



How Antimicrobial Resistance Is Threatening the Treatment of Tuberculosis Worldwide

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Seo-yeon is a 38-year-old public school teacher from Beijing who was recently diagnosed with active tuberculosis affecting her lungs and brain. Even after taking doctor-prescribed antibiotics for weeks, she just kept getting worse. Unfortunately, tests revealed that Seo-yeon had multidrug-resistant tuberculosis (MDR-TB). Seo-yeon had to undergo even more intense treatments for over a year with many side effects (Jung et al.). As a result, Seo-yeon had to take an extended leave from her job, and her family was put in a difficult financial situation. Seo-yeon is not the only one who has faced adversities due to this; antimicrobial resistance is a global problem that contributed to around five million deaths in 2019 (World Bank Group). A large number of these deaths were linked to MDR-TB (WHO, "Tuberculosis"). This global crisis is worsening by the day, and will harm so many more if left unchecked (Cox and Furin).

Tuberculosis (TB) is one of the world's deadliest infections, caused by a bacterium called *Mycobacterium tuberculosis*. Tuberculosis mainly affects the lungs, and its symptoms include ongoing coughing, chest pain, intense fevers, etc. (CDC, "About Tuberculosis"; WHO, "Tuberculosis," 2024). TB is spread rapidly through the air from someone sneezing or coughing and is most commonly treated through the use of antibiotics (Mayo Clinic). Around 25% of the world has latent tuberculosis, and five to ten percent of these cases will eventually turn active. This problem mainly affects low and middle-income countries due to their higher rates of HIV, malnutrition, overcrowding, worse living conditions, and weaker health care systems, which can worsen the spread of diseases (Dall; "Tuberculosis and Vulnerable Populations"). One of tuberculosis's most dangerous forms is multidrug-resistant tuberculosis. This form of tuberculosis is not responsive to multiple drugs, including isoniazid and rifampin, the most effective medicines for TB. This type of TB is much more difficult to treat and significantly more expensive than the normal treatments (CDC, "About Drug-Resistant Tuberculosis Disease"). This resistance is observed not only in tuberculosis but also in the majority of bacterial infections, like pneumonia and urinary tract infections. It is commonly referred to as antimicrobial resistance or AMR for short (University of Oxford).

Antimicrobial resistance (AMR) occurs when bacteria, viruses, parasites, and other microorganisms develop the ability to resist the effects of antimicrobial drugs and medicines. The development and evolution of these microorganisms can be tied to the overuse of antimicrobials. Three key contributors to the overuse of antimicrobials/antibiotics are livestock, horticulture, and medicine (World Health Organization, *Antimicrobial Resistance*). To get more technical, the microorganisms that survive the attacks from the antibiotics are able to multiply, and the microorganisms with favorable mutations survive through natural selection and keep multiplying and developing. The more one takes antibiotics, the more pressure is put on these microorganisms to evolve (CDC, *Forecasting the Fallout from AMR: Economic Impacts of Antimicrobial Resistance in Humans*).

Before discussing the overuse of antimicrobials, it is important to mention why we need antibiotics in the first place. Antibiotics are thought to be one of the greatest discoveries, saving millions upon millions of lives. They help to treat infections and kill bacteria, as well as aid with surgeries, finally creating a treatment for infections like tuberculosis and pneumonia (American Chemical Society). Antimicrobials are also used in livestock. The number of animals that are kept in small spaces in livestock farms creates a breeding ground for diseases and infections, which kills a lot of animals. To combat this and increase their productivity, farms use a lot of

antibiotics (Sneeringer). This process is similar when it comes to plants and their diseases; antibiotics can be a huge asset (McManus et al). Antimicrobials also play a big economic role, providing plenty of jobs and potentially growing the GDP by \$960 billion per year (McDonnell et al). This is why solving AMR is not as simple as removing access to antimicrobials. They play such a significant role in society that simply removing them is neither plausible nor realistic. That is why a more inventive solution is needed.

