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Research paper

Retrospective review of a weaning and rehabilitation cohort within a tertiary critical care unit

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ABSTRACT

Introduction: Patients admitted to critical care are increasingly older with complex comorbidities. These patients frequently have prolonged lengths of stay in intensive care and high rehabilitation requirements. Specialist weaning units have been developed to provide for a proportion of this patient cohort. However, often patients with ongoing multiorgan failure or persistent critical illness do not meet criteria for inclusion. We report on the development of a weaning and rehabilitation cohort within an existing critical care footprint, with the focus on improving outcomes for a broader group of patients with prolonged lengths of stay, stable multiorgan failure, and persistent critical illness.

Methods: Retrospective data were collected for all patients transferred to the weaning and rehabilitation cohort within a single tertiary critical care unit within the United Kingdom. Routine data were used from existing sources.

Results: During the 12-month evaluation period, there were 2018 admissions to the critical care unit. Of these, 92 (4.6 %) patients were transferred to the weaning and rehabilitation cohort, of which 74 met local inclusion with the remaining transferred for capacity purposes. The 74 patients had an average length of stay of 61.2 days, accounting for 32.6% of the total critical care bed days within the single intensive care unit. Survival at the point of intensive care unit and hospital discharge was 86.5% and 79.5%, respectively.

Conclusion: As critical care survival improves, there are an increasing number of patients with challenging ventilatory weaning and rehabilitation needs. The creation of a ventilatory weaning and rehabilitation area within a tertiary critical care unit has the potential to increase survival rates and liberation from both mechanical ventilation and long-term tracheostomisation in patients with significant needs.

1. Introduction

As the population of patients requiring critical care evolves, so should the processes in how care is delivered.[1] Patients admitted to critical care are increasingly older, and many carry a higher comorbidity burden.[2] Improvements in diagnostics and treatments have led to improved survival rates, but this has resulted in an increasing number of long-stay patients with significant ongoing physical and psychological care needs. How should the care we deliver evolve to best manage prolonged lengths of stay, increased costs, and far greater rehabilitation requirements?[3–6]

Over recent years, there has been increasing recognition of the "persistent critical illness" cohort, which refers to those with significant ongoing physical and nonphysical symptoms resulting in prolonged lengths of stay, increased costs, and far greater rehabilitation requirements.[3–6] While this cohort of patients is generally small, accounting for approximately 5–10% of all critical care admissions,[7] they occupy a much more considerable proportion of bed days within both critical care and acute care.[3,4]

Persistent critical illness is not a new concept, with previous epidemics such as polio in the 1950s resulting in significant increases in patients requiring prolonged lengths of stay. However, these epidemics were also associated with significantly higher

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mortality rates[8] and as such did not have the longer-term challenges associated with rehabilitation and recovery. Furthermore, there remains a lack of understanding about the characteristics of this population, such as their risk factors, long-term mortality, functional capacity, cognition, and return to daily activities after hospital discharge.[9] To further complicate the situation, the definitions of persistent critical illness within the literature are variable, ranging from those requiring 72 h or more on mechanical ventilation[10] to at least 21 days on mechanical ventilation.[11,12] Unsurprisingly, given the variation in definition, particularly duration of mechanical ventilation, results of clinical trials vary from centre to centre.[9,13]

However, despite the variation within the literature, there is acknowledgement of both the increasing number of patients with persistent critical illness and their complexity.[14] As such, critical care teams need to review current service pathways to ensure the needs of this cohort are met and that optimal outcomes are achieved. Specialist weaning units (SWUs) meet some of this demand[15]; however, many patients are not appropriate to transfer due to ongoing multiorgan failure, need for ongoing acute interventions, and physiological instability. As such, these patients need to remain within acute critical care environments.[15]

To overcome these challenges and to meet the needs of those with persistent critical illness, we developed a weaning and rehabilitation area (named "complex care") specifically designed for patients with ongoing critical illness, with significant rehabilitation needs that do not meet the criteria for referral to an SWU. The purpose of this study was to describe the service provided in "complex care" area and to explore the patient outcomes including survival, discharge locations, and ongoing ventilatory requirements.

