

Embedding national antimicrobial prescribing and stewardship competences into curricula

A survey of health education institutions Full report



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A survey of health education institutions on the embedding of the national antimicrobial prescribing and stewardship competences into curricula

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Foreword

The antimicrobial prescribing and stewardship (AMPS) competences, produced jointly by the Government's expert advisory group for antimicrobial resistance and healthcare acquired infections (ARHAI) and Public Health England were published in 2013. Implementation of the competences forms a key aspect of Key area 3 of the UK Government's five year strategy for tackling antimicrobial resistance - improving professional education, training and public engagement to improve clinical practice and promote wider understanding of the need for more sustainable use of antimicrobials.

In 2014 the joint Public Health England and Health Education England AMPS Competencies Implementation subgroup was established to review the educational landscape and potential mechanisms through which the AMPS competencies could become embedded into continuous professional development and both undergraduate and postgraduate curricula. The subgroup provided a report of its findings and made recommendations to HEE in March 2015. The recommendations were made based on discussions from the three meetings, results of the survey and presentations made to the subgroup by key research programmes. Amongst these recommendations included surveying the undergraduate curricula, to inform HEE's four geography directors of education and quality of the variation with which AMPS principles are included within undergraduate curricula, citing the results of the Imperial College London undergraduate curricula survey.

The goal of these competencies is to improve the quality of antimicrobial treatment and stewardship therefore reducing the risks of inadequate, inappropriate and ill-effects of treatment. This will enhance the safety and quality of patient care and make a positive contribution to the reduction in the emergence and spread of antimicrobial resistance. These competences can also be used by regulators, education providers and professional bodies to inform standards, guidance and the development of training. For healthcare professionals, it is vital students transfer their undergraduate knowledge and skills into practice to be competent practitioners. As undergraduate students appear interested in receiving increased antimicrobial education linked to the multidisciplinary use of antimicrobials, we welcome findings from this initial survey and hope best practices can be shared between higher health education institutions to enhance the adoption of these competencies. The importance of non-medical prescribing courses adopting these competencies has been highlighted too.

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Executive summary

Background

The threat posed by antimicrobial resistance to the future of healthcare and modern medicine is widely recognised. Education of healthcare workers and students on rational infection control, antimicrobial prescribing and antimicrobial stewardship is a key part of antimicrobial resistance containment activities. Health Education England (HEE) is responsible for ensuring that our future workforce has the right numbers, skills, values, cultural sensitivities and behaviours to meet patients' needs and deliver high quality care. The antimicrobial prescribing and stewardship (AMPS) competences can provide clarity for regulators, education providers and professional bodies to inform standards, guidance and the development of training. The competences consist of five dimensions; infection prevention and control, antimicrobial resistance and antimicrobials, the prescribing of antimicrobials, antimicrobial stewardship and monitoring and learning.

Methodology

A gap analysis/self-assessment survey was sent through HEE local offices to health education institutions asking questions about how antimicrobial prescribing and stewardship competencies were being embedded into the undergraduate curricula of health care students. The survey was completed separately for each of the courses; medicine, adult nursing, dentistry, pharmacy, midwifery, independent prescribing courses and allied health professionals. Respondents were asked to name the responding health care courses; their awareness of the national AMPS competencies; which undergraduate or independent prescribing courses specifically include learning content to address the five dimensions of the AMPS competences; the main mode of antimicrobial resistance content delivery; and methods used to evaluate learners' knowledge about antimicrobial resistance content.

Results

We had responses from 45 universities who provided responses for 100 different health courses, including 17 medical, 13 pharmacy, 22 independent prescribing, 5 dental, 23 nursing, 13 midwifery and 7 allied health professional courses. 86 courses (86%) confirmed they were aware of these AMPS competencies. Overall implementation of each domain was as follows:

COMPETENCY	Dentistry	Pharmacy	Medicine	Midwifery	Nursing	Indep prescr	Allied Health
1: Infection prevention and control.	100%	98%	99%	85%	86%	72%	94%
2: Antimicrobial resistance and antimicrobials.	97%	100%	99%	59%	56%	75%	41%
3: Prescribing antimicrobials.	88%	81%	96%	41%	29%	90%	30%
4: Antimicrobial stewardship.	73%	77%	91%	51%	42%	77%	25%
5: Monitoring and learning	50%	48%	63%	23%	16%	68%	14%
Total average	82%	81%	90%	52%	46%	76%	41%

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Conclusion

We had an average response rate of 46% from all health education institutions, and more may need to be done to explore how and what the rest of the 54% have done to implement the AMPS competences. The average implementation rate for all universities and courses was 67% for all the dimensions. This may not be satisfactory for some courses, especially in relation to the levels of professional clinical practice expected from qualified professionals. HEE may have a role in raising awareness nationally through its local offices, individual professional schools councils, professional bodies, regulators and the royal colleges.

Recommendations

Recommendations for HEE

- Inform the four regional directors of education and quality, local teams, advisory groups and local deans of the variation with which antimicrobial prescribing and stewardship (AMPS) principles are included within curricula.
- Inform relevant bodies including The Medical Schools Council, Dental Schools Council, Pharmacy Schools Council, Council of Deans of Health, Health and Care Professions Council, professional bodies, professional regulators and the royal colleges of the variation with which AMS principles are included within curricula.
- Explore whether HEE's Standardised Computerised Revalidation Instrument for Prescribing and Therapeutics ([SCRIPT](#)) package could be made more widely available to support undergraduate teaching within the prescribing professions.
- Explore the role of antimicrobial resistance, antimicrobial stewardship, infection prevention and control and sepsis within the [prescribing simulator](#) training tool for all NHS doctors to practice their prescribing skills.
- Explore further the provision of educational resources and tools on infection prevention and control and antimicrobial resistance and stewardship, designed specifically for undergraduate training.
- Encourage wide publicity when undergraduate students are granted access to HEE's e-Learning for Health (eLfh) resources in 2017, especially those available around infection prevention and control and antimicrobial resistance and stewardship.
- Undertake scoping work to identify whether there are any gap areas in relation to educational resources available to support current prescribers with prescribing antimicrobials and, if necessary, make recommendations to address the gaps.
- Explore the feasibility of an individualised online formative assessment tool for health students and professionals to support learning on infection prevention and control and antimicrobial resistance and stewardship.

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Recommendations for other institutions and organisations

- The Medical Schools Council, Dental Schools Council, Pharmacy Schools Council, Council of Deans of Health and Health and Care Professions Council should share the findings of this survey with their members and discuss this at their executive committee meetings. Areas for improvements and promotion of best practices should be highlighted to universities represented on these bodies.
- Professional bodies, professional regulators and the royal colleges should take account of these findings, and consider making recommendations as part of their curricula reviews of health education institutions and postgraduate curricula. They should also explore the possibility including [antimicrobial prescribing and stewardship principles](#) in professional registration examinations.
- Public Health England (PHE), Advisory Committee on Antimicrobial Resistance and Healthcare Associated Infection (ARHAI) and English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) should discuss these findings and consider any gaps that need addressing, including the provision of adequate and effective education tools for undergraduate students, around infection prevention and control and antimicrobial resistance and stewardship.
- Universities should consider the results of this survey within their institutions, and use up to date [national guidance](#) and other resources on antimicrobial resistance and stewardship in their learning materials to teach undergraduate students.
- Clinical tutors and lecturers should be made aware of how and where to access the latest [national information](#) on principles around infection prevention and control, antimicrobial resistance and antimicrobial stewardship.
- All stakeholders should consider the importance of making students aware of how to recognise, and assess patients on the risk of developing antibiotic associated hypersensitivity reactions. An educational resource to support this learning for all health workers should be considered.
- The uptake of online learning resources around infection prevention and control and antimicrobial resistance and stewardship for undergraduate learning, should be encouraged and supported by the Medical Schools Council, Dental Schools Council, Pharmacy Schools Council, Council of Deans of Health and Health and Care Professions Council.
- All health universities should proactively raise awareness of issues around antimicrobial resistance, such as through national initiatives like the [European Antibiotic Awareness day](#) and [Antibiotic Guardian campaign](#). Clinical lecturers, tutors and students should all be encouraged to take the pledge of becoming antibiotic guardians. Information raising and sharing on antimicrobial resistance with local communities should be encouraged.
- Educational outreach by clinicians and health professionals to universities on infection prevention and control and antimicrobial stewardship should be encouraged. Local antimicrobial networks should consider building links with local health universities, and

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support any learning requirements that undergraduate students may have. This could be actioned locally through [sustainability and transformation plans \(STPs\)](#) with support from local workforce action boards (LWABs)

- The inclusion of members of the multidisciplinary team to support teaching and learning on infection prevention and control, antimicrobial resistance and stewardship. Interdisciplinary learning on this area should be encouraged.
- Providers, commissioners and local authorities should be reminded of their responsibilities in ensuring that training sites provide opportunities for trainee prescribers and undergraduates on clinical placements to develop the knowledge and skills around antimicrobial prescribing and stewardship expected from fully qualified practitioners, and ensuring that their qualified staff remain up to date. All clinical staff should receive education on antimicrobial resistance as part of mandatory training.

Introduction

Health Education England (HEE) is responsible for ensuring that our future workforce has the right numbers, skills, values, cultural sensitivities and behaviours to meet patients' needs and deliver high quality care. Our [mandate](#) expects us to work jointly with Public Health England (PHE) through the English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) oversight group to ensure that the competence and principles of prescribing medicines, including antimicrobials, as set out by the National Prescribing Centre (NPC) and the Antimicrobial Resistance and Healthcare Acquired Infection (ARHAI) advisory group are embedded in professional curricula. In addition, we will work with universities, commissioners and employers to ensure workforce capability, capacity and planning mitigates the risk of antimicrobial resistance as set out in the UK Antimicrobial Resistance strategy. We also agreed to take steps to ensure that training is also available so that healthcare staff are competent in the recognition of, and response to, acute illness such as sepsis as a key factor in preventable mortality ([DH 2015](#)).

HEE made a commitment to include infection control within all its funded courses, and will build clinical capability to deliver effective antimicrobial stewardship amongst the healthcare workforce. Amongst the ways to ensure that the workforce is competent to deliver effective antimicrobial stewardship is to improve the knowledge and understanding of AMR by: incorporating antimicrobial resistance awareness, responsible prescribing, dispensing and administration practice, as well as effective prevention, management and control of infection in undergraduate and postgraduate curricula for human medicine, nursing, pharmacy, dentistry and other professionals; embedding an appreciation of AMR issues and strategies for containing resistance in undergraduate courses; and improved education and training ([DH & DEFRA 2013](#)).

We agreed to ensure that generic prescribing competences are adopted and embedded in curricula and work on exploring and understanding how this has been done. We are co-operating with equivalent organisations in the devolved administrations, and we are leading improvement in the education and training of healthcare workers by helping strengthen curricula on antimicrobial resistance, responsible prescribing, infection prevention and control and develop exploring educational tools to support this ([DH & DEFRA 2013](#)).

Background

The threat antimicrobial resistance poses to the future of healthcare and modern medicine is widely recognised ([Davies 2011](#); [DH & DEFRA 2013](#) & [WHO 2014](#)).

The education of healthcare workers and medical students on rational infection control, antimicrobial prescribing and antimicrobial stewardship is a key part of antimicrobial resistance containment activities (Gauthier et al. 2015; Ghafur 2013; Vickers 2011 & [WHO 2012](#)). Despite

global awareness on the threats posed by AMR, the inadequacy in the global infection control knowledge and practice of health professional graduates has been highlighted which could impact patient safety and care (Cox, Simpson, Letts & Cavanagh 2014; Liu, Curtis & Crookes 2014). Cox et al. (2015) have stressed the importance of re-thinking the microbiology and infection control education of undergraduate health professionals to allow accurate risk perception and maximise self-efficacy, resulting in the development of competent, work-ready graduates who will contribute to lessening the burden of healthcare associated infections (HAIs) through improved infection prevention and control practice.

Studies have shown undergraduate students are very keen on receiving education on the appropriate use of antimicrobials and on antimicrobial resistance; and agree that knowledge of antimicrobials is important in their careers, as inappropriate use causes antimicrobial resistance that can harm patients (Abbo et al. 2013; Castro-Sánchez et al. 2014; Dyar et al. 2014 & Minen et al. 2010). This has led to calls that universities should be partners in the effort to reduce antimicrobial resistance and “steward” our valuable antimicrobials (Abbo et al. 2013). It has been previously raised that there is scarcity in data on the incorporation of antimicrobial stewardship in university curricula, and more needs to be done to improve knowledge and practice (Azevedo, Capela & Baltazar 2013 & Cox et al. 2014).

This was also highlighted by the Parliamentary Science and Technology Committee (2014), which raised the inadequacies in undergraduate education for microbiology, in particular antibiotic prescribing being relatively weak, and the enormous variability in the education provided in UK medical schools. Proposals included improvement in education and teaching, having core principles and the extension of antimicrobial teaching to pharmacists and nurses.

Educational interventions on prudent antimicrobial prescribing within undergraduate medical students have been of much earlier interest here in the UK (Davenport, Davey & Ker 2005). This was followed by calls for interdisciplinary collaboration on education between the professions involved in the management of infection including that for undergraduates (Davey & Garner 2007). Efforts have been made in the EU to develop a curriculum on antimicrobial resistance aimed at wider undergraduate health professionals relevant to community-acquired lower respiratory tract infections (Finch et al. 2012).

National antimicrobial prescribing and stewardship competencies

The multiprofessional antimicrobial prescribing and stewardship ([AMPS](#)) competences were developed by a multiprofessional group led by the Advisory Committee on Antimicrobial Resistance and Healthcare Associated Infection (ARHAI) of the Department of Health in England. These were designed to complement the generic competency framework for all prescribers from the National Institute for Health and Care Excellence ([NICE](#)) and National Prescribing Centre ([NPC](#)) and aimed all independent prescribers, including doctors, dentists

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and non-medical practitioners. The competences can provide clarity for regulators, education providers and professional bodies to inform standards, guidance and the development of training (Ashiru-Oredope et al. 2014). These competences have also been mentioned in the recently released competency framework for all prescribers (2016) that expect prescribers to understand antimicrobial resistance and the roles of infection prevention, control and antimicrobial stewardship measures.

The competences consist of five dimensions, each of which includes statements that describe the activity and outcomes that prescriber should be able to demonstrate.

The five dimensions consist of:

- (i) infection prevention and control—understanding the principles and demonstrate competence in preventing and controlling infections (five statements)
- (ii) antimicrobial resistance and antimicrobials—understanding the modes of action and spectrum of action of antimicrobials and the mechanisms of resistance (six statements)
- (iii) the prescribing of antimicrobials—understanding the key elements in prescribing appropriate antimicrobial agents for prophylaxis and treatment (eight statements)
- (iv) antimicrobial stewardship—demonstrating an understanding of antimicrobial stewardship in day-to-day practice (eight statements)
- (v) monitoring and learning—demonstrating continuing professional development in antimicrobial prescribing and stewardship (four statements).

Five Dimensions	No of Statements	Illustrative <u>example</u> of competency statements
1) Infection prevention and control: all independent prescribers must understand the principles and demonstrate competence in preventing and controlling infections	5 statements	Understand how current vaccines can benefit prescribing practices, including reducing the need for prescribing antimicrobials and decreasing resistant antimicrobial resistant strains e.g. of <i>S. pneumoniae</i> .
2) Antimicrobial resistance and antimicrobials: including modes of action and spectrum of activities of antimicrobials and the mechanisms of resistance	6 statements	Knowledgeable in the appropriate use of antimicrobial agents for: <ul style="list-style-type: none"> • prophylaxis to minimise the risk of infection • treatment of infections
3) Prescribing antimicrobials: including the key elements in prescribing appropriate antimicrobial agents for prophylaxis and treatment	8 statements	Competent in antimicrobial prescribing by demonstrating knowledge of when not to prescribe antimicrobials, and use of alternatives, such as the removal of invasive devices, e.g. intravenous or urinary catheters and incision and drainage of abscesses.
4) Antimicrobial stewardship: demonstrating an understanding and including antimicrobial stewardship in	8 statements	Demonstrate clinical competence and understand the importance of Appropriately choosing one of the five antimicrobial prescribing decisions 48 hours after initiating antimicrobial treatment (ARHAI)

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day to day practice		Guidance – Start Smart – then Focus
5) Monitoring and learning: all independent prescribers must demonstrate continuing professional development in antimicrobial prescribing and stewardship	4 statements	Demonstrate continuous professional development in antimicrobial stewardship by using locally agreed process measures of quality (e.g. compliance with guidance), outcome and balancing measures, such as unintended adverse events or complications.

