

# The Public Health Threat of Antibiotic Resistance with a Reference to India

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Antimicrobial (antibiotic) resistance is a continuously evolving and growing problem that can affect anyone and is extremely dangerous to human health. Antibiotics were created to fight bacterial, fungal, and other infectious agents that can infect humans and other host organisms like livestock and feed animals. Certain viruses can be treated with antiviral medications but are not part of this discussion. Antibiotics use different mechanisms and pathways to kill the target pathogen. However, the chronic misuse and overuse of these drugs has become a worldwide problem that is worsening. The negative impact of antibiotic resistance affects developed countries with robust medical systems as well as the many developing regions of the world which lack adequate and available healthcare. Resistance arises when the target microbe, such as bacteria or fungus, develops a response to thwart the mechanism of action for a specific antibiotic (WHO, 2020). This is often seen in the agriculture and animal husbandry industry, where the overuse of antibiotics to prevent and treat infection is widespread and pervasive. Resistance then emerges, which can spill over to humans, resulting in infections and illnesses that are very difficult to control. Improper storage, transportation, and certain infrastructure deficiencies decrease the effectiveness of antibiotic use (WHO, 2020). While this phenomenon affects both developed and developing countries, this paper discusses the resistance specific to the developing country of India.

India has a high rate of antibiotic resistance. It has been referred to as the antimicrobial resistant capital of the world (Teneja and Sharma, 2018). There are many contributing factors. A lack of awareness about infectious diseases and their transmission mechanisms is a primary issue in that country. Additionally, limited access to healthcare leaves many individuals unable or unwilling to seek medical care. Healthcare is relatively expensive so many people turn to black market antibiotics that often turn out to be counterfeits (Teneja and Sharma, 2018). India is also a large producer of animal-derived products. The overuse and abuse of antibiotics used to prevent and treat infections and illness in their livestock commonly leads to resistant microbes. This is compounded by the fact that India is the world's fourth largest consumer of antimicrobial drugs (Teneja and Sharma, 2018). Hospitals and other healthcare facilities within India are places with some of the highest levels of antimicrobial consumption and resistance. Due to this very high usage, resistant microbes flourish, and the richest sources of these resistant microbes are found in the medical waste that these facilities generate (Teneja and Sharma, 2018). India's high rate of antimicrobial resistance affects multiple areas within the country and its people. This includes young children, agriculture, livestock and even the country's response to the Covid-19 pandemic has been affected by this resistance challenge (Sauerwein, 2021). COVID-19 is a viral infection, yet large doses of antibiotics were used to treat it, despite knowledge that antibiotics are not effective against viral infections.

*Escherichia coli* (*E. coli*) is a normally occurring resident bacteria within the gut of humans and animals. However, some strains of *E. coli* can be pathogenic and cause disease within the gut or in other body organs. Several pathogenic strains have developed antibiotic resistance. A symptom of this pathogen is diarrhea, which is considered to be a major cause of childhood mortality in the country (Singh et al., 2019). Remarkably, the identification of several antibiotic resistant genes in the pathogenic *E. coli* strains have shown a link to some of the factors that may have led to the resistance overall. These include the host's nutritional status and certain genetic factors as well as geographical circumstances like rural or urban residence (Singh et al., 2019). Other contributors to this resistance phenomenon include the wide-spread lack of public health services and a failure of strict adherence to antibiotic usage policy. Resistance has now extended from hospitals to the outside community (community-acquired resistance) suggesting that healthy children may become

increasingly involved in the development and propagation of antibiotic-resistant *E. coli* (Singh et al., 2019). In addition to antibiotic resistance in *E. coli*, there is an ever-worsening epidemic of fungal sepsis related to antimicrobial resistance among a vulnerable subset of neonates in India.

Alarming rates of antimicrobial resistance and fungal sepsis are present in outborn (outside the hospital) neonates in North India. Unhygienic birthing and cord practices and prelacteal feeds largely account for this rise of antibiotic resistance. This leads to excessive post-delivery infections and subsequent antibiotic misuse. In most low- and middle-income areas of India, a large number of sick neonates born outside of hospitals are admitted to neonatal intensive care units (NICU) for advanced care of fungal sepsis (Jajoo et al., 2018). Jajoo et al tracked this population and found that 55% of the outborn neonates had a final diagnosis of sepsis (2018). Most of the microbial isolates revealed a high degree of antibiotic resistance including the last resort "rescue" antibiotics such as carbapenems, vancomycin and linezolid (Jajoo et al., 2018). Sepsis is one of the most common diagnoses for outborn neonates on admission and is one of the most common causes of death in these neonates. Even some of the strongest, broad-spectrum antibiotics were unable to treat the underlying bacterial infection (Jajoo et al., 2018).

