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Investigating the Pharmacokinetic and Pharmacodynamics Modelling of Drug Interactions in Polypharmacy

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Introduction

Investigating the pharmacokinetic (PK) and pharmacodynamic (PD) modeling of drug interactions in polypharmacy scenarios is crucial for understanding the complex interplay between multiple drugs and their effects on drug absorption, distribution, metabolism and excretion, as well as their interactions with target receptors and biological pathways. Polypharmacy, the concurrent use of multiple medications by an individual patient, is increasingly common, particularly among older adults and patients with chronic medical conditions. However, polypharmacy can lead to drug-drug interactions (DDIs), where the pharmacokinetics and pharmacodynamics of one drug are altered by the presence of another drug, potentially affecting treatment outcomes and patient safety [1]. In this paper, we will explore the principles of PK/PD modeling, the mechanisms underlying drug interactions, current research findings, clinical applications, challenges and future directions in investigating drug interactions in polypharmacy scenarios.

Pharmacokinetic modeling involves quantifying the time course of drug absorption, distribution, metabolism and elimination in the body, while pharmacodynamic modeling focuses on describing the relationship between drug concentrations and pharmacological effects. PK/PD modeling integrates pharmacokinetic and pharmacodynamic data to characterize the concentration-effect relationship of drugs and predict their efficacy, toxicity and therapeutic outcomes. In polypharmacy scenarios, PK/PD modeling enables the assessment of potential drug interactions, the prediction of their magnitude and clinical significance and the optimization of drug regimens to minimize adverse effects and maximize therapeutic benefits.

Polypharmacy can result in various types of drug interactions, including pharmacokinetic interactions, pharmacodynamic interactions and pharmaceutical interactions. Pharmacokinetic interactions involve alterations in drug absorption, distribution, metabolism, or excretion due to changes in drug concentrations, enzyme activity, or transporter function. For example, co-administration of drugs that induce or inhibit cytochrome P450 enzymes (CYPs) can affect the metabolism of other drugs metabolized by the same enzymes, leading to changes in plasma concentrations and therapeutic effects. Pharmacodynamic interactions occur when drugs interact with the same or related receptors, enzymes, or signaling pathways, resulting in synergistic, additive, or antagonistic effects on pharmacological responses. Pharmaceutical interactions involve physical or chemical interactions between drugs or excipients in formulations, such as drug-drug incompatibilities, precipitation, or degradation, which can affect drug stability, bioavailability, or administration routes.

PK/PD modeling of drug interactions in polypharmacy scenarios requires consideration of various factors, including drug properties, patient characteristics, dosing regimens and treatment duration. Physicochemical properties of drugs, such as lipophilicity, protein binding and molecular size, influence their absorption, distribution and metabolism in the body. Patient factors, such as age, sex, genetics, renal function, hepatic function and comorbidities, can affect drug pharmacokinetics and pharmacodynamics, leading to interindividual variability in drug responses [2]. Dosing regimens, such as dose, frequency and route of administration, impact drug exposure and systemic concentrations, which in turn affect drug interactions and therapeutic outcomes. Treatment duration, including acute, chronic, or intermittent dosing, can influence the onset, duration and reversibility of drug interactions, as well as the development of tolerance, sensitization, or rebound effects over time.

Several mathematical models and computational techniques are used to characterize drug interactions and predict their effects on pharmacokinetics and pharmacodynamics in polypharmacy scenarios. Mechanistic PK/PD models describe the underlying physiological processes and molecular mechanisms governing drug absorption, distribution, metabolism and excretion, as well as drug-receptor interactions and downstream signaling pathways. These models incorporate pharmacokinetic parameters, such as clearance, volume of distribution and half-life, as well as pharmacodynamic parameters, such as potency, efficacy and receptor affinity, to simulate drug concentration-time profiles and pharmacological responses in various tissues and organs [3]. Population PK/PD models extend mechanistic models to account for interindividual variability in drug pharmacokinetics and pharmacodynamics, enabling personalized predictions of drug effects based on patient-specific characteristics.

Description

Physiologically-based pharmacokinetic (PBPK) models integrate physiological, anatomical and biochemical data to simulate drug disposition and interactions in different tissues and organs, such as the liver, kidney, intestine and brain. PBPK models incorporate drug-specific parameters, such as permeability, blood flow, metabolism and protein binding, as well as system-specific parameters, such as organ volumes, tissue composition and enzyme activity, to predict drug distribution, metabolism and elimination profiles in the body. PBPK models are particularly useful for predicting drug-drug interactions involving metabolic enzymes, transporters and barrier functions, as well as for extrapolating drug exposure from preclinical studies to clinical settings and across different patient populations.