Proposals were made to ESPAUR on how these generic competencies should be considered and evaluated by the various professional and allied professional groups interested in antimicrobial stewardship, for use in writing/reviewing their own more detailed competences. It was felt that to further support the UK Antimicrobial Resistance Strategy, it would be important to embed antimicrobial stewardship and the associated competences in the curricula and training of all healthcare professionals, to help them understand their individual contributions either as prescribers or as non-prescribers (Ashiru-Oredope et al 2014).

Methodology

We set out to understand how the antimicrobial prescribing and stewardship competencies were embedded into the undergraduate curricula of health care students. Health education institutions were invited to participate in a gap analysis/self-assessment survey, and were asked to let us know of any resources or examples of best practice that we could sign post to others to improve education in this area. The survey was completed separately for each of the courses namely medicine, adult nursing, dentistry, pharmacy, midwifery, independent prescribing courses and allied health professionals. This survey was devised by Dr Diane Ashiru-Oredope who was seconded to the role at HEE in 2015.

This survey ([link to SurveyMonkey](#)) was sent out via HEE local offices to cascade to heads of schools of health education institutions with the letter from PHE to universities co-signed by Ian Cumming, Chief Executive of HEE, Duncan Selbie, Chief Executive of Public Health England and the Chief Medical, Nursing, Pharmaceutical, Dental, Veterinary officers inviting them to participate and register their planned activities for World Antibiotic Awareness Week ([DH, 2015a](#)). In addition the PHE subgroup recommendation report to HEE (PHE 2015) and the work from Imperial College (Castro-Sánchez et al. 2014) was attached for reference and awareness. A response deadline was set and due to the limited number of responses received, we asked for this survey to be recirculated via individual schools councils to their membership. The survey was aimed at medical, dentistry, pharmacy, nursing, midwifery, allied health professionals, optometry and independent prescribing courses.

Respondents were asked about:

- Which health care courses they provided at their institutions and the course or courses they were providing answers for.

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- Their awareness of the national antimicrobial prescribing and stewardship competencies.
- Select which undergraduate or independent prescribing courses specifically include learning content to address the five dimensions of the AMPS competences.
- The main mode of antimicrobial resistance content delivery (e.g. online teaching, blended teaching (classroom and online activities), small group training, classroom based teaching, placements and other).
- Methods used to evaluate learners' knowledge about antimicrobial resistance content (e.g. essay, objective structured clinical examination (OSCE) stations, student presentations, student portfolio, short answer examination, long answer examination, multiple choice question examination and other).
- Approximately how many learning hours were assigned to antimicrobial resistance & infection prevention and control activities.
- Whether undergraduates from different professions learn any parts of the antimicrobial resistance and infection prevention and control content together.
- Any educational resources their institutions produced which could support general learning around antimicrobial resistance and stewardship e.g. as part of standalone courses/modules.
- Details of any other educational resources they were aware of which demonstrated embedding of some or all of the learning outcomes within the AMPS competencies into curricula or continued professional development (CPD) programmes.
- Any gaps in the resources available for education on antimicrobial prescribing, resistance and stewardship in undergraduate and postgraduate education and CPD. Details of any barriers that they believed exist to embedding the antimicrobial prescribing and stewardship competencies within undergraduate/post graduate curricula.
- Whether their institution provided training resources on recognition and treatment of sepsis.

Any further comments and thoughts from respondents were also welcomed.

Results

Quantitative results

We had responses from 45 universities providing 147 health related courses in England responding to this survey. A total of 100 course responses were submitted, and when compared to the total number of universities for each health related course in England, the responses received included 17 medical courses (65% of the total schools in England), 13 pharmacy courses (52% of the total schools in England), 22 independent prescribing courses (48% of the total schools in England), 5 dental courses (46% of the total schools in England), 24 nursing courses (42% of the total schools in England), 13 midwifery courses (25% of the total schools in England) and 7 allied health professional courses. When queried on their awareness of the

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national AMPS competencies, 86 courses (86%) confirmed they were aware of these competencies, 5 courses (5%) stated they were not aware of these competencies (one each from pharmacy, nursing, midwifery, independent prescribing and physiotherapy) whilst 9 courses (9%) did not specify an answer (3 allied health professions, 2 midwifery, 2 nursing and 2 independent prescribing).

1. Antimicrobial Stewardship and Prescribing Competencies in undergraduate curricula

Answers for each of the AMSP competency dimensions are as follows:

a. Infection prevention and control—understanding the principles and demonstrate competence in preventing and controlling infections (five statements).

The overall implementation was 91% for all the statements included in this domain for all health courses answered for.

The average for each of the statements across all health courses was as follows:

The nature and classification of pathogenic micro-organisms	92%
How micro-organisms cause infections in humans: the importance of understanding the differences between colonisation (e.g. of venous leg ulceration) and infection	91%
How micro-organisms are transmitted in both community and hospital settings.	94%
The principles and practice of the prevention and control of infection, and the need to have this reflected in individual job descriptions	90%
How current vaccines can benefit prescribing practices, including reducing the need for prescribing antimicrobials and decreasing resistant antimicrobial resistant strains e.g. of <i>S. pneumoniae</i>	86%

The average implementation for each of the professions to these five statements was 100% for dentistry, 99% for medicine, 98% for pharmacy, 94% for allied health professionals, 86% for nursing, 85% for midwifery and 72% for independent prescribing courses.

b. Antimicrobial resistance and antimicrobials—understanding the modes of action and spectrum of action of antimicrobials and the mechanisms of resistance (six statements).

The overall implementation was 75% for all the statements included in this domain for all health courses answered for.

The average for each of the statements across all health courses was as follows:

The modes of action of antibiotics and other antimicrobials	80%
Knowledge of the spectrum of activity for commonly prescribed antimicrobials	73%
The appropriate use of antimicrobial agents for prophylaxis to minimise the risk of infection and treatment of infections	77%
The use of microbiological and other investigations to diagnose and monitor the response to treatment of infections and their complications, such as severe sepsis, for individual patient care and for public health purposes	77%
The mechanisms of antimicrobial resistance including intrinsic or acquired resistance; the importance of selection advantages e.g. the greater ability for some to colonise, to alter virulence, and how this can be an amplification process for antimicrobial resistance	70%

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The appropriate use of antimicrobials to prevent the emergence of resistance and avoidance of adverse effects e.g. their disruptive effects on host normal flora, which may lead to, for example, C. difficile infection, Candida spp infection	74%
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The average implementation for each of the professions to these six statements was 100% for pharmacy, 99% for medicine, 97% for dentistry, 75% for independent prescribing courses, 59% for midwifery, 56% for nursing and 41% for allied health professionals.

c. The prescribing of antimicrobials — understanding the key elements in prescribing appropriate antimicrobial agents for prophylaxis and treatment (eight statements).

The overall implementation was 66.3% for all the statements included in this domain for all health courses answered for.

The average for each of the statements across all health courses was as follows:

Not initiating antibiotic treatment in the absence of bacterial infection	70%
An understanding of the key elements of prescribing an antimicrobial including: •Obtaining microbiological cultures or other relevant tests before commencing treatment as necessary •The choice of agent •The route of administration •Its pharmacokinetics and how this affects the choice of dosage regimen •How to monitor levels and adjust doses e.g. in the aged or renal impairment, or where to seek specialist advice •Decisions to switch agent e.g. from intravenous to oral, narrower to broader spectrum (or vice versa) based on microbiological results •The duration of treatment and when to consider review/stop dates	67%
Knowledge of how to select the appropriate antimicrobial, paying due consideration to local guidance, how, and where, to access this	66%
An understanding of local microbial antimicrobial susceptibility patterns when considering empiric treatments	48%
An understanding of common side-effects, including allergy, drug/food interactions, contraindications of the main classes of antimicrobials, and the importance of monitoring for these, and what to do when these are suspected e.g. documenting allergic reactions in patient records	83%
An awareness of trade and generic names, and the class, of a prescribed antimicrobial to avoid possible harm to patients in whom that antimicrobial is contraindicated e.g. due to hypersensitivity, coagulopathy or organ impairment	81%
Knowledge of when not to prescribe antimicrobials, and use of alternatives, such as the removal of invasive devices, e.g.: intravenous or urinary catheters and incision and drainage of abscesses	71%
Knowledge of when to use a delayed antimicrobial prescription and how to negotiate this with the patient	44%

The average implementation for each of the professions to these eight statements was 96% for medicine, 90% for independent prescribing courses, 88% for dentistry, 81% for pharmacy, 41% for midwifery, 30% for allied health professionals and 29% for nursing.

d. Antimicrobial stewardship—demonstrating an understanding of antimicrobial stewardship in day-to-day practice (eight statements).

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The overall implementation was 62% for all the statements included in this domain for all health courses answered for. The average for each of the statements across all health courses was as follows:

Using local guidelines to initiate prompt, effective antimicrobial treatment within one hour of presentation, or as soon as possible, in patients with life-threatening infections	68%
Recognition and treatment of sepsis	76%
Avoiding the unnecessary use of broad-spectrum antimicrobials	80%
Documentation in the prescription chart and/or in patients' clinical records, the clinical indication, route, dose, duration and review date of antimicrobials	77%
Using only single doses of antimicrobials for surgical and other procedures for which prophylaxis has been shown to be effective, unless the duration of the operation/procedure is prolonged, there has been excessive blood loss or published national recommendations suggest otherwise.	57%
Switching to the correct antimicrobial when susceptibility testing indicates resistance, or to a cheaper or more cost effective antimicrobial that is also compatible with the clinical presentation	64%
In primary care, awareness of Public Health England guidance and use of TARGET Antibiotics toolkit	31%
In secondary care, reviewing antimicrobial prescriptions for hospital inpatients on all ward rounds. Appropriately choosing one of the five antimicrobial prescribing decisions 48 hours after initiating antimicrobial treatment (ARHAI Guidance – Start Smart – then Focus): a. Stop antibiotics if there is no evidence of infection b. Switch antibiotics from intravenous to oral administration c. Change antibiotics – ideally to a narrower spectrum – or broader if required d. Continue and review again at 72 hours e. Outpatient Parenteral Antibiotic Therapy (OPAT)	46%

The average implementation for each of the professions to these eight statements was 91% for medicine, 77% for independent prescribing courses and pharmacy, 73% for dentistry, 51% for midwifery, 42% for nursing and 25% for allied health professionals.

e. Monitoring and learning—demonstrating continuing professional development in antimicrobial prescribing and stewardship (four statements).

The overall implementation was 40% for all the statements included in this domain for all health courses answered for.

Engaging the views of others involved in antimicrobial treatment policy decisions including championing best practice, and that it is a duty of care to cooperate with others more expert than oneself when such expertise is required	48%
Regular engagement in team based measurement of the quality and quantity of antimicrobial use and understanding that this should be shared with prescribers, as well as informing antimicrobial surveillance/infection prevention and control measures	32%
Using locally agreed process measures of quality (e.g. compliance with guidance), outcome and balancing measures, such as unintended adverse events or complications	38%
Using the results of adverse event monitoring, laboratory susceptibility reports, antimicrobial prescribing audits and antimicrobial usage data to inform, in a timely manner, best antimicrobial prescribing practices, and so produce sustained improvements in the quality of patient care	43%

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The average implementation for each of the professions to these four statements was 68% for independent prescribing courses, 63% for medicine, 50% for dentistry, 48% for pharmacy, 23% for midwifery, 16% for nursing and 14% for allied health professionals.

When universities were probed on whether the courses they had provided information about had been altered or updated, to support the achievement of the competencies listed since the publication of the ARHA antimicrobial prescribing and stewardship competencies in 2014, an average of 24% had (65% medicine, 45% independent prescribing courses, 20% dentistry, 17% nursing, 15% pharmacy, midwifery 8% and none for allied health professionals).

f. Average compliance rate per professional group

COMPETENCY	Dentistry	Pharmacy	Medicine	Midwifery	Nursing	Indep prescr	Allied Health
1: Infection prevention and control.	100%	98%	99%	85%	86%	72%	94%
2: Antimicrobial resistance and antimicrobials.	97%	100%	99%	59%	56%	75%	41%
3: Prescribing antimicrobials.	88%	81%	96%	41%	29%	90%	30%
4: Antimicrobial stewardship.	73%	77%	91%	51%	42%	77%	25%
5: Monitoring and learning	50%	48%	63%	23%	16%	68%	14%
Total average	82%	81%	90%	52%	46%	76%	41%

2. Methods of content delivery and learner evaluation for antimicrobial prescribing and stewardship competencies

a. Main modes of antimicrobial resistance content delivery - we also explored the main modes of antimicrobial resistance content delivery provided in 2014 – 2015.

The results are as follows:

Online teaching	9%
Blended teaching (classroom and online activities)	48%
Small group training	36%
Classroom based teaching	60%
Placements	55%

When broken down to the individual courses:

i) Medicine offered 81% classroom based teaching, 77% small group training, 71% placements, 59% blended teaching (classroom and online activities) and 29% online teaching.

ii) Dentistry offered 80% classroom based teaching and 60% for small group training and placements.

iii) Pharmacy offered 69% blended teaching (classroom and online activities), 62% classroom based teaching, 54% small group training, 38% placements and 8% online teaching.

iv) Independent prescribing courses offered 59% blended teaching (classroom and online activities), 45% classroom based teaching, 41% placements, 23% small group training and 18% online teaching.

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- v) Nursing offered 61% placements, 57% classroom based teaching, 35% blended teaching (classroom and online activities), 13% small group training and 9% online teaching.
- vi) Midwifery offered 69% for both classroom based teaching and placements, 54% blended teaching (classroom and online activities) and 8% small group training.
- vii) Allied Health Professionals offered 57% blended teaching (classroom and online activities), 43% placements, 29% classroom based teaching and 14% small group training.

b. Methods used to evaluate learners' knowledge about antimicrobial resistance content was also assessed.

The results are as follows:

Essay	8%
Objective structured clinical examination (OSCE) stations	39%
Student presentations	25%
Student portfolio	22%
Short answer examination	30%
Long answer examination	15%
Multiple choice question examination	54%

When methods of assessment broken down to the individual courses:

- i) Medicine offered 94% multiple choice question examination, 69% objective structured clinical examination (OSCE) stations, 47% short answer examination, 32% student presentations, 25% student portfolio and 13% long answer examination.
- ii) Dentistry offered 80% multiple choice question examination, 40% for student presentations, short answer examination and objective structured clinical examination (OSCE) stations, and 20% student portfolio.
- iii) Pharmacy offered 77% for multiple choice question examination and long answer examination, 69% for objective structured clinical examination (OSCE) stations, 54% short answer examination, 31% student presentations, 15% student portfolio and 8% essay.
- iv) Independent prescribing courses offered 55% for multiple choice question examination, 41% for student portfolio, 36% for objective structured clinical examination (OSCE) stations and short answer examination, 23% for essay, 13% for student presentations and 5% for long answer examination.
- v) Nursing offered 35% for multiple choice question examination, 22% for student portfolio, 17% for student presentations, 13% for short answer examination, 9% for objective structured clinical examination (OSCE) stations and 4% for essay and long answer examination.
- vi) Midwifery offered 23% for objective structured clinical examination (OSCE) stations, 15% for student presentations and student portfolio, 8% for essay, short answer examination, long answer examination and multiple choice question examination.
- vii) Allied Health Professionals offered 29% for multiple choice question examination, objective structured clinical examination (OSCE) stations and student presentations, and 14% for essay, student portfolio and short answer examination.

