Trends in Microbiology

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Special Issue: Antimicrobial Resistance and Novel Therapeutics

Editorial

Responding to Antimicrobial Resistance with Novel Therapeutics

Gail Teitzel[1,*]

From a public health perspective, the development of improved sanitation along with development of vaccines and antibiotics have been key in reducing the occurrence and lethality of infectious diseases. Within this trifecta, antibiotics are currently at the most risk of having their beneficial effects eroded away due to antimicrobial resistance.

When the antibiotic penicillin began to be used in the 1940s[i] it was a life-saving drug and heralded as 'the wonder drug', and while antibiotics continue to be life-saving drugs, transferable resistance to antibiotics was noticed shortly after their use by humans [1]. In fact, antimicrobial resistance has ancient roots in that this is tied back to the use of antimicrobial agents between microbial species targeted to other microbes [2]. This ability of microbes to transfer bits of genetic material, that aid microbial survival in the face of stress from antibiotic-producing organisms, has continued to occur after increasing human use of different antibiotics. In what is often termed an arms race, resistance has emerged to different antimicrobials and spread across microbes.

The current situation regarding antimicrobial resistance is deeply concerning in terms of the number of reports and the number of resistant microbes. In 2013 the CDC put together a report on antibiotic resistance threats and is working to update this in 2019[ii]. Some of the many resistant microbes include carbapenem-resistant Enterobacteriaceae, extended-spectrum β-lactamase (ESBL)-producing Enterobacteriaceae, vancomycin-resistant *Enterococcus* (VRE), methicillin-resistant *Staphylococcus aureus* (MRSA), and multidrug-resistant tuberculosis. It is estimated that, globally, every year, 700 000 deaths are due to antimicrobial-resistant infections[iii].

As serious as antimicrobial resistance is as a problem, I have hope because of the recognition that this is a problem from broad recognition within the scientific community up to the meetings by the United Nations on Antimicrobial Resistance[iv] and the global action plan on antimicrobial resistance from the World Health Organization [3]. Various approaches to try to address antimicrobial resistance have been proposed, for example from increasing awareness of antibiotic resistance and stewardship to aiding conversion from basic science leads and drug development, especially through innovative partnerships.

This themed issue of *Trends in Microbiology* aims to discuss some issues in antimicrobial resistance and novel therapeutic approaches to address infections. Developments at the science–policy interface and new innovations to strengthen this linkage are discussed. Issues around antimicrobial resistance are investigated, such as how this is acquired, tolerance to antibiotics through efflux pumps, and the Eagle effect of bacterial survival at high levels of antibiotics and comparing this with microbial persistence. We examine novel therapeutic approaches such as a survey of different alternatives in development to conventional antibiotics, using antibodies for treatment of *Staphylococcus aureus* biofilms, and developing immunocommensal therapies. Bacteriophages naturally target specific bacteria, and antimicrobial resistance has revived interest in using them therapeutically, including through engineering bacteriophages to act as biologics or using temperate phages. Antimicrobial resistance can also occur in viruses to antivirals, and this issue ends with an

[1]Editor, Trends in Microbiology
*Correspondence:
tim@cell.com (G. Teitzel).

infographic on the current direct-acting antivirals used to treat hepatitis C virus and the development of antiviral resistance.

I have been inspired by the continued action and passion of scientists towards rectifying this problem of antimicrobial resistance and rescuing the antibiotics legacy of microbiology. I hope that you also find our issue on antimicrobial resistance and novel therapeutics similarly stimulating. I wish to thank our authors for the light that they have shed on the problem, and the possible solutions raised, and I also thank our reviewers for their constructive advice. I look forward to seeing these potential solutions, and others, in action so that we are better able to treat infectious diseases.

Resources

[i]www.pbs.org/newshour/health/the-real-story-behind-the-worlds-first-antibiotic
[ii]www.cdc.gov/drugresistance/biggest_threats.html
[iii]https://amr-review.org/sites/default/files/160525_Final%20paper_with%20cover.pdf
[iv]www.who.int/antimicrobial-resistance/events/UNGA-meeting-amr-sept2016/en/

References

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2. D'Costa, V.M. *et al.* (2011) Antibiotic resistance is ancient. *Nature* 477, 457–461.
3. World Health Organization (2015) Global Action Plan on Antimicrobial Resistance. WHO.