BIOCHEMICAL SOCIETY

SOCIETY FOR GENERAL MICROBIOLOGY

LIVING IN A POST-ANTIBIOTIC ERA:

the impact on public health

WELCOME

This booklet was created by the Biochemical Society and the Society for General Microbiology as part of a series of public debates around antibiotic resistance, to provide a brief overview of the issue and to discuss how we can help.

WHAT ARE ANTIBIOTICS?

An antibiotic can be defined as any substance that kills a bacterium, or prevents its growth and replication. They can be used on or within the body, as creams, sprays, in tablet form or injected as liquids. Antibiotics occur in nature; bacteria produce them to kill nearby bacteria and gain competitive advantage.

Infectious diseases are common and are caused by a variety of microbes (bacteria, fungi and viruses). For centuries (often unknowingly) humans have been managing bacterial infections using antibiotics.

Humans have been utilising the amazing power of antibiotics for centuries, although we were not always aware of it. Ancient populations in Greece, China and Egypt would press mouldy bread against wounds to prevent and cure infections, while scientists have discovered that in Egypt, ancient Nubian people drank beer laced with the antibiotic tetracycline [1]!

After the accidental discovery of penicillin by Alexander Fleming in 1929, a “golden era” of antibiotic discovery occurred between 1940 and 1960, where more than 20 new classes of antibiotics were discovered. The development of modern industrial processes allowed scientists to produce antibiotics in large quantities, cheaply and efficiently. Unfortunately, no new classes of antibiotics have been discovered since 1970 and the ones we do have are becoming ineffective against a new enemy: the superbugs. These bacteria are resistant to one or more types of antibiotic, meaning some diseases like tuberculosis and gonorrhoea are becoming increasing difficult to treat.

WHAT IS ANTIBIOTIC RESISTANCE?

Bacteria are able to adapt and alter their genetic structure to survive in their ever changing environments. When an antibiotic is used, resistant bacteria have a greater chance of survival than susceptible bacteria which are killed. Resistant bacteria then go on to reproduce and pass on these resistant genes to their offspring, increasing the abundance of drug resistant bacteria.

While bacteria can become resistant to antibiotics naturally, this process is relatively slow. However, as humans, we are largely responsible for the current far-reaching, fast-paced uptake of antibiotic resistance by bacteria.

Over the last 70 years we have used and abused antibiotics, as if they were the "magic bullets" of medicine. If one didn't work, we would just start using another one. Many of us don't finish a course of antibiotics and save a few for the next time we get sick. In some countries it is possible to purchase antibiotics without a doctor's prescription. In developed countries especially, GPs are 40% more likely to prescribe antibiotics for coughs and colds than they were a decade ago [2]. The increase in international travel also means that resistant strains of bacteria can spread quickly and easily. Only recently are we realising the impact of a future without antibiotics.

A child with an ear infection in 1990 would recover almost instantly from one round of antibiotics. Now, it could take three or four rounds of antibiotics to clear the infection. Both doctors and patients need to be aware of the risks in taking antibiotics when they may not be necessary. For example, many children recover from an ear infection on their own, without needing antibiotics. The common cold is not cured by antibiotics, but many people ask for them when feeling unwell. Continued misuse of antibiotics will cause further resistance. This would mean many more people dying of infections that are currently easy to cure, and people being at a much greater risk of infection after even simple operations.

Antibiotics are also used extensively in farming to promote growth and to prevent disease in livestock. The antibiotics can be found in the meat we eat, meaning resistant strains of *Campylobacter* and *Salmonella* are passed on to humans and can cause us severe illness. The antibiotics are also found in manure, which is washed off fields when it rains into rivers and streams. Many species of bacteria live in soil and are exposed to antibiotics at concentrations greater than would occur naturally.