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c. Learning hours assigned to antimicrobial resistance and infection prevention and control activities.

We also explored how many learning hours were assigned to antimicrobial resistance and infection prevention and control activities in the undergraduate (discipline) curriculum offered by individual universities.

The average time dedicated to teaching antimicrobial resistance was 10 hours and teaching infection prevention and control was 15.6 hours as per the responses received from some universities. Results per individual courses were:

Course	Antimicrobial Resistance (average hours)	Infection Prevention and Control (average hours)
Dentistry	10 hours	9 hours
Pharmacy	27.7 hours	9.95 hours
Medicine	10.4 hours	11.2 hours
Midwifery	6.8 hours	19.2 hours
Nursing	4 hours	27 hours
Independent Prescribing	7.45 hours	16.5 hours
Allied Health	4 hours	16.5 hours

d. Inter-professional learning – we asked if undergraduates from different professions learning any parts of the antimicrobial resistance and IPC content together.

18 universities (40%) confirmed they provided inter-professional learning for undergraduates from different professions learning any parts of the antimicrobial resistance and IPC content together. Further details were provided for all except 3 universities.

4 universities (9%) that said no to this provided further comments that have been included below.

e. Standalone courses/modules – we also queried if universities produced dedicated educational resources which could support general learning around antimicrobial resistance and stewardship and asked respondents to share links if possible.

12 universities (27%) confirmed they had such courses/modules available. Three of these (25%) did not provide any further details.

5 universities (11%) that said no to this provided further comments that have been included below.

f. Provision of training on recognition and treatment sepsis – was explored too as there is often a perception that focus on AMR might pose a risk to patients with severe sepsis receiving urgent treatment.

57% courses confirmed they provided such training (81% for medicine, 80% for dentistry, 65% for nursing, 54% for pharmacy, 43% for allied health professionals, 41% for independent prescribing courses and 38% for midwifery).

22% did not know if this training was provided (23% for midwifery and independent prescribing courses, 22% for nursing, 20% for dentistry 19% for medicine and 14% for allied health professionals).

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17% of courses did not provide such training (31% for pharmacy, 29% for allied health professionals, 23% for midwifery, 18% for independent prescribing courses and 17% for nursing).

Qualitative results

The suitability of each of these domains to every course will need further discussion and evaluation in partnership with a variety of stakeholders.

We have further expanded on each of the domains based on the comments we received back from universities as below:

1. Antimicrobial Stewardship and Prescribing Competencies in undergraduate curricula

a. Infection prevention and control—understanding the principles and demonstrate competence in preventing and controlling infections (five statements).

The overall implementation was 91% for all the statements included in this domain for all health courses answered for. There was a 90% or greater implementation with all statements except one (how current vaccines can benefit prescribing practices, including reducing the need for prescribing antimicrobials and decreasing resistant antimicrobial resistant strains e.g. of *S. pneumonia* = 86%). One university commented that the role of vaccines in reducing antibiotic prescribing will be emphasised more now in pre-registration nursing. The next lowest implemented statement (the principles and practice of the prevention and control of infection, and the need to have this reflected in individual job descriptions = 90%) attracted two comments. Both stated that the principles and practice of prevention and control of infection are covered in their teaching but not necessarily as part of job descriptions.

With regards to the average implementation for each of the professions to these five statements, dentistry, medicine, pharmacy and allied health professionals showed a greater than 90% compliance rate, whilst nursing, midwifery and independent prescribing courses showed a lower than 90% compliance rate. For independent prescribing courses one university stated that “students on the prescribing course are expected to have these competencies prior to commencement of the programme if prescribing in this area of practice”.

Two medical schools added comments on the educational delivery methods. One included PBL (problem based learning) and systems based course covering microbiology and antimicrobial prescribing reinforced by spiral learning and the other stated that these topics are covered within the medical school, years 1-2 predominantly by biomedical scientists, years 3-5 by consultant microbiologists/immunologists.

b. Antimicrobial resistance and antimicrobials—understanding the modes of action and spectrum of action of antimicrobials and the mechanisms of resistance (six statements).

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The overall implementation was 75% for all the statements included in this domain for all health courses answered for, with a range from 70% to 80%. The average compliance per profession was lowest for midwifery (59%), nursing (56%) and allied health professionals (41%).

One university commented that as midwives are actively involved in administering antibiotics, the relevance of drug coherence/compliance is taught in the medicines management unit (5 credits of theory). They are also taught about Group B Streptococcal disease, evidence-based guidelines on intrapartum antibiotic prophylaxis (IAP), specific issues related to the use of narrow and broad spectrum antibiotics, antibiotic anaphylaxis in pregnant women and issues around antimicrobial resistance for example the issue of widespread resistance to Erythromycin is emphasised, all within their complex birth unit.

Two universities each covering general nursing and independent prescribing courses respectively, commented that these statements were not covered in depth, however students should have some awareness of these statements. U.S. Food and Drug Administration [resistance information](#) as well as university produced resources were used as part of the teaching process by the latter. Another university providing an independent prescribing course stated that these statements would be covered by the students' designated medical practitioner in practice, if applicable to their role.

Two medical schools added comments on the educational delivery methods. One used good prescribing practice for individual systems covered within modules, complemented by cross-module lectures within years, for example the Years 3 receive a lecture by [Prof David Livermore](#), Professor of Medical Microbiology at the University and also PHE Lead on Antibiotic Resistance entitled "Sunset on the Antibiotic Era". The other university elaborated on how they deliver training for these statements in practice, for example for statement two they introduce how specificity arises, linking this back to bacterial cell structure; for statement three, students in the third year are given access to their hospitals latest guidelines for current antibiotics in use and gain experience of this when they are on their clinical placements; and for statement four students undertake a guided tour of the microbiology lab with one of the microbiologists. They also cover various microbiological diagnostic procedures throughout the degree and have introduced a new student led 'grand rounds' style of case presentation which covers fever of unknown origin (and sepsis), how to diagnose and treat (with input from biomedical scientists and consultant microbiologists).

One pharmacy school commented that all pharmacy students become Antibiotic Guardians following a suitable activity.

c. The prescribing of antimicrobials—understanding the key elements in prescribing appropriate antimicrobial agents for prophylaxis and treatment (eight statements).

The overall implementation was 66.3% for all the statements included in this domain for all health courses answered for, with the lowest compliance for statements four on understanding of local microbial antimicrobial susceptibility patterns when considering empiric treatments

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(48%) and eight on knowledge of when to use a delayed antimicrobial prescription and how to negotiate this with the patient (44%). The average compliance per profession was lowest for midwifery (41%), allied health professionals (30%) and nursing (29%).

One university providing nursing education stated that some aspects of the statements are briefly addressed with the pre-registration students, for example, the use of rescue packs containing antibiotics for people with chronic obstructive pulmonary disease.

Another university providing midwifery training stated that all of the statements are taught to student midwives in respect of correct/evidence based good practice even though midwives do not prescribe antibiotics. This they feel ensures midwives are aware of sound prescribing practices and can challenge prescribers for poor practice and they can refuse to administer any drug where they feel safe practices have been overlooked.

One university providing nursing, midwifery and independent prescribing education stated that they share antimicrobial awareness day resources with students and recommend that these are disseminated within the student's workplace. Another university providing an independent prescribing course stated that these statements would be covered by the students' designated medical practitioner in practice, if applicable to their role.

Three universities providing dental education commented on these statements, with one stating that delayed prescriptions are not relevant in dentistry to the same extent as medicine, whilst another highlighted that these statements are limited in some areas to specific situations or examples, for instance, obtaining cultures are outlined but not common practice in dental infections, and there are limited instances for review / stop treatment and limited delayed prescription negotiations. This was also echoed by the third university, who raised the limited applicability to primary care dentistry for some of these statements although partially met, for example, how to monitor levels and adjust doses e.g. in the aged or renal impairment, or where to seek specialist advice and decisions to switch agent e.g. from intravenous to oral, narrower to broader spectrum (or vice versa) based on microbiological results.

Four universities providing medical education all commented on delayed antimicrobial prescribing. One stated that this is discussed in primary care; another had systems based teaching in place that mentions delayed prescriptions for respiratory tract infections (RTIs) and pre-emptive vs long term prophylaxis in urinary tract infections (UTIs); another university is currently introducing this into the year 4/5 curriculum which is under development; whilst one university stated that they discouraged delayed antimicrobial prescribing as they felt supplies of unused antimicrobials are a tempting source of antimicrobial misuse.

One university has dedicated sessions for third year students where local hospital guidelines are given prior to them entering their 'ward care' clinical pathway (mentioned before). The same university is also trying to work with consultants to build resources that make students aware of the resistant organisms they are likely to encounter; and even though they did not select the

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statement on the specific details on local antimicrobial resistance patterns, they state the copies of local trust guidelines they provide does contain this information.

d. Antimicrobial stewardship—demonstrating an understanding of antimicrobial stewardship in day-to-day practice (eight statements).

The overall implementation was 62% for all the statements included in this domain for all health courses answered for, with the lowest compliance for the last two statements on primary care, for awareness of PHE national guidance and use of [TARGET](#) (Treat Antibiotics Responsibly, Guidance, Education, Tools) antibiotics toolkit (30%) and on secondary care, reviewing antimicrobial prescriptions choosing one of the five antimicrobial prescribing decisions as per ARHAI Guidance – Start Smart – then Focus (46%). the average compliance per profession was lowest for midwifery (51%), nursing (42%) and allied health professionals (25%).

One university providing nursing education (the same that has commented previously) stated that despite not selecting some statements, these are briefly addressed with the pre-registration nursing students, where students will also gain experience of patients receiving antibiotics in practice and observe the decision-making processes involved.

Another university providing midwifery training stated that the first statement on prompt initiation of effective antimicrobial treatment is imperative in minimising deaths from maternal sepsis as indicated in the 2014 MBRRACE maternal mortality report ([Knight et al. 2014](#)). They were conscious that women died as a result of sub-standard care where immediate medical aid was not summoned hence, treatment delayed. Therefore the recognition and treatment of maternal sepsis is covered thoroughly in four taught units at undergraduate level namely: complex pregnancy, complex birth, complex postpartum care and medicines management for midwives.

For one independent prescribing course, the university covered this in generic terms when teaching in the university, and specifics were applied in the clinical practice situation where appropriate.

Two dental schools commented on these statements. One stated that they do not advocate surgical prophylaxis for dentists as per NICE guidance, and felt that “Start Smart – then Focus” is potentially less relevant for dentists and outpatient parenteral antimicrobial therapy (OPAT) is not used. The other similarly stated that the statement “using local guidelines to initiate prompt, effective antimicrobial treatment within one hour of presentation, or as soon as possible, in patients with life-threatening infections” is covered but has limited applicability to primary care dentistry, so local guidelines are only referred to in generic terms.

Three medical schools commented on these statements, with two stating that OPAT was covered briefly when appropriate in formal content, for example once a day antibiotics for orthopaedic infections was mentioned. One used weekly problem based learning (PBL) for primary care teaching where antibiotics were covered according to presentation, whilst another recently introduced “[Start Smart - then Focus](#)” into the Year 5 (final year) prescribing course. The third university provides links to Department of Health antimicrobial literature, and provides

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teaching sessions to support the statements they selected; for those statements they did not select, they may not have specific teaching sessions yet, however, some of this knowledge they feel will be gained whilst students are on their clinical rotations.

One university providing pharmacy training commented that the general points of "secondary care" statements are covered but not in exact detail.

e. Monitoring and learning—demonstrating continuing professional development in antimicrobial prescribing and stewardship (four statements).

The overall implementation was 40% for all the statements included in this domain for all health courses answered for. The lowest compliance was noted for “regular engagement in team based measurement of the quality and quantity of antimicrobial use and understanding that this should be shared with prescribers, as well as informing antimicrobial surveillance/infection prevention and control measures” (32%) and “using locally agreed process measures of quality (e.g. compliance with guidance), outcome and balancing measures, such as unintended adverse events or complications” (38%). The average compliance per profession was lowest for midwifery (23%), nursing (16%) and allied health professionals (14%).

One university that provided midwifery training commented that most of these statements in this competency are generic to the [Nursing and Midwifery Council Standards for Medicines Management](#), and are explicit within the [Nursing and Midwifery Council Code](#). Therefore midwives adhere to specific rules and standards for their discrete area of clinical practice. They felt that a remit within this is not administering any drug without special care and attention to correct procedures. In the Medicines Management Unit for Midwives, students cover for example, mechanisms for recognising and acting upon adverse drug reactions, near miss reporting, the [Yellow Card Scheme](#) and the role of the Medicines & Healthcare products Regulatory Agency (MHRA). They are also shown public health laboratory screening data for neonatal Group B Streptococcal infection cases, along with their statistics on antimicrobial usage and resistance.

One dental school commented that teaching is limited to the last statement “using the results of adverse event monitoring, laboratory susceptibility reports, antimicrobial prescribing audits and antimicrobial usage data to inform, in a timely manner, best antimicrobial prescribing practices, and so produce sustained improvements in the quality of patient care” and that they were not sure about “regular engagement in team based measurement of the quality and quantity of antimicrobial use and understanding that this should be shared with prescribers, as well as informing antimicrobial surveillance/infection prevention and control measures”.

Five independent prescribing courses commented on this competency, all of whom stated that all students are made aware of the statements in this competency. One stated that these are covered in generic terms in university and specifics applied in the clinical practice situation where appropriate. Two prescribing courses now specifically include an overview on the competency which was not included previously. Examples of supporting documents used by

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one university include ARHAI guidelines, [NICE AMS](#) and healthcare-associated infections: prevention and control guidelines, [RCP prescribing tips](#) and local guidelines. Another university has ensured they have a dedicated session on antimicrobial stewardship in their prescribing module, and they also include this in the prescribing updates they provide to registered non-medical prescribers.

Five medical schools commented on the statements in this competency. One felt that maybe not all the statements in this competency are appropriate at undergraduate level; whilst another mentioned that three statements were not selected as they were sure if they have specific teaching sessions related to these, however some of these are taught when students are on rotation on different wards and whilst working with prescribers. One university is still developing its undergraduate medical curriculum with a greater emphasis on microbiology and antimicrobials; whilst another mentioned that inclusion of the statements in this competency in its formal curriculum is relatively limited, although some students may undertake audits of antimicrobial prescribing as part of their selected component. Another university mentioned that inter professional learning with pharmacy students covers antibiotic prescribing as part of practical session.

2. Courses you have provided information about been altered or updated to support the achievement of the competencies listed since the publication of the ARHAI antimicrobial prescribing and stewardship competencies in 2014.

The highest changes were noted for medicine (65%) and independent prescribing courses (45%); whilst this was lower for dentistry (20%), nursing (17%), pharmacy (15%), midwifery (8%) and none for allied health professionals.

Comments received from universities have been grouped according to the professional group they cover as below:

i) General nursing

“No alterations or updates made - the nursing courses have a series of practice competencies related to infection prevention and control. These competencies are addressed in a variety of practice settings and on a number of occasions throughout the course.”

“Session content has been adjusted to emphasise key points more. All pre-registration health students from all programmes have been sent information about becoming an Antibiotic Guardian. They have been given the quiz and asked to spread the word about this topic too. There have been displays and posters at university and the student union have been involved, including distributing information via their social media channels.”

“Changes to BSc Adult Nursing, Public Health Unit.”

“Content is frequently reviewed and underpinned by contemporary evidence base.”

“Updated preps regarding infection control, increased inclusion of sepsis.”

“Movement to small group teaching for Infectious Diseases; greater awareness of competencies included across all courses.”

ii) Dentistry

“Teaching material does not make specific reference to the competencies but staff are aware of the document and key facets have been incorporated into the curriculum.”

