The delivery of antimicrobial stewardship competencies in United Kingdom pre-registration nurse education programmes: A national cross-sectional survey

Molly Courtenay[1]*, Enrique Castro-Sánchez[2], Rose Gallagher,[3] Dinah Gould, [4] Clare Hawker,[1] Nurse Antimicrobial Stewardship Group (NAG) [5]

[1]School of Health Sciences, Cardiff University, Cardiff, CF24 OAB, UK, [2] School of Health Sciences, City University, London, EC1V 0HB, [3] Royal College of Nursing, London W1G 0RN, UK, [4] Independent consultant in Infection Control, London, UK, [5] (see Appendix one)

Antimicrobial stewardship in nurse education

*Corresponding author:

Molly Courtenay

Email: courtenaym@cardiff.ac.uk

Tel: 02920688566

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STRUCTURED SUMMARY

Background: Registered nurses perform numerous functions critical to the success of antimicrobial stewardship but only 63% of pre-registration nursing programmes include any teaching about stewardship. Updated nursing standards highlight nurses require antimicrobial stewardship knowledge and skills.

Aim: To explore the delivery of key antimicrobial stewardship competencies within updated pre-registration nursing programmes.

Method: A cross-sectional survey design. Data was collected between March and June 2021.

Findings: Lecturers from 35 universities responsible for teaching antimicrobial stewardship participated. The provision of antimicrobial stewardship teaching and learning was inconsistent across programmes with competencies in infection prevention and control, patient centred care, and interprofessional collaborative practice taking precedent over those pertaining to the use, management, and monitoring of antimicrobials. On-line learning and teaching surrounding hand hygiene, personal protective equipment, and immunisation theory was reported to have increased during the pandemic. Only a small number of respondents reported that students shared taught learning with other healthcare professional groups.

Conclusion: There is a need to ensure consistency in antimicrobial stewardship across programmes, and greater knowledge pertaining to the use, management and monitoring of antimicrobials should be included. Programmes need to adopt teaching strategies and methods that allow nurses to develop interprofessional skill in order to practice collaboratively.

INTRODUCTION

Antimicrobials continue to be used significantly more per capita (per person) than in previous decades [1,2], with an associated increase in antimicrobial resistance (AMR) [3]. Increased use of antimicrobials during the pandemic, has escalated the timeline with regards to public health threat from AMR [4]. AMR infections (including fungal, viral, bacterial and parasitic infections) represent one of the greatest threats to human health and in 2016 were estimated to cause approximately 700,000 deaths globally each year [5]. Few new antibiotics are available with the last entirely original class of antibiotic discovered in the late 1980s [6]. Antimicrobial stewardship (AMS) programmes have been developed internationally [7} to ensure that current antimicrobial options remain viable. These programmes are essential to prevent AMR [8].

Registered nurses perform numerous functions pivotal to raising awareness of AMR and critical to the success of AMS programmes [9]. As prescribing emerges as a key nursing role [10-11], this places them as key contributors to appropriate prescribing interventions [12-13] with existing wider patient and medicine related stewardship activities (such as timely antibiotic administration, specimen collection, monitoring treatment and reporting of adverse events) [14] compounding the positive contribution of this profession.

There is international [15,16, 7], and national [17-18], acknowledgement of registered nurses as important to AMS efforts. Increasingly, the provision and management of care is seen as integral to AMS activities with good nursing described as 'good antimicrobial stewardship' [19]. However, undergraduate nurse students [20] and qualified nurses [21-22] report a poor knowledge of antibiotics with many unaware of the term AMS [20, 21]. Only 63% of undergraduate nursing programmes include AMS teaching with only 12% reported to include all AMS principles [23]. This lack of integration has been cited as a factor that can limit nurses' knowledge of AMR and subsequent engagement in AMS implementation [24,25, 26, 9, 14]

The Standards of Proficiency for registered nurses [Nursing and Midwifery Council [27] (the nursing regulatory body in the UK) stipulate the skills, knowledge and attributes all nurses must demonstrate to be registered to practise in the UK. These standards are the same regardless of nursing field and whether pre-registration programmes are at degree or master's level. They highlight that nurses must protect health through understanding and applying AMS knowledge and skills. In response to this standard, an international competency framework designed to address the spectrum of AMS activities in which nurses are involved, has been established [9].The framework, which was informed by other available stewardship frameworks, has been endorsed by the National Institute for Health and Care Excellence (National Institute for Health and Care Excellence (NICE) [28], and comprises six key domains (infection prevention and control (IPC), antimicrobials and antimicrobial resistance, the diagnosis of infection and use of antibiotics, antimicrobial prescribing practice, person-centred care (PCC), interprofessional collaborative practice (ICP)). These domains represent the knowledge, skills, attitudes, and values that shape the judgements essential for AMS. Each domain comprises a number of competency descriptors (63 in total) designed to reflect the level of experience of the learner and type of practice setting, essential for AMS practice [29]. This research study was undertaken to explore the delivery of key AMS competencies within pre-registration nursing programmes which meet the 2018 Standards [27], with a view to identifying any gaps in content delivered, or areas for improvement.

