MEDICATION ADMINISTRATION · CHAPTER 21

Part 2

Parenteral Administration

Intravenous Access · Blood Sampling

Part 2

Parenteral Administration and Intravenous Access

1. Syringes, needles & packaging
2. Intradermal, subcutaneous, intramuscular
3. IV fluids & administration sets
4. Cannulas & peripheral venipuncture
5. Complications & troubleshooting
6. IV bolus, infusion & saline lock
7. Venous blood sampling

The Parenteral Family

Outside the GI tract — the fastest routes you have, and the least forgiving

The definition

Parenteral denotes the administration of medication outside of the GI tract, and typically involves the use of needles as medications are injected into the circulatory system or tissues.

That second clause is the whole session: needles, and therefore sharps risk, infection risk and irreversibility.

Local or systemic

Parenterally administered medications can be absorbed locally or systemically. Intradermal is essentially local; intravenous is purely systemic.

Where a given injection falls on that scale is decided by one thing — how much blood flow reaches the tissue you put it in.

Depth determines speed — the spectrum that organises everything in this session

1 Intradermal

Into the dermis. 10–15°, bevel up. Minimal blood supply, so absorption is slow and largely local. Diagnostic and local anaesthetic work.

Slowest

2 Subcutaneous

Into the fat beneath the skin. 45°, pinch a 1-inch fold. Prolongs effect and slows absorption — that is the point of choosing it.

Slow, sustained

3 Intramuscular

Into muscle. 90°, skin pulled taut. Muscle is well perfused, so this is the moderate-rate route — and the one you will use most without a line.

Moderate

4 Intravenous

Directly into the vein. No absorption phase at all — the drug is in the circulation the moment you finish the push, and it cannot be recalled.

Immediate

Syringes and Needles

The gauge number runs backwards — and that trips people up under pressure

Figure 21-19 Syringe with hypodermic needle.

Figure 21-20 Safety needles.

Syringes

Syringes range in size from 1 to 100 mL and greater. Choose the smallest syringe that holds your dose — a 1 mL dose measured in a 10 mL syringe is measured badly, because each graduation is worth ten times as much.

Needles — and the backwards number

Hypodermic needles are hollow metal tubes used with the syringe to administer medications. Gauge ranges from 18 to 27, and the smaller the number, the larger the bore.

So an 18-gauge needle is fat and a 27-gauge needle is fine. There is no way to reason it out; it simply has to be known.

Packaged sterile, for a reason

Because syringes and hypodermic needles frequently involve invasive procedures, they are packaged sterile. Once you have broken that packaging you are the only thing maintaining sterility — and contamination that goes unnoticed is how a routine procedure becomes an infection.

Medication Packaging

Four containers, one label check — and a different trap inside each

Before anything else: be thoroughly familiar with the information on every container label

Name of medication

Read it off the label at the moment you draw it, not from memory of where it lives in the box.

Expiration date

Its own check, not part of a general glance at the label. Drug boxes sit in hot ambulances and some drugs degrade.

Total dose and concentration

The bridge between milligrams ordered and millilitres drawn. Check it every single time.

The four packages you will meet

1 Glass ampule

A single dose in sealed glass. Must be physically broken open. The trap is the glass itself — shards, cuts and the disposal problem.

2 Vial

Plastic or glass with a self-sealing rubber top; single-dose or multidose. The trap is the vacuum — you must replace the volume you remove with air.

3 Nonconstituted vial

Two vials: powdered medication and a liquid mixing solution. Nothing exists until you make it. The trap is sequence and complete mixing.

4 Prefilled syringe

Tamper-proof, medication already in the syringe, pop off the caps and screw together. The trap is complacency — it still needs all eight rights.

Intravenous medication solutions are packaged in an IV bag and may be premixed with specific medications — a fifth container, covered later with piggyback infusions.

Glass Ampules

One dose, sealed in glass — and the only package that can cut you

Figure 21-21 Ampules.

What it is

Glass ampules must be broken open to retrieve the medication, and they contain a single dose. There is no rubber stopper and no way to reseal one — what you do not use is wasted.

1. **Confirm first** — Confirm medication indications and patient allergies, then confirm the ampule label.
2. **Clear the neck** — Hold the ampule upright and tap its top to dislodge any solution trapped above the neck.
3. **Snap with gauze** — Place gauze around the thin neck and snap the top off with your thumb, away from you and the patient.
4. **Withdraw** — Place the tip of the hypodermic needle inside the ampule and withdraw the medication into the syringe.
5. **Reconfirm and give** — Reconfirm indication, medication, dose and route; administer; then dispose of needle, syringe and broken glass properly.

Single-Dose and Multidose Vials

The self-sealing top solves one problem and creates another — pressure

Figure 21-22 Vials.

Why the air step exists

A vial is a sealed container. Withdraw fluid without replacing it and you fight a growing vacuum — the plunger drags back, the dose is short, and air bubbles pull into the syringe.

Equal air in, equal fluid out.

1 Confirm

Confirm medication indications and patient allergies, then the vial label — name, dose and expiration.

2 Decide the volume

Determine the volume of medication to be administered before you touch the syringe.

3 Load the air

Prepare syringe and needle. Withdraw the plunger to draw a volume of air equal to the volume of medication to be removed — this maintains equilibrium in the vial.

4 Cleanse the top

Cleanse the vial's rubber top with an antiseptic alcohol preparation. The top is not sterile because it has been sitting in a drug box.

5 Inject air, withdraw drug

Insert the needle, inject the air, and withdraw the medication into the syringe.

6 Reconfirm, give, dispose

Reconfirm indication, medication, dose and route; administer; dispose of needle, syringe and vial properly.

Nonconstituted Vials and Field Reconstitution

Two containers, no drug until you make it — and the arithmetic is yours

Figure 21-23 A nonconstituted vial is two vials.

Bledsoe et al., Paramedic Care, 6th ed. © Pearson

What it is

A nonconstituted medication vial consists of two vials: one containing a powdered medication and one containing a liquid mixing solution.

Some drugs are simply not stable in solution, so they are stored dry and made up at the moment of use.

1 Draw the diluent

Confirm indications, allergies and both labels. Remove all mixing solution from its vial exactly as you would from any single-dose or multidose vial — including the air step.

