergency Supply Scheme and Independent Prescribing Service. In their integrated medium-term plan, DHCW (2022a) committed to delivering the functionality across other ChP modules. It is recommended that DHCW also enable access to the GP record through the DMR module.

Since Hodson et al. (2014a) identified that the lack of community pharmacist awareness of their patients' discharge from the hospital was a DMR engagement barrier, referrals and notifications will be needed even if community pharmacists could access a shared record. In contrast to the DMR referral system, which only notifies community pharmacists after patient discharge, Chapter

3 found that RTP and PharmOutcomes also notify community pharmacies of admission. Considering that a recent PharmOutcomes evaluation (Jeffries et al. 2021) and the focus group participants perceived admission notifications as beneficial for preventing waste from erroneous community pharmacy dispensing activities, DHCW should consider adding them to the DMR referral system.

10.3.3.3. Patients' Access to DMRs

Section 10.3.2.1 described the considerable variability in DMR provision between pharmacies and pharmacists. Patients may be excluded from the DMR if they attend a pharmacy which does not engage with the service. Nonetheless, the thesis highlighted circumstances where service or legislative factors may exclude certain patients. In a rural hospital focus group, participants described that many patients would not be eligible for a DMR because they received their medicines from a dispensing doctors' practice, not a community pharmacy. Since dispensing doctors' practices serve rural communities, rurality could reduce the number of DMRs provided. This hypothesis was confirmed by the descriptive analysis of DMR provision and exploratory data analysis (Chapter 8), which showed that pharmacies provided few DMRs in rural areas, including per pharmacy. However, there was no statistically significant difference in DMR volume between rural and urban pharmacies. Nonetheless, these patients should be able to access the DMR if needed. Perhaps hospitals could organise a DMR with the community pharmacy closest to the patient's home address, with the patient's consent.

For the DMR to exert its benefits, it must be accessible to patients who would benefit from it. The AWQPSG were keen to understand these patient demographics as they felt it would help them integrate referrals into the hospital pharmacy workflow for maximum benefit. Additionally, the lack of defined criteria has been identified as a barrier to community pharmacy service referrals in the original DMR evaluation (Hodson et al. 2014a) and the similar pharmacist-led domiciliary medicines review evaluated by Nazar and Nazar (2021) in England. In contrast, most thesis focus group participants suggested referral criteria were unnecessary since they knew who would benefit from a DMR, using their professional judgement. Interestingly, when analysed in Chapter 9, the community pharmacist professional judgement eligibility criteria for the DMR did not significantly affect discrepancy identification. However, the analysis identified only a few large effects, and the model fit was relatively poor. These factors may provide a helpful guide, but HPPs must primarily use their professional judgement when deciding whom to refer. Since some focus group participants suggested that professional judgement referrals would be more time-

consuming than those using strict criteria, their managers must empower them by providing adequate staffing.

There were some identified factors affecting discrepancy identification that overlap with other literature. For example, diuretics, anti-inflammatories, opiates, and antibacterial drugs are predictive factors of post-discharge MRH, as are medication changes (Parekh et al. 2018). Therefore, these criteria may constitute helpful evidence-based guidance for HPPs to support DMR referrals. Section 9.8.1 outlined the limitations of using identified DMR discrepancies as an endpoint, given that they are not explicitly indicative of clinical outcomes. Mantzourani et al. (2020) successfully linked NHS data to describe the effect of DMR1 on 40-day hospital readmissions. Although the authors demonstrated that data linkage was possible for evaluating the outcomes of the DMR, it was challenging because of the complex IT infrastructure in NHS Wales. In their integrated medium-term plan, DHCW (2022a) committed to developing the IT infrastructure in Wales to utilise healthcare data better to evaluate healthcare outcomes. As part of this commitment, they founded the National Data Resource (NDR), a central data repository for health and social care data in Wales, enabling timelier evaluation through data standardisation and curation. The introduction of the NDR will hopefully mean that future evaluations of the DMR and other pharmacy services are more straightforward, minimising the need for the extensive preparation procedures required for the DMR data, as described in Section 5.5.

Similar centralised data management and curation projects are ongoing in England, implementing recommendations from the recent Goldacre and Morley (2022) report, such as enhancing public trust in how their healthcare data are used. In 2021, NHS Digital aimed to enable researchers access to de-identified patient data unless the patient had opted out, leading to significant criticism from the public, HCPs, and the media (Anderson 2021). Consequently, many patients opted out of the perceived 'NHS data grab'. The Goldacre and Morley (2022) report described concerns regarding data linkage unintentionally identifying pseudonymised data. They suggested that data controllers have open and honest discourse with members of the public to assure them that such data will be protected and only used for valid purposes. Therefore, DHCW should openly communicate to the public how researchers may use their data and for what purpose to support timely future research.

Due to the increasing availability of healthcare data, modern machine learning techniques are being developed rapidly to predict healthcare outcomes. For example, PRIME is a regression model developed to describe factors for post-discharge MRH (Parekh et al. 2020). Unlike the regression method employed in Chapter 9, PRIME is a 'predictive model' that ultimately aims to be

used as a tool for hospital HCPs to input patient data and receive a score for that patient's risk of MRH. Although such models could be integrated into MTeD to support HPPs in selecting high-risk patients to refer for DMRs, accurate prediction depends on the validation of the model on a representative dataset. Since Parekh et al. (2020) only validated the model in older adults (>65 years old) in five NHS Trusts in England, a separate model would be needed for an all-Wales population.

The thesis focus group participants suggested that some patients could not access community pharmacy services, like the DMR, because they were elderly or housebound. They also felt these patients were at the highest risk of post-discharge issues, despite the contrary findings for elderly patients in Chapter 9 that younger patients were at higher risk. Although the DMR can be provided by telephone or in the patient's home, many focus group participants considered this infeasible. Community pharmacists delivering dMURs similarly identified that telephone provision was unsuitable for elderly patients who were often hard of hearing (Rutter et al. 2017). The content analysis (Chapter 6) found that some community pharmacists did not complete DMR2 because the patient was unwell, resided in a care home, or delegated responsibility for medicines to a carer. The descriptive analysis results partly contradicted these views, showing the mean DMR patient age was 74, with a skew for older patients. Also, a considerable proportion of DMRs were provided with carers, indicating accessibility for patients unable to access the service themselves. However, most DMRs were provided in the pharmacy and a small proportion (1-2%) in the patient's home.

Community pharmacists identified that domiciliary post-discharge services were rarely feasible due to the responsible pharmacist (RP) legislation, which prevented the provision of core services if the sole pharmacist left the premises to deliver a dMUR (Rutter et al. 2017). Some pharmacy stakeholders have lobbied for changes to this legislation to facilitate ongoing pharmacy operations in the physical absence of the RP to enable service provision (Wickware 2021). Following a four-year consultation, the UK Government enacted *The Pharmacy (Responsible Pharmacists, Superintendent Pharmacists etc.) Order 2022*, empowering the GPhC to make individual decisions on whether a pharmacy may operate without an RP; however, they have yet to use this power at the time of writing. Although the RP legislation may be a barrier to domiciliary pharmacist-led DMRs, PhT-led DMRs could circumvent this. Savickas et al. (2021) investigated PhT GP surgery roles in England, finding that 60% [n=10] had completed domiciliary medication reviews. These findings imply the feasibility of PhT-led domiciliary DMRs; however, further work should explore this in a Wales community pharmacy context.

10.3.3.4. Summary of the Fitness for Purpose Central Pillar and Recommendations

This central pillar considered the role of the wider primary care workforce, the nature of the DMR and its referrals, and vulnerable patient service accessibility. This pillar's critical implications for practice are that DMR referrals should be adapted to be more meaningful. These changes include adapting ChP eDALs to include clinical information and allowing referring practitioners to stipulate referral reasons, which could consist of other community pharmacy services, using their professional judgement. The ten recommendations developed from this central pillar (Table 10.5) aim to ensure patients are supported seamlessly post-discharge, facilitated by fit-for-purpose electronic systems, with minimal work duplication and services that are evidence- and value-based (Hurst et al. 2019). Although several recommendations are made regarding DHCW further developing DMR-related systems, this is contingent on the national prioritisation of this work and increased funding to release the capacity required to enact these changes. This funding should be considered to align with the WHO (2019) recommendations to reduce preventable MRH by improving information availability and quality across care settings.

Table 10.5: Recommendations from the Fitness for Purpose Central Pillar (Organised by Intended Outcome)

Recommendation	Recommendation Recipient(s)	Intended Outcome(s)
Consider the role of the DMR alongside PCP post-discharge support.	• Welsh Government • GP surgery organisations • Community pharmacy organisations	• To minimise perceived work duplication in post-discharge support.
Explore PCP perspectives on the DMR and its referrals.	• Researchers	
Consider the inclusion of PhTs in the DMR.†	• Welsh Government • HEIW	• Improve community pharmacy capacity for DMRs.
Describe community pharmacy DMR processes and outcomes across Wales, then adapt the DMR form to capture this routinely.	• Researchers • DHCW • Welsh Government	• To accurately describe how the DMR is provided across Wales. • Enable holistic evaluation of the DMR's outcomes, ensuring the service is cost-effective.
A holistic overview of community pharmacy work during the DMR should be disseminated to HPPs.	• Researchers • Hospital pharmacy management	• To ensure HPPs are aware of the holistic nature of the DMR, improving its perceived value.
Adapt the DMR referral system to include reasons for the referral and allow referring practitioners to identify the pharmacy professionals working in each community pharmacy.	• DHCW • Welsh Government	• To increase the perceived value of referrals.
Consider adapting the DMR referral system to increase the clinical information and information regarding medication changes on the ChP eDAL. Alternatively, provide access to the patient's GP record through the DMR module on ChP.†	• DHCW • Welsh Government	• Enable community pharmacists to provide more comprehensive post-discharge support. • To provide more context for community pharmacists to complete the DMR.
Adapt DMR notification systems to improve notification visibility, include admission notifications and distinguish between pre-registered patients and proactive referrals.	• DHCW • Welsh Government	• To improve notification visibility, facilitating eDAL access. • To facilitate community pharmacist prioritisation of DMRs and improve the perceived value of referrals.
Investigate the feasibility of domiciliary DMRs.	• Researchers	• To determine barriers to service provision.
Integrate Chapter 9's evidence-based recommendations into DMR referral processes as non-prescriptive guidance on patient prioritisation. However, HPPs should be encouraged to prioritise professional judgment to determine whom to refer for the DMR.	• Hospital pharmacy management	• To support hospital HCPs in referring for the DMR.

†The researcher and the wider team have begun implementing these recommendations (See Table 10.7).

10.4. Dissemination of Findings and Outputs

Each chapter outlined the dissemination of its findings. This section reflects on the employed dissemination strategy and its subsequent outputs, some of which were discussed above. Academic publication is often considered the cornerstone of research dissemination and output. Although the researcher published some of this thesis' work and intends to publish further, they planned further targeted dissemination to stakeholders at the outset of the thesis (see Section 2.3). Table 10.6 details the employed dissemination strategy, which aimed to bridge the research-practice gap, putting research findings into policy and practice.

Table 10.6: Dissemination of Thesis Findings to Stakeholder Groups

Stakeholder Group Name	Chapter 3	Chapter 4	Chapter 6	Chapter 8	Chapter 9
Research team					
DHCW Delivery Board					
ChP Clinical Reference Group					
AWQPSG					
P:DaHW Delivery Board					
P:DaHW Digital Medicines Management subgroup					
CVUHB Pharmacy Delivery Board					
P:DaHW DMR subgroup					
DMR Promotional Material Working Group					

Table Key	
	No planned dissemination
	To be disseminated
	Informal dissemination only (the researcher sat in meetings and provided expertise generated from findings)
	Formal dissemination only (presentations using Microsoft PowerPoint® and summary documents)
	Formal and informal dissemination

The contents of the findings disseminated to each group were targeted based on the group's function. For example, since the DHCW Delivery Board focuses on IT issues, the researcher focussed on results from Chapters 3 and 4 relating to the usability of ChP and MTeD. Table 10.6 highlights the different types of dissemination employed, including traditional didactic methods like presentations and more involved methods like joining working groups. On reflection, the researcher acted (and still acts) as a champion for the DMR service, promoting cross-sector discussions, raising awareness, and aiming to keep the DMR on the national agenda. Therefore, this dissemination addresses recommendations from Section 10.3.1.1 to promote the DMR and its referrals. Table 10.7 outlines the additional DMR-related outputs to which the researcher has contributed.

Table 10.7: Outputs from the Thesis Dissemination Strategy

Researcher's Activity	Outcome	Potential Benefits	Thesis Recommendation Targeted
Joined the P:DaHW Medicines Management subgroup and attended the Delivery Board to present thesis findings and promote the DMR.	Creation of a P:DaHW DMR subgroup.	Opportunity for cross-sector collaboration to promote engagement with the DMR and its referrals.	• Routine collaboration between hospital and community pharmacy professional organisations • A cross-sector promotional campaign for the DMR and its referrals.
	CPW employee applied for P:DaHW funding to develop DMR educational videos.	Improve patient, hospital and community pharmacy staff awareness and knowledge of DMRs and referrals.	• Develop cross-sector educational material to describe the DMR, its benefits, and how to use the appropriate systems to facilitate them. • Routine collaboration between hospital and community pharmacy professional organisations.
Represented the research team in a working group to develop the DMR educational videos.	The project produced several videos for different stakeholder groups. The researcher recommended inviting representatives from the AWQPSG to join the working group.	As a consequence of inviting AWQPSG representatives, an educational video was produced for HPPs. Furthermore, these meetings could contribute to improved cross-sector collaboration in the future.	
Presented thesis findings to CVUHB.	A CVUHB employee applied for P:DaHW funding to pilot a PhT-led DMR.	Provided information on PhT-led DMR feasibility.	• Consider the inclusion of PhTs in the DMR.
Led the evaluation of the PhT-led DMR pilot.	Welsh Government have altered the DMR specification so PhTs can provide DMRs (NHS Wales 2022).	Increase the community pharmacy capacity for DMRs.	
Presented thesis findings to the DHCW Delivery Board and the ChP Clinical Reference Group.	DHCW are planning to enable access to the whole DAL through the DMR referral system, including clinical information (Way 2022).	Increase the perceived value of DMR referrals and enable community pharmacists to provide a wider scope of post-discharge care.	• Consider adapting the DMR referral system to increase access to clinical information in the eDAL with patient consent or provide access to the patient's GP record through the DMR module on ChP.

10.5. Thesis Strengths and Limitations

Each empirical chapter discussed the strengths and limitations of its employed methods. This section considers the strengths and limitations of the overall thesis approach, which included five distinct objectives that the researcher addressed using several research designs. As detailed in Section 2.5, part of the rationale for using mixed methods was to minimise the limitations of qualitative and quantitative research alone. There was considerable integration between each chapter's results (see Section 10.2), evidencing the approach's credibility. These diverse methods

have contributed unique findings to pharmacy services, healthcare technology and transfer of care literature.

Chapters 3, 4 and 6 contained qualitative research, which is interpretative by design. Although some researchers may consider this subjectivity a source of bias, it is an inherent characteristic of qualitative research, and it is inappropriate to judge its quality using quantitative standards (Flick 2018). To manage the perceived bias, the researcher kept a reflexive diary (see Section 2.2) and used quotations to support findings, which experienced research team members reviewed. Although the content analysis of all free-text DMR data was time-intensive, it facilitated a detailed description of the provision of the DMR and its outcomes, which was a key attribute of the MRC process evaluation framework (Moore et al. 2015). Similarly, completing 16 focus groups was time- and resource-intensive but allowed a detailed exploration of HPPs' views whilst accounting for the differences across Wales, such as the use of electronic discharge systems.

As detailed in Section 1.5.4.2, the researcher did not explore patient or community pharmacist engagement with the DMR. Although qualitative studies for these groups may have been helpful, they would not have been feasible alongside the considerable work undertaken in this thesis. However, this thesis has built the foundation for this further work by describing the variability of DMR provision (descriptive analysis), lack of community pharmacist knowledge of the DMR (content analysis) and pharmacy-related factors affecting DMR delivery volume (Chapter 8).

The routinely collected DMR data were uniquely large for quantitative pharmacy services research, a testament to DHCW's work in developing ChP. Although managing and preparing these data was challenging and time-consuming, it was essential for addressing Thesis Objectives 3-5. Section 6.4.1 presented several limitations to using these data, notably the variability in its consistency. Although this was a useful finding, demonstrating the limited community pharmacist understanding of the DMR, it partly limits the generalisability of the results. However, it did highlight the need to adapt the DMR form to better fit how pharmacists authentically provided the service, which would optimise future evaluation.

