CJ Littlejohns health essay – Tom Bradley, year 12

Antibiotic Resistance - The Silent Pandemic

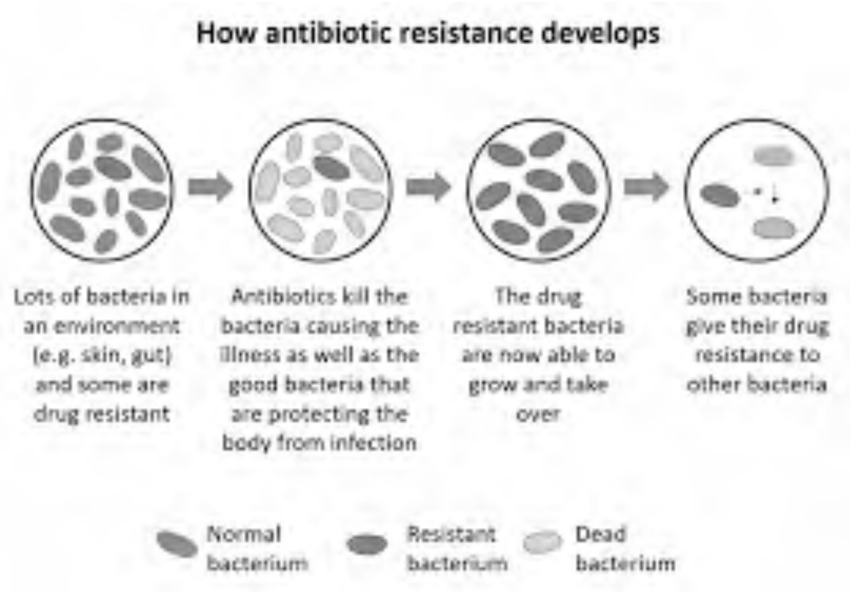
During my work experience in a medical practice, I noticed a pattern that at first seemed ordinary but, on reflection, showed something deeply concerning. Quite a few patients arrived with illnesses such as colds, flu or viral sore throats, but some still expected to be given antibiotics. Even after the doctors explained clearly to them that antibiotics do not work on viral infections, some patients still asked for them, 'just to be safe'. What I noticed was that the expectation to have 'medicine' often mattered more than the actual clinical need for it. For these patients, I think the placebo effect of taking any medicine, like antibiotics, represented thorough, high-quality care, rather than an actual effective treatment (which was usually just rest and recovery).

After doing research for this essay, I have found out that this observation reflects a much larger and very complex issue. Antimicrobial resistance (AMR) is a serious global problem, and it is usually explained primarily as a biological problem where bacteria evolve, antibiotics stop working, and medicine must develop ways to stay ahead. While this is true in theory, it is more complicated in practice. The extraordinary speed and global spread of modern antibiotic resistance in bacteria cannot be explained by bacterial evolution alone. The crisis is also driven hugely by human behaviour, involving social expectations, cultural aspects, agricultural demands, economic factors and global inequalities in healthcare in different countries around the world (5).

In this essay I have explored how antibiotic resistance is largely a behavioural and structural crisis as well as a biological one. By analysing how healthcare habits, farming practices, environmental contamination, and inequality contribute to antibiotic resistance, I believe that the real 'silent pandemic' is not just the bacteria themselves but also the way societies behave around the world that enables their evolution. Only by addressing these human factors, alongside scientific innovation, can we hope to preserve antibiotics for future generations.

