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Development of consensus based international antimicrobial stewardship competencies for undergraduate nurse education

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Antimicrobial stewardship competencies

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STRUCTURED SUMMARY

Background: There is growing recognition by national and international policy makers of the contribution nurses make towards antimicrobial stewardship. Although undergraduate education provides an ideal opportunity to prepare nurses for antimicrobial stewardship roles and activities, only two thirds of undergraduate nursing programmes incorporate any antimicrobial stewardship teaching and only 12% cover all the recommended antimicrobial stewardship principles. Nurses also report that they do not have a good knowledge of antibiotics, and many have not heard of the term antimicrobial stewardship.

Aim: To provide international consensus on the antimicrobial stewardship competency descriptors appropriate for undergraduate nurse education.

Methods: A modified Delphi approach comprising two on-line surveys delivered to an international panel of fifteen individuals reflecting expertise in prescribing and medicines management in the education and practice of nurses; and antimicrobial stewardship. Data collection took place between February and March 2019.

Findings: A total of 15 participants agreed to become members of the expert panel, of whom 13 (86%) completed round one questionnaire, and 13 (100%) completed round two. Consensus was achieved, with consistent high levels of agreement across panel members, on 6 overarching competency domains and 63 descriptors, essential for antimicrobial stewardship practice.

Conclusion: The competency descriptors should be used to direct undergraduate nurse education, and the AMS practices of qualified nurses (including those working in new roles such as Nursing Associates) given the high levels of agreement reached on competency descriptors.

Keywords

Antimicrobial stewardship, competencies, undergraduate nurse education, modified Delphi, antibiotic stewardship

INTRODUCTION

Antimicrobial resistant (AMR) infections cause approximately 700,000 deaths globally each year and this figure is predicted to rise to 10 million, combined with a cumulative cost of \$100 trillion, by 2050 [1]. Antimicrobial stewardship (AMS), described as 'a collection of co-ordinated interprofessional focused strategies to optimise antibiotic use by ensuring that every patient receives an antibiotic only when it is clinically indicated and then receives the appropriate antibiotic, at the right dose, duration and route of administration' [2], requires collaboration between different healthcare providers [3-5].

Nurses are the largest single group in health care. Although an applied discipline, nursing is implemented differently based upon the social, political, and cultural climate within which it is practiced. International [6-8] and national [9] nursing definitions and descriptions share key features including a common purpose, values, and functions, incorporating as its clientele, individuals of all ages, families and groups [9]. Nurses worldwide perform numerous functions critical to the success of AMS programmes. Not only are nurses increasingly prescribers of antimicrobials [10, 11], therefore making them key contributors to appropriate prescribing interventions [12, 13], but they are also directly involved in patient and medicine related stewardship activities (such as timely antibiotic administration, specimen collection, monitoring treatment and adverse events [14]). Nurses are also essential knowledge brokers [15] at the center of—and facilitators of—interprofessional collaborative practice necessary for optimal AMS practice [16]. Nurses can exert leadership to increase public education and awareness of AMR [9]. For example, general practice nurses are well placed to communicate AMR messages to the general public, school nurses are in an excellent position to communicate AMR messages to young people, and health visitors to communicate these messages to young families [9,3,17]. International [3, 18, 11, 19] and national policy [20, 21] include nurses as important to AMS efforts. Furthermore, some evidence suggests that AMS interventions targeted at nurses, can lead to improvements in overall volume and quality of antibiotic use [22-24].

Undergraduate healthcare professional education is a cornerstone for the containment of AMR [25], with a need to embrace a comprehensive and structured approach [26, 16] such as that adopted by infectious disease training programmes [27]. However, undergraduate healthcare professional students in the UK receive disparate stewardship education with only two thirds of nursing programmes incorporating any AMS teaching and only 12% covering all of the recommended AMS principles [26]. Furthermore, although both undergraduate student nurses [28] and qualified nurses [29] believe that AMS is relevant to pre-registration nursing education, they report that they do not have a good knowledge of antibiotics, and many have not heard of the term AMS [28-29], with fewer nurses as compared to doctors or pharmacists aware of the term.[30]. These educational gaps surrounding AMR and AMS are likely to be replicated worldwide, meaning that newly qualified nurses are at great risk of compromising patient safety. It is therefore vital that undergraduate education prepares them for the role they will play in AMS programmes.

To enable the nursing profession to define its own scope of AMS practice, it is essential to identify the knowledge, skills, attitudes and behaviours expected of nurses for optimal use of antibiotics. Fifty four national core competency descriptors in AMS have been previously developed for UK healthcare professional undergraduate education [16]. However, these competency descriptors represent a minimum standard. They will be emphasized to a greater or lesser extent depending on professional role, with each different profession requiring specific knowledge in order to achieve AMS competencies in a cohesive manner yet consistent with their role scope. This current research study was undertaken to provide international consensus on the AMS competency descriptors appropriate for undergraduate nurse education

METHODS

Ethical consideration

The School of Healthcare Sciences Research Governance and Ethics Committee, Cardiff University, provided ethical approval for the study (Reference number 607RE).

