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Commentary

Emerging Antimicrobial Resistance in Viral and Fungal Pathogens

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DESCRIPTION

The growing concern over antimicrobial resistance (AMR) has traditionally been associated with bacterial infections; however, recent trends underscore the alarming rise of resistance among viral and fungal pathogens. This shift has profound implications for public health, as therapeutic options for managing viral and fungal diseases are significantly more limited than for bacterial infections. In viral pathogens, the emergence of resistant strains, particularly in chronic viral infections such as HIV, hepatitis B and C, and influenza, poses a substantial challenge. Mutations in viral genomes, driven by selective pressure from prolonged antiviral therapy, lead to the development of drug-resistant variants that evade the effects of existing therapeutics. For example, resistance to nucleoside reverse transcriptase inhibitors (NRTIs) and non-nucleoside reverse transcriptase inhibitors (NNRTIs) in HIV has become a notable issue, especially in regions with suboptimal treatment adherence and inadequate monitoring infrastructure. Similarly, oseltamivir-resistant strains of influenza A have been reported in various outbreaks, complicating pandemic preparedness.

Parallel to the viral scenario, fungal pathogens are also evolving resistance at an alarming rate, particularly in healthcare settings. Candida auris, an emerging multidrug-resistant fungus, exemplifies the new wave of fungal threats. Its ability to resist azoles, polyenes, and echinocandins makes it extraordinarily difficult to treat. Other species such as Aspergillus fumigatus have developed resistance to triazole antifungals, mainly due to environmental fungicide use, highlighting the interconnectedness between clinical and agricultural practices. Invasive fungal infections, once rare and limited to immunocompromised individuals, are now more widespread due to increased use of immunosuppressive therapies, organ transplants, and intensive care procedures. The limited arsenal of antifungal drugs, combined with their toxicity profiles and emerging resistance, makes fungal infections particularly problematic.

Resistance in these non-bacterial pathogens is further complicated by the mechanisms that underlie their evolution. Viruses evolve rapidly due to their high mutation rates and short generation times. Fungal resistance, while slower, often involves genetic adaptations such as efflux pump overexpression, alterations in drug targets, and biofilm formation. These mechanisms not only reduce the efficacy of existing drugs but also limit the effectiveness of future treatments, as cross-resistance becomes a more prevalent concern. Moreover, both viral and fungal pathogens have demonstrated the ability to survive in biofilms complex communities that are inherently more resistant to antimicrobial agents. This survival strategy enhances their persistence in both hospital and community environments, leading to recurrent and chronic infections.

The issue of AMR in viral and fungal pathogens is not merely a biological phenomenon but a consequence of human behavior and healthcare practices. Overuse and misuse of antiviral and antifungal medications, often without definitive diagnosis or susceptibility testing, contribute significantly to resistance development. In many countries, empirical therapy is the norm, which while often necessary, also promotes resistance when inappropriate or prolonged. Moreover, gaps in surveillance systems make it difficult to detect resistance trends early, delaying response measures and facilitating spread. International travel and global trade further exacerbate the issue by accelerating the geographic dissemination of resistant strains.

Addressing this challenge requires a multifaceted approach that includes stewardship, surveillance, diagnostics, and research. Antimicrobial stewardship programs must be expanded beyond antibiotics to include antifungals and antivirals, ensuring that these agents are used judiciously and effectively. Investment in rapid diagnostic tools is also essential to distinguish between viral, bacterial, and fungal infections and to determine susceptibility profiles. This would enable clinicians to make informed treatment decisions, thereby reducing unnecessary drug exposure. Additionally, global surveillance networks should be strengthened to track resistance patterns in real time and to guide public health responses accordingly. Japan, with its robust healthcare infrastructure and research capabilities, is well-positioned to lead in AMR surveillance and management innovations, especially through integrated databases and molecular epidemiology initiatives.

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In conclusion, the emergence of antimicrobial resistance in viral and fungal pathogens presents a growing and under-recognized threat to global health. The limited availability of effective therapeutic agents against these pathogens, coupled with their capacity for rapid evolution and resistance development, demands urgent action. Preventive strategies must focus not only on the rational use of existing drugs but also on the development of novel therapeutics and vaccines. Collaborative international efforts, bolstered by investments in research and public health infrastructure, are essential to mitigate the spread of resistant viral and fungal infections. As the landscape of infectious diseases evolves, proactive and comprehensive measures will be vital to safeguard human health against the silent rise of non-bacterial antimicrobial resistance.