IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

A Review Article On: Antimicrobial Resistance (AMR)

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Abstract:

Anti-microbial resistance (AMR) represents a critical and escalating global health threat, characterized by the increasing ineffectiveness of antibiotics and other antimicrobial agents against a wide range of pathogens. This resistance undermines the effectiveness of treatment protocols, leading to longer hospital stays, higher medical costs, and increased mortality.

The rise of AMR is driven by factors such as overuse and misuse of antibiotics, inadequate infection prevention and control measures, and insufficient development of new antimicrobial agents. This abstract reviews current trends in AMR, highlights the mechanisms by which resistance develops and spreads, and discusses the impact on public health. It also examines global and local strategies for combating AMR, including stewardship programs, improved surveillance, and innovation in drug development. The urgency of a coordinated response involving policymakers, healthcare providers, and the public is emphasized to mitigate the threat of AMR and safeguard the efficacy of antimicrobial treatments.

Keywords

Antibiotic Resistance, Pathogens Resistance, Mechanism, Stewardship and Surveillance.

1. Overview of AMR

This section introduces what AMR is, how it develops, and its implications for public health.

Antimicrobial resistance (AMR) is the phenomenon where microorganisms such as bacteria, viruses, fungi, and parasites evolve to become resistant to the drugs that once effectively treated them. This resistance can render standard treatments ineffective, leading to persistent infections and increased risk of disease spread.

Antimicrobials – including antibiotics, antivirals, antifungals, and antiparasitics – are medicines used to prevent and treat infectious diseases in humans, animals and plants.

Antimicrobial Resistance (AMR) occurs when bacteria, viruses, fungi and parasites no longer respond to antimicrobial medicines. As a result of drug resistance, antibiotics and other antimicrobial medicines become ineffective and infections become difficult or impossible to treat, increasing the risk of disease spread, severe illness, disability and death.

AMR is a natural process that happens over time through genetic changes in pathogens. Its emergence and spread is accelerated by human activity, mainly the misuse and overuse of antimicrobials to treat, prevent or control infections in humans, animals and plants.

2. Mechanisms of Resistance.

Describes the various ways microorganisms develop resistance, such as genetic mutations, horizontal gene transfer, and enzymatic degradation of drugs.

Genetic Mutations:

Changes in the microorganism's genetic material that alter the target of the drug or increase the production of enzymes that inactivate the drug.

Horizontal Gene Transfer:

Transfer of resistance genes between organisms, often facilitated by plasmids or other mobile genetic elements.

Efflux Pumps:

Mechanisms that actively pump the drug out of the microorganism before it can be effective.

Enzymatic Degradation:

Production of enzymes that break down or modify the antimicrobial agent.

3. Causes of AMR.

Discusses factors that contribute to AMR, including overuse and misuse of antibiotics, poor infection control, and environmental contamination.

Overuse and Misuse:

Excessive or inappropriate use of antibiotics in humans and animals accelerates resistance.

Incomplete Courses:

Not completing prescribed courses of antibiotics can allow surviving microbes to develop resistance.

Poor Infection Control:

Inadequate hygiene and infection control measures contribute to the spread of resistant organisms.

Consequences:

Treatment Failures:

Increased difficulty in treating infections, leading to longer illnesses and higher mortality rates.

Increased Healthcare Costs:

Higher costs due to prolonged treatments and use of more expensive drugs.

Public Health Threat:

Spread of resistant infections can lead to outbreaks and complicates public health responses.

Global Impact:Cross-Border Spread:

Resistant microorganisms can spread across countries and continents, making AMR a global health issue.

Economic and Social Effects:

Impacts on productivity, healthcare systems, and overall quality of life**.**

4. Impact of AMR.

Examines the consequences of AMR on healthcare systems, including increased healthcare costs, longer hospital stays, and higher mortality rates.

Global Impact:

Cross-Border Spread:

Resistant microorganisms can spread across countries and continents, making AMR a global health issue.

Economic and Social Effects:

Impacts on productivity, healthcare systems, and overall quality of life.

5. Surveillance and Monitoring.

Reviews current strategies for tracking AMR patterns and the effectiveness of these surveillance systems.

6. Prevention and Control Strategies.

Highlights measures to combat AMR, such as promoting appropriate use of antibiotics, improving infection control practices, and developing new antibiotics.

7. Research and Development.

Discusses ongoing research efforts to discover new antibiotics, alternative treatments, and vaccines.

New Antibiotics and Antimicrobials.

1. Discovery of Novel Compounds:

Identifying new chemical entities that can effectively target resistant microorganisms. This involves exploring natural sources, synthetic chemistry, and repurposing existing drugs.

2. Advanced Drug Design:

Utilizing techniques such as structure-based drug design and high-throughput screening to develop drugs that overcome resistance mechanisms.

Alternative Therapies.

1. Phage Therapy:

Using bacteriophages (viruses that infect bacteria) to target specific resistant bacterial strains.

2. Antimicrobial Peptides:

Developing peptides that have unique mechanisms of action against resistant pathogens.

3. Immunotherapies:

Enhancing the body's immune response to help it fight infections more effectively.

Diagnostic Tools.

1. Rapid Diagnostic Tests:

Creating tests that can quickly identify resistant strains and their susceptibility profiles to guide appropriate treatment decisions.

