When you hear ‘dystopian future’, your mind most likely goes to a post-apocalyptic world; instead, we are currently facing the prospect of the post-antibiotic world. If ignored, antibiotic resistance will become the greatest challenge modern medicine will face. Without antibiotics minor surgeries will become too much of a risk, potentially causing the regression of treatments and patient care.

Antibiotics work by interfering with vital functions, such as preventing cell wall growth or protein synthesis, thereby inhibiting the microbes’ ability to spread further.

Antibiotic resistance is ultimately caused through the process of random genetic mutation, which may give a microbe an advantage over the antibiotic. The mutation can work in multiple ways. Sometimes the microbe invests energy into ejecting antibodies, other times the bacteria can alter the permeability of their membrane, preventing drugs from interfering with their vital systems. Bacterial DNA is contained within a circular strand as well as within plasmids which often carry the resistance gene. Resistance can be spread vertically via bacterial asexual reproduction or by the horizontal gene transfer of plasmids. [1] Horizontal transfer can happen through the processes of transformation, transduction and conjugation, and is possible between entirely different species of bacteria. This is a very worrying development.

Drug resistance is not just a future problem, it is happening right now. In schools, the example given for antibiotic resistance is MRSA, but that is only one part of a much greater problem. Another example is *Acinetobacter Baumannii* a previously low risk bacterium; however, *A.Baumannii* has become multiple drug resistant. Currently resistant strains can be treated using colistin, a last resort drug due to its potential side effects of muscle weakness and apnea. Unfortunately, reliance upon colistin has increased the bacteria’s’ exposure to it and resistant strains have now developed. The resistance can be traced to the mcr-1 gene, discovered first in animals but now within patients. [2]

Sepsis infections in neonatal intensive care units are becoming highly common -22% of infections in neonatal wards are due to sepsis. [3] This is especially prevalent in countries such as India. [4] Sepsis is caused by several bacteria and can be fatal. The restricted treatment options for patients will lead to infections being incurable.
Previously low risk infections are currently posing the same dangers they did in the past. In 2014, in the United Kingdom alone, there were 126 cases of Tuberculosis that were resistant to at least one antibiotic. 4.1% of new and 19% of previously treated TB cases are multidrug resistant. [5] As more and more bacteria become multidrug resistant, the low estimate of 700,000 people dying due to antibiotic resistance worldwide in 2016 could increase to 10 million in 2050. [6]

Why is this becoming such a challenge? In 2015, 39.4 million antibiotics were prescribed in the United Kingdom. [7] However, a Nesta survey [8] of GP’s reported 76% of GP’s will prescribe an antibiotic even if they are unsure it will treat the condition. Worryingly, this may be due to a general lack of knowledge and modern expectations; we know antibiotics can help, so we will want antibiotics to feel better about the problem thereby validating our illness. The placebo mindset is so great that 90% of GP’s felt pressure to prescribe antibiotics. [9]

Another major abuse of antibiotics is in agriculture. 80% of all antibiotics in the United States are for animal consumption. [10] This arises from the modern consumers’ growing demand of cheap, fast meat and has led to the creation of “super farms”, where perfectly healthy animals are fed antibiotics in their food and water to prevent illness. Antibiotics have become a cheaper alternative to adequate sanitation. This routine exposure of bacteria to antibiotics can lead to resistant strains. In turn, these

survive and as part of our food chain enter humans via consumption or through close proximity. In addition, horizontal gene transfer means any resistant properties could be passed onto other bacteria.

Furthermore, new drugs cannot simply be invented; a new class of antibiotic hasn't been discovered since 1987. Yet, only 4.7% of all pharmaceutical research and development was spent on antibiotic resistance between 2003 and 2013, out of a total $38billion [6]. Antibiotic resistance is a global scale problem with distressing future implications. With 100,000 flights every day, [11] our modern world is so connected that should a "superbug" develop it may spread disastrously. A pernicious disease could spread unnoticed as symptoms take time to develop fully.

So, why is such a threat to lives not as well-known as cancer or flu? It should be everyone's responsibility to combat the misuse of antibiotics. The first step is educating the public in the prevention of unnecessary disease. For example, reminders on handwashing technique, general hygiene, and use of vaccinations should be taught in conjunction with information regarding when antibiotics are needed. Organisations like Antibiotic Guardians encourage people to sign a pledge outlining how to "make better use of antibiotics and help save these vital medicines from becoming obsolete". [12] Since becoming a government issue, 70% of the U.K public are now aware that antibiotics are ineffective against viruses like colds, in comparison to the average 52% across the E.U. [13] In addition, the 2014 Longitude prize of £10 million was put towards antimicrobial resistance, helping raise awareness and further funding for preventive measures. [14]