Design

In the absence of research evidence, and where there is a desire to gather opinion, structured or formal methods are commonly used to reach consensus. The Delphi technique is a commonly used formal consensus method [31] which elicits the views of an Expert panel on a topic using a series of data collection rounds. A benefit of the Delphi technique is the potential to derive consensus across a large numbers of participants who are geographically dispersed. [31] Furthermore, unlike a traditional group meetings, the Delphi technique avoids meetings becoming dominated by one individual or influenced by coalitions between group members [31]. In a classic Delphi survey, the round one questionnaire, collects qualitative data through open ended questions. This data is then used to develop subsequent questionnaires [32-33]. As pre-existing national AMS competencies exist, [16] the current study adopted a modified Delphi survey, [31] whereby these pre-existing competencies replaced the round one survey. A modified Delphi is an appropriate option if pre-existing information is available [31].

Recruitment

As opposed to random sample representative of the target population, 'experts' are employed by the Delphi technique as Delphi panel members. However, there is a lack of agreement as to what constitutes an 'expert' and it is recommended that explicit criteria are used to recruit participants. [34]. The authors of the pre-existing AMS competencies [16] highlight that the competencies will be emphasized to a greater or lesser extent depending upon professional role and advocate testing and refining across the different healthcare professions. The aim of our study was to provide international consensus on the AMS competency descriptors appropriate for undergraduate nurse education.

Therefore, 'Experts' in this study were nurses reflecting expertise in infection, including prescribing and medicines management in the education and practice of nurses; and antimicrobial stewardship.

Identification of expert panel members

Purposive and snowball sampling methods (i.e. a nonprobability sampling technique whereby existing study participants identify potential future subjects) were used to recruit expert panel members across eight countries (including Brazil, UK, South Africa, US, Canada, Norway, Thailand, France). Using purposive methods, individuals in the 'international community of practice for nurses in AMS' (a group of nurses from several countries formed organically following the celebration of the first International Summit on Nurses in Antimicrobial Stewardship in London in 2016) who fulfilled the 'Expert' criteria were identified and contacted by the researchers. Individuals who fulfilled 'Expert' criteria were also identified through the Royal College of Nursing (RCN). Participants identified in this manner, then referred researchers to other potential participants (i.e. snowball sampling). All individuals contacted who fulfilled the 'Expert' criteria, were those experienced in AMS with advanced and specialist knowledge and working in clinical, managerial, education and research roles.

Sample size

In-line with sample size recommendations for a homogenous sample [35], we aimed to recruit between 15-20 participants. All those who expressed an interest to participate and fulfilled our 'expert' definition, were included.

Recruitment procedure

Fifteen individuals fulfilled the expert criteria and expressed enthusiasm to take part. Each participant received an email containing the Information Sheet, and were given the opportunity to speak to a researcher to address any queries they may have had. All fifteen agreed to participate. Implied consent to participate was provided through the completion of consensus survey questionnaires.

Data collection

On-line Surveys—a tool for creating web surveys—was used to develop each of the two survey rounds. An email (containing a link to on-line survey one and subsequently survey two) was sent to each participant inviting them to take part. Each survey round was open for 3 weeks and follow-up reminder emails were sent at weekly intervals. Data collection took place between February and March 2019.

First round questionnaire

The existing national AMS competencies appropriate for undergraduate healthcare professional education [16], formed the content of the round one Delphi survey. Using a 6 point Likert scale (1=not at all important to 6 =extremely important) participants were asked to rate each descriptor with regards to importance. An open-ended question at the end of each domain, invited interpretation and feedback, and the identification of any additional descriptors thought to be missing.

Second round questionnaire

Prior to round two, a report of the quantitative results of round one survey was circulated to panel members inviting interpretation and feedback. Descriptors for which there was a lack of agreement, those amended in the light of qualitative feedback, and additional descriptors identified by panel members, were included in survey round two. This survey, administered in the same way as round

one, was only administered to those who had completed round one. See Figure 1 for a summary of the Delphi process.

Data analysis

The most frequently used method to achieve consensus in Delphi studies is median scores and interquartile ranges (IQRs) [36]. This method was also used to develop the published consensus based national antimicrobial stewardship competencies [16] and is considered robust [37]. Median scores and IQRs were calculated for descriptor responses, to characterise the answer category above and below which 50% of the answers fell. IQRs were used to represent the spread of the data and to assess the level of consensus per question. Consistent with previous studies [38, 39, 16], responses where the median was equal to or higher than 5 (i.e. a high level of agreement that participants viewed it as important) with a small IQR (less than or equal to 1.5), were considered important descriptors that had reached consensus across expert panel members. Qualitative responses were explored using content analysis [40].

RESULTS

Of the 15 participants who agreed to take part, 13 (86%) completed round one questionnaire, and 13 (100%) completed round two (see Table 1 for Expert Panel details).

