

Chapter 12, Principles of Pharmacology

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1. Introduction to Pharmacology and Medication Safety

- **Medications** are a critical tool for EMTs. [3]
- Appropriate use can **alleviate pain** and **improve a patient's condition**. [3]
- However, unsafe administration can lead to **serious consequences**, including death. [3]
- Understanding **general pharmacology** is significant. [2]
- EMTs must identify, describe, and demonstrate the steps for assisting with or administering medications. [2]

2. Key Medical Definitions in Pharmacology

Term	Definition	Source
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Pharmacology	The science of drugs, including their ingredients, preparation, uses, and actions on the body.	[4]
Medication	A substance used to treat or prevent disease or relieve pain.	[4]
Pharmacodynamics	The process by which the medication works on the body.	[5]
Pharmacokinetics	The actions of the body upon the medication.	[9]
Agonist	A medication that causes stimulation of receptors.	[6]
Antagonist	A medication that binds to the receptor or blocks other medications or chemicals from attaching.	[6]
Dose	The amount of medication given, depending on patient's weight, age, or desired action.	[7]
Action	The therapeutic effect a medication is expected to have on the body.	[8]
Onset	The time from medication administration until clinical effects occur.	[10]
Duration	The length of time that the clinical effects persist.	[10]
Elimination	How medications and chemicals are removed from the body.	[10]
Peak	The point or period when the maximum clinical effect is achieved.	[10]

3. Factors Affecting Medication Action and Contraindications

- How a medication works depends on its **route of administration** and **shock states**. [11]
- **indications** are the reasons or conditions for giving a medication. [12]
- **Contraindications** are situations where a medication would harm or have no positive effect. [12]
- There are two types of contraindications. [12]
 - **Absolute contraindications** mean the medication should never be given if the contraindication is present. [13]
 - An example is a complete allergy causing anaphylaxis. [14]
 - **Relative contraindications** are situations where the benefits may outweigh the risks. [14]
 - An example might be a medication causing nausea. [15]

4. Adverse Effects and Medication Names

- **adverse effects** are any actions of a medication other than the desired ones. [16]
- There are different types of adverse effects. [17]
 - **Unintended effects** are undesirable but pose little risk to the patient. [17]
 - **Untoward effects** are those that can be harmful to the patient. [17]
- Medications have different names. [18]
 - The **generic name** is a simple, non-proprietary name, not capitalized. [19]
 - An example is **ibuprofen**. [20]
 - The **trade name** is a brand name given by the manufacturer and begins with a capital letter. [21]
 - One drug may have multiple trade names, such as **Tylenol**. [21]

5. Types of Drugs and Routes of Administration

- **Prescription drugs** require a physician's order and are distributed by pharmacists. [22]
- **Over-the-counter (OTC) drugs** can be purchased without a prescription. [22]
- Other drug types include **recreational drugs** (heroin, cocaine), **herbal remedies**, **enhanced drugs**, **vitamin supplements**, and **alternative medicines**. [23]

- Any medicine a patient takes can be **pharmacologically active** and cause an effect. [23]
- EMTs should ask patients about all medications and drugs they are taking. [23]
- Routes of administration can be categorized as internal or parenteral. [24]
- **Internal medications** enter through the digestive system, often as pills or liquids. [25]
 - They tend to absorb slowly and are not commonly used in emergency settings. [26]
- **Parenteral medications** enter the body by other means, often liquids administered through needles or syringes. [26]
 - They are absorbed more quickly and offer a more predictable response. [26]
- **absorption** is the process of medications traveling through body tissues into the bloodstream. [27]

Route of Administration	Description	Absorption Rate	Source
PR (Per Rectum)	By rectum; easy to administer, reliable absorption.	Not specified	[28]
PO (Oral)	By mouth; takes as long as one hour for absorption.	Slow	[28]
IV (Intravenous)	Into the vein; fastest delivery.	Fastest	[28]
IO (Intraosseous)	Into the bone marrow via drilling; reaches bloodstream.	Not specified	[29]
SC (Subcutaneous)	Injection into fatty tissue between skin and muscle.	Not specified	[30]