METHODS
Ethical considerations

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The School of Healthcare Sciences, Cardiff University, provided ethical approval for the study (Reference number REC 779)

Survey instrument
A cross-sectional survey design was adopted for this research. The survey instrument was informed by research by Castro-Sanchez et al [23]. As in the survey by Castro-Sanchez et al [23], we collected information on the level of academic award (i.e. degree or masters level), the presence of AMS competencies in course curriculum; professional background of lecturers in AMS sessions, mode of content delivery i.e. online learning, blended learning (classroom and on-line activities) or face-to-face taught sessions, teaching/learning strategies employed in AMS sessions (lectures, case studies, student presentations, activities in clinical settings, problem based learning, e-learning); estimated number of hours apportioned to AMS teaching; methods used to assess learners knowledge, types and methods of assessment (i.e. formative or summative), arrangements for multidisciplinary learning, changes in teaching in response to the development of AMS competencies, whether the pandemic had affected AMS teaching, and whether AMS is given priority within curricula and influences on its inclusion. The survey was delivered via Online Survey —a tool for creating web surveys.

Recruitment procedure
All universities (n=72) in the UK delivering pre-registration nursing programmes were identified from the 2020 Universities and Colleges Admissions Service (UCAS) list. The chief executive in each nursing department was identified via the university website and approached by email to invite participation and to nominate the member of staff best placed to complete the survey (i.e. involved in teaching AMS). Nominated staff representing 40 universities expressed an interest to participate. These staff were informed about the purpose of the study via email and sent a participant information sheet. Representatives from 35 universities agreed to take part. These representatives became known as the Nurses Antimicrobial Stewardship Group (NAG). All NAG members were invited to a 1 hour Zoom meeting. The aim of this meetings was to describe the competency framework, and review the survey instrument with regards to content validity and usability.

During the data collection period, two further meetings took place between NAG members and the researchers. The aim of these meetings was to provide a forum in which any issues or difficulties NAG members might have experienced completing the survey instrument could be discussed. Outcomes of these discussions included 1) the use of a data collection template (developed by one NAG member with agreement to be used by others) sent out to module leaders by NAG members to gather evidence of competencies 2) the need for NAG members to identify essential AMS knowledge associated with the skill reflected in descriptors, 3) the need for NAG members to map competencies across the whole programme as opposed to individual nursing fields, and 4) the requirement to complete the survey based on the competencies currently evident in programmes. Each meeting was recorded and a link to the recording sent to participants following each meeting. Completion of the survey instrument implied consent to participate. Data was collected between March and June 2021.

Data analysis
Descriptive statistics were provided via on-line surveys. Content analysis [30], used to analyse free text comments, was undertaken to further explore qualitative findings. This process involved initial identification of commonly occurring themes, representing the range of responses. Themes were then broken down into mutually exclusive and exhaustive categories, and responses were assigned to

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categories and coded. The frequency of different responses was then counted. This process was performed manually.

RESULTS

Degree or masters level programme
Of the 35 responses, 27 (78%) respondents reported programmes to be at degree level, and the remainder (8 or 22%) reported programmes to be at both degree and masters level.

Antimicrobial stewardship competencies in course curriculum
Table 1 describes the competency descriptors included within pre-registration programmes. There was variation across programmes with regards to the extent these descriptors were included within programmes. Furthermore, although high numbers of respondents indicated the presence of competency descriptors from Domains one (IPC), Domain five (PCC), and Domain six (ICP), fewer respondents indicated the presence of descriptors from Domain two (Antimicrobials and antimicrobial resistance), Domain three (The diagnosis of infection and the use of antibiotics), and Domain four (Antimicrobial prescribing practice). For example, only 17 (51.5%) respondents reported the descriptor 'Describe how to recognize the appropriate response to antimicrobial treatment and the main signs that demonstrate antimicrobial failures' (Domain two) to be included within programmes. The descriptors '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 three) was reported as included by only 12 (37.5%) respondents. Only eleven (34.4%) respondents indicated 'Describe the difference between empiric, targeted and prophylactic antimicrobial therapy' (Domain four) to be evident within curricula.

Background of lecturers delivering AMS
Of the 32 participants who responded to this question, all reported the background of lecturers to be nurses. Eight (25%) of these respondents also reported the background of lecturers to include pharmacists; 1 (3.1%) to be a doctor, and 11 (34.4%) to be infection specialists. Three respondents (9.4%) also reported lectureres had 'other' backgrounds. Free text comments indicated backgrounds to include clinical nurse specialist (n=2), physiology/bioscience lecturer (n=1), anaesthesia associate/biomedical scientist operating department practiioner (n=1), bioscientist/microbiologist (n=1).

Main mode of AMS content delivery
Of the 33 participants who responded, blended learning was reported to be the main mode of content delivery by 30 (90.9%) respondents. Ten (33.3%) reported the main mode to be on-line learning, with face-to-face teaching reported as the main delivery mode by 6 (18.2%) respondents.

