MAPPING EDUCATIONAL OPPORTUNITIES AND RESOURCES FOR HEALTH-CARE WORKERS TO LEARN ABOUT ANTIMICROBIAL RESISTANCE AND STEWARDSHIP

Human Resources for Health Observer Series No. 21

World Health Organization

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Abbreviations

AMR	antimicrobial resistance
AMS	antimicrobial stewardship
ASP	antimicrobial stewardship programme
BSAC	British Society for Antimicrobial Chemotherapy
CDC	Centers for Disease Control and Prevention
CDDEP	Center for Disease Dynamics, Economics and Policy (Washington, DC, USA)
CME	continuing medical education
EAAD	European Antibiotic Awareness Day
ESCMID	European Society of Clinical Microbiology and Infectious Diseases
GARP	Global Antibiotic Resistance Partnership
GHWN	Global Health Workforce Network (WHO)
HCW	health-care worker
IPC	infection prevention and control
LMICs	low- and middle-income countries
MAD-ID	Making a Difference in Infectious Diseases
MOOC	massive open online course
NGO	nongovernmental organization
NPS	National Prescribing Service (Australia)
ScRAP	Scottish Reduction in Antimicrobial Prescribing
Strama	Swedish Strategic Programme Against Antibiotic Resistance
WAAW	World Antibiotic Awareness Week
WHO	World Health Organization

Executive summary

Antimicrobial resistance (AMR) is an important global problem facing society and health-care workers. The misuse and overuse of antimicrobials over the past 50 years has accelerated the development of resistance to antimicrobial agents; and with few new antibiotics in development, it is essential that we preserve the usefulness of existing ones for as long as possible. Effective AMR control requires the optimal prescription and use of antimicrobials. Health-care workers need to be engaged in solving this problem as advocates for rational antibiotic use, stewards of sustainable effectiveness and educators of their patients. However, changing practice will require substantial effort, as few health-care workers currently receive training on AMR and rational antibiotic use.

Effectively combating AMR requires skilled health-care workers equipped with competencies regarding the use of antimicrobials. As evidenced by the Global Strategy on Human Resources for Health: Workforce 2030, health-care worker practice is influenced by a variety of other factors, including economic incentives, professional norms, the management environment and regulatory mechanisms. Ensuring progress in tackling AMR as part of the broader objective to "optimize the performance, quality and impact of the health workforce" is, therefore, best carried out as part of a holistic approach addressing simultaneously all the aforementioned components. World Health Organization (WHO), Member States and partners' efforts to create conducing environments within strengthened health systems for health workers are required to help ensure a fit-for-purpose and people-centred health workforce. A key component of this agenda includes providing health workers with the skills to tackle priority health issues such as AMR, both as part of their pre-service education and through opportunities to engage in continuous professional development.

In this report, we identify educational programmes on AMR that target health-care workers and health-care students, particularly in medicine, pharmacy and nursing. We contacted many experts and conducted a literature review and web search to compile a list of 91 recent educational initiatives that target health-care workers. In undertaking this search, our intention was not to be comprehensive; rather, we aimed to illustrate the range of approaches that have been taken to delivering AMR education for health-care workers. The identified programmes were developed and deployed in every WHO region. Many different groups of health-care workers were targeted, though physicians and pharmacists were the most commonly served groups. A wide range of programme types were identified, including resource websites, awareness campaigns, online and in-person courses, guidelines, workbooks and videos. Most of these programmes were created by governments or academic and professional societies, though universities, medical schools and hospitals also contributed. Many countries have expressed an interest in increasing the pre-service AMR education available to their students, but we identified only a few good examples of formal educational curricula for pre-service education of health-care students.

Funding for the programmes that we identified came from a range of sources, including government departments, professional and academic societies, industry, charitable foundations and WHO regional offices. Unfortunately, for many programmes it was not possible to identify their funding source.

This mapping exercise shows that many organizations are working to develop and share educational content on AMR for health-care worker training and continuing education around the world. This exercise also helped identify several opportunities for action.

- First, there is an opportunity to develop better competency frameworks and/or educational curricula and training opportunities for health-care workers during their pre-service education. Such a competency framework/curriculum could improve educational outcomes, and facilitate the implementation of educational programmes by reducing the time needed to develop learning materials in each country. To improve pre-service education, new curricula could incorporate active learning strategies that enable students to better integrate their knowledge on AMR with practice.

- Second, in-service training for current health-care workers seems to be under-recognized by existing professional development and continuing education programmes. Many excellent programmes and resources exist; however, busy physicians and other health-care workers may not have the time to participate if these educational opportunities are voluntary. Formally recognizing and accrediting these opportunities may incentivize participation. This aligns with the goals of the transformative education agenda of the United Nations High-Level Commission on Health Employment and Economic Growth, which advocates for the integration of quality education and life-long learning into health workforce policies in countries.

This mapping can inform efforts that contribute to the ultimate goal of ensuring that the necessary competencies, such as appropriate prescribing, and infection prevention and control, are embedded in AMR curricula of health education and training institutions. There is a number of excellent existing educational opportunities with which to engage health-care workers and students without needing to re-invent the wheel. While there are gaps in existing educational coverage and content, many useful resources were found that can be expanded and adapted to meet needs and ensure that all health-care workers receive sufficient training on AMR and stewardship. Regulators and professional councils should be engaged in devising strategies to facilitate the uptake and scale-up of AMR-related pre-service education and in-service training initiatives.

1 Introduction

Antimicrobial resistance (AMR) is a looming global health problem; misuse and overuse of antimicrobials over the past 50 years has accelerated the development of resistance to antibiotics and other antimicrobial drugs among many organisms *(1)*. Antibiotic agents have made possible much of modern medicine, including the ability to carry out routine surgeries, such as joint replacements and caesarean sections *(2, 3)*. With few new antibiotics in development *(4–6)*, it is essential that we preserve the usefulness of existing antimicrobials as long as possible.

In their capacity as prescribers, health-care workers (HCWs) will need to shoulder much of the burden in stewarding the preservation and longevity of antimicrobial agents. Inappropriate use of antimicrobials – such as prescribing antibiotics for viral illnesses or prescribing broad spectrum antibiotics where a narrow spectrum antibiotic would be preferable – can drive the development of resistance. In making smart prescribing choices, HCWs can reduce the genetic selection pressure that drives the development of resistance. Beyond the choices they make as prescribers, HCWs have a role to play in infection prevention and control (IPC), and to serve as advocates for rational antibiotic use and as educators of their patients. Health-care workers can provide their patients with information on safe and smart uses of antibiotics, and teach them that not every infection is a good candidate for antimicrobials. As evidenced by the Global Strategy on Human Resources for Health: Workforce 2030 *(7)*, HCW practice is also influenced by a variety of other factors, including economic incentives, professional norms, the management environment and regulatory mechanisms. Ensuring progress in tackling AMR as part of the broader objective to "optimize the performance, quality and impact of the health workforce" is, therefore, best carried out as part of a holistic approach addressing simultaneously all the aforementioned components. The efforts of the World Health Organization (WHO), Member States and partners to create conducing environments within strengthened health systems for HCWs are required to help ensure a fit-for-purpose and people-centred health workforce. A key component of this agenda includes providing HCWs with the skills to tackle AMR, both as part of their pre-service education and through opportunities to engage in continuous professional development. It is recognized that countries are at different stages of development regarding AMR education and training. However, the varying standards, quality and implementation in many countries leave gaps that cannot be ignored, especially in lower resource settings. The contribution of WHO, mapping available AMR educational resources, will ensure a guided process to developing tools. The education hub of the WHO Global Health Workforce Network (GHWN) *(8)* and the WHO online discussion forum for the development and implementation of AMR national action plans *(9)* are examples of active platforms for continued intersectoral engagement and policy dialogue to maximize the utility of the identified and prospective resources.

2 Method

We sought to identify AMR educational programmes targeting HCWs. For breadth, programmes were identified through multiple methods, including contact with key experts, web searches, and academic literature searches. An initial literature search in August and September 2016 identified educational programmes and key academic researchers who had published in the field over the previous decade. We emailed these key experts and others identified by WHO regional office contacts to request information relating to educational programmes on AMR and antimicrobial stewardship (AMS). A snowball strategy was applied to identify further experts, and additional experts were contacted as we progressed through web searching. Experts were asked to identify any recent or ongoing educational programmes on AMR/AMS in their country or region, and whether they were aware of any funding opportunities on AMR education.

We further identified educational programmes through online web searches. We hand-searched the websites of several relevant organizations to identify past and current educational opportunities. We also conducted a non-systematic web search using combinations of search-terms such as “antimicrobial resistance”, “antibiotic resistance”, “antibiotic stewardship”, “education”, “course”, “curriculum”, “workshop” and region or country in September and October 2016. Relevant articles, project reports, course flyers and other resources were reviewed to identify programme descriptions and further sources of information. We examined national action plans concerning AMR in search of references to educational initiatives. Once identified, these programmes were followed up with additional online research as necessary.

We summarized the identified programmes in tabular form, including participating organizations, programme types, region and intended audience. We then classified programmes, creating codes to assign categories for programme type, organization type and WHO region. Programmes that were not associated with any specific region (such as resources that were globally available and without a geographical target population) were classified under a “global” regional heading. As necessary, programmes were coded with multiple programme type codes. Programme type and organization codes were developed and updated iteratively as programmes were identified to form distinct separations and identify commonalities between initiatives. A full list of programme type codes and explanation is available in Appendix 1 (Table A1). After the inclusion and classification of all programmes, we described a group of larger, multifaceted programmes, which we titled “umbrella programmes.” Umbrella programmes were defined as those including four or more different programme types; we chose four programme types as the cut point based on the identification of many similarities between programmes with four or more programme type codes.

3 Results

3.1 Mapping educational initiatives

In total, 91 educational initiatives related to AMR/AMS were identified in our mapping exercise. The 91 initiatives represent a diverse array of programmes, including formal courses and workshops, conferences, guidelines, public outreach materials and online resource websites. The complete list of initiatives is available in the Appendix 2 (Table A2).

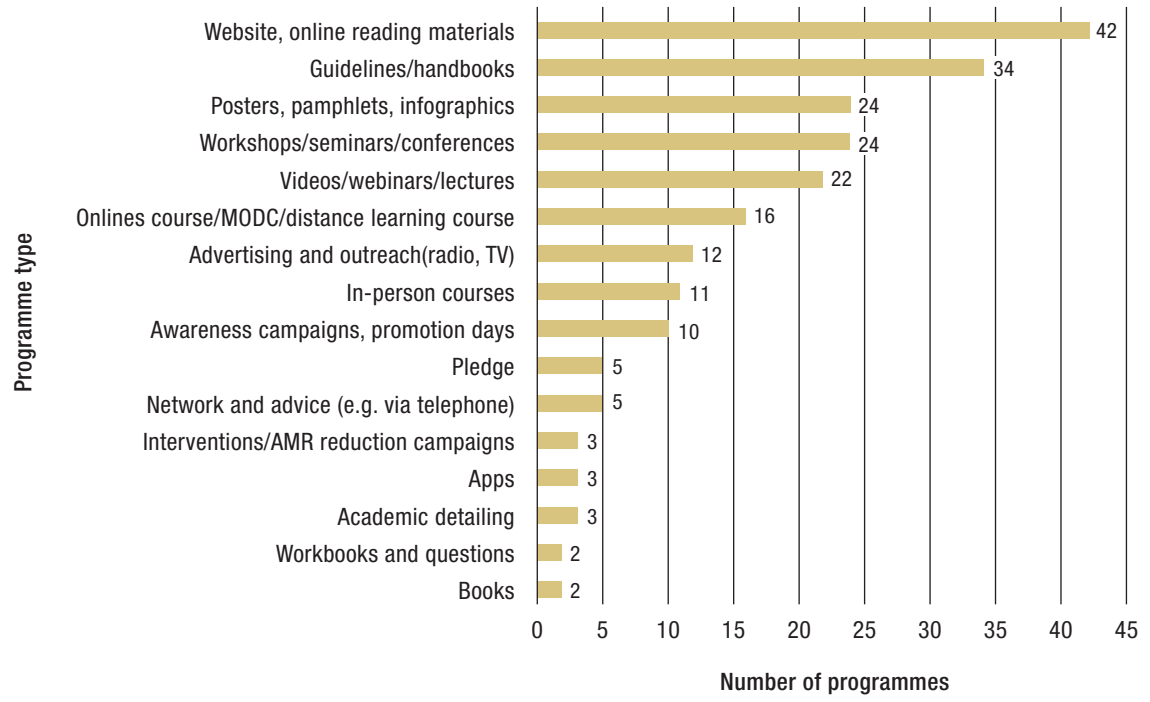
We identified 24 multi-component umbrella programmes, which typically included web-based resources, videos, references to guidelines and promotional materials, such as posters, pamphlets or infographics. Umbrella programmes tended to have broader target audiences and wider scopes; in many cases their awareness campaign materials and posters were targeted towards a general audience, while online reading and guidelines were more often aimed at HCWs. Many umbrella programmes targeted their messaging at HCWs as a group, rather than targeting each profession individually. Often programmes targeted physicians and pharmacists, while others included nurses. Other target groups that were few but notable included midwives, medical students, medical residents, nursing home staff and paediatricians. Not all programmes stated their target audience; for some, we inferred the target audience based on the resources available.