2 Inject into the powder

Cleanse the top of the powdered medication vial with an alcohol preparation and inject the mixing solution into it.

3 Agitate completely

Gently agitate the vial to ensure complete mixture. Incomplete mixing means an unknown concentration — which means an unknown dose.

4 Now do the maths

Determine the volume of the newly constituted medication to be administered. The concentration did not exist until you created it, so nothing on the original label answers this for you.

5 Draw and give

Air in, withdraw the volume, reconfirm indication, medication, dose and route, administer, monitor for the desired effects, and dispose of syringe and needle.

Region X worked example — push dose epinephrine: 1 mL of cardiac epinephrine 1 mg/10 mL, then 9 mL of normal saline into the same syringe, mixed, giving 10 mL at 10 mcg/mL. The epinephrine goes in first — with saline already in the syringe you cannot verify what you drew.

Prefilled Syringes

The fastest package to prepare — which is exactly where complacency lives

Figure 21-24 Prefilled syringes.

Why services carry them

Prefilled syringes are packaged in tamper-proof containers with the medication already in the syringe. No drawing up, no arithmetic at the bedside, no ampule to break — which is why the drugs you need fastest come this way.

1. **Confirm** — Confirm medication indications and patient allergies, then the prefilled syringe label — name, dose and expiration date.
2. **Assemble** — Remove the pop-off caps and screw the two halves together. Advance the plunger to expel air before it goes anywhere near the patient.
3. **Reconfirm** — Reconfirm the indication, medication, dose and route of administration — the same reconfirmation every other package gets.
4. **Administer and dispose** — Administer by the indicated route, then dispose of the needle and syringe properly.

The prefilled syringe removes the preparation error, not the identification error. Every right still applies.

Intradermal Injection

Into the dermis — the shallowest injection, and the one you judge by its bump

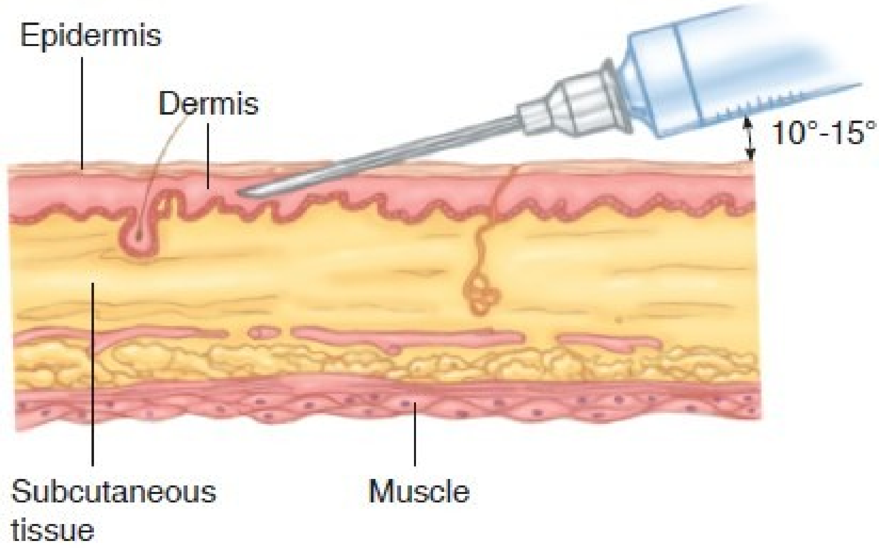

Figure 21-25 Intradermal injection.

What it is for

Intradermal injections deposit medication into the dermal layer of the skin. Blood supply there is minimal, so absorption is slow and the effect stays largely local.

That makes it a diagnostic and local-anaesthetic route rather than a therapeutic one — allergy testing, tuberculin testing, local infiltration.

1. **Prepare** — Assemble equipment, take Standard Precautions, and confirm the indication, medication, dosage and need for an intradermal injection. Draw up as appropriate.
2. **Prep and stretch** — Prepare the site with antiseptic solution, then pull the patient's skin taut with your non-dominant hand.
3. **10 to 15 degrees, bevel up** — Insert the needle bevel up at a 10- to 15-degree angle — almost parallel to the skin, because the target layer is barely a millimetre thick.
4. **Watch for the wheal** — Inject slowly and look for a small bump or wheal to form as medication collects in the intradermal tissue. No wheal means you went too deep.
5. **Finish** — Remove the needle and dispose of it in the sharps container. Place an adhesive bandage; use gauze for haemorrhage control if needed.

Subcutaneous Injection

Into the fat — chosen precisely because it is slow

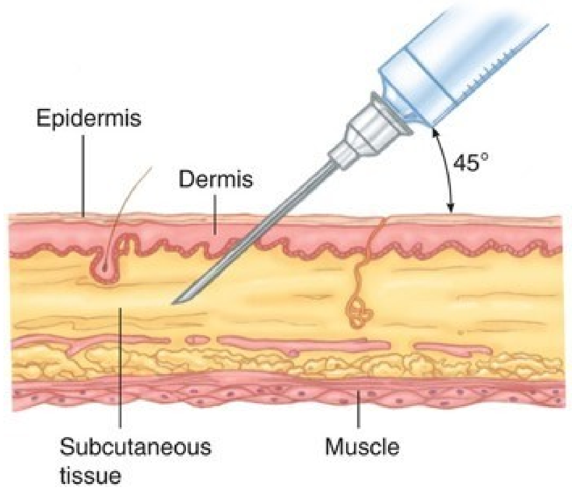

Figure 21-26 Subcutaneous injection.

Bledsoe et al., Paramedic Care, 6th ed. © Pearson

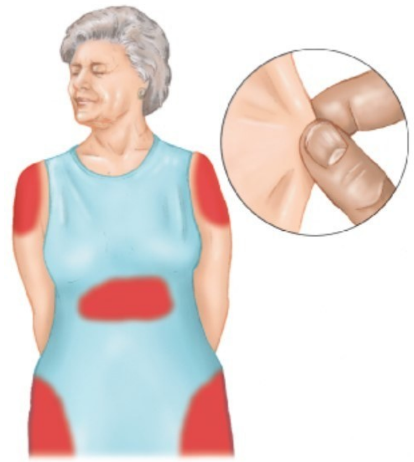

Figure 21-27 Subcutaneous sites.