IM (Intramuscular)	Into the muscle; usually absorbed quickly.	Quick	[32]
Inhalation	Breathed into the lungs; absorbed into bloodstream quickly.	Quick	[33]
Sublingual	Under the tongue; absorbed into bloodstream within minutes.	Quick	[34]
Transcutaneous/Transdermal	Through the skin (e.g., patches); longer lasting effect.	Longer lasting	[35]
Intranasal (IN)	Aerosolized liquid delivered into the nostril via a MAD device.	Very quick absorption	[38]

6. Medication Forms and Administration Steps

- The **form of the medication** often dictates the route of administration. [\[41\]](#)
- Manufacturers choose forms for proper route, timing of release, and effects. [\[41\]](#)
- Common medication forms include:
 - **Tablets and capsules:** Most medications given by mouth. [\[42\]](#) Capsules are gelatin shells; tablets are compressed with other materials. [\[43\]](#)
 - **Solutions and suspensions:** Liquid mixtures. Solutions are liquid mixtures that cannot be easily separated and can be given by almost any route. [\[44\]](#) Suspensions are mixtures of particles that separate and must be shaken before administration. [\[47\]](#)
 - **Metered-dose inhalers:** Liquids or solids broken into fine droplets or particles for inhalation, delivering a set amount each time. [\[48\]](#)
 - **Topical medications:** Lotions, creams, and ointments applied to the skin surface to affect only that area. [\[49\]](#) Examples: hydrocortisone cream,

Neosporin, calamine lotion. [49]

- **transcutaneous medications:** Applied through the skin for a systemic effect. [50] EMTs can absorb these if they touch them. [50]
- **Gels:** Semi-liquids administered in capsules or plastic tubes. [51] Oral glucose for diabetic emergencies is an example. [51]
- **Gas:** One of the most common is oxygen, delivered via non-rebreather or nasal cannula. [52]
- General steps for administering medications:
 - Administer only under **medical direction** (online or offline). [53]
 - Follow the **nine rights** of medication administration. [53]

7. The Nine Rights of Medication Administration

Right	Description	Source
Right Patient	Ensure the correct patient receives the medication.	[54]
Right Medication	Verify the proper medication and prescription.	[54]
Right Indication	Verify the proper indication for the medication.	[54]
Right Dose	Verify the form and dose of the medication.	[55]
Right Route	Verify the route of the medication.	[55]
Right Time	Check the expiration date and condition of the medicine.	[56]
Right Education	Inform the patient about the medication, including likely adverse effects or unusual sensations.	[57]

Right to Refuse	A patient with decision-making capacity can decline interventions or medication.	[58]
Right Response/Evaluation	Monitor vital signs, mental status, perfusion, and respiratory effort; assess for anticipated response and adverse effects.	[58]
Right Documentation	Document your actions and the patient's response.	[60]

8. Types of Medication Administration by EMTs

- EMTs have increasing responsibility with medications. [62]
- Many departments have **strict guidelines** on when EMTs can administer medication. [62]
- There are three ways EMTs may be allowed to administer medication:
 - **Peer-assisted medication:** Administering medication to yourself or your partner, such as after exposure to a toxic agent. [63]
 - **Patient-assisted medication:** Assisting the patient with administering their own medication. [63] Examples include an **Epi autoinjector**, **nitro**, or a **metered dose inhaler**. [63]
 - **EMT administration of medication:** The EMT directly administers the medication to the patient, often when the patient is confused or unable to understand. [64] Examples include **oxygen**, **oral glucose**, and **aspirin**. [65]
- **Medical control**, **state guidelines**, and **local protocols** determine what EMTs can administer. [66]

9. Specific Oral Medications Administered by EMTs

- Administering oral medications involves specific steps. [68]
 - Take **standard precautions**. [69]
 - Confirm the medication has **not expired**. [69]
 - Obtain **medical direction** per local protocol. [69]
 - Confirm the patient has a **patent airway** and can **swallow or chew**. [70]
 - **Monitor** the patient's condition and **document**. [71]
- **Oral Glucose:**