In vitro-in vivo extrapolation (IVIVE) techniques use in vitro data, such as enzyme kinetics, transporter activity and tissue distribution, to predict in vivo drug interactions and pharmacokinetics in humans. IVIVE approaches incorporate physicochemical properties, such as drug solubility, permeability and stability, as well as biological factors, such as enzyme expression, transporter function and tissue binding, to estimate drug disposition and interactions in vivo. IVIVE methods, such as static and dynamic modeling, physiologically-based scaling and extrapolation algorithms, enable the prediction of drug-drug interactions across different species, formulations and dosing regimens, providing valuable insights into the mechanisms and consequences of polypharmacy.

Clinical applications of PK/PD modeling in investigating drug interactions in polypharmacy scenarios include drug interaction screening, dose adjustment, therapeutic drug monitoring and drug regimen optimization. Drug interaction

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screening involves identifying potential interactions between co-administered drugs based on their pharmacokinetic properties, metabolic pathways and known interactions with drug-metabolizing enzymes or transporters. Dose adjustment strategies aim to minimize the risk of adverse effects or therapeutic failure by optimizing drug doses, dosing intervals, or administration routes to account for drug interactions, patient characteristics and treatment goals [4]. Therapeutic drug monitoring involves measuring drug concentrations in biological samples, such as blood, plasma, or urine, to assess drug exposure, adherence and response and to guide dose titration or regimen modifications based on individual patient pharmacokinetics and pharmacodynamics. Drug regimen optimization strategies involve selecting the most appropriate drug combinations, formulations and dosing schedules to achieve desired therapeutic outcomes while minimizing drug interactions, adverse effects and treatment costs.

Despite the advancements in PK/PD modeling and computational techniques for investigating drug interactions in polypharmacy scenarios, several challenges remain in clinical translation, validation and implementation. Limited availability of pharmacokinetic and pharmacodynamic data for drug interactions, variability in study designs and methodologies and heterogeneity in patient populations pose challenges to model development and validation. Additionally, differences in model assumptions, parameterization and validation criteria across studies can lead to inconsistencies in model predictions and interpretations, highlighting the need for standardized approaches and collaborative efforts to harmonize PK/PD modeling practices and data sharing [5]. Furthermore, the complexity of drug interactions in polypharmacy scenarios, including nonlinear, time-dependent and dynamic interactions, requires advanced modeling techniques, such as mechanistic modeling, systems pharmacology and machine learning, to capture and predict the complex interplay between multiple drugs, physiological processes and biological pathways.

Conclusion

In conclusion, investigating the pharmacokinetic and pharmacodynamic modeling of drug interactions in polypharmacy scenarios is essential for understanding the complexities of drug-drug interactions, predicting their effects on drug exposure and response and optimizing drug regimens to maximize therapeutic benefits and minimize adverse effects. Mathematical models, computational techniques and in vitro-in vivo extrapolation approaches enable the characterization and prediction of drug interactions in polypharmacy scenarios, providing valuable insights into the mechanisms and consequences of drug interactions on treatment outcomes and patient safety. Despite challenges in clinical translation and implementation, ongoing research efforts and collaborative initiatives are driving progress towards personalized, precision medicine approaches that optimize drug therapy in polypharmacy scenarios based on individual patient characteristics, treatment goals and pharmacological principles.

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Conflict of Interest

None.

References

1. Alhumaidi, Reham M., Ghazi A. Bamagous, Safaa M. Alsanosi and Hamsah S. Alqashqari, et al. "Risk of polypharmacy and its outcome in terms of drug interaction in an elderly population: a retrospective cross-sectional study." *J Clin Med* 12 (2023): 3960.
2. Vonbach, Priska, André Dubied, Stephan Krähenbühl and Jürg H. Beer. "Evaluation of frequently used drug interaction screening programs." *Pharm World Sci* 30 (2008): 367-374.
3. Jain, Shipra, Pushpawati Jain, Kopal Sharma and Pushpendra Saraswat. "A prospective analysis of drug interactions in patients of intensive cardiac care unit." *J Clin Diagn Res* 11 (2017): FC01.
4. Spanakis, Marios, Petros Ioannou, Sotiris Tzalis and Vasiliki Papakosta, et al. "Drug-drug interactions among patients hospitalized with COVID-19 in Greece." *J Clin Med* 11 (2022): 7172.
5. Tan, Yen Yi, Vaclav Papez, Wai Hoong Chang and Stefanie H. Mueller, et al. "Comparing clinical trial population representativeness to real-world populations: an external validity analysis encompassing 43 895 trials and 5 685 738 individuals across 989 unique drugs and 286 conditions in England." *Lancet Healthy Longev* 3 (2022): e674-e689.

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