Strategies used to deliver AMS content
Thirty two (97.0%) of the 33 participants who responded, identifed lectures as the strategy used to deliver AMS content. Other strategies included case studies and e-learning each reported by 27 (81.8%) respondents, activities in the clinical setting, indicated by 26 (78.8%) respondents, simulation or other virtual environment (reported by 21 respondents or 63.6%), problem based learning (indicated by 15 or 45.4%), and student presentations, reported by 6 respondents (18.2%). Other strategies were described by 4 (12.1%), respondents. Free text comments indicated these strategies to include evidence based learning i.e. the use of scenarios which develop and become more complex over time (n=1), tutorials i.e. group work and feedback (n=1), guided work books (n=1), e-learning lectures (n=1), panopto videos and self-directed learning with links to key websites and literature (n=1), Vivox poll or quiz to check student learning, becoming an antimicrobial guardian (n=1)..

The number of hours over in which AMS content is delivered

AMS content was reported to be delivered within 5 hrs by 6 (20%) of the thirty participants who responded. Three (10%) respondents indicated that this content was delivered in more than 30 hrs (see Table 2 for a full description of time spent teaching AMS content)

Type of assessments formative (informal) or summative (formal)
The majority of respondents (25 or 83.3%) out of the thirty responses, reported that a mixture of summative and formative assessments were used to assess learners' knowledge. Two (6.7%) respondents reported the use of summative assessments only. Three (10%) used formative assessments only.

Methods used to assess learners knowledge about AMS content
Of the 30 participants who responded, multiple choice questions (MCQs) was the method used by most respondents (i.e. 17 or 58.6%) to assess learners knowledge. Objective structured clinical examination (OSCE's) were reported to be used by 12 (41.4%) respondents, essays by 11 (37.9%) respondents, student portfolios and short answer examination each by 9 (31%) respondents, student presentations (4 or 13.8%) and long answer examination (2 or 6.9%). Other methods identified from free text comments included end of session questionnaire (n=1), case study (n=1), class discussion and simulation (n=1), script concordance testing (n=1), face to face Q &A (n=1), clinical skills.net test and care plans (n=1), group work/simulation (n=1), handbook completed by student during the course of learning (n=1), SNAP assessment (n=1). Three respondents reported that knowledge was not assessed.

Shared learning with other healthcare professional students
Only 5 (16.1%) of the 31 participants who responded, indicated that AMS learning was shared with other healthcare professional students, with the remainder of participants (26 or 83.9%) indicating that this learning was not shared.

Increased AMS knowledge taught in response to AMS competencies
Over half of the 31 participants who responded (17 or 54.8%) to this question indicated that they had increased the AMS knowledge taught in programmes in response to the AMS competencies.

Plan to increase AMS knowledge taught in response to AMS competencies
Of the 32 participants who responded, 29 (90.6%) indicated that they planned to increase the AMS knowledge taught.

Effects of COVID-19 on AMS teaching within the six domains
The pandemic was reported to have affected each of the six domains with regards to AMS teaching (see Table 3). Of the 32 participants who responded, over half of the sample (21 or 65.6%) indicated that it had affected Domain one teaching. Free text comments indicated that these affects had been a change in delivery methods with a move to on-line learning (n=6), and blended learning (n=2), increased IPC knowledge (n=2), increased covid specific preparation (including hand hygiene, personal protective equipment (PPE), and immunisation theory) (n=8) prior to practice placements, greater simulation and IPE (n=1).

Eight (25%) respondents indicated that the pandemic had not affected the content of AMS teaching.

Priority given to AMS within pre-registration programmes
Of the 33 participants who responded, 23 (69.7%) reported that AMS was not given prioirty in pre-registration programmes. Influences on inclusion of competencies identified from free text comments included; new NMC standards (n=5), increasing AMR (n=4), AMS competencies (n=2), the motivation

of staff (n-4), local /national policy and guidelines (n=2), COVID 19 (n=3), the inclusion of prescribing knowledge in NMC standards (n=2) , time available (n=1), expertise of teaching team (n=2)

DISCUSSION
Statement of principle findings
This is the first national study to investigate the delivery of AMS competencies specifically within pre-registration nurse education programmes in the United Kingdom (UK). The findings represent 35 out of a possible 72 universities offering pre-registration nurse education and delivering the 2018 NMC Standards [27], with a responsibility to educate an estimated 12250 nurses annually. Although knowledge from each of the six domains representing AMS are included within programmes, this knowledge is inconsistent across programmes, with IPC, PCC, and ICP, taking precedent over the domains specifically pertaining to the use, management and monitoring of antimicrobials. Nearly all respondents reported they had increased, or planned to increase, AMS knowledge taught, in response to AMS competencies. On-line learning and IPC teaching (including greater covid specific preparation) was reported to have increased during the pandemic.

