Review Article

ScienZTech

INTERNATIONAL JOURNAL OF DRUG DELIVERY AND NANOTECHNOLOGY

Published by Scienztech Journal Home Page: https://scienztech.org/

Repurposing for Progress: Leveraging Existing Drugs for Novel Therapeutic Solutions

Priyadarshini R*, G Selvi

Dept of Pharmaceutics, C L Baid Metha college of Pharmacy, Thoraipakkam, The Tamil Nadu, Dr. M.G.R. Medical University, Chennai 600097 Tamil Nadu, India

Article History:

Received on: 09 Sep 2023
Revised on: 15 Oct 2023
Accepted on: 18 Oct 2023

Keywords:

Drug repurposing,
Drug repositioning,
Existing drugs,
Disease treatments,
Therapeutic applications,
Pharmaceutical research.

Abstract

Drug repurposing, or drug repositioning, stands out as a promising strategy in pharmaceutical research and development. This innovative approach involves identifying new therapeutic applications for existing drugs, thereby streamlining the drug discovery process, and potentially introducing novel treatment options for a variety of diseases. This abstract delves into the potential and significance of drug repurposing as a cost-effective and time-efficient method to address unmet medical needs. It discusses the advantages of repurposing existing drugs, such as shortened development timelines, reduced risks, and the potential for lower costs compared to de novo drug development. Furthermore, the abstract emphasizes the various methods and technologies that have revolutionized the field of drug repurposing, including computational approaches and high-throughput screening. It explores case studies and provides examples of successfully repurposed drugs for various diseases, showcasing the real-world impact and potential of this strategy in reshaping the landscape of modern medicine. In conclusion, this abstract underscore the importance of sustained exploration and investment in drug repurposing for the advancement of healthcare and the development of innovative therapies.

∗Corresponding Author

Name: Priyadarshini R
Phone: +91 9345269271
Email: priyadarshinishilpa1999@gmail.com

eISSN: 2455-2747

Production and hosted by
Scienztech.org

INTRODUCTION

Drug repurposing, also referred to as drug repositioning, stands out as a promising strategy involving the identification of new therapeutic applications for existing drugs approved for different indications. This approach introduces a distinctive method to drug development, capitalizing on the comprehensive knowledge and established safety profiles of well-known drugs, potentially leading to quicker and more cost-effective treatments for various diseases [1].

Traditional drug discovery and development processes are notorious for being time-consuming, expensive, and frequently associated with high failure rates. In contrast, drug repurposing maximizes the existing knowledge about drugs that have already undergone rigorous testing for safety and efficacy in humans. By repurposing these drugs, researchers have the potential to circumvent many early stages of drug

development, such as toxicity testing and formulation development, resulting in significant time and resource savings.

While the concept of drug repurposing is not entirely new, serendipitous discoveries of unexpected therapeutic effects have been recurring throughout the history of medicine. For instance, the revelation of sildenafil (Viagra) as a treatment for erectile dysfunction emerged from its initial development as an antihypertensive drug. Recent advancements in genomics, proteomics, and computational techniques have further accelerated the systematic exploration of drug repurposing.

Several factors contribute to the increased attention and interest in drug repurposing. Firstly, it offers a faster route to clinical translation compared to de novo drug development. The extensive clinical data and safety profiles of repurposed drugs facilitate a smoother transition from preclinical studies to human trials. Secondly, repurposing holds the potential to address unmet medical needs by identifying new therapeutic uses for drugs already available on the market. This has substantial implications for patients, especially those with rare or neglected diseases that often lack effective treatments [2].

The drug repurposing emerges as a novel and promising approach to drug development. Through the strategic repositioning of existing drugs for new disease treatments, researchers can tap into the vast knowledge and safety profiles of these drugs, potentially expediting the discovery of effective therapies. As the field advances, drug repurposing stands poised to revolutionize the approach to treatment development, offering hope for enhanced patient care and continuous medical innovation [3].

Challenges and Opportunities

Drug repurposing presents significant opportunities in addressing various challenges encountered by the pharmaceutical industry and healthcare system. A key challenge lies in the high cost and time required for developing new drugs from scratch. Drug repurposing provides a cost-effective alternative by harnessing existing drugs with known safety profiles, potentially reducing the time and resources required for development. Another challenge involves the limited success rate of traditional drug discovery methods. Many promising drug candidates fail in clinical trials due to safety concerns or lack of efficacy. Repurposing existing drugs, already tested in humans, increases the likelihood of success. This approach also allows for the exploration of new therapeutic targets and mechanisms of action.