Round one survey results

Of the thirteen expert panel members who responded to the round one survey, there were high levels of agreement for all 54 competency descriptors with medians in the strong range of agreement (5-6 on the 6 point Likert scale) (see Table 2). The strength of agreement was high for 53 descriptors (IQR less than or equal to 1.5) but lower for 1 descriptors i.e. *‘Demonstrating knowledge and awareness of international/national strategies on infection prevention and control and antimicrobial resistance such*

as *Global Action Plan for AMR and Save Lives -Clean Your Hands* <http://www.who.int/qpsc/5may/en/> and the UK Governments 5 -year *Antimicrobial Resistance Strategy*'. Qualitative content analysis of open-ended responses identified 10 new descriptors (see Table 3). Four descriptors (including the descriptor above for which the strength of agreement was low) were amended in the light of qualitative feedback (see Table 3). These amended descriptors and the 10 new descriptors (14 in total) were taken forward to the round two survey.

Round two survey results

Thirteen participants (100%) responded to the second round. There were high levels of agreement for all 14 descriptors, with medians in the strong range of agreement (5-6 on the 6 point Likert scale) (see Table 4). The strength of agreement was high for 13 Descriptors (IQR less than or equal to 1.5) but lower for 1 descriptors i.e. '*Describe the most common mechanisms that microorganisms use to impair antimicrobial action*' (see Table 4). International consensus was reached on 6 overarching competency statements (sub divided into 6 domains), and 63 individual descriptors essential for AMS in nursing professional practice. (see Figure 2).

DISCUSSION

International AMS competencies were developed for undergraduate nurse education by use of a Delphi technique, a formal consensus process. The existing national AMS competencies for undergraduate healthcare professional education [16], formed the content of the round one survey, and so the traditional round one of a Delphi survey was unnecessary. Consensus was achieved, with consistent high levels of agreement across panel members, on 6 overarching competency domains representing the knowledge, skills, attitudes, and values that shape the judgements essential for AMS, and 63 descriptors, reflecting learners experience and type of practice setting. The integrative approach [41-42] used by the framework enables descriptors to be integrated throughout nurse

undergraduate education programmes facilitating the incremental building of AMS knowledge and skills.

Consensus was achieved on all but one of the 54 competency descriptors identified previously as a minimum standard for undergraduate healthcare professional education [16]. However, a further 9 descriptors were identified as specific to nursing in order to achieve AMS competencies consistent with the roles of nurses. Such addition to the descriptors may simply reflect the variety of roles and responsibilities as well as expectations included within the remit of nurses worldwide. Some of these new competency descriptors focused upon patient care activities (e.g. specimen collection, treatment monitoring, interpreting laboratory results) and their utilisation (e.g. recognising the importance of adequate specimen collection during antimicrobial use, recognising the response to antimicrobial treatment, interpreting culture and sensitivity results that demand prompt attention) to achieve optimal AMS practice. Other descriptors centred upon the central role of nurses as communicators and patient educators about AMR e.g. enabling selfcare for patients and promoting family engagement in infection prevention and control activities, or recognising those patients and families in need of support to complete a course of antibiotics. These findings align with the nursing literature that describes the role of nursing stewardship education as recognizing and utilizing established nursing functions to synergize with optimal AMS goals and outcomes [43-44].

Nurses worldwide are involved in an array of patient care activities critical to the success of AMS programmes. Our competencies will provide evidence of AMS in nurse education programmes and learners' practice. They also provide a baseline for those involved in continuing education, with regards to the minimum standard required of nurses. In addition to guidance for nurses, they will also provide guidance for those working in new roles such as Nursing Associates in the UK [45]. Increasing numbers of nurses prescribe medicines (including antimicrobials) with prescribing competencies now

embedded into nursing programmes. Within the UK, a novel approach to nursing practice and education has been initiated, with newly qualified nursing practitioners of the future graduating as being able to demonstrate “the ability to progress to a prescribing qualification following registration”, thus changing the landscape of how and by whom healthcare is delivered [46]. Our framework will strengthen AMS in undergraduate programmes, in preparation for this role. The competencies may serve as a template to support international cadres of healthcare providers other than nurses, yet closely aligned to nursing responsibilities, such as community health workers or community birth attendants who may also have a role in AMS [47]. Furthermore, through the use of a locally delivered modified Delphi survey, these competency descriptors can be refined, expanded and focused to reflect the local situation in countries other than those represented in this study. For example, in some countries, legislation does not permit nurses to prescribe medicines. A locally delivered survey will enable refining of competency descriptors consistent with role scope.

We encourage those involved in undergraduate nurse education to map these competencies against existing curricula, adopting (and if necessary adapting) them and then evaluating their efficacy and relevance to nursing practice. Although the competencies may result in clinical improvements by addressing well reported educational and attitudinal gaps about AMS among nurses, their effectiveness remains to be established. The competencies can be incorporated within the numerous learning opportunities integrated throughout undergraduate nurse education programmes, helping to refine existing resources, address shortfalls, and enabling AMS components to be clearly described and assessed. Additionally, the competency framework can be used by regulators and professional bodies to inform proficiency standards and guidance.