Comparison with other studies
Nineteen (63.4%) respondents devoted 11 or more hours to teaching AMS. This is higher than the median of 10 hours previously reported [23]. Blended learning was the main mode of content delivery, with on-line activities increasing during the pandemic. AMS is an interprofessional activity [31-32] with the need for a shared understanding about antimicrobial treatment decisions, plans, and expected therapy outcomes [33]. Interprofessional education is an expectation of pre-registration programmes [34], the learning environment enabling nurses to build competence to practice collaboratively. With many nursing students now undertaking practice learning in a simulated environment [35], the need to develop interprofessional skills is heightened. However, only 16% of respondents reported that students shared taught learning with other healthcare professional groups. Furthermore, although problem-based learning (PBL), with students set online materials to study, and then discuss in interprofessional groups, can be used as an opportunity to develop interprofessional skills [36], and enhance teamwork, [37], only 45% of respondents reported the use of PBL, with lectures and case studies cited as the main strategies used to deliver AMS content. This underutilisation of PBL was perhaps as a result of the speed in which face-to-face, synchronous classes needed to be converted to asynchronous learning at the beginning of the pandemic, with little time left for new AMS teaching development through interprofessional collaboration [38]. Only small numbers of respondents reported the professional background of lecturers to be from professions other than nursing. This lack of exposure to lecturers from multidisciplinary backgrounds, may also have had a negative influence on interprofessional working.

The COVID-19 pandemic was reported to have affected teaching across each of the six AMS domains, with free text comments indicating these effects to be within the theme IPC, including increased covid specific preparation (including hand hygiene, PPE, and immunisation theory). Given that the background of lecturers were predominantly nurses, and IPC is an area in which nurses have well defined and accepted roles and are leading IPC services [39], this could have been because they felt more comfortable teaching this knowledge. Had greater numbers of lecturers been from other professional backgrounds, this may have affected the knowledge taught in other domains. Most respondents reported that AMS was not given priority within curricula, with free text comments highlighting NMC standards, increasing AMR and the motivation of staff as important influences.

Meaning of the study : Possible explanations/implications

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Student nurses receive inconsistent stewardship education. Standardising this education with a greater focus on domains specifically pertaining to the use, management and monitoring of antimicrobials, would help to strengthen AMS in pre-registration programmes and be likely to influence more evidence based clinical practice. The increase in on-line learning seen during the COVID-19 pandemic, and also a move towards the simulated environment to replace practice hours, may change once the pandemic is over. However, it will be interesting to see how AMS content is delivered over the coming years, as it is important that learning environments enable student to develop skills to practice collaboratively. This may mean adopting a problem based approach and sharing learning with other healthcare professional students. Assessment methods also need to be able to assess these skills. Although on-line learning may help to overcome some of the difficulties associated with teaching large multi-professional groups (such as the need for large lecture rooms), the organisation of such learning will still remain complex if attempted on a large scale. Much will depend upon who the other healthcare professional students are, and how it is done. It may be better to make interprofessional collaboration a focus of practice placements, however, staff resources and therefore time can act as a barrier to such collaboration [40]. Exposing students more frequently to lecturers with backgrounds other than nursing, may also have a positive influence on interprofessional working, as this will ensure that the teaching of AMS is covered from multiple professional viewpoints. However, unless AMS activity is seen as a priority, healthcare professionals are perhaps unlikely to get involved in its teaching [40].

Given the importance of AMS, it will be important to repeat the study post-pandemic once all universities in the UK have adopted the 2018 Standards [27] and have become more confident delivering material about AMS, and, where restrictions and time pressures experienced during the pandemic, do not dictate the development of teaching material. The participative approach adopted by this research may help to increase participation from other UK universities delivering pre-registration nursing programmes and help to generate interest in AMS teaching. It would also be useful to assess self-reported preparedness, among final-year nursing students, to engage in AMS activities. Repeating the study in schools of nursing in other countries will enable continuous improvement in the stewardship effort at a global level. It would also be useful to repeat the study to investigate the delivery of key AMS competencies within Nurse Associate programmes.

Strengths and weaknesses
At the time of this study, new NMC Standards of proficiency for registered nurses had been published for three years. We collected data from pre-registration programmes who were delivering the updated curriculum. At least one university that we know of, were unable to contribute to the survey as the new curriculum did not start until Sept 2021. Many centres were in year 1 and/or 2 of the programme and so as a result, data for the final year, where material is likely to be related to some of the more advanced competencies taught, may be incomplete and account for some of the apparently low coverage identified. However, the participatory nature of our research brought the academic community together, raising awareness of AMS in pre-registration programmes. The majority of participants increased or planned to increase AMS knowledge taught, therefore enhancing the impact of AMS education and improving clinical practice.

Thirty-five (49%) of the 72 universities offering pre-registration nursing programmes in the UK participated in the survey. The sample appears representative of pre-registration programmes more generally. Those participating were drawn from all regions of UK countries and are typical in terms of number of students recruited and academic staff employed. As all pre-registration nursing programmes must comply with the same tightly-controlled standards set by the NMC, little scope for variation in entry requirements, clinical and academic standards or overall teaching hours exists between institutions.