Using the MRC's complex intervention process evaluation as a theoretical framework to develop the thesis methods facilitated a holistic view of the DMR and its referrals, identifying barriers and facilitators and developing recommendations for optimisation. Future development of pharmacy services should consider using this approach early in the implementation process to identify and address areas of complexity that could affect its fidelity. Over ten years have passed since the Welsh Government commissioned the DMR. Earlier process evaluation may have led to its benefits being better realised.

One critical strength of the thesis design was its inbuilt stakeholder dissemination strategy. The dissemination of findings detailed above appeared effective in increasing the awareness of the DMR and its place in the national agenda, evidenced by the development of DMR educational videos and PhT pilots. Additionally, the RPS (2022) launched a draft consultation to ratify the 2025 goals for P:DaHW, which include promoting the DMR and its referrals.

10.6. Conclusions

This thesis used a mixed methods approach to evaluate the DMRs provision, uniquely contributing to pharmacy services and care transition literature. The DMR and its referral system encompass all intervention types recommended by the WHO (2019) to reduce post-discharge MRH: engagement with patients, families and carers, improvement in information quality and availability across transitions, medicines reconciliation, and discharge and post-discharge interventions. Evaluating the DMR was essential due to its suboptimal uptake, despite its evidenced benefits for patient safety.

The findings from five empirical chapters were integrated to achieve the thesis aim, developing recommendations to optimise the DMR's use. The key recommendations included a cross-sector promotional campaign for the DMR to increase buy-in alongside the development of systematic dissemination strategies and routine cross-sector collaboration. To improve knowledge of the DMR and its referrals, higher education institutes, HEIW, and hospital and community pharmacy sectors should introduce specific training, including what the DMR is, its benefits, and how to refer to it. DHCW should consider actioning several recommendations to optimise the use of MTeD and DMR referrals, with financial and policy support from the Welsh Government. These developments include increasing the contents of the ChP eDAL to include clinical information, capturing a DMR referral reason, and ensuring community pharmacists can distinguish between patient pre-registration and DMR referrals from the hospital.

The P:DaHW vision document cited an ambitious aim for 2030: all patients should have a post-discharge review with a pharmacy professional, such as the DMR (Welsh Pharmaceutical Committee 2019). Recent research projected an annual cost of £2.21 billion for medicines-related hospital admissions in England alone (Osanlou et al. 2022). The DMR can reduce these pressures, as evidenced by its association with reduced hospital readmissions (Mantzourani et al. 2020), but only if pharmacy professionals buy into the service and its referrals. Adopting the evidence-based recommendations developed in this thesis may help optimise the DMR's use, working towards the WHO (2017) aim for *Medication Without Harm* and the 2030 aim to deliver *A Healthier Wales*.

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Appendices

Chapter 2 Appendices

Appendix 2.1. Reflexive Diary

I am a white male in his mid-late 20s living with Crohn's disease and osteoarthritis. While undertaking the PhD, I attended a hospital several times for inpatient surgery. These experiences provided a personal perspective of navigating the healthcare system as a patient, including discharge from hospitals. This experience afforded valuable insight, including witnessing the lack of communication across care boundaries, leading to potential discontinuity.

During my undergraduate training (pharmacy degree at Cardiff University), I undertook a research project during a summer recess involving the analysis of patient surveys regarding satisfaction with medication information provided at hospital discharge. Although this felt like an excellent opportunity to build research experience, it undoubtedly seeded my research interest in supporting patients through hospital discharge.

I qualified as a pharmacist in 2016 and worked in a community pharmacy in Wales full-time until starting my PhD in 2018. I have worked as a self-employed locum pharmacist during the length of my thesis, mostly on weekends. Amongst other valuable experiences during my work as a community pharmacist, I have completed many advanced services through Choose Pharmacy, including the DMR. From these experiences my preconceptions are that community pharmacy barriers to engagement may include a lack of familiarity with the DMR and lack of priority compared to dispensing. I also experienced the difficulties of conducting a DMR without having access to the electronic discharge advice letter, which I believe would present a barrier. As a Welsh pharmacist who believes in the benefits of the DMR, I could unwittingly be biased and unwittingly ignore its flaws. However, my motivation to complete this thesis was partly to ensure that the service is better utilised, which involves identifying areas for improvement.

Through data collection and analysis, I will need to be cognisant of the effect of these experiences on my interpretation. Although I do not believe it possible to bracket these preconceptions, I will reflect in individual reflexive entries so that the reader understands how my experiences may have affected the findings.

Appendix 2.1.1. Chapter 3 Reflexive Entry

Before the Study

As this study formed part of a PhD thesis, I had completed informal literature searches regarding technology-supported transfer of care systems before this work commenced and therefore had a general awareness of the topic. Hence, the systems were introduced in Chapter 1. I have a working knowledge of the DMR referral system due to my role as a practising community pharmacist, including some barriers to its use. My preconceived views were that DMR referral notifications were often easy to miss and that there was limited support for community pharmacists during implementation. However, I have limited insight into its initial implementation because it happened before I qualified as a pharmacist. Before starting this chapter, I was unaware of the other systems used in England or their differences to the DMR referral system. Since I am I Welsh pharmacist, I may be biased to the DMR and its referral system, weighting any identified benefits more strongly than those of the other systems.

During the Rapid Review

There are very few publications relating to the UK systems, especially explaining how they were implemented. The lack of publications was part of the rationale for completing this study but could be a barrier to the utility of the literature review approach. I have tried widening the search terms, but this captures many irrelevant studies, which are time-consuming to screen. I will have to screen through these since increasing specificity excludes many relevant publications.

If those developing or using the systems are not publishing information about them, how are practitioners supposed to learn about them or share good practice? In my past experience, I felt that the DMR referral system was somewhat 'thrust upon' pharmacists, without much guided support. Even with published information, I had to search extensively for it in "less academic" publication sources like the Community Pharmacy Wales website.

During the Targeted Grey Literature Search

The rapid review did identify some useful literature but very little on how the systems were implemented. After discussions with the research team, I decided to complete a targeted search of grey literature sources. As previously discussed, I had found DMR referral system literature in pharmacy practice publication sources. My supervisors also suggested that other sources like the Pharmaceutical Journal and PSNC may have relevant information. However, further methods may be required if this search includes little information regarding implementation.

During Literature Synthesis

YouTube was the most useful source for description of RTP and PharmOutcomes. Such videos would have been very useful for me as a pharmacist. Perhaps this view is borne of my age; although I remember the time before mass internet uptake, I grew up around it. I must remember that technology can exclude those less familiar with it. Perhaps formal publications are more suitable for these groups of pharmacists.

Although I was concerned about being somewhat protective of the DMR, there are some attributes of the other systems that I feel would be useful for the DMR referral system. Personally, admission notifications would have been valuable – many a time I was unaware that a patient had been admitted to hospital until they had run out of their medicines post-discharge. However, this view has also been highlighted by community pharmacists interviewed in published studies.

There was limited literature regarding system implementation in the literature. Through discussions with the research team, I decided to attempt interviews with individuals involved directly with system development or implementation. This should provide context of implementation and contemporary system use.

During the Key Informant Interviews

These interviews are very useful for 'filling in the blanks' with system implementation. It seems that RTP and PharmOutcomes were implemented with a plan, rather than the DMR referral system which 'evolved' from the service. I liked the idea of having staff whose role was to encourage implementation, this would have been useful for my colleagues in community pharmacy who often suggest they do not know who to contact if they are unsure of how to complete a service.

Since the key informant interviews are my first attempt at conducting qualitative research, my supervisors independently analysed the data. They constructed very similar themes and subthemes, indicating that my preconceptions (need implementation staff and admission notifications) had limited effects on my interpretation of the data. However, both supervisors are interested in the DMR so the 'member-checking' may not have accounted for related preconceptions.

Appendix 2.1.2. Chapter 4 Reflexive Entry

Before the Study

I have considerable experience using ChP and providing the DMR service through my work in community pharmacies in Wales. However, I have little experience in hospital pharmacies, save three weeks of placement work during my undergraduate degree. One of these placements was in the Princess of Wales hospital who were implementing an electronic discharge system at the time. This system was not MTeD, but I recall there being difficulties with encouraging staff engagement, the reasons for which I cannot remember.

Several of my friends from university work in hospital pharmacy. Informal discussions about my research demonstrated a lack of awareness regarding the DMR and its referrals. This preconception was reinforced by DD during study design and the previous DMR evaluation, which highlighted lack of awareness alongside barriers to engagement such as a lack of feedback and referral criteria, and poor communication with hospital pharmacy staff during service implementation. Rather than attempt to bracket these preconceptions, I designed the focus group schedule and analysis to explore this information. However, these could just be the experiences of a few so I will be mindful that participants could be well-versed in the DMR but have other barriers to engagement.

When recruiting for the focus groups, I asked the gatekeepers for any standard operating procedures for DMR referrals. Very few were identified, indicating that any processes are not formalised or do not exist.

During the Focus Groups

During a few groups, some participants were quite derogatory towards community pharmacists. Although this was challenging to listen to, these views are not uncommon in my experience. Some professionals think community pharmacy is the 'easy option', and hospital pharmacy is the 'real clinical work'. I will try to assess these views objectively, since they were sincerely held and despite my emotional gut reaction, they could be legitimate barriers to collaboration. From a methodology perspective, these findings are a relief since the participants appeared to be speaking freely, despite me moderating the groups as a practising pharmacist.

The strength of participant's belief in primary care pharmacists was surprising. I was also interesting that some felt so strongly that GP surgeries were the correct location for post-discharge support. However, other focus groups had limited experience with this professional group. Although I am somewhat 'protective' of the DMR, the participants made some compelling arguments which I will be sure to consider for recommendations.

Upon completing each focus group, it was clear that there was a profound lack of awareness of the DMR. To ensure this was grounded in the data rather than my preconceptions, I debriefed

with the assisted moderators after each group. Given both assistant moderators identified this strong theme, as did my supervisors when reviewing the themes, I am confident that this is not a product of my preconceptions.

When analysing the data, I found little differences between LHBs and professional groups. Pharmacy technicians were more positive about integrating referrals into their workflow whilst pharmacists were 'too busy'. However, there were considerable differences between hospitals in terms of culture, views of the DMR and community and GP pharmacists.

Appendix 2.1.3. Chapter 6 Reflexive Entry

My previous experience completing the DMR led to several preconceptions. I regularly encountered post-discharge discrepancies where the first post-discharge prescription had the incorrect quantity of medication. I have personally used the free type 'other' discrepancy to detail this. Additionally, I have had personal frustrations with using the eDAL, primarily that important information would frequently be omitted, especially items used as required. After completing Chapter 4, I wondered whether primary care pharmacists may have been involved in the DMR, in a collaborative capacity or independently completing post-discharge reviews.

Given the considerable quantity of data, I believe that category construction will be led by the data rather than my preconceptions. Regardless, I plan to use exemplar comments to evidence the constructed categories and have the results reviewed by my supervisors.

Chapter 3 Appendices

Appendix 3.1. Key Informant Interview Recruitment and Reminder Email

Version 1.2 18/02/19

Exploring Implementation, Barriers and Facilitators to Transfer of Care Systems in the UK

Key Informant interviews: Recruitment Email

Subject heading: "Transfer of care research: Invitation to participate"

Dear x,

I am a pharmacist who has recently started a PhD with Drs Karen Hodson and Efi Mantzourani at Cardiff University investigating factors affecting Discharge Medicines Review (DMR) service provision in Wales. As part of my PhD, it is important to understand all commissioned services in the UK that aim to facilitate the transfer of patients from hospital to community pharmacy. [System names] are such services which facilitate the transfer of discharge medicines information allowing medicine reconciliation and provision of a post-discharge medicines use review by a Community Pharmacist.

I am aware that you have been involved in the development and/or implementation and/or evaluation [delete as appropriate] of [system name] and would like to invite you to participate in an interview to help describe [system name], its development and its provision. A literature search has identified the key processes involved in [system name] but does not provide an authentic account of the implementation and provision of this service. The interview aims to fill these gaps, providing a richer description of these services and highlighting how they benefit patient care. In addition to this, access to any unpublished information that you could provide that would help describe the service and its benefits would be greatly appreciated.

Whilst this work is primarily for my thesis, it may lead to publications in the Pharmaceutical Journal and potentially other academic journals.

If you are interested in this interview, I have sent a further email containing a participant information leaflet and consent form. I would be grateful if you could return the consent form by e-mail by [insert date within two weeks of sending email once ethics received] if you would like to participate. If you have any questions about this study, please do not hesitate to contact me.

Kind regards,

Robert James, MPharm

E-mail:

Tel:

c.c Drs Karen Hodson and Efi Mantzourani, Cardiff School of Pharmacy and Pharmaceutical Sciences

Reminder email

Subject: Reminder - Invitation to participate in research

Dear x,

Please find enclosed a repeated email regarding involvement in interviews concerning transfer of care systems in the UK.

I've re-sent this email as I've yet to have a response to the invitation to research sent previously and as your participation would be invaluable, I would like to give you ample opportunity to respond. Please contact me by telephone or email in the next week if you would like to participate.

My contact details can be found in the original email, thank you for your consideration.

[Include copy of original email]

Appendix 3.2. Key Informant Interview Participant Information Leaflet

PARTICIPANT INFORMATION SHEET

Version 1.2 15/02/19

We would like to invite you to participate in a research study

Study Title: Exploring Implementation, Barriers and Facilitators to Transfer of Care Systems in the UK

We are conducting a study to investigate the implementation, barriers and facilitators of current transfer of care systems available in the UK. The purpose of these interviews is to aid our understanding of the protocols and implementation for each service and also identify which aspects have been successful alongside those which may benefit from refinement. Transfer of care from hospital to community is associated with high risks of medication errors and medication non-adherence. Attempts have been made to ease this transition by creating a service allowing healthcare professionals in secondary care to transmit discharge information to community pharmacy enabling them to conduct post-discharge support.

Participation in this study is voluntary and is further explained in this information sheet. If any areas require clarification, please do not hesitate to contact one of the members of the research team who will be happy to help.

1.1 What is the purpose of the study?
The study aims to understand the available transfer of care systems in the UK to highlight areas of good practice and to inform future developments of transfer of care systems.

1.2 Why have I been chosen?
You have been chosen to participate as you are a key stakeholder in a transfer of care system in the UK allowing you to provide unique insight into the development, introduction and ongoing use of the system. This was determined through your inclusion in key transfer of care literature including the Royal Pharmaceutical Society's Innovator's toolkit or through personal knowledge of the researchers.

1.3 Do I have to take part?
Participation is completely voluntary; consent will be sought before the study begins. If you decide to participate, consent can be withdrawn at any point without question by contacting the primary researcher.

1.4 What will happen if I take part?
If you consent to participation in this study, an interview either face-to-face or over the telephone will be organised at your convenience with the primary researcher. The interview, with your consent, will be audio-recorded to ensure all the key points are captured. This is anticipated to take 30 – 40 minutes.

1.5 What do I have to do?
If you consent to participate, you will be contacted by a member of the research team to organise a convenient time for the interview.

1.6 What are my rights during the study?
You have a number of rights under data protection law and can find out more about these on our website. Note that your rights to access, change or move your personal data are limited, as we need to manage your personal information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study, we will keep the information about you that we have already obtained. To safeguard your rights, we will use the minimum personally identifiable information possible.

1.7 What are the possible disadvantages and risks of taking part?
There are no risks and disadvantages to taking part in this study. We acknowledge that participation will utilise some of your time.

1.8 What are the possible benefits of taking part?
Participation in this study gives you the opportunity to be a stakeholder in shaping the future of transfer of care systems. Additionally, we would like to offer you co-authorship on a publication that will arise from this study.

1.9 What if something goes wrong?
If you have any concerns or complaints during the course of this research project, please contact Dr Karen Hodson [redacted] *who will address the issue. If you remain unhappy and wish to complain formally, you can do this by contacting the Director of Research, Cardiff School of Pharmacy and Pharmaceutical Sciences, Redwood Building, King Edward VII Avenue, Cardiff CF10 3NB,* [redacted]

1.10 Why are you collecting this data?
Under data protection law we have to specify the legal basis that we are relying on to process your personal data. In providing your personal data for this research we will process it on the basis that doing so is necessary for our public task for scientific and historical research purposes in accordance with the necessary safeguards and is in the public interest. The University is a public research institution established by royal charter to advance knowledge and education through its teaching and research activities. Our charter can be found on the Cardiff University website.

1.11 Will my information be kept confidential?
All data will be kept strictly confidential between the primary researcher and supervisors. Any data that we report from this study will be anonymised.

