

### *Abstract*

To date, antimicrobials have been primarily understood through largely biomedical perspectives. Antibiotics, for example, have been branded and consumed as miracle drugs. In this way there has been a tendency to focus upon the effectiveness of pharmaceuticals within individual bodies. However, the growing threat of antimicrobial resistance demands that we reconsider how we think about antimicrobials and their effects. Rather than understanding them primarily *within* bodies it is increasingly important to consider their effects *between* bodies, *between* species and *across* environments. We need to reduce the drivers of AMR at a global level, focussing on the connections between prescribing in one country and resistance mechanisms in another. We need to engage with the ways that antimicrobials within the food chain, or inside our domestic animals, can and will impact upon human health care. Moreover we need to realise what happens within the hospital ward can impact upon the environment. In the future imaginative interventions will be required to address such wicked problems. These interventions must make the most of biomedicine but draw equally across a wider range of disciplines (e.g., engineering, anthropology, ecologists) and include an ever increasing set of professionals (e.g., nurses, veterinarians, dentists and farmers). Such collective action demands a shift to working in new interdisciplinary and inter-professional ways. Mutual respect and understanding is required to enable each perspective to be combined to yield synergistic effects.

## Introduction

*'The time may come when penicillin can be bought by anyone in the shops. Then there is the danger that the ignorant man may easily underdose himself and by exposing his microbes to non-lethal quantities of the drug make them resistant. Here is a hypothetical illustration. Mr. X. has a sore throat. He buys some penicillin and gives himself, not enough to kill the streptococci but enough to educate them to resist penicillin. He then infects his wife. Mrs. X gets pneumonia and is treated with penicillin. As the streptococci are now resistant to penicillin the treatment fails. Mrs. X dies. Who is primarily responsible for Mrs. X's death? Why Mr. X whose negligent use of penicillin changed the nature of the microbe'*

(Fleming, 1945: 93)

The effectiveness of antimicrobials, such as antibiotics, has always been fraught with the threat of their failure. For antibiotics, from the very outset, there has been an acknowledgement of the interplay of biological, psychological and wider socio-cultural mechanisms in relation to effectiveness. In the quote above Fleming warned that biological resistance mechanisms are deeply inter-related to the actions of people (e.g., adherence and transmission behaviours). The extract also shows that such actions are loaded with morality and wider social significance (e.g., culpability). Such actions can also have profound consequences that include onwards transmission and even death.

Reflecting upon the 72 years that have passed since Fleming gave this lecture, it is worth noting that biological and biomedical aspects of antimicrobials have been ascendant, with antibiotics for example, branded and widely consumed as 'miracle drugs' emblematic of the success of modern medicine. In stark contrast to these more biological aspects, the psychological and socio-cultural aspects of antimicrobials have largely been absent for much of this time. However now, as the threat of antimicrobial resistance (AMR) increases, and

antimicrobial development stalls, there is a growing need to engage and utilise these perspectives more fully.

### *The growing threat of AMR*

There is a clear sense of the escalation of threat relating to AMR. Over the last few years there is a sense of momentum around the global threat of AMR. The growing sense of urgency in relation to AMR is palpable. In 2011, for example, World Health Organization's Director General, Margaret Chan, described AMR as "one of the three greatest threats to human health". In 2013, the United Kingdom's Chief Medical Officer, Dame Sally Davies, was quoted to have said that antimicrobial resistance was a catastrophe equal to terrorism and climate change (McCarthy, 2013). AMR has recently been predicted to be the main cause of death for 10 million people globally each year by the year 2050 (Department of Health, 2013). In 2015, AMR was listed on the United Kingdom's National Risk Register of Civil Emergencies (Cabinet Office, 2015). The World Bank has warned that, by 2050, drug-resistant infections could cause global economic damage on a par with the 2008 financial crisis. The potential economic cost of AMR by 2050 has been estimated to be around US\$100 trillion (O'Neill, 2016).