“Movement to small group teaching for Infectious Diseases; greater awareness of competencies included across all courses.”

iii) Pharmacy

“Clearer link to competencies and discussion of stewardship.”

iv) Midwifery

“The [UK Antibiotic Guardian Campaign](#) repository links are posted on student learning interface. The actual competency document is provided as compulsory reading on the student, online interface.”

v) Medicine

“Incorporated into our new curriculum starting Sept 2016.”

“Our course has been designed to accommodate the recommendations.”

“Movement to small group teaching for Infectious Diseases; greater awareness of competencies included across all courses.”

“No alterations or updates made - changes to the transition to foundation year course provided by pharmacists.”

“MBChB year 3 and year 4 curricula.”

“We have used materials from the toolkit in final year teaching to the medical students.”

“We have introduced a new session in the infection attachment for our year 4 students around antimicrobial stewardship.”

“We now provide details on AMR from lecture 1 of the pharmacology of antibiotics. We also link in this lecture too to materials on antimicrobial stewardship and ask formative questions to students on this topic too.”

“The School of Medicine underwent a whole curriculum review in 2014.”

“Reinforced medical students' awareness of and use of Trust-based antibiotic guidance. Use of interactive SCRIPT standard computerised revalidation instrument for prescribing and therapeutics), prescribing in the infection module to augment learning in Years 4/5 of MBBS.”

vi) Independent prescribing courses

“Revisions to teaching programme to ensure that topics are fully covered.”

“Movement to small group teaching for Infectious Diseases; greater awareness of competencies included across all courses.”

3. Methods of content delivery and learner evaluation for AMSP competencies

a. Main modes of antimicrobial resistance content delivery

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The most common modes for delivering antimicrobial resistance content in descending order were classroom based teaching (60%), placements (54%), Blended teaching (classroom and online activities) (47%), small group training (35%) and online teaching (9%).

Additional comments were also received for example, simulation and self-directed study for nursing; sign off as competent by designated medical practitioner for independent prescribing courses; and pharmacy game role play format of a final year pharmacy module.

Four medical schools commented mentioning lectures and clinical placements; PBL case scenarios; selectives in Advanced Medical Practice (SAMPs) and special study modules (SSMs) in microbiology, which although popular, do not cover the majority of students, and also convene a PBL module with microbiology and AMR theme; and one predominantly uses lectures although they are developing games (e.g. antibiotics dominoes, using technology-enhanced learning to teach on antibiotics).

b. Methods used to evaluate learners' knowledge

The most common methods used to evaluate learners' knowledge modes were multiple choice question examination (54%), objective structured clinical examination (OSCE) stations (39%) and short answer examination (30%); whilst other modes were lower like student presentations (25%), student portfolio (22%), long answer examination (15%) and essays (8%).

Comments received from universities have been grouped according to the professional group they cover as below:

i) General nursing:

“This would be formatively assessed in clinical practice following initial exposure to patients with infection or discussion around infection control competencies.”

“Assessment of learning relating to infection prevention and control occurs as part of online learning packages and in practice. Preregistration students are required to achieve Nursing and Midwifery Council progression criteria and competencies relating to this topic which form part of their practice assessment documents. Students are also assessed formatively in infection prevention and control using Direct Observation of Practical Skills forms during their placements. In addition students receive formative feedback during university sessions.”

“Students are assessed via an interactive computer marked assessment.”

“Performance in simulated scenarios.”

“Discussion in placement; students complete a medicine’s OSCE and may well administer antibiotics as part of this.”

ii) Pharmacy

“Problem based learning exercise.”

“Practical and analysis of lab results.”

iii) Midwifery

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“Students are required to achieve clinical competencies in safe drug administration on each clinical placement. They also have to comply with the Core Competency Framework on Infection Control. These are only provided within the context of other drug questions i.e. not specifically or solely tested on antibiotics because midwives administer other drugs that are used more frequently than antibiotics like antihypertensives, insulin, anticoagulants and anti-epileptic agents.

“Discussion and simulation.”

“Not tested specifically in midwifery (hence not answered).”

iv) Medicine

“PSA ([national prescribing safety assessment](#)).”

“The others are used or in development but do not, as yet, constitute a major element.”

“We have also used team based learning for asking more complex questions about antibiotic choice and mode of action.”

“Undergraduate Mini-Clinical Evaluation Exercise (Mini-CEX)

v) Allied Health Professionals

“Attendance to sessions, online quiz and practical hand washing assessment.”

c. Inter-professional learning - undergraduates from different professions learning any parts of the antimicrobial resistance and IPC content together?

For those who said yes, comments received include:

“All branches of nursing and paramedic practitioners.”

“The mental health, children’s and adult nurses are all taught together within the first year, and infection control activities sits within clinical skills and theory aspects.”

“In clinical practice undergraduate student nurses and operating department practitioners may spend time working together.”

“Life Sciences and midwifery.”

“For nursing, using the same online material.”

“For nursing possibly yes, while on placements.”

“Midwifery - some minimal contact with medical students; independent prescribing - cohorts may consist of individuals from nursing/midwifery/physiotherapy/podiatry/radiography.”

“In dentistry, some practical aspects of IPC are learnt by BDS and dental hygiene and therapy students in shared clinical skills sessions.”

“4th year inter-professional learning (IPL) with medical and pharmacy students.”

“For medicine occasionally in their placements.”

“Different branches of nursing learn together.”

“Yes - independent prescribers and pharmacy students (case based learning).”

“Yes we have inter-professional education (IPE) in all years of programme.”

“This is part of the design of the course.”

“Yes, non-medical prescribing (NMP) is a multi-professional module.”

“For medicine, occasionally in their placements.”

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“Allied Health Professions - physiotherapy and occupational therapy students.”

“For medicine, we have an integrated curriculum and antibiotic stewardship and infection control is everybody's business; so impossible to calculate beyond the formal sessions which are likely to be less than 10% of the actual learning that takes place over the course of 6 years.”

For those who said no, comments received include:

“No, except possibly on placement.”

“No, we only have medical students.”

“No, we have separate teaching for medicine and dentistry, though there is a student led initiative in development called 'Bridges' which is designed to improve inter-professional learning between disciplines.”

“Not for pharmacy, although an inter-professional education (IPE) was based around antibiotic prescribing.”

e. Standalone courses/modules

Comments received from those that confirmed their organisation produced dedicated educational resources which could support general learning around antimicrobial resistance and stewardship include:

“There is a session within the NMP programme which includes a quiz, the students also have access to online material to support their learning.”

“Resources include online learning packages on general principles of infection prevention and control and specific aspects, e.g. aseptic non-touch technique. There is also a dedicated Clinical Skills for Practice [website](#) which includes resources such as posters, videos and podcasts relating to specific aspects of infection prevention and control.”

“Part of nursing practice modules 1, 2 and 3 - no links available at this time.”

“Infection Prevention and Control; University of Brighton - Module code: NA6163 Credits: 20.

Description: To provide the background knowledge and support to health professional in key roles in infection prevention and control IPC so that they can develop their role as champion for the IPC agenda. These are being evaluated having been introduced during 2015.”

“Links aren't available, but we are happy to share our teaching materials with you if required.”

“[E-learning](#), [iBooks](#) and ID module (on intranet).”

“For pharmacy using [case studies](#) via xerte® toolkit software.”

“It could do, but at present not about stewardship.”

“Internal materials only as part of the learning environment.”

“These are being evaluated having been introduced during 2015.”

“Linked to [SCRIPT](#) specifically designed to support a range of interactive methods, draws on a wealth of experience from clinicians, underpins good prescribing practice, allows a flexible approach to learning, and readily available at users' convenience and as part of [QM+](#).”

For those that said their organisation did not produce dedicated educational resources which could support general learning around antimicrobial resistance and stewardship, for example as part of standalone courses/modules, comments received include:

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“Aspects embedded within [workbooks](#) etc.”

“There is a session within the non-medical prescribing (NMP) programme which includes a quiz; the students also have access to online material to support their learning.”

“We use classroom sessions plus the national e-learning programme for NMP.”

“We use the Antibiotic stewardship competencies.”

“Not yet, these are in development.”

One university providing post-graduate dental education that was not included in this survey said that they have [twitter feeds](#) directed towards AMR.

f. Sharing resources

One university providing nursing education, and another providing nursing, midwifery and independent prescribing courses shared resources from the [Centre for Pharmacy Postgraduate Education](#) (CPPE). Another university providing pharmacy and independent prescribing training shared the same CPPE resource on [infections](#). A midwifery school shared a published paper on oral antibiotic prescribing during pregnancy in primary care that was a UK population-based involving 114,999 women who gave live birth between 1992 and 2007 (Petersen et al. 2010).

A university providing nursing and independent prescribing shared [information from the Infectious Diseases Society of America](#) (IDSA).

One university providing nurse education stated that their practice assessment documents for each practice module have a series of practice competencies related to infection prevention and control.

For pharmacy one university shared [information from Antibiotic Action](#) and BBC news reports. Another university providing nursing, midwifery and independent prescribing courses provided information from RCP/NICE/ARHAI guidelines, World Antibiotic Week, [FDA resistance](#), relevant textbooks/journals, and the Centre for Pharmacy Postgraduate Education ([CPPE](#)) already mentioned above.

For one independent prescribing course the university provides a study guide for infectious diseases and clinical practice in stage 3. They also include specific learning outcomes in other study guides for example within clinical pharmacology and the therapeutics and prescribing strand. Prescribing in sepsis is specifically covered in their final year of their hospital based practice course.

Nine medical schools shared additional comments. One university gives their undergraduate medical students access to [SCRIPT resources](#) which includes some content on antimicrobial prescribing, whilst another is planning to introduce some e-modules from SCRIPT into their programme. A Massive Open Online Course (MOOC) on antimicrobial resistance is being developed by one university which they have not released yet, and they are aware of the [MOOC available from Dundee University](#). Another university hopes to offer students the chance to work together on the antimicrobial stewardship MOOC from Dundee University. Other comments received back include the availability of course materials on “Moodle” which is the

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university's virtual learning environment, another offering IPE in all years of their programmes and another offering their medical students laboratory based small group workshops. A [prescribing handbook ibook](#) mentioned above was also shared with medical students. Finally one university shared links from [its own assessment page](#) and [the European antibiotic awareness website](#).

g. Provision of training on recognition and treatment of sepsis

Three nursing schools responded with one including this in their [post-registration/CPD courses](#), another having this as part of their acute care module - [prevention and management of acute deterioration](#)), whilst the third has the deteriorating patient as a specific taught session in skills lab for each year.

One pharmacy school that commented stated that they do not include sepsis and cause of in their teaching and were not aware of the inclusion of detailed training of dealing with patients with sepsis.

Four medical schools commented, with one having a lecture on sepsis on their intranet for five years and they provide links to the Sepsis-6 guidance as part of this; another provided interactive workshop as well as other resources on recognising sepsis; the third covers the biomedical science of sepsis more in year 3 (basic microbiology and immunology is covered in years 1-2), where they have a new year 3 session 'Grand round' style covered by an emergency department consultant with an accompanying set of slides/notes made by students for students; and the fourth stated it is undertaken throughout the students' placements – especially general practice, emergency care, elderly care, paediatrics and intensive care.

4. Gaps and barriers on education on antimicrobial prescribing, resistance and stewardship and learning resources

Universities were invited to provide information on areas in which they felt there were gaps in the resources available for education on antimicrobial prescribing, resistance and stewardship in undergraduate and postgraduate education and continued professional development (CPD). The comments received have been grouped per professional groups as below.

i) Nursing

Ten universities commented on gaps with one calling for standardized teaching materials for use by all in the same way. Four universities asked for online educational resources for students/nurses. It was felt that this could provide contextualisation of the issues so that students can readily apply theory to practice. Students should also be given access to resources anytime and anywhere. The resources should be free and easy to use without necessity for passwords, and these should be short and targeted. It was also felt that there are large gaps in the undergraduate nursing programme and competing demands means focus on infection prevention rather than stewardship. One university commented that access to SCRIPT

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(standard computerised revalidation instrument for prescribing and therapeutics), would be useful for universities for use with students. Influence outside the classroom was also raised and there was a suggestion that prescription charts should include AMR information. Another university aimed infection control resource at stage 1 nurses and stage 1 healthcare practice students, and felt there are gaps around resistance, stewardship, and local policy implementation. One university felt it would be useful to develop an online or paper-based resource on this topic designed specifically for pre-registration nursing students.

Ten universities provided details of barriers they felt are present to embedding the antimicrobial prescribing and stewardship competencies.

Four universities felt time limitations in the curriculum and curriculum capacity / content acted as barriers. Some mentioned competing areas of specialisms, relevance to the professional's role, and content required by validating bodies for adult nursing curricula as barriers. Pressure of including recommended content in curricula was also raised, whilst others cited the lack of updated knowledge amongst staff and knowledge of the UK AMR strategy. One university commented that there is a perception amongst nurses that only prescribers can do anything about antibiotic use. Two universities felt that there were no barriers to embedding the competencies related to nursing and indeed many of these are already in existence. However one felt engaging materials that contextualise the issues may be helpful, and the other felt that learning materials will have to be developed and updated more regularly.

ii) Dentistry

Two universities commented on gaps with one stating that antimicrobial resistance is not specifically required for update CPD by the General Dental Council (GDC), and the other mentioned that there is limited material focused on dental relevance of AMR and stewardship for undergraduate students.

Similarly two responses were received on barriers with one mentioning timetable constraints as they felt the curriculum is already packed and this introduces additional depth in one subject area. The other felt that these competencies need to be embedded throughout practice and during experiential learning.

iii) Pharmacy

Four universities responded on gaps with two raising time as an issue - one mentioned the insufficient time to do full justice to the topic and the other raised curriculum slots as a limitation that makes full use of available resources in education problematic. Resource availability and the availability of a simple handbook for the undergraduate environment were raised. One university said that they felt undergraduate students may find it confusing that an antibiotic is chosen for a particular infection, whilst other antibiotics are effective, and why there are some bacteria more susceptible to some antibiotics but not others.

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Comments on barriers were similar to those received for other professionals above, with curriculum time cited by two universities to cover all competencies in an already very full curriculum.

One university felt that some competencies are difficult for students to comprehend, particularly as the MPharm undergraduate degree does not contain many placements. Another felt that there may be issues around public perception and sub-optimal inter-professional working. A third university commented on the fact that bacterial genetics (transfer of resistance) is difficult for students to understand especially if they do not have a biology background.

iv) Midwifery

Three universities shared their thoughts on gaps. Points raised include having accessible online learning which is free and easy to use without the need for passwords, and access to SCRIPT for all universities. One university felt that there are specific gaps around Group B Strep from a microbiology perspective, maternal sepsis and microbiology, and the role of pharmacists and antibiotics.

Comments on barriers to midwifery were similar to those obtained for nursing with four universities responding. Two universities raised curriculum capacity as a limitation, and one felt that they already have a lot of information in an already over-prescribed curriculum content. They also mentioned that NMC pre-registration hours and standards are very midwifery specific and have to be. Other comments already mentioned above include knowledge of the UK AMR strategy, belief about relevance to professional role and thoughts that only prescribers can do anything about antibiotic use.

v) Medicine

Nine universities commented on gaps. Time pressures in the undergraduate curriculum and space for small group teaching was raised by one, with another mentioning a lack of problem based learning materials at an appropriate level for medical students. One university had limited academic clinical pharmacologists to teach on the undergraduate course; however they are planning to move to e-modules to address this. One university felt that experience is important and that this can only be done once students start work. Another felt that game based learning resources would be useful as these would standardised MCQs aimed at medical students years 1-3. Three universities strongly felt that all medical schools should be covering these competencies as part of the routine teaching, and that there should not be a need for extra resources. Of these three, one university fills the gaps through ongoing revision of the MBChB curriculum and felt that inter-professional learning could be used more. Another university felt that this is an item high on their agenda and strongly reinforced in placement practice when students work in GP or in hospitals where they use their trust guidelines all the time.

