Bacteriophages: The Re-emergence of Phage Therapy in Treating Bacterial Infections.

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Introduction

Bacteriophages, often referred to simply as phages, are viruses that specifically infect bacteria. They are considered the most abundant organisms on Earth, outnumbering bacteria by a factor of ten. Phage therapy, the use of bacteriophages to treat bacterial infections, was once a promising approach to combat infections before antibiotics took center stage in medicine. However, with the growing crisis of antibiotic resistance, phage therapy is experiencing a renaissance, offering a potential solution to infections that are no longer treatable with conventional antibiotics [1].

Bacteriophages are viruses that infect bacteria by attaching to bacterial cells, injecting their genetic material, and hijacking the bacterial machinery to produce new phages. Once the bacterial cell is full of new viral particles, it typically bursts, releasing the phages to infect neighboring bacteria. Phages are highly specific, often targeting only certain strains of bacteria, making them ideal candidates for precision medicine in bacterial infections [2].

Phage therapy was first discovered in the early 20th century by Félix d'Hérelle and independently by Frederick Twort. D'Hérelle successfully treated patients with phages, particularly during outbreaks of dysentery and cholera. However, the discovery of antibiotics in the 1940s overshadowed phage therapy due to the broad-spectrum efficacy and ease of use of antibiotics. Over time, phage therapy became less popular in Western medicine, though it continued to be used in the former Soviet Union and Eastern Europe, where it has a long tradition of clinical application [3].

The increasing prevalence of antibiotic-resistant bacteria has rekindled interest in phage therapy. Bacterial infections once easily treatable with antibiotics are now becoming life-threatening due to multi-drug-resistant strains, such as methicillin-resistant Staphylococcus aureus (MRSA) and carbapenem-resistant Enterobacteriaceae (CRE). The World Health Organization (WHO) has declared antibiotic resistance one of the biggest threats to global health, food security, and development. Phage therapy offers a targeted alternative to antibiotics, particularly for drug-resistant infections [4].

Phage therapy works by exploiting the natural life cycle of bacteriophages. When phages infect a bacterial cell, they take over its replication machinery to produce more phages. This results in the lysis, or destruction, of the bacterial cell, releasing new phages to continue the cycle. Phages can be administered to patients as a cocktail of different viruses that target specific bacterial pathogens. Since phages are highly specific, they can be used to treat infections without disrupting the beneficial bacteria in the human microbiome, unlike broad-spectrum antibiotics, which often cause dysbiosis [5].

One of the key advantages of phage therapy is its specificity. Phages target only specific bacterial strains, leaving the rest of the microbiota unharmed. This minimizes the side effects associated with antibiotics, such as diarrhea and secondary infections like Clostridioides difficile. Additionally, phages have a self-limiting life cycle: they replicate only in the presence of their target bacteria and disappear once the infection is cleared. Furthermore, phages can evolve alongside bacteria, potentially keeping up with bacterial mutations that lead to resistance, unlike static antibiotic molecules [6].

Despite its promise, phage therapy faces several challenges. One of the primary limitations is the specificity of phages, which, while beneficial in some cases, also means that finding the right phage for the right bacterial strain can be time-consuming. Phage therapy also requires careful regulatory oversight, as it involves live organisms, which may raise safety concerns. Additionally, some bacteria can develop resistance to phages, though this issue may be mitigated by the use of phage cocktails or by evolving phages alongside bacterial resistance [7].

There have been several recent success stories involving phage therapy. In 2016, a man in the United States suffering from a life-threatening multidrug-resistant Acinetobacter baumannii infection was successfully treated with phage therapy after conventional antibiotics failed. Similar cases have been reported worldwide, highlighting the potential of phage therapy as a last resort for antibiotic-resistant infections. Clinical trials are now underway to assess the safety and efficacy of phage therapy for various bacterial infections, including skin infections, chronic wounds, and lung infections in cystic fibrosis patients [8].

One of the major hurdles to the widespread adoption of phage therapy is the regulatory framework governing its use. In the United States, phage therapy is classified as an experimental treatment and is subject to strict regulatory oversight by the Food and Drug Administration (FDA). This limits its

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availability and makes it difficult to implement on a large scale. Additionally, phage therapy raises ethical concerns related to the use of living organisms as treatments, particularly in cases where genetically modified phages are used to enhance efficacy [9].

Beyond human medicine, phage therapy is being explored for its potential in agriculture and environmental health. Phages have been used to reduce bacterial contamination in food products, prevent bacterial infections in livestock, and control bacterial populations in water treatment facilities. For example, phage preparations have been used to target Salmonella and Escherichia coli in poultry and cattle, reducing the spread of these pathogens in the food chain. Phage therapy thus holds promise not only for human health but also for improving food safety and environmental sustainability [10].

Conclusion

As research on bacteriophages progresses, the future of phage therapy looks promising. Advances in genetic engineering and synthetic biology are enabling scientists to create custom phages with enhanced efficacy and specificity. These engineered phages can be designed to overcome bacterial resistance or to deliver therapeutic genes to infected cells. Moreover, as the global crisis of antibiotic resistance worsens, phage therapy may become a critical tool in the fight against bacterial infections. Continued investment in research, clinical trials, and regulatory approval processes will be essential to realizing the full potential of this innovative treatment.

References

1. Naqvi WM, Sahu A. Paradigmatic Shift in the Education System in a Time of COVID 19. J Evol Med Dent Sci. 2020;9(27):1974-6.
2. Prasad N, Bhatt M, Agarwal SK, et al. The adverse effect of COVID pandemic on the care of patients with kidney diseases in India. Kidney Int Rep. 2020;5(9):1545-50.
3. Kolhe S, Dambhare M, Dhankasar P, et al. Home Remedies During Covid Pandemic Lockdown. J Med Dent Sci. 2020:103-7.
4. Garlapati K, Chavva S, Vaddeswarupu RM, et al. Fulminant mucormycosis involving paranasal sinuses: a rare case report. Case Rep Dent. 2014;2014.
5. Chayakulkeeree M, Ghannoum MA, Perfect JR. Zygomycosis: the re-emerging fungal infection. Eur J Clin Microbiol. 2006;25(4):215-29.
6. Kontoyiannis DP, Lewis RE. Agents of mucormycosis and entomophthoramycosis. 2010; 3257-69.
7. Afroze SN, Korlepara R, Rao GV, et al. Mucormycosis in a diabetic patient: a case report with an insight into its pathophysiology. Contemp Clin Dent. 2017;8(4):662.
8. Jones HE. Immune response and host resistance of humans to dermatophyte infection. J Am Acad Dermatol. 1993;28(5):S12-8.
9. Chakrabarti A. Epidemiology of central nervous system mycoses. Neurol India. 2007;55(3):191.
10. Mahalaxmi I, Jayaramayya K, Venkatesan D, et al. Mucormycosis: An opportunistic pathogen during COVID-19. Environ Res. 2021;201:111643.

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