Our findings should be integrated within national and international AMR action plans. This will ensure that the contribution of nursing is recognised, and can be demonstrated and monitored. Many AMR

action plans are explicit at strategic level but may not always include implementation details. Refining and detailing the contribution of nurses provides a unique opportunity to demonstrate what other professionals can do in the implementation of AMS strategies and the difference they make. These competencies, and their inclusion within undergraduate nurse education programmes, should be promoted globally by Schools of Nursing and National Councils of Nursing. Nursing as a profession continues to evolve and build upon evidence-based research. As our understanding of how nurses can contribute to stewardship and support other healthcare professionals develops, these competencies will form a framework to provide continuous improvement in stewardship efforts.

STUDY LIMITATIONS

The main strengths of this work are that it is based on responses from an international panel of defined experts, had a good response rate, and offers a framework of AMS competencies appropriate for undergraduate nurse education. This is the first nursing framework addressing AMR and AMS. However, there are some limitations. Firstly, purposive and snowball sampling methods were used to recruit expert panel members. Although such experts were chosen to achieve a broad range of expertise, with experience of collaborative working, researching and designing nursing services, and involvement in national and international policy, only a small number of participants were included from each country and so may not reflect the full spectrum of nurses involved in AMS. Therefore, our findings may not present an accurate picture of this population or be completely relevant to all nurses engaged in AMS interventions. Despite this we argue that multiple elements of these competencies reflect optimal nursing behaviours that are shared across different countries, clinical areas and domains and are already embedded in nursing practice and applied to the local situation.

Secondly, in an attempt to reduce attrition rate, the round 2 questionnaire was shortened by only including the descriptors from round 1 for which there was a lack of agreement. This meant that stability of responses was not assessed across the two survey rounds. However, interpretation and

feedback was invited from participants on a report of the collated results which was shared with participants prior to survey round 2.

Finally, we acknowledge that these competency descriptors focus largely on clinical and bed-side aspects, and may be further expanded and refined to explore other elements centred on leadership [48] or executive and even political [49] skills that may be increasingly seen as essential to enable clinical competence. As AMR is recognised as a global and planetary matter driven by broad social determinants [50], such leadership skills may also be progressively adopted.

CONCLUSION

The competency descriptors should be used to direct undergraduate nurse education, and the AMS practices of qualified nurses (including those working in new roles such as Nursing Associates) given the high levels of agreement reached on competency descriptors. This will help to optimise AMS goals and outcomes. We encourage those involved in nurse education to map this framework to existing curricula and adopt and test competency descriptors.

DECLARATION OF INTEREST

Declarations of interest: none

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CONTRIBUTORSHIP STATEMENT

MC made substantial contributions to the concept and design of the work, and the acquisition, analysis and interpretation of the data. ECS made substantial contributions to the design of the work, and the acquisition and interpretation of the data. RG, and JM, contributed to the acquisition and interpretation of the data. AB, YC, BT,RF, EG, NH, LJ, VN, RO, MP, JR, NG, YZ (all Expert Panel members) contributed to the interpretation of the data. All authors contributed to drafting and/or revising this manuscript, approved the final version of the paper, and agreed to be accountable for all aspects of the work.

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Figure 1 – Summary of the Delphi process