Six universities commented on barriers with three universities citing time as a limitation. One felt that they only have 5 years to cover everything, and if they increase teaching none aspect of the Tomorrow's Doctor's (TD) curriculum, then something else has to be dropped. One university

cited the lack of awareness on the importance of these two topics. Another felt that for self-directed learning (SDL) and problem-based learning (PBL), ensuring the students are actually engaging with the topic can be a difficult question to answer. One university felt that they have not encountered any barriers, and commented that the faculty of health and medicine has been very keen to expand infection teaching. Another commented that there are a multitude of resources available which means PHE resources get “a bit lost” and they tend to go to the trust sites.

vi) Independent prescribing courses

Six universities commented on gaps, with two raising time as an issue - one mentioned the insufficient time to do full justice to the topic and the other raised curriculum slots as a limitation that makes full use of available resources in education problematic (mentioned above under pharmacy too). There was also a call for accessible online learning which is free and easy to use without necessity for passwords and access to SCRIPT for universities to use with students (mentioned above under nursing too). One university felt that there are many resources available, and the gap is in them not all being drawn together or available in one place, so a national repository of resources on this topic that is available outside the NHS IT system would be useful. This should be accessible to all as universities as they train practitioners from private practice as well as the NHS, and access to NHS resources is sometimes limited. Another university felt that there is a need to use the most current and up-to-date resources for antimicrobial prescribing and resistance and stewardship, especially for external speakers who teach on their universities non-medical prescribing module. Influence outside the classroom was also raised by another university (mentioned above under nursing too).

Eight universities commented on barriers with five universities citing curriculum time / capacity as a barrier. One mentioned the breadth of content required by validating bodies for prescribing modules, whilst another mentioned balancing the many competing demands regarding the content. The lack of updated knowledge amongst staff and knowledge of the UK AMR strategy were cited by two separate universities respectively. As mentioned previously, one university felt there are issues around public perception and sub-optimal inter-professional working, whilst another quoted belief about relevance to one’s professional role. One university said that they were not aware of any barriers apart from what they have already raised before, with regards to resource accessibility especially for those who did not have [nhs.net](https://www.nhs.uk) accounts for access to NHS resources; these they felt need to be made publically accessible.

vii) Allied health professionals

No comments were received on barriers, however two universities commented on gaps. One university felt that they were limited by the time and content of undergraduate curriculum, whilst the other felt that there is a lack of recognition of the role of AHP in this area.

5. Further comments received

Respondents were invited to provide any further information that they thought may be useful. One dentistry university commented and they fully support this initiative, and feel that this is extremely important, and receives significant attention throughout the 5 year BDS (Dentistry) curriculum.

The only pharmacy school that commented said that they cover bacterial and fungal infection in detail during the first year of undergraduate study, and this is covered again in more detail in the final year of the course. They also invite antibiotic pharmacists to give guest lectures on their course. However they felt providing further visual learning resources (videos explaining key concepts for example), aimed at undergraduates on this subject would be most useful.

One midwifery school that responded shared two resources; [one from NHS Choices](#) with reference to a newspaper article on whether antibiotic used in pregnancy linked to risk of epilepsy and cerebral palsy; and [a published article](#) on early onset neonatal sepsis: diagnostic dilemmas and practical management.

We received further additional comments from three medical schools. One stated that they felt our questionnaire was not particularly relevant to a PBL and systems-based course as most of the infection seminars and lectures have an element of antibiotic prescribing and resistance within a broader base, for example, talking about animal husbandry during seminars on gastrointestinal infections, spread of extended-spectrum beta-lactamases (ESBLs) and New Delhi metallo-beta-lactamase (NDM-1) during a talk on infectious hazards of travel, and incidence of penicillin resistance in pneumococci in a meningitis lecture.

The other university felt that in hospital, most antimicrobials are prescribed by junior doctors. The principle driver to antimicrobial overuse is a lack of confidence in infection on the part of the prescribers. The respondent felt that whatever the students know in theory, will default to the use of broad spectrum antibiotics "just in case", wherever infection might be a possibility and that constitutes most admissions. They therefore felt that undergraduate education must be followed up with prescribing support in the foundation years and this is much more difficult. The third university felt that AMR is a very important issue, and they welcome the opportunity to be part of any ongoing consultation about teaching in this area.

One university providing independent prescribing courses stated that students attended from all specialisms of nursing and therefore have a wide range of learning requirements. The programme therefore only delivers and assesses generic principles of prescribing. Students are then encouraged to explore in their portfolio issues pertinent to their practice. Although the whole BNF is open to nurse prescribers – they will only prescribe drugs specific to their own area of practice. All nurse prescribers are responsible for demonstrating their own competence in the group of drugs they will be prescribing. As a minority of students will be prescribing antibiotics – they will be encouraged to direct their learning to this area of practice. The NMC which governs the content and assessment of the programme only stipulate in their guidance

that students will be made aware of policies relating to the prescribing of antibiotics. Therefore students in lectures are made aware of antimicrobial stewardship and the specific competency framework. Students' competency in practice is assessed by a GP or medical consultant using the single competency framework which is used for all prescribers in all allied health professions. There is one competency out of approximately 80 that refers to prescribing antibiotics, that is “understands antimicrobial resistance and the roles of infection prevention, control and antimicrobial stewardship measures”. As a consequence only 20 minutes to half an hour is devoted to antimicrobial stewardship in the taught element of the programme.

Discussion

We had an average response rate received from 65% of medical schools, 52% of pharmacy schools, 48% independent prescribing courses, 46% dental schools, 42% nursing schools and 25% midwifery schools.

When this initial survey was undertaken last year, one university that responded and provides professional courses to all professions being scoped in this survey did not participate this time around. Their response in the previous survey was that they completed a number of questionnaires on antimicrobial stewardship over the previous six months, and said that none appeared to be joined up (PHE & HEE, 2015). Based on these comments, and to ensure future initiatives can elicit maximal responses, co-ordination of any surveys or audits on health education institutions around AMR should be centrally co-ordinated if possible. Co-ordination between Professional Schools Councils that Health Education Institutions are part of, Advisory Committee on Antimicrobial Resistance and Healthcare Associated Infection (ARHAI), English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR), National Institute of Health Research (NIHR), Medical Research Council (MRC), PHE and HEE may help for any future work proposed.

As mentioned, our survey followed an initial piece of work from PHE and HEE (2015), which identified the following potential barriers to embedding AMS principles in practice across the whole healthcare economy:

- Public and patient understanding of AMR and expectations of antibiotic treatment
- Lack of continuity of care.
- Problems in specialist areas with local guidelines
- In-grained attitudes of older healthcare professionals.
- Haphazard organisation in medical schools with very variable teaching
- The knowledge and skills of non-prescribing professionals around antimicrobial prescribing may relate to the critical evaluation of another professional's prescribing. The AMPS competences do not directly allow for this distinction, making some of them less relevant to non-prescribing professionals.

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The last point on the relevance of the AMPS competencies to non-prescribing professionals is one that needs further discussion under the auspices of ARHAI & ESPAUR. The highest compliance to these competencies was observed for medical schools (90%) followed by, dentistry (82%), pharmacy (81%), independent prescribing courses (76%), midwifery (52%), nursing (46%) and allied health professionals (40.8%). Further details on the corresponding compliance rates for each professional group are found below in Appendix 3.

Implementation for each competency and potential solutions to improve education

1. Infection prevention and control—understanding the principles and demonstrate competence in preventing and controlling infections (five statements).

The highest implementation rate of 91% was observed for professional courses was to competency one for infection prevention and control. The lowest implementation to this was for independent non-medical prescribing courses at 72%. As this courses is undertaken by qualified post-graduate professionals who are often pharmacists, midwives, nurses and allied health professionals in practice, this training should be covered under their individual organisations' mandatory training. However we observed an implementation rate of 86% and 85% for undergraduate nursing and midwifery schools respectively. In addition, only seven allied health professional courses responded to this survey; some that broadly included physiotherapy, radiography, occupational therapy, paramedic practice, operating department practitioners and podiatry. We received no answers from any optometry schools.

Therefore as non-medical prescribers include nurses, pharmacists, optometrists, radiographers (supplementary prescribers only), physiotherapists and podiatrists or chiropodists, it could be argued that institutions providing independent prescribing training should still cover this as a core area, and the low compliance rate could be deemed as being unacceptable. However one university did state that students on the prescribing course are expected to have these competencies prior to commencement of the programme if prescribing in this area of practice. In addition, the provision of infection prevention and core training on induction for all healthcare staff by organisations in the public and private sector is a legal requirement covered under the [Health and Social Care Act \(2008\)](#), and compliance monitored by the [Care Quality Commission \(CQC\)](#) through its inspections of provider organisations.

The lower rates for midwifery and nursing schools may need further discussion and exploration by the Council of Deans of Health, which is the representative body for these groups. Of course our data may not be indicative of average practice due to the low response rate received for these two schools (42% for nursing and 25% for midwifery), however the emphasis and importance of infection prevention and control training is vital for all future health professionals, as set out by the code of practice on the prevention and control of infections ([DH 2015b](#)). HEE could have a role in supporting this, especially promoting modules on infection prevention and

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control available on the e-Learning for Health (eLfh) to undergraduates. Work is underway to provide undergraduate students with access to eLfh by autumn 2017.

Various national guidelines and standards on preventing and controlling infections are available for providers of healthcare in primary and community care settings ([NICE 2012](#)), healthcare-associated infections ([NICE 2016](#)), infection prevention and control ([NICE 2014](#)) and healthcare-associated infections: prevention and control ([NICE 2011](#)) that can be shared with students.

- Information from [NHS England](#) on healthcare associated infections.
- Information from [PHE](#) on healthcare associated infections: guidance, data and analysis.
- The [AMR resource handbook](#) from PHE.
- [Various tools and workbooks](#) to support education around infection prevention and control.
- Epic3: National Evidence-Based guidelines for preventing healthcare-associated infections in NHS hospitals in England ([Loveday et al 2014](#))
- Education on infection prevention and control from [NHS Education for Scotland](#).
- Education and guidance from various organisations such as the [Healthcare Infection Society](#), [National Audit Office](#), [Infection Prevention Society](#), [British Infection Association](#) and [British Society of Antimicrobial Chemotherapy](#).

2. Antimicrobial resistance and antimicrobials—understanding the modes of action and spectrum of action of antimicrobials and the mechanisms of resistance (six statements).

The second highest implementation rate was to the competency on antimicrobial resistance and antimicrobials. Again independent prescribing courses showed a 75% implementation rate. However, as stated before, professionals that undertake this course are qualified health professionals, and one university commented that this would be covered by the student's designated Medical Practitioner in practice if applicable to their role. In addition, the standards for education providers and registrants for non-medical prescribers does cover the role of registrants in understanding antimicrobial resistance and the roles of infection prevention and control ([HCPC, 2013](#)). Therefore the Health and Care Professions Council (HCPC) should consider the findings of this survey and explore possible solutions and improvements with its membership. Much lower implementation rates were observed for midwifery (59%), nursing (56%) and allied health professionals (41%). as mentioned before, these professional groups can further train as non-medical prescribers, and it could be argued it is absolutely critical that they are well informed on the modes of action and spectrums of activity of these agents at undergraduate level. There is a lack of data on the appropriate prescribing of antimicrobials by non-medical prescribers as highlighted by one Scottish survey; however their quality indicators may possibly suggest that nurse prescribers are following best practice (Ness et al 2015). The translation of these AMS competencies by qualified non-medical prescribers in daily practice may need further exploration by ARHAI & ESPAUR. A possible solution in ensuring all clinical staff working in the health service are adequately informed on antimicrobial resistance and antimicrobials, is to include such training as a core part of mandatory clinical training by all health organisations (similar to IPC above). However, with the recent changes in the

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prescribing landscape, we now have the possibility of all non-medical prescribers recommending antibiotics for their patients for all disease and infection states, and as antimicrobials cover a huge spectrum of disease and infection treatments, the Council of Deans of Health should explore the training of their undergraduates on this.

HEE may have a role in supporting learning in this area by promoting learning resources available on the e-Learning for Health (eLfH) platform on antibiotic use and action available to undergraduates (once access available), such as sessions available on the:

- “[principles of antibiotic use](#)” and “[antibiotics: mechanisms of action](#)”. These perhaps could be made available via the open session portal to enable access by a wide variety of audiences. All HEIs would then be able to recommend these resources to their students.
- Knowledge on antimicrobial resistance can also be obtained via the eLfH session “[Reducing Antimicrobial Resistance: An Introduction](#)”, which is already available on the open access portal and free for universities to use as part of their teaching.
- Other modules could be made available to all via the open access portal by HEE include sessions on “[antibiotic policies](#)”; and “prudent use of antibiotics” – [part 1](#), [part 2](#) and [Part 3](#).

There are 44 courses and 375 sessions that cover infections as part of learning on the eLfH platform. HEE needs to ensure these incorporate and comply with recommendations on antimicrobial stewardship as specified by NICE ([2015](#)). This will ensure that all prescribers regardless of background are adequately equipped to address the effective use of antimicrobials, help change prescribing practice to help slow the emergence of antimicrobial resistance, and ensure that antimicrobials remain an effective treatment for infection. Indeed, one study showed that students who referred to infectious disease specialists, pharmacists, or Infectious Diseases Society of America (IDSA) guidelines as sources of educational information, had statistically significant higher knowledge scores compared with students who did not use these resources (Abbo et al. 2013). It has been recommended that rather than formal lectures, interactive learning in the format of problem-based learning with case vignettes can be suitable for this topic (Lee et al. 2015). All these actions may ensure that future health professionals are clearly aware on what antimicrobial resistance is, and the associated risks to the future health of the nation; the mechanism of action and prudent use of antimicrobials encouraging appropriate use; and how prescribing decisions and treatment of infections can have adverse consequences on patient care, morbidity and mortality.

Universities should ensure they use up to date local and [national resources](#) on antimicrobial resistance and stewardship in their learning materials to teach undergraduate students. This will ensure the future workforce is engaged on principles around infection prevention and control, antimicrobial resistance and antimicrobial stewardship; and they are aware of local and national challenges, and how and where to get this information. Clinical tutors and lecturers should share information with their students from UK bodies like the Department of Health, Public Health England, and Department for Environment, Food & Rural Affairs, NHS England and Health Education England as found here:

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- Information and resources on the government's plans to slow the growth of [antimicrobial resistance](#) (includes guidance from the DH, PHE and DEFRA).
- Information from [NHS England](#) on AMR.
- Information from [Health Education England](#) and [e-Learning for Health](#) on AMR.
- The Chief Medical Officer (CMO), Professor Dame Sally Davies's report on the [threat of antimicrobial resistance and infectious diseases](#)
- Professor Dame Sally Davies Chief Medical Officer's talk on "[A ticking time bomb: the infectious threat of antibiotic resistance](#)" at Oxford Martin School Public Lecture (University of Oxford)
- The UK Government commission on the [Review on Antimicrobial Resistance](#) in collaboration with the Wellcome Trust
- [E-Bug](#) project is led by the Public Health England's (PHE) Primary Care Unit in England and involves a consortium of 28 international partner countries. [Training resources](#) although aimed at health educators including teachers and school nurses are freely available for all.
- A free e-learning module, "[Reducing Antimicrobial Resistance](#)" is available for everyone to access (those working in the NHS and the social-care setting should register before accessing).
- A short informative [animation](#) aimed at the public to help all prescribers respond appropriately to patients requesting antibiotics without medical need is also available.
- MOOC's are available for students to access free from the university of [Uppsala](#) and [Dundee](#).

3. The prescribing of antimicrobials—understanding the key elements in prescribing appropriate antimicrobial agents for prophylaxis and treatment (eight statements).

