Adapting to survive: addressing the global problem of Antimicrobial Resistance

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Abstract

Antimicrobial resistance (AMR) is a significant, emerging threat to global public health. In this article, we describe the scale of the threat and why it is such a global concern. We also outline actions that have been identified to address this threat, which includes focusing on the education of healthcare workers and clinicians, as well as members of the public. We describe how medical curricula currently offer opportunities for improving educational interventions that are focused on better prescribing and antimicrobial stewardship. Finally, we argue that by itself, this is not sufficient. Medical students also require a robust understanding of key microbiological principles to underpin and consolidate their prescribing skills when it comes to antibiotics and this need to be consolidated throughout the duration of all medical curricula and beyond. Integrating the medical sciences to create a clinical behaviour change is key to combating (AMR).

Keywords: Antimicrobial Resistance; Microbiology; Medical Science Education; Public Health

Why is Antimicrobial Resistance Such a Serious Threat?

The British Government, the World Health organisation and the United Nations have identified Antimicrobial resistance (AMR) as one of the greatest emerging threats to public health (Shallcross & Davies, 2014) ("WHO Antimicrobial resistance," 2015) (The United Nations, 2016). The problem of life-threatening infection is returning with a vengeance as microbes continue to demonstrate how species can persist even in adverse conditions such as exposure to antibiotics, through adaptation. Current antibiotics are becoming obsolete disturbingly rapidly. Despite sporadic advances, few clinically relevant antibiotics have been found in the previous 30 years. (Bowater, 2017)

In the UK, the Chief Medical Officer, Professor Dame Sally Davies and the former UK Prime Minister, David Cameron, have both warned of the potential risks society faces if we do not immediately address the threat of antimicrobial resistance. ("Chief Medical Officer annual report 2011," n.d.) To evidence this threat, David Cameron
commissioned a series of reports in 2014, the O'Neill report on Antimicrobial Resistance, which was published in its entirety in 2016 (The UK Government, 2016).

This equates to a global financial loss of 2-3.5% GDP ($100 trillion) reducible by $65 trillion if resistance to common pathogens listed in the report can be delayed by 10 years. (Figure 1) Even the General Medical Council has commented on the issue of resistance, via Tomorrow's Doctors, specifically stating that graduates should "demonstrate knowledge of drug actions: therapeutics and pharmacokinetics [...] including the effects on the population, such as the spread of antibiotic resistance". (General Medical Council (Great Britain, 2009). By all standards, antimicrobial resistance is a multifaceted problem of international concern. (Figure 2)
How can Antimicrobial Resistance be tackled on a global scale?

Having declared AMR a significant and imminent threat the WHO has developed a global action plan for combating AMR with 5 key objectives that outline how different key stakeholders can work together to combat AMR (World Health Organisation, 2017):

1. Improve awareness of AMR through communication, education and training,
2. Surveillance and research to strengthen knowledge and evidence base,
3. Reduce incidence of infection, through sanitation, hygiene and other infection prevention measures,
4. Optimise the use of antimicrobials in human and animal health,
5. Sustainable investment in new medicines and other interventions

In this article we will focus on how we can improve the awareness of AMR through communication, education and training.
How can we fight back against Antimicrobial Resistance?

We are a medical scientist and a 4th-year medical student based at an English university that uses a modular, integrated, systems-based curriculum degree that seeks to integrate theory and clinical learning. We have experienced first-hand and from different perspectives (teacher and student) some of the barriers that prevent medical students from improving their awareness of AMR. Firstly, from our personal experience and research of the primary literature, we recognise that medical students view prescribing as an integral part of being a medical professional, almost a "rite of passage" and an essential aspect of clinical learning (General Medical Council, Great Britain, 2009). There is also an assumption that better prescribing skills, especially around antibiotics, will address the growing problem of AMR by optimising the use of antimicrobials in human or animal health. Better antibiotic stewardship among clinicians and healthcare professionals is the key to addressing the growing problem of AMR; reducing microbes exposure to antimicrobial drugs through improved regulation. Therefore emphasis should be placed on teaching better prescribing skills for antimicrobial drugs when curricula are designed and developed to combat AMR. This view has been supported by papers identified by the co-author when undertaking research as part of a Masters in Clinical Education dissertation. However, a key point that has also been identified is the inherent paradox where, as student knowledge increases, student behaviours towards the proper use of antibiotics tend to shift away from national guidelines. Sciaioli et al (2013) describe how "healthcare students do not practice what they know". (Sciaioli et al., 2015) This is one of the issues that also needs to be addressed in our approach to prescribing antibiotics. We need to emphasise that the focus should not be, ‘what should I prescribe?’ but, ‘do I need to prescribe at all?’

