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Investigate the reasons for and impact of antibiotic resistance and the barriers to finding new antibiotic drugs. Introduction to antibiotics and how they work Antibiotics are drugs used to control bacterial growth or to kill bacteria. The term ‘ antibiotics’ was first used in 1940’s by a microbiologist Selman Waksman who is considered as the father of antibiotics as he discovered over 20 different antibiotics. The first antibiotics was actually known as chemotherapy discovered by a scientist called Paul Ehrlich, he found a cure to syphilis in 1909. Years later in 1928 Alexander Fleming accidentally found what is now the most common antibiotic, penicillin, accidentally by culturing bacteria in agar and adding a chemical which he later found to have killed the bacteria (Society, 2017).

Different antibiotics have their own specific mechanisms so it’s hard to state how an antibiotic works but the most common one, Penicillin works by inhibiting the production of a cell wall in the harmful bacteria which stops DNA replication and protein synthesis so that the bacteria won’t replicate. It is believed that antibiotics work in a way that affects bacterial cells but not human cells, for example they target bacterial cell walls and damage it/ stops it being built so that the cell can easily go through lysis. It is also believed that some antibiotics target bacterial ribosomes which are different to human ribosomes, meaning that the cells can no longer translate mRNA and hence build proteins and without proteins the cells cannot function. Finally, antibiotics affects DNA replication by breaking the double strands so the cells can no longer live or reproduce (learn genetics, 2017). However in 2007, James Collins (biomedical engineer) and his team did a study on antibiotics and stated that they kill bacteria by increasing the reactive

oxygen species which corrodes their DNA. In contrast, another two teams that published in Science proved that antibiotics only work in conditions where there is a lack of oxygen which proves Collins wrong because reactive oxygen species cannot be present without oxygen.

This article therefore shows how scientists are still not exactly sure about the proper mechanism of antibiotics, which is not ideal as some bacteria have began to gain the ability to become resistant to antibiotics so it is no longer effective in stopping bacterial growth. (Moyer, 2013) This has a become a major problem worldwide as it is extremely difficult to treat life threatening bacterial infections such as tuberculosis (TB) and meticillin-resistant Staphylococcus aureus (MRSA) due to antibiotic resistance (Tuftsedu, 2017). There are many other drug resistant bacterial infections but the main focus will be on these two as they are one of the main ones recently. Ways in which antibiotic resistance is spreadBacteria can be either naturally resistant to antibiotics or become resistant by a genetic mutation or acquire it from another bacterium. Genetic mutations are random and rare but the overuse of antibiotics can increase the chances of it spreading. When exposed to antibiotics, the susceptible bacteria will die and resistant one will survive, which can lead to selection pressures for the survival of resistant strains of bacteria because the resistant strains have more chance of surviving due to less competition from the susceptible strains. This means the resistant strains of bacteria are more likely to reproduce and pass on their advantageous alleles onto their offsprings, increasing the number of resistant strains of bacteria. (Tuftsedu, 2017 and Lowrie, 2015, ch.

11). Figure 1. Genetic material being passed from one cell to another. (Bbc. co.

uk, 2018))Another way that resistance can spread is due to conjugation which is also known as the horizontal transfer of genes. This is when genetic material, including the genes for antibiotic resistance, are passed from one bacterium to another and this can be done in many ways, one of which is shown in figure 1. This is the process of conjugation where a donor cell forms a tube with a recipient cell and transfer its genetic material in the form of a plasmid.

Another example of horizontal gene transmission is through a virus called a bacteriophage, which attacks one bacterium which has a gene for drug resistance and then injecting this gene into a different bacterium (APUA, 2014). This again increases the resistant bacteria, making it harder to treat. Also the overuse of antibiotics can increase the chances of resistant bacteria surviving and hence multiplying. In some countries people can buy antibiotics without prescription for colds and coughs, which are not bacterial infections but are viral infections. This is unnecessary and can spread resistance by natural selection (Tuftsedu, 2017). Drug resistance in TBTB has become the second most cause of death after HIV from infection and has alone been able to cause approximately 2 million deaths annually.

This is because the mycobacterium tuberculosis responsible for causing TB has become resistant to the two most effective drugs used to treat TB, isoniazid and rifampin. These are the first line of treatment and resistance to this is known as multidrug resistance TB (MDR TB) and is treated with second

line of drugs. In contrast, extensively drug resistant TB (XDR TB) can not be treated with some of the second line of drugs either so the last option of drugs are ineffective, making it very hard to cure (New Tactics Against Tuberculosis, 2009). Although only 9. 7% of 480, 000 patients diagnosed with drug resistant TB had XDR TB, it is still becoming a major concern as it is spreading fast due to immigration and also due to people travelling abroad and hence something needs to be done to prevent it (World Health Organisation 2015). TB was eradicated in the UK in the past due to the use of BCG vaccinations and treatment being available, however it is starting to spread again due drug resistance which makes it difficult to get rid of TB as it is harder to treat and hence people are more likely to spread TB.

