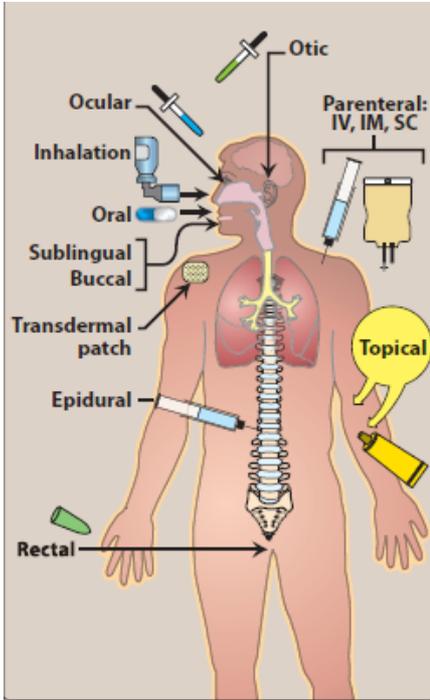


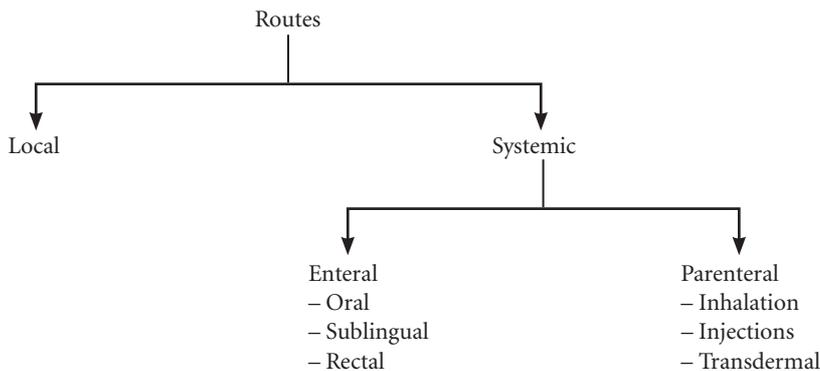
ROUTES OF DRUG ADMINISTRATION



Route for administration	Time until effect
intravenous	30-60 seconds
intraosseous	30-60 seconds
endotracheal	2-3 minutes
inhalation	2-3 minutes
sublingual	3-5 minutes
intramuscular	10-20 minutes
subcutaneous	15-30 minutes
rectal	5-30 minutes
ingestion	30-90 minutes
transdermal (topical)	variable (minutes to hours)

Most of the drugs can be administered by different routes. Drug- and patient-related factors determine the selection of routes for drug administration. The factors are:

1. Characteristics of the drug.
2. Emergency/routine use.
3. Site of action of the drug—local or systemic.
4. Condition of the patient (unconscious, vomiting, diarrhoea).
5. Age of the patient.
6. Effect of gastric pH, digestive enzymes and first-pass metabolism.
7. Patient's/doctor's choice (sometimes).



Local Routes

It is the simplest mode of administration of a drug at the site where the desired action is required. Systemic side effects are minimal.

1. **Topical:** Drug is applied to the skin or mucous membrane at various sites for local action.
 - a. **Oral cavity:** As a suspension, e.g. nystatin; as a troche, e.g. clotrimazole (for oral candidiasis); as a cream, e.g. acyclovir (for herpes labialis); as ointment and jelly, e.g. 5% lignocaine hydrochloride (for topical anaesthesia); as a spray, e.g. 10% lignocaine hydrochloride (for topical anaesthesia).
 - b. **GI tract:** As tablet that is not absorbed, e.g. neomycin (for sterilization of gut before surgery).
 - c. **Rectum and anal canal:**
 - i. *As an enema* (administration of drug into the rectum in liquid form):
 - Evacuant enema (for evacuation of bowel): For example, soap water enema—soap acts as a lubricant and water stimulates the rectum.
 - Retention enema: For example, methylprednisolone in ulcerative colitis.
 - ii. *As a suppository* (administration of the drug in a solid form into the rectum), e.g. bisacodyl— for evacuation of bowels.
 - d. **Eye, ear and nose:** As drops, ointments and sprays (for infection, allergic conditions, etc.), e.g. gentamicin eye/ear drops.
 - e. **Bronchi:** As inhalation, e.g. salbutamol, ipratropium bromide, etc. (for bronchial asthma and chronic obstructive pulmonary disease).
 - f. **Skin:** As ointment, cream, lotion or powder, e.g. clotrimazole (antifungal) for cutaneous candidiasis.
2. **Intra-arterial route:** This route is rarely employed. It is mainly used during diagnostic studies such as coronary angiography and for the administration of some anticancer drugs, e.g. for treatment of malignancy involving limbs.
3. **Administration of the drug into some deep tissues** by injection, e.g. administration of triamcinolone directly into the joint space in rheumatoid arthritis.

