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Innovative Strategies and Comprehensive Insights into Combating Antimicrobial Resistance in India: A One Health Approach

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Abstract: Antimicrobial resistance (AMR) represents a critical global health threat, with India experiencing one of the highest burdens due to widespread misuse of antibiotics and suboptimal infection control. This comprehensive review examines the current status of AMR in India, highlighting alarming resistance rates among key pathogens such as Escherichia coli, Klebsiella pneumoniae, Acinetobacter baumannii, and Staphylococcus aureus. It delves into the multifaceted drivers of AMR, including over-the-counter antibiotic availability, poor infection control, agricultural practices, environmental contamination, and low public awareness. National initiatives like the National Action Plan on AMR, NARS-Net, and antimicrobial stewardship programs are evaluated for their impact on mitigating this crisis. Recent research emphasizes the One Health approach, surveillance data, novel antibiotics, and the COVID-19 impact on AMR trends. The review also discusses challenges and future directions, advocating for stronger regulatory measures, capacity building, public education, research, innovation, and international collaboration to effectively combat AMR. Understanding India's unique challenges and implementing targeted strategies are essential for addressing this escalating public health issue.

Keywords: Antimicrobial resistance, India, antibiotic misuse, infection control, One Health approach.

INTRODUCTION

Antimicrobial resistance (AMR) has emerged as one of the gravest threats to global public health in the 21st century. This phenomenon, where microorganisms develop the ability to withstand antimicrobial treatments, undermines the effectiveness of drugs that once successfully treated infections. The consequences are dire: prolonged illnesses, higher mortality rates, and increased healthcare costs. Among the nations grappling with AMR, India stands out as a significant battleground. The country's high burden of infectious diseases, coupled with widespread misuse of antibiotics, has created a perfect storm for the proliferation of resistant pathogens. [1-3]

India's AMR crisis is characterized by alarmingly high resistance rates among common pathogens such as Escherichia coli, Klebsiella pneumoniae, Acinetobacter baumannii, and Staphylococcus aureus. These pathogens, responsible for a multitude of infections, have shown increasing resistance to last-resort antibiotics, complicating treatment protocols and leading to higher morbidity and mortality rates. The Indian Council of Medical Research (ICMR) has documented these trends, revealing a growing challenge in managing infections that were once easily treatable. [4,5]

The drivers of AMR in India are multifaceted and deeply rooted in various sectors. Over-the-counter availability of antibiotics, self-medication, and inadequate prescription regulations contribute significantly to the problem. Moreover, suboptimal infection control practices in healthcare settings, extensive use of antibiotics in agriculture, environmental contamination from pharmaceutical waste, and a general lack of public awareness exacerbate the situation. These factors collectively create an environment conducive to the emergence and spread of resistant bacteria. [5,6]

Recognizing the urgency of the situation, India has launched several initiatives to combat AMR. The National Action Plan on AMR, established in 2017, outlines strategic priorities aimed at improving

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awareness, strengthening surveillance, reducing infections, optimizing antimicrobial use, promoting research, and enhancing governance. Additionally, the National Antimicrobial Surveillance Network (NARS-Net) and antimicrobial stewardship programs in hospitals represent significant steps towards better management of antibiotic use and resistance patterns.[5-7]

Recent research has underscored the complex interplay of environmental, human, and animal health in the spread of AMR, advocating for a One Health approach. Despite these efforts, challenges remain in balancing the need for antibiotic access with the imperative to prevent overuse. Regulatory gaps, inadequate infrastructure for AMR surveillance, and insufficient public awareness further complicate the response to this pressing issue.[2,8]

This comprehensive review aims to provide an in-depth analysis of the current status of AMR in India, exploring the key drivers, national initiatives, recent research, and future directions. By examining these elements, this paper seeks to highlight the critical areas requiring attention and to propose strategies for a more effective response to the AMR threat in India. As the world grapples with this global health crisis, understanding and addressing the specific challenges faced by countries like India is crucial for developing sustainable and effective solutions.