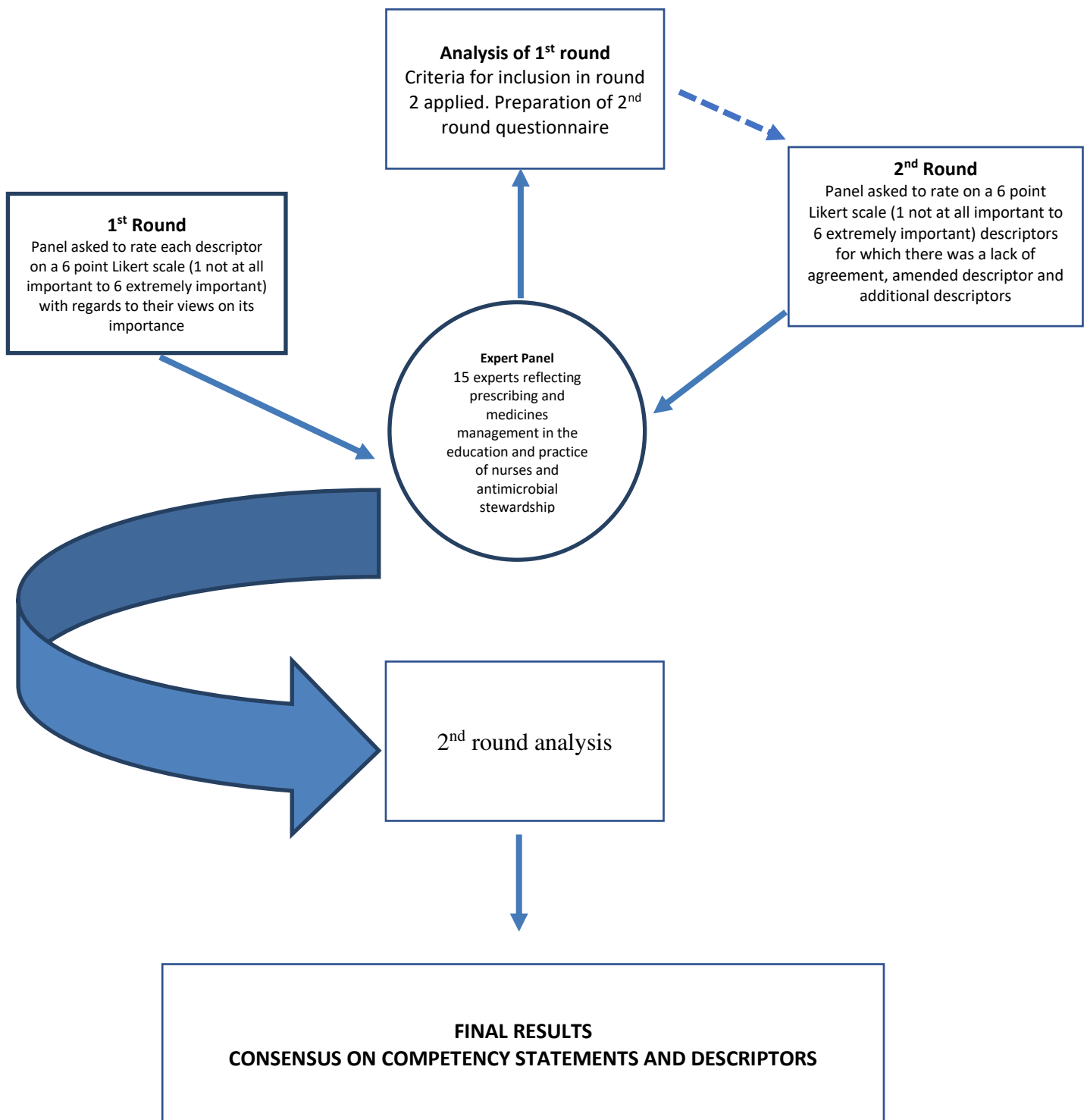


Figure 2 – Antimicrobial stewardship framework

DOMAIN ONE: INFECTION PREVENTION AND CONTROL

COMPETENCY STATEMENT: All qualified health care professionals must understand the core knowledge underpinning infection prevention and control, and use this knowledge appropriately to prevent the spread of infection.

Descriptors

To support antimicrobial stewardship learners must demonstrate infection prevention and control by:

1. Describing what a micro-organism is
2. Describing the different types of organisms that may cause infections
3. Explaining what an antimicrobial resistant organism is
4. Explaining the 'Chain of Infection'.
5. Defining the components required for infection transmission (i.e. presence of an organism, route of transmission of the organism from one person to another, a host who is susceptible to infection).
6. Describing the routes of transmission of infectious organisms i.e., contact, droplet, airborne routes.
7. Present and recognize the characteristics of a susceptible host.
8. Demonstrate an understanding of the importance of surveillance.
9. Describe how vaccines can prevent infections in susceptible persons.
10. Demonstrate the application of standard precautions in healthcare environments.
11. Apply appropriate policies/procedures and guidelines when collecting and handling specimens.
12. Apply policies, procedures and guidelines relevant to infection control when presented with infection prevention and control cases and situations.
13. Implement work practices that reduce the risk of infection (such as taking appropriate immunization or not coming to work when sick to ensure patient and other healthcare worker protection).
14. Appreciate that healthcare workers have the accountability and obligation to follow infection prevention and control protocols as part of their contract of employment.
15. Act as a role model to healthcare workers and members of the public by adhering to infection prevention and control principles.
16. Demonstrating knowledge and awareness of international/national strategies on infection prevention and control and antimicrobial resistance such as Global Action Plan for AMR and

national recommendations, guidelines, and legal requirements-or equivalent

17. Understanding the role of the environment in optimal infection prevention and control practices including hand hygiene and environmental cleaning
18. Enabling infection prevention and control self-care for patients and family'

DOMAIN TWO: ANTIMICROBIALS AND ANTIMICROBIAL RESISTANCE

COMPETENCY STATEMENT: All qualified health care professionals need to understand the core knowledge underpinning the concept of antimicrobial resistance and use this knowledge to help prevent antimicrobial resistance.

Descriptors

To support antimicrobial stewardship learners must be able to:

1. Recognise the signs and symptoms of infection
2. Discuss how inappropriate antimicrobial use (including non-adherence to treatment regime) may lead to antimicrobial resistance
3. Identify approaches to support optimal prescribing of antimicrobials
4. Recognise the importance of adequate specimen collection during relevant stages of antimicrobial use (i.e. prior/during antibiotic treatment)
5. Describe how to recognize the appropriate response to antimicrobial treatment and the main signs that demonstrate antimicrobial failures

DOMAIN THREE: THE DIAGNOSIS OF INFECTION AND THE USE OF ANTIBIOTICS

COMPETENCY STATEMENT: All qualified health care professionals need to demonstrate knowledge in how infections are diagnosed and the appropriate use of antimicrobials, and use this knowledge appropriately to support the accurate diagnosis of infection and the appropriate use of antimicrobials.