It is likely that those who participated included centres where staff were interested in the study and confident of teaching in relation to AMR. Furthermore, participants were answering survey questions with regards to their own centre. This may have influenced responses. Although we were dependent upon the responses of one individual from each organisation, information was gathered by participants from module leaders using a data collection template. This helped to validate responses. Participation may also have been influenced by the availability of resources (including staffing levels) and the impact of the pandemic. These factors are likely to have had an impact on the ability to plan and deliver teaching, and for staff to find time to complete the survey, introducing bias.

The style of questions in our survey did not adopt forced-response conditions (i.e., whereby participants are unable to proceed to the next question unless they respond). This condition has been reported to have a lower response rate than non-forced conditions [41] and increase survey dropouts [42]. As such, and with all survey research, the self-report information collected, was therefore based on individual effort and knowledge by respondents of their programme. Although some of the questions were answered by slightly fewer than the 35 respondents, the majority of respondents responded to most of the questions with a good overall response rate.

A final limitation is that this study benchmarks institutions and programmes against a given set of competencies, which although endorsed and scientifically developed, may not be the only set to consider

CONCLUSION

AMS competencies are evident within pre-registration programmes however, there is a need to ensure consistency in AMS education across programmes, and greater knowledge pertaining to the use, management and monitoring of antimicrobials should be included. Programmes need to adopt teaching strategies and methods that allow nurses to practice collaboratively, enabling a shared understanding of antimicrobial treatment plans, decisions and outcomes. Exposing students to lecturers with backgrounds other than nurses, may well have a positive influence on content and interprofessional working. A variety of resources are available that could be used in users in these resources will also contributes to improved quality of care and effective health services. nurses to build competence in AMS to practice collaboratively. The active involvement and engagement of service

APPENDIX ONE
NAG Co-authors [5]
Dawn Hennefer, University of Salford
Clare Liptrott, University of Salford
Daniel Cooper, Liverpool John Moore University
Emma Johnston Smith, Liverpool John Moore University
Rebecca Craig, University of Brighton
Gemma Halewood Muse, Gemma Halewood-Muse, De Montfort University
Peter Aires, De Montfort University
Jonathan Hinkin, Swansea University
Alex Holmes, University of South Wales
Val Ness, Glasgow Caledonian University –
Clair Merriman, Oxford Brookes University
Lorraine Whatley, Oxford Brookes University
Sarah Beresford, University of Lincoln
Jennifer Bate, Staffordshire University-

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Tracey Jones, University of Chester
Kate Morrow, University of Hertfordshire
Paul Evans, Birmingham City University
Sharon McLeod, Birmingham City University
J. Claire Sevenoaks, University of Greenwich
Stephanie Manning, University of Nottingham
Rebecca Cooper, University of Nottingham
Lorraine Whatley, Oxford Brookes University
Sarah O'Reilly, University of York
Emily Ellis, Edge Hill University
Andrew Nichols, Plymouth University
Debbie Fallon, Manchester University
Bernard Ojiambo Okeah, Bangor University
Jaci Huws, Bangor University
Angela Hale, Manchester Metropolitan University
Liz Underhill, University of Hull
Alison Buckley, University of Cumbria
Fay Codona, University of Cumbria
Jane Turner, Derby University
Suzanne Monks, Sheffield Hallam University

CONFLICT OF INTEREST STATEMENT

REFERENCES

1. CDDEP. State of the World's Antibiotics, 2015.Washington, D.C. CDDEP,2015.Google Scholar
2. WHO. Report on surveillance of antibiotic consumption, 2019a. Available at; https://www.who.int/medicines/areas/rationaluse/oms-amr-amc-report-2016-2018/en/Google Scholar (last accessed July 2021)
3. Llor C, Bjerrum L. Antimicrobial resistance: risk associated with antibiotic overuse and initiatives to reduce the problem. Ther Adv Drug Saf. 2014 Dec;5(6):229-41. doi: 10.1177/2042098614554919. PMID: 25436105; PMCID: PMC4232501.
4. Strathdee SA, Davies SC, Marcelin JR. Confronting antimicrobial resistance beyond the COVID-19 pandemic and the 2020 US election. Lancet 2020; vol 396 October 10. https://doi.org/10.1016/ S0140-6736(20)32063-8
5. O'Neill, J. (2016) The review on Antimicrobial Resistance. Tackling Drug-Resistant Infections Globally: Final Report and Recommendations 2016; Available at https://amr-review.org/sites/default/files/160525_Final%20paper_with%20cover.pdf (last accessed July 2021)
6. Plackett B. Why big pharma has abandoned antibiotics. *Nature 202.* 586, S50-S52 (2020)