Current Status of AMR in India [5,6,9,10]

India faces a severe AMR crisis, with high resistance rates among various pathogens. According to the Indian Council of Medical Research (ICMR), the resistance trends between 2016 and 2021 show a worrying increase:

- **Escherichia coli**: Resistance to imipenem rose from 14% in 2016 to 36% in 2021.
- **Klebsiella pneumoniae**: High resistance to third-generation cephalosporins and carbapenems.
- **Acinetobacter baumannii**: 87.8% resistance to carbapenems in 2022.
- **Staphylococcus aureus**: Up to 47% of infections are methicillin-resistant.

These trends indicate a growing challenge in treating common infections, leading to higher morbidity and mortality rates.

Escherichia coli

Escherichia coli (E. coli) is a common pathogen responsible for a wide range of infections, including urinary tract infections (UTIs), septicemia, and neonatal meningitis. The increasing resistance to imipenem, a last-resort antibiotic, is particularly alarming. In 2016, 14% of E. coli isolates were resistant to imipenem, but by 2021, this figure had increased to 36%. This rise indicates the limited treatment options available and highlights the urgent need for new antibiotics and better stewardship practices.

Klebsiella pneumoniae

Klebsiella pneumoniae is another critical pathogen associated with severe infections such as pneumonia, bloodstream infections, and UTIs. High resistance to third-generation cephalosporins and carbapenems complicates treatment. The resistance to carbapenems, which are often used as a last resort, is especially concerning. Carbapenem-resistant K. pneumoniae (CRKP) is associated with high mortality rates and limited treatment options, underscoring the need for stringent infection control measures and the development of new antimicrobial agents.

Acinetobacter baumannii

Acinetobacter baumannii is a significant cause of hospital-acquired infections (HAIs), including ventilator-associated pneumonia and bloodstream infections. The resistance rates to carbapenems have reached an alarming 87.8% in 2022. This high resistance rate is often linked to poor infection control practices and the overuse of antibiotics in healthcare settings. The prevalence of carbapenem-resistant A. baumannii (CRAB) necessitates enhanced infection control measures and the exploration of alternative therapeutic options, such as combination therapies and non-antibiotic treatments.

Staphylococcus aureus

Staphylococcus aureus is a common cause of skin and soft tissue infections, as well as more severe infections like bacteremia and endocarditis. The rise in methicillin-resistant Staphylococcus aureus (MRSA) infections, which account for up to 47% of cases, poses significant treatment challenges. MRSA infections are more difficult to treat due to limited effective antibiotics, leading to longer hospital stays

and higher healthcare costs. Addressing MRSA requires comprehensive strategies, including improved infection control, antimicrobial stewardship, and the development of new antibiotics.

Drivers of AMR in India [5,6,11-14]

Several factors contribute to the high burden of AMR in India:

Overuse and Misuse of Antibiotics

The overuse and misuse of antibiotics are major contributors to AMR in India. Antibiotics are often available over-the-counter without a prescription, leading to widespread misuse. Self-medication and the lack of prescription regulation exacerbate the problem. For instance, antibiotics are frequently used for viral infections, against which they are ineffective. This misuse drives the selection of resistant bacteria, reducing the effectiveness of antibiotics for future infections.

Poor Infection Control

Infection control practices in healthcare facilities are often suboptimal. This leads to high rates of hospital-acquired infections involving drug-resistant organisms. A study found that more than 92% of Acinetobacter baumannii infections in COVID-19 patients were carbapenem-resistant. Inadequate sanitation, overcrowding in hospitals, and insufficient training of healthcare workers contribute to the spread of resistant bacteria. Improving infection control measures is essential to reduce the incidence of HAIs and limit the spread of resistant pathogens.

Agricultural Practices

Antibiotics are extensively used in animal husbandry as growth promoters and disease preventatives. This practice contributes to antibiotic residues in meat and other animal products, leading to resistance in humans. The use of antibiotics in agriculture is a significant driver of AMR, as resistant bacteria can be transmitted to humans through the food chain. Implementing stricter regulations on the use of antibiotics in agriculture and promoting alternative practices, such as improved animal husbandry and vaccination, can help mitigate this issue.

