Pharmacokinetics

Unique challenges in blood monitoring for oncology nurses

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BACKGROUND: Pharmacokinetics (PK) is the study of the absorption, distribution, metabolism, and excretion of drugs. Many chemotherapeutic agents have a sensitive PK index, in which a small margin in blood concentrations is the difference between nontherapeutic, therapeutic, and adverse outcomes.

OBJECTIVES: This article will provide an overview of evidence-based approaches to the collection of PK samples, monitoring of PK levels, and the resulting management of patients undergoing PK testing.

METHODS: A case study involving busulfan, an alkylating agent used in the pre–stem cell transplantation setting, will highlight the cross-contamination of samples while a drug is being infused through a central venous catheter with PK sample collection from a proximal peripherally inserted central catheter. The influence of false elevations in drug concentrations on PK-guided dose adjustments will also be emphasized.

FINDINGS: Imprecise blood collections or cross-contamination of samples may lead to inaccurate drug concentration results and, subsequently, undesired low or high drug dosage calculations.

KEYWORDS
stem cell transplantation; busulfan; pharmacokinetics; blood sampling

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NURSES ARE AT THE FOREFRONT IN PROVIDING EVIDENCE-BASED CARE to patients with cancer in a variety of clinical settings. Nurses also play a crucial role in educating patients and their family members (and caregivers) regarding various pharmacologic interventions and monitoring the side effects of those drugs. Current academic nursing curriculum concentrates on medication competencies, which include accurate administration using the six rights (person, drug, dose, route, time, and documentation) along with basic pharmacokinetic (PK) principles (Sulosaari, Suhonen, & Leino-Kilpi, 2011). However, such curriculum may lack specific information about PK collection and monitoring that is fundamental to the safe administration and monitoring of numerous medications in the oncology setting. Because of a revolution in cancer treatment modalities, it is essential to empower nurses with enhanced medication administration competencies, including knowledge regarding the fundamentals of PK as well as the associated nursing aspects in regard to accurate serial blood sampling during real-time PK monitoring in the clinic.

PK is the study of the absorption, distribution, metabolism, and excretion of drugs (Hughes, 2014a, 2014b). Drug absorption is the process by which a drug moves into the bloodstream after administration. Absorption affects how quickly and how much of the drug reaches its intended site of action (e.g., drug receptor on tissue). After a drug is absorbed into the bloodstream, it rapidly circulates throughout the body and eventually distributes into peripheral tissues, a process termed drug distribution. Drug metabolism is the course of action by which the liver (or other tissues) breaks down the drug into chemically distinct metabolites for eventual elimination from the body. Finally, drug excretion is the rate and extent by which the drug is removed from the body, such as by the kidneys into urine.

Many chemotherapeutic drugs have what is called a narrow therapeutic range. This narrow range signifies the desired blood concentrations that are effective without risk of adverse drug toxicities. For example, busulfan has a narrow therapeutic range and busulfan concentrations above that range can result in serious toxicities (e.g., seizures, veno-occlusive disease, acute graft-versus-host disease), whereas busulfan concentrations below this threshold are associated with disease relapse and failed engraftment (Myers et al., 2017). Examples of drugs prescribed in oncology care that have a narrow therapeutic range and may require PK monitoring include methotrexate, cyclosporine, tacrolimus, voriconazole, mycophenolate, mitotane, vancomycin, and aminoglycoside antibiotics.

To ensure safe and effective therapy, patients who are administered a drug with a narrow therapeutic window are often tracked by a process