7. Okeah BO, Morrison V, Huws JC. Antimicrobial stewardship and infection prevention interventions targeting healthcare- associated Clostridioides difficile and carbapenem-resistant Klebsiella pneumoniae infections: a scoping review. BMJ Open 2021;11:e051983. doi:10.1136/bmjopen-2021-051983]
8. Dyar OJ, Huttner B, Schouten J, *et al.* What is antimicrobial stewardship? Clin Microbiol Infect 2017;23(11):793–798.
9. Courtenay, M., Lim, R., Castro-Sanchez, E., Hodson, K., Morris, G. et al. Development of consensus based international antimicrobial stewardship competencies for undergraduate nurse education. Journal of Hospital Infection. 2019a; 103(3), pp. 244-250. (
10. Courtenay M, Burnett E, Castro-Sanchez E, Du Toit B, Figueiredo R, Gallagher R, Gotterson F, Kennedy H, Manias E, McEwen J, Ness V, Padoveze MC. Preparing nurses for COVID-19 response efforts through involvement in antimicrobial stewardship programmes. J Hosp Infect. 2020 Sep; 106(1): 176–178

11. American Association of Nurses (AANs). White Paper: Redefining the antibiotic stewardship team: Recommendations from the AANs/Centers for Disease Control (CDC) and Prevention workgroup on the role of registered nurses in hospital antibiotic stewardship practices. Available at: https://www.cdc.gov/antibiotic-use/healthcare/pdfs/ANA-CDC-whitepaper.pdf (last accessed July 2021)
12. Courtenay M, Rowbotham S, Peters S, Yates K, Chater A. Examining the influences on antibiotic prescribing by nurse and pharmacist prescribers: A qualitative study using the Theoretical Domains Framework and COM-B. BMJ Open 2019b; 9;9(6):e029177. doi: 10.1136/bmjopen-2019-029177.
13. Courtenay M, Lim R, Deslandes R, Ferriday R, Gillespie D, Hodson K, et al A theory-based electronic learning intervention to support appropriate antibiotic prescribing by nurses and pharmacists: intervention development and feasibility study protocol. BMJ Open 2019c; 9(8); 2019
14. WHO. Competency Framework for health workers' education and training on antimicrobial resistance. Geneva: World Health Organization, 2019b. Available in: http://apps.who.int/medicinedocs/documents/s23443en/s23443en.pdf (last accessed July 2021)

15. European Commission. EU Guidelines for the prudent use of antimicrobials in human health 2017; Available at: https://ec.europa.eu/health/amr/sites/amr/files/amr_guidelines_prudent_use_en.pdf. (last accessed July 2021)
16. EFN. Nurses are frontline combating antimicrobial resistance. Available at ;http://www.efnweb.be/wp-content/uploads/EFN-AMR-Report-Nurses-are-frontline-combating-AMR-07-11-2017.pdf (last accessed July 2021)
17. HM Government. *Tackling antimicrobial resistance 2019–2024 The UK's five-year national action plan 2019;*. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/784894/UK_AMR_5_year_national_action_plan.pdf (last accessed July 2021)
18. HM Government. *Contained and controlled. The UK 20-year vision for antimicrobial resistance How the UK will contribute to containing and controlling antimicrobial resistance (AMR) by 2040 2019;* Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/773065/uk-20-year-vision-for-antimicrobial-resistance.pdf (last accessed July 2021)
19. Olans RN, Olans RD, DeMaria A. The Critical Role of the Staff Nurse in Antimicrobial Stewardship--Unrecognized, but Already Clin Infect Dis 2016;1;62(1):84-9
20. McEwen J, Burnett E. Antimicrobial stewardship and pre- registration student nurses: Evaluation of teaching. J Infect Prev 2019 Mar;19 (2):80-86
21. McGregor W, Walker G, Bayne G, McEwen J. Assessing knowledge of antimicrobial stewardship. Nursing Times 2015; 111: 15–17.
22. Mostaghim M, Snelling T, McMullan B, Konecny P, Bond S, Adhikari S, et al. Nurses are underutilised in antimicrobial stewardship – results of a multisite survey in paediatric and adult hospitals. Infection, Disease and Health 2017; 22(2): 57-64
23. Castro-Sánchez E, Drumright LN, Gharbi M, Farrell S, Holmes AH. Mapping Antimicrobial Stewardship in Undergraduate Medical, Dental, Pharmacy, Nursing and Veterinary Education in the United Kingdom. PLoS ONE 2016;11(2): e0150056. doi:10.1371/journal.pone.0150056
24. Abbas S, Lee K, Pakyz A, Markely D, Cooper K, Vanhoozer G, Doll M, Bearman G, Stevens MP. Knowledge, attitudes, and practices of bedside nursing staff regarding antibiotic stewardship: A cross-sectional study**.** Am J infect Control 2018; 47(3):230-233.