■ Systemic Routes

Drugs administered by this route enter blood and produce systemic effects.

■ Enteral Routes

It includes oral, sublingual and rectal routes.

▶ Oral Route

It is the most common and acceptable route for drug administration. Dosage forms are tablet, capsule, syrup, mixture, etc., e.g., paracetamol tablet for fever, omeprazole capsule for peptic ulcer are given orally.

Advantages

- Safer.
- Cheaper.
- Painless.
- Convenient for repeated and prolonged use.
- Can be self-administered.

Disadvantages

- Not suitable for emergency as onset of action of orally administered drugs is slow.

- It is not suitable for/in:
 - Unpalatable and highly irritant drugs.
 - Unabsorbable drugs (e.g. aminoglycosides).
 - Drugs that are destroyed by digestive juices (e.g. insulin).
 - Drugs with extensive first-pass metabolism (e.g. lignocaine).
 - Unconscious patients.
 - Uncooperative and unreliable patients.
 - Patients with severe vomiting and diarrhoea.

Sublingual Route

The preparation is kept under the tongue. The drug is absorbed through the buccal mucous membrane and enters the systemic circulation directly, e.g. nitroglycerin for acute anginal attack and buprenorphine for myocardial infarction.

Advantages

- Quick onset of action.
- Action can be terminated by spitting out the tablet.
- Bypasses first-pass metabolism.
- Self-administration is possible.

Disadvantages

- It is not suitable for:
 - Irritant and lipid-insoluble drugs.
 - Drugs with bad smell and taste.

Rectal Route

Drugs can be given in the form of solid or liquid.

1. **Suppository:** It can be used for local (topical) effect (see p.2.) as well as systemic effect, e.g. indomethacin for rheumatoid arthritis.
2. **Enema:** *Retention enema* can be used for local effect (see p.2.) as well as systemic effect. The drug is absorbed through rectal mucous membrane and produces systemic effect, e.g. diazepam for status epilepticus in children.

Parenteral Routes

Routes of administration other than enteral route are called parenteral routes.

Advantages

- Onset of action of drugs is faster; hence it is suitable for emergency.
- Useful in:
 - Unconscious patient.
 - Uncooperative and unreliable patients.
 - Patients with vomiting and diarrhoea.
- It is suitable for:
 - Irritant drugs.
 - Drugs with high first-pass metabolism.

- Drugs not absorbed orally.
- Drugs destroyed by digestive juices.

Disadvantages

- Require aseptic conditions.
- Preparations should be sterile and is expensive.
- Requires invasive techniques that are painful.
- Cannot be usually self-administered.
- Can cause local tissue injury to nerves, vessels, etc.

► Inhalation

Volatile liquids and gases are given by inhalation for systemic effects, e.g. general anaesthetics.

Advantages

- Quick onset of action.
- Dose required is very less, so systemic toxicity is minimized.
- Amount of drug administered can be regulated.

Disadvantages

- Local irritation may cause increased respiratory secretions and bronchospasm.

► Injections (Fig. 1.1)

Intradermal route: The drug is injected into the layers of the skin, e.g. Bacillus Calmette–Guérin (BCG) vaccination and drug sensitivity tests. It is painful and only a small amount of the drug can be administered.

Subcutaneous (s.c.) route: The drug is injected into the subcutaneous tissues of the thigh, abdomen and arm, e.g. adrenaline, insulin, etc.