It is especially a major problem in the less economically developed countries such as Bangladesh, India, south AFrica etc. It is also a problem for health care workers in these TB-endemic countries, who are at greater risks of catching TB and the mortality rate amongst these workers constitute to about 25% of all TB cases. The mortality rate in drug resistant TB worldwide is about 40-60% which is more than most cancers, therefore it is becoming a major health concern worldwide.

It is also extremely costly to treat and in 2014 alone, $1. 8 billion was spent on MDR-TB, but the funding for drug resistant TB have to double by 2020. This means it is a major challenge for WHO to deal with (Dheda et al., 2017). Drug resistance in MRSAMRSA is an everyday germ found on skin and nostrils of a third of healthy people, however it can be dangerous if it pursues a cut or wound in the body. This is because MRSA have built resistance to methicillin drugs. Some people carry it harmlessly, and it can

be carried for weeks and months without them knowing as it does not show any symptoms, which is known as colonisation. MRSA and other germs cause problems in hospitals, and are known as opportunistic pathogens.

Difficult medical treatments, including operations and intravenous lines (drips), provide opportunities for germs to enter the body. MRSA and other types of Staphylococcus aureus can cause local skin infections such as boils and, in more vulnerable patients, they can cause more serious infections in wounds, bones, lungs and blood (bloodstream infections)(GOV, 2017). Patients in hospitals are more vulnerable to infections caused by MRSA as they are exposed to wounds so someone carrying MRSA can easily carry the bacteria and pass it on to other patients. Furthermore, MRSA bacteria can survive on surfaces for a long time so skin contact with soiled linens and towels patients use can pass that bacteria on and this is why at hospitals it has the most risk (Aftermath. com, 2016). For this reason, parts of Europe take prevention measures to stop its spread.

For example, in Netherlands and Denmark patients with a high risk are separated from the rest until they are proved to be free of MRSA, which helps to prevent MRSA from spreading to other patients and staff members. In contrast America does not adopt this strategy, which is the reason why there were 11, 285 people who died due to MRSA in America in 2011. Out of all the cases of drug resistant bacteria in the US, MRSA resistance is the second biggest cause of death (Library, 2018). This is also a major concern worldwide: in some regions of Africa, almost 80% of MRSA cases are drug resistant; in some parts of Eastern Mediterranean region, more than 50% of MRSA cases reported are drug resistant and this figure is about 80% in

Western Pacific region and 60% in European region. This means it has to be dealt with soon and special prevention methods must be taken to stop its spread as it is not responding to the main antibiotics available (Who.

int, 2018). Issues with creating new antibiotic drugsWhile these Antibiotic resistant bacteria survive, less new antibiotics drugs are being produced to encounter the harmful bacteria. Although we have a fair amount of drugs to combat MRSA, in the near future it can become a problem. The lack of new antibiotics being made is due to economic reasons. Antibiotics are only taken for a short amount of time to treat infections whereas other drugs are take for a longer time, for example drugs to treat diabetes and cancer can be taken for a lifetime so pharmaceutical companies have discovered that they will make a lot more money by selling tablets for chronic diseases than bacteria related infections (Who. int 2011). Also pharmaceutical companies are more likely to spend money on researching and developing drugs for more serious illnesses such as cancer since people are more afraid of cancer than they are of infectious diseases as we have had penicillin for a long time now. Therefore, people need to be educated on the risks of antibiotic resistance so that more companies will be willing to develop new antibiotics (Emerald.

tufts. edu, 2012). Another major problem is that antibiotic resistance is inevitable because the more the bacteria is exposed to antibiotics, the greater the chance of a selection pressure against the non mutant bacteria. An FDA (Food and Drug Administration) advisory board had stated that for new drugs to be considered and approved, they must have the potential to be better than the existing antibiotics.

However, most of the new drugs that target drug resistance are likely to be similar to existing antibiotics (Antibiotics, 2005). According to a comprehensive study of antibiotic development in 2008, only 15 out of 167 antibiotics which were under development had a new mechanism for dealing with multidrug resistance. Therefore, it is a struggle to develop antibiotics with a new molecular structure and mechanism which is why a lot of companies are not willing to spend money on researching it (Who. int 2011).

ConclusionTo conclude, there are a lot of mechanisms in which bacteria develop resistance toantibiotics, and pharmaceutical companies are reluctant to develop new drugs as they are afraid due to financial reasons. Therefore, it is better to focus more on prevention while research into development of new antibiotics is being done. In the case of TB, BCG injection should be given to those at a high risk, such as the immigrants coming from areas with high risk of TB and all health care professionals. In the case of bacterial infections especially in the hospital, basic hygienic procedures should be followed, such as washing hands, and wearing appropriate personal protective equipment (PPE).

Most importantly, doctors should not use antibiotics for viral infection, such as mild throat infections as they are caused by virus which are not treated with antibiotics.