Promisingly, the use of antibiotics in farming within the U.K has decreased as part of regulations and improved sanitation. Outside of the U.K however, changes are still required. Pressure needs to be applied on major nations, such as the U.S, and developing countries, where antibiotics are systematically abused agriculturally, to grow animals without relying upon antibiotics. For instance, if fast food retailers stopped minimalizing costs and shifted to antibiotic free produce, farmers would be incentivised to avoid antibiotic misuse. One of the largest fast-food chains, McDonalds, has announced a move to antibiotic-free chicken in their produce. [15]

Finally, having suggested preventative measures above, it must not be forgotten that infections will still need a treatment. Replacement of ineffective drugs is critical. For this to happen, greater funding for antibiotic research and development is required. Alternative methods of treating bacterial infections like bacteriophages [16] or an open mind to the application of other untrialled materials may be crucial in getting the pharmaceutical industry interested. Furthermore, as funding based secrecy can hinder communication of ideas, regulations should be implemented to make shared research easier, so we can get closer to the trialling of new treatments.

As more bacteria become resistant, the future could very easily begin to look like the past, with minor surgeries, orthopaedic operations and chemotherapy carrying more risk than benefit. Unless modern medicine manages to overcome this challenge, Man's Room 101 will contain a single microbe. "We have reached a critical point and must act now on a global scale to slow down antimicrobial resistance" – Professor Dame Sally Davies, UK Chief Medical Officer.

Bibliography

[1] Michigan State University, "Antimicrobial Resistance site," 2011. [Online]. Available: https://amrls.cvm.msu.edu/microbiology/molecular-basis-for-antimicrobial-resistance/acquired-resistance/acquisition-of-antimicrobial-resistance-via-horizontal-gene-transfer. [Accessed 22 February 2018].

[2] D. L. M. Robert L. Skov, "Plasmid-mediated colistin resistance (mcr-1 gene): three months later, the story unfolds," Euro Surveillance, 3 March 2016. [Online]. Available: http://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2016.21.9.30155.

[3] S. S. S. A. B. A. A. A. H. A. K. D. Dattatreyo Chatterjee1, "Indian Journal of Pharmacology," 30 Janurary 2015. [Online]. Available: http://www.ijp-online.com/article.asp?issn=0253-7613;year=2015;volume=47;issue=1;spage=105;epage=108;aulast=Chatterjee. [Accessed 22 Ferbruary 2018].

[4] S. Kadam, "How antibiotic resistance is affecting newborn babies in India," Longitude Prize, 8 August 2017. [Online]. Available: https://longitudeprize.org/blog-post/how-antibiotic-resistance-is-affecting-newborn-babies-india.

[5] WHO, "Global tuberculosis report 2017," World Health Organisation, 2017. [Online]. Available: http://www.who.int/tb/publications/global_report/en/.

[6] amr-review, "Review on Antimicrobial Resistance," AMR, 2016. [Online]. Available: https://amr-review.org/.

[7] C. Baker, "Medicine statistics: GP prescribing by constituency, 2015," Friday 28th October 2016. [Online]. Available: http://researchbriefings.parliament.uk/ResearchBriefing/Summary/CBP-7161#fullreport. [Accessed 22 02 2018].

[8] Nesta, "Antibiotics: GPs still erring on side of caution despite patients requesting less," Nesta, 13 November 2017. [Online]. Available: https://www.nesta.org.uk/news/antibiotics-gps-still-erring-side-caution-despite-patients-requesting-less.

[9] C. Price, "GPs feel under pressure to prescribe antibiotics," 19 August 2014. [Online]. Available: http://www.pulsetoday.co.uk/clinical/prescribing/gps-feel-under-pressure-to-prescribe-antibiotics/20007616.article.

[10] G. Guglielmi, "Are antibiotics turning livestock into superbug factories?," Science Magazine, 28 Septemeber 2017. [Online]. Available: http://www.sciencemag.org/news/2017/09/are-antibiotics-turning-livestock-superbug-factories.

[11] F. A. Administration, "Air Traffic By The Numbers," FAA, 14 November 2017. [Online]. Available: https://www.faa.gov/air_traffic/by_the_numbers/.

[12] Antibiotic guardian, 2018. [Online]. Available: http://antibioticguardian.com/.

[13] Department of Health and Social Care, "Progress report on the UK 5 year AMR strategy: 2016,"

Gov.Uk, 24 November 2017. [Online]. Available: https://www.gov.uk/government/publications/progress-report-on-the-uk-5-year-amr-strategy-2016.

[14] "Antimicrobial resistance," Longitude Prize, 2018. [Online]. Available: https://longitudeprize.org/antimicrobial-resistance.

[15] L. Baertlein, "McDonald's to phase out critically important antibiotics in chickens to help fight superbugs," Independent, 24 August 2017. [Online]. Available: http://www.independent.co.uk/news/business/news/mcdonalds-antibiotics-chickens-superbugs-fight-high-value-human-fast-food-supply-chain-a7909641.html.

[16] D. U. Bajpai, "When the drugs don't work, could bacteriophages?," Longitude Prize, 10 January 2018. [Online]. Available: https://longitudeprize.org/blog-post/when-drugs-dont-work-could-bacteriophages.