UK Centre for Ecology & Hydrology

Antibiotic resistance factsheet

Q. How do bacteria develop and spread resistance to antibiotics?

A. There is a vast number of human and veterinary antibiotics in the environment, present in excrement from people and animals. While these antibiotics kill some microbes, others 'learn' how to fight them. The resulting antibiotic-resistant genes are rapidly shared among microbial communities, either through mutation or 'bacterial sex'. Antibiotic misuse, over prescribing, poor sanitation, hygiene and infection control practices, as well as global trade and travel are contributing factors in the spread of antibiotic-resistant genes. 'Antibiotic resistance refers to the ability of bacteria to survive exposure to a medicine that would normally kill them or stop their growth.

Q. How do antibiotics end up in our rivers and seas?

A. Up to 90% of the antibiotics we consume passes through our body into the sewerage system. Scientists estimate that sewage treatment works, which aren't designed to remove antibiotics or treat resistant bacteria, remove about half of antibiotic material, with the remainder ending up in our rivers (or seas in coastal areas). Some classes of antibiotics such as penicillin biodegrade fairly quickly and do not reach the river, while others, such as macrolides and fluoroquinolones, are more persistent.

Q. What is the scale of the problem?

A. In a single day, treated wastewater discharged from the 9,000 sewage works into rivers and the sea in the UK contains at least 40 quadtrillion ($4x10^{16}$) bacteria – five orders of magnitude higher than the number of galaxies in our known universe. Each harbours at least one antibiotic-resistant gene. Modelling led by the UK Centre for Ecology & Hydrology estimated across three-quarters of the River Thames catchment, the antibiotics present due to effluent discharge were likely to be at levels high enough for antibiotic-resistant bacteria to develop.

Antibiotics in untreated effluent also pass directly into rivers and seas during times of heavy rainfall, from an overflowing sewerage system. There are around 15,000 combined sewer overflows (CSOs) in England per year.

Q. How are antibiotic-resistant genes passed to humans?

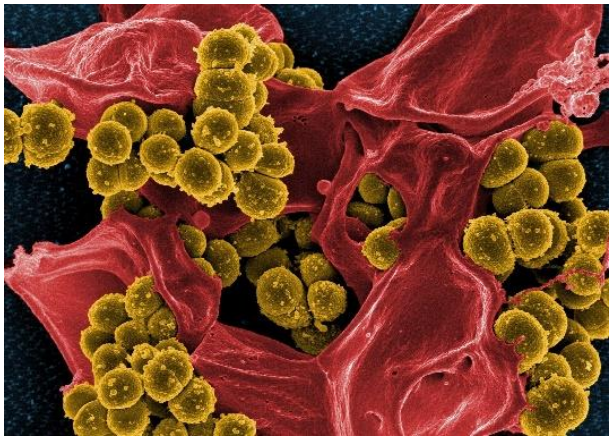
A. Humans are at risk from direct exposure to river and sea water, including swimming and watersports, as well as indirectly by eating fish and other food that has been in the water, plus contact with cats and dogs that have been in the river. Antibiotic-resistant bacteria found in manure (spread on cropland) can contaminate food, groundwater or adjacent rivers due to run-off after heavy rainfall, plus also pass to humans and animals via dust in the air.

Q. How can we stop antibiotics getting into our rivers?

A: Preventing pharmaceutical waste getting into rivers would limit bacteria's exposure to antibiotics and thereby reduce the rate of antibiotic resistance. While it is not possible, at present, to prevent all antibiotics getting into the environment, possible ways to reduce the problem include:

- reducing inappropriate prescriptions, either because the antibiotics will not reduce the infection, or the course of treatment is longer than is medically necessary
- preventative action so fewer medicines are needed in the first place, such as more rapid diagnosis of medical conditions, greater uptake of vaccinations for illnesses and better hygiene controls in hospitals.
- increased investment in research and development of new wastewater treatment processes that would remove the drugs and bugs from sewage.

Q. Are antibiotics keeping pace with 'superbugs'?



A. Previously treatable infections are becoming increasingly harder to treat with traditional medicines. For example, antibiotic-resistant bloodstream infections that were once treatable rose by 35% between 2013 and 2017 in England. Particularly virulent antibiotic-resistant 'superbugs' include E-coli, MRSA and *Klebsiella pneumoniae.*

No new class of antibiotics has been approved for more than 30 years, with pharmaceutical firms reluctant to invest in research and development because they fear a lack of profitability.

Suggested solutions include financial incentives for companies developing new drugs, or the establishment of a global, publicly-funded antibiotic research and development institute.

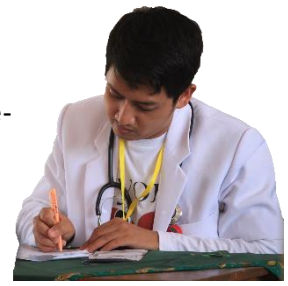
Q. What is the impact of antibiotic resistance on human health?

A. Across Europe, an estimated 33,000 people (including 2,100 in the UK) die each year from an infection due to antibiotic-resistant bacteria – comparable to influenza, tuberculosis and HIV/AIDS combined. UK government officials warn that by 2050, if the rate of increase in drug-resistant infections continues unchecked:

- Additional deaths worldwide each year will rise from 700,000 to 10 million
- Annual global GDP could be cut by up to 3.5%
- A total of up to 100 trillion USD could be lost in global economic output over that entire timeframe

Public Health England says without antibiotics, 3 million common procedures such as cesarean sections, hip replacements and some cancer treatments in England could become life-threatening. In 2017, the then Chief Medical Officer for England, Professor Dame Sally Davies, warned "we risk the end of modern medicine" without swift action to tackle antibiotic resistance.

Q. What is being done to tackle the problem?



A: The Government and health officials recognise that reducing antibiotic prescribing in human and animal healthcare is key to tackling antibiotic resistance, and the UK has a five-year action plan in place.

There was a 6.1 per cent reduction in total antibiotic consumption in primary and secondary care in England between 2014 and 2018, while sales of antibiotics for use in food-producing animals dropped by 40% between 2013 and 2017. However, antibiotics prescriptions per person in the UK is still higher than several European countries and double that of the Netherlands, where their controls on prescribing antibiotics and effective hygiene measures in the healthcare system have resulted in relatively low rates of antibiotic resistance.

The UK Government and NHS already have campaigns to encourage greater uptake of vaccinations for illnesses, and hopefully more people in vulnerable groups will take advantage of them.

Q. What is meant by antimicrobial resistance (AMR)

A. Microorganisms that cause infections including bacteria, viruses and fungi. Antimicrobials are the medicines used to treat them, eg antibiotics for bacteria, anti-virals for viruses and anti-fungal treatments for fungal infections.

Antibiotic resistance is a sub-set of antimicrobial resistance, and other subsets include antiviral resistance, antifungal resistance and antiparasitic resistance.