25. Padigos J, Ritchie S, & Lim A G. Enhancing nurses' future role in antimicrobial stewardship. Collegian 2020. Available at: https://doi.org/10.1016/j.colegn.2020.01.005 (last accessed July 2021)
26. Kirby E, Broom A, Overton K, Kenny K, Post JJ, Broom, J. Reconsidering the nursing role in antimicrobial stewardship: a multisite qualitative interview study. BMJ Open 2020. Available at 10.1136/bmjopen-2020-042321 (last accessed July 2021)
27. NMC. (2018). Standards for prescribing programmes. London, UK: NMC.
28. NICE. Being antibiotic aware. Available here; https://www.cardiff.ac.uk/healthcare-sciences/research/publications/being-antibiotic-aware (last accessed July 2021)
29. Courtenay, M. and Castro-Sanchez, E. eds. 2020. Antimicrobial stewardship for nursing practice. CABI.
30. Braun V, Clarke V. . Using thematic analysis in psychology. Qualitative research in psychology 2006;**3**:77–101.
31. Fishman N. Antimicrobial stewardship. American Journal of Infection Control 2006*,* 34(5 suppl 1), S55-S63
32. Doron S, Davidson LE. Antimicrobial stewardship.Mayo Clin Proc.2011; 86(11):1113-23
33. Gerding DN. The search for good antimicrobial stewardship. Jt Comm J Qual Improv 2001; 27(8):403-404

34. Health Education and Improvement Wales. NHS Wales Shared Services Partnership: Invitation to tender (2020). Available at https://bidstats.uk/tenders/2020/W47/739049521 (last accessed July 2021)

35. NMC. Nmc-introduces-new-recovery-standard-offering-simulated-learning-to-students-covid-19-180221. Available at https://www.rcn.org.uk/news-and-events/news/uk-nmc-introduces-new-recovery-standard-offering-simulated-learning-to-students-covid-19-180221 (last accessed July 2021)

36. Tobie A, Jones Graciela V, & Taylor C. Interprofessional education during the COVID-19 pandemic: finding the good in a bad situation. Journal of Interprofessional Care 2020; 34, Issue 5

37. Nancarrow SA, Booth A, Ariss S, Smith T, Endreby P, Roots A. Ten principles of good interdisciplinary team work. Hum Resour Health 2013; 11: 19. doi: 10.1186/1478-4491-11-19

38. Dhawan S. (2020). Online Learning: A Panacea in the Time of COVID-19 Crisis. *Journal of Educational Technology Systems*, *49*(1), 5–22. https://doi.org/10.1177/0047239520934018

39. DoH. The UK's 5 year antimicrobial resistance strategy. DoH 2013: London

40. Currie K, Laidlaw R., Ness V. *et al.* Mechanisms affecting the implementation of a national antimicrobial stewardship programme; multi-professional perspectives explained using normalisation process theory. *Antimicrob Resist Infect Control 2020* 9,99 https://doi.org/10.1186/s13756-020-00767-w

41. Derouvray C, & Couper MP. Designing a strategy for reducing "no opinion" responses in web-based surveys. Social science computer review 2002, 20(3), 3-9.

42. Stieger S; Reips UD, & Varocek M. Forcedresponse in online surveys: Bias from reactance and an increase in sex-specific dropout. Journal of the American society for information science and technology 2007, 58(11), 1653-1660.

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Table 1: AMS descriptors included within programs

Domains: Competency statements and descriptors	n (%) of universities
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.	
1. Describing what a micro-organism is	31 **(93.9)**
2. Describing the different types of organisms that may cause infections	31 (93.9)
3. Explaining what an antimicrobial resistant organism is	31 (93.9)
4. Explaining the 'Chain of Infection'.	32 (97)
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).	33 (100)
6. Describing the routes of transmission of infectious organisms i.e., contact, droplet, airborne routes.	31 (93.9)
7. Present and recognize the characteristics of a susceptible host.	31 (93.9)
8. Demonstrate an understanding of the importance of surveillance.	24 (72.7)
9. Describe how vaccines can prevent infections in susceptible persons.	25 (75.8)
10. Demonstrate the application of standard precautions in healthcare environments.	33 (100)
11. Apply appropriate policies/procedures and guidelines when collecting and handling specimens.	29 (87.9)
12. Apply policies, procedures and guidelines relevant to infection control when presented with infection prevention and control cases and situations.	30 (90.9)
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).	29 (87.9)
14. Appreciate that healthcare workers have the accountability and obligation to follow infection prevention and control protocols as part of their contract of employment.	32 (97)
15. Act as a role model to healthcare workers and members of the public by adhering to infection prevention and control principles.	30 (90.9)
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	24 (72.7)
17. Understanding the role of the environment in optimal infection prevention and control practices including hand hygiene and environmental cleaning	30 (90.9)
18. Enabling infection prevention and control self-care for patients and family'	27 (81.8)
Total number of responses n=33 universities	

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.

1. Recognise the signs and symptoms of infection	32 (97)
2. Discuss how inappropriate antimicrobial use (including non-adherence to treatment regime) may lead to antimicrobial resistance	25 (75.8)
3. Identify approaches to support optimal prescribing of antimicrobials	20 (60.6)
4. Recognise the importance of adequate specimen collection during relevant stages of antimicrobial use (i.e. prior/during antibiotic treatment)	22 (66.7)
5. Describe how to recognize the appropriate response to antimicrobial treatment and the main signs that demonstrate antimicrobial failures	17 (51.5)
Total number of responses n=33 universities	

DOMAIN THREEE: 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.