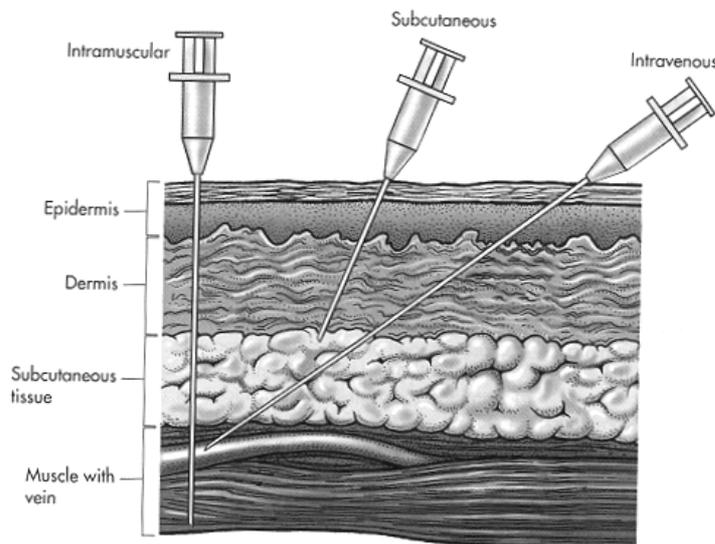


Fig. 1.1 Injectable routes of drug administration.

Advantages

- Self-administration is possible (e.g. insulin).
- Depot preparations can be inserted into the subcutaneous tissue, e.g. norplant for contraception.

Disadvantages

- It is suitable only for nonirritant drugs.
- Drug absorption is slow; hence it is not suitable for emergency.

Intramuscular (i.m.) route: Drugs are injected into large muscles such as deltoid, gluteus maximus and vastus lateralis, e.g. paracetamol, diclofenac, etc. A volume of 5–10 mL can be given at a time.

Advantages

- Absorption is more rapid as compared to oral route.
- Mild irritants, depot injections, soluble substances and suspensions can be given by this route.

Disadvantages

- Aseptic conditions are needed.
- Intramuscular injections are painful and may cause abscess.
- Self-administration is not possible.
- There may be injury to the nerves.

Intravenous (i.v.) route: Drugs are injected directly into the blood stream through a vein. Drugs are administered as:

1. **Bolus:** Single, relatively large dose of a drug injected rapidly or slowly as a single unit into a vein. For example, i.v. ranitidine in bleeding peptic ulcer.
2. **Slow intravenous injection:** For example, i.v. morphine in myocardial infarction.
3. **Intravenous infusion:** For example, dopamine infusion in cardiogenic shock; mannitol infusion in cerebral oedema; fluids infused intravenously in dehydration.

Advantages

- Bioavailability is 100%.
- Quick onset of action; therefore, it is the route of choice in emergency, e.g. intravenous diazepam to control convulsions in status epilepticus.
- Large volume of fluid can be administered, e.g. intravenous fluids in patients with severe dehydration.
- Highly irritant drugs, e.g. anticancer drugs can be given because they get diluted in blood.
- Hypertonic solution can be infused by intravenous route, e.g. 20% mannitol in cerebral oedema.
- By i.v. infusion, a constant plasma level of the drug can be maintained, e.g. dopamine infusion in cardiogenic shock.

Disadvantages

- Once the drug is injected, its action cannot be halted.
- Local irritation may cause phlebitis.
- Self-medication is not possible.
- Strict aseptic conditions are needed.
- Extravasation of some drugs can cause injury, necrosis and sloughing of tissues.
- Depot preparations cannot be given by i.v. route.

Precautions

- Drug should usually be injected slowly.
- Before injecting, make sure that the tip of the needle is in the vein.

Intrathecal route: Drug is injected into the subarachnoid space (spinal anaesthetics, e.g. lignocaine; antibiotics, e.g. amphotericin B, etc.).

Intra-articular route: Drug is injected directly into the joint space, e.g. hydrocortisone injection for rheumatoid arthritis. Strict aseptic precautions should be taken. Repeated administration may cause damage to the articular cartilage.

Transdermal route: The drug is administered in the form of a patch or ointment that delivers the drug into the circulation for systemic effect (Fig. 1.2).

For example, scopolamine patch for sialorrhoea and motion sickness, nitroglycerin patch/ointment for angina, oestrogen patch for hormone replacement therapy (HRT).

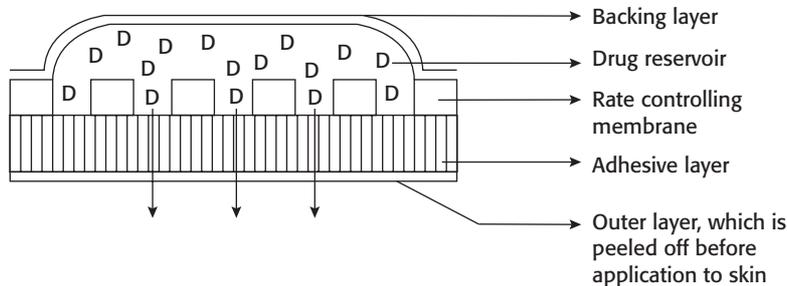


Fig. 1.2 Transdermal drug-delivery system.

