

# APPLICATION OF MEDICINAL SUBSTANCES

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## Abstract

The application of medicinal substances is a fundamental component of nursing and clinical practice that ensures effective prevention, treatment, and management of diseases. It involves the correct selection, dosage calculation, administration routes, and monitoring of drug effects on the human body. Safe and effective medication use requires a deep understanding of pharmacological principles, patient assessment, and adherence to clinical protocols.

In modern healthcare systems, nurses play a key role in medication administration, including oral, intravenous, intramuscular, subcutaneous, inhalation, and topical routes. Each method requires specific technical skills, strict adherence to aseptic techniques, and careful observation of patient responses. Incorrect drug administration can lead to serious complications such as toxicity, allergic reactions, or therapeutic failure, highlighting the importance of precision and responsibility in nursing practice.

**Keywords:** Medicinal substances, pharmacology, drug administration, nursing practice, dosage calculation, intravenous therapy, oral medication, intramuscular injection, patient safety

## Introduction

The application of medicinal substances is a core component of modern healthcare, combining pharmacology, clinical nursing practice, and evidence-based medicine to achieve safe and effective treatment outcomes. According to the World Health Organization (WHO) and international clinical pharmacology guidelines, rational use of medicines ensures maximum therapeutic benefit while minimizing adverse drug reactions, toxicity, and medication errors. WHO emphasizes that medication safety is a global health priority, especially in clinical settings where nurses are directly responsible for drug administration and patient monitoring (WHO, Medication Without Harm, Global Patient Safety Challenge, 2017-present updates 2023-2024).

## Main Part

In clinical practice, medicinal substances are applied through various routes, including oral, intravenous, intramuscular, subcutaneous, inhalation, and topical administration. Each route has specific pharmacokinetic properties that determine absorption rate, bioavailability, onset of action, and therapeutic duration. For example, intravenous administration provides 100% bioavailability with immediate drug effect, while oral administration is influenced by gastrointestinal absorption and first-pass hepatic metabolism. These pharmacological principles are essential for nurses to ensure correct drug delivery and therapeutic effectiveness.



A major principle in medication administration is the concept of rational drug use, defined by WHO as the appropriate selection, correct dosage, proper duration, and cost-effective use of medicines. According to WHO reports updated in 2023, more than 50% of medicines worldwide are still used inappropriately, leading to increased resistance, adverse effects, and unnecessary healthcare costs. This highlights the importance of strict adherence to clinical guidelines and nursing protocols in every healthcare setting.

Nursing responsibility in the application of medicinal substances is defined through standardized safety frameworks such as the “Five Rights of Medication Administration”: right patient, right drug, right dose, right route, and right time. Additional safety components include right documentation, right indication, and right response monitoring. These principles are globally recognized in nursing practice standards and are reinforced by the American Nurses Association (ANA, updated guidelines 2022-2024).

Application of medicinal substances in clinical practice can be analyzed as a laboratory-based quantitative system where drug dosing, distribution, metabolism, and elimination are governed by mathematical relationships and physiological parameters. Safe and effective pharmacotherapy depends on maintaining drug concentration within a therapeutic window while continuously monitoring laboratory indices such as renal function, liver enzymes, electrolytes, and hematological values.

A fundamental principle in drug administration is dose calculation, which ensures that the administered amount matches the patient’s physiological needs. The standard dosing equation is expressed as  $D = (C \times W) / S$ , where  $D$  represents the required dose,  $C$  is the desired concentration per kilogram,  $W$  is body weight, and  $S$  is drug strength. For example, in a patient weighing 70 kg requiring 5 mg/kg of a drug with a concentration of 50 mg/mL, the required dose becomes  $D = (5 \times 70) / 50 = 7$  mL. This type of calculation is essential in preventing underdose or overdose conditions in clinical nursing practice.

In pediatric pharmacology, dosing must be adjusted using proportional models such as Clark’s rule, where  $\text{Dose} = (\text{Weight} / 70) \times \text{Adult dose}$ . If a child weighs 20 kg and the adult dose is 500 mg, then the pediatric dose equals  $(20 / 70) \times 500 = 142.8$  mg. This mathematical adjustment ensures safety by scaling drug exposure according to body mass and metabolic capacity.

A more precise method is based on body surface area (BSA), which correlates better with metabolic rate. BSA is calculated using  $\text{BSA} = \sqrt{(\text{Height} \times \text{Weight} / 3600)}$ . For a patient with height 170 cm and weight 70 kg,  $\text{BSA} = \sqrt{(170 \times 70 / 3600)} = \sqrt{3.30} = 1.81$  m<sup>2</sup>. Drug dose adjustment is then calculated as  $(\text{BSA} / 1.73) \times \text{Adult dose}$ . If the adult dose is 500 mg, the adjusted dose becomes  $(1.81 / 1.73) \times 500 = 523$  mg, demonstrating a physiologically accurate dosing approach.

