

## Educating healthcare professionals in antimicrobial stewardship: can online-learning solutions help?

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Education is widely recognized as one of the cornerstones of successful antimicrobial stewardship programmes. There is evidence of important knowledge flaws around antimicrobial prescribing among both medical students and clinicians. Educational interventions improve antimicrobial prescribing, but traditional tools may be insufficient to deliver training to meet the complex demands of global healthcare professionals working across a diverse range of healthcare and resource settings. The educational solutions increasingly need to be timely, efficient, pragmatic, high quality, aligned to the needs of the professional in a specific context, sustainable and cost-effective. Online learning has been playing a growing role in education about antimicrobial stewardship and the recent phenomenon of massive open online courses (MOOCs) offers novel and additional opportunities to deliver relevant information to a wide range of people. Additional research on MOOCs as an educational approach is needed in order to define their effectiveness, sustainability and the best ways to achieve the intended results. Although the precise value of new online strategies such as MOOCs is ill defined, they certainly will have an important place in increasing awareness and improving antimicrobial prescribing.

*'Live as if you were to die tomorrow. Learn as if you were to live forever.'* (Mahatma Gandhi)

The inappropriate and excessive use of antimicrobials is a prime contributor to the rise of antimicrobial resistance (AMR),<sup>1</sup> a global health emergency.<sup>2</sup>

The importance to the healthcare professional team working across the healthcare communities of education and lifelong learning in relation to antimicrobial prescribing has been recognized as critical to supporting and effecting a response to the global challenge of AMR.<sup>3</sup> Evidence of inconsistent teaching on clinical infectious diseases in undergraduate medical curricula and perceived unpreparedness for practice around antimicrobial prescribing<sup>4,5</sup> is informing calls to address undergraduate teaching urgently.<sup>3,6</sup>

It is widely recognized that what, how and where healthcare professionals are taught and who educates and trains the health workforce are major factors in determining the readiness and resilience of a health system, including the capacity to produce the adequate types and number of health workers, to equip them with the required competencies and to deploy and retain them where they are most needed.<sup>7</sup> This is also very relevant to the context of infection prevention and management practice.

E-learning has become well established in medical education.<sup>8</sup> It is effectively the application of technology to support teaching and learning and involves different devices, digital tools and media. It supports face-to-face and online learning as well as blended learning by combining traditional classroom methods

with online approaches. The World Wide Web has made information more available and in turn web-based learning offers the advantage of improved access to learning by overcoming distance.<sup>9</sup> Learning can be accessed anytime, anywhere, as individuals are increasingly connected 24/7 via mobile devices. Online learning and resources have already been playing a growing role in supporting national efforts to address the educational needs of healthcare professionals across the continuum of education in relation to antimicrobial stewardship.<sup>10,11</sup> The main advantages and disadvantages of e-learning are outlined in Table 1. Whilst there are barriers (e.g. poor Internet access) to accessing online learning, particularly in resource-limited and remote communities, these are not insurmountable. Egranary (<http://www.ictregulationtoolkit.org/4.1.6.1>) provides an example of how poor access can be overcome, by offering a digital library of >30 million Internet resources that has been installed in >650 schools, clinics and universities in Africa, Bangladesh, Haiti, India and elsewhere.

Given the evidence, how can these advantages of online learning be translated into supporting global antimicrobial stewardship education? Recently, the reported effectiveness of a blended e-learning programme on primary care prescribing practice<sup>12</sup> stimulated the development and implementation of blended modules for primary care in the UK<sup>13</sup> and Scotland.<sup>14</sup> Meanwhile, INTRO, an online programme trialled in five European countries, despite its reported success, raised important caveats about the importance of such programmes being sensitive to the learning needs and practices of different cultures and