Environmental Contamination

Pharmaceutical manufacturing plants often discharge untreated waste into the environment, contributing to the spread of resistant bacteria. Studies have found high concentrations of antimicrobials in hospital effluents, capable of causing genotoxic alterations and modifying bacterial strains. Environmental contamination with antibiotics and resistant bacteria can lead to the spread of resistance genes to other bacteria, exacerbating the AMR crisis. Implementing stricter regulations on waste disposal and promoting environmentally friendly practices in pharmaceutical manufacturing are crucial steps in addressing this issue.

Lack of Public Awareness

Public understanding of AMR remains low. Many people do not understand the implications of not finishing a course of antibiotics or using them unnecessarily, which can lead to bacteria evolving to withstand these medications. Educational campaigns and community engagement are essential to improve public awareness of AMR and promote responsible antibiotic use. Increasing public knowledge about the risks of antibiotic misuse and the importance of adherence to prescribed treatments can help reduce the spread of resistance.

National Initiatives to Combat AMR [5-7,9,15]

National Action Plan on AMR

Launched in 2017, the National Action Plan on AMR outlines six strategic priorities:

1. **Improving awareness and understanding of AMR**
2. **Strengthening surveillance and research**
3. **Reducing the incidence of infection**
4. **Optimizing the use of antimicrobial agents**
5. **Promoting research and innovation**
6. **Strengthening governance and investment in AMR control**

This comprehensive plan aims to address the multifaceted nature of AMR and promote a coordinated response across various sectors.

National Antimicrobial Surveillance Network (NARS-Net)
Established by ICMR, NARS-Net includes 35 labs across 26 states/UTs, providing valuable data on resistance trends. The network aims to generate quality data on AMR and promote the rational use of antimicrobials. By monitoring resistance patterns, NARS-Net helps inform treatment guidelines and policy decisions, contributing to better management of AMR.

Antimicrobial Stewardship Programs
These programs are implemented in hospitals as part of an accreditation process. They include training hospital staff in responsible antibiotic use, testing for resistance before prescribing antibiotics, and monitoring antibiotic prescribing patterns. Antimicrobial stewardship programs aim to optimize the use of antibiotics, reduce unnecessary prescriptions, and minimize the development of resistance. By promoting the judicious use of antibiotics, these programs help preserve the effectiveness of existing treatments.

Regulatory Measures
The Indian government has introduced regulations like Schedule H1, which mandates that certain antibiotics be sold only with a prescription. However, enforcement remains a challenge. Strengthening the enforcement of existing regulations and introducing new measures to control the sale and use of antibiotics are essential to reduce misuse and curb the spread of resistance. Ensuring that antibiotics are only available through prescription can help prevent self-medication and inappropriate use.

Recent Research and Developments

Environmental AMR
Research has highlighted the role of environmental contamination in the spread of AMR. For instance, high concentrations of antimicrobials in hospital effluents have been shown to cause genotoxic alterations and modify bacterial strains. Studies have demonstrated that environmental contamination with antibiotics can promote the selection of resistant bacteria, which can then spread to humans and animals. Addressing environmental sources of AMR requires comprehensive strategies, including improved waste management and environmental monitoring.

One Health Approach
Recent studies emphasize the need for a holistic approach considering human, animal, and environmental factors in AMR control. The One Health approach aims to integrate efforts across these sectors to effectively combat AMR. By recognizing the interconnectedness of human, animal, and environmental health, the One Health approach promotes coordinated actions to reduce the emergence and spread of resistance. This approach encourages collaboration between healthcare providers, veterinarians, environmental scientists, and policymakers.

Surveillance Data
The ICMR's AMR surveillance network has expanded, providing valuable data on resistance trends. For example, the 2022 report highlighted that E. coli was the most commonly isolated pathogen, followed by Klebsiella pneumoniae and Pseudomonas aeruginosa. Surveillance data are crucial for understanding the prevalence and distribution of resistant bacteria, informing treatment guidelines, and identifying priority areas for intervention. Expanding surveillance networks and improving data quality are essential for effective AMR management.

Novel Antibiotics
While global antibiotic development has slowed, efforts are underway to bring new antibiotics to India. However, challenges remain in ensuring timely registration and access. For instance, GSK's gepotidacin, a new antibiotic for uncomplicated urinary tract infections, lacks clear plans for accessibility in India. Developing and introducing new antibiotics is critical to addressing the growing resistance problem. However, ensuring that these new treatments are accessible and affordable is equally important. Collaborative efforts between pharmaceutical companies, regulatory authorities, and healthcare providers are needed to facilitate the availability of new antibiotics in India.