1. Explain how microbiology samples may aid diagnosis of infection	27 (84.4)
2. Describe how and demonstrate (following local procedures) the appropriate taking of samples	26 (81.3)
3. Interpret microbiology results/reports from the laboratory at a basic level	20 (62.5)
4. Explain why self-limiting bacterial or viral infections are unlikely to benefit from antimicrobials	23 (71.9)
5. Describe and demonstrate the self-management strategies required to treat self-limiting infections (i.e. analgesia /rest /fluids)	20 (62.5)
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	21 (65.6)
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	20 (62.5)
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)	18 (56.3)
9. Describe broad spectrum and narrow spectrum antimicrobials and the contribution of broad spectrum antimicrobials to AMR	19 (59.4)
10. Present and be able to recognise the common side effects associated with commonly administered antimicrobials	20 (62.5)
11. Demonstrate an understanding of why documenting a patient allergy to an antimicrobial is important	20 (62.5)
12. Explain why it is important to consider certain physiological conditions (such as renal function) in patients who receive an antimicrobial	21 (65.6)

13. Describe what is meant by delayed prescribing	12 (37.5)
14. Explain why it is essential that an accurate diagnosis of an allergy to an antimicrobial is based on history and laboratory tests.	18 (56.3)
15. Demonstrate an understanding of the role of the nurse regarding quality and safety of antibiotic prescriptions	19 (59.4)
16. Demonstrate an awareness of laboratory results (i.e. culture and sensitivity) that demand prompt intervention)	18 (56.3)
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	12 (37.5)
Total number of responses n=32 universities	

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:

1. Explain how you would recognise and manage sepsis	31 (96.8)
2. Describe why it is important to use local guidelines to initiate prompt effective antimicrobial treatment in patients with life threatening infections	26 (81.3)
3. Describe why it is important to switch from intravenous antimicrobials to oral therapy	21 (65.6)
4. Describe how to switch from IV antimicrobials to oral therapy	18 (56.3)
5. Understand the appropriateness of antimicrobial administration models such as outpatient parenteral antimicrobial therapy (OPAT)	12 (37.5)
6. Demonstrate an understanding of the rationale and use of perioperative prophylactic antimicrobials to prevent surgical site infection	13 (40.6)
7. Discuss factors that can influence antimicrobial prescribing and the implications for antimicrobial stewardship programmes	17 (53.1)
8. Describe the national guidance on completion of a course of antimicrobials	18 (56.3)
9. Explain how you would identify the medicines with which antimicrobials can interact and why this is important	16 (50.0)
10. Describe the difference between empiric, targeted and prophylactic antimicrobial therapy	11 (34.4)
Total number of responses n=32 universities	

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

1. Support participation of patients/carers, as integral partners when planning/delivering their care.	30 (93.8)
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.	30 (93.8)

3. Ensure that appropriate education and support is provided by learners to patients/carers, and others involved with their care or service	29 (90.6)
4. Listen respectfully to the expressed needs of all parties in shaping and delivering care or services.	30 (93.8)
5. Discuss patient/carer expectations or demands of antimicrobials and the need to use antimicrobials appropriately.	25 (78.1)
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	21 (65.6)
7. Recognize patients and families who require support to complete a course of antimicrobial therapy.	20 (62.5)
Total number of responses n=32 universities	
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.	
1. Demonstrate an understanding of the roles, responsibilities, and competencies of other health professionals involved in antimicrobial treatment policy decisions	20 (64.5)
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	18 (58.1)
3. Establish collaborative communication principles and actively listen to other professionals and patients/carer involved in the delivery of antimicrobial therapy	19 (61.3)
4. Communicate effectively to ensure common understanding of care decisions	30 (96.8)
5. Develop trusting relationships with patients /carer and other health/social care professionals	31 (100)
6. Effectively use information and communication technology to improve interprofessional patient -centred care	29 (93.5)
Total number of responses n=31 universities	

Table 2: Time spent teaching AMS content per programme

Time (hours) spent teaching content	No. (%) of respondents
1-5	6 (20)
6-10	5 (16.7)
11-15	6 (20)
16-20	5 (16.7)
21-25	2 (6.7)
26-30	3 (10)
Over 30	3 (10)
	Total 30 (100%)

Table 3: Teaching of the AMS competency framework domains reported to be affected by Covid 19

Domain	No. (%) of respondents
Infection prevention and control	21 (65.6)
Antimicrobials and antimicrobial resistance	11 (34.4)
The diagnosis of infection and use of antibiotics	10 (31.3)
Antimicrobial prescribing practice	8 (25)
Patient centred care	8 (25)
Interprofessional collaborative practice	7 (21.9)
Total responses n= 32 universities	