ANTIBIOTIC RESISTANCE
CONFRONTING THE GLOBAL CRISIS

PLUS: Brexit; Flooding in France; Nanoparticles & First Responders; Agriculture & terrorism; Search & Rescue in Antarctica; Crisis leadership; Stability policing; Public information & social media; Conflict de-escalation; Robotic developments; Command & Control in the 21st Century
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Mendelson and Ramanan Laxminarayan explain how antibiotic resistance can be toxic for humans, especially first responders.

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Antibiotic resistance:

As leaders gather at the UN General Assembly to fight antimicrobial resistance – only the fourth time in UN history that a health topic has been discussed at this level – Marc Mendelson and Ramanan Laxminarayan explain why the issue is so important.

In 1899, a report published in the Athens-Clarke County Weekly Banner described the case of CW Jones whose foot was cut by a blade of grass. In this pre-antibiotic era, his foot had to be amputated to prevent the spread of an infection. Twenty-nine years later, Fleming discovered penicillin, since when millions of lives have been saved using antibiotics.

However, only 75 years after that fortuitous discovery, a man with a severely fractured ankle and secondary infection of the joint was admitted to a hospital in Cape Town in July 2016. Having received multiple courses of antibiotics to try to control the infection, he grew a bacterium from a bone biopsy that was resistant to the last line of antibiotics. Just as in the case of Jones, the man’s foot had to be amputated to control the infection.

The scenario of untreatable bacterial infection, or those that are susceptible only to the last line of antibiotics, is now commonplace across the globe, and heralds a change in modern medicine as we know it. Antibiotics are vital to maintain health; not only to treat bacteria causing pneumonia, meningitis, gonorrhoea, urinary tract infections and a long list of other common infections, but also to prophylaxis to prevent infections in persons whose immune systems are compromised, such as those living with HIV or receiving a transplant, and to prevent surgical wounds becoming infected at the time of operation.

Smith and Coast estimate that without antibiotics, just under half of patients who undergo a total hip replacement would develop a post-operative infection in the new joint, and about one third who developed such an infection would die. Although estimates of the number of additional deaths from loss of antibiotics as surgical site infection prophylaxis for total hip replacement in the US were lower in modelling reported by Teillant and colleagues, with markedly increased odds of death the decision to have a total hip replacement – even if you really needed one – would be far more difficult to make. Similarly, chemotherapy used to treat cancer causes the body’s normal defence mechanisms against bacteria to be suppressed. If a patient with cancer is carrying a highly resistant bacterium to which no antibiotic is available, then giving chemotherapy to that person would carry an extremely high risk that an infection with that bacterium would develop and be fatal. These cases exemplify how great a game-changer the loss of antibiotics to treat bacterial infections will be.

It seems counterintuitive that taking an antibiotic can itself encourage the development of resistance to that antibiotic. Most antibiotics have been isolated from soil bacteria and fungi, and are chemicals that are produced by these microorganisms to attack other bacteria. Just as with any example of natural selection, some bacteria have a survival advantage and possess the capability to resist such an attack. Furthermore, the majority of genes that code for the different resistance mechanisms are carried on plasmids (circular pieces of DNA), which can be transferred from bacteria to bacteria of the same, or different species. Hence, antibiotic resistance in bacteria can either be naturally occurring or acquired. Humans share a symbiotic relationship with around 100 trillion bacteria and other microorganisms that live on epithelial linings of our gut, respiratory tract, skin and other body surfaces. These microorganisms play vital roles in the development of our immune system, digestion of food and vitamin metabolism, and provide a virtual barrier to more pathogenic microorganisms, outcompeting them by their sheer number.

When we take an antibiotic, bacteria sensitive to the action of that antibiotic will be killed, but those that are able to resist will be selected out. Given the right circumstances, the resistant strains will replicate and become the dominant species. Those that colonise body linings such as skin are transferable to other people, which is a danger, particularly in hospitals where sick patients are in abundance. Alternatively, it may cause an infection in that person, which would then need to be treated with a ‘higher-level’ antibiotic that remains.
A One Health approach to building antimicrobial resistance National Action Plans in middle and low income countries

William Park in the UK recently hosted a meeting that brought together representatives from countries in middle and low income economic settings, who are leading the development and implementation of their NAPs, sharing their experiences so far and learning from one another. NAPs should embrace a “One Health” approach to combat antimicrobial resistance (AMR). It brought together representatives from countries in middle and low income economic settings, who are leading the development and implementation of their NAPs, sharing their experiences so far and learning from one another. NAPs should embrace a “One Health” approach to combat antimicrobial resistance (AMR).

Overall antibiotic consumption

What remains unclear is the degree to which development of bacterial resistance in animals is driving increasing resistance in human medicine. The problem is yet more complex, with bacteria-carrying resistance genes entering the environment through farm silos, antibiotic manufacturing facilities discharging antibiotics directly into the environment from run-offs, and antibiotics being used in aquaculture to prevent disease. There are a number of de-linkage models have been proposed by independent AMR Review, led by Lord O’Neill.

Antibiotics, 2015

The required international response and funding models to address infection prevention to reduce the need for antibiotics, as well as improving diagnostics and treatments (phage therapy, and probiotics), are underpinned by education, public awareness, and R&D of new antibiotics, vaccines and diagnostics.

The Global Action Plan for Antimicrobial Resistance (AMR), which was established by the tripartite alliance and organisations such as the Global Health Organization (WHO), the World Organisation for Animal Health (OIE), and the United Nations (UN), is a High-Level Co-ordinating Mechanism (HLCM), which could drive many of the interventions discussed here at a high level. HLCM functions would include driving the global access to vaccination to prevent pneumonia and other illnesses also reducing unnecessary antibiotic use. Similarly, increasing access to clean water and adequate sanitation, which if put in place, are estimated to reduce diarrheal illness by up to 66 per cent and therefore also reducing unnecessary antibiotic use. For example, increasing access to clean water and adequate sanitation, which, if put in place, are estimated to reduce diarrheal illness by up to 66 per cent and therefore also reducing unnecessary antibiotic use.

Awards

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