Descriptors

To support antimicrobial stewardship, learners must be able to:

1. Explain how microbiology samples may aid diagnosis of infection
2. Describe how and demonstrate (following local procedures) the appropriate taking of samples
3. Interpret microbiology results/reports from the laboratory at a basic level
4. Explain why self-limiting bacterial or viral infections are unlikely to benefit from antimicrobials

5. Describe and demonstrate the self-management strategies required to treat self-limiting infections (i.e. analgesia /rest /fluids)
6. Understand the importance of following local antimicrobial policies (i.e. their development is based on local resistance patterns) and follow these policies in practice
7. Explain the importance of documenting the indications for an antimicrobial (i.e. the route by which it is administered, its duration, dose, dose interval, and review date), in clinical notes and demonstrate this in practice
8. Demonstrate an understanding of the factors that need to be considered when choosing an antimicrobial (including site of infection and type of bacteria likely to cause an infection at a particular site)
9. Describe broad spectrum and narrow spectrum antimicrobials and the contribution of broad spectrum antimicrobials to AMR
10. Present and be able to recognise the common side effects associated with commonly administered antimicrobials
11. Demonstrate an understanding of why documenting a patient allergy to an antimicrobial is important
12. Explain why it is important to consider certain physiological conditions (such as renal function) in patients who receive an antimicrobial
13. Describe what is meant by delayed prescribing
14. Explain why it is essential that an accurate diagnosis of an allergy to an antimicrobial is based on history and laboratory tests.
15. Demonstrate an understanding of the role of the nurse regarding quality and safety of antibiotic prescriptions
16. Demonstrate an awareness of laboratory results (i.e. culture and sensitivity) that demand prompt intervention)
17. Recognize antimicrobials that should be preserved for treatment of specific infections e.g. carbapenemase-producing Enterobacteriaceae (**CPE**) or colistin –resistance or colistin resistant pathogens

DOMAIN FOUR: ANTIMICROBIAL PRESCRIBING PRACTICE

COMPETENCY STATEMENT: All qualified health care professionals need to be aware of how antimicrobials are used in practice in terms of their dose, timing, duration and appropriate route of administration, and apply this knowledge as part of their routine practice as follows:

Descriptors

To support antimicrobial stewardship, learners must be able to:

1. Explain how you would recognise and manage sepsis
2. Describe why it is important to use local guidelines to initiate prompt effective antimicrobial treatment in patients with life threatening infections
3. Describe why it is important to switch from intravenous antimicrobials to oral therapy
4. Describe how to switch from IV antimicrobials to oral therapy
5. Understand the appropriateness of antimicrobial administration models such as outpatient parenteral antimicrobial therapy (OPAT)
6. Demonstrate an understanding of the rationale and use of perioperative prophylactic antimicrobials to prevent surgical site infection
7. Discuss factors that can influence antimicrobial prescribing and the implications for antimicrobial stewardship programmes
8. Describe the national guidance on completion of a course of antimicrobials
9. Explain how you would identify the medicines with which antimicrobials can interact and why this is important
10. Describe the difference between empiric, targeted and prophylactic antimicrobial therapy

DOMAIN FIVE: PERSON CENTRED CARE

COMPETENCY STATEMENT: All qualified health care professionals must seek out, integrate and value the input and engagement of the patient /carer as a partner in designing and implementing care

Descriptors: To support antimicrobial stewardship that is patient centred, learners need to:

- 1) Support participation of patients/carers, as integral partners when planning/delivering their care.
- 2) Share information with patients/carers in a respectful manner and in such a way that is understandable, encourages discussion, and enhances participation in decision-making.
- 3) Ensure that appropriate education and support is provided by learners to patients/carers, and others involved with their care or service;
- 4) Listen respectfully to the expressed needs of all parties in shaping and delivering care or services.

- 5) Discuss patient/carer expectations or demands of antimicrobials and the need to use antimicrobials appropriately.
- 6) Recognize patient social-economic restrictions (or other conditions of vulnerability) that may limit the appropriate course of antimicrobials, and support patients and their families for social protection achievement
- 7) Recognize patients and families who require support to complete a course of antimicrobial therapy.

DOMAIN SIX: INTERPROFESSIONAL COLLABORATIVE PRACTICE

COMPETENCY STATEMENT: All qualified health care professionals need to understand how different professions collaborate in relation to how they contribute to AS.