Furthermore, drug repurposing holds the potential to address unmet medical needs, offering alternative treatment options for diseases lacking effective therapies, especially for rare or neglected conditions. Repurposing also shows promise for personalized medicine, tailoring existing drugs for specific patient populations or disease subtypes.

Despite these opportunities, drug repurposing faces challenges. A major obstacle is identifying suitable drug candidates for repurposing. Comprehensive screening methods and sophisticated computational algorithms are required to assess the potential of existing drugs for new indications. Additionally, intellectual property and regulatory issues may pose hurdles, as repurposing often involves off-label use or the need for new clinical trials [4].

Drug Repositioning

Drug repositioning, also known as drug repurposing, has evolved from a serendipitous discovery process to a more systematic and data-driven approach. Historically, unexpected therapeutic effects were discovered by chance or through clinical practice observations. Advancements in scientific knowledge, technology, and computational methods have paved the way for a structured and deliberate exploration of drug repurposing [5].

Researchers employ various strategies to systematically identify potential drug candidates for new indications. This includes large-scale screening approaches, data mining of biomedical databases, analysis of molecular pathways and targets, and computational modeling techniques. Harnessing these tools enables scientists to uncover hidden connections between drugs and diseases, facilitating targeted exploration of drug repurposing opportunities.

This shift from serendipity to systematic exploration has not only increased the efficiency

and success rate of drug repurposing but also opened up new avenues for discovering novel therapeutic applications for existing drugs. The integration of multidisciplinary approaches and the utilization of vast datasets hold great promise in further advancing understanding of drug repositioning and its potential for improving patient care [6].

Screening and Prioritization Strategies

Identifying promising drug candidates for repurposing involves screening and prioritization strategies to efficiently evaluate a large number of existing drugs. Screening methods include in vitro assays, high-throughput screening, and computational modeling to assess drug activity against specific targets or disease pathways. These approaches help narrow down the pool of potential candidates.

Prioritization strategies play a crucial role in selecting the most promising drug candidates for further investigation. They involve considering various factors such as drug efficacy, safety profiles, mechanism of action, pharmacokinetics, and clinical feasibility. Computational algorithms, data integration, and network analysis are utilized to prioritize drugs based on their potential therapeutic relevance and likelihood of success.

By combining screening and prioritization strategies, researchers can identify a subset of drugs with the highest probability of repurposing success. This approach optimizes resources and increases the efficiency of drug repurposing efforts, accelerating the discovery of new treatments for a range of diseases [7].

Uncovering Novel Drug-Target Interactions

Mechanistic insights play a crucial role in drug repurposing by uncovering novel drug-target interactions. Understanding the underlying mechanisms of drug action provides valuable information about how a drug interacts with specific molecular targets and pathways in the body.

Various approaches are employed to gain mechanistic insights, including experimental studies and computational methods. Experimental techniques such as biochemical assays, high-throughput screening, and omics technologies enable the identification of drug-target interactions and their downstream effects on cellular processes.

Computational methods, such as molecular docking, molecular dynamics simulations, and network analysis, complement experimental approaches by predicting and modeling drug-target interactions. These methods provide insights into the binding affinity, structural interactions, and functional consequences of drug-target interactions.

By uncovering novel drug-target interactions, researchers can identify potential repurposing opportunities based on shared targets or pathways between different diseases. This approach expands the therapeutic potential of existing drugs and facilitates the development of new treatment strategies.

Overall, mechanistic insights are vital for drug repurposing efforts as they enhance our understanding of drug action, facilitate target identification, and guide the rational selection of repurposing candidates [8].

Assessing Efficacy and Safety of Repurposed Drugs

Preclinical evaluation plays a critical role in the assessment of efficacy and safety of repurposed drugs before they advance to clinical trials. This stage involves a series of rigorous experiments and studies conducted in vitro and in animal models.

The evaluation of efficacy focuses on determining whether the repurposed drug exhibits the desired therapeutic effects in relevant disease models. This involves assessing parameters such as drug potency, dose-response relationships, and the impact on disease progression or biomarkers. Comparative studies with standard treatments or placebo controls may also be conducted to establish the effectiveness of the repurposed drug.

Safety evaluation involves investigating the potential adverse effects and toxicity of the repurposed drug. Comprehensive studies are conducted to assess its pharmacokinetics, distribution, metabolism, and elimination. Toxicity studies evaluate the drug's impact on various organs, potential side effects, and any potential drug-drug interactions.