Of the programmes identified (see Figure 3.1), the most common type was websites; typically, however, online resources were only part of a larger program. This is unsurprising as online resources are effective platforms for sharing multiple programme types, including videos, guidelines, pamphlets and workbooks. Guidelines and handbooks were also a common resource, often shared online in government and hospital education initiatives. Guidelines and handbooks often described information about key patient populations and prescribing guidelines, and were intended as reference resources. By contrast, we also identified a small number of workbooks and question sets intended as teaching resources.

Other teaching resources available online included videos, webinars and lecture slides, made available for reference and independent study. Online courses, including massive open online courses (MOOCs), are increasingly common and often incorporate online videos and discussion boards to engage with participants. In autumn 2016 there were two MOOCs running simultaneously on the FutureLearn platform (Initiatives no. 44 and no. 87). The MOOC run by the University of Dundee and British Society for Antimicrobial Chemotherapy (BSAC) (Initiative no. 87) has become popular globally. Several experts we consulted from around the world referenced this course as a resource being used in their country. Participants in the first two course sections came from 41 different countries; a third session recently ended, and there are plans to translate the course contents into Spanish and Mandarin.

Less common programme offerings included pledges, where physicians, pharmacists and other HCWs sign a document pledging to be more careful antibiotic stewards. The Philippines has a particularly comprehensive set of pledge documents as part of their Win the War Against AMR campaign (Initiative no. 86), with separate pledge sheets for registered pharmacists, future pharmacists, physicians, future physicians, other HCWs and patients. While these pledges are also an advocacy tool, we found that the websites and pledge sheets often conveyed several key educational messages about appropriate prescribing very succinctly, and could be a useful tool for engaging with HCWs. Most pledge documents and sites summarized the risks of AMR, the importance of IPC, the need for rational antibiotic use, and the need for patient engagement and education. Sharing pledge documents online is an interesting strategy for raising awareness and conveying key messages with other HCWs without enrolling them in formal educational courses.

Figure 3.1 Identified AMR education programmes by type

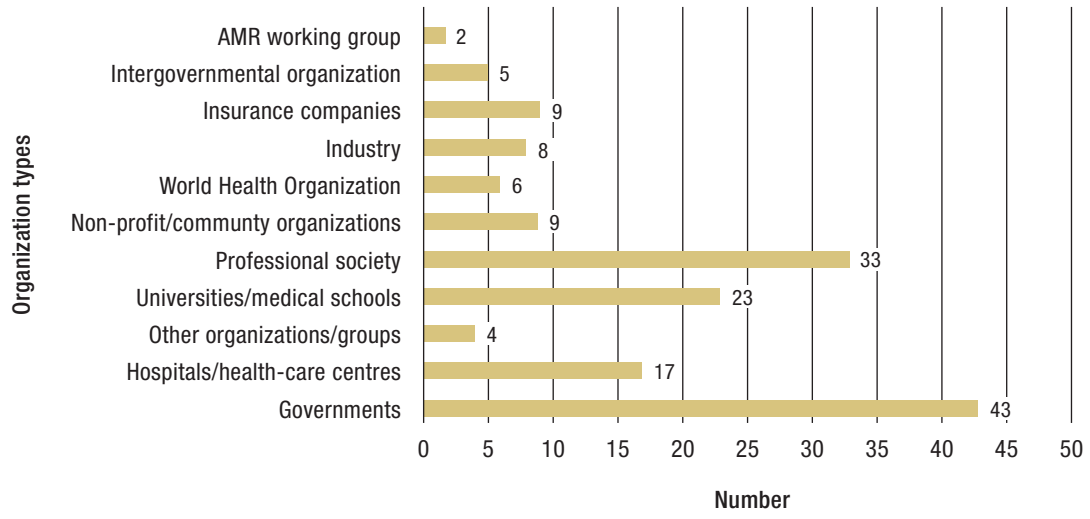


We grouped participating organizations by type, as shown in Figure 3.2. Names of specific participating organizations for each educational project can be found in the Appendix 2 (Table A2). Overall, the most commonly identified organizations were governmental bodies – often the national/provincial/state-level body responsible for health and/or education. In the United States of America we found that it was common for the state-level health department to partner with the Centers for Disease Control and Prevention (CDC) and several other organizations to provide a large educational campaign which adapted elements of the CDC Get Smart programme. We also found that health insurance companies often partnered with other organizations in the United States of America to support AMR education campaigns. Elsewhere in the world, the only other campaigns that partnered with a health insurance provider were in France.

Professional societies, particularly those with a strong tie to AMR, were heavily involved in the creation and provision of resources for HCWs. Three examples include: the BSAC, which has been involved in the creation of resource websites, coordination of a MOOC (Initiative no. 87) and provision of funding for AMR education; the European Society of Clinical Microbiology and Infectious Diseases (ESCMID), which runs a study group on antimicrobial resistance, develops and coordinates courses, and carries out collaborative academic research; and the Infection Control Africa Network, which organized a free distance learning course for HCWs in Africa in 2014. Many professional bodies with broader mandates, for example medical associations and paediatric societies, have partnered with others to support larger projects but were rarely the lead organization in the projects that we identified. For example, the NPS MedicineWise project (Initiative no. 82) in Australia engaged the Australian College of Nursing, Australian Association of Consultant Pharmacy, the Australian College of Rural & Remote Medicine, and the Australian Nursing and Midwifery Federation and many others alongside, government bodies to produce resources and course content for the website. However, there were a small number of examples where societies with broad mandates took the lead; as discussed later, the Philippines Pharmacists Association has been working to develop curriculum modules on pharmacy-led AMR interventions.

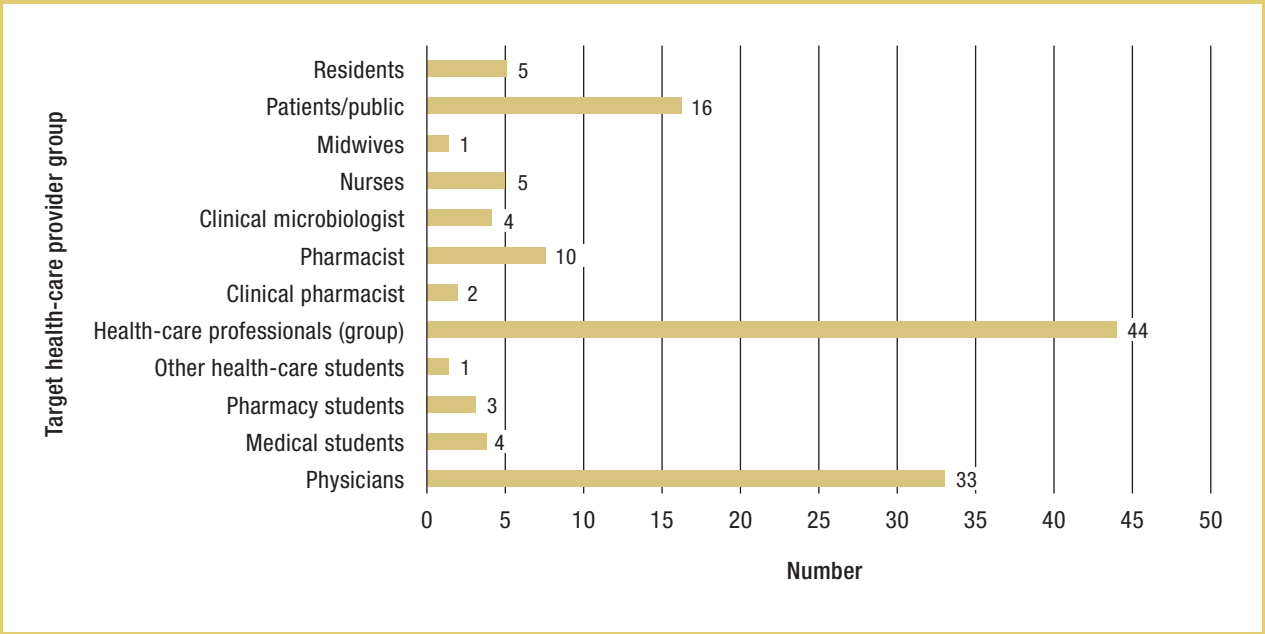
University-led projects were typically related to courses and resource websites. Many of these sites provide lecture slides, or recorded video lectures, as well as information on guidelines and policies. Other organizations were engaged in a wide variety of projects. Hospitals and health-care centres, for example, engaged with broad umbrella programmes, courses and workshops, intervention studies and resource guides. Collaborations with industry came almost entirely from North America. The European Centres for Disease Control contributed to the bulk of projects which we tagged as intergovernmental organizations.

Figure 3.2 Organization types



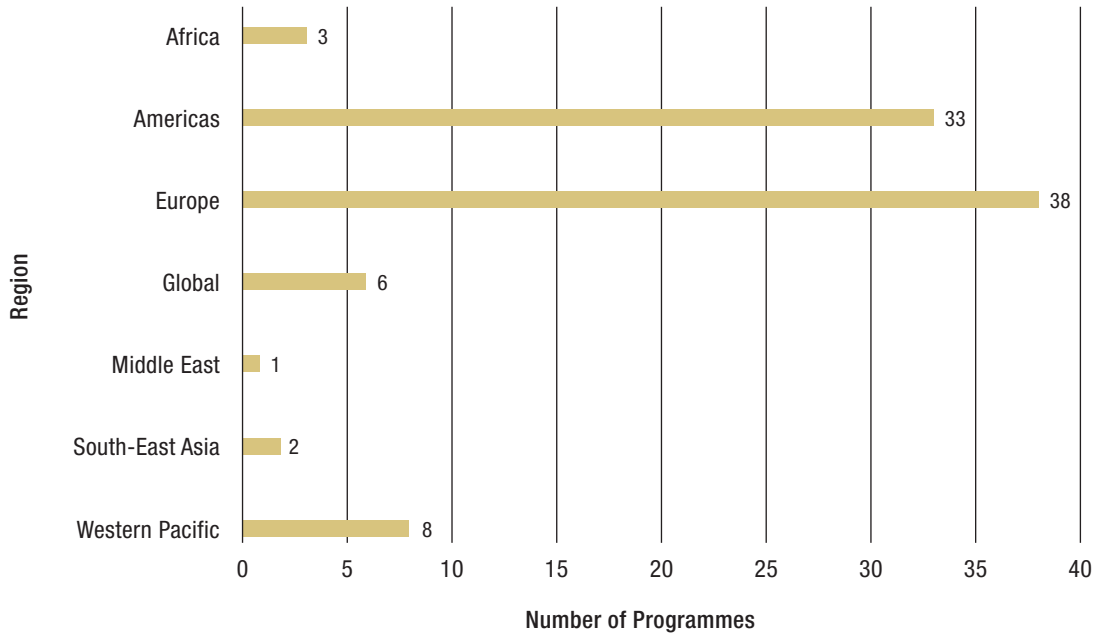
Most of the programmes identified in Table A2 were broadly targeted at HCWs as a group. Figure 3.3 shows the target audiences for the 91 programmes that we identified. Several of these broadly focused programmes also included components aimed at patients and the public. We found 33 programmes aimed at physicians, including a small number that targeted specialists such as infectious disease physicians and paediatricians. While nurses, pharmacists and midwives were targeted through the general HCW programmes, fewer programmes targeted them specifically. A small number of programmes, predominantly based in universities, targeted medical and pharmacy students. Four programmes, particularly courses and workshops, targeted clinical microbiologists alongside other HCWs.