Descriptors: To support AMS, learners are able to:

- 1) Demonstrate an understanding of the roles, responsibilities, and competencies of other health professionals involved in antimicrobial treatment policy decisions
- 2) Explain why it is important that healthcare professionals, involved in the delivery of antimicrobial therapy (including the prescription, delivery and supply), have a common understanding of antimicrobial treatment policy decisions, the quantity of antimicrobial use, and effective patient/client outcomes
- 3) Establish collaborative communication principles and actively listen to other professionals and patients/carer involved in the delivery of antimicrobial therapy
- 4) Communicate effectively to ensure common understanding of care decisions
- 5) Develop trusting relationships with patients /carer and other health/social care professionals
- 6) Effectively use information and communication technology to improve interprofessional patient-centred care

Table I – Expert panel details

Country	Panel member role
Brazil	Assistant Professor, Nursing

	Associate Professor, Nursing
United Kingdom	Infection Control Nurse Lecturer Nursing
South Africa	Infection Prevention and Control Specialist Advanced Critical Care Nurse Specialist Infection Prevention and Control Officer
United States	Assistant Professor, Nursing
Canada	Clinical Nurse Leader
Norway	Infection Control Nurse
Thailand	Lecturer, Nursing
Central Africa	Infection Control Africa Network
France	Infection Prévention and Control Nurse

Table 2– Round one survey response

Domain One	IQR	Median
Describing what a micro-organism is	1	5.5

Describing the different types of organisms that may cause infections.	1	5.5
Explaining what an antimicrobial resistant organism is.	1	5.5
Explaining the 'Chain of Infection'.	1	5.5
Defining the components required for infection transmission (i.e. presence of an organism, route of transmission of the organism from one person to another, a host who is susceptible to infection).	0	6.0
Describing the routes of transmission of infectious organisms i.e., contact, droplet, airborne routes.	0	6.0
Present and recognize the characteristics of a susceptible host.	1	5.5
Demonstrate an understanding of the importance of surveillance	0	6.0
Describe how vaccines can prevent infections in susceptible persons.	1	5.5
Demonstrate the application of standard precautions in healthcare environments	0	6.0
Apply appropriate policies/procedures and guidelines when collecting and handling specimens.	0	6.0
Apply policies, procedures and guidelines relevant to infection control when presented with infection control cases and situations	0.25	5.86
Implement work practices that reduce risk of infection (such as taking appropriate immunization or not coming to work when sick to ensure patient and other healthcare worker protection).	1	5.5
Appreciate that healthcare workers have the accountability and obligation to follow infection prevention and control protocols as part of their contract of employment.	1	5.5
Act as a role model to healthcare workers and members of the public by adhering to infection prevention and control principles.	0	6.0
Demonstrating knowledge and awareness of international/national strategies on infection prevention and control and antimicrobial resistance such as Global Action Plan for AMR and Save Lives -Clean Your Hands http://www.who.int/gpsc/5may/en/ and the UK Governments 5	2	5.0

-year Antimicrobial Resistance Strategy		
Domain Two		
Recognise the symptoms of infection.	0	6.0
Describe at least two different ways that antimicrobials may kill bacteria.	1	5.5
Discuss how inappropriate antibiotic use (including non-adherence to treatment regime) may lead to antimicrobial resistance	1	5.5
Identify approaches to support optimal prescribing of antimicrobials	1	5.5
Domain Three		
Explain how microbiology samples may aid diagnosis of infection	1	5.5
Describe how and demonstrate (following local procedures) the appropriate taking of samples	0	6.0
Interpret microbiology results/reports from the laboratory at a basic level	0	6.0
Explain why self-limiting bacterial or viral infections are unlikely to benefit from antimicrobials	1	5.5
Describe and demonstrate the self-management strategies required to treat self-limiting infections (i.e. analgesia /rest /fluids)	1	5.5
Understand the importance of following local antibiotic policies (i.e. their development is based on local resistance patterns) and follow these policies in practice	0	6.0
Explain the importance of documenting the indications for an antimicrobial (i.e. the route by which it is administered, its duration, dose, dose interval, and review date), in clinical notes and demonstrate this in practice	0	6.0
Demonstrate an understanding of the factors that need to be considered when choosing an antimicrobial (including site of infection and type of bacteria likely to cause an infection at a particular site)	1.5	5.0

Describe broad spectrum and narrow spectrum antimicrobials and the contribution of broad spectrum antimicrobials to AMR	1	5.5
Present and be able to recognise the common side effects associated with commonly administered antimicrobials	1	5.5
Demonstrate an understanding of why documenting a patient allergy to an antimicrobial is important	0	6.0
Explain why it is important to consider certain physiological conditions (such as renal function) in patients who receive an antimicrobial	0	6.0
Describe what is meant by delayed prescribing	1	5.5
Explain why it is essential that an accurate diagnosis of an allergy to an antimicrobial is based on history and laboratory tests	1	5.5
Domain Four		
Explain how you would recognise and manage sepsis	0	6.0
Describe why it is important to use local guidelines to initiate prompt effective antimicrobial treatment in patients with life threatening infections	1	5.5
Describe why it is important to switch from IV antimicrobials to oral therapy	0	6.0
Describe how to switch from IV antimicrobials to oral therapy	1	5.5
Understand the appropriateness of antimicrobial administration models such as outpatient parenteral antimicrobial therapy (OPAT)	1	5.5
Demonstrate an understanding of the rationale and use of perioperative prophylactic antimicrobials to prevent surgical site infection	0	6.0
Discuss factors that can influence antibiotic prescribing and the implications for antimicrobial stewardship programmes	1	5.5
Describe the national guidance on completion of a course of antimicrobials	1	5.5