Bledsoe et al., Paramedic Care, 6th ed. © Pearson

Why you would choose it

Subcutaneous injections place medication into the subcutaneous tissue, which prolongs the medication's effects and slows absorption.

Read that as a feature. Slow and sustained is the right profile for insulin, for some analgesics and for epinephrine in a stable allergic reaction — and the wrong profile for anything you need working in the next two minutes.

1. **Prepare and prep** — Assemble equipment, Standard Precautions, confirm indication, medication, dosage and need. Draw up, then prepare the skin with antiseptic solution.
2. **Pinch a 1-inch fold** — Gently pinch a 1-inch fold of skin. The pinch lifts the fat away from the muscle beneath so a shallow needle lands in the right layer.
3. **45 degrees, bevel up** — Insert the needle just into the skin at a 45-degree angle with the bevel up.
4. **Aspirate** — Pull the plunger back to aspirate tissue fluid. If blood appears, restart the procedure with a new syringe. If none appears, proceed.
5. **Inject slowly, then finish** — Slowly inject the medication. Remove the needle, dispose in a sharps container, bandage the site and monitor the patient.

Intramuscular Injection

Into well-perfused muscle — the route you use when there is no line

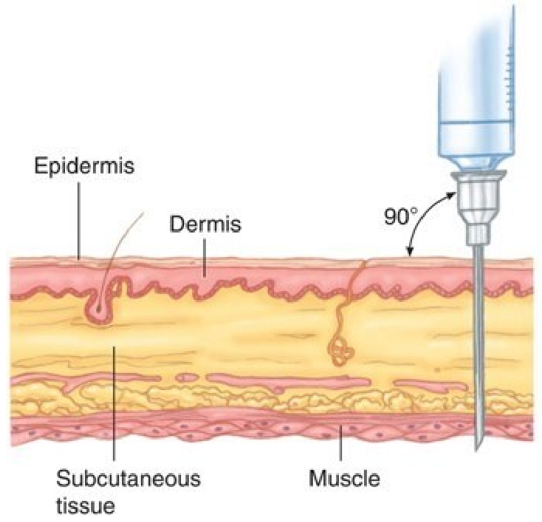

Figure 21-28 Intramuscular injection.

Bledsoe et al., Paramedic Care, 6th ed. © Pearson

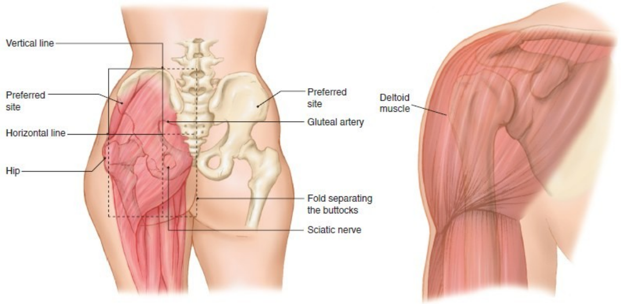

Figure 21-29 Intramuscular injection sites.

Bledsoe et al., Paramedic Care, 6th ed. © Pearson

Sites and why the choice matters

The text lists the deltoid, dorsal gluteal, vastus lateralis and rectus femoris.

Size and perfusion decide between them. The deltoid takes about 1 mL and is convenient; the thigh muscles take more, are better perfused, and are reachable through clothing on a patient who is fighting you — which is why Region X puts emergency epinephrine in the anterolateral thigh.

1. **Prepare and prep** — Assemble equipment, Standard Precautions, confirm indication, medication, dosage and need. Draw up, then prepare the site with antiseptic solution.
2. **Stretch the skin taut** — Stretch the skin taut over the injection site with your non-dominant hand — the opposite of the subcutaneous pinch, and for the opposite reason.
3. **90 degrees** — Insert the needle just into the skin at a 90-degree angle with the bevel up. Straight down is the shortest path through fat to muscle.
4. **Aspirate for blood** — Pull the plunger back and observe. If blood appears, restart with a new syringe. Skipping it is how an intended IM dose ends up intravascular.
5. **Inject, dispose, monitor** — Slowly inject. Remove the needle, dispose in a sharps container, apply direct pressure, cover the site and monitor the patient.

Controlled Substances and Push Rate

Two things the textbook underplays and your protocols spell out

Controlled substances — accountability runs from the safe to the report

What you are carrying

Region X stocks fentanyl at 100 mcg/2 mL, midazolam in two concentrations, and ketamine at 500 mg/10 mL for intramuscular use only.

Every one of those is a scheduled drug, and every one of them is counted.

Security and the count

Controlled drugs are sealed, counted at shift change and signed for. Knowing your own service's procedure is part of being able to work a shift.

A count that does not reconcile is an incident, not a paperwork problem.

Waste is documented, not discarded

Single-dose packaging means partial doses generate waste on nearly every administration — a 100 mcg fentanyl ampule for a 70 mcg dose.

Waste is witnessed and recorded. Never quietly, never alone.

Push rate is part of the order, not a matter of style

1 The default

Unless otherwise specified, Region X gives all medications IV/IO as a slow push over 60 seconds. That is the baseline every drug falls back to when the protocol does not say otherwise.

2 Rapid push

Adenosine 6 mg rapid IVP with an immediate 20 mL flush. Its half-life is seconds — and the SOP warns that giving it slowly increases the risk of sustained asystole.

3 Slow push

Diphenhydramine 50 mg over 2 minutes. Verapamil 5 mg over 5 minutes. Etomidate over 1 minute. Lidocaine for intraosseous pain over 1 to 2 minutes.

4 Why the rate is the dose

Rate sets the peak plasma concentration. The same milligrams delivered twice as fast produce a higher peak — and for a vasoactive or sedating drug, the peak is where the harm lives.

A correct dose given at the wrong speed is a medication error. Rate belongs in the order you read back and in the report you write.