Pharmacokinetic behavior of drugs is described using exponential decay models. Drug concentration over time follows  $C(t) = C_0 e^{-kt}$ , where  $C_0$  is initial concentration,  $k$  is elimination constant, and  $t$  is time. For example, if  $C_0 = 100$  mg/L and  $k = 0.2$  per hour, after 5 hours the concentration becomes  $C(5) = 100 e^{-1} = 36.7$  mg/L. This model is essential in determining dosing intervals and preventing drug accumulation.

Drug half-life is another critical laboratory parameter defined as  $t_{1/2} = 0.693 / k$ . If  $k = 0.2$ , then  $t_{1/2} = 3.46$  hours, which indicates the time required for plasma concentration to reduce by 50 percent. This value directly influences how frequently a drug should be administered in clinical settings.



Distribution of medicinal substances in the body is described using volume of distribution,  $V_d = \text{Total drug in body} / \text{Plasma concentration}$ . If 500 mg of a drug is distributed with a plasma concentration of 10 mg/L, then  $V_d = 50$  L. A high  $V_d$  indicates extensive tissue binding, while a low  $V_d$  indicates confinement within plasma compartments.

Intravenous infusion therapy requires precise calculation of flow rates. The infusion rate is calculated as  $\text{Flow rate (mL/hr)} = \text{Total volume} / \text{Time}$ . For example, 500 mL infused over 4 hours results in 125 mL/hr. Additionally, drip rate is calculated as  $\text{Drops/min} = (\text{Volume} \times \text{Drop factor}) / \text{Time}$ . If 500 mL is administered using a 20 drops/mL set over 240 minutes, the drip rate is approximately 42 drops per minute.

Therapeutic drug monitoring ensures that drug concentration remains within the safe range. The therapeutic index is defined as  $TI = TD_{50} / ED_{50}$ . If  $TD_{50} = 100$  mg and  $ED_{50} = 10$  mg, then  $TI = 10$ , indicating a relatively safe drug profile. Drugs with low therapeutic index require strict laboratory monitoring to avoid toxicity.

Renal clearance is another important laboratory measure defined as  $Cl = (\text{Urine concentration} \times \text{Urine flow rate}) / \text{Plasma concentration}$ . If urine concentration is 50 mg/L, urine flow is 1 mL/min, and plasma concentration is 10 mg/L, clearance equals 5 mL/min. This value reflects the kidney's ability to eliminate drugs from the bloodstream.

Electrolyte balance is also crucial in drug therapy. Potassium correction can be calculated using  $K \text{ deficit} = (4.5 - \text{measured K}) \times \text{body weight} \times 0.4$ . For a patient with potassium level 3.0 mmol/L and weight 70 kg, the deficit is 42 mmol. Such calculations are important when administering potassium-containing medications to prevent arrhythmias.

Glucose control with insulin therapy is another key example. Insulin dose is calculated as  $(\text{Blood glucose} - \text{Target glucose}) / \text{Correction factor}$ . If blood glucose is 15 mmol/L, target is 6 mmol/L, and correction factor is 2, then required insulin dose is 4.5 units. This ensures controlled glycemic reduction without inducing hypoglycemia.

Overall, application of medicinal substances represents a mathematically defined biological system where drug dose, concentration, half-life, clearance, and physiological response are interconnected. Maintaining the therapeutic condition  $C_{min} \leq C(t) \leq C_{max}$  is essential for achieving effective treatment while avoiding toxicity or therapeutic failure. Continuous laboratory monitoring and precise calculations are therefore fundamental components of modern pharmacological nursing practice.

### Conclusion

The application of medicinal substances is a highly structured and quantitatively regulated process in modern clinical practice, where therapeutic success depends on the precise integration of pharmacological principles, mathematical dosing models, and continuous laboratory monitoring. Analysis of clinical formulas such as dose calculation ( $D = C \times W / S$ ), pharmacokinetic models ( $C(t) = C_0 e^{-kt}$ ), half-life determination ( $t_{1/2} = 0.693/k$ ), volume of distribution ( $V_d = \text{Dose}/C_p$ ), and clearance equations demonstrates that drug therapy is fundamentally a measurable biological system rather than a purely empirical procedure.

Laboratory indicators including hemoglobin, renal clearance, liver enzyme activity, electrolyte balance, and plasma drug concentration play a decisive role in determining both the safety and



effectiveness of medicinal substances. Maintaining drug concentration within the therapeutic window ( $MEC \leq C(t) \leq MSC$ ) is essential to ensure optimal therapeutic response while preventing toxicity or treatment failure.

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