Describe some of the medicines with which antimicrobials can sometimes interact	1	5.5
Domain Five		
Support participation of patients/carers, as integral partners when planning/delivering their care	0	6.0
Share information with patients/carer in a respectful manner and in such a way that is understandable, encourages discussion, and enhances participation in decision-making	0	6.0
Ensure that appropriate education and support is provided by learners to patients/carer, and others involved with their care or service;	1	5.5
Listen respectfully to the expressed needs of all parties in shaping and delivering care or services.	0	6.0
Discuss patient/carer expectations or demands of antimicrobials and the need to use antibiotics appropriately.	1	5.5
Domain Six		
Demonstrate an understanding of the roles, responsibilities, and competencies of other health professionals involved in antimicrobial treatment policy decisions	1	6.0
Explain why it is important that healthcare professionals, involved in the delivery of antimicrobial therapy (including the prescription, delivery and supply) , have a common understanding of antimicrobial treatment policy decisions, the quantity of antimicrobial use, and effective patient/client outcomes	0	6.0
Establish collaborative communication principles and actively listen to other professionals and patients/carer involved in the delivery of antimicrobial therapy	0	6.0
Communicate effectively to ensure common understanding of care decisions	0	6.0
Develop trusting relationships with patients /carer and other health/social care professionals	0	6.0

Effectively use information and communication technology to improve interprofessional patient -centred care	1	5.5
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*Green - lack of agreement i.e. IQR more than 1.5 – include in round 2 questionnaire

Table 3 – New and amended descriptors

New Descriptors
Domain One: Infection prevention and control
Understanding the role of the environment in optimal infection prevention and control practices including hand hygiene
Enabling infection prevention and control self-care for patients and family'
Domain Two: Antimicrobials and antimicrobial resistance
Recognise the importance of adequate specimen collection during relevant stages of antimicrobial use (i.e. prior/during antibiotic treatment)
Describe how to recognize the appropriate response to antimicrobial treatment and the main signs that demonstrate antimicrobial failures
Domain Three: The diagnosis of infection and the use of antimicrobials
Demonstrate an understanding of the role of the nurse regarding quality and safety of antibiotic prescriptions
Demonstrate an awareness of laboratory results (i.e. culture and sensitivity) that demand prompt intervention)
Recognize antimicrobials that should be preserved for treatment of specific infections e.g. carbapenemase-producing Enterobacteriaceae (CPE) or colistin -resistant
Domain Four: Antimicrobial prescribing practice
Describe the difference between empiric, targeted and prophylaxis antimicrobial therapy
Domain Five: Person centred care
Recognize patient social-economic restrictions (or other conditions of vulnerability) that may limit the appropriate course of antimicrobials, and support patients and their families for social protection achievement
Recognize patients and families who require support to complete a course of antimicrobial therapy
Amended Descriptors
Domain One: Infection prevention and control

Demonstrating knowledge and awareness of international /national strategies on infection prevention and control and antimicrobial resistance such as Global Action Plan for AMR and national recommendations, guidelines, and legal requirements-or equivalent
Domain Two: Antimicrobials and antimicrobial resistance
Describe the most common mechanisms that microorganisms use to impair antimicrobial action Recognise the signs and symptoms of infection
Domain Four: Antimicrobial prescribing practice
Explain how you would identify the medicines with which antimicrobials can interact and why this is important

Table 4 – Round two survey response

Domain One	IQR	Median
Demonstrating knowledge and awareness of international /national strategies on infection prevention and control and antimicrobial resistance such as Global Action Plan for AMR and national recommendations, guidelines, and legal requirements-or equivalent	0.5	5
Understanding the role of the environment in optimal infection prevention and control practices including hand hygiene	0	6
Enabling infection prevention and control self-care for patients and family	1	5.58
Domain Two		
Recognise the signs and symptoms of infection	0	5.83
Describe the most common mechanisms that microorganisms use to impair antimicrobial action	2.0	5.17
Recognise the importance of adequate specimen collection during relevant stages of antimicrobial use (i.e. prior/during antibiotic treatment)	0	5.92

Describe how to recognize the appropriate response to antimicrobial treatment and the main signs that demonstrate antimicrobial failures	0	5.83
Domain Three		
Demonstrate an understanding of the role of the nurse regarding quality and safety of antibiotic prescriptions	1.25	5.75
Demonstrate an awareness of laboratory results (i.e. culture and sensitivity) that demand prompt intervention)	0.25	5.75
Recognize antimicrobials that should be preserved for treatment of specific infections e.g. carbapenemase-producing Enterobacteriaceae (CPE) or colistin -resistant	1.0	5.33
Domain Four		
Explain how you would identify the medicines with which antimicrobials can interact and why this is important	1.0	5.5
Describe the difference between empiric, targeted and prophylaxis antimicrobial therapy	1.0	5.58
Domain Five		
Recognize patient social-economic restrictions (or other conditions of vulnerability) that may limit the appropriate course of antimicrobials, and support patients and their families for social protection achievement	1.25	5.25
Recognize patients and families who require support to complete a course of antimicrobial therapy	0.25	5.67

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*Green - lack of agreement i.e. IQR more than 1.5