Figure 3.3 Target health-care worker groups



We identified programmes from each WHO region, though, as expected, they were unequally distributed between countries and regions, with a larger share from the Americas and Europe (see Figure 3.4). This discrepancy is due partially to language barriers, which limited the effectiveness of our web searching strategy in some regions, but also represents a difference in the level of resources available for AMR/AMS education in low- and middle-income countries (LMICs). Many of the large-scale AMR/AMS educational campaigns took place in wealthy American and European countries, whereas many of the programmes in Africa and Asia were workshop or course based. There were many easily identified programmes in the United States of America, because several initiatives were based on existing programmes, and adapted to the local context in conjunction with local partners. This strategy facilitated the growth of programming in specific regions, and has made online information about AMR/AMS widely available to HCWs and the public. For instance, state-specific AMR educational initiatives, such as "Get Smart Colorado: Use Antibiotics Wisely" (Initiative no. 17), appeared to tailor new resources and share/endorse existing resources from the comprehensive national "Get Smart" programme (Initiative no. 15) produced by the CDC in the United States of America.

Figure 3.4 Identified AMR educational programmes by region



3.2 Pre-service education curricula

Few countries have mandated that students in the health-care professions be taught AMR or AMS during their education, and even fewer have formally developed an AMR or AMS curriculum. Table 3.1 summarizes the types of engagement in AMR/AMS curriculum development that we encountered in our research. At the earliest stage, we found countries which highlighted the development of a curriculum or commitment to including AMS and/or IPC in all stages of HCW education as part of their national action plan on AMR *(10, 11)*. Other countries have already imposed a requirement of including AMR/AMS topics in medical or HCW education *(12, 13)*, but we were unable to locate information on the contents of any such training programmes. At the highest level, a small number of countries, including the United Kingdom, have developed formal curricula for training HCWs. These countries have formal curricula with competencies and expectations for each level of training. Finally, some universities and nongovernmental organizations (NGOs) have independently undertaken the development of AMR/AMS curricula or are developing modules to fit the mandate. In the United States of America, Wake Forest University Medical School partnered with the CDC under the auspices of the Get Smart programme to develop a curriculum for medical students *(14)*. While the curriculum is not mandatory for American medical schools, Wake Forest makes the curriculum resources freely available on their website. Resources include lecture slides and video recordings, examination questions in the format of the United States Medical Licensing Examination, and small group case study activities (with facilitator notes) for students undertaking five different clerkship specializations: family medicine, internal medicine, surgery, paediatrics and emergency medicine.

It is of note that many curriculum development initiatives have taken place outside of Europe and North America. Several Asian countries, including the Philippines, Bangladesh, Bhutan, Indonesia and Thailand, have implemented a national guideline that health-care students receive education on AMR during their studies. In the Philippines, AMR has also been included as part of national licensing exams. To support the national mandate, the Philippine Pharmacists Association has been working to develop curriculum modules on pharmacy-based AMS interventions. In the Lao People's Democratic Republic, all medical students attend a single university. While it does not yet include AMS, their curriculum includes credits on antibiotic prescribing, antibiotic resistance and rational use of medicines; the curriculum is reviewed and updated every year *(15)*. Finally, in Nepal, one of the major initiatives of the Global Antibiotic Resistance Partnership (GARP) has been the creation of a curriculum on AMR for undergraduate medical students; a project that will be completed in 2016 *(16)*.

Table 3.1 Location and target audience for curriculum development efforts by level of curriculum development

LEVEL OF CURRICULUM DEVELOPMENT	EXAMPLES	
	Location	Audience
AMR/AMS education in action plan	South Africa	Health professional students
	Sweden	Health professional students
	Australia	Health professional students
National guideline to include AMR in training programme	The Philippines	Health professional students
	Bangladesh	Pharmacy students*
	Bhutan	Medical students, pharmacy students, nursing students*
	Indonesia	Medical students, nursing students*
	Thailand	Medical students*
	Netherlands	Health professional students
Formal curriculum developed	United Kingdom	Medical students, pharmacy students, nursing students
	Lao People's Democratic Republic	Medical students
	Denmark	Medical students
	Norway	Medical students
Independently developed curricula	United States of America: Wake Forest University	Medical students
	Canada: University of Toronto	Medical students
	South Africa: Stellenbosch University, University of Witwatersrand, University of KwaZulu-Natal	Infection prevention and control practitioners
	Nepal: GARP and the Nepal Public Health Foundation	Medical students (in development)
	Philippine Pharmacists Association	Pharmacists
	Zambia: University of Zambia School of Medicine	Medical students

* From communication with WHO South-East Asia Regional Office.

We identified fewer formal government mandates for curriculum development in Africa; however, we did find examples of independent work in this field. In South Africa, three large universities have partnered to develop a common core curriculum for IPC practitioners *(17),* and a ministerial advisory committee has been formed to provide advice on core curricula for AMR *(18)*. In Zambia, the University of Zambia School of Medicine hosted a series of workshops in 2007 to review and consider revisions to their curriculum on AMR; discussions included core topics for instruction and teaching methods and led to a revised curriculum *(19)*.

3.3 Funding sources

Table 3.2 provides an overview of some funding mechanisms for AMR/AMS education identified in our research, along with examples of each. It was difficult to identify funding partners for many projects; as such the table is neither exhaustive nor necessarily representative. However, for those projects where we could identify the funding source they were often funded by one of five entities: government, professional/academic societies, industry, regional/local foundations or WHO regional offices. Funding by government department was most common among projects where we could identify the funding sources; this was often because the larger umbrella campaigns were run by or in conjunction with the local ministry of health. Often these campaigns were aimed at both HCWs and the public, with specialized resources targeting each audience.

Several projects, particularly courses such as the FutureLearn MOOC, received funding from professional and academic organizations. The BSAC is a major player in this field, funding not only the MOOC, but partnering on several resource websites and action groups, and it also offers one of the few grant programmes that we identified specific to education on AMR and AMS. Grants are available to fund projects for improving undergraduate and postgraduate teaching on AMR, projects to improve public education on AMR, and for the assessment of educational interventions on AMR *(20)*.

Industry funding, from pharmaceutical companies, medical device companies and others, ranged from grants to support the development of a website for a professional organization (e.g. the Federation of Infectious Diseases Societies of Southern Africa) to larger grants to fund entire projects. Some websites clearly indicated that funding from industry was unrestricted and financing did not influence the contents of the project or website, while in other cases the relationship between the programme and industry funder was unclear. It is of note that some organizations, such as ReAct, clearly state that they will not accept industry funding for their projects *(21)*.

The last major source of funding we identified was from WHO regional offices, particularly in Asia. WHO has provided funding for a wide range of projects in the region, including educational workshops, early phase public education campaigns, collaborative research projects and training abroad for HCWs. Finally, some organizations and projects have funding from small local foundations; this is a useful source of funding but likely to be available only on a case-by-case basis.

Table 3.2 Examples of funding partnerships by type

FUNDING SOURCE	EXAMPLE
Government department	NPS MedicineWise is funded by the Department of Health, Government of Australia.
	Do Bugs Need Drugs is funded by Alberta Health Services and the British Columbia Centre for Disease Control, Canada.
	ReAct is funded by the Swedish International Development Cooperation Agency.
	In 2016, the United Kingdom Department of Health launched a funding competition to fund projects that advance the country's ability to tackle AMR.
Professional societies and academic affiliated organizations	The FutureLearn MOOC on antibiotic stewardship is funded by the BSAC.
	The BSAC has a funding pool available to fund research projects and initiatives aimed at: • Improving undergraduate or postgraduate teaching on antimicrobial chemotherapy in the United Kingdom. • Development/delivery of initiatives that promote awareness and public understanding about antibiotics. • Development and assessment of educational interventions that aim to reduce inappropriate prescribing of antimicrobial agents.
	GARP is funded by the Center for Disease Dynamics, Economics and Policy (CDDEP).
	The ESCMID provides research grants for young researchers and to study groups looking to do collaborative research on AMR.
	The Australian Society of Antimicrobials provides annual grants of up to Aus$ 25 000 to support original research conducted by its members.
Industry	The Alliance for the Prudent Use of Antibiotics has received funding from several industry and pharmaceutical partners, including Alere Inc, BioMérieux Inc, Bayer Healthcare Pharmaceuticals, Clorox Healthcare, and BacterioScan.
	The Center for Infectious Disease Research and Policy at the University of Minnesota, has received grant funding for their Antimicrobial Stewardship Project from Merck, and unrestricted financial support from Gilead and 3M.
	The Federation of Infectious Diseases Societies of Southern Africa has received funding from Aspen Pharmacare to run their website.
	The National Information Program on Antibiotics (Canada) received an educational grant from Pfizer and funding from Rogers Media.
Regional/local foundations	The Center for Infectious Disease Research and Policy at the University of Minnesota, has also received unrestricted financial support from the Bentson Foundation, which provides funding for higher education and public health initiatives specifically in the Minneapolis/St Paul area of Minnesota.
	ReAct has also received financial support from the the Kjell and Marta Beijer Foundation in Sweden.
WHO regional offices	Phase 1 of the Smart Use programme in Thailand was partially funded by WHO.
	In the Philippines, WHO financially supported the training of two pharmacy fellows at Singapore General Hospital. They also financially supported two advocacy workshops in 2015 and the development of a manual of procedures for AMS implementation in hospitals.
	Research partnerships between ReAct and universities in South-East Asia have been predominantly funded by the WHO South-East Asia Regional Office.
	The WHO Western Pacfici Regional Office partnered with the Government of Viet Nam to organize the first Vietnamese Antibiotic Awareness Week in 2015.

* From communication with WHO South-East Asia Regional Office.

4 Discussion

This mapping exercise shows that many organizations are working to develop and share course content and educational resources for both HCW training and continuing education around the world. We identified several types of resources, from traditional in-person courses, workshops and conferences, to MOOCs, online campaign materials, handbooks and workbooks. Governments, hospitals and professional societies, in particular, appear to be driving action on this front; all have been successful in creating partnerships with other types of organizations, including non-profits, insurance companies and WHO regional offices.

This level of work and collaboration is promising; however, we have identified opportunities for further action on several fronts.

- First, there is an opportunity for the development of better educational curricula and training opportunities for HCWs during their pre-service education. Implementing this change now, and introducing consistent messaging on AMR/AMS around the world, would likely have an impact going forward as students graduate to become prescribers.

- Second, in-service training for current HCWs is probably under-recognized by professional development and continuing education programmes. HCWs need to have their AMR learning efforts formally recognized, as they may find it more difficult to engage in substantial additional training on a purely voluntary basis.

Below we discuss how addressing these two elements of training, both pre-service and continuing education, can improve the content, delivery, uptake and scale-up of AMR/AMS education, and identify programmes that are interesting models for development of further resources.

4.1 Pre-service training curricula

We found that many countries had identified AMR/AMS education as a priority in their national action plans, or had mandated at the national level that health-care students receive AMR/AMS training. However, we also found very few examples of formal educational curricula for all health-care students, and particularly for nursing, midwifery and dentistry students.

The National Health Service in England has embedded a set of competencies into the curriculum of health professional schools; students now receive approximately 10 hours of AMR instruction and 15 hours of IPC instruction *(22)*. An evaluation, three years after the curriculum was introduced, suggests that implementation is high among pharmacy, medical and dental schools, with an average of 81%, 90% and 82% respectively, for implementation of the five competencies. The implementation among other health-care students has been lower, and points to the need for curricula that is targeted by HCW group. In nursing, for example, there has been only 29% implementation of the competency on prescribing antimicrobials *(22)*; this is likely because nurses do not regularly prescribe medicines unless they have completed advanced training *(23)*.

The lack of formal curricula in other countries is important because several studies have shown that medical students would like more training on antibiotic prescribing *(24–28)*. Without detailed curriculum content, it is difficult to ascertain where the gaps in content coverage exist. A survey of medical schools in Europe found that nearly all students received some training on the prudent use of antimicrobials. When investigated in more detail, however, it was found that many topics were not taught, or only partially covered *(13)*. This study found that audit and feedback for assessing prescribing practice was not covered in 43% of medical schools, and educating patients about the need for prudent antibiotic prescribing was not covered in 46% of schools. Other important topics, such as the need to prescribe antibiotics in accordance with national and local practice guidelines, were taught in approximately half of schools. It is clear from this study that, despite having a school-level curriculum for AMR/AMS, several important gaps in coverage remain.