### *Conceptualising AMR as a key way of combatting AMR*

Economic factors block the development of many new antimicrobials. In this way major biomedical solutions to the increasing AMR problem are unlikely. Furthermore, as Fleming outlined, they come with built in obsolescence as evolution drives the adaption of microbes to the new selective pressures associated with the drugs. The lack of new antimicrobials

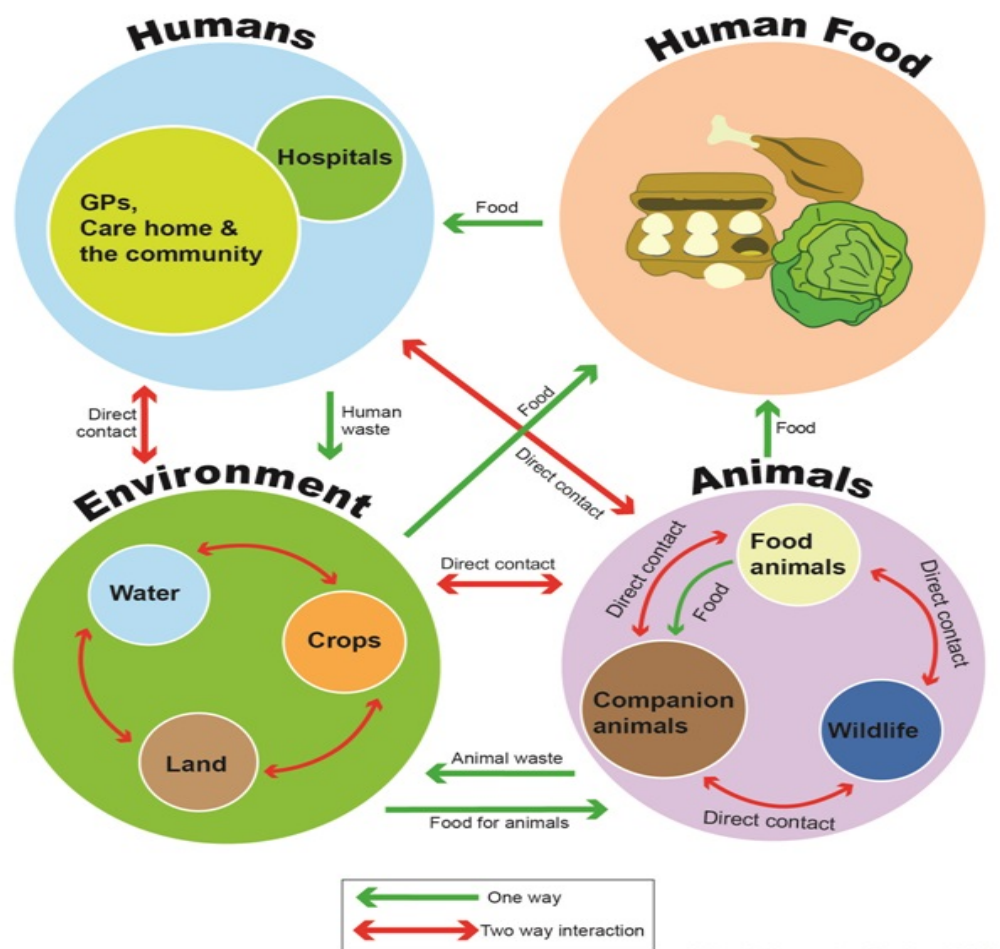
such as antibiotics has led to a focus on how we can conserve, or steward, the antimicrobials that are currently in existence. This has led to interdisciplinary research which has investigated the complex journey of our existing antimicrobials outside of the bodies in which their biomedical actions are intended are intended to work. There are a wealth of frameworks (Department of Health, 2014) available to help us understand these ecological, or One-health (European Commission, 2017) approaches to AMR (see Figure 1).

These conceptualisations show, for example, how away from the hospital wards in which they are consumed antimicrobials can enter the environment through waste water (Baquero et al., 2008). Equally, the very same antimicrobial agents can exert equally complex and far reaching effects through their use in agriculture (Baquero et al., 2008) or indeed within domestic animals (Guardabassi et al., 2004). Moreover, it is now increasingly acknowledged that modern travel and other aspects of globalisation mean that pharmaceuticals as well as microbial life move readily across the globe (MacPherson et al., 2009). Given the gross diversity in the regulation and consumption of antimicrobials across the world, interventions to reduce AMR must have global relevance. Ensuring effective interventions are in place within low and middle income countries is as important as ensuring there are effective interventions within the developed world.