**Table 1.** Potential advantages and disadvantages of e-learning

Advantages	Disadvantages
<ul style="list-style-type: none"><li>• Wide availability, breaking down of geographical and temporal limits</li><li>• Reduce costs of educational content delivery</li><li>• Flexibility of schedules</li><li>• Portability of educational content</li><li>• Access to experts and curricula otherwise inaccessible</li><li>• Easier development and update of educational resources and activities</li><li>• Self-paced learning</li><li>• Potential for improved student–teacher and student–student contact and discussions</li><li>• Access to national and international experts</li><li>• Potential to connect with other learners worldwide and develop personal learning networks</li><li>• Potential to learn in teams that may replicate the workplace</li></ul>	<ul style="list-style-type: none"><li>• Laborious preparation of educational contents</li><li>• More time-consuming for students</li><li>• Lack of student–teacher interaction and tutor support</li><li>• Possibility of isolation</li><li>• Inability to clarify doubts properly</li><li>• Lack of in-depth group discussion</li><li>• Difficulty of delivering some educational contents without human interaction</li><li>• Learners may feel isolated</li><li>• Lack of local technical infrastructure and resource may limit access to online resources and learning opportunities</li><li>• Language translation and cultural context</li></ul>

healthcare systems.<sup>15</sup> Although web-based resources or e-learning programmes exist for hospitals, they are of variable quality, often promotional and not always accessible without cost.<sup>16</sup>

The potential value of the growing online phenomenon of massive open online courses (MOOCs) offers new possibilities to support educational activity on antimicrobial stewardship on a global scale not previously possible. In medicine, the potential for MOOCs to support postgraduate medical training<sup>17</sup> and continuing professional development<sup>18,19</sup> is being recognized and there is evidence of doctors and undergraduate students participating in them.<sup>18,20</sup>

From first-hand experience, Bali<sup>21</sup> proposes that the personal benefits of MOOCs lie in the space they create for engagement, the opportunities for critical thinking and peer interaction. This ability to create a unique learning space that could support antimicrobial stewardship education synchronously at scale on a global level provides interesting new opportunities. The University of Dundee and the BSAC in collaboration with FutureLearn are grasping this opportunity to develop such a MOOC. In creating this MOOC, the importance of good educational design to enhance the learning experience<sup>22</sup> and encourage higher-order thinking and active learning have been imperatives.<sup>21</sup> The contexts of antimicrobial stewardship and the learners are informing development together with the understanding that online educational resources based on real or near-real clinical experiences are more effective<sup>22</sup> and authentic. Including content focused on real-life problems promotes more effective learning than simply transmitting information<sup>23</sup> and can help learners to set learning goals that relate and can be applied to their personal practice.<sup>24</sup>

The objective of antimicrobial stewardship is to bring about behaviour change<sup>25</sup> and the MOOC will include demonstrations of good practice. Learning activities will provide opportunities for MOOC participants to apply their understanding by beginning to articulate and share with other learners how they can start to address problems in their own healthcare setting.<sup>22</sup> Learning steps will also facilitate learner reflection on the new skills and knowledge they acquire, demonstrating they have integrated these and can communicate these to their peers.<sup>22</sup> These key

educational principles are being incorporated into the design of the antimicrobial stewardship MOOC (to register please go to: <https://www.futurelearn.com/courses/antimicrobial-stewardship>). The global ambition of the MOOC is reflected in its author faculty and use of relevant illustrated examples. The developers are considering offering non-English translations in future versions. The use of social media channels such as Twitter, Facebook and Google+ will offer additional opportunities for peer-to-peer interaction and sharing of experiences as well as networking and learning from each other to continue once the MOOC has been completed, thereby nurturing the development of a global community of practice in antimicrobial stewardship.

The importance of key success factors such as infrastructure functionality, learner, staff and institutional support and high-quality content based on robust educational pedagogy cannot be overemphasized. However, many questions remain unanswered. First and foremost, more evaluation and research, including longitudinal follow-up, are required to clarify the added value to traditional models of teaching, its sustainability and the best ways to achieve the intended results. Measurement of the effectiveness of these approaches in changing and improving antimicrobial prescribing will ultimately define the role that these tools can play in antimicrobial stewardship education.

Transparency declarations

N. R.-P. has no conflict of interests to declare. N. L. has been involved in the development of the BSAC-UoD Antimicrobial Stewardship MOOC and D. N. is the Programme Director of the MOOC.

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