1.12 Who looks after my data/information?
Cardiff University is the Data Controller and is committed to respecting and protecting your data in accordance with your expectations and Data Protection legislation. The University has a Data Protection Officer who can be contacted at [redacted] *Further information about Data Protection, including your rights and details about how to contact the Information Commissioner's Office should you wish to complain, can be found at the following: https://www.cardiff.ac.uk/public-information/policies-and-procedures/data-protection*

1.13 Will I be recorded and how will this be used?
With consent, the interviews will be audio-recorded. Recordings will be transcribed ad verbatim by the primary researcher. Anonymised quotations may be used in reporting of the study to illustrate key points.

1.14 How long will my data be kept for?
Consent forms and interview transcriptions will be kept for five years after the conclusion of the research in accordance with Cardiff University policy. Original audio recordings will be deleted once transcription has been completed.

1.15 What will happen to the results of this study?
The data collected from this study will be used for publications related to this research area and will also be used in the PhD thesis of the primary researcher. All data reported from this study will be anonymised. If you wish to be given a copy of the thesis, please inform the primary researcher.

1.16 Who is organising and funding the research?
The research is organised through Cardiff School of Pharmacy and Pharmaceutical Sciences with Robert James as the primary researcher and Dr Karen Hodson and Dr Efi Mantzourani as supervisors. Funding has been provided through a 50:50 studentship with Cardiff School of Pharmacy and Pharmaceutical Sciences and NHS Wales Informatics Service (NWIS).

1.17 Who has ethically reviewed the project?
Ethical approval has been granted by the research ethics committee in the Cardiff University School of Pharmacy and Pharmaceutical Sciences (approval number: 1819-11)

1.18 Who can I contact for further information?

Please do not hesitate to ask any of the following for any further information.

***Primary Researcher**: Robert James, Cardiff School of Pharmacy and Pharmaceutical Sciences,* King Edward VII Avenue, Cardiff, CF10 3NB *(Email, phone number)*

***Research Supervisor**: Dr Karen Hodson, Cardiff School of Pharmacy and Pharmaceutical Sciences,* King Edward VII Avenue, Cardiff, CF10 3NB *(Email, phone number)*

***Research Supervisor**: Dr Efi Mantzourani, Cardiff School of Pharmacy and Pharmaceutical Sciences,* King Edward VII Avenue, Cardiff, CF10 3NB *(Email, phone number)*

Thank you for considering participation in this study

Appendix 3.3. Key Informant Interview Consent Form

Version 1.2 15/02/19

Study Title: Exploring Implementation, Barriers and Facilitators to Transfer of Care Systems in the UK

Primary Researcher: Robert James, Cardiff School of Pharmacy and Pharmaceutical Sciences, King Edward VII Avenue, Cardiff, CF10 3NB

Supervisors: Dr Karen Hodson and Dr Efi Mantzourani, Cardiff School of Pharmacy and Pharmaceutical Sciences, King Edward VII Avenue, Cardiff, CF10 3NB

Consent form

(Please initial box)

- ☐ I have had the purpose and nature of the study explained to me in writing (*Participant information leaflet version 1.2, 15/02/19*) and I have had the opportunity to ask questions about the study and had them answered satisfactorily.
- ☐ I understand that even if I agree to participate now, I can withdraw at any time or refuse to answer any question without affecting my legal rights
- ☐ I agree to my interview being audio-recorded.
- ☐ I understand that anonymised extracts from my interview may be quoted in publications and conference proceedings.
- ☐ I consent for anonymised transcriptions and quotations from my interview may be used in the primary researcher's PhD thesis.
- ☐ I understand that signed consent forms and interview transcriptions will be retained in digital format within Cardiff University for five years from the conclusion of the research.
- ☐ I understand that I am free to contact any of the people involved in the research to seek further clarification and information.
- ☐ I voluntarily agree to participate in this research study.

Signature of research participant _____

Name of research participant _____

Date _____

I believe that the participant is giving informed consent to participate in this study

Signature of researcher _____

Name of researcher _____

Date _____

Appendix 3.4. Key Informant Interview Schedule

Version 1.1 10/01/19

Exploring Implementation, Barriers and Facilitators to Transfer of Care Systems in the UK

Key Informant Interview Schedule

Thank you for your time.

My name is Rob and I'm a PhD student at Cardiff University studying the factors affecting Discharge medicines review service uptake in Wales.

The purpose of this interview is to provide insight into the current commissioned transfer of care services in the UK in order to highlight the successes and areas for refinement. This will contribute to my PhD and hopefully lead to academic publications.

You have been asked to take part as you are a key stakeholder having a key role in the development and implementation of DMR/Refer-To-Pharmacy/PharmOutcomes/Help for Harry.

There are no right or wrong answers during this interview as any insight will be valuable.

The interview consists of 10 main questions although this is only a guide and will follow the course of the interview; I anticipate this will take no longer than an hour.

You've already signed a form for the interview, but I'd like to take the opportunity to check that you're happy to give consent to take part in this interview and for audio-recording, all of which will be anonymised.

Ready to get started?

1) Could you explain a bit about the history of DMR/Refer-To-Pharmacy/PharmOutcomes/Help for Harry?
    a. Why was it set up?
2) Could you please take me through a step-by-step process of the service from identification of patients to post-discharge follow-up
3) How is patient consent managed throughout the service?
    a. Hospital consent (what is this for?)
    b. Community consent (what is this for?)
4) What data are routinely collected through each service?
    a. Medication names
    b. Number of discrepancies
    c. Outcome of referral
    d. Demographics
5) How many pharmacies currently provide this service? (Clarify if this is increasing)
    a. How many did it start with, as a pilot?
    b. Is this still increasing?
    c. How have you managed to get pharmacies on board?
6) Through research on DMRs, it was found that many hospital staff felt that they initiate the scheme but see no end-product. What feedback is routinely provided to hospital staff?
    a. How is this recorded?
7) How do community pharmacists receive notification that a patient has been discharged from hospital? (Clarify whether personal/NHS email etc)
    a. Has this changed since inception of the service?
    b. Do you see any issues with these methods?
    c. Any additional notifications provided? (admission)

8) What do you consider are the barriers to the provision of RTF/DMR/PharmOutcomes
    a. Have these changed over time?
9) What do you consider are the facilitators to the provision of RTP/DMR/PharmOutcomes/Help for Harry
    a. Have these changed over time?
10) What, if any improvements or advances are planned in the foreseeable future for this service?
    a. Are changes in services based on service evaluations?
    b. What further service evaluations are planned and how do you hope these will implement further change?

Do you have any further comments or information you think would be useful?

[Prompt – summarise all key points to ensure accurate data collection]

Thank you again for your time

Chapter 4 Appendices

Appendix 4.1. Focus Group Recruitment and Reminder Emails

Version 1.3 27/08/19

Subject heading: Transfer of care study: Invitation to participate

R.e. Hospital Pharmacy Staff's Perceived Barriers and Facilitators to Discharge Medicines Review Referrals in Wales

Dear Pharmacy Colleague,
We would like to invite you to participate in a study to allow you to provide ***your*** valuable professional insight into the barriers and facilitators to the provision of the DMR (Discharge Medicines Review) service. This study is being performed in conjunction with NWIS (NHS Wales Informatics Service) and with support from Andrew Evans (Chief Pharmaceutical Officer for Wales).

The DMR service supports patients with their medicines during discharge from hospital involving medicines reconciliation, medicines-use review and the transfer of discharge information from hospital to community pharmacy. The DMR service has been shown to deliver positive patient outcomes through the identification of medicines discrepancies as well as saving the NHS £3 for every £1 invested. Despite this, only 0.7% of commissioned DMRs are currently being utilised. We are conducting focus groups, or interviews if required, to provide an opportunity for hospital pharmacy staff to provide their valuable opinions on the factors affecting engagement to DMR referrals. We expect that these focus groups and interviews will take 45 – 60 minutes. The opinions collected in this study will be analysed and presented to NWIS, informing the future of transfer of care in Wales.

If you would like to participate, please find enclosed a participant information leaflet and a consent form to be completed and returned by email at your earliest convenience; physical or electronic signatures may be used. Following this, a liaison from your hospital will get in touch to organise a convenient time for your focus group or interview.

Thank you for your consideration.
Robert James, MPharm
Email: XXXX
Tel: XXXX

c.c Drs Karen Hodson and Efi Mantzourani, Cardiff School of Pharmacy and Pharmaceutical Sciences

Version 1.3 27/08/19
Reminder Email.

Dear Pharmacy Colleagues,
I recently sent information regarding a study in Cardiff University exploring hospital pharmacy engagement to DMR referrals in Wales. This study is aiming to use your professional insight to improve the DMR service and transfer of care, improving patient safety. I would really appreciate your engagement and would ask again for you to get in touch to be involved with this study. The consent forms and information leaflets are attached for your ease.
Please return the consent form by [date two weeks from date sent] to participate or contact me for any further details. The consent form may be returned by email with either a physical or electronic signature.
Please disregard this email if you've already returned the consent form.

Thanks in advance,
Robert James, MPharm
Cardiff School of Pharmacy & Pharmaceutical Sciences
Email: XXXX
Phone: XXXX

Appendix 4.2. Focus Group Participant Information Leaflet

PARTICIPANT INFORMATION SHEET

Version 1.3 27/08/19

We would like to invite you to participate in a study

Study Title: Hospital Pharmacy's Perceived Barriers and Facilitators to Discharge Medicines Review Provision in Wales

We are conducting a study in conjunction with and NWIS (NHS Wales informatics service), supported by Andrew Evans (Chief Pharmaceutical Officer for Wales) to gather information on hospital pharmacist and hospital pharmacy technician perceived barriers and facilitators for the provision of referrals for the Discharge Medicines Review (DMR) service in Wales.

Participating in this study is completely voluntary but will provide your valuable professional insight into the DMR service, helping to shape the future of transfer of care in Wales.
This leaflet will take only a few minutes to read and provides further information about this study. If you have any further questions, please don't hesitate to contact a member of the study team who will be more than happy to help.

1.1 What is the purpose of the study?
The study aims to identify perceived barriers and facilitators to providing referrals for the DMR service from the perspective of hospital pharmacy staff. Identification of these issues will inform recommendations to adapt transfer of care in Wales.

1.2 Why have I been chosen?
You have been chosen to participate as you are a practising member of a hospital pharmacy department in Wales who will be able to provide valuable insight into factors that affect DMR referrals.

1.3 Do I have to take part?
Participation is completely voluntary; consent will be sought before the study begins. If you decide to participate, consent can be withdrawn at any point without question by contacting a member of the study team.

1.4 What will happen if I take part?
If you consent to participation in this study, you will participate in a focus group with a number of other hospital pharmacy staff. Interviews can be offered as a practical alternative. This will involve a discussion about various aspects of DMR engagement. The study will give you an opportunity to give your opinion on the DMR service and how you feel it could be improved. Audio-recording will take place with your consent. We approximate this will take 45 - 60 minutes.

1.5 What do I have to do?
If you consent to participate, you will be contacted by a member of the study team to organise the time and place of the focus group or interview. Any additional materials required for the study will be provided to you.

1.6 What happens if I withdraw from the study?
You can withdraw from the study at any time without question. If you decide to withdraw, you will not be included in the study any further, but we may have limited ability to remove some of the data you have provided as it may not be possible to identify you in the audio recordings. Your identity will be protected through anonymisation of any data that is reported.

1.7 What are the possible disadvantages and risks of taking part?
There are no risks and disadvantages to participation in this study. We acknowledge the use of your time to help shape the future of transfer of care in Wales.

1.8 What are the possible benefits of taking part?

Taking part in the study gives you the opportunity to provide your opinion on the DMR service and transfer of care. The data generated from this study will be analysed and presented to NWIS (NHS Wales Informatics Service) to inform changes to transfer of care in Wales.

1.9 What if something goes wrong?

If you have any concerns or complaints during the course of this project, please contact Dr Karen Hodson [redacted] who will address the issue. If you remain unhappy and wish to complain formally, you can do this by contacting the Director of Research, Cardiff School of Pharmacy and Pharmaceutical Sciences, Redwood Building, King Edward VII Avenue, Cardiff CF10 3NB, [redacted]

1.10 Will my information be kept confidential?

Due to the nature of focus group discussions, we can't guarantee confidentiality. No identifiable information will be shared by the study team and a clause is included in the consent form to encourage participants to maintain that same level of confidentiality. Any data shared outside of the study team will be anonymised.

1.11 Who looks after my data/information?

Cardiff University is the Data Controller and is committed to respecting and protecting your personal data in accordance with your expectations and Data Protection legislation. The University has a Data Protection Officer who can be contacted at [redacted].
Data collected will be stored electronically in a form protected by passwords and other suitable security processes and technologies. If you wish to withdraw at any point, your data will remain confidential.

1.12 Will I be recorded and how will this be used?

The focus groups or interviews, with your consent, will be audio-recorded to allow the researchers to accurately transcribe all the information gathered. Anonymised quotations may be used in reporting of the study to illustrate key points.

1.13 How long will my data be kept for?

Consent forms and transcriptions will be kept for 5 years after the conclusion of the study in accordance with Cardiff University Policy. Original audio recordings will be destroyed once transcription is complete in accordance with data protection legislation.

1.14 What will happen to the results of this study?

The data collected from this study will be analysed and presented to NWIS, forming the basis of recommendations for adaptations of transfer of care in Wales. It will also be used in the PhD thesis of the primary researcher, the Master's theses of participating undergraduate students and in any future publications or conference proceedings related to this study. Any data shared or published will be anonymised. Transcription may be performed by participating undergraduate students as part of their Master's project.

1.15 Who is organising and funding this study?

The study is organised through Cardiff School of Pharmacy and Pharmaceutical Sciences with Robert James as the primary researcher and Drs Karen Hodson and Efi Mantzourani as supervisors. Funding has been provided through a 50:50 studentship with Cardiff School of Pharmacy and Pharmaceutical Sciences and NWIS.

PARTICIPANT INFORMATION SHEET

Version 1.3 27/08/19

***Primary Researcher**: Robert James, Cardiff School of Pharmacy and Pharmaceutical Sciences,* King Edward VII Avenue, Cardiff, CF10 3NB *(*Email, phone number*)*
***Research Supervisor**: Dr Karen Hodson, Cardiff School of Pharmacy and Pharmaceutical Sciences,* King Edward VII Avenue, Cardiff, CF10 3NB (Email, phone number)
***Research Supervisor**: Dr Efi Mantzourani, Cardiff School of Pharmacy and Pharmaceutical Sciences,* King Edward VII Avenue, Cardiff, CF10 3NB *(*Email, phone number*)*

Thank you for considering participation in this study

Appendix 4.3. Focus Group Consent Form

Version 1.2 27/08/19

Study Title: Hospital Pharmacy Staff's Perceived Barriers and Facilitators to Discharge Medicines Review Referrals in Wales

Primary Researcher: Robert James, Cardiff School of Pharmacy and Pharmaceutical Sciences

Supervisors: Drs Karen Hodson and Efi Mantzourani, Cardiff School of Pharmacy and Pharmaceutical Sciences

Consent form

Please initial boxes

- ☐ I confirm that I have read the information sheet dated 27/08/19 (*version 1.3*) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily ☐
- ☐ I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without my legal rights being affected ☐
- ☐ I agree to the focus group being audio-recorded ☐
- ☐ I consent for the use of anonymised quotations from this focus group in scientific journals and conference proceedings ☐
- ☐ I consent for the use of anonymised transcriptions and quotations from this focus group in the PhD thesis of the primary researcher ☐
- ☐ I consent for the use of anonymised transcriptions and quotations from this focus group in the master's dissertation of participating students ☐
- ☐
- ☐ I agree to keep all information discussed in this focus group confidential ☐
- ☐ I voluntarily agree to participate in this study ☐

Signature of participant _____

Print name _____

Date _____

I believe the participant is giving informed consent to participate in this study