2. Methods

2.1. Design and setting

This retrospective cohort study was completed in a 1080-bed university teaching hospital within South Wales (the UK). The hospital has a 44-bed, mixed-dependency critical care unit, admitting more than 1500 patients per year from all major specialties including general medicine, liver, major trauma, neurocritical care, and complex upper gastrointestinal surgery.

2.2. Participant selection

All patients treated within the "complex care" area of critical care between April 2023 and March 2024 were included in the review. The criteria for transfer to this area are shown as follows. Patients needed to meet all criteria prior to transfer.

- Patients requiring level 3 critical care, defined as those needing advanced respiratory monitoring and support alone, or patients requiring monitoring and support for two or more organ systems at an advanced level[16]
- Patients with anticipated prolonged ventilation and/or complex weaning requirements due to underlying pathology, e.g., SCI, significant intensive care unit–acquired weakness, and chest wall trauma
- Minimum 7 days' mechanical ventilation and where active attempts to liberate from mechanical ventilation have been unsuccessful, e.g., unable to complete spontaneous breathing trial
- Requiring rehabilitation input from several disciplines from the multiprofessional team (including, but not exclusively, physiotherapy, psychology, speech and language therapy, occupational therapy, and dietetics)
- Tracheostomy in already situ or tracheostomy planned

2.3. Description of service

The following provides a description of the services provided within complex care. The TIDieR checklist was utilised to aid explanation.[17]

Why: Development of a complex care area to provide holistic rehabilitation and ventilator weaning for those with persistent critical illness and meeting predefined admission criteria.

What (procedures): Holistic multiprofessional rehabilitation and ventilatory weaning. Interventions included at least twice-daily rehabilitation interventions, weekly multidisciplinary team meetings including goal setting, completion of patient outcome measures, and greater focus on ongoing rehabilitation requirements including likely discharge requirements.

Who provided: Multiprofessional input provided including consultant intensivist (fulfilled by 5 out of 27 of the consultant body), consistent allied health professional presence including dietetics, occupational therapy, psychology, physiotherapy, and speech and language therapy, and increased nursing staff consistency.

Where: Creation of separate 8-bedded complex care area of critical care, colocated with tertiary long-term ventilation service, which is physically separated but geographically close to the main critical care unit. Transfers into, and discharges out of, the complex care unit only happened during daytime hours, with no acute emergency admissions.

When and how much: Interventions provided throughout admission to complex care area, until the point of discharge from critical care.

Modification: Patients becoming acutely unwell were transferred to the main critical care unit on the discretion of the duty consultant. Decision to transfer was based on medical staffing availability (reduced presence on complex care overnight and weekends) and overall admission capacity. Once stabilised, patients were transferred back to complex care.

How well (actual): The timing of transfer to complex care area was dependent on capacity. All patients referred to complex care were transferred at some point during their critical care admission.

2.4. Measures

Data were retrospectively collected from patients treated within the "complex care" area of the critical care unit at University Hospital of Wales (UHW), between April 2023 and April 2024. Routinely collected data were utilised to review patient demographics, including age, gender, reason for admission to critical care, Acute Physiology and Chronic Health Evaluation II score, and frailty.[18] Intensive Care National Audit and Research Centre (ICNARC) mortality prediction was also included which provides a death-risk stratification based on a range of factors including physiological parameters at the time of admission, existing comorbidities, age, and frailty.[19] Outcome data were reviewed for the number of level 3 bed days, total length of critical care stay, need for ongoing organ support, tertiary service input, post–critical care ward stay, and post–critical care mortality. Additional data were also available including frequency of tracheostomy insertion, decannulation success, and location of decannulation.

2.5. Analysis

Simple descriptive data are presented using means (standard deviation) or median (interquartile range) depending on the nature of the data. Due to the design of the study, no statistical testing was completed.