THE SECOND THIRTY MINUTES

Intravenous Access

The largest single section in the chapter

1. Fluid and blood replacement
2. Medication administration
3. Venous blood specimens

Peripheral and Central Access

Two kinds of venous access — you will perform one of them

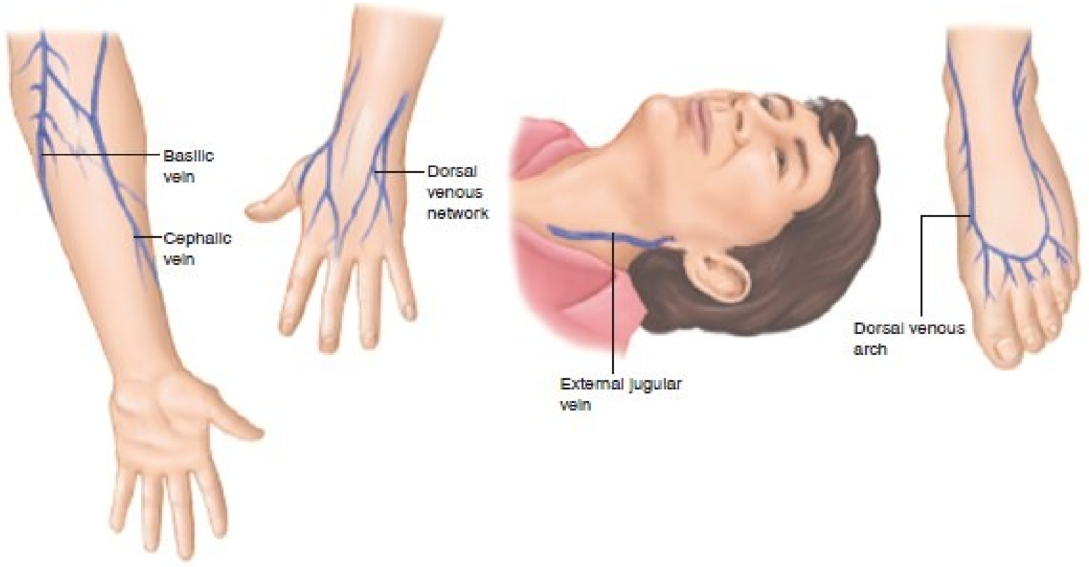

Figure 21-30 Peripheral IV access sites.

Bledsoe, Porter & Cherry, Paramedic Care: Principles & Practice, 6th ed. © Pearson Education, Inc.

Peripheral — yours

Challenging but relatively easy to master. Common sites are the arms and legs and, when necessary, the neck.

Some veins are readily accessible; others must be located anatomically, by knowing where they run rather than by seeing them.

Central — not yours

Central venous access uses veins deep within the body and is typically placed for long-term use and invasive monitoring.

It is rarely, if ever, performed out of hospital, because it is highly invasive and carries a high risk of complications.

Three rules for choosing a site

Start distal

Start distally and work proximally. A blown proximal site takes every vein below it out of play.

Match the need

Rapid fluid administration requires larger veins — and a larger catheter in them.

EJ is a fallback

The external jugular may be used when other sites are unavailable.

Intravenous Fluids

Chemically prepared solutions tailored to the body's specific needs

Colloids

Contain large proteins and are used to increase intravascular volume. Large molecules stay in the vessel and pull water in with them, so a small volume expands the plasma substantially.

Crystalloids

Contain electrolytes and water. These are the primary out-of-hospital solutions — cheap, stable, shelf-safe, and carried on every ambulance.

Tonicity — the direction water moves once the fluid is in

1 Isotonic

Tonicity equal to that of blood plasma. Water does not shift across the cell membrane in either direction, so the fluid stays where you put it — in the extracellular space. This is why isotonic fluids are the volume-replacement fluids.

2 Hypertonic

Higher solute concentration than the cells. Water is drawn out of the cells and into the extracellular compartment, expanding intravascular volume at the cells' expense.

3 Hypotonic

Lower solute concentration than the cells. Water moves from the extracellular compartment into the cells, which is useful for rehydrating cells and useless for filling a vascular space.

The most desirable fluid for replacement is whole blood — it carries oxygen, which no crystalloid does. Everything you carry is a compromise made necessary by storage, typing and shelf life.

The Three Fluids You Will Actually Meet

And what your protocols do with the one you carry

1 Lactated Ringer's

Isotonic crystalloid containing sodium, potassium, calcium, chloride and lactate. Composition is closer to plasma than saline, and the lactate is metabolised to bicarbonate. Common in trauma and burn resuscitation.

2 Normal saline

0.9 percent sodium chloride — isotonic, compatible with almost every drug and with blood products, and the workhorse of prehospital care. This is the fluid your protocols name.

3 5 percent dextrose in water

Isotonic in the bag; the dextrose is metabolised almost immediately, leaving free water that distributes throughout the body. A poor volume expander — it is a vehicle for drugs and a source of glucose.

Region X volumes — the numbers behind the bag

Adult shock

Normal saline in 500 mL increments, titrated to a MAP of 65 or greater. Increments, not "wide open" — you reassess between them.

Paediatric shock

Normal saline 20 mL/kg, repeatable if the patient remains unstable, to a maximum of 60 mL/kg. Cardiogenic: 10 mL/kg.

As a flush

Adenosine 6 mg rapid IVP followed by a rapid 20 mL normal saline flush. The flush is part of the dose, not an afterthought.

As a diluent

Magnesium sulfate 2 g diluted in 100 mL of D5W, given IVPB over 5 minutes. This is where the third fluid earns its place.

Verify and check often that lung sounds are clear — the SOP prints this beside its fluid orders because the fastest way to harm a cardiogenic shock patient is to keep giving fluid past the point where it helps.

Administration Sets

Macrodrip or microdrip — the choice is made by what you intend to deliver

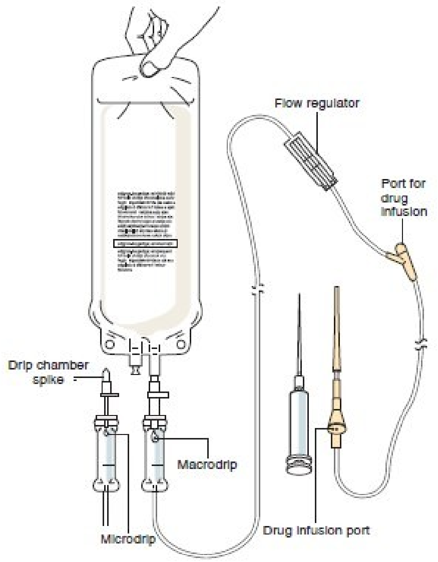

Figure 21-33 Macrodrip and microdrip sets.