Advantages

- Self-administration is possible.
- Patient compliance is better.
- Duration of action is prolonged.
- Systemic side effects are reduced.
- Provides a constant plasma concentration of the drug.

Disadvantages

- Expensive.
- Local irritation may cause dermatitis and itching.
- Patch may fall-off unnoticed.

Key Points for Dentists

- Read the label of the drug carefully before administering a drug to the patient.
- Strict aseptic precautions should be taken while giving injections.
- Care should be taken to avoid needle-stick injuries, which may transmit infections, e.g. human immunodeficiency virus (HIV), hepatitis B, hepatitis C, etc.

II. Routes of Drug Administration

ROUTE OF ADMINISTRATION	ABSORPTION PATTERN	ADVANTAGES	DISADVANTAGES
Oral	<ul style="list-style-type: none"> Variable; affected by many factors 	<ul style="list-style-type: none"> Safest and most common, convenient, and economical route of administration 	<ul style="list-style-type: none"> Limited absorption of some drugs Food may affect absorption Patient compliance is necessary Drugs may be metabolized before systemic absorption
Intravenous	<ul style="list-style-type: none"> Absorption not required 	<ul style="list-style-type: none"> Can have immediate effects Ideal if dosed in large volumes Suitable for irritating substances and complex mixtures Valuable in emergency situations Dosage titration permissible Ideal for high molecular weight proteins and peptide drugs 	<ul style="list-style-type: none"> Unsuitable for oily substances Bolus injection may result in adverse effects Most substances must be slowly injected Strict aseptic techniques needed
Subcutaneous	<ul style="list-style-type: none"> Depends on drug diluents: Aqueous solution: prompt Depot preparations: slow and sustained 	<ul style="list-style-type: none"> Suitable for slow-release drugs Ideal for some poorly soluble suspensions 	<ul style="list-style-type: none"> Pain or necrosis if drug is irritating Unsuitable for drugs administered in large volumes
Intramuscular	<ul style="list-style-type: none"> Depends on drug diluents: Aqueous solution: prompt Depot preparations: slow and sustained 	<ul style="list-style-type: none"> Suitable if drug volume is moderate Suitable for oily vehicles and certain irritating substances Preferable to intravenous if patient must self-administer 	<ul style="list-style-type: none"> Affects certain lab tests (creatinine kinase) Can be painful Can cause intramuscular hemorrhage (precluded during anticoagulation therapy)
Transdermal (patch)	<ul style="list-style-type: none"> Slow and sustained 	<ul style="list-style-type: none"> Bypasses the first-pass effect Convenient and painless Ideal for drugs that are lipophilic and have poor oral bioavailability Ideal for drugs that are quickly eliminated from the body 	<ul style="list-style-type: none"> Some patients are allergic to patches, which can cause irritation Drug must be highly lipophilic May cause delayed delivery of drug to pharmacological site of action Limited to drugs that can be taken in small daily doses
Rectal	<ul style="list-style-type: none"> Erratic and variable 	<ul style="list-style-type: none"> Partially bypasses first-pass effect Bypasses destruction by stomach acid Ideal if drug causes vomiting Ideal in patients who are vomiting, or comatose 	<ul style="list-style-type: none"> Drugs may irritate the rectal mucosa Not a well-accepted route
Inhalation	<ul style="list-style-type: none"> Systemic absorption may occur; this is not always desirable 	<ul style="list-style-type: none"> Absorption is rapid; can have immediate effects Ideal for gases Effective for patients with respiratory problems Dose can be titrated Localized effect to target lungs: lower doses used compared to that with oral or parenteral administration Fewer systemic side effects 	<ul style="list-style-type: none"> Most addictive route (drug can enter the brain quickly) Patient may have difficulty regulating dose Some patients may have difficulty using inhalers
Sublingual	<ul style="list-style-type: none"> Depends on the drug: Few drugs (for example, <i>nitroglycerin</i>) have rapid, direct systemic absorption Most drugs erratically or incompletely absorbed 	<ul style="list-style-type: none"> Bypasses first-pass effect Bypasses destruction by stomach acid Drug stability maintained because the pH of saliva relatively neutral May cause immediate pharmacological effects 	<ul style="list-style-type: none"> Limited to certain types of drugs Limited to drugs that can be taken in small doses May lose part of the drug dose if swallowed

Figure 1.5

The absorption pattern, advantages, and disadvantages of the most common routes of administration.