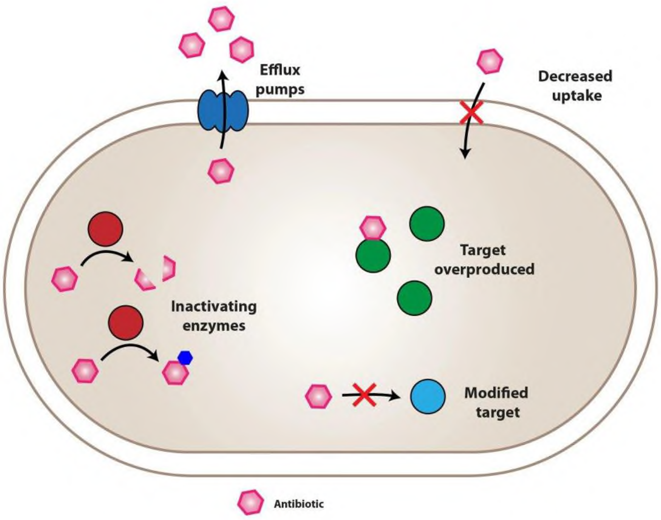
How do bacteria become resistant to antibiotics?

Antibiotic resistance occurs when bacteria develop mechanisms that allow them to survive exposure to drugs designed to kill them. Since the discovery of penicillin, antibiotics have saved millions of lives, enabling safe surgery, cancer treatment and the management of infectious diseases. However, their widespread use has created intense evolutionary pressure. Bacteria adapt quickly when exposed to antibiotics repeatedly or unnecessarily because they evolve mechanisms that allow them to survive (6).



Bacteria resist antibiotics through several strategies:

- Target modification, where bacteria alter the molecules antibiotics bind to,
- Reduced permeability, preventing drugs from entering the cell,
- Efflux pumps, actively removing antibiotics,
- Enzymatic destruction, for example lactamases, that disable penicillin-like drugs,
- Horizontal gene transfer, where resistance genes spread rapidly through plasmids.



These defences allow bacteria not only to survive antibiotics but also to reproduce and multiply, passing on resistant characteristics to future generations and, in many cases, to other bacterial species.

These mechanisms are impressive but also predictable. Evolution favours survival and any population exposed repeatedly to a threat will eventually adapt. This is also true for bacteria although the speed and global scale of resistance today are far beyond what natural evolutionary processes would produce naturally. For example, carbapenem-resistant Enterobacterales (below) used to be rare but are now found on every continent [1]. The World Health Organisation warns that antimicrobial resistance could cause 10 million deaths per year by 2050 if unchecked [9], [10].

The problem is not just the biology, but the enormous selective pressure created by human behaviour. Bacteria evolve predictably but humans use antibiotics unpredictably. Understanding resistance as a biological phenomenon without recognising the social structures that accelerate it is therefore misleading and part of the problem.

Patient expectations around prescribing antibiotics

My work experience observations in a medical practice mirrors a widely documented global trend. Antibiotics are often requested for reassurance rather than medical necessity. Even individuals who understand that antibiotics do not treat viral infections can still associate receiving a prescription with proper care. The reasons behind this are complex:

(a) Patient perception of illness and emotional reassurance. Many patients overestimate the danger of everyday illnesses and see antibiotics as a 'safety net', even when the risks, such as allergies or long-term resistance, outweigh any benefit [8].

(b) Cultural expectations. In some families and communities, antibiotics function as a routine response to any infection-like symptom. For these people this 'normal' cultural behaviour makes refusal of antibiotics feel like inadequate care [1].

(c) Feeling like there should be action. For a lot of patients giving them antibiotics represents action. In contrast to this, advice from doctors such as 'rest and drink fluids' can feel passive or uncaring, even when it is clinically correct and the best thing to do.

(d) Pressure on healthcare professionals. Doctors may also contribute to the problem inadvertently. Under time pressure, some prescribe antibiotics to avoid lengthy discussions. Others are concerned about patient satisfaction scores, complaints, or the risk of missing an early bacterial infection.

All these factors can contribute to overuse and misuse of antibiotics and encourage resistance to build up in bacteria. This creates a dangerous cycle where patients expect antibiotics, and doctors, sometimes reluctantly, prescribe them. Over time, this changes cultural norms and expectations, so the situation gets worse. In 2022, for example, UK primary care prescribed over 24 million antibiotic courses, a significant proportion of which were unnecessary.