Bledsoe et al., Paramedic Care, 6th ed. © Pearson

Figure 21-32 IV solution container.

Bledsoe et al., Paramedic Care, 6th ed. © Pearson

What it is

Administration tubing connects the solution bag to the IV cannula inserted into the patient's vein. You must be familiar with both the macrodrip and microdrip sets, their components, and their subtle differences — because externally they look nearly identical.

The drop former decides everything

Inside the drip chamber is a drop former, and its bore is the only meaningful difference between the two sets. A larger opening makes larger drops, so fewer of them make a millilitre.

The components, in the order the fluid meets them

1. Spike
2. Drip chamber
3. Drop former
4. Tubing
5. Clamp
6. Flow regulator
7. Injection ports
8. Needle adapter

IV bags run from 50 to 3,000 mL. Some medications are incompatible with plastic or vinyl and must be packaged in glass bottles — a vented set is required to drain a rigid container.

Specialty Administration Sets

Four variations, each solving a problem the standard set cannot

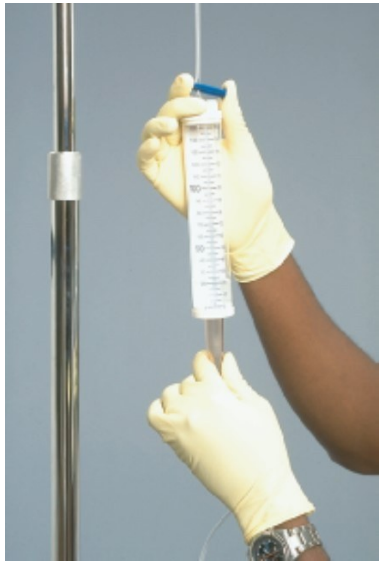

Figure 21-36 Measured volume set.

Bledsoe et al., Paramedic Care, 6th ed. © Pearson

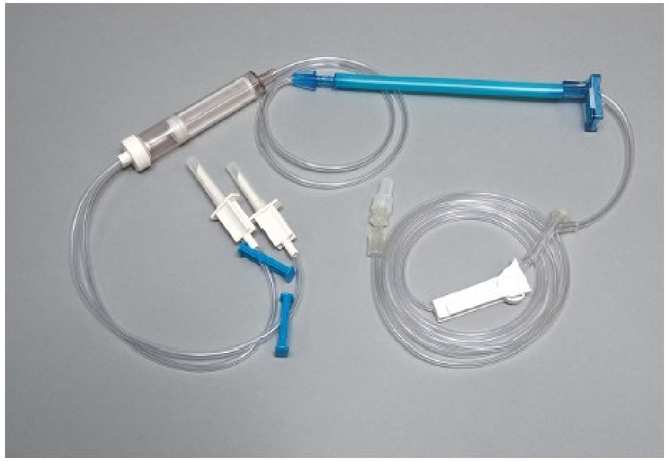

Figure 21-37 Blood administration tubing.

Bledsoe et al., Paramedic Care, 6th ed. © Pearson

Extension tubing

Used to extend the original macrodrip or microdrip setup. Buys you working distance between the patient and the bag — useful during extrication and moves, at the cost of a little added length and resistance.

Electromechanical pump tubing

Mechanical infusion devices may require specially manufactured pump tubing. It is not interchangeable, and discovering that at the bedside costs you the infusion.

Measured volume sets — the burette

Deliver specific volumes with or without medication. The burette chamber is filled with a set amount and only that amount can reach the patient — a mechanical dose limit. Components: flanged spike, clamp, airway handle, medication port, burette chamber, float valve, drip chamber, flow regulator, second port, needle adapter.

Blood tubing

Administering whole blood or blood components requires blood tubing, which contains a filter that prevents clots and other debris from entering the patient. Often Y-configured so normal saline can run alongside. Newer sets add a manual dial for drops per minute or a set flow rate.

Intravenous Cannulas

Three designs — and only one of them is your first choice

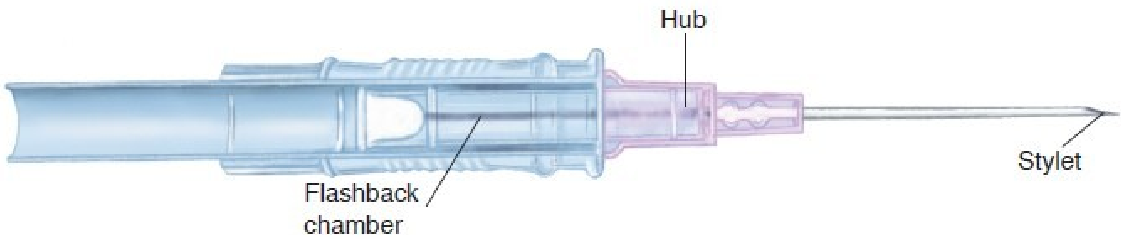

Figure 21-38 Over-the-needle catheter.

Bledsoe, Porter & Cherry, Paramedic Care: Principles & Practice, 6th ed. © Pearson Education, Inc.

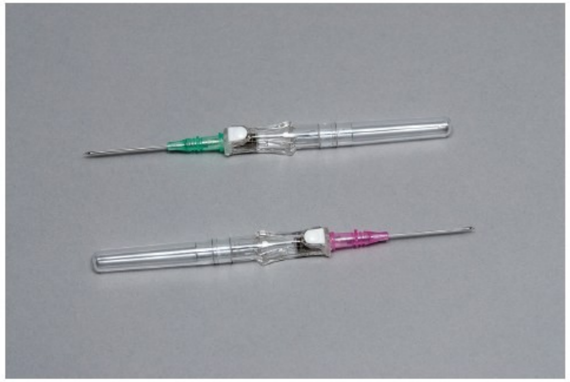

Figure 21-39 Safety IV catheters.