Signature of researcher _____

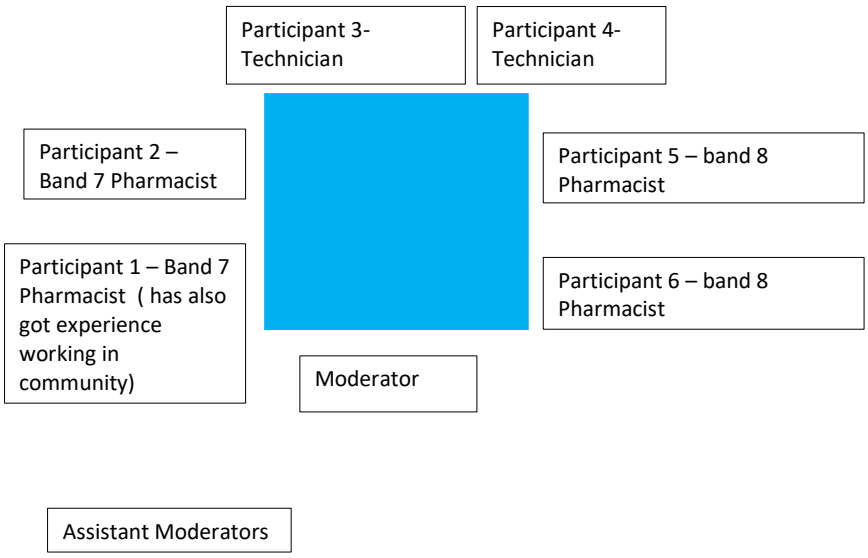
Print name _____

Date _____

Appendix 4.4. Example of Focus Group Assistant Moderator Notes

Hospital Focus Group Notes

17/10/19



[redacted]= established discharge system for Medical patients

P3 was very chatty throughout and was P5 and P2. P6 was relatively quiet

I got the impression that P5 is well respected among the other participants

Body language: all very engaged

01:40	P1 makes a comment about 'depends who's doing it' and P3 agrees
P6 makes a point about that they don't always think when they're busy	All nod in agreement
P5 made a point about about the busy-ness of the hospital so therefore they are sometimes a bit removed from the discharge process	This was an agreed point among all – all nod in agreement
When discussing who needs a DMR	All agreed that those with multiple changes

11:50	All agreed and nodded about surgical patients medicines not changing
All nod in agreement about MTeD is slow and long winded RPS sheet introduced at 18:25 Looking at left hand side of page	
19:10	Agreed point all nod in agreement to P3's point about it depends who is doing it and P5's point about the paper system being poor.
21:40	P6 has an angry tone emphasising 'eventually'
25:18 – point 3	All nod in agreement with P5's point about certain things such as anticoagulants being high risk
Point 4	When doctor's and paper notes came up – there is a shaking of heads indicating frustration
Moving onto right hand side of page	
	All nod in agreement to p5's point that it feels like it's all coming to pharmacy P6 has an angry tone again when speaking about the doctors
46:50	Agreed point all nod that patient's don't know what they are and that more publicity is needed
52:35	Agreed point all nod -they all want feedback from the local area
Repeated point	Want to know if it's worthwhile/ worth giving something else up for if they're going to invest the time

BARRIERS:

- So many locums – are they accredited? Should organisations think more about this as they are employing?
- Time
- No easy way to do it
- Unsure if it is worthwhile
- Potential for repetition in primary care – also that primary care have more access to information so are they better placed to carry the DMR's out?
- Lack of access to information that community pharmacy have and therefore they can't do as much

- They trust primary care pharmacists more as they have access to the GP's more readily and they know them, so they can chase them up more.

FACILIATORS:

- Feedback – trust for community pharmacists to invest their time and community pharmacists to do their bit
- Box why referring patient on MTeD
- Electronic prescribing
- Universal health boards
- IT systems being slick and quick

Appendix 4.5. Focus Group Participant Characteristics

Hospital	Participant	Notable Characteristics
LHB1-FG1	PhT1	Medicines management pharmacy technician (PhT).†
	PhT2	Principal PhT for hospital.
	JP1	Previous community pharmacist.
	JP2	Rotational pharmacist.
	SP1	Clinical lead and works with informatics.
LHB2-FG1	PhT1	Medicines management PhT.
	JP1	None noted.
	JP2	None noted.
	SP1	Experience working as a primary care pharmacist.
	SP2	Specialist clinical pharmacist. Locums in community pharmacy.
LHB2-FG2	PhT1	Medicines management PhT.
	PhT2	Medicines management PhT.
	JP1	Locums in community pharmacy.
	JP2	Trained as a pharmacist in England.
	SP1	Senior manager.
	SP2	Specialist clinical pharmacist.
LHB2-FG3	PhT1	Senior PhT.
	PhT2	None noted.
	JP1	Rotational pharmacist.
	SP1	Medicines information pharmacist.
	SP2	Specialist clinical pharmacist.
LHB3-FG1	PhT1	Works with informatics.
	JP1	Rotational pharmacist.
	JP2	Elderly care pharmacist.
	SP1	Specialist clinical pharmacist.
	SP2	Specialist clinical pharmacist.
	SP3	Specialist clinical pharmacist.
	SP4	Senior manager.
LHB3-FG2	PhT1	Medicines management PhT. Previously worked in community.
	PhT2	Medicines management PhT. Previous experience in community pharmacy.
	JP1	Paediatric pharmacist.
	JP2	New to LHB.
	JP3	Surgical pharmacist.
	SP1	Specialist clinical pharmacist manager.
LHB4-FG1	PhT1	Medicines management PhT.
	PhT2	Medicines management PhT.
	SP1	Respiratory pharmacist. Had previously worked on a DMR referral project for the hospital.
LHB4-FG2	PhT1	Medicines management PhT.
	PhT2	Medicines management PhT.
	JP1	Newly qualified pharmacist.
	JP2	Community pharmacy experience.
	SP1	Senior manager with community pharmacy experience.
	SP2	Medicines information pharmacist.
LHB4-FG3	PhT1	Medicines management PhT.
	PhT2	Medicines management PhT.
	JP1	Surgical pharmacist, experience in primary care.
	JP2	Surgical pharmacist.
	SP1	Specialist clinical pharmacist.

Hospital	Participant	Notable Characteristics
LHB5-FG1	PhT1	Medicines management PhT.
	PhT2	None noted.
	JP1	Pharmacist undertaking their diploma in clinical pharmacy.
	JP2	Previous community experience.
	SP1	Emergency department clinical pharmacist. Small experience in community pharmacy.
	SP2	Lead clinical pharmacist.
LHB5-FG2	PhT1	Senior PhT.
	PhT2	Medicines management PhT.
	JP1	Previous experience in community pharmacy.
	JP2	None noted.
	SP1	Senior manager.
	SP2	Senior manager. Previous experience in community pharmacy.
LHB5-FG3	PhT1	None noted.
	PhT2	None noted.
	JP1	Pharmacist undertaking their diploma in clinical pharmacy with previous community pharmacy experience.
	JP2	None noted.
	SP1	Senior manager.
	SP2	Specialist clinical pharmacist.
LHB5-FG4	PhT1	Medicines management PhT.
	PhT2	Senior PhT.
	JP1	Experience in community pharmacy and primary care.
	SP1	Specialist clinical pharmacist.
	SP2	Specialist clinical pharmacist. Previous experience in community pharmacy.
	SP3	Senior manager.
LHB6-FG1	PhT1	None noted.
	PhT2	None noted.
	PhT3	Locum medicines management PhT.
	PhT4	None noted.
	JP1	None noted.
	JP2	None noted.
	JP3	Locum pharmacist.
	SP1	Senior manager.
LHB7-FG1	PhT1	Senior PhT.
	PhT2	None noted.
	JP1	Locum in community.
	SP1	Senior manager, previous experience in community pharmacy.
	SP2	Specialist clinical pharmacist. Previous experience in community pharmacy.
LHB7-FG2	PhT1	Senior PhT.
	PhT2	None noted.
	PhT3	Previous work in community.
	JP1	Pharmacist undertaking their diploma in clinical pharmacy.
	JP2	Limited community experience in pre-registration year.
	SP1	Senior manager.
	SP2	Specialist clinical pharmacist.

[†]Medicines management PhTs are involved in processes such as medicines reconciliation, overseeing patients' use of medication and technical checking.

Chapter 5 Appendices

Appendix 5.1. Medication Item Descriptions Not Describing a Distinct Item

Reduced Entries not Corresponding with a Single Item	Example [Verbatim Indicative Comment]
The hospital made no medication changes [n=934]	*"Medicines not changed"*
Entry describing that only changed medications were listed [n=593]	*"Changes have been made to the patient's existing medication and are listed"*
No discrepancies were found [n=63]	*"No discrepancies"*
Entry contained no clear information about an item [n=51]	*"1 every 12 hours"*
The entry listed more than one item [n=20]	*"Sildenafil, hydralazine, lisinopril 5mg & furosemide"*
The patient had their medicines dispensed into an MCA, requiring further attention [n=10]	*"Patient given meds in original box's [packaging] as family said this was fine but on discharge requested MDS asap [Multicompartment Compliance Aid as soon as possible]".*
Contextual information about the DMR [n=5]	*"Note from Hospital not to change regular medication but for GP to review Aripiprazole & Ramipril"*
There were discrepancies between the DAL and the first GP post-discharge prescription, but individual items were not specified [n=3]	*"Initial Rx [prescription] from surgery was not because of discharge. Therefore, certain items did not correlate with discharge"*

Appendix 5.2. Pharmacy Type Transformation Detail

The researcher decided only to include pharmacies with an NHS contract for calculating pharmacy type and to include pharmacies from England and Scotland in the calculation, using their dispensing data (Public Health Scotland 2020; NHS Business Services Authority 2021). Although pharmacies outside of Wales cannot provide the DMR, they could impact the organisational characteristics of the pharmacies within Wales. For example, the organisational characteristics of a contractor with one pharmacy in Wales and ten in England would likely be closer to that of a medium-sized multiple than an independent.

Appendix 5.3. Dosage Directions Data Transformation Detail

As described in Section 5.4.3.4.6, the researcher extracted dosage directions features that were not specified, i.e., when-required, as-directed and changes after discharge. The researcher first familiarised themselves with the data to identify different phrasing used for the target dose directions, using the text frequency and word tree functions in NVivo® to show common and associated phrases. The researcher developed search strings iteratively using their familiarity with the data and trial-and-error. These phrases often contained wildcards (see Section 3.3.1), including *"?"* which matches any letter replacing its position. For example, *"??/?"* would identify *"13/5"* and *"25/4".* The following table describes the search strings used.

Target Features	Search String
When-required	"Required" OR "When req*" OR "As req*" OR "prn"
As-directed	"As dir*" OR "Asd*" OR "Mdu" OR "Yellow Book" OR "INR"
Change after discharge	"Then" NOT "then close" NOT "then swallow" NOT "then takes home" OR "start* after" OR "after aspirin" OR "until" OR "to start" OR "after loading" OR "withhold" OR "withold *[sic]*" OR "thereafter" OR "reducing" OR "restart taking" OR "after ??/?" OR "for ????? day*" OR "for ????? week*" OR "for ????? month*" OR "for ?/?"

Chapter 6 Appendices

Appendix 6.1. Re-Categorisation of the ChP Consultation Dataset DMR1 Delivery Method

Other DMR1 Delivery Method Subcategory [n=2,235]	Pharmacy Involvement	Carer Involvement
With carer at pharmacy [n=127]	In pharmacy	With carer
With patient (and carer) at pharmacy [n=2]		
With carer at unknown location [n=212]	Unknown pharmacy	
With patient (and carer) at unknown location [n=2]		
With carer at patient's home [n=36]	Not in pharmacy	
With carer by telephone [n=1,335]		
With patient (and carer) at patient's home [n=28]		
With patient (and carer) by telephone [n=14]		
With patient at patient's home [n=119]	Not in pharmacy	Without carer
With patient by telephone [n=4]		
With GP surgery staff by telephone [n=41]		
With hospital by telephone [n=16]		
With patient at pharmacy [n=1]	In pharmacy	
With patient at unknown location [n=1]	Unknown pharmacy	
With GP surgery staff at unknown location [n=38]		
With hospital at unknown location [n=33]		
With unknown person at unknown location [n=11]	Unknown pharmacy	Unknown carer
With unknown person at pharmacy [n=7]	In pharmacy	
With unknown person at patient's home [n=128]	Not in pharmacy	
With unknown person by telephone [n=4]		

Appendix 6.2. Number and Percentage of Items Associated with the DMR by Route of Administration

Route of Administration [n=268,020]	Proportion	Most Frequent Item
Oral [n=223,427]	83.4%	Paracetamol 500mg tablets [n=9,533]
Inhaled [n=16,476]	6.1%	Salbutamol 100mcg CFC-free inhaler [n=4,828]
Topical [n=7,939]	3.0%	Ibuprofen 5% gel [n=719]
Ophthalmic [n=5,350]	2.0%	Latanoprost 50mcg/ml eye drops [n=594]
Subcutaneous [n=4,964]	1.9%	Insulin glargine 100units/ml solution prefilled disposable devices [n=589]
Sublingual [n=2,869]	1.1%	Glyceryl trinitrate sublingual spray [n=2,643]
Transdermal [n=2,164]	0.8%	Nicotine 21mg/24hours transdermal patches [n=551]
Intramuscular [n=961]	0.4%	Hydroxocobalamin 1mg/1ml solution for injection ampoules [n=820]
Nasal [n=912]	0.3%	Beclomethasone 50mcg/dose nasal spray [n=298]
Oropharyngeal [n=676]	0.3%	Chlorhexidine gluconate 0.2% mouthwash [n=167]
Device [n=652]	0.2%	AeroChamber Plus [n=145]
Rectal [n=381]	0.1%	Paracetamol 120mg suppositories [n=137]
Dressing [n=324]	0.1%	Aquacel Extra dressing 10cm x 10cm square [n=28]
Intravenous [n=320]	0.1%	Zoledronic acid 4mg/100ml infusion [n=109]
Parenteral indistinct [n=306]	0.1%	Cyclizine 50mg/1ml solution for injection ampoules [n=87]
Auricular [n=100]	0.0%	Olive oil ear drops [n=67]
Unknown [n=75]	0.0%	Furosemide 40mg unknown [n=6]
Vaginal [n=52]	0.0%	Estradiol 10mcg pessaries [n=44]
Dental [n=38]	0.0%	Sodium fluoride 5000ppm toothpaste [n=25]
Combination drops [n=28]	0.0%	Prednisolone sodium phosphate 0.5% ear/eye drops [n=13]
Intracorporal [n=2]	0.0%	Alprostadil 20mcg powder and solvent for solution for injection vials [n=2]
Intragastric [n=1]	0.0%	Vancomycin 500mg powder for solution for infusion vials [n=1]
Intravitreal [n=1]	0.0%	Aflibercept 2mg/50microlitres vials [n=1]
Intrauterine [n=1]	0.0%	Mirena 20mcg/24hours intrauterine device [n=1]
intraarticular [n=1]	0.0%	Triamcinolone acetonide 40mg/1ml suspension for injection vials [n=1]

Chapter 8 Appendices

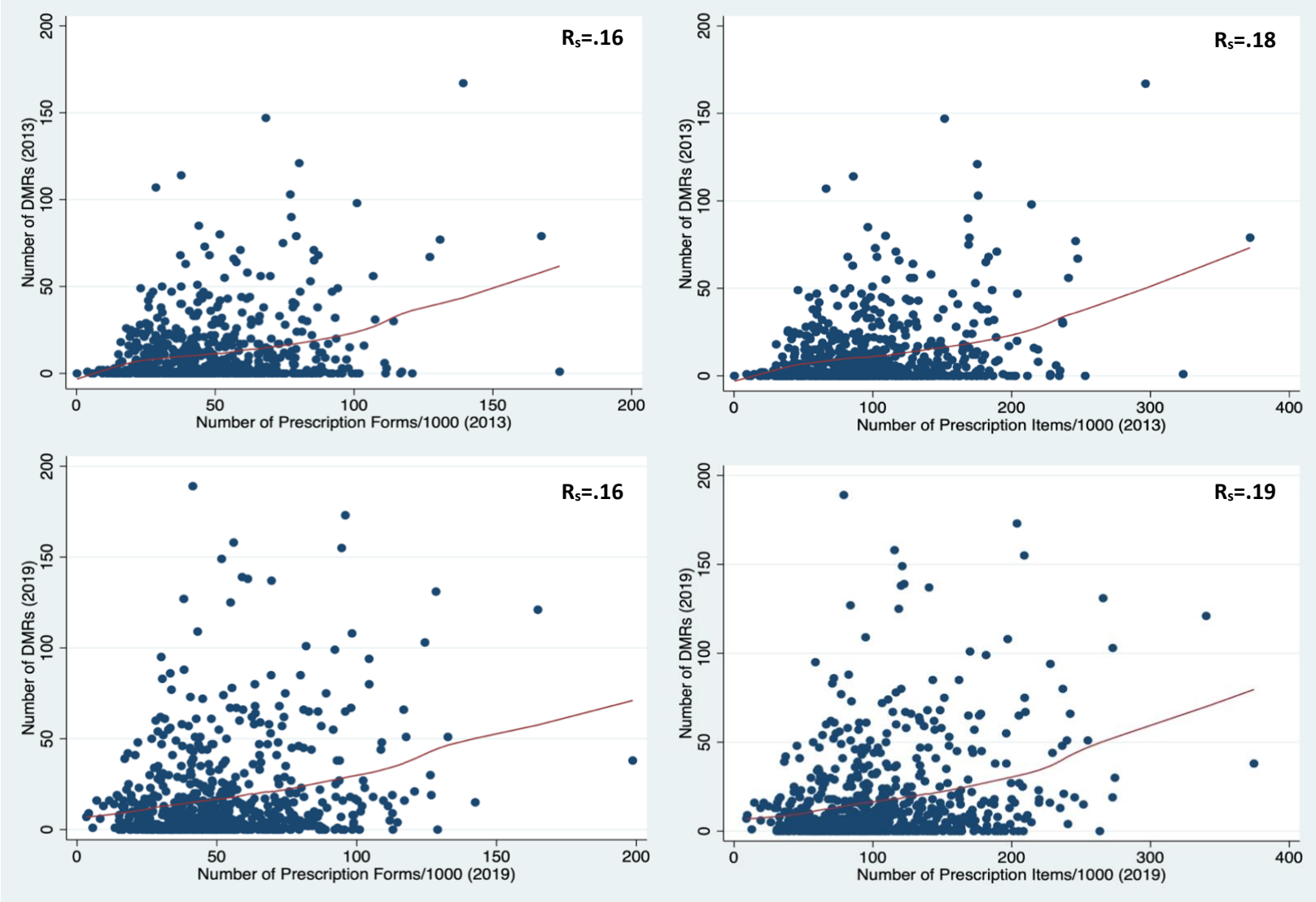
Appendix 8.1. Preliminary Model 1 with All Interaction Terms