There are educational campaigns that explain the difference between viruses and bacteria, and that antibiotics only work against bacteria (for example in medical surgeries there are posters on the wall explaining this), but unfortunately these seem to have had limited success. Studies done in behavioural science show that knowledge on its own rarely changes behaviour when expectations, fears or habits are so strong. To reduce misuse and overuse, we must understand the social and emotional factors behind patient decision-making as well as the scientific reasons for antibiotic resistance, and re-design communication strategies around this.

Agricultural and economic factors that increase pressure for overuse

Antibiotic resistance does not only originate from hospitals. The agricultural sector plays a major, and often under-acknowledged, role. Globally, over two-thirds of antibiotic use occurs in animals rather than humans. In many farming systems, antibiotics are used to treat illness, to prevent possible infections in crowded facilities, and also to promote growth of livestock to get a better yield [11].

Farmers often operate within narrow profit margins so are under pressure to adopt intensive farming practices to maximise their profits. However, intensive farming methods often decrease the quality of life for animals and increases the risk of disease, and antibiotics are a cheap, immediate solution. The issue is therefore not ignorance but economic pressure, where responsible antibiotic use often costs more than irresponsible use. Without sustainable change, farmers are often trapped in a sitution that demands efficiency but undermines public health.

Resistant bacteria generated in farms can spread through various routes:

- contaminated meat and dairy products,
- direct contact with farmworkers,
- water systems (lakes, rivers) polluted by runoff, and
- soil ecosystems exposed to animal waste.

A striking example is the rise of mcr-1, a gene that gives bacteria resistance to colistin, one of the world's 'last-resort' antibiotics. It was first identified in Chinese livestock, then it spread globally within a few years [(12)]. This showed how agricultural misuse of antibiotics can directly compromise human medicine and affect global health.

Solving the problems of agricultural antimicrobial resistance requires combining economic incentives with public health. Farmers must be supported through subsidies, veterinary support and international regulation to ensure responsible antibiotic use is not a financial disadvantage.

Global inequality in access to antibiotics, and their overuse

Antibiotic resistance is a global crisis, but it does not affect all regions equally. Countries face different challenges depending on economic conditions, healthcare infrastructure and regulations.

In low- and middle-income countries there is a problem of under-regulation of antibiotic use. In many lower-income regions, antibiotics can be bought without a prescription [(9)]. This leads to incorrect drug selection, incomplete courses, substandard or counterfeit medications, and widespread use of antibiotics without proper control. These factors significantly accelerate resistance. Poor sanitation further increases infection rates, prompting more antibiotic use [(7)].

In contrast to this, in high-income countries the problem is often associated with overuse and demand. High-income countries therefore struggle with patient expectation, defensive prescribing, convenience-driven treatment, and high rates of non-bacterial infections in primary care.

These two crises, under-access versus overuse, appear contradictory but create the same result: widespread pressure on bacteria to evolve.

Because resistant bacteria do not respect borders, global inequality makes AMR seemly impossible to solve nationally. For example, resistant strains of the bacteria *Klebsiella pneumoniae* (below) have spread internationally through travel and healthcare tourism [(10)]. High-income countries therefore have a responsibility to support lower income countries through investment in sanitation, laboratory capacity, surveillance, and secure supply chains of medicines.

Ethical and environmental factors as the invisible accelerators of resistance

Antibiotic resistance raises ethical questions about responsible use of antibiotics. Every unnecessary prescription today risks depriving future patients of effective treatment. Ethical decision making is therefore an inter-generational responsibility, and we must think in the long term, not the short term if future generations are to be safe (4).

However, an equally important but less obvious factor is environmental contamination. Antibiotics from hospitals, households and especially pharmaceutical factories can enter water systems. Studies in India have found river concentrations of certain antibiotics exceeding safe levels by up to 1,000 times, creating hotspots for the evolution of resistant bacteria (7).