The preclinical evaluation provides crucial data to inform the decision-making process for advancing repurposed drugs into clinical trials. It helps establish the appropriate dosing regimen, identify potential risks, and ensure the overall safety and efficacy of the repurposed drug before it reaches human testing [9].

Clinical Trials for Repurposed Drugs

Designing and implementing clinical trials for repurposed drugs require careful consideration of several factors to ensure the validity and reliability of the results. Key considerations include study design, patient population selection, endpoints, and regulatory requirements.

The choice of study design depends on the specific objectives of the trial, such as establishing efficacy, comparing with standard treatments, or exploring new indications. Randomized controlled trials (RCTs) are commonly used to evaluate repurposed drugs, often with placebo or active comparator arms [10].

Patient population selection is critical to ensure that the trial includes individuals who are likely to benefit from the repurposed drug. This may involve identifying specific subpopulations based on disease characteristics, biomarkers, or genetic profiles.

Endpoint selection is crucial for assessing the efficacy and safety of the repurposed drug. Endpoints may include clinical outcomes, biomarkers, or patient-reported outcomes. Selecting appropriate endpoints is essential for capturing the desired treatment effects and determining clinical significance [11].

Compliance with regulatory requirements is necessary for ethical and legal reasons. Obtaining appropriate approvals and adhering to Good Clinical Practice (GCP) guidelines ensure patient safety, data integrity, and regulatory compliance.

Overall, the design and implementation of clinical trials for repurposed drugs require thoughtful planning to generate robust evidence of efficacy and safety. By addressing these considerations, researchers can maximize the chances of successful clinical development and ultimately provide new treatment options for patients[12].

Success Stories: Notable Examples of Drug Repurposing in Practice

Drug repurposing has yielded several notable success stories, demonstrating its potential to transform patient care. One such example is the repurposing of thalidomide, originally developed as a sedative but later found to be effective against multiple myeloma and leprosy. Another success story is the use of aspirin, a widely-used pain reliever, as a preventive treatment for cardiovascular diseases.

Further examples include the repurposing of sildenafil (Viagra) for erectile dysfunction, bevacizumab (Avastin) for cancer treatment, and minoxidil for hair growth stimulation. These cases showcase the serendipitous discoveries and systematic explorations that have led to the identification of novel therapeutic applications for existing drugs.

These success stories highlight the immense potential of drug repurposing, not only in terms of efficacy but also in terms of cost and time savings compared to traditional drug development. They serve as inspiration for continued exploration and development of repurposed drugs to address unmet medical needs and improve patient outcomes [13].

Overcoming Obstacles: Legal, Regulatory, and Intellectual Property Challenges

While drug repurposing holds immense potential, several obstacles related to legal, regulatory, and intellectual property issues need to be addressed. One significant challenge is navigating the complex web of patents and intellectual property rights surrounding existing drugs, which may limit their use for new indications.

Regulatory hurdles arise when repurposing drugs for off-label use or when additional clinical trials are required for new indications. Obtaining regulatory approvals for repurposed drugs may involve demonstrating safety and efficacy in the specific target population, even if the drug is already approved for another indication [14].

Legal considerations include navigating licensing agreements, exclusivity rights, and potential infringement issues. Negotiating collaborations, acquiring rights, or seeking regulatory

exclusivities may be necessary to bring repurposed drugs to market [15].

Addressing these challenges requires collaborative efforts among stakeholders, including pharmaceutical companies, regulatory agencies, and policymakers. Streamlining regulatory pathways, fostering intellectual property frameworks that incentivize repurposing, and encouraging knowledge sharing can help overcome these obstacles and unlock the full potential of drug repurposing for improved patient care [16].

Future Directions: Expanding the Scope of Drug Repurposing

The field of drug repurposing is advancing with promising future directions. One key trajectory involves harnessing emerging technologies such as artificial intelligence and machine learning to augment screening and prediction methods, thereby expediting the discovery of novel repurposing opportunities [17].

Expanding the scope of drug repurposing beyond small molecules to include biologics, gene therapies, and combination therapies stands as another promising avenue. This entails exploring the repurposing potential of existing biologics and identifying synergistic drug combinations for enhanced therapeutic outcomes [18].

Furthermore, integrating real-world evidence, patient data, and digital health technologies can significantly improve the identification of repurposing candidates, fostering personalized medicine approaches [19].