Predictor	Group	Main Effect		Year Interaction Effect	
		Regression Coefficient [95% Confidence Interval]	P-Value	Regression Coefficient [95% Confidence Interval]	P-Value
Number of years	N/A	0.165 [-0.004 to 0.333]	0.055	N/A	N/A
Social deprivation quartile	Quartile 1 (most deprived)	Reference	Reference	Reference	Reference
	Quartile 2	0.158 [-0.360 to 0.675]	0.550	0.041 [-0.067 to 0.149]	0.459
	Quartile 3	0.466 [-0.060 to 0.992]	0.083	-0.007 [-0.117 to 0.103]	0.905
	Quartile 4 (least deprived)	0.344 [-0.311 to 0.998]	0.303	0.026 [-0.110 to 0.163]	0.707
Dichotomised rural-urban classification	Urban	Reference	Reference	Reference	Reference
	Rural	-0.005 [-0.435 to 0.426]	0.983	0.030 [-0.061 to 0.121]	0.518
Dichotomised pharmacy type	Multiple	Reference	Reference	Reference	Reference
	Non-multiple	0.666 [0.217 to 1.114]	0.004	-0.041 [-0.143 to 0.061]	0.428
Number of prescription items/1000	N/A	0.006 [0.001 to 0.010]	0.009	0.000 [-0.001 to 0.001]	0.924
Number of Medicines Use Reviews (MURs)	N/A	0.006 [0.005 to 0.008]	<0.001	0.000 [-0.001 to 0.000]	0.037
Emergency Hormonal Contraception Service (EHC) provision	No EHCs provided	Reference	Reference	Reference	Reference
	At least one EHC provided	1.392 [1.001 to 1.783]	<0.001	-0.069 [-0.171 to 0.034]	0.189
Seasonal Flu Vaccination service (SFV) provision	No SFVs provided	Reference	Reference	Reference	Reference
	At least one SFV provided	0.379 [0.037 to 0.720]	0.030	0.125 [0.027 to 0.223]	0.012
Co-location status	Not co-located	Reference	Reference	Reference	Reference
	Co-located	0.010 [-0.406 to 0.425]	0.963	0.033 [-0.057 to 0.122]	0.473
Constant	N/A	-3.411 [-4.123 to -2.700]	<0.001	N/A	N/A

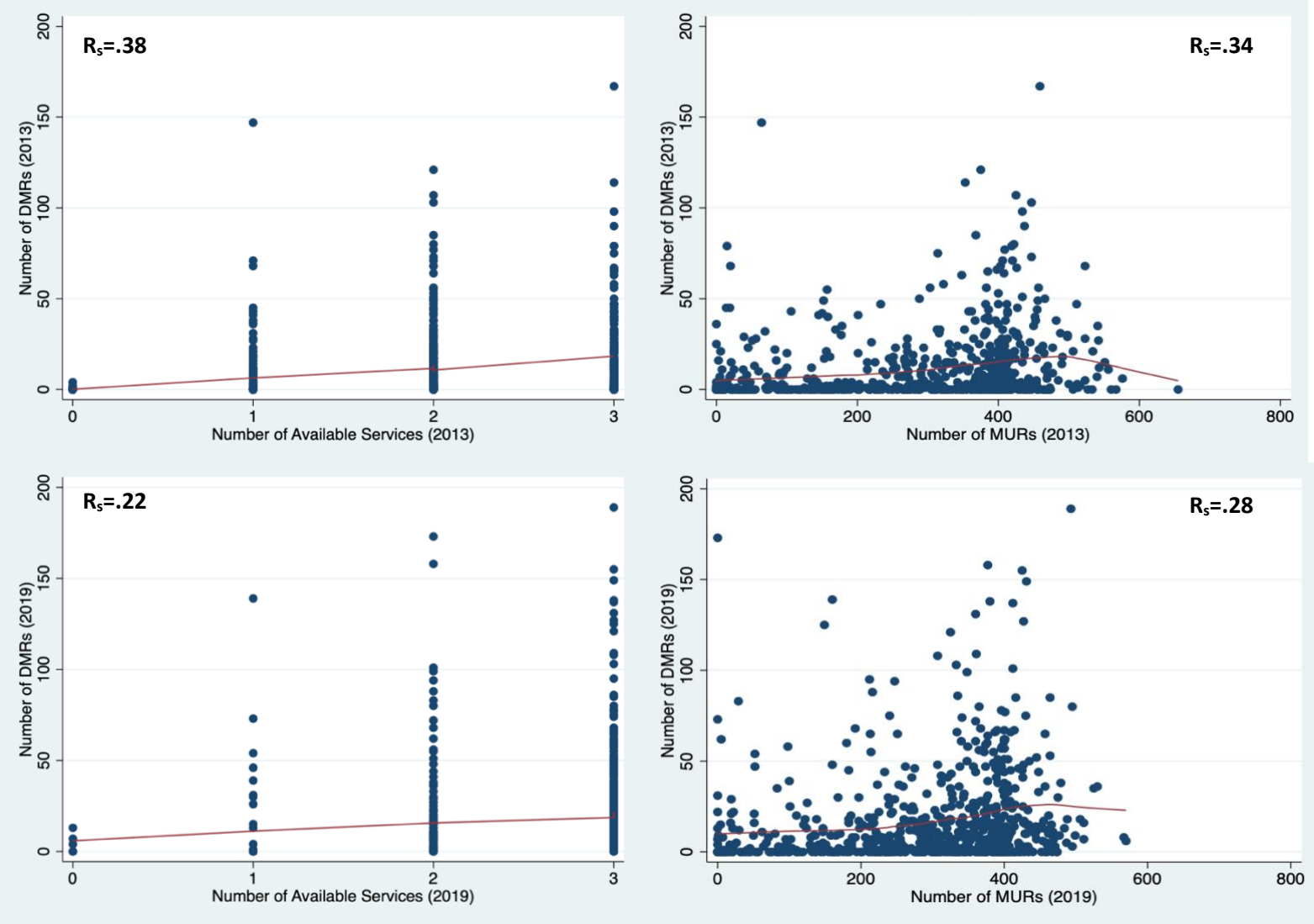
Appendix 8.2. Preliminary Model 2 with All Interaction Terms

Predictor	Group	Main Effect		Year Interaction Effect	
		Regression Coefficient [95% Confidence Interval]	P-Value	Regression Coefficient [95% Confidence Interval]	P-Value
Number of years	N/A	0.034 [-0.036 to 0.103]	0.345	N/A	N/A
Social deprivation quartile	Quartile 1 (most deprived)	Reference	Reference	Reference	Reference
	Quartile 2	-0.084 [-0.317 to 0.150]	0.482	0.002 [-0.038 to 0.042]	0.907
	Quartile 3	-0.018 [-0.256 to 0.219]	0.880	0.006 [-0.034 to 0.046]	0.781
	Quartile 4 (least deprived)	0.045 [-0.249 to 0.339]	0.765	-0.028 [-0.077 to 0.022]	0.273
Dichotomised rural-urban classification	Urban	Reference	Reference	Reference	Reference
	Rural	0.138 [-0.055 to 0.331]	0.162	-0.028 [-0.061 to 0.005]	0.093
Dichotomised pharmacy type	Multiple	Reference	Reference	Reference	Reference
	Non-multiple	0.434 [0.239 to 0.629]	<0.001	0.004 [-0.032 to 0.039]	0.843
Number of prescription items/1000	N/A	0.006 [0.004 to 0.007]	<0.001	0.000 [0.000 to 0.000]	0.340
Number of Medicines Use Reviews (MURs)	N/A	0.001 [0.001 to 0.002]	<0.001	0.000 [0.000 to 0.000]	0.599
Emergency Hormonal Contraception Service (EHC) provision	No EHCs provided	Reference	Reference	Reference	Reference
	At least one EHC provided	0.275 [0.085 to 0.464]	0.004	-0.015 [-0.062 to 0.032]	0.534
Seasonal Flu Vaccination service (SFV) provision	No SFVs provided	Reference	Reference	Reference	Reference
	At least one SFV provided	0.252 [0.125 to 0.379]	<0.001	-0.013 [-0.050 to 0.024]	0.495
Co-location status	Not co-located	Reference	Reference	Reference	Reference
	Co-located	-0.028 [-0.208 to 0.153]	0.763	-0.025 [-0.057 to 0.006]	0.114
Constant	N/A	0.848 [0.516 to 1.181]	<0.001	N/A	N/A

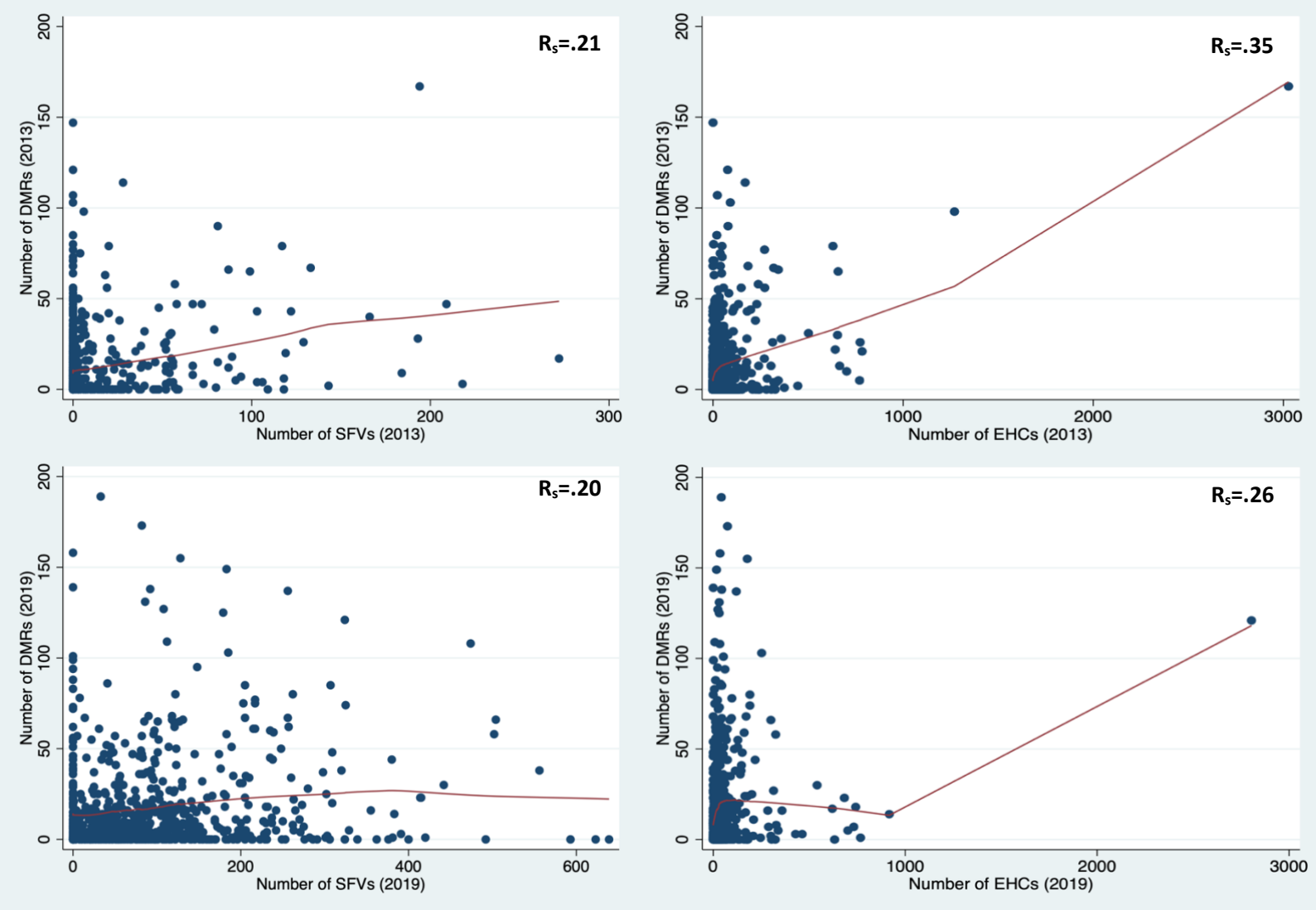
Appendix 8.3. Scatter Plots Showing the Relationship Between the Number of Prescription Forms and Items (/1000), and the Number of DMRs (2013 and 2019)



Appendix 8.4. Scatter Plots Showing the Relationship Between the Number of Available Service and MURs, and the Number of DMRs (2013 and 2019)



Appendix 8.5. Scatter Plots Showing the Relationship Between the Number of FLVs and EHCs, and the Number of DMRs (2013 and 2019)



Chapter 9 Appendices

Appendix 9.1. Transformation of Route of Administration Predictor

Route of Administration	Frequency [n=265,605]	Condensed Route
Auricular	100	Ear/eye/nose
Combination drops	28	
Ophthalmic	5,336	
Nasal	910	
Oral	221,422	Oral
Device	646	Device/dressing
Dressing	322	
Inhaled	16,421	Inhaled
Intraarticular	1	Injection
Intracorporal	2	
Intravenous	319	
Intramuscular	956	
Parenteral indistinct	305	
Subcutaneous	4,952	
Intravitreal	1	
Intrauterine	1	Other
Intragastric	1	
Dental	38	
Oropharyngeal	668	
Rectal	204	
Unknown	72	
Vaginal	52	
Sublingual	2,863	Sublingual
Topical	7,824	Topical
Transdermal	2,161	Transdermal

Appendix 9.2. Transformation of Anatomical Therapeutic Chemical (ATC) 2 Groups

ATC2 Groups [n=265,605]	ATC2 Groups Transformed [n=265,605]	Rationale for Reclassification
Agents acting on the renin-angiotensin system [n=9,903]	No change	N/A
Anti-anaemic preparations [n=7,821]		
Antibacterials for systemic use [n=18,171]		
Anti-inflammatory and antirheumatic products [n=592]		
Antiepileptics [n=6,924]		
Antithrombotic agents [n=21,191]		
Corticosteroids for systemic use [n=394]		
Diuretics [n=12,049]		
Drugs for acid-related disorders [n=18,171]		
Drugs for constipation [n=11,233]		
Beta-blocking agents [n=10,953]		
Calcium channel blockers [n=5,557]		
Lipid-modifying agents [n=13,633]		
Mineral supplements [n=6,573]		
Psychoanaleptics [n=12,157]		
Psycholeptics [n=6,420]		
Analgesics [n=20,874]	Opioid analgesics [n=10,128]	High-risk criteria inclusion
	Non-opioid analgesics [n=10,746]	
Cardiac therapy [n=8,663]	Anti-arrhythmics, class I and III [n=474]	High-risk criteria inclusion
	Cardiac glycosides [n=1,804]	
	Other [n=59,757]	
Drugs used in diabetes [n=10,545]	Oral drugs used in diabetes [n=7,668]	High-risk criteria inclusion
	Insulin and analogues [n=2,877]	
Other nervous system drugs [n=1,963]	Drugs used in addictive disorders [n=1,261]	High discrepancy rate as described in Section 9.3.2.5.2.
All other non-therapeutic products [n=320]	Other [n=59,757]	Not in most frequent categories except 'drugs for obstructive airway diseases' which was excluded due to potential collinearity with 'inhaled' route of administration.
All other therapeutic products [n=187]		
Anaesthetics [n=181]		
Anti-acne preparations [n=22]		
Anti-Parkinson's drugs [n=1,505]		