Implementation of competency 3 on the prescribing of antimicrobials was the third highest at 66.3%. The lowest implementation was noted for allied health professionals (30%) and nursing (29%). As discussed earlier, these two professional groups could become prescribers, and even though it could be argued that this does not happen until later on in their practice once they have more knowledge, a basic understanding of the statements under this competency is important. For example for statement one on not initiating antibiotic treatment in the absence of bacterial infection, this should have scored 100% across all groups. It could be argued that this is irrelevant for all health professionals especially those who are not prescribers; however as health undergraduate students are future advocates and promoters of effective healthcare, a mention on the inappropriate use antibiotics should be made. This is keeping with the broader message being promoted to the general public, on the ineffectiveness and inappropriateness of taking antibiotics in the absence of a bacterial infection, or for minor cold and flu caused by viruses ([Wellcome Trust 2015](#)). Even though the perceptions of UK health students on taking antibiotics has not been quantified, a study in Italy involving 1,050 medical students found that around 20% of stated that antibiotics are appropriate for viral infections, and 15% of students said that they stop taking these when symptoms decrease (Scaioli et al. 2015).

Another area on "knowledge of how to select the appropriate antimicrobial, paying due consideration to local guidance, how, and where, to access this", showed a 13% implementation

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within nursing courses. This was in contrast to 29% observed for AHPs, 46% for midwifery and 80% for dentistry. Again a mention of compliance to organisational antibiotic guidelines and policies should be made to undergraduates, ensuring future health-workers are aware of what is expected of them. Lecturers and course tutors may wish to use [NICE guidance](#) (2015) and some elements of the “[Start Smart - Then Focus](#)” Antimicrobial Stewardship Toolkit for English Hospitals (PHE 2015) in their learning materials ensuring students are aware of these principles early on in their career. The Dental Schools Council may want to pay closer attention to the 80% implementation rate too. This in view of a study that showed inappropriate prescribing in UK general dental practice antibiotics of 65.6% where there was no evidence of spreading infection, and only 19% of antibiotics were prescribed in situations where their use was indicated by clinical guidelines (Cope et al. 2015).

Nursing courses showed the lowest implementation to having ensuring students had an understanding of common side-effects, including allergy, drug/food interactions, contraindications of the main classes of antimicrobials, and the importance of monitoring for these, and what to do when these are suspected e.g. documenting allergic reactions in patient records of 57%. This was even lower than that for midwifery (69%) and AHPs (71%). This may be of concern to some considering most nurses are expected to administer medicines to patients in certain clinical settings. However it could be argued that students can never administer or supply medicinal products without direct supervision (NMC 2008), and such knowledge about side-effects and allergies is picked up on clinical placements when they work as part of a multidisciplinary team. A literature review on the reporting of adverse drug reactions amongst nurses found that nurses are not fully aware of their role in adverse drug reaction reporting (De Angelis et al. 2015). This is something the Council of Deans of Health may wish to discuss and consider amongst their membership. Universities, especially pharmacy schools may also find this [online learning on adverse drug reactions produced by NHS Education for Scotland](#) useful to share with their students (although this may be too broad for all disciplines at undergraduate level). However there may be scope for a simple e-learning resource or guide, explaining the nature and categories of medication related allergies, with a mention of what is meant by a true penicillin allergy and penicillin related antibiotics. This could be aimed at undergraduate students and qualified health professionals. According to two studies presented at the American College of Allergy, Asthma and Immunology (ACAAI) Annual Scientific Meeting in 2014, the first study showed that from 384 people who believed they were allergic to penicillin, 94% tested negative for penicillin allergy. The second study of 38 people who believed they were allergic to penicillin found that all of them showed a negative result to a penicillin skin testing to, meaning that they did not have a true penicillin allergy. This false perception that patients could have on them being penicillin allergic could deny them life-saving treatments that could be critical to improving their survival, care and treatment outcomes. They could also inadvertently fuel antibiotic resistance to a narrow pool of antibiotic treatments options that are given to patients who have a true penicillin allergy (Shah et al. 2016 & Blumenthal et al. 2016). In addition the number of UK suspected spontaneous ADR reports received by the MHRA of ‘allergic conditions’ associated with penicillin (Benethamine Penicillin,

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Benzylpenicillin, Penicillin, Phenoxymethylpenicillin) between 1 January 2010 and 4 September 2015 showed an incremental increase from 4 cases to 68 cases ([DH 2015c](#)). Of course strictly speaking, patients who have a penicillin allergy in essence will have allergies to all beta-lactam containing antibiotics. These may not share the same name as penicillin, and could result in unwanted harm to patients if health professionals cannot make this link. Indeed, beta-lactams are known to be the most frequent cause of immediate and delayed hypersensitivity reactions (Mirakian et al. 2015). Students should be made aware of this much earlier on in their careers ensuring they are clearly aware of treatment choices, especially if they will be future prescribers, minimising any harm to patients.

Two areas that showed a lower implementation in dentistry compared to their average was for understanding of local microbial antimicrobial susceptibility patterns when considering empiric treatments, and when to use a delayed antimicrobial prescription and how to negotiate this with the patient. And even though it was felt this has a lower bearing in dentistry compared to medical colleagues, there may be situations prescribing decisions should be considered, especially in view of findings that half of antibiotics (65.6%) were prescribed in situations where there was no evidence of spreading infection, and 70.6% were used without the provision of an operative intervention (Cope et al. 2015). There are times when antibiotics are ineffective in the treatment of pulpal pain evoked by hot and cold, and these are not appropriate in the absence of signs of spreading infection or systemic upset, as they do not prevent the development of severe complications. In addition, localised dental abscesses respond well to incision and drainage, root treatment, or extraction and hence the importance for prompt dental surgery rather than a prescription for unnecessary antibiotics (Robertson et al. 2015). Although this may not be applicable to dentists per se, a survey of more than 1,000 GPs - commissioned by the Association of Dental Groups (ADG), found that 87% of GPs were feeling under pressure by patients with oral health problems ([Pulse 2013](#)). However, patients presenting at dental surgeries with “toothache” also routinely expect an antibiotic for the treatment (Lewis et al. 2008), and patients not only pressurise their dentist to get an antibiotic prescription, they also self-medicate (Dar-Odeh et al. 2010). Delayed prescriptions may have a role in dental prescribing in addressing patient expectations (McNulty et al. 2015), and dental schools should consider including this as part of their training. The importance of understanding local microbial antimicrobial susceptibility patterns when considering empiric treatments should be mentioned as part of dental training. Dental professionals have a duty of using best evidence-based practices available, that can enable them to educate their patients about the choices made and reasons for doing so (Johnson & Hawkes 2014).

- [The Prudent Antibiotic User](#) website shares standardised teaching materials for prudent antimicrobial prescribing for use in the undergraduate medical curriculum. This website provides standardised patient-focused and reflective learning teaching aides for all educators of antibiotic prescribing. These resources are designed to help students prepare for interactive sessions, that enable them to ponder on standard patient cases to their own clinical experience. Students are required to prepare using a structured format, and the interactive discussion sessions

enable reflective practice, enhancing learning on prudent antibiotic prescribing. The materials for the structure and content of each interactive session are available as a “PowerPoint” for tutors to use. These can also be adopted for postgraduate training.

- [SCRIPT](#) is an innovative e-learning resource for effective and appropriate prescribing practice that won the patient safety award (2013). It covers all ranks of prescribers both medical and non-medical, and also provides resources for undergraduates. More information on the module content and current medical schools using this for teaching purposes is found under appendix 3 (page 67) of this report. A resource for [nurses](#) in all sectors of healthcare is currently underway.

- TARGET (Treat Antibiotics Responsibly, Guidance, Education, Tools) [resources](#) aims to help influence health-workers, prescribers’ and patients’ personal attitudes, social norms and perceived barriers to optimal antibiotic prescribing. It includes a range of resources that can each be used to support health-workers, prescribers’ and patients’ responsible antibiotic use, helping to fulfil CPD and revalidation requirements. The [training resources](#) are available for free and can be accessed online by different health professionals, GPs, trainee GPs, medical students, GP trainers, physician assistants, practice nurses and non-medical prescribers. More information can be found in Appendix 4 (page 69).

- The [prescribing simulator](#) is an online training environment that provides the opportunity for prescribers to practice in a simulated online environment at any time or place. Users are presented with clinical scenarios that require a prescription on a certain prescription form. The prescription is then automatically scored and feedback is provided to guide the user as to where future improvements can be made.

- The competency framework for all prescribers (2016) expects prescribers to understand antimicrobial resistance and the roles of infection prevention and antimicrobial stewardship.

4. Antimicrobial stewardship—demonstrating an understanding of antimicrobial stewardship in day-to-day practice (eight statements).

Implementation for this competency was the fourth highest at 62% for all the statements included in this domain for all health courses answered for. The lowest implementation was observed for allied health professionals (25%), nursing (42%) and midwifery (51%). However some could argue that implementation for prescribing courses for example independent non-medical prescribing (77%) and dentistry (73%) may not be up to par. In addition pharmacy courses showed a 77% implementation rate too. Interestingly, recently published work mapping antimicrobial stewardship in undergraduate medical, dental, pharmacy, nursing and veterinary education in the United Kingdom found that 80.7% from 109 courses explicitly taught antimicrobial stewardship in their curriculum (Castro-Sánchez et al. 2016). Our work similarly received a comparative response rate of 100 courses in England (not the whole of the UK was included and veterinary schools were excluded). In terms of implementation rates, they found all dentistry and veterinary medicine schools (100%), 95% medical, 87% pharmacy schools and 63.2% nursing schools reported teaching antimicrobial stewardship. When probed further on inclusion of all the recommended principles of antimicrobial stewardship in their curricula, however only 36.3% implemented this (Castro-Sánchez et al. 2016). Undergraduates could

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benefit from the mention of current recommendations on antimicrobial stewardship practices even though these are only geared towards NHS organisations ([NICE 2015](#)). Awareness on the facts that antibiotic policies are used in practice by organisations and the compliance to these is important, ensuring appropriate recognition and management of patients with sepsis, and avoiding the use of broad-spectrum antimicrobials should be mentioned in the undergraduate curricula. This will ensure that practitioners of the future are aware of antimicrobial stewardship processes and their role in supporting this to ensure patient safety, through a reduction in morbidity and mortality linked to sepsis, AMR and healthcare associated infections.

Recent work exploring the coverage of antimicrobial stewardship across UK clinical postgraduate training curricula found this to be poor, with little depth of learning required. The authors have called for cross-specialty action to address this current lack of engagement (Rawson et al. 2016). Professional bodies, professional regulators and the royal colleges should take account of these findings, and consider making recommendations as part of their curricula reviews of health education institutions and postgraduate curricula.

Some of the other elements may be more applicable to foundation year trainees and not strictly to undergraduates. However a brief mention in undergraduate educational materials for all prescribers of “[Target](#)” and “[Start Smart – then focus](#)” can be made.

The [Antibiotic Guardian Campaign](#) was publicised to Universities in 2015 (DH 2015a). There were 1,302 student pledges taken and participation from 41 universities during last year’s World Antibiotic Awareness week and European Antibiotic Awareness Day (EAAD); future information on pledges taken will be available on [PHE fingertips](#). The winner of this year’s EAAD Antibiotic Guardian initiative was Hannah Bloor (undergraduate pharmacy student at the University of Manchester) for her work on raising awareness on antimicrobial awareness amongst high school students. She ran interactive workshops for year 10 high school students citing the fact that they are future patients and health professionals. She undertook an initial questionnaire on student knowledge and then ran a [prezi clip](#). She went through infections the students have heard about and went through hand-washing techniques. This has been delivered to 14 high schools to date. Her recommendations are for this to be included in the pharmacy student syllabus and for all third year students to go out and deliver these workshops. For more information contact Dr David Allison (Reader in Pharmacy Education, University of Manchester). The antibiotic guardian campaign was first started by members of CPPE at Manchester University in 2014. Last year’s event (2015) involved an inter-professional campaign that included undergraduate volunteers from the Schools of Pharmacy, Medicine and Nursing. This was also attended and supported by Sir Bruce Keogh, medical director to NHS England, where he [completed an online survey and signed up to be an Antibiotic Guardian](#).

e. Monitoring and learning—demonstrating continuing professional development in antimicrobial prescribing and stewardship (four statements).

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This showed the lowest implementation of 40% for all the statements included in this domain for all health courses answered for. This is understandable as it could be said that these statements are more applicable for use in practice rather than at undergraduate level. However these should be considered when students undertake their clinical placements. Involvement of clinical members of the multidisciplinary team e.g. antimicrobial pharmacists, infection control nurses, consultant microbiologists etc. in teaching session as external speakers could help address some of these statements at undergraduate level. This could help undergraduates understand the roles of other members of the multidisciplinary team and the roles of experts involved in antimicrobial stewardship practices. Examples of audits and surveillance undertaken in clinical settings can then be shared for student's awareness. Students should also be encouraged to undertake research around infection prevention and control and antimicrobial resistance and stewardship as part of their undergraduate dissertations. This can be achieved by universities linking up with local hospitals to encourage more collaboration. Educational outreach visits to local universities should be undertaken by members or representatives from local antimicrobial networks that exist around the country. This may give students the opportunity to understand more the issues and threats that surround antimicrobial resistance and stewardship.

There is particular concern on infections caused by Gram-negative bacteria, including Enterobacteriaceae, as resistance to multiple drugs is now accumulating in these species. Although the most serious MDR infections are in healthcare settings due to high antibiotic selective pressure and vulnerable patients, these bacteria are also spreading in the community ([DH & PHE 2014](#) & [PHE 2016](#)). Health and education institutions have an important role in informing staff of this serious challenge in the clinical management of infections, and educational interventions should be used to help support staff learning and awareness of this growing problem.

Providers, commissioners and local authorities have an important role in supporting the monitoring and learning around antimicrobial resistance. Providers should ensure that all prescribers receive induction and training in prudent antimicrobial use and are familiar with the antimicrobial resistance and stewardship competencies as per [The Health and Social Care Act 2008](#) requirement. There should be mandatory core training in prudent antibiotic use for [doctors, pharmacists and nurses](#), in addition to an introductory session on each induction programme that should be repeated every three years as defined by [national standards](#). Providers need to ensure that the principles and practice of prevention of infection (including cleanliness) are included in induction and training programmes for new staff, and that there is appropriate on-going education for existing staff (including support staff, volunteers, agency/locum staff and staff employed by contractors), which should incorporate the principles and practice of prevention and control of infection to comply with criterion 10 of [The Health and Social Care Act 2008](#). The [Care Quality Commission](#) will ensure registered providers comply with the infection prevention and antimicrobial resistance and stewardship requirements, and there is a record of training and update for all staff as set out in national [regulations](#).

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[Commissioners and local authorities](#) also have a role in ensuring prescribers meet their professional standards of education and [antimicrobial prescribing and stewardship principles](#) and 100% of medical and registered nursing/midwifery staff receive education as part of mandatory training on antimicrobial resistance. [Providers](#) need to provide information to [commissioners](#) on the numbers of different professional groups receiving training and competency assessment as per [antimicrobial prescribing and stewardship principles](#) compared to those that are eligible.

Leeds University run a series of 7 workshops over 2 days workshops for fifth year medical students. These are 30 minutes each focusing on key challenges for Foundation Year (FY1's) including antimicrobial prescribing. Other sessions cover anticoagulation, opioids, diabetes, fluids, CD writing and poly-pharmacy (Elderly), run over 24 sessions (11 – 12 per group). The antimicrobial prescribing session covers all the AMS competencies (PHE and ARHAI, 2013) and starts off with a future case scenario on antibiotics, prescribing antibiotics rationally, antibiotic discovery and resistance, the benefits of prescribing rationally, public health interventions and offers a case study for discussion. These sessions are run by [Mr Philip Howard](#) (Consultant Antimicrobial Pharmacist, Leeds Teaching Hospitals NHS Trust and Project Lead - Healthcare Acquired Infection and Antimicrobial Resistance at NHS England).