2.6. Ethical statement

This study was discussed with the Cardiff and Vale University Health Board (UHB) research and development department and Health Care Research, Wales, and deemed not to require full ethical application. All information collected was routinely collected data, and no identifiable data were used within the analysis or manuscript. The study met the definition of a service evaluation project under the National Health Service Health Research Authority guidelines. The project was registered with Cardiff and Vale UHB as Service Evaluation via Audit Management and Tracking system.

3. Results

3.1. Demographics

During the 12-month evaluation period, there were 1267 admissions to the critical care unit. Of these, 92 (7.3%) patients were transferred to the "complex care" area. Of these 92 patients, 74 patients met the local inclusion criteria for transfer to the "complex care" area. The remaining 18 were transferred to create admission capacity within the critical care unit. Data for these patients were excluded from further analysis.

Patients had an average age of 58 years, with 52 (56.5%) being male. At the point of critical care admission, 16 (17.4%) patients were clinically frail, with a further four (4.3%) having a diagnosis of a stable long-term disability including younger adults with congenital disabilities. Further demographics are shown in Table 1.

Of the 74 patients, all were receiving level 3 care at the point of transfer, with 56 requiring advanced respiratory support. Of these, 26 patients (35.1%) were receiving more than single organ support. Most patients had been tracheostomised prior to transfer (n = 68, 91.2%), with an average critical care length of stay of 20.6 ± 16.2 days at the point of transfer to the "complex care" area. Patients presented with a range of underlying pathologies, with the most frequently occurring ones being respiratory failure secondary to underlying medical pathology (n = 13, 17.5%), trauma and orthopaedics including spinal cord injuries (SCIs) (n = 9, 12.1%), and those with neurological presentations (n = 8, 10.8%). Of note, 34 patients (45.9%) resided outside of the health board's catchment, with 21 of these (61.2%) receiving tertiary or regional services which prohibited repatriation to their local hospital.

3.2. Ventilator and tracheostomy weaning

Average duration of mechanical ventilation was 39.1 ± 27.8 days, with all patients successfully liberated from mechanical ventilation (including days of mechanical ventilation prior to transfer to complex care). No patients required any form of ongoing ventilatory support.

Of the 68 receiving a tracheostomy, 51 (75%) were successfully decannulated prior to discharge or repatriation to their local hospital, with 42 (82.4%) being decannulated during the critical care admission. Decannulation status for those repatriated with a tracheostomy tube in situ was not explored.

3.3. Critical care and hospital length of stay

Average critical care length of stay (including days prior to and during stay within "complex care") was 61.2 ± 66.1 days, with the average complex care stay lasting 30.7 ± 51.7 days. Those transferred to "complex care" accounted for a total of 4528 critical care bed days or 32.6% of the total bed days within the whole critical care unit capacity.

Of the 74 patients, 64 patients (86.5%) survived to the point of critical care discharge. The discharge destinations from critical care are shown in Table 2.

For those surviving beyond critical care, the length of time between critical care discharge and hospital discharge was 39.7 (58.6) days. Four patients (5.4%) of those discharged required readmission to critical care during their acute stay, one of whom had two readmissions. However, all survived till being discharged from hospital.

3.4. Outcome on hospital discharge

A total of 59 (79.7%) survived to the point of hospital discharge. After discharge from hospital, 21 (35.6%) required readmission to hospital (including admissions to local hospitals), with a median time to first readmission of 121 (47–289) days. Of those readmitted, the median number of readmissions was 1 (1–2). Fig. 1 shows overall survival at the point of evaluation (12 months post evaluation period), with 52 (70.3%) of the overall cohort alive.

4. Discussion

There is increasing awareness of patients developing persistent critical illness. This is associated with prolonged ventilation requirements, increased length of stay, and greater demand on rehabilitation services.[1,2,20] To better support this patient group, critical care services may need to be adapted to focus on ensuing improved outcomes for this cohort.