ATC2 Groups [n=265,605]	ATC2 Groups Transformed [n=265,605]	Rationale for Reclassification
Antibiotics and chemotherapeutics for dermatological use [n=206]	Other (continued)	(continued)
Antidiarrheals, intestinal anti-inflammatory/anti-infective agents [n=1,292]		
Antiemetics and antinauseants [n=281]		
Antifungals for dermatological use [n=507]		
Antigout preparations [n=1,731]		
Antihemorrhagics [n=88]		
Antihistamines for systemic use [n=2,242]		
Antihypertensives [n=1,428]		
Antimycobacterial [n=63]		
Antimycotics for systemic use [n=52]		
Antineoplastic agents [n=117]		
Anti-obesity preparations, excluding diet products [n=12]		
Antiprotozoals [n=174]		
Antipruritic, incl. antihistamines, anaesthetics, etc. [n=80]		
Antipsoriatics [n=44]		
Antiseptics and disinfectants [n=134]		
Antivirals for systemic use [n=299]		
Appliances [n=605]		
Bile and liver therapy [n=124]		
Blood substitutes and perfusion solutions [n=134]		
Calcium homeostasis [n=90]		
Contrast media [n=2]		
Corticosteroids, dermatological preparations [n=786]		
Cough and cold preparations [n=2,230]		
Diagnostic agents [n=1]		
Digestives, including enzymes [n=335]		
Drugs for functional gastrointestinal disorders [n=1,261]		
Drugs for obstructive airway diseases [n=16,672]		

ATC2 Groups [n=265,605]	ATC2 Groups Transformed [n=265,605]	Rationale for Reclassification
Drugs for treatment of bone diseases [n=2,495]	Other (continued)	(continued)
Ectoparasiticides, including scabicides, insecticides and repellents [n=1]		
Emollients and protectives [n=4,054]		
Endocrine therapy [n=636]		
General nutrients [n=1,465]		
Gynaecological anti-infectives and antiseptics [n=16]		
Immune sera and immunoglobulins [n=2]		
Immunostimulants [n=7]		
Immunosuppressants [n=882]		
Medicated dressings [n=92]		
Muscle relaxants [n=336]		
Nasal preparations [n=899]		
No code [n=4]		
Ophthalmological and otological preparations [n=15]		
Ophthalmological [n=5,359]		
Other alimentary tract and metabolism products [n=9]		
Other dermatological preparations [n=127]		
Other drugs for disorders of the musculoskeletal system [n=708]		
Other gynaecological [n=11]		
Other haematological agents [n=2]		
Other respiratory system products [n=8]		
Otological [n=101]		
Pancreatic hormones [n=26]		
Peripheral vasodilators [n=82]		
Pituitary and hypothalamic hormones and analogues [n=58]		
Preparations for treatment of wounds and ulcers [n=4]		

ATC2 Groups [n=265,605]	ATC2 Groups Transformed [n=265,605]	Rationale for Reclassification
Sex hormones and modulators of the genital system [n=436]	Other (continued)	(continued)
Stomatological preparations [n=662]		
Thyroid therapy [n=5,475]		
Topical products for joint and muscular pain [n=1,275]		
Urological [n=5,733]		
Vaccines [n=12]		
Vasoprotectives [n=162]		
Vitamins [n=5,484]		

Appendix 9.3. Variance Inflation Factor Values

Predictor	Group	Variance Inflation Factor (VIF)	Adjusted VIF
Electronic Discharge Advice Letter (eDAL) availability	eDAL available	1.27	1.27
Discharge information provider	Not hospital	1.29	1.29
Discharge weekend	Weekend	1.01	1.01
Days between discharge and DMR1	Over 28 days	1.05	1.05
Eligibility criteria	Number of eligibility criteria	8,427.89	N/A
	Patient requires adjustment to medicines	2,516.78	1.11
	Medicines changed during admission	2,314.06	1.04
	Pharmacist's professional judgement	1,872.66	1.04
	Patient taking four or more medicines	1,209.82	1.03
Item descriptor	Controlled drug	4.67	N/A
	Incomplete item description	1.02	1.02
Anatomical Therapeutic Chemical 2 (ATC2) condensed	Mineral supplements	1.13	1.13
	Drugs for acid related disorders	1.33	1.33
	Antibacterial for systemic use	1.18	1.18
	Corticosteroids for systemic use	1.15	1.15
	Calcium channel blockers	1.12	1.12
	Diuretics	1.23	1.23
	Antiepileptics	1.29	1.13
	Psycholeptics	1.71	1.13
	Psychoanaleptics	1.23	1.23
	Lipid modifying agents	1.26	1.26
	Antithrombotic agents	1.43	1.43
	Anti-anaemic preparations	1.18	1.18
	Drugs for constipation	1.23	1.23
	Agents acting on the renin-angiotensin system	1.19	1.19
	Beta-blocking agents	1.21	1.21
	Opioid analgesics	4.41	1.33
	Non-opioid analgesics	1.32	1.31
	Cardiac glycosides	1.04	1.04
	Insulin and analogues	1.88	1.88
	Anti-inflammatory and antirheumatic products	1.01	1.01

Predictor	Group	Variance Inflation Factor (VIF)	Adjusted VIF
ATC2 (continued)	Drugs used in addictive disorders	1.31	1.29
	Anti-arrhythmics, class I and III	1.01	1.01
	Oral drugs used in diabetes	1.15	1.15
Route of administration	Injections	1.89	1.88
	Inhaled	1.36	1.36
	Transdermal	1.36	1.36
	Topical	1.20	1.19
	Sublingual	1.13	1.13
	Other routes	1.03	1.03
	Device/dressing	1.07	1.06
	Ear/eye/nose	1.13	1.13
Gender	Female	1.03	1.03
Patient age	Unknown age	2.28	2.28
	0 to 39 years	1.07	1.07
	40 to 79 years	1.38	1.37
DMR1 year	N/A	2.04	2.03
Carer involvement	With carer	1.58	1.58
	Unknown carer involvement	1.12	1.12
Pharmacy status	Not in pharmacy	1.58	1.58
	Unknown pharmacy status	1.11	1.11
Dose direction features	As-directed feature	1.19	1.19
	When-required feature	1.36	1.36
	Change term feature	1.14	1.14

Appendix 9.4. Preliminary Model Results

Preliminary Model 1 Predictors	Groups	Regression Coefficient [95% Confidence Interval]	P-Value
Days between discharge and DMR1	28 days or less	Reference	Reference
	Over 28 days	0.079 [0.039 to 0.118]	<0.001
Discharge weekend status	Weekday	Reference	Reference
	Weekend	0.144 [0.091 to 0.197]	<0.001
Electronic Discharge Advice Letter (eDAL) availability	eDAL not available	Reference	Reference
	eDAL available	-0.250 [-0.287 to -0.213]	<0.001
Discharge information provider	Hospital	Reference	Reference
	Not hospital	0.150 [0.109 to 0.191]	<0.001
Medicines changed during admission	Medicines not changed during admission	Reference	Reference
	Medicines changed during admission	0.633 [0.595 to 0.671]	<0.001
Patient taking four or more medicines	Patient not taking four or more medicines	Reference	Reference
	Patient taking four or more medicines	-0.146 [-0.190 to -0.101]	<0.001
Patient requires adjustment to medicines	Patient does not require adjustment to medicines	Reference	Reference
	Patient requires adjustment to medicines	-0.084 [-0.118 to -0.050]	<0.001
Pharmacist's professional judgement	No pharmacist's professional judgement	Reference	Reference
	Pharmacist's professional judgement	0.043 [-0.003 to 0.088]	0.066
Incomplete item description status	Complete item description	Reference	Reference
	Incomplete item description	0.440 [0.290 to 0.591]	<0.001
Anatomical Therapeutic Chemical 2 (ATC2) condensed	Other	Reference	Reference
	Mineral supplements	0.293 [0.205 to 0.380]	<0.001
	Drugs for acid related disorders	0.122 [0.060 to 0.183]	<0.001
	Anti-bacterial for systemic use	0.619 [0.539 to 0.700]	<0.001
	Corticosteroids for systemic use	0.310 [0.202 to 0.418]	<0.001
	Calcium channel blockers	0.088 [-0.010 to 0.187]	0.079
	Diuretics	0.508 [0.443 to 0.573]	<0.001
	Antiepileptics	0.000 [-0.092 to 0.093]	0.993
	Psycholeptics	0.294 [0.208 to 0.380]	<0.001
	Psychoanaleptics	-0.294 [-0.375 to -0.213]	<0.001
	Lipid-modifying agents	-0.583 [-0.667 to -0.498]	<0.001

Preliminary Model 1 Predictors	Groups	Regression Coefficient [95% Confidence Interval]	P-Value
ATC2 condensed (continued)	Antithrombotic agents	-0.100 [-0.161 to -0.038]	0.002
	Anti-anaemic preparations	0.004 [-0.085 to 0.093]	0.935
	Drugs for constipation	0.648 [0.583 to 0.713]	<0.001
	Agents acting on the renin-angiotensin system	0.259 [0.185 to 0.333]	<0.001
	Beta-blocking agents	0.029 [-0.046 to 0.105]	0.449
	Opioid analgesics	0.815 [0.746 to 0.883]	<0.001
	Non-opioid analgesics	0.393 [0.321 to 0.465]	<0.001
	Cardiac glycosides	-0.025 [-0.197 to 0.146]	0.772
	Insulin and analogues	-0.318 [-0.482 to -0.154]	<0.001
	Anti-inflammatory and antirheumatic products	0.955 [0.741 to 1.168]	<0.001
	Drugs used in addictive disorders	1.359 [1.193 to 1.526]	<0.001
	Anti-arrhythmics, class I and III	0.624 [0.362 to 0.886]	<0.001
	Oral drugs used in diabetes	-0.110 [-0.202 to -0.019]	0.018
Route of administration	Oral	Reference	Reference
	Injections	0.545 [0.443 to 0.648]	<0.001
	Inhaled	-0.288 [-0.359 to -0.216]	<0.001
	Transdermal	-0.156 [-0.303 to -0.010]	0.036
	Topical	0.321 [0.239 to 0.402]	<0.001
	Sublingual	-0.382 [-0.535 to -0.230]	<0.001
	Other routes	0.293 [0.109 to 0.478]	0.002
	Device/dressing	0.461 [0.256 to 0.666]	<0.001
	Ear/eye/nose	-0.163 [-0.264 to -0.062]	0.002
Gender	Male	Reference	Reference
	Female	0.058 [0.031 to 0.085]	<0.001
Patient age	Age 80+	Reference	Reference
	Unknown age	0.008 [-0.047 to 0.063]	0.761
	Age 0 to 39 years	0.233 [0.142 to 0.324]	<0.001
	Age 40 to 79 years	-0.032 [-0.065 to 0.001]	0.056
DMR1 year	N/A	-0.139 [-0.161 to -0.118]	<0.001
Carer involvement	Not with carer	Reference	Reference
	With carer	-0.036 [-0.072 to -0.001]	0.045
	Unknown carer involvement	0.198 [-0.078 to 0.475]	0.159

Preliminary Model 1 Predictors	Groups	Regression Coefficient [95% Confidence Interval]	P-Value
Pharmacy status	In pharmacy	Reference	Reference
	Not in pharmacy	-0.080 [-0.116 to -0.044]	<0.001
	Unknown pharmacy status	-0.129 [-0.295 to 0.037]	0.129
As-directed dosage feature	Not as-directed	Reference	Reference
	As-directed	-0.059 [-0.134 to 0.016]	0.125
When required feature	No when-required feature	Reference	Reference
	When-required feature	0.069 [0.020 to 0.118]	0.006
Change term feature	Change term feature	Reference	Reference
	No change term feature	0.494 [0.412 to 0.576]	<0.001
Constant	N/A	-2.478 [-2.07 to -2.349]	<0.001
Pharmacy ID constant	N/A	0.884 [0.766 to 1.021]	N/A

Preliminary Model 2 Predictors	Groups	Regression Coefficient [95% Confidence Interval]	P-Value	Percentage Coefficient Change from Preliminary Model 1
Days between discharge and DMR1	28 days or less	Reference	Reference	Reference
	Over 28 days	0.079 [0.039 to 0.118]	<0.001	0.102
Discharge weekend status	Weekday	Reference	Reference	Reference
	Weekend	0.144 [0.091 to 0.197]	<0.001	0.175
Electronic Discharge Advice Letter (eDAL) availability	eDAL not available	Reference	Reference	Reference
	eDAL available	-0.251 [-0.288 to -0.214]	<0.001	0.287
Discharge information provider	Hospital	Reference	Reference	Reference
	Not hospital	0.150 [0.109 to 0.191]	<0.001	0.113
Medicines changed during admission	Medicines not changed during admission	Reference	Reference	Reference
	Medicines changed during admission	0.633 [0.595 to 0.671]	<0.001	0.009
Patient taking four or more medicines	Patient not taking four or more medicines	Reference	Reference	Reference
	Patient taking four or more medicines	-0.146 [-0.190 to -0.101]	<0.001	0.297
Patient requires adjustment to medicines	Patient does not require adjustment to medicines	Reference	Reference	Reference
	Patient requires adjustment to medicines	-0.084 [-0.117 to -0.050]	<0.001	0.110
Pharmacist's professional judgement	No pharmacist's professional judgement	Reference	Reference	Reference
	Pharmacist's professional judgement	0.043 [-0.003 to 0.088]	0.065	0.069
Incomplete item description status	Complete item description	Reference	Reference	Reference
	Incomplete item description	0.441 [0.290 to 0.591]	<0.001	0.048
Anatomical Therapeutic Chemical 2 (ATC2) condensed	Other	Reference	Reference	Reference
	Mineral supplements	0.293 [0.206 to 0.381]	<0.001	0.271
	Drugs for acid related disorders	0.122 [0.061 to 0.184]	<0.001	0.531
	Antibacterial for systemic use	0.620 [0.539 to 0.700]	<0.001	0.085
	Corticosteroids for systemic use	0.308 [0.200 to 0.416]	<0.001	0.456
	Calcium channel blockers	0.089 [-0.009 to 0.187]	0.076	0.982
	Diuretics	0.509 [0.444 to 0.574]	<0.001	0.178
	Antiepileptics	0.001 [-0.092 to 0.094]	0.981	5.342
	Psycholeptics	0.294 [0.209 to 0.380]	<0.001	0.229
	Psychoanaleptics	-0.293 [-0.374 to -0.212]	<0.001	0.299
	Lipid-modifying agents	-0.582 [-0.667 to -0.498]	<0.001	0.155
	Antithrombotic agents	-0.107 [-0.168 to -0.046]	0.001	7.543

Preliminary Model 2 Predictors	Groups	Regression Coefficient [95% Confidence Interval]	P-Value	Percentage Coefficient Change from Preliminary Model 1
ATC2 condensed (continued)	Anti-anaemic preparations	0.004 [-0.085 to 0.093]	0.933	2.919
	Drugs for constipation	0.648 [0.583 to 0.713]	<0.001	0.030
	Agents acting on the renin-angiotensin system	0.260 [0.186 to 0.334]	<0.001	0.368
	Beta-bocking agents	0.030 [-0.045 to 0.106]	0.435	3.186
	Opioid analgesics	0.814 [0.746 to 0.882]	<0.001	0.055
	Non-opioid analgesics	0.393 [0.321 to 0.465]	<0.001	0.050
	Cardiac glycosides	-0.024 [-0.196 to 0.147]	0.780	3.868
	Insulin and analogues	0.332 [-0.495 to -0.169]	<0.001	4.364
	Anti-inflammatory and antirheumatic products	0.956 [0.743 to 1.170]	<0.001	0.142
	Drugs used in addictive disorders	1.355 [1.189 to 1.521]	<0.001	0.315
	Anti-arrhythmics, class I and III	0.624 [0.362 to 0.886]	<0.001	0.033
	Oral drugs used in diabetes	-0.110 [-0.201 to -0.018]	0.019	0.535
Route of administration	Oral	Reference	Reference	Reference
	Injections	0.539 [0.437 to 0.641]	<0.001	1.222
	Inhaled	-0.289 [-0.360 to -0.217]	<0.001	0.403
	Transdermal	-0.160 [-0.307 to -0.014]	0.032	2.390
	Topical	0.310 [0.229 to 0.390]	<0.001	3.433
	Sublingual	-0.390 [-0.542 to -0.238]	<0.001	2.018
	Other routes	0.282 [0.099 to 0.466]	0.003	3.809
	Device/dressing	0.424 [0.225 to 0.624]	<0.001	7.953
	Ear/eye/nose	-0.166 [-0.266 to -0.065]	0.002	1.634
Gender	Male	Reference	Reference	Reference
	Female	0.058 [0.031 to 0.086]	<0.001	0.160
Patient age	Age 80+	Reference	Reference	Reference
	Unknown age	0.008 [-0.047 to 0.063]	0.771	0.188
	Age 0 to 39 years	0.232 [0.141 to 0.323]	<0.001	0.272
	Age 40 to 79 years	-0.032 [-0.065 to 0.001]	0.056	0.062
DMR1 year	N/A	-0.140 [-0.162 to -0.118]	<0.001	0.042
Carer involvement	Not with carer	Reference	Reference	Reference
	With carer	-0.036 [-0.071 to -0.001]	0.046	0.405
	Unknown carer involvement	0.199 [-0.078 to 0.475]	0.159	0.149