It is important to grapple with the systemic qualities of AMR. Without doing so can mean that effective interventions in one location can cause the system to adapt and create problems elsewhere. Effective interventions focusing upon the reduction of antibiotics within primary care for example, may well drive potential negative, unanticipated and remote effects elsewhere. These could include increasing the unregulated patient

consumption of internet-purchased antibiotics, or indeed poor compliance with drug regimes in order to retain and store for potential future use. Equally, interventions that restrict and severely regulate the use of third line antibiotics within human health care will not reduce the drivers of resistance to them if they are prescribed to domestic animals without such regulation. Such systemic conceptualisations of the drivers of AMR mean we need to be creative with how we use our research methods, for example, the way we measure outcomes within randomised controlled trials for example to assess remote and unanticipated negative effects.

Figure 1 conceptualising complexity within AMR systems



*What AMR asks of us as experts within infection prevention*

AMR demands to be understood and addressed outside of any particular species (e.g., human, pig or domestic cat), outwith any particular physical location (e.g., the hospital ward), across a variety of disciplinary lenses (e.g., psychology or engineering), between professional perspectives (e.g., nursing vs vet), across national borders (Scotland vs India). AMR also warrants an approach which is trans-generational and which frames the drivers of AMR as an inevitable and enduring process that is both complex and, as Figure 1 indicates, systemic.

Beyond the adaptation of microbes to pharmaceuticals, the drivers of AMR are deeply multifaceted. They result from the actions of, and interactions between, microbes, more complex animal species, and within the human species, between governments, organisations, institutions, professionals and amongst the public, particularly when they become patients. Public health interventions rarely focus upon so many things at once; they rarely attempt to examine the connections between elements within complex and adaptive systems. Yet, this is exactly what the threat of AMR demands of us. We need to be creative with regard to the ways we consider our theories and methods. We need to be innovative in terms of interdisciplinary and transdisciplinary practice. The drivers of AMR are distributed across multiple and multi-layered stakeholders, from the role of an infection prevention and control nurse to a salmon farmer in the highlands of Scotland. AMR must be understood outside of any sole disciplinary lens or professional perspective. It should be thought of and addressed directly as both complex, systemic and distributed. However, this extended reach must not be allowed to elicit any diffusion of responsibility or dilution of expertise. Each discipline must excel within its own particular domain to enable the best possible

interdisciplinary and inter-professional solutions to be generated. We need more effective ways of communicating between our disciplines and professions to understand our distinct roles and contributions in relation to combating AMR.

### *The role of health psychologists within AMR*

The contribution of health psychology is to demonstrate the value and significance of understanding the drivers of AMR from an individual, and typically, behaviour change perspective. At first glance this might appear antithetical to the complex systemic framework depicted earlier. However, each discipline and profession has its unique yet complementary role to play. From a psychological perspective the commonalities across the system and its plethora of stakeholders relates to the multiple embedded individuals who each represent a particular and often distinct lever for AMR-related behaviour change. What differentiates these individuals across the AMR system is the very particular locus of change: the exact target of behaviour change interventions.

In this way, the same psychological perspectives can illuminate the very different decision-making processes of, for example, government officials in changing the financial models underpinning drug development. Or equally leaders within Pharmaceutical companies who can be targeted to persuade and change the focus of their programme of drug development. Furthermore, psychological perspectives can be used to target the decision-making of professional prescribers such as companion animal vets, nurse-led catheter care or indeed compliance with antibiotic prescriptions amongst the patient population. The commonality of psychological approach consistently focuses upon an analysis of i) which behaviours need to be changed (specifying a behavioural target) and; ii) an examination of

the antecedents of these particular behaviours (often as barriers and facilitators to changing the specific behavioural target). To oversimplify things, behaviour change interventions seek to change the particular antecedents of particular behaviours (so make most of the facilitators and respond where possible by removing barriers to behaviour change). The process of intervention development, or much of implementation science, is about ensuring the right mixture of active components within behaviour change interventions. Behaviour change interventions which tailor intervention components to the right antecedents of behaviour change, amongst the right people at the right time within the right context are most likely to be effective.

In recent years health psychology has undergone profound and positive change in relation to how it thinks about its core business of understanding and intervening in relation to behaviour change. Historically the discipline has suffered from an unhealthy proliferation of broadly similar, yet slightly different, theoretical models each mapping models of the ways varied antecedents relate to behaviour and behaviour change. Classic health behaviour change models include, for example, the Health Belief Model (Becker, 1974), the Theory of Reasoned Action (Fishbein and Ajzen, 1975) or Social Learning theory (Bandura, 1977) Arguably this led to the discipline appearing to others as opaque at best and in a state of pointless inertia at worst.

