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Repurposing Drugs to Combat Multidrug-resistant Infections

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Introduction

Multidrug-resistant (MDR) infections are a critical public health threat, causing widespread illness and deaths globally. Pathogens, particularly bacteria, have developed resistance to multiple antibiotics, rendering standard treatments ineffective and necessitating new approaches. The rise of MDR pathogens has outpaced the development of new antibiotics, partly due to the long and costly process of drug discovery. As a result, an innovative approach gaining traction is drug repurposing: identifying new uses for existing medications. Originally developed for other diseases, repurposed drugs offer an expedited pathway to combatting MDR infections because they have already been approved for safety, significantly reducing the time and cost to bring effective treatments to patients. Drug repurposing thus holds promise as a crucial tool in the fight against MDR infections, offering a potentially sustainable and rapid means to address this urgent medical challenge [1].

Description

Drug repurposing leverages existing drugs, often with established safety profiles, to target pathogens that have developed resistance to conventional treatments. This approach allows for shorter research timelines and lower costs compared to developing entirely new drugs. Several types of drugs, including antifungals, antivirals, and even non-antibiotic drugs like antipsychotics and anti-inflammatories, have shown surprising efficacy against bacteria in recent studies. For example, certain non-antibiotic drugs disrupt bacterial cell membranes, inhibit biofilm formation, or interfere with virulence factors that pathogens use to cause infections. These effects can weaken MDR bacteria, making them more susceptible to immune system attacks or traditional antibiotics. Furthermore, using drugs in novel combinations, such as pairing a repurposed drug with a conventional antibiotic, has demonstrated success in overcoming resistance mechanisms in laboratory settings. However, challenges remain: repurposing efforts must be balanced with thorough clinical testing to confirm effectiveness and prevent unintended consequences, like adverse drug interactions or accelerated resistance to repurposed drugs themselves [2].

The rise of multidrug-resistant infections has spurred an urgent need for alternative treatments beyond traditional antibiotics. Drug repurposing offers a promising solution by identifying unexpected antibacterial effects within drugs originally developed for unrelated conditions, such as cancer, heart disease, or neurological disorders. This approach capitalizes on the extensive safety data and established manufacturing processes of these drugs, potentially accelerating the process of making effective treatments available for MDR infections. The mechanisms through which repurposed drugs target MDR pathogens are varied. Some drugs disrupt bacterial biofilms structures that protect bacteria from antibiotics and immune responses by impairing the bacteria's ability to adhere to surfaces or communicate via signalling molecules. For example, antifungal drugs like amphotericin B have demonstrated biofilm-disrupting effects that make bacteria more vulnerable to antibiotics. Other drugs, such as certain antimalarial and antidepressants, can destabilize bacterial cell walls or membranes, leading to direct bacterial damage or allowing other antibiotics to penetrate more effectively [3].

Additionally, drugs like statins, commonly used for cholesterol management, have shown anti-inflammatory properties that may reduce bacterial virulence, helping to manage the infection indirectly by mitigating harmful immune responses. Drug repurposing also opens up new possibilities for combination therapies. By pairing an MDR-targeting repurposed drug with a traditional antibiotic, researchers can exploit synergistic effects that improve the overall efficacy of treatment and potentially restore sensitivity to previously ineffective antibiotics. For instance, studies have shown that pairing metformin, an antidiabetic drug, with specific antibiotics can suppress resistance mechanisms in bacterial strains such as Mycobacterium tuberculosis, the causative agent of tuberculosis. These drug combinations can target multiple bacterial processes simultaneously, creating a multifaceted attack that is difficult for bacteria to resist [4].

While promising, repurposing drugs for bacterial infections is not without its challenges. One significant concern is the potential for unintended consequences, such as adverse side effects that were not present in the original disease context. Drugs that have been safe for one application might interact differently when combined with antibiotics or when used in patients with compromised immune systems. Moreover, resistance to repurposed drugs can still develop if bacteria find ways to counteract the drug's new mechanism. Rigorous clinical testing is thus essential to confirm both the efficacy and safety of repurposed drugs in treating MDR infections. Nonetheless, given the dire need for new treatments, the benefits of drug repurposing are compelling. It presents a quicker, cost-effective option to deliver lifesaving therapies to patients suffering from infections that have become resistant to all other options [5].

Conclusion

Drug repurposing represents an essential strategy in the global effort to combat multidrug-resistant infections, offering the potential to sidestep lengthy development pipelines and introduce new treatment options more quickly. By exploiting drugs already approved for other uses, researchers can potentially develop effective therapies against MDR pathogens faster than ever. While challenges such as the need for further clinical validation remain, the initial successes in drug repurposing point to a promising avenue for addressing one of modern medicine's most daunting threats. As the prevalence of antibiotic resistance grows, the adoption of innovative, resource-efficient approaches like drug repurposing will be pivotal in preserving the efficacy of our medical arsenal and safeguarding public health on a global scale.

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Conflict of Interest

No potential conflict of interest was reported by the authors.

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