- A sugar used by cells for energy, necessary for brain cells. [72]
- Counters effects of **hypoglycemia** (extremely low glucose). [72]
- EMTs can give glucose only **by mouth in gel form**. [73]
- Never administer to an **unconscious patient** or one **unable to swallow** or protect their airway. [73]
- **Aspirin:**
 - Reduces fever, pain, and inflammation. [75]
 - In the pre-hospital field, given to **inhibit platelet aggregation**, useful during a potential heart attack. [75]
 - **Contraindications:** hypersensitivity to aspirin, pre-existing liver damage, bleeding disorder, or asthma. [76]
 - Should **not be given to children**. [76]

10. Sublingual Medications: Nitroglycerin

- **sublingual administration** (under the tongue) has considerations. [77]
 - **Advantages:** Easy to talk with awake patients and advise them to place the pill; absorption rates are relatively quick. [78]
 - **Disadvantages:** Requires consent and constant airway evaluation; should not be used if the patient is uncooperative or unconscious. [80]
- **Nitroglycerin (Nitro)** is a common sublingual medication used by cardiac patients to relieve angina pain. [81]
 - Increases blood flow by relieving spasm and causing arteries to **dilate**. [82]
 - Relaxes veins throughout the body, decreasing blood return to the heart and reducing workload. [83]
 - Will **decrease blood pressure**. [83]
 - Must check **blood pressure** before administering. [84]
 - Obtain orders or follow local protocols. [84]
 - Can have **fatal interactions** with erectile dysfunction medication (Viagra, Cialis, Levitra) taken within the last 24 hours, as these are also vasodilators. [85]
 - Can be administered by **metered dose spray** or **tablet**. [88]
 - Tablet: Place under the tongue to dissolve; patient may feel a tingling or burning sensation. [89] Store in original glass container with tight cap. [90]

- Spray: Deposit medication under the tongue; one spray equals one tablet. [91]
- Administration considerations:
 - Wait **five minutes** before repeating the dose and waiting for a response. [92]
 - Closely monitor **vital signs**, especially blood pressure. [93]
 - Give repeated doses per medical control or local protocol. [93]
 - Always wear **gloves** as the medication can be absorbed by your skin. [94]
 - Reconfirm the medication is still indicated and understand local protocols. [94]

11. Intramuscular Medications: Epinephrine and Naloxone

- **intramuscular (im) administration** has considerations. [96]
 - **Advantages:** Quick and easy access to the circulatory system without a vein needle; blood flow to muscles is relatively stable. [97]
 - **Disadvantages:** Requires using a needle and involves some pain. [98]
- **Epinephrine (Epi)**, also known as adrenaline, is an IM medication. [98]
 - Released naturally by adrenal glands during stress. [99]
 - Controls the body's **fight-or-flight response**. [99]
 - **Dilates passages in the lungs, constricts blood vessels**, and increases heart rate and blood pressure. [100]
 - Should only be given for **life-threatening allergic reactions**. [101]
 - Often dispensed via an **auto-injector**, which delivers a pre-set amount (usually 0.3 mg). [101]
 - Some services allow EMTs to assist patients in administering their own Epi. [102]
- **Naloxone (Narcan)** is another IM medication used to reverse opiate overdose effects. [103]
 - Can be administered by family members or caregivers. [103]
 - Can also be administered via the **intranasal route**. [102]
 - Considerations:
 - Follow **local protocol**. [103]
 - Determine if naloxone was given by a bystander. [103]
 - Effects may not last as long as opiates, so **repeated doses may be needed**. [104]

- Giving naloxone to opiate-dependent patients can cause **severe withdrawal symptoms**, including seizures and cardiac arrest. [105]
- Consider your **personal safety**. [105]
- If naloxone is not available, **bag valve mask** ventilation may be required. [110]