Bledsoe et al., Paramedic Care, 6th ed. © Pearson

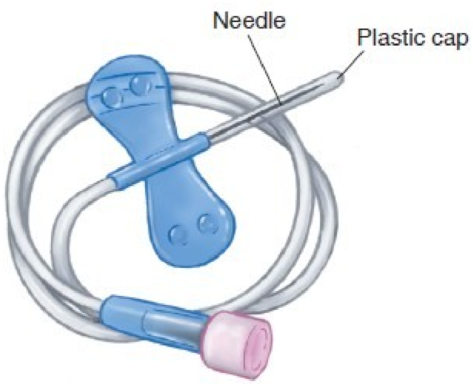

Figure 21-40 Butterfly catheter.

Bledsoe et al., Paramedic Care, 6th ed. © Pearson

Over-the-needle — the standard

A semiflexible catheter enclosing a sharp metal stylet that is hollow and bevelled at the distal end. The stylet makes the hole; the catheter stays behind in the vein and the stylet is removed and discarded.

This is what you will use on nearly every patient.

Hollow-needle — the butterfly

Smaller, and reserved for accessing smaller veins. A rigid metal needle remains in the vein, so it is easily dislodged and easily infiltrates. Paediatric and blood-draw use, rarely a transport line.

Through-the-needle — not yours

Also called an intracatheter, used in the hospital setting to place central lines. Its placement requires great skill. Recognise it; do not plan to use it.

Preparing the Administration Set

Everything that happens before you touch the patient

Confirm the indication and the type of IV setup needed, then gather and arrange all supplies beforehand

- IV fluid
- Administration set
- Intravenous cannula
- Tape or securing device
- Blood drawing equipment
- Venous constricting band
- Antiseptic solution

1 Examine the fluid

Check the IV fluid for clarity and expiration date. Confirm it is the right solution, look for particulate matter, and check the protective covers on the tail ports.

2 Spike the bag

Insert the administration tubing spike into the solution bag's administration set port — twisting and pushing until the inner seal is punctured, while maintaining sterility.

3 Fill the drip chamber

Squeeze fluid into the drip chamber until it reaches the fill line, roughly half-way. Too full and you cannot count drops; too empty and you draw air.

4 Flush the line

Open the clamp or flow regulator and run solution through the tubing to expel trapped air bubbles, maintaining sterility at the far end.

5 Shut down and cap

Shut the flow regulator once the large bubbles are purged, and replace the cap over the needle adapter. The line is now ready and still sterile.

The flow clamp should already be positioned up near the drip chamber and closed before you spike — a clamp near the bag gives you finer control and stops fluid escaping the moment the seal is broken.

Performing the Venipuncture

From constricting band to secured line — the sequence, and where it goes wrong

1 Band and site

Place the constricting band proximal to the intended puncture, tight enough to impede venous flow without restricting arterial passage. Select the site and palpate the vein.

2 Cleanse outward

Cleanse the site with alcohol or antiseptic, starting at the site itself and working outward in an expanding circle. Never back over ground you have already cleaned.

3 Stabilize and enter

Pull the skin taut with your non-dominant hand to stabilise the vein and stop it rolling. Warn the patient, then insert bevel up until you feel the pop or see blood in the flashback chamber.

4 Advance, then thread

Advance approximately 0.5 cm so the catheter tip is inside the lumen too. Then hold the stylet stationary and slide the catheter over it into the vein until the hub meets skin.

5 Tamponade and remove

Occlude the vein at or near the catheter tip, remove the stylet straight into the sharps container, and release the constricting band.

6 Draw samples

Obtain venous samples now if they are indicated — this is the one moment when the vein is open and no tubing is attached.

7 Connect and run

Attach the administration tubing to the hub, open the flow regulator and let it run freely for several seconds to confirm patency, then set the rate. Do not let go until it is secured.

8 Secure and label

Cover the site, loop the distal tubing and tape it proximal to the puncture. Label the bag with the date, time and who started it — then monitor the patient and the flow rate continually.

Choosing the Insertion Angle

Why the textbook gives you a range rather than a number

The textbook says 10 to 30 degrees

Insert the cannula at a 10- to 30-degree angle with the distal bevel of the metal stylet up, continuing until you feel the pop or see flashback.

That is a range, not a setting

The correct angle is a property of how deep the vein sits and which part of the insertion you are in. A superficial hand vein under thin skin needs a shallower approach than an antecubital vein under more tissue.

Two phases, two angles — and two ways to get it wrong

1 Steeper through the skin

Skin is the tough part and the painful part. A steeper entry crosses it quickly and gives you a definite pop rather than a vague drag, so you know where you are.

2 Shallower inside the vein

Once you have flashback, lower the stylet almost flat before you advance. This is the shallow end of the range, and it is what keeps the tip off the far wall of the vein.

3 Too shallow and you skive

The needle tents the skin and slides along underneath it without ever entering the vein. No flashback, no pop, and the patient feels every millimetre of it.

4 Too steep and you transfix

You get a flash and lose it immediately, because you have passed through the vein and out the back wall. Haematoma, and that site is finished.

External Jugular Cannulation

A large vein, a bad place to be wrong, and a narrow set of indications

Who it is for

Reserved for patients who require immediate and rapid fluid administration, and for patients with decreased or complete loss of consciousness and no other accessible veins.

Both halves matter — it is a large-bore route and a last-resort route at the same time.

The syringe on the hub — why

Prepare as for any peripheral IV, but fill a 10 mL syringe with 3–5 mL of sterile saline and attach it to the flashback chamber of a large-bore catheter.

You withdraw on the plunger as you advance, so aspirated blood confirms entry and negative pressure guards against drawing air.

1 Position

Supine, and Trendelenburg if tolerated. Turn the head to the side opposite the access, which flattens the skin over the vein and moves your hands away from the airway.

2 Cleanse

Start at the centre of the intended puncture and work outward one to two inches in ever-increasing circles.

3 Occlude below

Place a finger on the external jugular just above the clavicle. This is your constricting band — it distends the vein and makes it visible.

4 Aim and enter

Align with the vein midway between the angle of the jaw and the clavicle. Point at the medial third of the clavicle and insert bevel up at 10 to 30 degrees, withdrawing on the plunger as you go.

5 Thread and secure

Advance 0.5 cm, slide the catheter in, remove and immediately dispose of the stylet. Attach tubing, run freely for several seconds, set the rate, secure, and monitor for complications.

The IRM is explicit: students must not perform external jugular cannulation on one another because of the risk and complications involved. Mannequins only.