4.2 Improving content and delivery

Considering the gaps in education and curricula coverage, there is an opportunity to improve pre-service training content and delivery by developing a competency framework and/or a series of AMR/AMS curricula targeted to different groups of health-care students. Such a competency framework/curriculum would need to include specific learning outcomes and competencies that would ensure a minimum coverage of AMR content across disciplines and countries; preferably such a competency framework/curriculum would also be flexible and adaptable to local needs and health system capacities. We would recommend using the curricula developed in England as a starting point, but developing a version that is easy to adapt to local contexts and is translated into several languages.

Researchers from the ESCMID Study Group for Antibiotic Policies have suggested that undergraduate training should be focused on principles of AMS and on building good prescribing habits, while continuing medical education courses should be about implementation, measurement of practice and changing habits *(29)*. Pre-service training might therefore include content such as IPC, resistance mechanisms, antimicrobial mechanisms, when to prescribe an antimicrobial, how to choose the appropriate antimicrobial, and prescribing in accordance with local guidelines. The ESCMID will be offering an in-person course in October 2017 that includes a component on teaching medical students and residents about AMR/AMS (Initiative no. 75). Educational research suggests that the undergraduate level of training should ideally be delivered through active learning sessions, which allow students to integrate their knowledge with practice *(29, 30)*. Use of these educational practices in medical education has been increasing over the past several years, particularly in Europe and North America; however, more than half of medical school content is still taught using didactic lecture methods in the United States of America *(30, 31)*. Examples of active learning methods include flipped classrooms, problem-based learning, simulation-based education and team-based learning *(30)*. We identified some resources for this type of educational practice, including the small group case studies and facilitator guides from Wake Forest University *(14)* and the e-learning vignettes on sore throat, surgical site infections, urinary tract infections provided by NHS Education for Scotland (Initiative no. 63). The MOOCs have also been successful at integrating a more varied type of educational resource, including video interviews with experts, case study videos, and discussion boards (Initiatives no. 44 and no. 87).

The key principles of AMR/AMS will be similar across all disciplines, however, we recommend using specialization-specific case studies, vignettes, and simulations. The Wake Forest University case studies have been structured in this way so that students encounter different case studies as they complete rotations in family medicine, paediatrics, emergency medicine and surgery *(14)*. Creating different case studies by specialty allows students to actively engage with the issues that they will encounter in practice. The timing of the Wake Forest University case studies, during clinical rotation, agrees with the recommendation by Pulcini and Gyssens that training of prescribers should begin during undergraduate studies to shape prescriber behaviour early; they suggest training on AMS and prudent prescribing begin in the third year of undergraduate medical education or equivalent for other HCWs *(29)*.

Adapting existing AMR/AMS curricula and educational content to active learning strategies will not be easy. While these strategies have been used in Europe and North America, many other countries still rely completely on didactic lecture methods, and both students and professors will find it difficult to adapt. A medical school in Malaysia recently worked with professors from Johns Hopkins University, United States of

America, to implement the Johns Hopkins medical school curriculum. In a qualitative study, students noted that Malaysian-style education was lecture-based, students were discouraged from asking questions, and examinations were based on rote memorization, while American-style education was interactive, encouraged students to ask questions and examinations focused on integration of knowledge. Students ultimately adapted to the new style and supported the change, but found the transition difficult *(32)*. Based on these experiences, we expect that implementing active learning strategies for AMR/AMS will also require training for professors on the broader goals and methods of these education strategies, as well as the provision of curricula and resource packages.

4.3 Improving uptake

Many countries have identified AMR/AMS education as a priority in their national action plans or have mandated at the national level that health-care students receive AMR/AMS training. This step should be promoted to countries that have not yet made AMR/AMS education a priority. We recommend that a basic AMR/AMS curriculum/competency framework is developed that includes a series of basic competencies and learning outcomes for pre-service training of HCWs. Development of this curriculum resource/competency framework could expedite and facilitate the roll-out of better pre-service AMR/AMS in many countries since countries will not need to create a full AMR curriculum from scratch.

Ideally, this curriculum resource/competency framework would be comprehensive, and yet flexible enough that countries could adapt it to suit their local context. This is important as an essential and ongoing component of AMR/AMS education for HCWs will be the need to stay apprised of the local AMR context; for example, HCWs must have knowledge of the level of resistance for different drug and bug combinations in their country and region. Countries must also be able to adapt the content to reflect differences in health-care systems, and in the roles of members of a hospital AMS team, based on the types of HCWs that participate. For example, in discussions with experts, we learned that neither France nor the Lao People's Democratic Republic trains or employs clinical pharmacists; all pharmacists in these health systems are employed in dispensing roles. In this type of system, a physician or other qualified HCW must fill the role typically played by a clinical pharmacist in audit and feedback programmes. In other countries, such as the Netherlands, experts told us that clinical microbiologists played a key role in AMS efforts. Given these differences it is therefore important that any training modules or curricula that are developed are flexible enough to account for these differences. It is very likely that regional adaptations will be necessary, but different training may also be necessary within countries to account for differences between rural and urban practices. A balance will need to be struck between ensuring that all HCWs receive adequate training on the basics of AMR/AMS, and yet that training is flexible enough to be adapted to suit the context in which each HCW will be delivering care.

4.4 Curricula resources to build on

The curricula developed in the United Kingdom by Public Health England for health-care students *(33)* and by the Royal Pharmaceutical Society Faculty, United Kingdom Clinical Pharmacy Association, and Pharmacy Infection Network for pharmacists *(34)* would be an excellent model from which other curricula could be built. These curricula are the most detailed that we identified in our research; they consist of five and six key competencies, respectively. Public Health England's curriculum includes IPC, AMR and antimicrobials, prescribing antimicrobials, AMS, and monitoring and learning; there are a total of 31 specific learning goals within these five categories. The pharmacy curriculum consists of six key competencies: infection and AMS in context, clinical infection management principles, clinical microbiology, antimicrobials, management of clinical syndromes, and principles of an AMS plan. This curriculum is somewhat more detailed than the Public Health England curriculum; within each section there are several learning goals, each coded as general (common clinical pharmacy knowledge) or specialist (specific to infection and AMS), and as advanced stage I, advanced stage II and mastery level. For example, knowing the roles and responsibilities of an antimicrobial pharmacist is considered general knowledge, while the role of the antimicrobial pharmacy

service in delivering AMS is considered specialist level at advanced stage 1 *(34).* The methods applied in developing this programme have been published according to an open access policy *(35)* and the documentation on this curriculum is clear, detailed and easily available online, making it an ideal model for other countries to adapt and modify to suit their own circumstances.

4.5 In-service training and continuing education

With regards to in-service training and continuing education, researchers from the ESCMID Study Group for Antibiotic Policies, who have been providing courses on AMR/AMS for over 10 years, have recommended that all HCWs who are in contact with patients must, as a minimum, be educated on: the principles of resistance, the lack of benefit from using antibiotics for some conditions, microbiology laboratory tests to guide antibiotic treatment, and how to manage demanding patients. In their continuing education workshops, the group also focuses on measuring antibiotic use, auditing antibiotic use, and improving antibiotic use *(29)*; this can be seen in their upcoming course (Initiative no. 75). We identified other continuing education courses from Europe and North America that offer training on similar topics, including the Making a Difference in Infectious Diseases (MAD-ID) programme aimed at pharmacists (Initiative no. 22), the BSAC MOOC (Initiative no. 87), and the Public Health Ontario Stewardship Workshop (Initiative no. 6). The continuing education courses that we identified from Africa took a different approach, with a broader focus on IPC and more disease-specific prescribing information (Initiatives no. 1 and no. 2) or on rational use of medicines (Initiative no. 3), but not specific to antibiotics.

4.6 Improving scale-up

We found that many excellent courses already exist, and several are available online at low or no cost. Participation in the MOOCs (Initiatives no. 44 and no. 87) was also free, though participants who wanted proof of their participation needed to pay for the certificate. Another online course, the Infection Control Africa Network course (Initiative no. 2), was available free of charge to participants in Africa. As the content is already available, improving roll-out is a matter of ensuring that these courses can run repeatedly; preparing a course for a single session is likely a waste of resources. Another way to improve roll-out is to facilitate translation of course materials into other languages. Consulted experts noted that translating currently available content, such as a MOOC, from English into other languages is a slow and difficult process. In Canada, pharmacists participated in an adapted version of the MAD-ID programme from the United States of America (Initiative no. 21); this would have been much more difficult if Canada and the United States of America did not share a common language. In addition to lecture slides, there is a need to obtain other resources, such as academic articles and video content, in the foreign language. A database that brings together resources on AMR/AMS in other languages would facilitate the adaptation of courses from one language to another.

Improving uptake of existing educational opportunities is also key. We note that among the resources identified in Table A2, very few are accredited as continuing professional education. This is probably a major oversight – and opportunity – as evidence suggests that HCWs are not receiving enough training on AMR/AMS *(36)*. It is likely that HCWs would be incentivized to participate if the courses were accredited as continuing medical education (CME), as HCWs in many countries must undertake several hours of CME per year. Experts that we spoke with expressed a desire to have courses accredited as CME, but found the process challenging and slow. To date, most courses have been developed by academic societies and there is an opportunity here for greater collaboration between academic societies and professional societies. Academic societies have knowledge and resources at their disposal, and, by partnering with professional societies such as paediatrics societies or nurses' associations, could adapt their existing programmes to meet the specific training needs of these health-care specializations and provide training to a larger number of HCWs. Regulators and professional councils should be engaged in devising strategies to facilitate the uptake and scale-up of AMR-related pre-service education and in-service training initiatives.

4.7 Continuing education resources to build upon

The National Prescribing Service MedicineWise (Initiative no. 82) resource website from Australia has a number of useful tools for continuing education and professional development. While only available in English, online case study based learning modules are available for antimicrobial prescribing, bacterial infections, urinary tract infections, pneumonia and surgical antibiotic prophylaxis. These are self-study modules, some of which have been accredited by the Royal Australian College of General Practitioners and Australian College of Rural and Remote Medicine for professional development credit. Another interesting tool provided on the site is the clinical e-audit which encourages general practitioners to evaluate their own clinical practice through prompted reflections about previous patient infections.

The MOOC run by the University of Dundee and BSAC (Initiative no. 87) is not currently accredited for CME credit but is popular with HCWs around the world. It makes use of a variety of resources, including videos, discussion boards, case studies, and readings to cover topics such as key elements of and emerging strategies for AMS, behaviour change, measuring antibiotic prescribing and the importance of collaboration and coordination. The course providers have plans to translate the course contents into Chinese and Spanish, though unfortunately these versions will not be facilitated.

The MAD-ID programme (Initiative no. 22) in the United States of America targets pharmacists and offers two programmes: a basic AMS programme that consists of an online self-study module, a live online teleconference with faculty, and a practical exercise; and an advanced programme which combines an in-person lecture component offered at the MAD-ID annual meeting, and a practical component. The basic programme covers the principles of AMS, basics of pharmacodynamics and microbiology of resistance, stewardship interventions and surveillance. The advanced programme is aimed at practitioners with stewardship experience and offers advanced information on specific settings, patient populations and analysing stewardship metrics. Both courses are currently accredited as continuing education by the Accreditation Council for Pharmacy Education.

4.8 Other mechanisms of engagement

Many of the programmes that we identified made their content freely available online. In addition to these courses, we found lecture slides, video lectures, case studies, facilitator guides, handbooks, posters and other campaign material online. The presence of so many high-quality resources online suggests that it is not necessary for new educational campaigns and courses to reinvent the wheel; a large amount of information is already available. However, much of this content is scattered across the web. It would be very useful to develop a resource site or database of good AMR content. Bringing this content together in a single location would allow educators to focus their efforts on developing course content specific to the local context, while using the basic educational materials that have already been produced. The ReAct Toolbox (Initiative no. 91) is an excellent model, which provides basic information on several aspects of AMR/AMS, and provides links to other online resources. The toolbox provides information relevant to both LMICs and high-income countries. The main limitation of the site, and many of the other educational resources that we have identified, is that it is currently only available in English.