More recently, there has been a move to systematise the literally hundreds of behavioural models which exist and focus upon their similarities rather than their differences. In relation to the goal of interdisciplinary and inter-professional work, this simplification of theory clarifies the role of health psychology. It enables an easier inter-professional understanding



of what health psychology is, and health psychologists can offer. This is exactly what the threat of AMR demands. The behaviour change wheel (Michie et al., 2014) offers the most accessible framework to understanding how a psychological lens can illuminate behaviour and behaviour change. Its logic enables the systematic and specific development of intervention components to address the particular determinants of specific behaviours (e.g., compliance with all steps of hand hygiene versus the appropriate use of alcohol based hand rub by visitors to a hospital ward).

At the heart of the behaviour change wheel is the familiar depiction of behaviour and its antecedents. In contrast to the several hundred antecedents of behaviour suggested across the many previous models of behaviour change the behaviour change wheel offers three major ways of characterising antecedents, capability, opportunity and motivation (the COM-B model of behaviour change). More nuanced ways of conceptualising antecedents are also available within the behaviour change wheel which characterise antecedents across the fourteen domains of the theoretical domains framework (Prestwich et al., 2014; Atkins et al., 2017).

Broadly speaking intervention components are matched to each of the relevant antecedents. If the antecedents of GP's issuing delayed prescriptions relate to issues of their capability then interventions that address capability are more likely to be effective. Equally, if the issue of storing antibiotics amongst the public relates primarily to their motivations to keeping antibiotics then interventions that target their motivations are likely to be effective.

There have also been considerable developments in the ways we can communicate the active components of behaviour change interventions. For example, the specification and communication of behaviour change techniques (BCTs) used within behaviour change interventions. The focus upon BCTs represents an attempt to develop a common language relating to key aspects of active intervention content. In turn this facilitates the development of cumulative knowledge and creates a better evidence base able to combat issues such as AMR. To date, 93 individual BCTs have been identified; these individual techniques are clustered into 16 distinct groups of behaviour change techniques (Michie et al., 2013; Michie et al., 2016). Many of these behaviour change techniques will already be familiar to health professionals working within infection prevention and control and the wider field of AMR. The BCT taxonomy represents a major step forwards because it provides a common language rather than because it generates new techniques. Such shared vocabulary is central to addressing complex issues such as AMR where varied health professionals will be delivering interventions and utilising BCTs.

These exciting developments within health psychology are of interest and relevance to combatting AMR for two main reasons. Firstly, within the discipline itself, they provide both clarity and consistency of the basic work of health psychologists. Such approaches will reduce un-necessary duplication of effort. Instead these developments will focus psychological contributions on applied work, developing and implementing effective interventions rather than reinventing explanatory frameworks. This shift in focus creates capacity to address AMR and other complex issues. Secondly, recent developments help health psychologists work more effectively with other disciplines and professionals. Establishing common understanding, and common language, relating to the basic function

of health psychology is an essential step in understanding its unique contribution and also in illuminating its particular limitations.

### *Conclusion*

Imaginative, innovative and interdisciplinary interventions are needed to reduce the drivers of AMR across the coming decades. This ambitious enterprise warrants the best of what each individual, discipline and profession can offer. There can be no dilution of particular expertise and contribution. However, the need for better interdisciplinary and inter-professional work is not without its challenges. We need effective ways of communicating our relative expertise. A mutual understanding is needed in order to capitalise upon the synergies offered by different approaches working together. This is essential to enable the strengths in one approach to compensate for the weaknesses in others. In this way we need to create opportunities for connecting the best of health psychology with the best of medical sociology for example. The former has a clear focus upon the individual and their behaviour. In contrast the latter focuses on the systems and organisations in which such individual behaviours are embedded. We also need to understand and capitalise upon how diverse professions work together, what lessons concerning AMR can be learned and shared across prescribing (Vet, Nurse, and Medic). How can hospital based infection prevention and control illuminate veterinarian practice or the farmyard. It is only together, with genuine dialogue and collaboration that we can address the complexity and gravity of challenges posed by AMR.

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