Iwashyna et al.[4] have previously identified several recommendations for improvement in care for those with persistent critical illness, which included (but were not limited to) multiprofessional coordination, improved communication with family, setting of limits by care team, and treatment or management of delirium.

In this study, we report on the development of a complex care area as part of a 44-bedded critical care unit. During the 12-month inclusion period, 74 patients were deemed appropriate to be transferred to the "complex care" area of intensive care. This

Table 1
Participant demographics of those meeting complex care criteria (n = 74).

	Median (IQR) or n (%)
Age (years)	58.0 (47.5–67.5)
Male gender	52 (56.5%)
ICNARC mortality prediction, %	21.4 (11.6–43.2)
APACHE II score	17.0 (11.8–20.0)
Frailty score	3.0 (2.0–3.0)
Admission diagnosis:	
Intracranial pathology	9 (12.1%)
General medicine	18 (24.3)
Post surgical	10 (13.5%)
Major trauma	21 (28.4%)
Cardiology/cardiac surgery	10 (13.5%)
Other	6 (8.1%)

APACHE: Acute Physiology and Chronic Health Evaluation; IQR: interquartile range.

Table 2
Discharge destinations from "complex care".

	Frequency	Percentage (%)
Died within complex care	10	13.5
Ward (acute and subacute)	52	70.3
Home directly from critical care	6	8.1
Repatriation to local critical care unit	6	8.1
Total	74	100

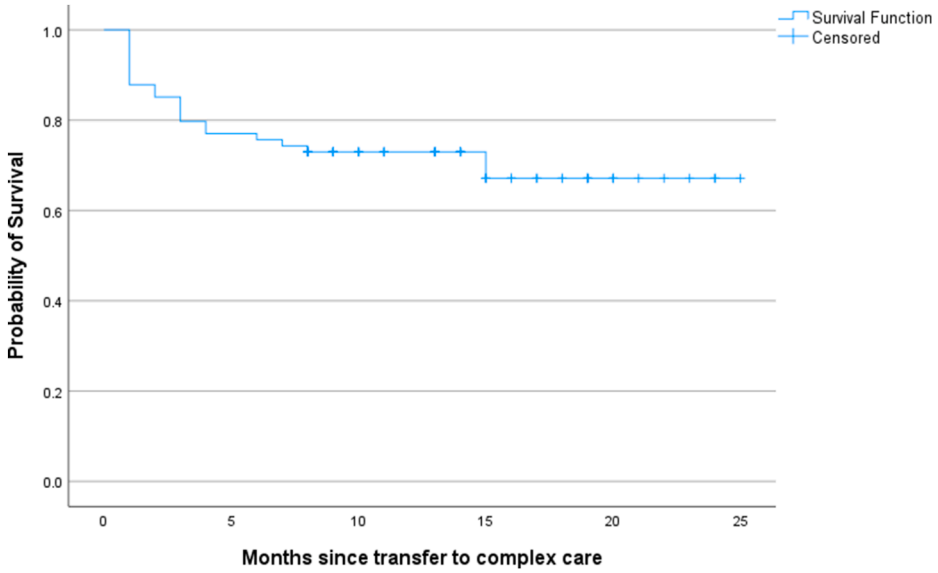

Fig. 1. Kaplan–Meier survival curve for patients transferred to complex care (n = 74).

included a heterogeneous cohort with a range of underlying clinical pathologies including neuromuscular disease, SCIs, and respiratory failure, with all patients still receiving invasive ventilatory support at time of transfer.

There was wide variation in time to transfer to the complex care unit. While the reason for this was not explored, it is likely multifactorial including acuity of illness, transfer capacity (e.g., beds available within complex care), and anticipated likely time to wean from mechanical ventilation. As such, patients will have been at varying stages in their "weaning journey" at the point of transfer. However, as expected, these patients did have prolonged lengths of stay with an average of nearly 40 days of advanced respiratory support. Most required a tracheostomy, but a significant majority were decannulated prior to transfer to the ward environment, hence potentially reducing acuity and dependency on the acute wards. Unlike previously reported outcomes from SWUs within the UK,[21] no patients required ongoing ventilatory support (either invasive or noninvasive ventilation) at the point of critical care discharge.