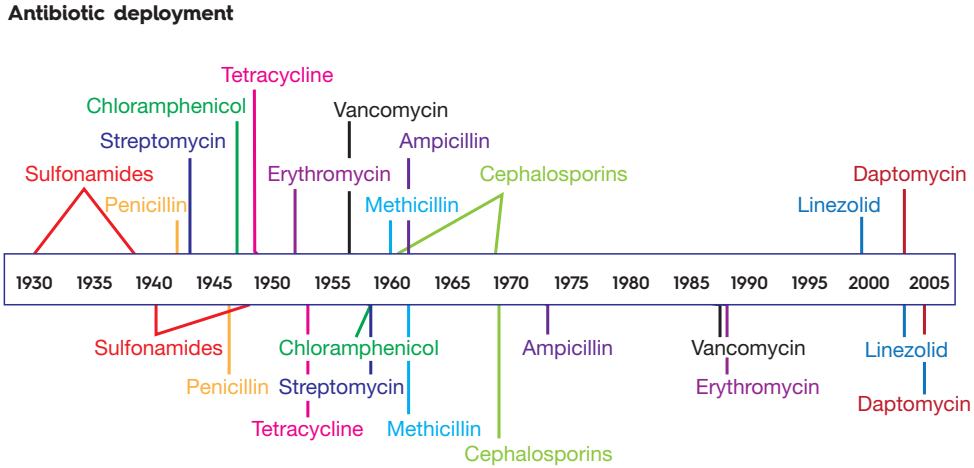

Figure 1 – Timeline of antibiotic use in a clinical setting and the evolution of antibiotic resistance from: "Targeting virulence: a new paradigm for antimicrobial therapy" Anne E Clatworthy, Emily Pierson & Deborah T Hung. Nature Chemical Biology 3, 541 – 548 (2007) Published online: 20 August 2007 doi:10.1038/nchembio.2007.

Antibiotic resistance can also affect our pets. Vets are finding cases of MRSA are increasing among our pets and they are running out of drugs to treat them with. Some resistant strains of bacteria can be passed from the animal to the owner, the vet and to other pets [3]. When a pet gets sick, vets can perform sensitivity tests to determine which organism is infecting the animal and the best drug to treat it with. This will reduce the misuse of antibiotics in pets.

Ever since antibiotics were discovered, the threat of resistance has been strong.

"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 [bacteria] but enough to educate them to resist penicillin. He then infects his wife. Mrs X gets pneumonia and is treated with penicillin. As the [bacteria] are now resistant to penicillin the treatment fails. Mrs X dies. Who is primarily responsible for Mrs X's death?"

Alexander Fleming, Nobel Prize speech, 1945.

RESISTING THE RESISTANCE

Scientists continue to look for new classes of antibiotics, alternatives to antibiotics such as phage therapy (using viruses that attack bacteria but are harmless to people) and investigating the possibility of genetically modifying bacteria to remove antibiotic resistance.

There is also a need for more targeted tests to be developed and used. If physicians could quickly and easily find out which microbe is causing illness, they could prescribe a specific treatment, rather than a broad-spectrum antibiotic.

Doctors and clinicians can help in the fight against antibiotic resistance by being better informed, and better informing patients, about the correct use of antibiotics. At Churchill Medical Centre in Surrey, posters and leaflets were displayed in doctors' waiting rooms highlighting the illnesses that do not require antibiotics. An audit was carried out to measure the projects results. It showed a 15% drop in antibiotic prescriptions for coughs and colds [4].

By informing the public clearly about treatments for different illnesses, they will know what to expect from their GP. This will reduce the uptake of antibiotics, ensuring we use them in the most appropriate way.

So, what small things can we all do to help preserve our supplies of antibiotics?

- Practise good hygiene to prevent the spread of infection
- Trust your pharmacist! They are experts in helping you choose what medication can help alleviate your symptoms and whether or not you need to see your GP
- Familiarise yourself with what symptoms are more likely to be caused by a virus and therefore untreatable with antibiotics (all colds, most coughs, sore throats and earaches)
- Symptoms of a cold, flu, nasal congestion, sore throat or cough can last longer than you think. Follow NHS guidelines (web address on the back page) as to whether you should visit your GP with these symptoms
- Only use antibiotics when they are prescribed to you by a medical professional.
- If you are prescribed antibiotics, ensure you take them as directed and complete the entire course
- Become an Antibiotic Guardian! Sign the pledge http://antibioticguardian.com/
- If you are a pet owner, follow these guidelines for them too

FURTHER READING:

Phage Therapy

National Centre for Biotechnology Information
http://1.usa.gov/1GHhwyd

Phage Therapy Centre
http://bit.ly/1ueJvjx

Genetically modifying antibiotic resistant bacteria

Popular Science Magazine
http://bit.ly/1GHhNS1

Advice on using antibiotics

NHS
http://bit.ly/1waHPGi

Antibiotic Resistance and the Longitude Prize

https://longitudeprize.org/challenge/antibiotics

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[1] Sohn E (2012) Ancient Nubians drank antibiotic laced beer. Discovery News http://news.discovery.com/history/ancient-egypt/antibiotic-beer-nubia.htm

[2] Robinson S (2014) GPS 40% more likely to prescribe antibiotics than they were a decade ago. GP Online http://www.gponline.com/gp-antibiotic-prescribing-rises-40-decade/respiratory-system/urtis/article/1306474

[3] Lloyd DH (2007) Reservoirs of Antimicrobial Resistance in Pet Animals. Clin Infect Dis. 45 (Supplement 2): S148-S152.

[4] NICE (2014) Project to reduce antibiotic prescribing wins 2014 NICE Shared Learning Award. NICE News and Features https://www.nice.org.uk/news/article/project-to-reduce-antibiotic-prescribing-wins-2014-nice-shared-learning-award

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