The PHE team from [Cheshire and Merseyside](#) developed an AMR strategy which has been adopted across the North West, with adaptations made to suit each locality. This work started following publication of the national UK AMR strategy in 2013, with one of the drivers being carbapenemase-producing Enterobacteriaceae (CPE) outbreaks in the area's hospitals. The PHE centre organised a workshop with all relevant stakeholders to discuss focus for the next three years, resulting in the formation of [five work streams](#); delayed/back-up prescribing, antimicrobial stewardship, education and training, near patient/point of care testing and intelligence on antibiotic prescribing and AMR.

Work on antimicrobial stewardship in collaboration with the education working group include:

- Undergraduate lectures: a new series of lectures has been incorporated into the second and third year undergraduate medical curricula (understanding bacteria & antibiotics; principles of antibiotic prescribing; and mix of common infections).
- An interactive population health seminar for third year medical students, exploring the topics of antimicrobial resistance and antibiotic stewardship in primary care.
- Interactive workshops and educational presentations for GPs in the Whiston and St Helens, Liverpool and Sefton areas, and workshops for pre-registration pharmacists.
- Recording educational seminars, to be made available online to medical students, junior doctors and GPs. Two interviews offering practical advice for junior doctors regarding antibiotic resistance have been recorded for BMJ Learning.
- Helping to facilitate research projects for final-year pharmacy students at John Moores University, examining aspects of antimicrobial prescribing in the community.

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The role of the education and training group is to focus on primary and community care and they:

- Identify and share high quality AMR education resources.
- Review CPD activities for medical and non-medical prescribers, practice nurses, community nurses, care home managers, dentists and community pharmacists.
- Work with the stewardship group to review how AMR is included in medical, dental, nursing and pharmacy undergraduate and postgraduate curricula, and develop a plan to strengthen this.
- Promote awareness of AMR amongst CCGs and other key influencers to encourage prioritisation of the reduction of antibiotic prescribing.
- Share learning with veterinary colleagues.

For more information please contact: Joanna Cartwright (Consultant in Health Protection, Cheshire and Merseyside, PHE) / Emer Coffey (Consultant in Public Health, Liverpool City Council and Sefton Council).

Modules are also available on [antibiotic resistance](#) and [gram-negative bacterial](#) infections on BMJ Learning.

This module on [Multi Resistant Gram Negative Bacilli](#) (MRGNB) developed in Scotland is aimed at supporting the understanding of the importance of infection control in reducing transmission of these bacteria and the role of antibiotic stewardship in limiting bacterial resistance.

Conclusion

We had an average response rate of 46% [medical (65%), pharmacy courses (52%), independent prescribing (48%), dental (46%), nursing (42%) & midwifery (25%)]. More may need to be done to explore how and what the rest of the 54% have done to implement the AMPS competences. The Medical Schools Council, Dental Schools Council, Pharmacy Schools Council, Council of Deans of Health and Health and Care Professions Council, should share the findings of this survey with their members and discuss this at their executive committee meetings. Areas for improvements and promotion of best practices should be highlighted to universities represented on these bodies.

The average implementation rate for all universities and courses was 67% for all the dimensions [infection prevention and control (91%), antimicrobial resistance and antimicrobials (75%), the prescribing of antimicrobials (66.3%), antimicrobial stewardship (62%) & monitoring and learning (40%)]. Again this may not be satisfactory for some courses, especially in relation to the levels of professional clinical practice expected from qualified professionals. HEE local offices should share the findings of this survey with their local universities, and ensure awareness is raised on the importance of education and learning around the principles of infection prevention and control, antimicrobial resistance and stewardship. The AMPS competencies can provide a useful guide in ensuring core elements are covered within the undergraduate curricula. HEE needs to promote these findings to the relevant professional

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bodies, royal colleges & professional regulators and encourage them to take account of these findings as part of their curricula reviews of health education institutions. ESPAUR should discuss these findings and consider any gaps that need addressing, including the provision of adequate and effective education tools for undergraduate students, around infection prevention and control and antimicrobial resistance and stewardship.

The main modes of antimicrobial resistance content delivery; methods used to evaluate learners' knowledge; learning hours assigned to antimicrobial resistance and infection prevention and control activities; inter-professional learning; and the availability of standalone courses and modules on antimicrobial resistance and infection prevention and control were all explored. These may need to be assessed further, especially the best ways to embed students understanding on antimicrobial resistance, stewardship and infection prevention and control, and how best to evaluate their learning. The time dedicated to teaching this may need further evaluation too and what the most appropriate average length should be. The content of the standalone courses and modules on antimicrobial resistance and infection prevention and control were not explored as part of this work, and may need to be evaluated further before they can be widely promoted. These should comply with the most up to date national recommendations and principles on infection prevention and control and antimicrobial resistance and stewardship. Universities should ensure they consider the results of this survey within their institutions, and ensure they use up to date national guidance and resources on antimicrobial resistance and stewardship in their learning materials to teach undergraduate students. Clinical tutors and lecturers should be made aware of how and where to access the latest national information on principles around infection prevention and control, antimicrobial resistance and antimicrobial stewardship.

The uptake of online learning resources around infection prevention and control and antimicrobial resistance and stewardship for undergraduate learning, should be encouraged and supported by the Medical Schools Council, Dental Schools Council, Pharmacy Schools Council, Council of Deans of Health and Health and Care Professions Council. The availability of access to the eLfh resources by students late in 2017 should be widely promoted and uptake encouraged, especially to resources that will help support the implementation of the AMPS competencies. All stakeholders should consider the importance of ensuring students are aware of how to recognise, and assess patients on the risk of developing antibiotic associated hypersensitivity reactions. An educational resource to support this learning for all health workers should be considered. Provision for data collection on usage and feedback of these resources by undergraduates, may prove beneficial in understanding how best to target, and provide education for the future workforce.

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Appendix 1: Table showing compliance to each dimension and statements for each professional group, in addition to areas explored around courses that were altered or updated to support the achievement of the AMPS competencies, main modes of antimicrobial resistance content delivery, methods used to evaluate learners' knowledge about antimicrobial resistance content, and whether they provided training resources on recognition and treatment sepsis.

	Dentistry	Pharmacy	Medicine	Midwifery	Nursing	Independent prescribing	Other / AHP
Total number of course responded=	5 courses	13 courses	17 courses	13 courses	23 courses	22 courses	7 courses
COMPETENCY 1: Infection Prevention and Control.							
The nature and classification of pathogenic micro-organisms	5 (100%)	13 (100%)	17 (100%)	12 (92%)	20 (87%)	14 (64%)	7 (100%)
How micro-organisms cause infections in humans: the importance of understanding the differences between colonisation (eg of venous leg ulceration) and infection	5 (100%)	13 (100%)	17 (100%)	11 (85%)	19 (83%)	15 (68%)	7 (100%)
How micro-organisms are transmitted in both community and hospital settings.	5 (100%)	13 (100%)	17 (100%)	12 (92%)	22 (96%)	16 (73%)	7 (100%)
The principles and practice of the prevention and control of infection, and the need to have this reflected in individual job descriptions	5 (100%)	12 (92%)	16 (94%)	11 (85%)	19 (83%)	17 (77%)	7 (100%)
How current vaccines can benefit prescribing practices, including reducing the need for prescribing antimicrobials and decreasing resistant antimicrobial resistant strains eg of S. pneumoniae	5 (100%)	13 (100%)	17 (100%)	9 (69%)	19 (83%)	17 (77%)	5 (71%)
COMPETENCY 2: Antimicrobial resistance and antimicrobials							

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The modes of action of antibiotics and other antimicrobials	5 (100%)	13 (100%)	17 (100%)	7 (54%)	15 (65%)	21 (95%)	3 (43%)
Knowledge of the spectrum of activity for commonly prescribed antimicrobials	5 (100%)	13 (100%)	17 (100%)	7 (54%)	11 (48%)	18 (82%)	2 (29%)
The appropriate use of antimicrobial agents for prophylaxis to minimise the risk of infection and treatment of infections	5 (100%)	13 (100%)	17 (100%)	8 (62%)	14 (61%)	19 (86%)	2 (29%)
The use of microbiological and other investigations to diagnose and monitor the response to treatment of infections and their complications, such as severe sepsis, for individual patient care and for public health purposes	5 (100%)	13 (100%)	17 (100%)	9 (69%)	15 (65%)	14 (64%)	3 (43%)
The mechanisms of antimicrobial resistance including intrinsic or acquired resistance; the importance of selection advantages eg the greater ability for some to colonise, to alter virulence, and how this can be an amplification process for antimicrobial resistance	4 (80%)	13 (100%)	17 (100%)	7 (54%)	9 (39%)	13 (59%)	4 (57%)
The appropriate use of antimicrobials to prevent the emergence of resistance and avoidance of adverse effects eg their disruptive effects on host normal flora, which may lead to, for example, C. difficile infection, Candida spp infection	5 (100%)	13 (100%)	16 (94%)	8 (62%)	13 (57%)	14 (64%)	3 (43%)
COMPETENCY 3: Prescribing antimicrobials.							
Not initiating antibiotic treatment in the absence of bacterial infection	5 (100%)	11 (85%)	17 (100%)	6 (46%)	9 (39%)	20 (91%)	2 (29%)
An understanding of the key elements of prescribing an antimicrobial including: •Obtaining microbiological cultures or other relevant tests before commencing treatment as necessary	5 (100%)	13 (100%)	17 (100%)	5 (38.5%)	8 (35%)	18 (82%)	1 (14%)

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<ul style="list-style-type: none"> •The choice of agent •The route of administration •Its pharmacokinetics and how this affects the choice of dosage regimen •How to monitor levels and adjust doses eg in the aged or renal impairment, or where to seek specialist advice •Decisions to switch agent e.g. from intravenous to oral, narrower to broader spectrum (or vice versa) based on microbiological results •The duration of treatment and when to consider review/stop dates 							
Knowledge of how to select the appropriate antimicrobial, paying due consideration to local guidance, how, and where, to access this	4 (80%)	13 (100%)	17 (100%)	6 (46%)	3 (13%)	21 (95%)	2 (29%)
An understanding of local microbial antimicrobial susceptibility patterns when considering empiric treatments	3 (60%)	13 (100%)	16 (94%)	1 (8%)	0	17 (77%)	0
An understanding of common side-effects, including allergy, drug/food interactions, contraindications of the main classes of antimicrobials, and the importance of monitoring for these, and what to do when these are suspected e.g. documenting allergic reactions in patient records	5 (100%)	12 (92%)	17 (100%)	9 (69%)	13 (57%)	20 (91%)	5 (71%)
An awareness of trade and generic names, and the class, of a prescribed antimicrobial to avoid possible harm to patients in whom that antimicrobial is contraindicated e.g. due to hypersensitivity, coagulopathy or organ impairment	5 (100%)	13 (100%)	16 (94%)	10 (77%)	11 (48%)	20 (91%)	4 (57%)
Knowledge of when not to prescribe antimicrobials,	5 (100%)	10 (77%)	16 (94%)	6 (46%)	8 (35%)	22 (100%)	3 (43%)

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and use of alternatives, such as the removal of invasive devices, eg: intravenous or urinary catheters and incision and drainage of abscesses							
Knowledge of when to use a delayed antimicrobial prescription and how to negotiate this with the patient	3 (60%)	9 (69%)	15 (88%)	0	0	20 (91%)	0
COMPETENCY 4: Antimicrobial Stewardship.							
Using local guidelines to initiate prompt, effective antimicrobial treatment within one hour of presentation, or as soon as possible, in patients with life-threatening infections	4 (80%)	9 (69%)	16 (94%)	9 (69%)	15 (65%)	19 (86%)	1 (14%)
Recognition and treatment of sepsis	4 (80%)	11 (85%)	17 (100%)	10 (77%)	17 (74%)	13 (59%)	4 (57%)
Avoiding the unnecessary use of broad-spectrum antimicrobials	5 (100%)	13 (100%)	17 (100%)	9 (69%)	14 (61%)	19 (86%)	3 (43%)
Documentation in the prescription chart and/or in patients' clinical records, the clinical indication, route, dose, duration and review date of antimicrobials	4 (80%)	11 (85%)	17 (100%)	10 (77%)	17 (74%)	20 (91%)	2 (29%)
Using only single doses of antimicrobials for surgical and other procedures for which prophylaxis has been shown to be effective, unless the duration of the operation/procedure is prolonged, there has been excessive blood loss or published national recommendations suggest otherwise. (16,17)	3 (60%)	9 (69%)	16 (94%)	8 (62%)	6 (26%)	16 (73%)	1 (14%)
Switching to the correct antimicrobial when susceptibility testing indicates resistance, or to a cheaper or more cost effective antimicrobial that is also compatible with the clinical presentation	4 (80%)	13 (100%)	17 (100%)	5 (38.5%)	7 (30%)	16 (73%)	2 (29%)
In primary care, awareness of HPA national guidance (18) and use of TARGET Antibiotics toolkit	2 (40%)	5 (38.5%)	9 (53%)	0	0	18 (82%)	0

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In secondary care (13), reviewing antimicrobial prescriptions for Hospital inpatients on all ward rounds (see 13). Appropriately choosing one of the five antimicrobial prescribing decisions 48 hours after initiating antimicrobial treatment (ARHAI Guidance – Start Smart – then Focus) ⁵ a. Stop antibiotics if there is no evidence of infection b. Switch antibiotics from intravenous to oral administration c. Change antibiotics – ideally to a narrower spectrum – or broader if required d. Continue and review again at 72 hours e. Outpatient Parenteral Antibiotic Therapy (OPAT)	3 (60%)	9 (69%)	15 (88%)	2 (15%)	2 (9%)	15 (68%)	1 (14%)
COMPETENCY 5: Monitoring and learning							
Engaging the views of others involved in antimicrobial treatment policy decisions including championing best practice, and that it is a duty of care to cooperate with others more expert than oneself when such expertise is required	3 (60%)	8 (62%)	11 (69%)	4 (31%)	7 (30%)	16 (73%)	1 (14%)
Regular engagement in team based measurement of the quality and quantity of antimicrobial use and understanding that this should be shared with prescribers, as well as informing antimicrobial surveillance/infection prevention and control measures	2 (40%)	4 (31%)	9 (53%)	2 (15%)	2 (9%)	14 (64%)	1 (14%)
Using locally agreed process measures of quality (e.g. compliance with guidance), outcome and balancing	2 (40%)	6 (46%)	10 (59%)	3 (23%)	4 (17%)	15 (68%)	1 (14%)

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measures, such as unintended adverse events or complications							
Using the results of adverse event monitoring, laboratory susceptibility reports, antimicrobial prescribing audits and antimicrobial usage data to inform, in a timely manner, best antimicrobial prescribing practices, and so produce sustained improvements in the quality of patient care	3 (60%)	7 (54%)	12 (71%)	3 (23%)	2 (9%)	15 (68%)	1 (14%)
Q 14. Have any of the courses you have provided information about been altered or updated to support the achievement of the competencies listed since the publication of the ARHAI antimicrobial prescribing and stewardship competencies in 2014? Yes / No	Yes = 1 (20%) No = 3 (60%)	Yes = 2 (15%) No = 11 (85%)	Yes = 11 (65%) No = 5 (32%)	Yes = 1 (8%) No = 7 (54%)	Yes = 4 (17%) No = 10 (43.5%)	Yes = 10 (45%) No = 10 (45%)	Yes = 0 No = 5 (71%)
Q 15. What was the main mode of antimicrobial resistance content delivery in 2014-15?							
Online teaching	0	1 (8%)	5 (29%)	0	2 (9%)	4 (18%)	0
Blended teaching (classroom and online activities)	0	9 (69%)	10 (59%)	7 (54%)	8 (35%)	13 (59%)	4 (57%)
Small group training	3 (60%)	7 (54%)	13 (77%)	1 (8%)	3 (13%)	5 (23%)	1 (14%)
Classroom based teaching	4 (80%)	8 (62%)	13 (81%)	9 (69%)	13 (57%)	10 (45%)	2 (29%)
Placements	3 (60%)	5 (38%)	12 (71%)	9 (69%)	14 (61%)	9 (41%)	3 (43%)
Q 16. What method was used to evaluate learners' knowledge about antimicrobial resistance content?							
Essay	0	1 (8%)	0	1 (8%)	1 (4%)	5 (23%)	1 (14%)
Objective structured clinical examination (OSCE) stations	2 (40%)	9 (69%)	11 (69%)	3 (23%)	2 (9%)	8 (36%)	2 (29%)
Student presentations	2 (40%)	4 (31%)	5 (32%)	2 (15%)	4 (17%)	3 (13%)	2 (29%)
Student portfolio	1 (20%)	2 (15%)	4 (25%)	2 (15%)	5 (22%)	9 (41%)	1 (14%)
Short answer examination	2 (40%)	7 (54%)	8 (47%)	1 (8%)	3 (13%)	8 (36%)	1 (14%)
Long answer examination		10 (77%)	2 (13%)	1 (8%)	1 (4%)	1 (5%)	0

