

Pharmacokinetics

Pharmacokinetics: Definition and Introduction

Definition

- Pharmacokinetics (PK) is the branch of pharmacology that deals with the quantitative study of how a drug moves into, through, and out of the body over time.
- It answers the question: "What does the body do to the drug?"
- Pharmacokinetics focuses on four primary processes, collectively referred to as **ADME**:
 - **Absorption**
 - **Distribution**
 - **Metabolism**
 - **Excretion**

Importance of Pharmacokinetics

- Helps determine proper dosage regimens, frequency of administration, and the optimal route of drug delivery.
- Aids in predicting drug-drug interactions, avoiding toxicity, and optimizing therapeutic efficacy.

Key Aspects of Pharmacokinetics (ADME)

1. Absorption

- The process of a drug entering the bloodstream from its site of administration.

2. Distribution

- The dispersion of the drug throughout the fluids and tissues of the body.

3. Metabolism (Biotransformation)

- The biochemical modification of the drug, mainly occurring in the liver.

4. Excretion

- The removal of the drug and its metabolites, primarily via the kidneys (urine) or bile (feces).

Plasma Drug Concentration-Time Profile / Drug Levels in Blood

- Plasma drug concentration-time profiles (often referred to as **drug levels in blood**) represent how the concentration of a drug in the bloodstream changes over time.
- This data is essential for evaluating the **ADME** phases (Absorption, Distribution, Metabolism, and Elimination) and guiding clinical decisions regarding **dosage** and **therapeutic drug monitoring (TDM)**.

Phases of Drug in Blood

1. Absorption Phase

- Occurs after administration (especially non-IV routes).
- Drug levels increase as the drug enters systemic circulation.

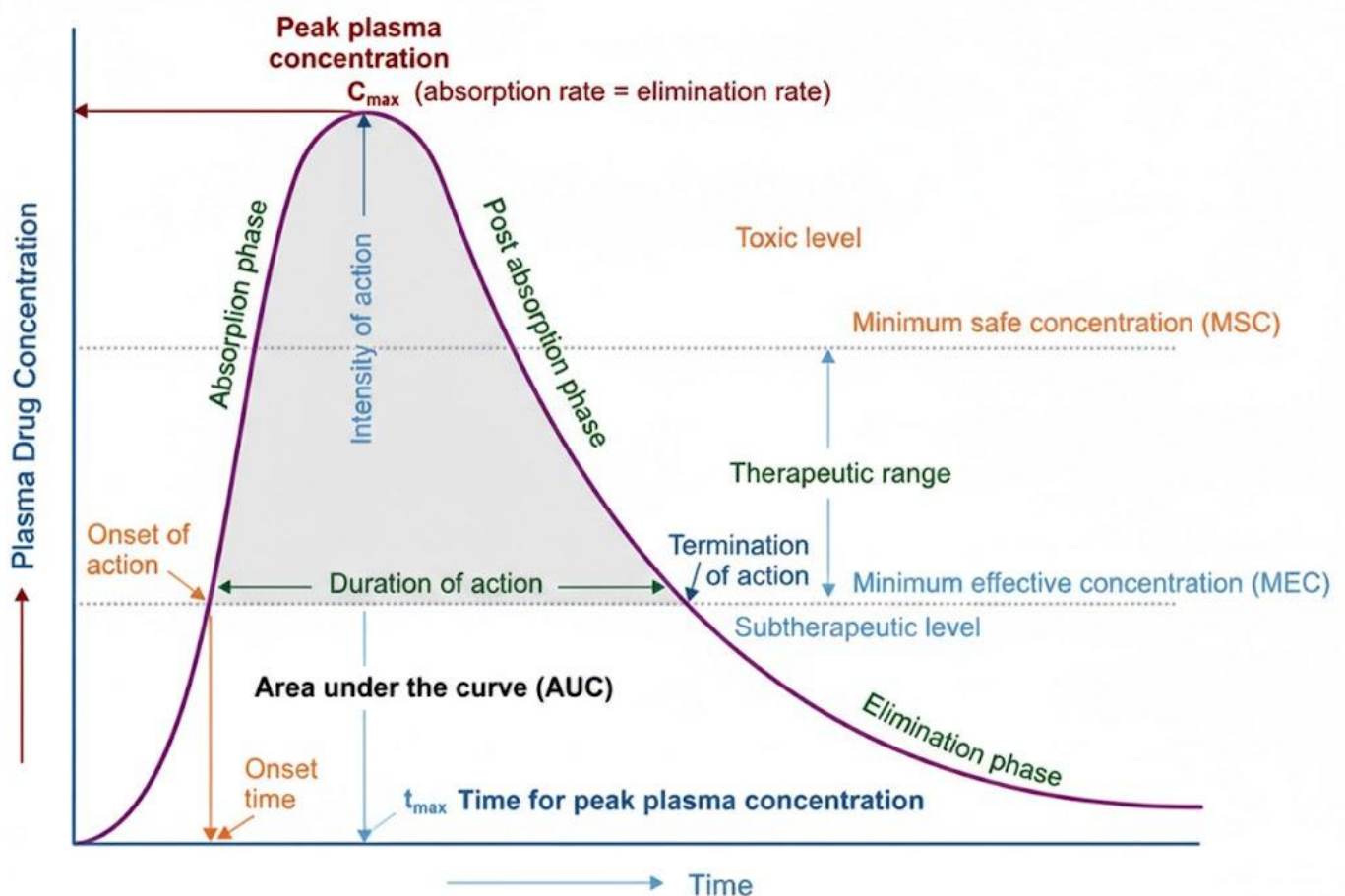
2. Distribution Phase

- Drug begins to move from the blood into various tissues.
- Plasma levels may drop even though the total body drug amount is still high.

3. Elimination Phase

- Metabolism and excretion lower the drug concentration over time.

Key Pharmacokinetic Parameters



- C_{max} :** Peak plasma concentration achieved after administration.

- **T_{max}**: Time taken to reach C_{max}.
- **AUC (Area Under the Curve)**: Total drug exposure over time.
- **Half-life (t_{1/2})**: Time required for plasma concentration to reduce by 50%.
- **Clearance (Cl)**: Volume of plasma cleared of the drug per unit time.
- **Volume of Distribution (V_d)**: Theoretical volume linking the plasma concentration to the total amount of drug in the body.
- Represents total drug exposure over time.
- Helps in determining **half-life (t_{1/2})**, **clearance (Cl)**, and **volume of distribution (V_d)**.

Importance in Clinical Settings

- **Therapeutic Drug Monitoring (TDM)**: Especially for drugs with narrow therapeutic windows (e.g., digoxin, lithium).
- **Dose Adjustment**: Based on individual metabolism, age, disease state, or drug interactions.
- **Bioavailability Assessment**: Compares drug levels between different formulations.

Drug Monitoring Techniques

- **Blood Sampling**: At specific time intervals.
- **Chromatographic Methods**: HPLC, LC-MS used for measuring drug levels.
- **Non-invasive Alternatives**: Under development (e.g., saliva, sweat analysis).

Reaction Kinetics: Rate, Rate Constants, and Order

Basic Concepts

A. Rate of Reaction:

- Measures how fast reactants are converted into products. Influenced by **temperature**, **concentration**, **catalysts**, and **surface area**.

B. Rate Constant (k):

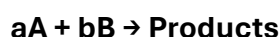
- A constant specific to a given reaction at a certain temperature.

C. Order of Reaction:

- Indicates how the reaction rate depends on the concentration of reactants.

General Rate Equation:

- For a reaction:



$$\text{Rate} = k[A]^m[B]^n$$



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