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COVID-19 Impact

The pandemic led to increased antibiotic use, potentially exacerbating AMR. A study found that more than 92% of A. baumannii infections in COVID-19 patients were carbapenem-resistant, highlighting the impact of the pandemic on AMR trends. The increased use of antibiotics during the pandemic, often without appropriate indications, has likely contributed to the rise in resistant infections. Addressing the impact of COVID-19 on AMR requires enhanced infection control measures, careful antibiotic use, and ongoing surveillance to monitor resistance patterns.

Challenges and Future Directions [15-18]

Access vs. Excess

Balancing the need for antibiotic access with preventing overuse remains a significant challenge. While antibiotics are essential for treating infections, their misuse leads to resistance. Regulatory measures and public awareness campaigns are crucial in addressing this issue. Ensuring access to life-saving antibiotics while minimizing their misuse requires a coordinated approach involving healthcare providers, policymakers, and the public. Strategies to improve access to antibiotics in underserved areas, while promoting responsible use, are essential.

Regulatory Gaps

Strengthening regulations on antibiotic sales and use is essential. The enforcement of existing regulations like Schedule H1 needs to be improved to prevent over-the-counter sales of antibiotics. Addressing regulatory gaps requires collaboration between government agencies, healthcare providers, and the pharmaceutical industry. Implementing stricter controls on antibiotic sales and promoting compliance with regulations can help reduce inappropriate use and curb the spread of resistance.

Capacity Building

Enhancing laboratory infrastructure and trained personnel for AMR surveillance is vital. The expansion of the NARS-Net and capacity building initiatives are steps in the right direction. Building the capacity of laboratories to accurately diagnose and monitor resistant infections is crucial for effective AMR management. Training healthcare workers in appropriate antibiotic use and infection control practices is equally important. Investing in infrastructure and education can help strengthen the healthcare system's ability to respond to AMR.

Public Awareness

Improving public understanding of appropriate antibiotic use is crucial. Educational campaigns and community engagement can help reduce the misuse of antibiotics. Raising awareness about the risks of antibiotic misuse and the importance of completing prescribed courses of treatment can help reduce the spread of resistance. Public education initiatives should target various audiences, including patients, healthcare providers, and the general public. By promoting responsible antibiotic use, these efforts can contribute to the overall reduction of AMR.

Research and Innovation

Encouraging the development of new antibiotics and alternative therapies is essential. The exploration of non-traditional biological agents, such as bacteriophages and immune-modulating agents, offers hope but faces regulatory and clinical challenges. Investing in research and innovation is crucial to address the growing resistance problem. Developing new treatments and alternative therapies can provide additional options for managing resistant infections. Supporting research initiatives and facilitating the regulatory approval process can help bring new treatments to market.

International Collaboration

Global cooperation is necessary to address AMR effectively. Initiatives like the Global Antibiotic Research & Development Partnership (GARDP) aim to develop and deliver new treatments for drug-resistant infections, but more collaborative efforts are needed. AMR is a global issue that requires coordinated international efforts. Sharing data, resources, and best practices can help countries address the AMR challenge more effectively. Collaborating with international organizations, governments, and research institutions can promote the development and implementation of global strategies to combat AMR.

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CONCLUSION

India has made significant strides in recognizing and addressing the AMR threat. However, the country's unique challenges, including its large population, high infectious disease burden, and complex healthcare system, necessitate continued efforts. A multi-sectoral, One Health approach involving healthcare, agriculture, environment, and policy sectors will be crucial for effectively combating AMR in India.

Future research should focus on understanding regional variations in AMR patterns, evaluating the impact of interventions, and developing India-specific solutions to address this critical public health challenge. By strengthening regulatory frameworks, enhancing surveillance, promoting public awareness, and fostering innovation, India can lead the global fight against antimicrobial resistance.