Collaboration with health-care students is an excellent mechanism for creating engagement with AMR/AMS issues. Canadian medical students at the University of Toronto started an organization in 2014 called the Students for Antimicrobial Stewardship Society. This programme has now expanded to include chapters in both the dentistry and pharmacy schools at the University of Toronto, and chapters at other Canadian medical schools. The students have launched an annual awareness campaign on AMR, and organized educational lectures and interprofessional panels on stewardship to provide students with opportunities to ask questions (Initiative no. 37). The Do Bugs Need Drugs? programme (Initiative no. 14) in Canada has also engaged students from medicine, pharmacy, nursing and dentistry in delivering the programme to elementary school students. The health-care students participate in teaching young students about AMR and the importance of handwashing. This type of student engagement offers opportunities for early engagement with AMR issues, as well as opportunities for students in different health-care specializations to discuss and learn about AMR from each other. The development of similar student groups abroad should be encouraged to promote greater student involvement in AMR/AMS education initiatives.

4.9 Strengths and limitations of this study

We contacted more than 50 experts during this project, and identified educational resources and projects in all WHO regions. This project is the first attempt that we know of to map AMR educational resources for HCWs around the world. We developed a clear classification system for educational programmes, resources and participating organizations, which allowed us to see the breadth of resources already available for training HCWs on AMR/AMS.

As we relied extensively on web searching in addition to expert advice, it is likely that we identified more of some types of resource than others. Therefore, the quantity of identified programmes of this type should not be interpreted as proof that these resources are the most common programme type. We paired our web searching with expert input to identify those other resources that are more difficult to identify online. We recognize that some web resources, such as guidelines, are more likely to endure on the internet than others, such as advertisements for courses and conferences.

We conducted our web and academic searching in English, and relied upon on expert contacts to provide information on educational programmes in other languages. We identified and reviewed some educational programmes where the detailed information online was in French, but likely missed other educational resources posted online that are only available in other languages.

Finally, we note that longevity of resources on the internet is an issue. We found many broken links, where programme information could no longer be obtained. We were also unable to find any information online about the Coursera MOOC that ran in 2014 because the content had been removed from the website. Resource sites will need to be monitored to ensure that content remains up to date. To facilitate the sharing of resources between countries, it will also be important to find a mechanism so that content does not become inaccessible because it has been removed from websites.

5 Conclusion

In mapping the available educational programmes on AMR/AMS for HCWs, we have identified 91 existing programmes and resources, and several opportunities for improvement and expansion on the existing resources. Many high-quality educational campaigns already exist and there are many opportunities to adapt these programmes to meet educational needs in other contexts. But gaps persist, particularly when it comes to the content of AMR/AMS curricula for health-care students, and provision of accredited training for current HCWs. In the wake of the WHO Global Action Plan on AMR *(37)*, there is now an opportunity to fill these gaps by developing a comprehensive AMR/AMS curricula for different types of HCWs, and incentivizing HCWs to participate in AMR/AMS courses by ensuring that they are accredited as continuing education. Implementing a structured approach to addressing AMR educational needs in countries aligns with the goals of the transformative education agenda of the United Nations High-Level Commission on Health Employment and Economic Growth *(38)*, which advocates for the integration of quality education and life-long learning into health workforce policies in countries. Action on these fronts would support both the goals laid out in many national AMR action plans, and the desires of many HCWs, to ensure that all HCWs receive sufficient training on AMR and AMS.

The mapping of AMR educational resources is a step in the right direction, however we note that the resources documented in this paper focus mainly on the human health aspect of AMR education. Our list of resources is not exhaustive, and the resources have not been endorsed by WHO. Reducing the misuse or overuse of antimicrobials by HCWs is a complex challenge that will require broader measures beyond the provision of education and training resources. Additional measures will be necessary to address issues such as the incentives and practices that negatively influence prescribing and dispensing behaviour in the first place.

Building on the outcomes of this mapping exercise, WHO has identified key resources to be developed following an expert consultation meeting on AMR and health workforce education held 23–24 March 2017. These tools will include:

- A global, multidisciplinary, competency framework for AMR education.
- A prototype curricula developed for HCW roles and cadres.
- A country AMR education assessment tool.

It is anticipated that the development of these tools by WHO will add value by ensuring a standardized, global approach to addressing AMR education, increase Member States' ownership, and ensure ease of adaptation by users across countries. A repository to be housed by a sub-community of the WHO online discussion forum for the development and implementation of AMR national action plans *(9)* will function partly to build and strengthen the current set of tools in addition to other capacity-building initiatives to support AMR education. The implementation of the outcomes of the communities of practice shall be linked to the education hub activities of the WHO Global Health Workforce Network *(8)* to enhance coordination and improve the visibility and use of the resources.

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1 Appendix

Table A1. Descriptions of programme classifications

PROGRAMME TYPE	CODE	DESCRIPTION
Academic detailing	ACD	Non-commercial educational outreach involving face-to-face information sharing between health-care professionals
Advertising and outreach (radio, television)	ADO	Public promotional initiatives, such as public service announcements on television or radio, and billboards
Apps	APP	Downloadable interactive applications for devices, such as smart phones and tablets
Awareness campaigns, promotion days	AWC	Public awareness and promotional campaigns, often held annually, such as European Antibiotic Awareness Day (EAAD) and World Antibiotic Awareness Week (WAAW)
Books	BOK	Print or online books published
Guidelines/handbooks	GBK	Codes of practice and recommendations produced to inform the practice of workers and other target groups
In-person courses	IPC	Courses and classes offered in-person, as opposed to those offered online
Interventions	IRC	Initiatives involving actions of change with educational components
Network and advice (e.g. via telephone)	NET	Educational programmes providing networks and communication between professionals as an educational resource, for example telephone helplines where prescribers can ask questions of experts
Online course/MOOC/distance learning course	OOC	Courses offered online, including MOOCs, that are available freely online as well as exclusive courses (e.g. limited to membership in a society or school) that are offered online
Pledge	PLE	Pledges can be symbolically signed or agreed to in order to represent a commitment to a specified cause, such as AMR
Posters, pamphlets, infographics	PPP	Visual resources that can be posted and distributed for educational or promotional purposes
School curricula	SCU	Educational systems and guidelines for educational content and teaching
Videos/webinars/lectures	VID	Educational videos, including promotional initiatives and recorded lectures
Website, online reading materials	WON	Online websites and webpages with reading and other materials that are not videos, posters, pamphlets or other categories of programmes
Workbooks and questions	WBQ	Includes interactive workbooks, educational practice questions, multiple choice quizzes and relevant assessments
Workshops/seminars/ conferences	WSS	Formalized meetings for the discussion of a particular topic

2 Appendix

Table A2. Listing of identified educational initiatives

NO.	INITIATIVE	LEAD ORGANIZATION	COUNTRY	REGION	TARGET AUDIENCE	DESCRIPTION	WEBLINK OR SOURCE
1	Clinical Antibiotic Stewardship for South Africa	South African Antibiotic Stewardship Programme	South Africa	Africa	Medical students, physicians	This self-paced online course aims to introduce AMS, describe how to implement stewardship programmes, provide guidance for prescribing and interpreting clinical results, and teach about IPC. The course is taught online through video lectures and is free.	https://www.openlearning.com/courses/clinical-antibiotic-stewarship-for-south-africa
2	Distance Learning Course in Antimicrobial Stewardship for Africa	Infection Control Africa Network	Multiple	Africa	Physicians, clinical pharmacists, clinical microbiologists, nurses	This online distance learning course lasts three and half months and comprises five modules relating to infectious diseases, one of which is focused on AMS. The programme includes lectures, reading materials and discussion forums to engage with tutors and other students. The programme is free for African participants.	http://www.icanetwork.co.za/education/distance-learning-course-in-antimicrobial-stewardship-for-africa/
3	Online Rational Medicines Use Module	University of the Western Cape	South Africa	Africa	Health-care professionals	This semester-long online course focuses on the rational use of medicines and associated problems. Content is taught through online media and reading materials, and learning is encouraged through weekly tasks, online discussion forums and written assignments.	http://www.fidssa.co.za/Content/Documents/UWC_RATIONAL_MEDICINES_USE_CE_MODULE_2015_ADVERTFinal_(2).pdf
4	Antibiotic Pharmacology webcasts	Cleveland Clinic: Center for Continuing Education	United States of America	Americas	Physicians	A collection of six continuing education webcasts on AMR focusing on different types of antimicrobial treatments. Webcasts can be completed for credit towards the American Medical Association's Physician Recognition Award Credit System.	http://www.clevelandclinicmeded.com/online/pharmacology/pharm-antibiotic.htm
5	Antimicrobial Management Team	University of Kentucky	United States of America	Americas	Health-care professionals	Resource website, including policies, institution-specific antibiotic guidelines and personnel training resources.	http://www.hosp.uky.edu/pharmacy/amt/default.html

NO.	INITIATIVE	LEAD ORGANIZATION	COUNTRY	REGION	TARGET AUDIENCE	DESCRIPTION	WEBLINK OR SOURCE
6	Antimicrobial Stewardship - Moving Knowledge to Action, 2014	Public Health Ontario	Canada	Americas	Health-care professionals	A workshop series focused on providing support to develop and grow hospital AMR stewardship programmes. Workshops include lectures, participant networking and highlighted local experiences. The workshops occurred in four cities in Ontario and were broadcast via teleconference. Presentation notes and slides are available freely online.	https://www.publichealthontario.ca/en/BrowseByTopic/InfectiousDiseases/AntimicrobialStewardshipProgram/Pages/Antimicrobial_Stewardship_Workshop.aspx
7	Antimicrobial Stewardship Program (ASP) at Nebraska Medicine	Nebraska Medicine	United States of America	Americas	Health-care professionals	The programme includes video lectures, antimicrobial restrictions list, institution-specific antibiotic guidelines, microbiology information and other educational material. A mobile app provides clinical guidelines, protocols and dosing adjustments for antimicrobial use. Many web sources are available freely online, but the app requires specific login credentials.	http://www.nebraskamed.com/careers/education-programs/asp
8	Antimicrobial Stewardship: A tipping point, transforming practice	Mount Sinai Hospital, University Health Network	Canada	Americas	Physicians, pharmacists	A three-day workshop to identify key antimicrobial stewardship programme (ASP) priorities and resources, better understand the microbiology laboratory, and consider infectious disease management from an ASP perspective.	Weblink no longer available. Contact: Andrew Morris at Mount Sinai Hospital.
9	Antimicrobial Stewardship: Optimization of Antibiotic Practices	Stanford University	United States of America	Americas	Health-care professionals	A MOOC covering the Infectious Diseases Society of America guidelines, stewardship principles for special populations and evidence-based antibiotic management for surgical prophylaxis, outpatient care and sepsis treatment.	http://www.euro.who.int/en/health-topics/disease-prevention/antimicrobial-resistance/news/news/2014/05/massive-online-open-course-mooc-on-antimicrobial-stewardship
10	Anti microbial Stewardship: Taking it to the Next Level	Mount Sinai Hospital, University Health Network	Canada	Americas	Physicians, pharmacists	Offered in 2011, a course providing information on how to: • prepare a business case for funding an ASP; • identify the data elements required to start and monitor an ASP; • choose ASP priorities; • change prescriber behaviour; and • report success and challenges. Continuing education credit was available for this course.	http://www.antimicrobialsteward ship.com/educational-opportunities

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11	Bugs & Drugs	Alberta Health Services	Canada	Americas	Health-care professionals	The Bugs & Drugs reference guide provides recommendations for antimicrobial use and infection prevention and management to improve patient care and limit AMR, toxicity and costs. It is available as a book and mobile app.	http://www.bugsanddrugs.ca
12	Cleveland Clinic Guidelines for Antimicrobial Use 2012–2013	Cleveland Clinic	United States of America	Americas	Physicians	The Cleveland Clinic Guidelines for Antimicrobial Use consist of tables describing laboratory tests, treatment guidelines for infections and preferred antimicrobial use in various situations, such as pregnancy and transplants. Topics addressed include cost-effectiveness, resistance patterns and antimicrobial usage data.	http://www.clevelandclinicmeded.com/medicalpubs/antimicrobial-guidelines/
13	Decision+/ Decision+2	Université Laval, Government of Quebec	Canada	Americas	Physicians, residents	Decision+ and Decision+2 integrate multiple educational/ behavioural change components to promote shared decision-making on antibiotic treatment options. Included is a Diagnostic Decision Support Tool for physician and patient, to illustrates risks and benefits. It has been pilot tested, and embedded as a mandatory component of family medicine residency in Quebec.	http://www.decision.chaire.fmed.ulaval.ca/en/research/projects/decision/
14	Do Bugs Need Drugs?	Government of Alberta, Government of British Columbia	Canada	Americas	Health-care professionals	Do Bugs Need Drugs is a community education project that includes resources and accredited courses for physicians and pharmacists, non-accredited courses for students and other professionals, and campaigns for the general public. Health professional students are involved in delivering the programme to school children.	http://www.dobugsneeddrugs.org/about/no.bc

