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Editorial

Advancing the fight against infections and antimicrobial resistance: Need for multidisciplinary translational research

Anand Bhimaray Janagond[1*]

[1]Dept. of Microbiology, S. Nijalingappa Medical College, Bagalkot, Karnataka, India

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Infectious diseases continue to be a formidable challenge to global health, driven by evolving pathogens, increasing threat of antimicrobial resistance (AMR), and complex ecological interactions. Indian Journal of Microbiology Research (IJMR), a journal aiming to address issues related to microorganisms of importance to human, animal and environmental health, bear witness to a ceaseless stream of research dedicated to understanding these threats. The articles in the current issue can be categorized into two major themes: studies on the prevalence and trends of infectious diseases, AMR patterns, their molecular mechanisms, and studies on organisms impacting animal health, environment, ecology, and topics that are under the ambit of the 'One Health' approach.

1. The Indispensable Role of Surveillance

Estimating the prevalence and ongoing trends of infectious diseases is foundational to understanding their burden and various factors influencing the burden. Prevalence studies provide much needed data on disease distribution, enabling targeted interventions. Studies determining global/regional burden of infectious diseases, tracking AMR patterns, including their underlying mechanisms fuel further research in effective control and prevention, by providing critical epidemiological intelligence, enabling early detection of outbreaks, guiding intervention strategies, and informing vaccination campaigns.[1,2] For instance, the recent COVID-19 pandemic clearly demonstrated how real-time epidemiological data on disease transmission dynamics were crucial for containment efforts and appropriate public health response.[3] The longitudinal monitoring of disease trends allows scientific community and the policy makers to identify shifts in pathogen distribution, host susceptibility, and environmental factors influencing disease dynamics. This insight is crucial not just for prevention but also for assessing the long-term implications of infectious diseases on populations, including economic and social impact.[4]

The rise of drug-resistant pathogens threatens to undermine decades of medical advancement, rendering common infections untreatable and making routine medical procedures challenging.[5] In the ever-changing scenario of AMR, the research into AMR patterns and their underlying molecular mechanisms is paramount. Understanding the genetic mechanisms which facilitate the acquisition and spread of resistance genes, or mechanisms such as efflux pumps and enzymatic inactivation, provides critical insights into bacterial adaptation that offer potential targets for novel therapeutic strategies, bridging basic science and clinical application.[6] IJMR has been able to disseminate crucial information by publishing such research since its inception, and the current issue is no exception.

2. Need for Multidisciplinary Translational Research

To effectively combat these multifaceted challenges of infectious diseases and AMR, our research must evolve. The

*Corresponding author: Anand Bhimaray Janagond
Email: dranandj2021@gmail.com

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observational studies provide valuable insights into disease associations, and possible effectiveness of remedies, they are inherently limited by several characteristics including confounding factors and selection bias.[7] Observational studies, are valuable, but often lack the rigor to establish causality or evaluate interventions. Now the time is ripe for the investigators to prioritise translational research which can bridge the gap between basic microbiological findings, and tangible clinical and public health outcomes. This requires moving beyond simple prevalence studies to research that integrates in-depth clinical data, including infection-related complications, treatment responses, and long-term outcomes. Furthermore, where ethically and practically feasible, the research community should strive for adopting randomised controlled trials (RCTs). RCTs remain the gold standard for evaluating the efficacy and safety of potential interventions. They offer the highest level of evidence by minimising bias through randomisation.[8] Generally, RCTs are resource-intensive and sometimes limited in generalizability, but the insights gained from well-designed RCTs on interventions such as, new antimicrobial therapies, infection control measures, or stewardship interventions are critical for framing robust clinical guidelines and public health policies.[9] A balanced approach that leverages the strengths of both RCTs and robust observational studies, especially those utilizing real-world data and advanced statistical methods to adjust for confounders, will accelerate our progress.[7] In this regard, the researchers are encouraged and urged to look beyond observational studies, include appropriate clinical components in their research to make their studies more relevant, meaningful and impactful.

3. The Imperative of a One Health Approach

The interconnectedness of human, animal, and environmental health, encapsulated by the 'One Health' concept, is much evident in the context of infectious diseases and AMR.[10] It is an established fact that, the antibiotic use in animal husbandry and agriculture, often for disease prevention or growth promotion, significantly contributes to the global AMR burden. Resistant bacteria can transfer from animals to humans through direct contact, the food chain, and environmental contamination via manure and agricultural runoff.[10]

A rational approach to antibiotic use across all sectors, instead of only on human healthcare components, is therefore critical. This necessitates robust antimicrobial stewardship programs in veterinary medicine, promoting prudent use, restricting non-therapeutic applications, and enforcing withdrawal periods by evidence-based approaches.[10,11] Apart from veterinary and animal husbandry, the role of practices in agriculture sector that are contributing to the development of AMR dissemination are gaining recognition. Integrated research efforts under the ‘One Health’ concept must analyse these issues, and develop interventions to reduce the environmental reservoir of resistance genes. It is encouraging to note that several researchers are focusing their research on such topics.

Moreover, the environmental dimension of AMR extends to pollution from pharmaceutical waste and inefficient wastewater treatment, leading to the accumulation of antibiotics and antibiotic resistance genes (ARGs) in the environment.[11,12] Here, bioremediation emerges as a promising solution. Bioremediation, by employing microorganisms to degrade or detoxify pollutants, offers an eco-friendly and cost-effective approach to mitigate environmental contamination.[12] Research into microbial communities that are capable of breaking down pharmaceutical residues, ARGs, and also other harmful components like plastics & heavy metals whether through enzymatic action, or other metabolic pathways, is much needed. Advances in synthetic biology and microbial engineering could further enhance these bioremediation strategies, and offer innovative ways to clean up contaminated environmental sites and reduce the spread of diseases.[12]

4. The Path Forward

Through the current issue of the IJMR, we wish to emphasize that the fight against infectious diseases and AMR is a dynamic, and ongoing battle. As we move forward, the microbiology research community must take up research that is not only scientifically sound but also deeply translational, linking molecular insights to clinical outcomes and epidemiological impact through robust study designs, including RCTs whereever appropriate. Furthermore, adopting and rigorously pursuing a One Health approach is essential. By integrating research on rational antibiotic use in all concerned sectors, investing in environmental interventions like bioremediation, and fostering interdisciplinary collaborations, we can collectively strengthen our defenses against these pervasive threats.

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