To effectively combat AMR, India needs a coordinated and sustained effort across multiple sectors. This includes implementing and enforcing regulations, improving infection control practices, promoting responsible antibiotic use, and investing in research and development. Public awareness and education campaigns are essential to change behaviors and reduce the misuse of antibiotics. International collaboration can help share knowledge and resources, ensuring a more comprehensive and effective response to AMR.

The fight against AMR is a long-term commitment that requires the involvement of all stakeholders, including government agencies, healthcare providers, researchers, and the public. By working together, India can make significant progress in controlling AMR and ensuring the continued effectiveness of antibiotics for future generations.

REFERENCES

1. Prestinaci et al; "Antimicrobial Resistance: A Global Multifaceted Phenomenon" 109.7 (2015) Pp309-318, doi https://doi.org/10.1179/2047773215Y.0000000030
2. Tang et al; "Antimicrobial Resistance (AMR)" 80.1 (2023) Pp11387, doi https://doi.org/10.3389/bjbs.2023.11387
3. Salam et al; "Antimicrobial Resistance: A Growing Serious Threat for Global Public Health" 11.13 (2023) Pp1946, doi https://doi.org/10.3390/healthcare11131946
4. Taneja et al; "Antimicrobial Resistance in the Environment: The Indian Scenario" 149.2 (2019) Pp119-128, doi https://doi.org/10.4103/ijmr.IJMR_226_18
5. Sharma et al; "The Challenge of Antimicrobial Resistance in the Indian Healthcare System" 15.7 (2023) Ppe42231, doi https://doi.org/10.7759/cureus.42231
6. Ranjalkar et al; "India's National Action Plan for Antimicrobial Resistance - An Overview of the Context, Status, and Way Ahead" 8.6 (2019) Pp1828-1834, doi https://doi.org/10.4103/jfmpc.jfmpc_275_19
7. Nair et al; "India's National Action Plan on Antimicrobial Resistance: A Critical Perspective" 27.1 (2021) Pp236-238, doi https://doi.org/10.1016/j.jgar.2021.09.004
8. Velazquez-Meza et al; "Antimicrobial Resistance: One Health Approach" 15.3 (2022) Pp743-749, doi https://doi.org/10.14202/vetworld.2022.743-749
9. Indian Council of Medical Research et al; "Annual Report Antimicrobial Resistance Research and Surveillance Network" 1.1 (2022) Pp1-2, Available from: https://main.icmr.nic.in/sites/default/files/upload_documents/AMRSN_Annual_Report_2022.pdf
10. Sihombing et al; "Response to Antimicrobial Resistance in South-East Asia Region" 18.1 (2023) Pp100306, doi https://doi.org/10.1016/j.lansea.2023.100306
11. Samreen et al; "Environmental Antimicrobial Resistance and Its Drivers: A Potential Threat to Public Health" 27.1 (2021) Pp101-111, doi https://doi.org/10.1016/j.jgar.2021.08.013
12. World Health Organization et al; "Antimicrobial Resistance" 1.1 (2023) Pp1-2, Available from: https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance
13. Drishti IAS et al; "Antimicrobial Resistance" 1.1 (2023) Pp1-2, Available from: https://www.drishtiias.com/daily-updates/daily-news-analysis/antimicrobial-resistance-11
14. Broom et al; "Antimicrobial Resistance, Politics, and Practice in India" 30.11 (2020) Pp1684-1696, doi https://doi.org/10.1177/1049732320927299

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15. Government of India et al; "National Action Plan on Antimicrobial Resistance (NAP-AMR) 2017–2021" 1.1 (2017) Pp1-2, Available from: https://www.flemingfund.org/app/uploads/3e22d14796e76f01959dbce0b2438851.pdf
16. Llor et al; "Antimicrobial Resistance: Risk Associated with Antibiotic Overuse and Initiatives to Reduce the Problem" 5.6 (2014) Pp229-241, doi https://doi.org/10.1177/2042098614554919
17. Aslam et al; "Antibiotic Resistance: A Rundown of a Global Crisis" 11.1 (2018) Pp1645-1658, doi https://doi.org/10.2147/IDR.S173867
18. Kanan et al; "Empowering Low- and Middle-Income Countries to Combat AMR by Minimal Use of Antibiotics: A Way Forward" 12.10 (2023) Pp1504, doi https://doi.org/10.3390/antibiotics12101504