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Pharmacokinetics of Vacomycin

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Abstract

Vancomycin, a glycopeptide antibiotic renowned for its efficacy against gram-positive bacterial infections, has been a mainstay in the treatment of serious infections, particularly those caused by methicillin-resistant Staphylococcus aureus (MRSA). Vancomycin is primarily administered intravenously due to its negligible oral absorption. The drug exhibits a large volume of distribution, predominantly in the extracellular fluid, with limited penetration through the blood-brain barrier. Despite its significant role in combating infections, Vancomycin is not metabolized extensively in the body. Dosing adjustments are crucial, particularly in patients with impaired renal function, to prevent drug accumulation and associated toxicity. Extended interval dosing strategies may be employed to optimize efficacy while minimizing nephrotoxic and ototoxic risks. Special populations, including pediatric and elderly patients, as well as those with obesity, may require individualized dosing approaches.

Keywords: Glycopeptide antibiotic; Methicillin-resistant; Oral absorption; Extracellular fluid; Nephrotoxic; Ototoxic risks

Introduction

Vancomycin is a glycopeptide antibiotic that is commonly used to treat serious bacterial infections, especially those caused by Methicillin Resistant *Staphylococcus aureus* (MRSA) and other gram-positive bacteria. Understanding the pharmacokinetics of Vancomycin is crucial for optimizing its therapeutic efficacy and minimizing the risk of toxicity. Vancomycin is not absorbed orally and is typically administered intravenously for systemic infections. It has a large volume of distribution, primarily in the extracellular fluid and limited penetration through the blood-brain barrier, so it may not be effective in treating central nervous system infections. This drug does not bind significantly to plasma proteins. The primary route of elimination is renal, with about 90% of the unchanged drug excreted through the kidneys. The elimination half-life of Vancomycin is typically 4 to 6 hours in individuals with normal renal function. Due to the variability in pharmacokinetics among patients, therapeutic drug monitoring is often recommended for Vancomycin. Monitoring involves measuring trough levels just before the next dose to ensure that concentrations remain within the therapeutic range. The therapeutic range for Vancomycin trough levels is typically 15-20 mg/L for serious infections, although specific recommendations may vary [1].

Description

Vancomycin absorption

Vancomycin has very low oral bioavailability, meaning that when taken by mouth, only a small percentage of the drug is absorbed into the bloodstream. As a result of its poor oral absorption, oral Vancomycin is not effective for systemic infections and is mainly used for the treatment of gastrointestinal infections, particularly those caused by Clostridium difficile. The preferred route of administration for systemic infections is Intravenous (IV). This allows for rapid and reliable delivery of the drug into the bloodstream, achieving therapeutic concentrations. While intravenous administration is common, Vancomycin can also be administered via intramuscular injection. However, intramuscular administration may cause pain and local irritation. Once in the bloodstream, Vancomycin has a large volume of distribution, primarily distributing in the extracellular fluid. This distribution pattern allows it to reach various tissues and organs, making it effective against a range of gram-positive bacteria. Vancomycin has limited penetration through certain barriers, such as the blood-brain barrier. Consequently, it may be less effective in treating central nervous system infections [2,3].

Volume of distribution

Vancomycin has a large volume of distribution, primarily distributing in the extracellular fluid. This characteristic allows the drug to reach various tissues and organs, making it effective against a broad spectrum of gram-positive bacteria.

Extracellular fluid distribution: The distribution of vancomycin is mainly confined to the extracellular space, including interstitial fluid and plasma. This distribution pattern is significant for targeting infections that occur outside of cells, such as skin and soft tissue infections [4].

Limited tissue penetration: While vancomycin has good distribution in the extracellular space, its penetration into certain tissues and organs is limited. Notably, vancomycin does not penetrate well through the blood-brain barrier, making it less effective for treating central nervous system infections [5].

Protein binding: Vancomycin has low protein binding, meaning that only a small fraction of the drug is bound to plasma proteins. This characteristic contributes to the drug's distribution in the extracellular fluid and enhances its availability for exerting antibacterial activity [6].

Pulmonary distribution: Vancomycin has been found to accumulate in the lungs, and this property is often utilized in the treatment of pulmonary infections, including pneumonia [7].

Distribution in body fluids: Vancomycin distributes well into various body fluids, including synovial fluid, pleural fluid, and pericardial fluid. This property allows it to be effective in treating

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infections in these fluid-filled spaces.

Metabolism of vancomycin

Vancomycin is a large, complex molecule that is not subject to extensive metabolism in the liver or other tissues. The lack of significant metabolism contributes to the drug's relatively straightforward pharmacokinetics. Approximately 90% of the administered Vancomycin is excreted unchanged in the urine. This high renal clearance highlights the importance of monitoring renal function when using Vancomycin. The elimination half-life of Vancomycin is around 4 to 6 hours in individuals with normal renal function. The relatively short half-life necessitates frequent dosing to maintain therapeutic drug concentrations. In individuals with impaired renal function, the clearance of Vancomycin is reduced, leading to potential drug accumulation. This may increase the risk of Vancomycin-associated toxicities, such as nephrotoxicity and ototoxicity. Dosing adjustments are often required in patients with renal impairment to prevent excessive drug accumulation. Therapeutic drug monitoring is involved to measure Vancomycin concentration just before the next dose. This optimizes the efficacy while minimizing the risk factors [8].