2. Genomic and Molecular Techniques:

Leveraging genomic sequencing and other molecular methods to understand resistance mechanisms and track resistance patterns.

Vaccines.

1. Development of Vaccines:

Creating vaccines to prevent infections from pathogens that are prone to developing resistance, thus reducing the need for antibiotics.

2. Resistance Mechanism Studies:

Understanding Mechanisms:

Researching how microorganisms acquire and develop resistance, including studying genetic mutations, horizontal gene transfer, and biofilm formation.

Counteracting Resistance:

Identifying strategies to inhibit resistance mechanisms, such as enzyme inhibitors that block resistance enzymes.

Stewardship and Surveillance.

1. Antimicrobial Stewardship Programs:

Implementing programs to promote the responsible use of antimicrobials in healthcare and agriculture.

2. Surveillance Systems:

Developing and improving systems to monitor and track AMR trends, which inform policy and public health interventions.

3. Regulatory and Policy Research:

Policy Development: Studying the impact of regulatory policies on antimicrobial use and resistance, and advocating for changes that can mitigate AMR.

Global and Local Efforts.

Reviews international guidelines and initiatives, such as those from the World Health Organization, and local efforts to combat AMR.

Key facts.

Antimicrobial resistance (AMR) is one of the top global public health and development threats. It is estimated that bacterial AMR was directly responsible for 1.27 million global deaths in 2019 and contributed to 4.95 million deaths (1).The misuse and overuse of antimicrobials in humans, animals and plants are the main drivers in the development of drug-resistant pathogens.

AMR affects countries in all regions and at all income levels. Its drivers and consequences are exacerbated by poverty and inequality, and low- and middle-income countries are most affected.

AMR puts many of the gains of modern medicine at risk. It makes infections harder to treat and makes other medical procedures and treatments – such as surgery, caesarean sections and cancer chemotherapy – much riskier.

A Global Concern.

Antimicrobial medicines are the cornerstone of modern medicine. The emergence and spread of drug-resistant pathogens threatens our ability to treat common infections and to perform life-saving procedures including cancer chemotherapy and caesarean section, hip replacements, organ transplantation and other surgeries.

In addition, drug-resistant infections impact the health of animals and plants, reduce productivity in farms, and threaten food security.

AMR has significant costs for both health systems and national economies overall. For example, it creates need for more expensive and intensive care, affects productivity of patients or their caregivers through prolonged hospital stays, and harms agricultural productivity.

What is the present situation?

Drug-resistance in bacteria.

The global rise in antibiotic resistance poses a significant threat, diminishing the efficacy of common antibiotics against widespread bacterial infections. The 2022 Global Antimicrobial Resistance and Use Surveillance System (GLASS) report highlights alarming resistance rates among prevalent bacterial pathogens. Median reported rates in 76 countries of 42% for third-generation cephalosporin-resistant E. coli and 35% for methicillin-resistant Staphylococcus aureus are a major concern. For urinary tract infections caused by E. coli, 1 in 5 cases exhibited reduced susceptibility to standard antibiotics like ampicillin, co-trimoxazole, and fluoroquinolones in 2020. This is making it harder to effectively treat common infections.

Drug resistance in fungi.

As drug-resistant fungal infections increase, WHO is monitoring their magnitude and public health impact. Fungal infections can be difficult to treat, including due to drug-drug interactions for patients with other infections (e.g. HIV). The emergence and spread of multi-drug resistant Candida auris, an invasive fungal infection, is of particular concern. Development of WHO's Fungal Priority Pathogens List (see below) included a comprehensive review of fungal infections and drug-resistant fungi globally.

High-level meetings on AMR.

In March 2022, United Nations General Assembly resolution A/RES/76/257 established a second High-level Meeting on AMR to be held in 2024, in collaboration with the Quadripartite Organizations and with the support of the Global Leaders Group. In October 2023, The President of the General Assembly appointed the Permanent Representatives of Barbados and Malta to co-facilitate the high-level meeting. The high-level meeting is an important opportunity for countries to make ambitious commitments and agree targets, and the Quadripartite Joint Secretariat is working closely with the co-facilitators and Global Leaders Group to ensure optimal participation and inputs from the human, animal, agri-food and the environment sectors.

Programmatic response to AMR in countries.

AMR national action plans.

As of November 2023, 178 countries had developed AMR national action plans aligned with the GAP. To ensure sustained progress, countries need to establish a functioning multisectoral AMR governance mechanism, prioritize activities, develop a costed operational plan, mobilize resources (both domestic and external), and effectively implement their plan. Monitoring mechanisms are needed to track progress, identify challenges and report periodically.

To globally track the progress in AMR national action plan implementation, countries have committed to completing the multisectoral annual Tracking AMR Country Self-Assessment Survey (TrACSS) that was launched in 2016.

Priority-setting for AMR research and product development.

The clinical pipeline of new antimicrobials is almost dry and there is a pipeline and access crisis for antibiotics. WHO's latest annual review of the pre-clinical and clinical antibacterial pipelines identified 27 antibiotics in clinical development that address WHO bacterial priority pathogens, of which only 6 were classified as innovative. In addition, a lack of access to quality antimicrobials and shortages of generic off-patent antibiotics affect countries across all levels of income and development.

Conclusion.

Summary of Findings: Recap the major findings regarding the prevalence and patterns of antimicrobial resistance in the studied population or environment. This may include trends, specific resistant strains, and impacts on public health.

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