Survival to both critical care and hospital discharge was high, which is higher than the outcomes of all patients admitted to critical care within the UK.[22] We recognise that this will be influenced by selection bias with these patients identified from the overall critical care cohort. Mortality within critical care is highest during the early aspect of admission.[23] In the case of this study, only those patients surviving to at least 7 days were included, and hence, the risk of death was reduced. However, the reported data are also aligned to those reported in the literature for other SWUs.[21] Additionally, patients were transferred to the "complex care" area that otherwise would not meet traditional SWU admission criteria.[24] This includes 35.1% of patients receiving multiorgan support at the point of transfer, those not for cardiopulmonary resuscitation, and patients with unclear physiological trajectories. The ability to care for those with multiorgan failure increases flexibility within the capacity of the critical care unit, preventing patients needing to be transferred back to acute critical care units in the event of deterioration and hence reducing unnecessary clinical transfers or bed moves.

Of interest, nearly half the admitted patients resided outside of the host organisation. Many of these were continuing to receive tertiary care, and hence repatriation was not possible, but the reasons for nonrepatriation for the remaining patients are not clear. This needs further exploration and consideration in the potential planning of services, particularly the potential number of beds required to deliver such services, and the associated workforce. Furthermore, depending on outcomes and aligned with SWU recommendations, this may raise the suggestion to create more regional approaches for those with persistent critical illness. In turn, this may increase efficiency and support specialist workforce development.

Further work is needed to determine the optimal approach for those with persistent critical illness. We have presented a possible model; however, many other options may be available. This includes fundamental elements such as the admission criteria and the model of care. As previously identified, there is wide variation in the definition of persistent critical illness particularly regarding duration of mechanical ventilation prior to "diagnosis". Defining appropriate inclusion criteria may then be challenging to ensure that all those who may benefit do indeed have access to such services. Additionally, it is unclear from our data which patients may have been eligible for admission to an SWU.

We also recognise that we opted to create a separated area. The reasons for this were to allow colocation with the existing tertiary long-term ventilation service and perceived improvements in patient experience through controlled transfer processes and the absence of emergency admissions. However, it is likely that the approaches taken within complex care would benefit the entire critical care population, e.g., consistency of staffing, multiprofessional meetings, and goal planning. Services would need to consider how these interventions are best provided. This would include consideration of workforce training, the number of patients, and overall size of the critical care unit.

The absence of a direct comparator group means it is not possible to determine if these patients had improved outcomes because of transfer to the "complex care" cohort. Additionally, we recognise the need for further studies to consider longer-term outcomes for patients requiring prolonged admission to critical care including mortality and morbidity and future healthcare utilisation.

5. Conclusion

As critical care survival improves, there are an increasing number of patients with challenging ventilatory weaning and rehabilitation needs. The creation of a ventilatory weaning and rehabilitation area within a tertiary critical care unit has the potential to improve survival rates and liberation from both mechanical ventilation and artificial airways in patients with significant needs.

CRediT authorship contribution statement

All authors have approved the final article, agree to be accountable for all aspects of the work, and acknowledge that all those entitled to authorship are listed as authors.

Paul Twose: Project Administration; Conceptualisation; Methodology; Investigation; Formal Analysis; Writing Original Draft; Writing – Review & Editing.

Jack Parry-Jones: Conceptualisation; Methodology; Writing – Review & Editing.

Benjamin Jones: Conceptualisation; Methodology; Writing – Review & Editing.

Joseph Riddell: Conceptualisation; Methodology; Writing – Review & Editing.

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Data availability statement

Anonymised data are available on direct request to the corresponding author.

Declaration of competing interests

None of the authors have any conflicts of interest.

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