Elimination of this drug

Vancomycin is primarily eliminated from the body through renal excretion. The major route of elimination for vancomycin is renal excretion. Approximately 90% of the administered dose is excreted unchanged in the urine. The kidneys play a crucial role in clearing vancomycin from the bloodstream. Vancomycin is filtered by the glomerulus in the kidneys, and its clearance is dependent on the Glomerular Filtration Rate (GFR). In individuals with normal renal function, vancomycin is eliminated relatively efficiently. Impaired renal function can significantly affect the elimination of vancomycin. In patients with reduced GFR, the clearance of vancomycin is decreased, leading to potential drug accumulation. Dose adjustments are often necessary in individuals with renal impairment to prevent excessive drug concentrations and associated toxicities. TDM involves measuring vancomycin concentrations, particularly trough levels just before the next dose, to ensure that concentrations remain within the therapeutic range. This helps optimize efficacy while minimizing the risk of adverse effects. While renal excretion is the primary route, vancomycin can also be found in other body fluids, including pleural fluid, pericardial fluid, and synovial fluid. These fluid distributions contribute to its efficacy in treating infections in these spaces [9].

Adjustment of dosage

Renal function plays a crucial role in vancomycin clearance. Dosage adjustments are often necessary in patients with impaired renal function to prevent drug accumulation and toxicity. Extended interval dosing strategies may be used in certain cases to optimize efficacy and minimize the risk of nephrotoxicity. Regular assessment of renal function is crucial. This is often done by monitoring serum creatinine levels and calculating the estimated glomerular filtration rate (eGFR). Both are indicators of kidney function. Dosage adjustments should be individualized based on patient-specific factors, including age, weight, renal function, and the specific clinical scenario. Close monitoring and collaboration between healthcare providers, pharmacists, and clinical pharmacologists are crucial for tailoring vancomycin dosing to each patient. Factors such as age, body weight, and comorbidities may influence vancomycin pharmacokinetics. These should be considered when determining the appropriate dosage [10].

Nephrotoxicity of Vacomycin

Vancomycin, while effective in treating serious bacterial infections, is associated with the potential risk of nephrotoxicity, particularly when administered at high doses or in patients with underlying renal impairment. Nephrotoxicity refers to kidney damage or dysfunction caused by a drug or its byproducts. Nephrotoxicity is a known adverse effect of vancomycin, but the incidence varies. It is more commonly observed when the drug is administered at higher doses or for prolonged durations. The exact mechanism of vancomycin-induced nephrotoxicity is not fully understood. It is believed to involve direct tubular toxicity. Vancomycin may accumulate in renal proximal tubular cells, leading to cellular injury and dysfunction. Nephrotoxicity may manifest as an increase in serum creatinine levels and a decrease in urine output. In severe cases, Acute Kidney Injury (AKI) can occur, requiring immediate medical attention. To minimize the risk of nephrotoxicity, healthcare providers often consider dose adjustments, extended interval dosing, or alternative antibiotics in patients at higher risk. Adequate hydration and monitoring of concurrent nephrotoxic medications are important preventive measures.

Conclusion

A balanced approach is necessary in utilizing vancomycin for optimal therapeutic efficacy while minimizing the potential for adverse effects. Healthcare professionals should consider patient-specific factors, employ therapeutic drug monitoring, and make individualized dosage adjustments to achieve the desired balance between efficacy and safety. In clinical practice, a vigilant approach to monitoring and adjusting vancomycin dosages, along with consideration of patient-specific factors, contributes to the effective and safe use of this important antibiotic.

References

1. Alberti TB, Barbosa WL, Vieira JL, Raposo NR, Dutra RC (2017) (-)-β-Caryophyllene, a CB2 receptor-selective phytocannabinoid, suppresses motor paralysis and neuroinflammation in a murine model of multiple sclerosis. Int J Mol Sci. 18: 691.

2. Anthony M, Romero K, Malone DC, Hines LE, Higgins L, et al. (2009)Warfarin interactions with substances listed in drug information compendia and in the FDA-approved label for warfarin sodium. Clin Pharmacol Ther. 86: 425-429.

3. Babatope T, Chotalia J, Elkhatib R, Mohite S, Shah J, et al. (2016) A study of the impact of cannabis on doses of discharge antipsychotic medication in individuals with schizophrenia or schizoaffective disorder. Psychiatry J. 87: 729-737.

4. Boswell Smith V, Spina D, Page CP (2006) Phosphodiesterase inhibitors. Brit J Pharmacol. 1: S252-S257.

5. Carbone K, Gervasi F (2022) An updated review of the genus humulus: a valuable source of bioactive compounds for health and disease prevention. Plants. 1: 3434.

6. Czigle S, Tóth J (2011) Interakcie konopy (Cannabis L.), jej živice a obsahových látok s liečivami a niektorými liečivými rastlinami. In: Liekové interakcie. Bratislava: Dr. Josef Raabe Slovensko. 1-24.

7. Franco L, Sánchez C, Bravo R, Rodríguez AB, Barriga C, et al. (2012) The sedative effect of non-alcoholic beer in healthy female nurses. PLOS ONE. 7: e37290.

8. Härtter S, Korhonen T, Lundgren S, Rane A, Tolonen A, (2006) Effect of caffeine intake 12 or 24 hours prior to melatonin intake and CYP1A2-1F polymorphism on CYP1A2 phenotyping by melatonin. Basic Clin Pharmacol Toxicol. 99: 300-304.

9. Hwang HS, Baldo MP, Rodriguez JP, Faggioni M, Knollmann BC (2019) Efficacy of flecainide in catecholaminergic polymorphic ventricular tachycardia is mutation-independent but reduced by calcium overload. Front Physiol. 10: 992.

10. James JS (2000) St. John's wort warning: do not combine with protease inhibitors, NNRTIs. AIDS Treatment News 3-5.