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15	Get Smart	Centers for Disease Control and Prevention	United States of America	Americas	Health-care professionals	The Get Smart for Healthcare programme is a comprehensive programme produced by the United States of America CDC to improve antibiotic use. Resources for health-care professionals include a collection of programme examples. There are implementation resources, fact sheets, research evidence, video commentaries and PowerPoint slides. General resources include video and radio public service announcements, pamphlets, posters, online resources, and more. This programme includes Get Smart About Antibiotics Week, an annual awareness campaign, complete with educational and promotional materials, such as posters, graphics, press materials and interactive activity ideas.	http://www.cdc.gov/getsmart/
16	Get Smart About Antibiotics	Wake Forest School of Medicine, CDC	United States of America	Americas	Medical students	Wake Forest University has developed a medical school curriculum around AMR. Several resources have been developed to assist with student learning, including a series of video lectures and lecture notes, case studies and exam style questions.	http://www.wakehealth.edu/School/CAUSE/Get-Smart-About-Antibiotics.htm
17	Get Smart Colorado: Use Antibiotics Wisely	Coalition	United States of America	Americas	Health-care professionals, patients and the public	This campaign used pamphlets and posters, billboards, radio, television, website, letters, guidelines and seminars to promote proper antibiotic use. Resources specifically for health-care providers included newsletters, externally sourced treatment guides, paediatric academic detailing sheets, and links to external resources. Multiple resources were directed to health-care providers but for use with patients, such as examination room posters and educational “prescription pads” for viral infections. These types of resources were available in English and Spanish. The website also shares tips for non-prescription care and appropriate antibiotic use.	http://www.getsmartcolorado.com/

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18	Healthy Canadians Collection: Antibiotic Resistance	Government of Canada	Canada	Americas	Health-care professionals, patients and the public	The Government of Canada produced an online resource for bacteria, antibiotics, AMR, surveillance and Canada's efforts on these fronts. Resources for health-care professionals include guidelines on infection management from the Public Health Agency of Canada, posters about reducing the spread of resistance in health-care settings, and external resources such as Bugs & Drugs (see Initiative no. 11). Other resources include educational videos, letters, infographics, posters and pamphlets for the general public, and for First Nations and Inuit peoples specifically.	http://www.healthycanadians.gc.ca/drugs-products-medicaments-produits/buying-using-achat-utilisation/antibiotic-resistance-antibiotique/index-eng.php
19	Infectious Diseases Management Program at UCSF	University of California San Francisco	United States of America	Americas	Health-care professionals	An interprofessional, interhospital collaboration to improve antimicrobial use and patient care. The programme includes guidelines for antimicrobial therapy for various conditions, hospital-specific guidelines and antimicrobial susceptibility information relevant to hospitals in San Francisco.	http://idmp.ucsf.edu/
20	Johns Hopkins Antimicrobial Stewardship Program	Johns Hopkins	United States of America	Americas	Physicians	Resource site for physicians, including guidelines for acceptable and unacceptable use of antibiotics, antibiotic dosage and toxicity for adults, antifungals and vaccines, institution-specific guidelines and regulations, microbiology information and treatment recommendations for specific infections.	http://www.hopkinsmedicine.org/microbiology/specimen/index.html Guidelines: http://www.hopkinsmedicine.org/amp/guidelines/Antibiotic_guidelines.pdf
21	Making a Difference in Infectious Diseases (MAD-ID), Canada	MAD-ID, University of Toronto	Canada	Americas	Pharmacists	A workshop held in Toronto in 2010, using an adapted version of the MAD-ID programme that included additional content for the Canadian context. Topics included de-escalation and streamlining, and making AMS work.	Contact: Linda Dresser at University Health Network in Toronto.
22	Making a Difference in Infectious Diseases (MAD-ID), USA	MAD-ID	United States of America	Americas	Pharmacists	MAD-ID offers both a basic and an advanced AMS training programme, designed for pharmacists and physicians. Continuing education credits are available for pharmacists in the United States of America.	http://mad-id.org/antimicrobial-stewardship-programs/

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23	Michigan Antibiotic Resistance Reduction Coalition	Coalition	United States of America	Americas	Health-care professionals, patients and the public	This state campaign provided information about antimicrobials and resistance for health-care providers and the public, using television and radio announcements, pamphlets, educational cartoons for children and posters. Health-care professionals were targeted specifically with infographics, and pamphlets about prescribing and communicating with patients. A webinar on antibiotics in upper respiratory tract infections was also promoted to health-care providers.	http://www.mi-marr.org/
24	Multipronged education strategy on antibiotic prescribing in Quebec	Institute national d'excellence en santé et services sociaux, Quebec	Canada	Americas	Physicians, pharmacists, medical residents	Educational mail-out with guidelines targeting the most common conditions in outpatient settings, clinical information on diagnosis and antibiotic recommendations. The emphasis was on proper antibiotic regimens and not using antibiotics when viral infections were suspected, plus using the shortest possible duration of treatment. Guidelines were produced by the Quebec Medication Council in collaboration with physicians and pharmacists. A letter of support from all key stakeholders (Ministry of Health, College of Physicians, College of Pharmacists, Medical Associations etc.) accompanied the mail-out.	Academic article by Weiss et al. Clinical Infectious Diseases. 2011;53(5):433–9. https://www.ncbi.nlm.nih.gov/pubmed/21791439
25	National Information Program on Antibiotics	Coalition	Canada	Americas	Physicians, pharmacists, patients and the public	This programme uses pamphlets and posters, print media, radio and letters to summarize information on antibiotics, bacterial infections, antibiotic use and resistance.	http://www.antibiotics-info.org
26	National Collaborating Centre for Infectious Diseases resources for health-care providers website (Antibiotic Awareness Week webinar archives)	National Collaborating Centre for Infectious Diseases	Canada	Americas	Health-care professionals	The National Collaborating Centre for Infectious Diseases website provides free online resources focused on antibiotics and AMR. The Antibiotic Awareness Week webinar archives is an online resource that compiles YouTube videos, transcripts, and presentation slides from previous seminars. Resources are available in English or French and online access is free. Resources for Healthcare Providers include factsheets, prescription sheets, a script outlining how to communicate with patients, treatment guidelines.	http://nccid.ca/antibiotic-awareness/

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27	Nebraska appropriate antibiotic use campaign	Nebraska Department of Health and Human Services	United States of America	Americas	Health-care professionals, patients and the public	A state antibiotic awareness campaign. Resources for health-care providers include links to local AMR stakeholder organizations such as the Nebraska Infection Control Network, and other external resources, such as links to CDC resources.	http://dhhs.ne.gov/publichealth/HAI/Pages/Resistance.aspx
28	Nursing Home Antimicrobial Stewardship modules	Agency for Healthcare Research and Quality	United States of America	Americas	Nurses	The Nursing Home Antimicrobial Stewardship Guide provided by the Agency for Healthcare Research and Quality seeks to train nurses and other nursing home staff on AMR and treatment decisions. The programme provides toolkits on AMS and antibiotic treatment which include informational handouts, online training resources, educational PowerPoint slides, and links to academic articles.	http://www.ahrq.gov/professionals/quality-patient-safety/patient-safety-resources/resources/nh-aspguide/index.html
29	Oregon Alliance Working for Antibiotic Resistance Education	Coalition	United States of America	Americas	Health-care professionals; patients and the public	This state coalition seeks to promote careful use of antibiotics by targeting health-care providers and the general public. Provider resources include posters, continuing education course links, prescribing statistics, treatment guidelines, and seminars and the CDC's Get Smart week are promoted. Resources for the public include activity books for children, brochures and information sheets about prudent antibiotic use and resistance.	https://public.health.oregon.gov/DiseasesConditions/CommunicableDisease/AntibioticResistance/Pages/index.aspx
30	Public Health Ontario Antimicrobial Stewardship Program	Public Health Ontario	Canada	Americas	Doctors, nurses, pharmacists	Public Health Ontario provides resources, such as posters, to promote appropriate prescribing in hospital settings, presentation slides on AMR and stewardship, webinars and print guidelines. These resources are shared to support acute care facilities in meeting Accreditation Canada's mandate requiring AMS programmes.	https://www.publichealthontario.ca/en/BrowseByTopic/InfectiousDiseases/AntimicrobialStewardshipProgram/Pages/Antimicrobial-Stewardship-Program.aspx
31	South Carolina Careful Antibiotic Use (CAUse)	South Carolina Department of Health and Environmental Control	United States of America	Americas	Health-care professionals, patients and the public	An adapted version of the CDC Get Smart programme, which initially targeted HCW for education on diagnostic and treatment guidelines, then targeted parents of young children about appropriate use.	Weblink is broken, however an overview is available in this report: http://www.scstatehouse.gov/Archives/DHEC/AROStrategicPlan-final1-15-07dr_3.pdf

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32	Stop Antibiotic Misuse in Minnesota	Coalition	United States of America	Americas	Health-care professionals, patients and the public	This state programme used pamphlets and posters, letters, guidelines, seminars and a childcare curriculum. The website provides links for professionals include policy statements, statistics, journal articles and guidelines relating to AMR and infections.	http://www.minnesotaarc.org/
33	Stop the Resistance – Use Antibiotics Wisely	Nevada Public Health Foundation	United States of America	Americas	Health-care professionals, patients and the public	This state educational campaign seeks to reach health-care providers and the public to encourage appropriate antibiotic use. This campaign provides resources, including clinical practice guidelines, resources from the CDC and information sheets informing prescribers about appropriate antibiotic use. General resources include educational brochures on AMR, colds and infections in English and Spanish, and links to websites and games for children's education on topics such as handwashing and bacteria.	Weblink no longer available; Contact via www.neadapublichealthfoundation.org
34	The California Antimicrobial Stewardship Program Initiative	California Department of Public Health	United States of America	Americas	Health-care professionals	This programme shares resources associated with the California Department of Public Health, such as an AMS webinar series directed to nursing homes, and a compilation of example stewardship programmes. The focus of this programme is to support the implementation of stewardship programmes in California hospitals and health-care facilities.	https://www.cdph.ca.gov/Programs/CHCQ/HAI/Pages/CA_Anti microbial StewardshipProgramInitiative.aspx
35	University of Pennsylvania Antimicrobial Stewardship	University of Pennsylvania	United States of America	Americas	Medical students, residents	This educational webpage includes presentation slides, PDF handouts and lecture recordings relevant to antimicrobial education for medical students and residents. Topics include drug availability, prophylaxis, as well as university-specific stewardship policies, antibiotic prescribing recommendations, restrictions and economic considerations.	http://www.uphs.upenn.edu/antibiotics/
36	Washington State's campaign to fight antibiotic resistance	Washington State Department of Health	United States of America	Americas	Physicians, patients and the public	This state health department website compiled links to publications and external resources on AMR for patients, physicians and educators. Resources for the public include school-based awareness programmes, information sheets and links to the Federal Drug Administration and CDC.	http://www.doh.wa.gov/YouandYourFamily/IllnessandDisease/AntibioticResistance