12. Inhaled Medications: Oxygen, MDIs, and Nebulizers

- **Oxygen** is the most commonly administered medication pre-hospital. [111]
 - Needed by all cells, especially in the heart and brain. [112]
 - Generally given via **non-rebreather mask** (10–15 L/min) or **nasal cannula** (2–6 L/min). [112]
 - Artificial ventilations with a **BVM** (15 L/min) are needed if the patient is not breathing. [113]
 - Ensure **no open flame, cigarettes, or sparks** when administering oxygen. [113]
- **metered dose inhalers (MDIs) and nebulizers** are used to administer liquid medications as a fine mist. [114]
 - Medication is atomized and breathed into the lungs, delivered to the alveoli. [115]
 - **Advantages:** Fast and relatively easy route to access. [115]
 - **Disadvantages:** Patient needs to be cooperative and have controlled breathing; cannot be used for unconscious patients. [116]
 - MDIs require coordination, which can be difficult during breathing trouble. [118]
 - A **spacer** fits over the MDI, allowing the patient to spray the dose into a chamber and then inhale the mist, useful for young children. [119]
 - Small Volume nebulizers (SVNs) are easier to use than MDIs and can be more effective for moderate to severe respiratory distress. [121]
 - They take longer to deliver medication and require an external air or oxygen source. [122]
 - Can be used while the patient is on CPAP, during BVM ventilation, or adapted to a non-rebreather mask. [122]

13. Patient Medications and Implications for EMS Providers

- Finding out what medications a patient is taking is vital. [124]
- Medication history provides **clues to the patient's condition** and helps guide treatment. [124]

- It is useful for determining **chronic or underlying conditions** when a patient cannot provide history. [125]
- Ask about prescription and non-prescription drugs (OTC, herbal, illegal). [126]
- Transport the medications or a list with the patient to the emergency department. [125]
- Do not underestimate the importance of a **thorough medical history**. [127]
- Consider a patient's medications in the context of the clinical encounter. [128]
- Patient medications can significantly alter the **clinical presentation** of acute medical problems or injuries. [129]
 - Examples: **beta-adrenergic blocking agents** and **calcium channel blockers** can slow heart rates. [130]
 - **anti-platelet** and **anticoagulant medications** can cause significant bleeding from minor injuries like a head bump. [131]

14. Medication Errors and Quality Improvement

- A **medication error** is the inappropriate use of a medication that could lead to patient harm. [132]
- To prevent errors:
 - Ensure the environment does not contribute, with sufficient lighting and organized equipment. [133]
 - Limit distractions as much as possible. [133]
 - Consider using a **cheat sheet** for critical administration steps. [133]
- If a medication error occurs:
 - Rapidly provide any **appropriate care**. [134]
 - Notify **medical control** quickly. [135]
 - Follow local protocols. [136]
 - **Document the incident** thoroughly, accurately, and honestly. [136]
 - Talk with your partner, supervisor, or medical director. [137]
- Medication errors are an opportunity to learn and identify areas for **quality improvement**. [138]

15. Review Questions and Conclusion

- Q: pharmacology is defined as the?
 - A: The field of science that deals with the study of drugs and medications. [140]

[140]

- Q: Which of the following statements regarding medications is false? Over-the-counter drugs must be prescribed by a physician.
 - A: False. OTC drugs do not need a prescription. [141]
- Q: Which of the following routes of medication administration is the fastest?
 - A: IV (intravenous), directly into the vein and bloodstream. [144]
- Q: When administered to a patient, a metered dose inhaler will...?
 - A: Deliver the same dose each time it's administered. [146]
- Q: You are managing a patient with crushing chest pain, BP 84/64, HR 110. Medical control advises you to assist with nitro. After receiving this order, what should you do?
 - A: Repeat the patient's blood pressure to the physician and confirm the order. [147]
- Q: Activated charcoal is indicated for patients who have ingested certain drugs and toxins because...?
 - A: It will bind to chemicals in the stomach and delay absorption. [152] It is an oral medication used for overdoses. [153]
- Q: With regard to pharmacology, the term action refers to what?
 - A: The effect that the drug is expected to have on the patient's body. [154]
- Q: Which of the following patients is best candidate for oral glucose?
 - A: A conscious patient who is showing signs of hypoglycemia. [155] Never administer to an unconscious or semi-conscious patient. [156]
- Q: Epi is given to patients with anaphylactic shock because of its effects on...?
 - A: Bronchodilation and vasoconstriction. It opens bronchioles and constricts vessels to increase blood pressure. [160] Anaphylactic shock involves bronchoconstriction and vasodilation. [162]
- Q: The process by which medications travel to the body until they reach the bloodstream is called...?
 - A: absorption. Adsorption is the binding of one chemical to another. [163]

Understanding these principles is crucial for safe medication administration.