When the Line Will Not Flow

Seven checks, in order, before you decide the IV has failed

1 The constricting band

Still on the arm. It is the commonest cause and the most embarrassing one. Check it first, every time, before anything else.

2 Edema at the site

Swelling around the puncture means the fluid is going into tissue rather than vein. That is infiltration, and the line comes out.

3 Catheter against a wall or valve

The tip is abutting the vein wall or resting on a valve. Slight repositioning of the limb or the catheter hub often restores flow.

4 Control valves

Administration set control valves — roller clamp, flow regulator, and any clamp on an extension set. More than one of them can be shut.

5 Bag height

Gravity is your entire pumping mechanism. Raise the bag. A bag resting on the stretcher beside the patient will not flow at all.

6 Drip chamber completely filled

A chamber squeezed too full cannot form drops. Invert the bag and squeeze fluid back up until the chamber is half full again.

7 Catheter patency

If everything else checks out, the catheter itself may be clotted, kinked or positional. That is when you consider replacing it.

These are arranged cheapest and fastest first. The band takes one second to check; replacing the catheter costs a new site, new equipment and more pain.

A provider who works the list in order fixes most failed lines without a second stick.

Complications of Peripheral Venous Access

Even though it is routine, it is not trouble free

Local — at or around the site

Pain

The needle stick itself, and chemical irritation from the medication or solution. Warn the patient; a warned patient moves less.

Local infection

You created a portal through the skin. Presents late, usually after your contact has ended — which is exactly why asepsis is a discipline rather than a preference.

Hematoma

Blood escaping into surrounding tissue from a through-and-through puncture or an unsealed site after removal. Direct pressure is both the treatment and the prevention.

Infiltration

Fluid entering tissue instead of vein. Swelling, coolness, tenderness, slowed flow — and any medication given has not reached the circulation.

Thrombophlebitis and thrombus

Inflammation of the vein and clot formation at the catheter. Redness, a palpable cord, tenderness along the vein's course.

Necrosis

Tissue death from extravasated drug. The reason certain medications are never given peripherally and others are diluted.

Systemic — the ones that reach the whole patient

Pyrogenic reaction

Fever and chills from contaminants in the solution or set. Stop the infusion — the line is the source.

Allergic reaction

To the solution, the medication, or the antiseptic. Treat as any anaphylaxis and stop the offending infusion.

Circulatory overload

Too much fluid, too fast, into a patient who cannot take it. This is why lung sounds appear beside every fluid order.

Arterial puncture

Bright red pulsatile flow, and pain out of proportion. Remove and hold pressure for far longer than a vein requires.

Shear and air embolism

Technique failures, not bad luck — a catheter withdrawn back over its stylet, or a line that was never flushed.

The Intravenous Bolus

A concentrated dose into an established line — the fastest thing you will ever do to a patient

Figure 21-42 Needleless IV systems.

Why needleless matters here

Needleless systems significantly reduce the risk of needle stick injury at the exact moment when your attention is on the drug rather than the sharp.

Where they are unavailable, the needle must be securely taped to the port before you let go of it.

1 Confirm the line and the drug

Ensure the primary IV line is patent. Confirm the medication, indication, dosage and need for a bolus — and confirm the medication is compatible with the solution being infused.

2 Prepare

Draw up the medication or assemble the prefilled syringe, dispelling air. Cleanse the medication port nearest the IV site with an antiseptic preparation.

3 Pinch above the port

Insert into the port and pinch the IV line above it, so the drug travels toward the patient rather than up into the fluid bag.

4 Push at the right rate

Inject as appropriate. Rate is part of the order — diphenhydramine slowly over 2 minutes, adenosine as a rapid push. Both are on your protocol page.

5 Flush and restore flow

Remove the syringe, release the tubing, dispose of the sharp immediately, and open the flow regulator for a 20 mL flush — then set the rate back to TKO.

Turn the IV back on after the push — a drug left sitting in the tubing has not been given.

Medicated Infusions and the Piggyback

A steady, continual dose through an existing line

Figure 21-43 If a solution is not premixed, you must mix and label it.

1 Establish and confirm

Establish a primary line and ensure patency. Confirm the administration indications and patient allergies.

2 Mix the bag

Draw the medication, cleanse the bag's medication port, inject, and gently agitate to mix. Then label the bag — date, time, medication, concentration, dosage, initials.

3 Prime the secondary

Connect tubing to the medication bag, fill the drip chamber to the fluid line, and flush the tubing with solution so no air remains.

4 Connect and secure

Cleanse the medication port on the primary line, insert the secondary line, and tape it securely if a needleless set is unavailable.

5 Run it

Reconfirm indication, medication, dose and route. Shut down the primary so no fluid flows from it, then adjust the secondary to the desired drip rate — or set the pump.

Region X worked example

Magnesium sulfate 2 g diluted in 100 mL of D5W, given IVPB over 5 minutes for torsades — or 25 mg/kg in 100 mL over 15 minutes in the pediatric respiratory protocol.

Every element of the piggyback procedure is visible in that one order: a secondary bag, a diluent, a dose and a time.

The label is the whole safety system for a mixed bag — an unlabelled bag of clear fluid with a drug in it is indistinguishable from saline.

Saline Locks and Vascular Access Devices

Access without a bag — and access the patient already had

Figure 21-44 Saline or heparin lock.

Bledsoe et al., Paramedic Care, 6th ed. © Pearson

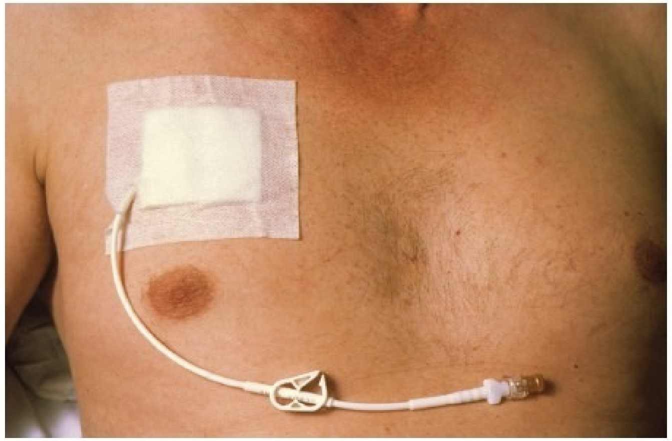

Figure 21-46 Medication port venous access device.