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37	Awareness week, lectures and panel discussions	Students for Antimicrobial Stewardship Society	Canada	Americas	Health-care students	This student society has chapters in medical, dental and pharmacy schools across Canada. They have organized an annual awareness week with lectures and panel discussions to educate students about AMR and AMS.	http://www.sass-canada.ca/
38	Antibioclic: Antibiothérapie rationelle en soins primaires	Société de Pathologie Infectieuse de Langue Francaise (French Infectious Diseases Society)	France	Europe	Physicians	This website offers therapeutic recommendations to primary care physicians. Physicians input their patients' pathology and other clinical considerations, and the website provides recommended antibiotic treatment with considerations and options for allergies and contraindications, as well as brief information about the antibiotics. The website also shares news related to infections and antibiotics.	http://antibioclic.com/
39	Antibioguide and Antibioville	Antibiolor	France	Europe	Physicians	The Antibiolor guidelines were published to assist physicians in the management of infections: Antibioguide (2005) for hospital physicians and Antibioville (2004) for community physicians. The guidelines are available online, in print and through an app. Antibiolor also provides Antibiotel, a telephone advice service for physicians requiring advice regarding management of patients with infectious diseases	http://www.antibiolor.org/
40	Antibiotic advice in Île-de-France	Société de Pathologie Infectieuse de Langue Francaise (French Infectious Diseases Society)	France	Europe	Physicians	Telephone advice relating to antibiotics provided by physicians for physicians.	Academic article by Wang et al. Médecine et Maladies Infectieuses. 2015;45(4):111–23. https://www.ncbi.nlm.nih.gov/pubmed/25747501
41	Antibiotic Awareness Campaign	European Phamacy Students Association	Multiple	Europe	Pharmacy students	The European Pharmacy Students Association created an Antibiotic Awareness Campaign to raise awareness about antibiotic use, decrease demand for antibiotics and to educate the public on AMR. The association created a campaign for their assembly in 2013 and a digital campaign was developed in partnership with the European Centre for Disease Prevention and Control for the EAAD.	Weblink no longer available; Contact via http://www.epsa-online.org/

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42	Antibiotic Guardian	Public Health England	United Kingdom	Europe	Health-care professionals, patients and the public	Antibiotic Guardian consists of a collection of pledges with over 30 000 signatures directed to health-care professionals, students, and the general public. Resources for health-care professionals include links to country-specific EAAD and WAAW resources, and public resources include patient stories, posters, leaflets and links to other programmes, including WAAW, e-bug and other informational websites.	http://antibioticguardian.com/
43	Antibiotic Resistance in Primary Care E-Module	Royal College of General Practitioners Learning	United Kingdom	Europe	Health-care professionals	This hour-long continuing professional education course is for primary care physicians in the United Kingdom looking to learn about antibiotic prescribing, resistance and resources for practice.	http://elearning.rcgp.org.uk/course/info.php?popup=0&id=167
44	Antibiotic Resistance: The Silent Tsunami	Uppsala University	Sweden	Europe	Health-care professionals	This four-week online course discusses the spread of antibiotic resistance, the development of antibiotics, the current state of resistance and antibiotic use, and actions to tackle AMR. The course is free and composed of three hours per week of online content.	https://www.futurelearn.com/courses/antibiotic-resistance
45	Antibiotics only when necessary (Le Projet Gepie: Groupe d'Etude et de Prévention des Infections de l'Enfant)	Coalition: Academic centres, health insurers, medical associations, institutes for public health	France	Europe	Physicians	This campaign employed pamphlets and posters, website, letters, guidelines and academic detailing. The programme's website contains resources such as guidelines for antibiotic use or disuse, progression of conditions such as bronchitis, in addition to general guidelines and guidelines for antibiotic use in children. A list of publications by the GEPIE group is provided. This group also supports an initiative for teacher and youth education about microorganisms, infections and their treatment know as Projet E-BUG.	http://www.gepie.org/
46	Appropriate use of antibiotics	Coalition: Pharmaceutical industry, Department of Health, professional organizations	Portugal	Europe	Health-care professionals, patients and the public	A seasonal campaign to reduce antibiotic use in Portugal that used several intervention types to target a wide range of professionals and the public.	Academic article by Huttner et al. Lancet (Infectious Diseases). 2010;10(1):17–31. https://www.ncbi.nlm.nih.gov/pubmed/20129146

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47	Antimicrobial Resistance and Healthcare Associated Infections Foundation Course on Hospital Infection Control	Healthcare Infection Society	United Kingdom	Europe	Residents	This three-day, in-person, course provides information on health-care associated infections and AMR, developing surveillance programmes, outbreak investigation, hospital hygiene and the basics of AMS. It can be taken as a stand-alone course or as part of a masters or diploma course.	https://www.his.org.uk/education/courses/
48	Antimicrobial Resource Centre	British Society for Antimicrobial Chemotherapy	United Kingdom	Europe	Health-care professionals	This database of resources compiles many educational materials and links, including links to open online courses, audio, guidelines, images, press articles, publications, posters, research papers, slide sets, systematic reviews and video lectures on diverse topics relating to antimicrobials and resistance.	http://stage.bsac-arc.com/no.
49	Antimicrobial Stewardship Educational Workbook	Scottish Antimicrobial Prescribing Group	United Kingdom	Europe	Nurses, midwives	This interactive workbook contains question prompts and links to informational videos to support learning around AMS, specifically including chapters on stewardship in practice, bacteria, resistance and antibiotics, assessment of infection and hospital practice.	http://www.scottishmedicines.org.uk/files/sapg/Final_Antimicrobial_Stewardship_Print_Wkb_Jan_2016.pdf
50	Antimicrobial stewardship: Systems and processes for effective antimicrobial medicine use	National Institute for Health and Care Excellence	United Kingdom	Europe	Health-care professionals, patients and the public	The National Institute for Health and Care Excellence publishes guidelines, including on AMS. These guidelines include recommendations for the implementation of stewardship programmes, antimicrobial prescribing and new antimicrobials.	https://www.nice.org.uk/guidance/ng15
51	Antimicrobial Susceptibility Testing and Surveillance: From Laboratory to Clinic	ESCMID	Germany	Europe	Clinical microbiologists	This three-day-long workshop consists of a series of lectures and laboratory sessions that cover European Committee on Antimicrobial Susceptibility Testing clinical breakpoints, antimicrobial susceptibility testing, antimicrobial surveillance systems and antimicrobial guidelines. This is part of a series of microbiology workshops organized by the ESCMID.	Weblink not available; contact via www.escmid.org
52	Antimicrobials and infection management	Centre for Pharmacy Postgraduate Education	United Kingdom	Europe	Pharmacists, pharmacy students	This 10-hour e-learning course focuses on describing the action of antimicrobials, selecting appropriate antimicrobial agents, antimicrobial prophylaxis, patient treatment and health-care associated infections. This programme is only available to members of the General Pharmaceutical Council.	https://www.cppe.ac.uk/programmes/l/antimicro-e-01/

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53	Bugs and antibiotics: The role of the Greek physician in the fight against microbial resistance	University of Athens	Greece	Europe	Physicians	A regional education campaign in 2009/10 organized by the University of Athens medical school. A series of meetings were organized with primary care physicians followed by four interactive case study sessions. Participants also received a set of guidelines and a booklet on management of community-acquired infections.	Academic article by Plachouras et al. BMC Public Health. 2014;14:866. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4148920/
54	National Health Insurance Fund for Salaried Workers Programme	National Health Insurance Fund for Salaried Workers	France	Europe	Physicians	The National Health Insurance Fund for Salaried Workers' work on AMR includes holding meetings with delegates of the National Health Insurance and physicians. Information sheets and recommendations on medical practice are handed out to physicians during these meetings, which are held three or four times a year.	Academic article by Huttner et al. Lancet (Infectious Diseases) 2010;10(1):17–31. https://www.ncbi.nlm.nih.gov/pubmed/20129146
55	Collection: Antimicrobial resistance (AMR)	United Kingdom Government	United Kingdom	Europe	Health-care professionals	The United Kingdom Government supports an online collection of resources relating to AMR and links to research publications, technical and clinical guidelines, posters, research, news updates, and strategic documents, such as the United Kingdom's AMR strategies and progress reports. One noteworthy resource is the Antimicrobial Resistance: Resource Handbook, which provides information on policy, recommendations, education, tools, surveillance and other resources that support stewardship and AMR reduction.	https://www.gov.uk/government/collections/antimicrobial-resistance-amr-information-and-resources
56	Antibiotics: Use them correctly	Belgian Antibiotic Policy Coordination Committee	Belgium	Europe	Health-care professionals, patients and the public	This programme's webpages offer links to academic articles, directed towards health-care professionals. Webpages answer basic questions (e.g. what are antibiotics, asking advice from your health-care provider), promote children's educational comics on antimicrobials and infections, and provide links to external resources for the general public. The programme also includes radio commercials. Many resources are available in French, English, Dutch and German.	http://www.correctuseantibiotics.be/en

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57	ESCMID Summer School	ESCMID	Spain	Europe	Physicians, clinical microbiologists	This week-long, in-person course focuses on clinical microbiology and infections. Topics include infection management, therapy beyond antibiotics, viral infections, multidrug resistance, international health and career development.	https://www.escmid.org/dates_events/escmid_summer_school/
58	ESCMID/ASM Conference on Drug Development to Meet the Challenge of Antimicrobial Resistance	ESCMID	Austria	Europe	Health-care professionals	This three-day conference consists of a series of lectures, symposiums, debates, round table discussions, and interactive question and answer sessions relating to AMR. Topics include clinical use of off-patent antibiotics, future areas of research, breakpoints, and changing antimicrobial administration and guidelines.	Weblink not available; contact via www.escmid.org
59	European Antibiotic Awareness Day	European Centre for Disease Prevention and Control		Europe	Health-care professionals, patients and the public	European Antibiotic Awareness Day promotes education about antibiotic use and resistance annually on 18th November. The website contains diverse downloadable resources for prescribers as well as patients and the public. Toolkits for prescribers include presentations for in-hospital training on AMR, patient dialogue guides and fact sheets.	http://ecdc.europa.eu/en/eaad/Pages/Home.aspx
60	General practitioner conferences to reduce over-prescribing	Health insurance office, Créteil hospital	France	Europe	Physicians	Conferences and meetings involving a discussion on prescribing profiles and promoting awareness of antibiotic use.	Academic article by Wang et al. Médecine et Maladies Infectieuses. 2015;45(4):111–23. https://www.ncbi.nlm.nih.gov/pubmed/25747501
61	Interdisciplinary Regional Programme for the Control of Antimicrobial Resistance		France	Europe	Physicians	This programme promoted continuing education and antibiotic treatment guidelines for general practitioners in the Franche-Comté region of France.	Academic article by Wang et al. Médecine et Maladies Infectieuses. 2015;45(4):111–23. https://www.ncbi.nlm.nih.gov/pubmed/25747501
62	MedQual	Centre Ressource en Antibiologie	France	Europe	Health-care professionals, patients and the public	This network is dedicated to monitoring antibiotic use and antibiotic resistance. The website provides online advice and decision trees for physicians managing infectious diseases. It also publishes a monthly electronic newsletter. Telephone advice to health-care professionals is provided.	http://www.medqual.fr/ http://www.nes.scot.nhs.uk/education-and-training.aspx

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63	National Health Service for Scotland Education and Training	National Health Service Education for Scotland	United Kingdom	Europe	Physicians, nurses, pharmacists	The Scottish Reduction in Antimicrobial Prescribing (ScRAP) programme is an educational toolkit to encourage a reduction in unnecessary antibiotic prescribing. ScRAP includes teaching topics and lesson plans for local facilitators, video lectures, videos of patient-scenarios and other teaching materials. Some programmes include clinical vignettes and multiple choice assessments. Other resources include interactive AMS educational textbooks/workbooks targeted towards nurses and midwives, complete with information, best practice examples, evaluation questions, and reflection prompts, as well as PowerPoint presentation slides for practitioner education.	http://www.nes.scot.nhs.uk/education-and-training.aspx
64	Nice, France, teaching hospital telephone advice service	Nice Teaching Hospital, France,	France	Europe	Physicians	This service consisted of telephone advice with the option of in-person consultations for general practitioners in the Provence-Alpes-Côte d'Azur Est region of France. Terminated due to lack of resources.	Academic article by Wang et al. Médecine et Maladies Infectieuses. 2015;45(4):111–23. https://www.ncbi.nlm.nih.gov/pubmed/25747501
65	PrescQIPP Antimicrobial Stewardship web hub	PrescQIPP	United Kingdom	Europe	Health-care professionals	This webpage provides resources and links to educate health-care providers about AMS and AMR. Types of resources include data on infections, infographics, guidelines relating to AMR, information about diagnoses and online links.	https://www.prescqipp.info/antimicrobial-stewardship/projects/antimicrobial-stewardshipno.diagnostics
66	Project on children and antibiotics –appropriate antibiotic use in children	Emilia Romagna Department of Health	Italy	Europe	Physicians	This programme is targeted at paediatricians prescribing antibiotics; running seminars and adapting "Do Bugs Need Drugs" (see Initiative no. 14).	Academic article by Huttner et al. Lancet (Infectious Diseases. 2010;10(1):17–31. https://www.ncbi.nlm.nih.gov/pubmed/20129146
67	Reducing Antimicrobial Resistance	E-Learning for Healthcare, Health Education England	United Kingdom	Europe	Health-care professionals, patients and the public	This programme consists of an e-learning session, short videos and links to other resources such as Antibiotic Guardian (see Initiative no. 42) and the FutureLearn MOOC (see Initiative no. 87). The objective is to discuss risks and development of AMR, the misuse of antibiotics, and improve responses to patients.	http://www.e-lfh.org.uk/programmes/antimicrobial-resistance