Another concern that emerges from the literature is that medical students can struggle to understand simple concepts of microbiology. These concepts include the inefficacy of antibiotics in viral infection and the apparent idea that antibiotics are somehow a "harmless" prescription despite the clearly outlined evidence of their potential harmful side effects as well as their role in secondary infections. (Sciaioli et al., 2015)(Pulcini et al., 2015)(Dyar, Howard, Nathwani, & Pulcini, 2013) It suggests that reiteration of basic microbiology and antimicrobial biochemistry should be emphasised in medical education, and covered "little and often" throughout curricula if we are to address AMR. A thorough knowledge and understanding of the different microbiological bacterial species and viruses will help promote effective prescribing by addressing the issue of "do I need to prescribe at all?" and why secondary antimicrobial resistant infections can emerge. Improved antimicrobial biochemistry teaching would demonstrate why antimicrobial drugs have potential side effects. There is a need to address these all too common misconceptions and this firm knowledge of the medical sciences should underpin prescribing teaching too.

However, reducing AMR is not just the responsibility of medical professionals changing their prescribing practice. Instead, it should be viewed in the same way that we promote effective vaccination programmes to combat outbreaks of infectious diseases; we emphasise the public health concept that prevention is better than cure. There is a multitude of evidence that shows it is more economically viable to focus on prophylaxis, reducing our reliance on antibiotics so that levels of antimicrobial resistance stop increasing.

Change is obviously required if we are to overcome this growing issue of resistance and it will not be simple. However, if we return to the WHO guidelines;

1. Improve awareness of AMR through communication, education and training,

It is clear that we need to approach the issue through communication, education and training.

Of course, careful prescribing by clinicians is important. However, this needs to be underpinned by effective
teaching in the medical sciences. In addition, we should not be relying on this teaching just being delivered in a Medical School curricula Instead we need to target school-age children, through the use of interactive online materials and science fairs. (McNulty et al., 2011) A better, informed public will be more open to accepting alternatives to antibiotic prescribing and medical students and clinicians have a role to play in this. However informing the public about the growing problem of AMR relies on clinicians and medical students having a firm bedrock of medical science knowledge and understanding. Teaching about AMR should also continue throughout medical and professional careers. This threat presented by AMR is imminent and is taking place in a shifting landscape of pathogens that are becoming more resistant to the clinical antibiotic options that we have at our current disposal; Continuing Professional Development (CPD) must be a requirement for medical and health care professionals. (Dyar et al., 2013)

If we are to combat an issue of this scale we need to fight fire with fire, we need to think like the microbes, we need to adapt our curriculum and our teaching of this vital subject if we are going to survive.

Take Home Messages

Antimicrobial resistance is an imminent threat that will be responsible for significant numbers of additional human deaths caused by pathogens that no longer respond to the drugs that we currently use in clinical practice. Tackling this problem needs a multifaceted approach and a change in behaviour from a variety of significant stakeholders including the medical and healthcare professions. This behavioural change must be underpinned by appropriate educational interventions. Focussing on prescribing skills and better antimicrobial stewardship is important but it must be taught in combination with a better knowledge and understanding of medical sciences and public health education interventions.

Notes On Contributors

Professor Laura Bowater is a Professor of Microbiology Education and Engagement at the Norwich Medical School, in the University of East Anglia. She has a special interest in the growing threat of Antimicrobial Resistance and has recently published a popular science book *The Microbes Fight Back; Antibiotic Resistance* (Royal Society of Chemistry 2017).

Jonathan Pyatt is an intercalating medical student at the Norwich Medical School in the University of East Anglia who is currently undertaking a Masters in Clinical Education prior to completing his final year of medicine. He is particularly interested in the teaching of clinical examination skills and public health.

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Appendices

Declarations

The author has declared that there are no conflicts of interest.

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