Preliminary Model 2 Predictors	Groups	Regression Coefficient [95% Confidence Interval]	P-Value	Percentage Coefficient Change from Preliminary Model 1
Pharmacy status	In pharmacy	Reference	Reference	Reference
	Not in pharmacy	-0.080 [-0.116 to -0.044]	<0.001	0.185
	Unknown pharmacy status	-0.129 [-0.295 to 0.037]	0.128	0.006
When required feature	No when-required feature	Reference	Reference	Reference
	When-required feature	0.070 [0.021 to 0.119]	0.004	2.277
Change term feature	Change term feature	Reference	Reference	Reference
	No change term feature	0.495 [0.413 to 0.576]	<0.001	0.151
Constant	N/A	-2.478 [-2.607 to -2.349]	<0.001	0.013
Pharmacy ID constant	N/A	0.884 [0.766 to 1.021]	N/A	0.002

Preliminary Model 3 Predictor	Groups	Regression Coefficient [95% Confidence Interval]	P-Value	Percentage Change from Preliminary Model 2
Days between discharge and DMR1	28 days or less	Reference	Reference	Reference
	Over 28 days	0.079 [0.039 to 0.118]	<0.001	0.326
Discharge weekend status	Weekday	Reference	Reference	Reference
	Weekend	0.144 [0.091 to 0.198]	<0.001	0.369
Electronic Discharge Advice Letter (eDAL) availability	eDAL not available	Reference	Reference	Reference
	eDAL available	-0.251 [-0.288 to -0.214]	<0.001	0.093
Discharge information provider	Hospital	Reference	Reference	Reference
	Not hospital	0.151 [0.110 to 0.192]	<0.001	0.329
Medicines changed during admission	Medicines not changed during admission	Reference	Reference	Reference
	Medicines changed during admission	0.631 [0.593 to 0.669]	<0.001	0.303
Patient taking four or more medicines	Patient not taking four or more medicines	Reference	Reference	Reference
	Patient taking four or more medicines	-0.145 [-0.189 to -0.100]	<0.001	0.809
Patient requires adjustment to medicines	Patient does not require adjustment to medicines	Reference	Reference	Reference
	Patient requires adjustment to medicines	-0.085 [-0.119 to -0.052]	<0.001	2.102
Incomplete item description status	Complete item description	Reference	Reference	Reference
	Incomplete item description	0.441 [0.291 to 0.592]	<0.001	0.139
Anatomical Therapeutic Chemical 2 (ATC2) condensed	Other	Reference	Reference	Reference
	Mineral supplements	0.293 [0.206 to 0.381]	<0.001	0.033
	Drugs for acid related disorders	0.122 [0.061 to 0.183]	<0.001	0.072
	Anti-bacterial for systemic use	0.620 [0.540 to 0.700]	<0.001	0.048
	Corticosteroids for systemic use, combinations	0.308 [0.200 to 0.416]	<0.001	0.011
	Calcium channel blockers	0.089 [-0.010 to 0.187]	0.077	0.22
	Diuretics	0.509 [0.444 to 0.574]	<0.001	0.000
	Antiepileptics	0.001 [-0.092 to 0.094]	0.840	16.899
	Psycholeptics	0.295 [0.209 to 0.380]	<0.001	0.031
	Psychoanaleptics	-0.293 [-0.374 to -0.212]	<0.001	0.007
	Lipid modifying agents	-0.582 [-0.667 to -0.498]	<0.001	0.023
	Antithrombotic agents	-0.107 [-0.168 to -0.046]	0.001	0.030
	Anti-anaemic preparations	0.004 [-0.085 to 0.093]	0.934	0.417
	Drugs for constipation	0.648 [0.583 to 0.713]	<0.001	0.010

Preliminary Model 3 Predictor	Groups	Regression Coefficient [95% Confidence Interval]	P-Value	Percentage Change from Preliminary Model 2
ATC2 condensed (continued)	Agents acting on the renin-angiotensin system	0.260 [0.186 to 0.334]	<0.001	0.006
	Beta-blocking agents	0.030 [-0.046 to 0.16]	0.435	-0.103
	Opioid analgesics	0.814 [0.746 to 0.882]	<0.001	0.009
	Non-opioid analgesics	0.393 [0.321 to 0.465]	<0.001	0.011
	Cardiac glycosides	-0.024 [-0.196 to 0.148]	0.785	2.66
	Insulin and analogues	-0.331 [-0.494 to -0.168]	<0.001	0.117
	Anti-inflammatory and antirheumatic products	0.957 [0.743 to 1.170]	<0.001	0.078
	Drugs used in addictive disorders	1.355 [1.189 to 1.522]	<0.001	0.006
	Anti-arrhythmics, class I and III	0.624 [0.361 to 0.886]	<0.001	0.084
	Oral drugs used in diabetes	-0.109 [-0.201 to -0.018]	0.019	0.240
Route of administration	Oral	Reference	Reference	Reference
	Injections	0.539 [0.437 to 0.641]	<0.001	0.002
	Inhaled	-0.289 [-0.360 to -0.217]	<0.001	0.001
	Transdermal	-0.160 [-0.307 to -0.014]	0.032	0.085
	Topical	0.310 [0.229 to 0.390]	<0.001	0.047
	Sublingual	-0.389 [-0.542 to -0.237]	<0.001	0.093
	Other routes	0.282 [0.098 to 0.465]	0.003	0.190
	Device/dressing	0.425 [0.225 to 0.624]	<0.001	0.156
	Ear/eye/nose	-0.165 [-0.266 to -0.064]	0.001	0.360
Gender	Male	Reference	Reference	Reference
	Female	0.058 [0.031 to 0.085]	<0.001	0.186
Patient age	Age 80+	Reference	Reference	Reference
	Unknown age	0.008 [-0.047 to 0.063]	0.775	1.565
	Age 0 to 39 years	0.235 [0.144 to 0.326]	<0.001	1.177
	Age 40 to 79 years	-0.032 [-0.065 to 0.001]	0.056	0.042
DMR1 year	N/A	-0.139 [-0.161 to -0.117]	<0.001	0.186
Carer involvement	Not with carer	Reference	Reference	Reference
	With carer	-0.036 [-0.071 to 0.000]	0.049	1.363
	Unknown carer involvement	0.200 [-0.076 to 0.477]	0.155	0.868
Pharmacy status	In pharmacy	Reference	Reference	Reference
	Not in pharmacy	-0.080 [-0.116 to -0.043]	<0.001	0.389
	Unknown pharmacy status	-0.129 [-0.295 to 0.037]	0.128	0.107

Preliminary Model 3 Predictor	Groups	Regression Coefficient [95% Confidence Interval]	P-Value	Percentage Change from Preliminary Model 2
As-directed dosage feature	Not as-directed	Reference	Reference	Reference
	As-directed	-0.059 [-0.134 to 0.016]	0.124	0.093
When required feature	No when-required feature	Reference	Reference	Reference
	When-required feature	0.070 [0.021 to 0.119]	0.005	0.367
Change term feature	Change term feature	Reference	Reference	Reference
	No change term feature	0.495 [0.413 to 0.576]	<0.001	0.012
Constant	N/A	-2.473 [-2.602 to -2.344]	<0.001	0.219
Pharmacy ID constant	N/A	0.887 [0.768 to 1.023]	N/A	0.261

Preliminary Model 4 Predictors (All Interactions)	Groups	Odds Ratio [95% Confidence Interval]
Days between discharge and DMR1	28 days or less	Reference
	Over 28 days	0.079 [0.040 to 0.119]
Discharge weekend status	Weekday	Reference
	Weekend	0.144 [0.091 to 0.197]
eDAL availability	eDAL not available	Reference
	eDAL available	-0.252 [-0.289 to -0.215]
Discharge information provider	Hospital	Reference
	Not hospital	0.151 [0.110 to 0.191]
Medicines changed during admission	Medicines not changed during admission	Reference
	Medicines changed during admission	0.633 [0.595 to 0.671]
Patient taking four or more medicines	Patient not taking four or more medicines	Reference
	Patient taking four or more medicines	-0.148 [-0.221 to -0.074]
Patient requires adjustment to medicines	Patient does not require adjustment to medicines	Reference
	Patient requires adjustment to medicines	-0.083 [-0.117 to -0.050]
Incomplete item description status	Complete item description	Reference
	Incomplete item description	0.442 [0.291 to 0.593]
ATC2 condensed	Other	Reference
	Mineral supplements	0.293 [0.206 to 0.381]
	Drugs for acid-related disorders	0.122 [0.060 to 0.183]
	Antibacterial drugs for systemic use	0.619 [0.538 to 0.699]
	Corticosteroids for systemic use	0.308 [0.200 to 0.416]
	Calcium channel blockers	0.089 [-0.009 to 0.188]
	Diuretics	0.509 [0.444 to 0.574]
	Antiepileptics	-0.002 [-0.094 to 0.091]
	Psycholeptics	0.294 [0.208 to 0.380]
	Psychoanaleptics	-0.294 [-0.375 to -0.213]
	Lipid-modifying agents	-0.582 [-0.667 to -0.498]
	Antithrombotic agents	-0.107 [-0.168 to -0.046]
	Anti-anaemic preparations	0.003 [-0.085 to 0.092]
	Drugs for constipation	0.647 [0.582 to 0.712]
	Agents acting on the renin-angiotensin system	0.260 [0.186 to 0.334]
	Beta-blocking agents	0.030 [-0.045 to 0.106]

Preliminary Model 4 Predictors (All Interactions)	Groups	Odds Ratio [95% Confidence Interval]
ATC2 condensed (continued)	Opioid analgesics	0.814 [0.746 to 0.882]
	Non-opioid analgesics	0.393 [0.321 to 0.465]
	Cardiac glycosides	-0.025 [-0.197 to 0.147]
	Insulin and analogues	-0.334 [-0.497 to -0.171]
	Anti-inflammatory and antirheumatic products	0.954 [0.740 to 1.167]
	Drugs used in addictive disorders	1.356 [1.190 to 1.522]
	Anti-arrhythmics, class I and III	0.625 [0.363 to 0.888]
	Oral drugs used in diabetes	-0.110 [-0.202 to -0.019]
Route of administration	Oral	Reference
	Injections	0.539 [0.437 to 0.641]
	Inhaled	-0.289 [-0.361 to -0.218]
	Transdermal	-0.160 [-0.306 to -0.013]
	Topical	0.308 [0.228 to 0.388]
	Sublingual	-0.390 [-0.542 to -0.238]
	Other routes	0.282 [0.099 to 0.466]
	Device/dressing	0.419 [0.219 to 0.619]
	Ear/eye/nose	-0.165 [-0.266 to -0.065]
Gender	Male	Reference
	Female	0.058 [0.031 to 0.085]
Patient age	Age 80+	Reference
	Unknown age	-0.015 [-0.127 to 0.097]
	Age 0 to 39 years	0.571 [0.382 to 0.760]
	Age 40 to 79 years	-0.059 [-0.147 to 0.029]
Patient taking four or more medicines interaction with patient age	Unknown age	0.026 [-0.088 to 0.140]
	Age 0 to 39 years	-0.433 [-0.645 to -0.220]
	Age 40 to 79 years	0.031 [-0.063 to 0.124]
DMR1 year	N/A	-0.140 [-0.162 to -0.118]
Carer involvement	Not with carer	Reference
	With carer	-0.036 [-0.071 to 0.000]
	Unknown carer involvement	0.203 [-0.074 to 0.479]

Preliminary Model 4 Predictors (All Interactions)	Groups	Odds Ratio [95% Confidence Interval]
Pharmacy status	In pharmacy	Reference
	Not in pharmacy	-0.080 [-0.116 to -0.044]
	Unknown pharmacy status	-0.132 [-0.298 to 0.034]
When required feature	No when-required feature	Reference
	When-required feature	0.071 [0.022 to 0.120]
Change term feature	No change term feature	Reference
	Change term feature	0.493 [0.412 to 0.575]
Constant	N/A	-2.476 [-2.614 to -2.337]

Chapter 10 Appendices

Appendix 10.1. Full Description of Data Integration

Central Pillar	Pillars	Relevant Study	Findings
Knowledge	DMR awareness	Key informant interviews	RTP prompts practitioners to make a referral when completing a patient's drug history.
			The RTP informant considered integrated patient consent support (such as educational videos) effective.
		Focus groups	Some staff suggested automated discharge notifications would optimise DMR uptake.
			Lack of hospital pharmacy professional DMR awareness.
			Referral consent was considered a barrier to engagement because patients were unaware of the DMR.
			HPPs frequently took 'pragmatic consent' for MCA patients to overcome the barrier of consent.
			HPPs considered that documentation of referral consent in MTeD would be useful.
			Updates to MTeD were poorly communicated to HPPs.
			Awareness of the DMR was typically spread by word of mouth rather than formal methods.
			HPPs considered it important to educate other stakeholder groups about the DMR to optimise its use, including hospital nurses and GP surgeries.
			HPPs considered it essential to involve patients in referrals by developing educational material. Additionally, hospital and community pharmacy staff should engage patients regarding the DMR to increase awareness.
		Content analysis	Several DMR2s were not completed because the pharmacist did not believe they could provide the service to patients who delegate responsibility for their medicines.
		Content analysis and descriptive analysis	Pharmacists provided 41.5% of DMRs by methods other than in-person in the pharmacy (ChP categories using the content analysis of DMR1 delivery method free-text).
			A considerable proportion of DMRs (31-41%) were provided with a carer (ChP categories using the content analysis of DMR1 delivery method free-text).
	Procedural knowledge	Key informant interviews	Time was spent during implementation showing community and hospital professionals how to use RTP and PharmOutcomes.
			The RTP and PharmOutcomes informants suggested specific staff training to support referrals.
		Literature review	RTP and PharmOutcomes had on-screen referral eligibility screening for commissioned post-discharge support services.
		Focus groups	Lack of HPP awareness of how to refer patients for a DMR.
			Lack of awareness of the ChP functionality in MTeD.
			Most HPPs were confident in knowing whom to refer based on their professional judgement.
			Training at induction was considered beneficial.
		Content analysis	Pharmacists often provided insufficient information in the free text ChP data entry.
			Pharmacists often miscategorised discrepancy types as 'other'.

Central Pillar	Pillars	Relevant Study	Findings
Knowledge (continued)	Procedural knowledge (continued)	Content analysis (continued)	Many pharmacists did not consider family members as carers.
			Some pharmacists described that they could not provide DMR2 since the patient moved, often into a residential care facility.
			Some pharmacists described how they did not complete DMR2 because the patient was unwell, resided in a care home, or delegated responsibility for medicines to a carer.
	Knowledge of the DMR's benefits	Key informant interviews	RTP has outcomes feedback automatically returned to the referring practitioner. PharmOutcomes has outcomes feedback accessible for the referring practitioner to access.
		Literature review	
		Focus groups	There was poor dissemination of the DMR evidence to frontline HPPs.
			Profound lack of HPP knowledge and scepticism of the benefits of the DMR.
			Lack of capacity for referrals when HPPs did not consider it valuable.
			Some HPPs considered that the quality of service would be better in independent pharmacies than in multiples.
			HPPs desired DMR outcomes feedback on a hospital or LHB basis.
			HPPs desired DMR outcomes as patient case studies presented in team meetings.
		Content analysis	Some community pharmacists stated they did not complete DMR2 because the patient did not attend the appointment.
			Some community pharmacists stated they did not complete DMR2 because they did not perceive a benefit.
		Descriptive analysis	12.4% of incomplete DMR2s were because the patient did not attend the appointment.
		Discrepancy regression	There was considerable variability in identified discrepancies between pharmacies (intra-class correlation = 22.1%).
			The mean number of discrepancies was higher for non-multiples (1.28) than multiples (1.09). This trend reversed for item discrepancy occurrence, where the proportions were 9.6% and 10.7% for non-multiples and multiples, respectively.
			There were greater odds (odds ratio=1.16) of discrepancy identification when the patient was discharged on the weekend.
Optimising system cohesiveness	Buy-in and role integration	Key informant interviews	RTP and PharmOutcomes informants emphasised the importance of being persistent in engaging community pharmacists during system implementation.
			RTP and PharmOutcomes had dedicated implementation staff to disseminate information and facilitate buy-in.
			RTP and PharmOutcomes informants considered system-enabled notification of patient admission beneficial.
			The RTP and PharmOutcomes informants discussed keeping community pharmacists accountable for actioning referrals.