Antimicrobial resistance is currently one of the most pressing global health threats (World Health Organization, *Antimicrobial Resistance*). When it comes to tuberculosis specifically, MDR-TB has been determined by the World Health Organization to be a global health crisis (World Health Organization, "Tuberculosis"). This threat can be even more complex in developing countries, especially since the prescribing and distribution of antimicrobials can be less regulated (Ayuokebong et al.). However, this is not the primary issue when it comes to developing countries. Developing countries heavily rely on agriculture, and farms are among the largest consumers of antibiotics (Meade et al.). They are used in farming for rapid animal growth, as well as the prevention and treatment of diseases (Isaacson and Torrence). The antibiotics used end up in the food that most people consume. This has caused an increase in demand for food with fewer antibiotics (Brown et al.). However, while some farms are able to meet these demands, most farmers in developing countries need to focus on efficiency and growing a steady income before they can worry about problems like AMR (Manyi-Loh et al.).

In many countries, antimicrobial resistance has been overlooked or ignored. Few countries have policies limiting the use of antibiotics. China, however, the largest consumer of antimicrobials in livestock farming, has begun to introduce policies to limit the amount of medicated additives used in farming (Hu and Cowling). The European Union and other countries have begun to develop National Action Plans (NAPs) to address AMR. These plans would map out their situations and the next steps they need to take. While these countries have not specifically addressed MDR-TB, these plans are a step in the right direction (World Health Organization, *Supporting policy development and national action plans on antimicrobial resistance*). The United States has also played a key role in combating this and has developed an action plan specifically for MDR-TB. Some steps they have taken include scaling up the identification of multidrug-resistant tuberculosis, trying to moderate the spread of antimicrobial resistance, increasing the amount of research being done on the subject, and enhancing infection prevention strategies ("National Action Plan to Combat Multidrug-Resistant Tuberculosis"). Now that countries have started to address the issue, more steps can be taken to improve and potentially solve the problem of MDR-TB in the future.

In addition to these government efforts, there are also plenty of organizations and programs helping to combat MDR-TB indirectly by fighting against AMR. One of the most notable is CARB-X, a global non-profit that is focused on developing antibacterial products that can fight antimicrobial resistance (Boston University School of Law). The UN has also begun to take action against AMR as part of its Global Development Goal of Good Health and Well-being. They have partnered with other big organizations like the World Health Organization, the Food and Agriculture Organization, and so on. Their target was to have 60% of countries have a plan of action for AMR by 2030. They will do this by spreading awareness, supporting countries in creating NAPs, and gathering funding and support for the cause ("World leaders"). There are also so many other programs targeting antimicrobial resistance, working to spread awareness and collaborate to solve this global crisis to prevent a future of untreatable infections.



While these programs and the awareness they raise are progress, there is still a lot of work that needs to be done, especially within the health care systems. For one, addressing the diagnosis of antibiotics. One big factor of AMR is the overdiagnosis and misuse of antibiotics. In the US for example, it is estimated that 30% of the prescriptions for antibiotics are unnecessary (Macy). This overprescription is a global problem, and it allows for resistance to spread, reducing the effectiveness of treatments over time (CDC, *Forecasting the Fallout from AMR: Economic Impacts of Antimicrobial Resistance in Humans*). This causes a rise in MDR-TB, which calls for more expensive, risky, and time-consuming treatments. One approach to solving this is by creating stricter guidelines for diagnosing antibiotics. A part of this could be to ban over-the-counter antibiotics. This will keep antibiotics out of the hands of those who don't need them. It will also keep doctors from overprescribing antibiotics for minor issues. This solution could also include double-checking TB tests for false positives. While it is rare, it does happen and can lead to needless use of antibiotics (CDC, "Clinical Testing Guidance for Tuberculosis: Tuberculin Skin Test"). However, not every country has this problem; the shortage of medication for Tuberculosis is a major problem in less developed countries (CDC, "Tuberculosis Drug Supply Interruptions and Shortages"). This could be tackled through redistribution. While it would be extremely difficult to implement, countries with major overuse of antibiotics could allocate some of their resources to countries in need of antibiotics. The problem with these solutions is that they could lead to some people not being able to get the medication that they need, and it could also be hard for some countries to enforce, as it is not their main issue. However, if it can be implemented thoroughly in multiple countries, it can be a great contributor to reducing antibiotic resistance and solving the global crisis of MDR-TB.

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