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Multiple choice question examination	4 (80%)	10 (77%)	16 (94%)	1 (8%)	8 (35%)	12 (55%)	2 (29%)
Q 23. There is often a perception that focus on AMR might pose a risk to patients with severe sepsis receiving urgent treatment. Does your institution provide training resources on recognition and treatment sepsis? Yes / No / Don't know	Yes = 4 (80%). Don't know = 1 (20%)	Yes = 7 (54%) No = 4 (31%)	Yes = 14 (82%) Don't know = 3 (19%)	Yes = 5 (38%) Don't know=3 (23%) No = 3 (23%)	Yes = 15 (65%) Don't know = 5 (22%) No = 4 (17%)	Yes = 9 (41%) Don't know = 5 (23%) No = 4 (18%)	Yes = 3 (43%) Don't know = 1 (14%) No = 2 (29%)

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Appendix 2: Information on the teaching hours universities dedicated to antimicrobial resistance and infection prevention and control

	Antimicrobial Resistance teaching in hours	Infection Prevention and Control teaching in hours
Dentistry	University of Birmingham = 2	University of Birmingham = 5
	University of Bristol = Difficult to establish accurately, certainly >10 hours formal teaching	University of Bristol = Difficult to establish accurately, certainly >10 hours formal teaching
	Newcastle University = 20	
	University of Plymouth = AMR Integrated and Spiralled throughout 5 year programme.	University of Plymouth = IPC Integrated and Spiralled throughout 5 year programme.
	University of Sheffield = 8	University of Sheffield = 12
<i>Total:</i>	<i>40 hours (average 10 hours)</i>	<i>27 hours (average 9 hours)</i>
Pharmacy	University of Bath = 150	University of Bath = 0
	University of Bradford = 6 hours	University of Bradford = 3-4 hours
	University of Brighton = 15	University of Brighton = 15
	University of Central Lancashire = 12	University of Central Lancashire = 10
	University of Greenwich = 5	University of Greenwich = 2
	University of Hertfordshire = 20	University of Hertfordshire = 15
	Keele University = 40	Keele University = 40
	Liverpool John Moores University = 11	Liverpool John Moores University = 6
	King's College London = Our course is integrated it is too difficult to untangle the teaching hours	King's College London = Our course is integrated it is too difficult to untangle the teaching hours
	University of Nottingham = 12	University of Nottingham = 6
	University of Portsmouth = 6	University of Portsmouth = 2
<i>Total:</i>	<i>277 hours (average 27.7 hours)</i>	<i>99.5 hours (average 9.95 hours)</i>
Medicine	University of Birmingham = 2	University of Birmingham = 3
	University of Brighton = 4	University of Brighton = 4
	University of Central Lancashire = AMR only year one of the course so far - not possible to give an answer for all five	University of Central Lancashire = AMR only year one of the course so far - not possible to give an answer for all five

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years yet	years yet
University of East Anglia = Difficult be precise - this is a PBL based course so the concept is covered during independent learning as well as during classroom based teaching. As this is a systems based course, the subject is covered repeatedly during all 5 years but comes up during appropriate teaching e.g. RTIs, UTIs, bone infection, sepsis etc. There are a minimum of 4 hours specific ABx lectures during the course, but all lectures on infection cover ABx and resistance as a matter of course.	University of East Anglia = covered informal classroom based teaching, PL scenarios, clinical placements.
Imperial College London= 8	Imperial College London= 6
Lancaster University = 40 AMR It is not appropriate to separate IP and antimicrobials for the general themes of infection diagnosis and treatment. (See below). Therefore we embed the antimicrobial issues in the infection teaching. This is currently about 40 hours for the course and expanding	Lancaster University= 40 AMR It is not appropriate to separate IP and antimicrobials for the general themes of infection diagnosis and treatment. (See below). Therefore we embed the antimicrobial issues in the infection teaching. This is currently about 40 hours for the course and expanding
King's College London = AMR Impossible to quantify as blended through clinical attachments	King's College London = IPC Impossible to quantify as blended through clinical attachments
University of Manchester = 15 (these figures are rough estimates as it is not possible to provide exact figures for a PBL based programme	University of Manchester = 10
Newcastle University: AMR Difficult to quantify. We run a 4 week rotation in infection in stage 3 with teaching in years 1 2 4 and 5 on this topic.	
University of Oxford = 10	University of Oxford = 10
University of Plymouth = 1	University of Plymouth = 0.5
University of Sheffield: Cannot be determined as integral	University of Sheffield: Hard to determine as is an integral

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	part of formal teaching and clinical placements including general practice placements	part of formal teaching and clinical placements, including general practice placements
	Warwick Medical School = Cannot specify due to the nature of clinical attachments	
	Queen Mary, University of London = 10	Queen Mary, University of London = 16
Total:	<i>84 hours (average 10.5 hours)</i>	<i>73.5 (average 10.5 hours)</i>
Midwifery	Bournemouth University = 5	Bournemouth University = 10
	University of East Anglia = this varies across courses	University of East Anglia = this varies across courses and with mandatory updates.
	Liverpool John Moores University = 15	Liverpool John Moores University = 30
	University of Manchester = 8	University of Manchester = 20
	Oxford Brookes University = 4	Oxford Brookes University = 30
	Staffordshire University: difficult to quantify as taught over 3 yr curriculum	Staffordshire University: difficult to quantify as taught over 3 yr curriculum
	University Campus Suffolk = 2	University Campus Suffolk = 6
Total:	<i>34 hours (average 6.8 hours)</i>	<i>96 hours (19.2 hours)</i>
Nursing	Anglia Ruskin University = approx 2- 3 hours	Anglia Ruskin University = IPC Difficult to quantify but students spend 750 hours per year (3 year course) in clinical practice and 20% of their practice competencies focus on infection prevention and control ~ 150 hours?
	University of Birmingham = 4	University of Birmingham = 10
	Bournemouth University = 5	Bournemouth University = 10
	University of Chester = 3	University of Chester = 18
	Coventry University = 2-3 hours	Coventry University = 2-3 hours
	University of East Anglia: this varies across courses	University of East Anglia: this varies across courses and with mandatory updates.
	University of Hertfordshire = 1	University of Hertfordshire = 18

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	Kingston University = 2	Kingston University = 20
	University of Liverpool = 2 hours	University of Liverpool= 25 hours
	Liverpool John Moores University = 15	Liverpool John Moores University = 30
	Northumbria University = This is integrated into sessions rather than in stand alone sessions.	Northumbria University = There are dedicated classroom and online sessions and the content is also integrated into other sessions.
	Open University = 1	Open University = 4
	Oxford Brookes University = 4	Oxford Brookes University = 30
	Staffordshire University: difficult to quantify as taught over 3 yr curriculum	Staffordshire University: difficult to quantify as taught over 3 yr curriculum
	University of Surrey = 8	University of Surrey = 32
	University of the West of England = 1	University of the West of England = 3
	University Campus Suffolk = difficult to identify - covered in both theory and practice	University Campus Suffolk = difficult to identify - covered in both theory and practice
Total:	<i>52 hours (average 4 hours)</i>	<i>352.5 hours (average 27 hours)</i>
Independent prescribing courses	Bournemouth University = 15	Bournemouth University = 15
	University of Brighton = 15	University of Brighton = 15
	Coventry University = 2-3 hours	Coventry University = 2-3 hours
	University of East Anglia = 5	University of East Anglia = this varies across courses and with mandatory updates.
	University of Greenwich = 5	University of Greenwich = 2
	University of Hertfordshire = 3	University of Hertfordshire = 2
	Kingston University = 2	Kingston University = 20
	Liverpool John Moores University = 15	Liverpool John Moores University = 30
	King's College London = Our course is integrated it is too difficult to untangle the teaching hours	King's College London = Our course is integrated it is too difficult to untangle the teaching hours
	Northumbria University = This is integrated into sessions	Northumbria University = There are dedicated classroom

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	rather than in stand alone sessions.	and online sessions and the content is also integrated into other sessions.
	Oxford Brookes University = 4	Oxford Brookes University = 30
	University of Surrey = 8	University of Surrey = 32
<i>Total:</i>	<i>74.5 hours (average 7.45 hours)</i>	<i>148.5 (average 16.5 hours)</i>
Allied Health Professionals	Bournemouth University = 0	Bournemouth University = 3
	Oxford Brookes University = 4	Oxford Brookes University = 30
<i>Total:</i>	<i>4 hours (average 4 hours)</i>	<i>33 hours (average 16.5 hours)</i>

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Appendix 3: Further information on universities that use SCRIPT as part of their undergraduate teaching, those that are exploring this as an option, and the content.

Academic institutions with access to SCRIPT are:	UK medical schools that are trialling SCRIPT:
University of Southampton	Imperial College.
University of Birmingham*	University College London
Warwick Medical School	University of Leicester
Queen Mary University of London	
Keel School of Medicine	
Kings College London	
University of Liverpool	

* At the University of Birmingham, Pharmacy undergraduates (3rd and 4th years) and non-medical prescribers in training have access to the modules.

The modules relating to infection are:

Principles of Prescribing in Infection

Learning outcomes

- Describe the different classes of antibacterials available and their site of action on a microorganism.
- Describe how bacteria can be resistant to antibacterials.
- Explain why certain antimicrobials might be restricted in a Trust, and how access to them could be obtained.
- Know where to look for guidelines on treating infections and why adherence is important.

Infection in Secondary Care

Learning outcomes

- Select the most appropriate drug, dose, route and duration of treatment for commonly encountered infections in secondary care.
- Describe which antibacterials are contraindicated in patients who are pregnant or breastfeeding, or who have hepatic or renal dysfunction.
- Recall the common drug-drug interactions encountered when prescribing in infection.
- Explain when to consult senior clinical advice.
- Explain how and why to monitor and review treatment.
- Describe where to look for information regarding the safe and effective management of infection, both locally and nationally.

Since the SCRIPT modules are focused on prescribing and therapeutics, the content covers: microbiology and infectious diseases, antimicrobial resistance and stewardship, and include recommendations from NICE AMS guidance and “Start Smart-Then Focus” from Public Health England in the content.

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Sepsis

Learning outcomes:

- Discuss the spectrum of infection and continuum of sepsis.
- Use evidence-based reputable action tools to help you screen patients for their risk of sepsis.
- Recognise the signs of sepsis and identify whether the patient is at high or moderate risk of sepsis.
- List situations where patients may not manifest the traditional signs and symptoms of sepsis.
- Discuss the factors to consider when prescribing for the patient with sepsis.
- List the six elements of the Sepsis Six[®] Care bundle and the timeframe in which these should be administered.
- Discuss good antimicrobial stewardship relating to the management of sepsis.
- Discuss the ongoing management of the patient with sepsis, including the importance of source control.

Antibiotic allergy

This has been covered in the 'Drug Allergy and Anaphylaxis' module which is found under the 'Principles of Prescribing' section of the resource. Areas covered include cross-reacting drugs, prediction of risk and managing allergic reactions.

Learning outcomes:

- Take an accurate history of any previous reactions to drugs, medicinal and related products and non-drug allergies.
- Examine a drug chart, and decide which drugs might pose a risk to the patient in light of known allergies.
- Recognise the signs and symptoms of allergic reactions to drugs.
- Distinguish allergic reactions from other adverse drug reactions.
- Manage acute allergic reactions to drugs.
- Arrange appropriate follow up in cases of suspected drug reactions.

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Appendix 4: Information on TARGET (Treat Antibiotics Responsibly, Guidance, Education, Tools) resources.

The TARGET Antibiotics Toolkit aims to help influence health-workers, prescribers' and patients' personal attitudes, social norms and perceived barriers to optimal antibiotic prescribing. It includes a range of resources that can each be used to support health-workers, prescribers' and patients' responsible antibiotic use, helping to fulfil CPD and revalidation requirements.

The [training resources](#) are available for free and can be accessed online by different health professionals, GPs, trainee GPs, medical students, GP trainers, physician assistants, practice nurses and non-medical prescribers.

The TARGET Antibiotics Toolkit is designed to be used by the whole primary care team within the GP practice or out of hours setting. These resources can be used flexibly, either as standalone materials or as part of an integrated package. It is recommended that all resources are used if this is feasible.

Using the resources in the TARGET Antibiotics Toolkit will enable primary care organisations to demonstrate compliance with the Health and Social Care Act 2008: Code of Practice on the prevention and control of infections and related guidance. The Toolkit also supports recommendations made in the recent NICE guideline: [Antimicrobial stewardship: systems and processes for effective antimicrobial medicine use](#).

TARGET was developed by the Antimicrobial Stewardship in Primary Care (ASPIC) collaboration which was established in 2009 and includes:

- Public Health England
- Royal College of General Practitioners
- Department of Health
- British Society for Antimicrobial Chemotherapy
- Care Quality Commission
- British Infection Association
- National Prescribing Centre
- Infection Prevention Society and British Paediatric Allergy, Immunology and Infectious Diseases Group
- Royal College of Nursing
- Health Protection Scotland
- Public Health Wales and Northern Ireland
- NHS Information Centre
- interested GPs, pharmacists and microbiologists

These training resources cover different areas:

1. **TARGET antibiotics group presentation:** This presentation through clinical cases aims to provide up to date evidence to primary care clinicians about

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why optimising antibiotic prescribing is important and how this can be achieved. The presentation lasts 60 minutes and includes slide notes and references. It can also be modified. It may be given by GPs, microbiologists or medicine managers with an interest in antibiotic use, and can also be used by less experienced presenters or within a GP practice.

2. **TARGET antibiotic resistance in primary care [online course](#):** This course will assist you in identifying the need for optimised antibiotic prescribing, as well as equipping you with tools for improving your antibiotic prescribing. Evidence showing the link between prescribing and resistance rates in GP patients is explored and useful resources to use in your surgery are included.
3. **Skin infections [online course](#):** Skin infections are commonly seen in general practice. With ever increasing rates of antibiotic resistance, it is important for GPs to feel confident about making a diagnosis and to understand when antibiotic treatment is indicated. This course describes common presentations of bacterial, viral and fungal skin infections and outlines their management.
4. **Managing acute respiratory tract infections (MARTI) [training e-module](#):** The MARTI series of training modules enables you to improve the care you provide to patients presenting with acute ear pain, acute sore throat, sinusitis and acute cough. It explains why it is crucial to evaluate your everyday prescribing decisions and gives examples of methods you can use to do this, as an individual and within a practice, and encourages you to identify barriers to change. It also reviews the clinical knowledge, communication skills and tools needed to assess and treat patients most effectively.
5. **Urinary tract infections [training e-module](#):** Urinary tract infections are frequently seen in primary care. What may seem initially a simple diagnosis, on closer inspection and reflection can be quite complex. This course explains the importance and appropriateness of diagnostics and offers advice on how to assess and treat patients with a range of urinary symptoms. It encourages reflection on how to minimise antibiotic resistance and offers 'real-life' cases.
6. **Managing infectious diarrhoea [training e-module](#):** This course uses case studies to illustrate various points in the clinical management of patients with infectious diarrhoea, as well as covering the public health issues involved. The wider differential diagnosis of diarrhoea is also discussed.