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68	STAR: Stemming the Tide of Antibiotic Resistance	Healthcare CPD	United Kingdom	Europe	Physicians	This hour-long training intervention informs medical practitioners about antibiotic prescription, resistance, and encourages behavioural change and reflection about current practices.	http://www.healthcarecpd.com/course/star-stemming-the-tide-of-antibiotic-resistance
69	Strama	Swedish Strategic Programme Against Antibiotic Resistance (Strama)	Sweden	Europe	Health-care professional	The Swedish Strategic Programme Against Antibiotic Resistance (Strama) shares action plans, scientific research protocols and data. They link to other resources, such as online courses for doctors and nurses. The National Strama Days are annual awareness campaigns meant to provide education on antibiotic issues, including resistance and policy-making and facilitate networking.	https://www.folkhalsomyndigheten.se/contentassets/dae82c7afd424a57b 57ec8 1818793346/swedish-work-on-containment-of-antibiotic-resistance.pdf
70	Strategic and Exploratory Workshop	Joint Programming Initiative on Antimicrobial Resistance	Norway	Europe	Health-care professionals	The Joint Programming Initiative on Antimicrobial Resistance facilitates a series of workshops. These workshops revolve around selected keynote lectures, breakout sessions and plenary discussions. Workshop titles include “The interplay between AMR surveillance and science” and “Early discovery of new antibiotics”.	http://www.jpiamr.eu/activities/the-interplay-between-amr-surveillance-and-science/
71	Dutch Working Party on Antibiotic Policy	Society of Infectious Diseases	The Netherlands	Europe	Health-care professionals	The Dutch Working Party on Antibiotic Policy has developed numerous guidelines relating to antibiotics and AMR focusing on general information, specific infections, MRSA and antibiotic prophylaxis. The group also holds an annual symposium on AMR and contributes to EAAD online resources.	http://www.swab.nl/swab/cms3.nsf/viewdoc/102D6425C642468DC125757F0039CDDE
72	Regional Functional Unit of Infectious Diseases	Ajaccio Hospital Directorate, Corsica Regional Health Authority	France	Europe	Physicians	Telephone advice for general practitioners in Corsica as well as postgraduate education on antibiotics.	Academic article by Wang et al. Médecine et Maladies Infectieuses. 2015;45(4):111–23. https://www.ncbi.nlm.nih.gov/pubmed/25747501

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73	Treat Antibiotics Responsibly, Guidance, Education, Tools (TARGET) Antibiotics Toolkit	Royal College of General Practitioners, Public Health England	United Kingdom	Europe	Health-care professionals	This toolkit includes antibiotic prescribing data, toolkits for conducting audits, posters and pamphlets for patients, guidelines from Public Health England, resources to support implementation of the TARGET toolkit, and links to external resources and stakeholders relevant to AMR and antibiotics. Resources for general practitioners specifically include a self-assessment checklist evaluating good antimicrobial practices. Training resources include a webinar series, presentation templates and notes, and links to two e-modules. The webinar series ran from November to December 2016 and provides information on how to improve prescribing and patient care.	http://www.rcgp.org.uk/TARGETantibiotics
74	Regional Union of Healthcare Professionals Programme	Nord-Pas-de-Calais Regional Health Authority; Regional Union of Healthcare Professionals;	France	Europe	Physicians	As a local initiative, information sheets were distributed to general practitioners at clinical presentations. Information sheets related to infection management, clinical presentation, and antibiotic prescribing for patients aged 15 to 65.	Academic article by Wang et al. in Médecine et Maladies Infectieuses. 2015;45(4):111–23. https://www.ncbi.nlm.nih.gov/pubmed/25747501
75	Antimicrobial Stewardship: Principles and Practice	European Society of Clinical Microbiology and Infectious Diseases		Europe	Health-care professionals	This postgraduate education course from October 2017 discussed basic principles of AMR and consumption surveillance, implementation of AMS programmes, how to change prescriber behaviours, and how to integrate AMS education in student, resident and postgraduate education at an institutional level.	https://escmid.pulselinks.com/event/13464
76	Antibiotic campaign	Health maintenance organization	Israel	Middle East	Physicians	A seasonal campaign to distribute guidelines and information on resistance to physicians, with a mass media component.	Academic article by Huttner et al. Lancet (Infectious Diseases). 2010;10(1):17–31. https://www.ncbi.nlm.nih.gov/pubmed/20129146
77	Antibiotics Smart Use: Thailand	Thai Food and Drug Administration (Thai FDA), Ministry of Public Health	Thailand	South-East Asia	Health-care professionals, patients and the public	Countrywide campaign that educated prescribers about antibiotics in half-day-long, in-hospital training sessions. The training included sharing experiences, learning about treatment guidelines and diagnostic tools, as well as instructions on implementing resources for patient education, such as DVDs, pamphlets and other materials.	https://www.reactgroup.org/toolbox/rational-use/examples-from-the-field/antibiotics-smart-use-thailand/

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78	Antibiotic Stewardship, Prevention of Infection & Control	Indian Council of Medical Research	India	South-East Asia	Clinical pharmacists, clinical microbiologists	This workshop taught skills and knowledge about infection prevention and control, implementation of antimicrobial policy guidelines for rational use of antibiotics to curb resistance, conducting research projects in antibiotic policy. Workshop consisted of five days of lectures, site visits, practical training, demonstrations and project discussions.	Academic article by Chandy et al. Indian Journal of Medical Research. 2014;139(2):226–230. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4001333/
79	AMR training	Songdo Hospital	Mongolia	Western Pacific	Physicians	Quarterly education sessions and surveys of antimicrobial prescribing in hospital.	WHO Mongolia Country Report May 2016 by Sonia Koning and Trish Peel at National Centre for Antimicrobial Stewardship and Melbourne Health (document provided by Western Pacific Regional Office).
80	Antibiotic Awareness Week	Government of Viet Nam, WHO	Viet Nam	Western Pacific	Health-care professionals, patients and the public	This awareness week campaign included a pledge initiative, public outreach events, posters and banners in hospitals, and social media use.	http://www.wpro.who.int/vietnam/mediacentre/releases/2015/antibiotics_resistance_week2015/en/
81	Department of Health Manual of Procedures for Implementing AMS in Hospitals	Department of Health (Philippines), WHO	Philippines	Western Pacific	Physicians	The Department of Health Manual of Procedures for Implementing AMS in Hospitals is an operational guide that is also used as a reference for developing training programmes and materials.	Information received from contacts in the Philippines via Western Pacific Regional Office (Ketevan Kandelaki)
82	National Prescribing Service (NPS): MedicineWise resource website	National Prescribing Service: MedicineWise	Australia	Western Pacific	Health-care professionals	The NPS MedicineWise (Australia) website includes resources and online learning modules. The website of antibiotic resources for health-care providers includes tools for consultation with patients, pamphlets and posters, and guidelines. Five online case study-based modules are available for general practitioners, nurses and health-care professional students on the topics of antimicrobial prescribing, bacterial infections, urinary tract infections, pneumonia and surgical antibiotic prophylaxis. These modules are recognized by the Royal Australian College of General Practitioners as fulfilling some requirements of their continuing professional development programme as well as by the Australian College of Rural and Remote Medicine for some of their professional development programme requirements.	http://www.nps.org.au/medicines/infections-and-infestations/antibiotics http://www.nps.org.au/health-professionals/cpd

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83	Training-of-Trainers Workshop on the Antimicrobial Stewardship Advocacy Training	Department of Health (Philippines), WHO (Western Pacific Region)	Philippines	Western Pacific	Health-care professionals	The workshop was delivered by a representative from NPS MedicineWise. It consisted of an interactive session on current initiatives and challenges of each hospital in relation to IPC, rational use of antimicrobials and surveillance of AMR. Also included was a consultation on draft AMS pilot programme implementation.	Weblink no longer available
84	Training-workshop for government level III hospitals on the implementation of AMS	Department of Health (Philippines), WHO, Corazon Locsin Montelibano Memorial Regional Hospital	Philippines	Western Pacific	Physicians	This workshop began as a pilot programme at Philippine General Hospital and Corazon Locsin Montelibano Memorial Regional Hospital. An AMS programme with an educational component was tested and has now been scaled up to provide training at all Department of Health level III hospitals.	Information received from contacts in the Philippines via Western Pacific Regional Office (Ketevan Kandelaki)
85	WHO WPR Pledge to Use Antibiotics Responsibly	WHO (Western Pacific Region)		Western Pacific	Health-care professionals	This pledge, designed by the WHO Western Pacific Regional Office, discusses a commitment on the use of antibiotics as prescribed, good hygiene, and encouraging responsible use by friends and family. Includes information on AMR.	https://apps.wpro.who.int/amr/pledge.aspx
86	Win the War Against AMR	Department of Health (Philippines)	Philippines	Western Pacific	Health-care professionals	Win the War Against AMR is a pledge for health-care providers to use antimicrobials responsibly. Pledge documents comment on the judicious use of antimicrobials, continuing education of others, promoting preventative measures, and supporting research into antimicrobial drugs and diagnostic technologies.	Weblink no longer available
87	Antimicrobial Stewardship: Managing Antibiotic Resistance	University of Dundee, BSAC	United Kingdom	Global	Health-care professionals	This six-week MOOC focuses on improving antimicrobial prescribing and AMS in hospital settings and can be applied to other settings. The course has run twice on the FutureLearn platform and involves readings, case study videos, video interviews with experts, and online discussion with peers and educators. Course topics include an overview of resistance as a global problem, the importance and key elements of AMS, measurement of antibiotic prescribing, emerging strategies for AMS, behaviour change, and the importance of collaboration and coordination.	https://www.futurelearn.com/courses/antimicrobial-stewardship

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88	Basic Concepts	International Federation of Infection Control	United Kingdom	Global	Health-care professionals	This book, Basic Concepts, by the International Federation of Infection Control contains a chapter on "Principles of antibiotic policies". Key topics in this chapter include, the rational use of antibiotics to combat resistance, the role of AMR stewardship programmes, targeted antibiotic prescribing and treatment, and microbiology laboratory services in relationship to AMR. It is available in English, Arabic, French, Spanish, Italian, Bulgarian and Hungarian.	http://theific.org/basic-concepts-english-version-2016/
89	Basic Infection Control Training Programme Course	International Federation of Infection Control	United Kingdom	Global	Health-care professionals	This infection control course contains a module that focuses explaining how antibiotic use selects strains of bacteria, identifying mechanisms of AMR stewardship programmes, the role of microbiology laboratories in resistance, as well as health-care associated infections and outbreaks in general.	http://theific.org/basic-ic-training-course-outline/
90	Coursera course: Antimicrobial Resistance – Theory and Methods	Technical University of Denmark	Denmark	Global	Health-care professionals	This five-week MOOC covers antimicrobial action, antimicrobial resistance, antimicrobial susceptibility testing, interpretation, quality assurance, and bacterial genomic testing through online videos lectures and graded quizzes.	https://www.coursera.org/learn/antimicrobial-resistance
91	ReAct Toolbox	Uppsala University	Sweden	Global	Health-care professionals	Resource website on AMR and AMS with profiles of useful interventions.	http://www.reactgroup.org/toolbox/

Health Workforce Department
World Health Organization
20 Avenue Appia
CH 1211 Geneva 27 Switzerland
www.who.int/hrh

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