Ignorance to the problem of antibiotic resistance in the livestock and animal husbandry industry is another significant contributor to this problem in India. For example, antibiotics are extensively overused in the dairy industry to keep the dairy cows healthy and producing milk (Sharma et al., 2022). Dairy products are a staple of the Indian diet and residual antibiotic drugs are routinely found in tested milk. Farmers are largely unaware of the effects of antibiotic use and misuse and the downstream effects of these practices on resistance (Sharma et al., 2022). Most farmers use antibiotics on their livestock for prevention of infection without regard to the animal's state of health. Both sick and healthy animals are commonly treated with broad-spectrum antibiotics (Sharma et al., 2022). The issue with treating infections with broad spectrum antibiotics is that infections themselves often require more specific antibiotics for optimal coverage which will minimize the development of resistance. Antibiotic resistance in livestock poses a serious threat for transmission to humans. This lack of education in the industry has only continued to increase resistance.

Nosocomial infections are contracted while someone is in the hospital or a healthcare facility for a different diagnosis. Due to the widespread use of antimicrobial agents in the hospital setting, especially in the intensive care unit (ICU), these nosocomial infections are often extremely resistant to antimicrobial drugs. Many individuals in India seek medical care via urgent care or emergency care and wind up in the ICU. Unfortunately, contracting a nosocomial bacterial infection while in the ICU is extremely dangerous and can be hard to treat. These pathogens have likely built up a strong resistance to some of the very powerful antimicrobial drugs used extensively in that setting. In India, many ICU patients are put on broad-spectrum antibiotics, which are often ineffective (Moolchandani et al., 2017). This induces selective antibiotic pressure which leads to development of resistance among the microorganisms of ICUs. Moolchandani et al (2017) shows a range of hospital acquired infections in ICU patients, with pneumonia having the largest infectious rate in Southern India hospitals (Figure 6). These newly acquired infections increase the stay of the patient and in return make these stays expensive (Moolchandani et al., 2017). This is a serious public health threat and is only getting worse. An important tool in assessing this trend of antibiotic resistance is surveillance.

More recent issues, such as the Covid-19 pandemic, have also worsened India's antibiotic resistance problem. When the first surge of Covid-19 hit India, antibiotics were used to treat mild and moderate cases which accounted for around 90% of infections (Sauerwein, 2021). Covid-19 is a virus and these antimicrobial drugs were used heavily despite widespread knowledge about the ineffectiveness of antimicrobials on viral infections. High income countries such as the US, UK, and Canada used fewer antibiotics during Covid as the antibiotics themselves were not used to treat the virus (Sauerwein, 2021). In contrast, low and middle income countries were more likely to skip testing and give broad spectrum antibiotics for respiratory illness because most patients could not afford more thorough testing (Sauerwein, 2021). In India, 90%

of antibiotics sales come from unregulated sectors and this induces an epidemic of over-prescribing (Sauerwein, 2021). These findings suggest that more education and regulation around how antibiotics are distributed and accessed may slow the rate of development of antibiotic resistance.

Multiple studies from around India indicated that antibiotic resistance is only increasing. Neonates are significantly impacted by this resistance and Jajoo et al (2018) notes that national programs are needed to better implement antibiotic stewardship policies. This would help with managing the well-being of the population and to help guide their health system overall. Not only in India, but also globally, one of the leading contributors to resistance is via the agriculture and livestock industry. More education, specifically targeting farmers, may lead to a decrease in resistance in that industry. Sharma et al, (2022) suggests that a "One Health" approach could facilitate interventions of behavioral change in both farmers and veterinarians. The CDC (2023) notes that a "One Health" approach works at the local, regional, national, and global levels to achieve optimal health outcomes, especially between animals, people, plants and their overall shared environment. Hospitals are another key factor in the antibiotic resistance paradigm. Finding ways to decrease inappropriate use is required to lessen the burden of resistance. Moolchandani et al expressed the need for antibiotic surveillance to combat this problem (2017). Improving the quantity and quality of surveillance in the health-care setting might allow for better data collection, analysis, and interpretation to assess and inform public health actions. Antibiotic resistance is a global threat that affects everyone, and action is desperately needed to help slow the rate at which these medications become resistant.

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