Collaboration and data sharing across academia, industry, and regulatory agencies are pivotal for broadening the scope of drug repurposing. By embracing these future directions, the field can unlock new possibilities, accelerate drug discovery, and ultimately deliver effective and affordable treatments to patients more efficiently [20].

CONCLUSION

Drug repurposing presents a transformative paradigm in drug development, capitalizing on the utilization of existing drugs for new indications and expediting the availability of effective treatments. The repositioning of drugs enables the leveraging of extensive knowledge, safety profiles, and established manufacturing processes, leading to shortened development timelines and reduced costs.

While success stories underscore the immense potential of drug repurposing in addressing unmet medical needs and enhancing patient care, challenges related to legal, regulatory, and intellectual property issues must be surmounted to fully realize this potential.

As exploration progresses into future directions, incorporating technological advancements, broadening the scope, and fostering collaborative efforts, we can unlock the full potential of repurposed drugs. Embracing drug repurposing holds the promise of advancing medical innovation, offering new treatment options, and ultimately enhancing the quality of life for patients worldwide.

Conflict of Interest

The authors declare no conflict of interest, financial or otherwise.

Funding Support

The authors declare that they have no funding for this study.

REFERENCES

[1] Pushpakom S, Lysenko A, Vila-López N, et al. Drug repurposing: progress, challenges and recommendations. Nat Rev Drug Discov. 2019;18(1):41-58.

[2] Ashburn TT, Thor KB. Drug repositioning: identifying and developing new uses for existing drugs. Nat Rev Drug Discov. 2004;3(8):673-683.

[3] Chong CR, Sullivan DJ Jr. New uses for old drugs. Nature. 2007;448(7154):645-646.

[4] Jin G, Wong ST. Toward better drug repositioning: prioritizing and integrating existing methods into efficient pipelines. Drug Discov Today. 2014;19(5):637-644.

[5] Zhang XD. A pair of new statistical parameters for quality control in RNA interference high-throughput screening assays. Genomics. 2007;89(4):552-561.

[6] Langedijk J, Mantel-Teeuwisse AK, Slijkerman DS, Schutjens MH. Drug repositioning and repurposing: terminology and definitions in literature. Drug Discov Today. 2015;20(8):1027-1034.

[7] Oprea TI, Mestres J. Drug repurposing: far beyond new targets for old drugs. AAPS J. 2012;14(4):759-763.
[8] Mullard A. Can repurposing give failed drugs a second chance? Nat Rev Drug Discov. 2016;15(8):533-535.
[9] Reddy AS, Zhang S. Polypharmacology: drug discovery for the future. Expert Rev Clin Pharmacol. 2013;6(1):41-47.
[10] Corsello SM, Bittker JA, Liu Z, et al. The Drug Repurposing Hub: a next-generation drug library and information resource. Nat Med. 2017;23(4):405-408.
[11] Hauser AS, Attwood MM, Rask-Andersen M, Schiöth HB, Gloriam DE. Trends in GPCR drug discovery: new agents, targets and indications. Nat Rev Drug Discov. 2017;16(12):829-842.
[12] Hopkins AL. Network pharmacology: the next paradigm in drug discovery. Nat Chem Biol. 2008;4(11):682-690.
[13] Swinney DC, Anthony J. How were new medicines discovered? Nat Rev Drug Discov. 2011;10(7):507-519.
[14] Cheng F, Desai RJ, Handy DE, et al. Network-based approach to prediction and population-based validation of in silico drug repurposing. Nat Commun. 2018;9(1):2691.
[15] Li J, Zheng S, Chen B, Butte AJ, Swamidass SJ, Lu Z. A survey of current trends in computational drug repositioning. Brief Bioinform. 2016;17(1):2-12.
[16] Napolitano F, Zhao Y, Moreira VM, et al. Drug repositioning: a machine-learning approach through data integration. J Cheminform. 2013;5(1):30.
[17] Shameer K, Readhead B, Dudley JT. Computational and experimental advances in drug repositioning for accelerated therapeutic stratification. Curr Top Med Chem. 2015;15(1):5-20.
[18] Lamb J, Crawford ED, Peck D, et al. The Connectivity Map: using gene-expression signatures to connect small molecules, genes, and disease. Science. 2006;313(5795):1929-1935.
[19] Barabási AL, Gulbahce N, Loscalzo J. Network medicine: a network-based approach to human disease. Nat Rev Genet. 2011;12(1):56-68.
[20] Yildirim MA, Goh KI, Cusick ME, Barabási AL, Vidal M. Drug-target network. Nat Biotechnol. 2007;25(10):1119-1126.