Environmental exposure allows bacteria from soil, water and wastewater to exchange resistance genes. These ecological interactions are often more common than those occurring in humans or animals. For instance, resistance genes found in hospital pathogens have been traced to environmental bacteria that had never been exposed directly to medical settings (3).

This highlights the need for environmental regulation. Without monitoring antibiotic pollution, progress in hospitals and farms will be undermined. Antibiotic resistance in bacteria is therefore not only a medical issue but a multidisciplinary one, requiring cooperation between environmental agencies and health authorities.

Why current global strategies aren't working as well as they could

Despite decades of campaigns, international programmes and educational initiatives, antibiotic resistance continues to rise. The main reason is that these strategies rely heavily on the assumption that increased knowledge will change behaviour. In reality this hasn't happened because:

- convenience often outweighs long-term risk,
- economic growth outweighs environmental responsibility,
- cultural norms override clinical advice, and

- fear and uncertainty override scientific information.

Antibiotic misuse persists not just because people are unaware of resistance, but because the systems they live in make misuse easy and responsible use difficult. For example, it is easier for a GP to prescribe antibiotics than to negotiate expectations in a 10-minute appointment. It is cheaper for a farmer to use antibiotics than to redesign production systems. It is quicker for a patient in a low-income country to buy antibiotics over the counter than to access a clinic.

As long as these structures and systems stay in place, strategies to combat antimicrobial resistance that are based mainly on education will fail. Bacteria are simply evolving faster than we can develop new antibiotics. Without addressing the systems that drive misuse, scientific innovation alone cannot solve the problem.

The way forward against resistance

To combat AMR effectively, we must treat behaviour and structures with the same seriousness as biology. I think there could be four strategies for designing an effective way to combat resistance:

(1) Changing patient expectations. Doctors must explain not only what antibiotics cannot do, but what good care without antibiotics looks like. This includes clear reassurance, symptom management advice, and emphasising community-level responsibility.

(2) Supporting agriculture. Farmers should be supported through subsidies for improved animal welfare, affordable veterinary support, international regulation on antibiotic imports, and global standards ensuring fair competition. Responsible use should be economically affordable.

(3) Improving global equity. High-income nations should invest in helping develop sanitation infrastructure, reliable pharmaceutical supply chains, trained clinicians, and national surveillance systems. Global action is essential because resistance anywhere is a threat everywhere

(4) Regulating environmental contamination. Antibiotic waste should be treated like any hazardous pollutant. Environmental and health agencies must coordinate to monitor and reduce contamination in rivers, soil and wastewater.

Conclusion

Antibiotic resistance is often described as an evolutionary arms race between medicine and microbes. This is definitely true, but it is not the only issue. Resistance is not only a biological process but a reflection of human behaviour, economic systems, cultural expectations and environmental problems.

This 'silent pandemic' is the interaction between our heavy reliance on antibiotics and our failure to protect them, resulting in the emergence of resistant forms. Treating AMR as a scientific challenge alone leads to incomplete solutions. The crisis is fundamentally human in origin and must be addressed through changes in behaviour, communication, economics and global equity, as well as science.

If antibiotics were discovered today, they would probably be regulated with extraordinary caution, much more than is done today. Instead, society has a tendency to treat them as everyday commodities. If we design policies and systems that reinforce responsible use, we can preserve antibiotics for future generations.

Glossary

AMR – Antimicrobial Resistance.

Antibiotic – a substance that inhibits the growth of, or kills, bacteria

Antibiotic resistance – when bacteria evolve to survive antibiotics that are meant to kill or inhibit them

Bacteria – microscopic single-celled microorganisms

Pandemic - a worldwide epidemic of a disease

Pathogen – a biological agent that causes disease in other organisms

Placebo – a medicine given for psychological benefit rather than physiological effect

Plasmids – small circular bits of DNA in bacteria. Bacteria can exchange genes through plasmids

Virus – an infectious agent composed of genetic material (DNA or RNA) surrounded by protein.

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