Bledsoe et al., Paramedic Care, 6th ed. © Pearson

The lock — access without volume

Used when the patient does not need continuous IV fluids. The procedure is identical to starting any IV, except that instead of attaching tubing to the catheter hub you attach lock tubing and secure it.

Administering medication is then the same as using a port on IV tubing.

Why locks exist

They give you access for the deterioration you are anticipating without committing a patient to fluid they may not tolerate — and without a bag and line to manage during a move.

Know your protocol

A venous access device is surgically implanted to permit repeated access to the central circulation. Whether you may access one, and when, is a local decision — find it in your SOP before you need it.

Implanted devices — accessing what is already there

The Huber needle sequence

Standard precautions. Fill a 10 mL syringe with about 7 mL of normal saline. Place a 21- or 22-gauge Huber needle on it. Cleanse over the port. Stabilise with one hand and insert at 90 degrees until it meets resistance. Pull back to observe blood return, then slowly inject saline to confirm patency.

Infusion Devices and Ultrasound Guidance

Optional equipment — teach it so students recognise what they meet on transfers and in the services that carry it

Figure 21-48 Modern infusion pump.

Figure 21-51 Forearm vascular anatomy on ultrasound.

Electromechanical infusion devices

Permit the precise delivery of fluids and medications through electronic regulation. Two families — infusion controllers, which regulate gravity flow, and infusion pumps, which generate pressure of their own.

Both require specific devices and specific tubing.

Portable ultrasound

Ultrasound guidance for peripheral IV placement is now common in hospital emergency departments, and with newer portable machines it is moving into the out-of-hospital setting.

It turns the difficult-access patient from a problem of luck into a problem of skill.

Venous Blood Sampling

One window, during cannulation, before anything else goes in

Figure 21-54 Blood tubes.

Bledsoe et al., Paramedic Care, 6th ed. © Pearson

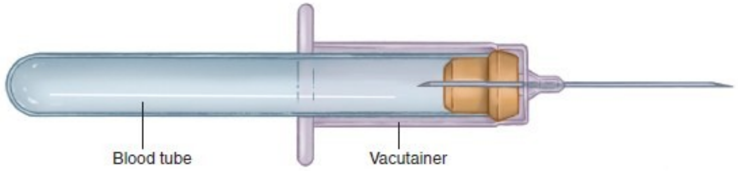

Figure 21-55 Vacutainer and multi-draw needle.

Bledsoe et al., Paramedic Care, 6th ed. © Pearson

Consider it before medication administration and complete it during peripheral access — but never let it delay care.

1. **Prepare** — Assemble equipment. Inspect the blood tubes for expiration or damage, and insert the multidraw needle into the vacutainer.
2. **Access, then pause** — Establish IV access with the catheter, but do not connect the administration tubing yet. This is the window.
3. **Attach and draw** — Attach the multidraw needle adapter to the hub of the cannula. Insert the tubes in the correct order so the rubber-covered needle punctures each self-sealing top.
4. **Fill completely and mix** — Fill all tubes completely — the anticoagulant is proportional to the tube's volume. Gently agitate each to mix it evenly with the blood.
5. **Finish and label** — Tamponade the vein, remove the vacutainer, attach the IV and confirm patency. Dispose of sharps. Label every tube with the patient's name, age and gender, date and time drawn, and who drew it.

Changing a Bag and Removing a Line

The two ends of a line's life — both simple, both easy to do badly

Changing the IV solution — change it at 50 mL or less remaining, if the patient needs more fluid

1 Prepare the new bag

Remove the protective cover from the new bag's IV tubing port. Have it open and ready before you disconnect anything.

2 Stop the flow

Occlude flow from the depleted bag by moving the roller clamp on the administration tubing. The drip chamber still holds fluid, which is what keeps air out.

3 Remove the spike

Remove the spike from the depleted bag, being careful not to drop or contaminate it in any way. It is a sterile item in an unsterile environment.

4 Spike the new bag

Insert the spike into the new bag and ensure the drip chamber is filled appropriately before restoring flow.

5 Restore the rate

Open the roller clamp to the appropriate flow rate — the rate the patient needs now, not necessarily the rate that was running.

Removing a peripheral IV — remove any line that has stopped flowing or has fulfilled its need

1 Occlude

Shut the flow with the regulator or clamp before anything else, so fluid is not running as you withdraw.

2 Free the catheter

Remove all tape and securing devices, holding the catheter hub so the dressing does not pull it as it comes away.

3 Pressure ready

Place sterile gauze over the puncture site and apply pressure with the fingers or thumb of your non-dominant hand.

4 Withdraw swiftly

Remove the catheter swiftly while maintaining pressure over the site — and inspect the tip to confirm it came out intact.

5 Hold five minutes

Keep direct pressure over the site for at least 5 minutes or until bleeding stops. Longer on anticoagulated patients.

Part 2 — Key Takeaways

1. **Depth determines speed.**

   Intradermal 10–15°, subcutaneous 45° with a pinch, intramuscular 90° with the skin stretched taut, intravenous no absorption at all. Derive the angles from the anatomy and you will not have to memorise them.

2. **The concentration is yours to establish.**

   A vial needs air in before fluid out. A nonconstituted vial has no concentration until you create one. Push dose epinephrine is 1 mL of epi then 9 mL of saline — in that order, because the sequence is what makes it verifiable.

3. **A line has exactly three indications.**

   Fluid and blood replacement, medication administration, and blood specimens. Anything else is a habit, and every line costs a breach of the skin, a pain stimulus and an infection risk.

4. **Flashback is not access.**

   The catheter tip sits behind the bevel. Advance the whole assembly another 0.5 cm before threading, hold the stylet still, and never withdraw the catheter back over it.

5. **Check the band first.**

   Seven things stop a line flowing and they are ordered cheapest first. Most failed IVs are fixed without a second stick by someone who works the list in order.

6. **Pinch, push at the right rate, flush, turn it back on.**

   Rate is part of the order — adenosine rapid, diphenhydramine over 2 minutes. And a drug left in the tubing has not been given — stop the flow to push, then turn it back on.