Central Pillar	Pillars	Relevant Study	Findings
Optimising system cohesiveness (continued)	Buy-in and role integration (continued)	Key informant interviews (continued)	The RTP informant discussed keeping hospital staff accountable for referrals.
			The RTP informant discussed how automated feedback to referring practitioners helped 'close the loop'.
		Literature review	Community pharmacists using RTP and PharmOutcomes can accept or reject referrals, which is fed back to the referring practitioner.
		Focus groups	Lack of DMR referral process uniformity.
			HPPs rarely referred patients for DMRs, but routinely referred MCA patients to ensuring continuity of medicines supply.
			Many HPPs felt that community pharmacists did not want referrals.
			Some HPPs felt that independent pharmacies would provide more DMRs than multiples.
			HPPs lacked interest in post-discharge activities since their management had not emphasised them.
			HPPs considered community pharmacists would not have the capacity to action many referrals. HPPs felt they would need to prioritise referrals by flagging them on the system if referring all patients.
			DMR referrals were only sustained with a dedicated staff member to promote them.
			Management had not integrated DMR referrals into the hospital workflow.
			DMR referrals needed to be integrated into the HPP workflow to be feasible.
			Referrals were not integrated into the HPP workflow, and most hospitals did not have SOPs.
			Lack of HPP capacity for referrals when not integrated into the workflow.
			Some HPPs felt that DMR referrals would need to be completed at admission to successfully integrate them into their workflow. However, others felt they could not know at admission whether a patient would need a DMR.
			HPPs felt referring everyone for DMRs was easier than choosing specific patients when considering integrating them into the workflow. However, some felt this would be inappropriate.
			Referrals were considered suitable for PTs' workflow.
			Hospital management had not made efforts to implement DMR referrals.
			Many HPPs felt that improved staffing levels were required to implement referrals.
			Many HPPs thought many pharmacies did not provide DMRs, so it was not a consistent service to refer to.
			Some HPPs perceived that low staff continuity (locums) would reduce DMR uptake.
			Mixed views on automated feedback for referrals.
			HPPs desired information regarding the proportion of referrals that resulted in a DMR.
			Cost savings feedback was considered important for management.
			Mixed views on benchmarking the proportion of discharged patients referred.
			Discussion of the DMR and its referrals in team meetings was considered beneficial.

Central Pillar	Pillars	Relevant Study	Findings
Optimising system cohesiveness (continued)	Buy-in and role integration (continued)	Content analysis	The DMR2 incompletion reason was sometimes that the pharmacist who completed DMR1 did not follow up.
		Descriptive analysis	DMR provision varied by season, decreasing between December and March.
			The mean number of monthly DMRs per pharmacy increased over time.
			The number of DMRs varied by the associated discharging healthcare organisation (11 to 17,337).
			There was large variability in the number of DMRs provided per pharmacy (0 to 1,156), contractor (0 to 22,095) and pharmacist (0 to 448).
			The percentage of premises providing at least one monthly DMR increased over time but ranged from 14% to 44%.
			90.9% of DMR2s were provided by the same pharmacist that provided DMR1.
			Large-sized multiples provided 60.4% of DMRs, whilst supermarkets provided 0.6%.
			The range of DMR1 by rural-urban classification ranged from 0.4% (Villages, not sparse) to 70.1% (City and town, not sparse).
			Most (66.2%) DMR1s were provided from non-co-located premises.
			Pharmacies in the two most deprived social deprivation quartiles provided 67.1% [n=85,573] of all DMRs.
			Proportions of DMRs with eDAL availability varied by the discharging healthcare organisation (~0% to ~100%), but this increased over time for most LHBs.
		DMR volume regression	The mean number of annual DMRs per pharmacy increased over time from 11.34 in 2013 to 17.23 in 2019.
			Variability in DMR provision increased between 2013 and 2019 (interquartile range from 15 to 20).
			The mode number of DMRs per pharmacy was zero.
			There was large intra-premises variation in the number of DMRs over time (intraclass correlation = 58.8%).
			The DMR year increased the likelihood of a pharmacy providing at least one DMR (odds ratio = 1.15) and the DMR incidence, but this effect was small (incidence rate ratio =1.02).
			Each model had a suboptimal fit (pseudo R2 ranged from 0.02 to 0.14), suggesting that there were many predictive factors that were not included in the model.
			GP co-location had no significant effect on DMR volume.
			Non-multiple pharmacies had greater odds (odds ratio = 1.73) of providing at least one DMR and a greater incidence rate (incidence rate ratio=1.56) of DMRs than multiples.
			Social deprivation did not significantly affect DMR provision, except in quartile 3, where pharmacies had higher odds (odds ratio = 1.56) of providing at least one DMR.
			The number of MURs increases the likelihood of a pharmacy providing at least one DMR (odds ratio = 1.01) and increasing DMR provision (incidence rate ratio=1.002).

Central Pillar	Pillars	Relevant Study	Findings
Optimising system cohesiveness (continued)	Buy-in and role integration (continued)	DMR volume regression (continued)	The effect of MURs on the likelihood of providing at least one DMR decreased over time (odds ratio = 0.999967), but this effect was small.
			Providing at least one EHC increased the likelihood of a pharmacy providing at least one DMR (odds ratio = 3.34) and increased DMR provision (incidence rate ratio = 1 .26).
			Providing at least one FLV increased the likelihood of a pharmacy providing at least one DMR (odds ratio = 1.52) and increased provision (incidence rate ratio = 1.24).
			The number of prescription items/1000 increased the likelihood of a pharmacy providing at least one DMR (odds ratio=1.01) and DMR provision (incidence rate ratio = 1.01).
			The effect of FLV provision on the increased likelihood of a pharmacy providing at least one DMR increased over time (odds ratio = 1.12).
	Collaboration	Key informant interviews	Collaboration between professional organisations was considered important in optimising system engagement.
		Focus groups	There was poor collaboration between HPPs and community pharmacies.
			Many HPPs lacked awareness of community pharmacy roles, except those who had significant experience working in them.
			Some HPPs wanted primary care post-discharge liaisons to centralise referral recipients.
			HPPs lacked personal relationships with community pharmacists compared with PCP.
			HPPs felt PCPs were easier to contact than community pharmacists.
			Challenges with referring to community pharmacy since patients are not registered like they are with GP surgeries.
			Many HPPs perceived community pharmacists as business-oriented rather than patient-oriented
			Integrated training across boundaries for pharmacists and PhTs was desirable to improve cross-sector understanding and collaboration.
	Referral system implementation and usability	Key informant interviews	Different piloting approaches were taken for each system. The "big bang" approach was considered effective by the RTP informant.
			The RTP informant considered their pre-planned implementation strategy effective.
			IT interoperability between the system and hospital and community pharmacy systems was considered essential to optimise workflow.
			Responsiveness to feedback during implementation was considered effective at promoting engagement by the RTP and DMR informants.
		Literature review	The DMR referral system is national, whilst the other systems were confined to specific CCGs.
			RTP was designed with a seamless workflow in mind, and stakeholder feedback was positive.

Central Pillar	Pillars	Relevant Study	Findings
Optimising system cohesiveness (continued)	Referral system implementation and usability (continued)	Focus groups	There was a lack of electronic discharge system uniformity within hospitals and between them, a barrier to referral engagement.
			Electronic discharge systems were considered better than paper discharges for workflow.
			HPPs considered system interoperability between the discharge system and ChP essential for DMR referral engagement. Therefore, HPPs in many hospitals without MTeD did not think routine DMR referrals were feasible.
			Lack of capacity for referrals when the IT was not interoperable.
			HPPs in some areas felt left behind with IT developments: mental health/acute wards and hospitals on the Wales-England border.
			Some HPPs were reluctant to adopt MTeD rather than their own electronic discharge systems since they perceived it as 'clunky' and non-user-friendly by comparison.
			HPPs desired seamless information transfers.
			Many HPPs stated that MTeD referrals were not suitable for MCA patients since they were only sent after discharge when MCAs required pre-discharge organisation.
			The slow implementation of MTeD was considered a barrier for DMR referrals due to associated operational issues.
			HPPs thought that a single patient care record would improve community pharmacist access to discharge information, hence optimising DMR provision. Additionally, they felt it would circumvent the need for them to refer patients.
		Descriptive analysis	2.4% of DMRs were provided to patients discharged from English hospitals.
Fitness for purpose	Pharmacy professional post-discharge support	Focus groups	Many HPPs were enthusiastic about PCP roles in post-discharge support, although not all hospitals had collaborated with them.
			HPPs were concerned about work duplication between PCP post-discharge support and the DMR.
			HPPs would preferentially refer to PCP than community pharmacists.
			Some HPPs viewed community pharmacists as less competent than PCP, especially for clinical services.
			Many HPPs considered DMRs less valuable than PCP post-discharge support since they perceived community pharmacists as 'non-clinical'.
			HPPs perceived the DMR as a role for PhTs.
			Perceived lack of dedicated time for services in community pharmacy.
			Some HPPs felt that community pharmacy continuity was a strength of the DMR since the staff often knew their patients well.

Central Pillar	Pillars	Relevant Study	Findings
Fitness for purpose (continued)	Pharmacy professional post-discharge support (continued)	Content analysis	The 'other' discrepancy type explanatory comments described many types of discrepancy and variations in how pharmacists logged them.
			Pharmacists often pre-empted the first GP prescription.
			Some pharmacists described intentional discrepancies, demonstrating resolution of discrepancies before DMR1.
			Pharmacists provided patient care outside the DMR service specification, including clinical care and general healthcare support.
			Pharmacists provided further support after the DMR, including compliance support and following patients up.
			Many 'other' DMR delivery methods were with the patient's carer by telephone [n=1,335].
			Some DMRs were completed with alternative professional groups, including PCPs.
			Pharmacists often resolved discrepancies during DMR1.
		Descriptive analysis	Most (85.0%) DMR1s were provided within 28 days of discharge.
			Pharmacists had resolved most discrepancies by DMR2.
			Many item discrepancies [n=2,291] were described as intentional.
			The mean number of discrepancies decreased over time, with monthly means ranging from 0.4 to 1.8 per NECAF DMR.
			The largest proportion of discrepancy types were medicines discontinued (27-30%) or restarted in the community after discharge (14-24%) or 'other' (26-34%).
			The item discrepancy rate decreased over time, with monthly proportions ranging from 8% to 25%.
		Discrepancy regression	DMR1s completed >28 days after discharge had higher odds of discrepancy identification (odds ratio = 1.08).
			The odds of discrepancy identification decreased over time.
	The nature of DMR referrals	Literature review	RTP provided access to all discharge information, including clinical.
			RTP and PharmOutcomes allow referring practitioners to stipulate reasons for their referrals.
			RTP and PharmOutcomes allow community pharmacists to accept or reject referrals. The systems feed the outcomes back to referring practitioner.
			RTP and PharmOutcomes had admission and discharge notifications. In contrast, the DMR referral system only notified community pharmacists of discharge.
			RTP and PharmOutcomes had more visible notification methods than the DMR referral system. PharmOutcomes users can pay for a flashing USB device to notify them of discharge.
			In contrast to the DMR referral system, RTP has outcomes feedback direct to the referring practitioner. PharmOutcomes has outcomes feedback accessible for referring practitioners to access.

Central Pillar	Pillars	Relevant Study	Findings
Fitness for purpose (continued)	The nature of DMR referrals (continued)	Literature review and key informant interviews	Other systems could facilitate referrals for many different post-discharge services. In contrast, the DMR referral system could only refer to the DMR.
		Focus groups	HPPs saw value in information transmission to community pharmacists for elderly or MCA patients.
			HPPs perceived electronic DAL transmission as more timely, comprehensive and accurate than paper and fax methods.
			Most HPPs felt community pharmacists needed access to discharge information.
			HPPs had mixed opinions on community pharmacist access to clinical information. Some felt community pharmacists did not need access, whilst others felt it would lead to more meaningful DMRs.
			Many HPPs wanted the facility for meaningful referrals by stipulating referral reasons.
			HPPs felt that access to DMR outcomes when needed would be beneficial.
		Content analysis	Pharmacists were forwarding the DAL to the patient's GP surgery so they could reconcile the medicines.
			Post-discharge ambiguity was caused by inadequate information about changes in the hospital, including formulary swaps and consolidation of dosages.
		Descriptive analysis	The proportion of DMRs where the hospital provided discharge information has increased over time in line with eDAL availability.
		Discrepancy regression	eDAL availability was associated with decreased odds (odds ratio=0.78) of discrepancy identification.
	Patients' access to DMRs	Literature review	The DMR has broader eligibility criteria than the dNMS and dMUR.
			The DMR can be provided to a patient or carer, whilst the dNMS and dMUR are patient only.
		Focus groups	The hospitals with an active DMR referral process prioritised MCA patients, those on high-risk drugs, inhalers, four or more medicines or that had an in-hospital medicine change.
			HPPs perceived that DMRs would not be accessible for elderly and housebound patients.
			HPPs considered strict referral criteria undesirable since they were confident who would benefit from post-discharge support. However, they considered guidance might be helpful for PhTs or junior staff.
			HPPs from a rural hospital suggested that the DMR was unsuitable for many of their patients because they had medicines dispensed in dispensing doctors' practices.
		Content analysis	Some pharmacists described that they could not provide DMR2 since the patient moved residence, often into a residential care facility.
			Some pharmacists described how they did not complete DMR2 because the patient was unwell, resided in a care home, or delegated responsibility for medicines to a carer.

Central Pillar	Pillars	Relevant Study	Findings
Fitness for purpose (continued)	Patients' access to DMRs (continued)	Descriptive analysis	85,573 DMRs were provided in total (November 2011 to January 2021).
			The mean DMR1 patient age was 74.0 and was skewed for older patients.
			Pharmacists provided a small proportion (1-2%) of DMRs in the patient's home.
			Pharmacists provided most DMRs in the pharmacy.
			A considerable proportion of DMRs (31-41%) was provided with a carer.
		DMR volume regression	There was no statistically significant effect between rural-urban classification or GP co-location and DMR volume.
		Discrepancy regression	There was an apparent weak curvilinear relationship between the number of medicines and identified discrepancies (Spearman's correlation coefficient = 0.16). Discrepancy identification appeared higher at middle age. In contrast, item discrepancy proportion highlighted greater discrepancy rates at the extremes of age.
			The 'four or more medicines' eligibility criterion was associated with decreased odds (odds ratio = 0.88) of discrepancy identification.
			The 'medicines change during admission' eligibility criterion was associated with increased odds (odds ratio=1.88) of discrepancy identification.
			The 'when required' and 'change after discharge' dosage features were associated with increased odds (odds ratio = 1.07 and 1.64, respectively) of discrepancy identification.
			The 'adjustment to medicines' (i.e., patients who have their medicines dispensed into an MCA) eligibility criterion was associated with reduced odds (odds ratio = 0.92) of discrepancy identification.
			Younger patients (0 to 39 years) had a higher risk of discrepancy identification (odds ratio=1.80).
			The 'professional judgement' eligibility criterion was not significantly associated with the odds of discrepancy identification.
			The regression model had a suboptimal fit (pseudo $R^2 = 0.03$), indicating that there were many explanatory predictors that were not considered.
			There were few predictors with large effects on discrepancy identification.
			Specific medicines classifications were associated with increased odds of discrepancy identification, e.g., drugs for constipation, opioid and non-opioid analgesics, and non-steroidal anti-inflammatory drugs.
			Specific routes of administration were associated with greater odds of discrepancy identification (odds ratio for injections = 1.71, device/dressings = 1.52, topical = 1.36, other routes = 1.33).