Parenteral Medication Administration

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ANBLPN | AIAANB
Association of New Brunswick Licensed Practical Nurses
L'Association des Infirmiéres Auxiliaires Autorisés du Nouveau-Brunwick

Mission

The Association of New Brunswick Licensed Practical Nurses (ANBLPN) is the regulatory authority for Licensed Practical Nurses (LPN) in New Brunswick. ANBLPNs mandate is protection of the public by promoting the provision of safe, competent, ethical, and compassionate care. ANBLPN sets, monitors, and enforces practical nurse education, registration, and professional conduct. ANBLPN creates Standards of Practice, establishes a Code of Ethics, and develops and implements a Continuing Competence Program. Additionally, ANBLPN publishes documents to support the practice of LPNs in New Brunswick.

Table of Contents

INTRODUCTION

Parenteral medication administration are medications that are injected into body tissues and enter the circulatory system. When medications are administered by injection, they are absorbed much faster than when they are administered by the oral route.

The parenteral route is used for a variety of reasons such as; when clients are NPO (nothing by mouth), when a rapid therapeutic response is required (i.e., pain relief, reversing an adverse reaction), when certain medications are poorly absorbed in the gastrointestinal tract, or when clients cannot swallow or are experiencing extreme nausea and vomiting (Perry, Potter, Ostendorf, & Cobbett, 2020).

Parenteral medication administration is a more invasive procedure and therefor poses a greater risk than when administering medications via a non-parenteral route. There are advantages and disadvantages that must be considered with this route of medication administration.

ADVANTAGES	DISADVANTAGES
• Medication is absorbed rapidly producing a therapeutic effect more quickly	• Rapid absorption and effect make it more difficult to reverse an undesired effect (adverse reaction)
• Effective medication delivery for clients unable to take oral medications (NPO, nausea/vomiting)	• Increased risk of infection or emboli
• Extended duration of effect	• Increased risk of hypersensitivity reaction
• Localized delivery of the medication	• Increased cost

(Vega, Ochoa & Holder, 2015)

The four most common routes of parenteral medication administration are:

- **Subcutaneous Injection:** injecting a medication into tissues located just below the dermis of the skin, such as insulin. (Angle of insertion is 45 degrees)
- **Intramuscular Injection:** injecting a medication directly into a muscle, such as the seasonal influenza vaccine. (Angle of insertion is 90 degrees)
- **Intradermal Injection:** injecting into the dermis just under the epidermis, such as tuberculin testing. (Angle of insertion is 15 degrees)
- **Intravenous Injection/Infusion:** injecting a medication directly into the vein, such as IV antibiotics.

These four routes of parenteral medication administration are all within the professional scope of practice of Licensed Practical Nurses (LPN) in New Brunswick. LPNs must have the knowledge, competence, and authorization in each route before performing this nursing intervention. As always, LPNs are also expected to adhere to any employer policy that is in place regarding medication administration authorization.

EQUIPMENT

Some of the equipment required for injecting a medication are alcohol swabs, gauze, appropriate needle length and size, syringe, and sharps container. Intravenous medication administration would also require IV tubing, IV pole, and a pump.

Needles

Needles come in different gauges and lengths and the appropriate size is determined by the type of medication prescribed, the route, viscosity of the medication, volume of the solution, client size, and client age. When selecting a needle, you should always use the smallest gauge and shortest shaft that can effectively deliver the medication.

Some needles come attached to a syringe while others are packaged individually. They are disposable and made of stainless steel. A needle has three parts; the **hub** which fits onto the syringe, the **shaft** which connects to the hub, and the **bevel** which is located at the end of the needle and is the point of entry into the body tissue. All three parts must always remain sterile.

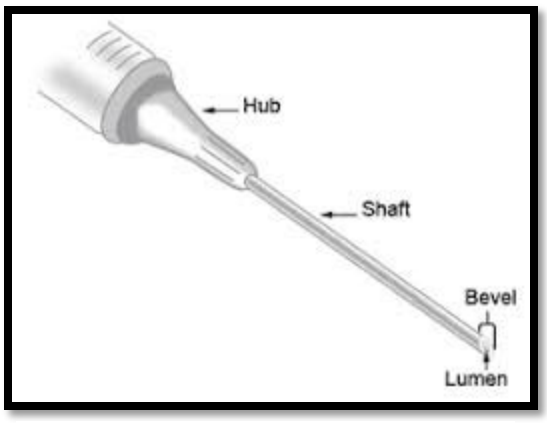


Figure 1: Parts of a needle

Some needles also have a **filter**, which is used when withdrawing medications from glass ampoules to prevent any glass particles from being withdrawn along with the medication. After withdrawing the medication from the ampoule, the filter is discarded (Perry et al., 2020).

Filtered needles create a one-way flow; meaning they can only be pulled or pushed in one direction. This reduces the chances of glass being introduced into a medication when withdrawing from an ampoule.

Needle lengths vary from approximately 1 to 3 inches and should be chosen according to the type of tissue that the medication is being injected into. Needle length should also be chosen based on the client's weight, body mass index, and gender. Children or slender adults generally require a shorter needle length, while females generally have more subcutaneous tissue at the ventrogluteal site and therefore would require a longer needle to ensure the needle penetrates the muscle.

Needles also have different gauges; as the needle gauge number becomes smaller, the needle diameter becomes larger. Selecting the appropriate needle gauge depends on the viscosity of the fluid to be injected – the greater the viscosity, the larger the gauge.

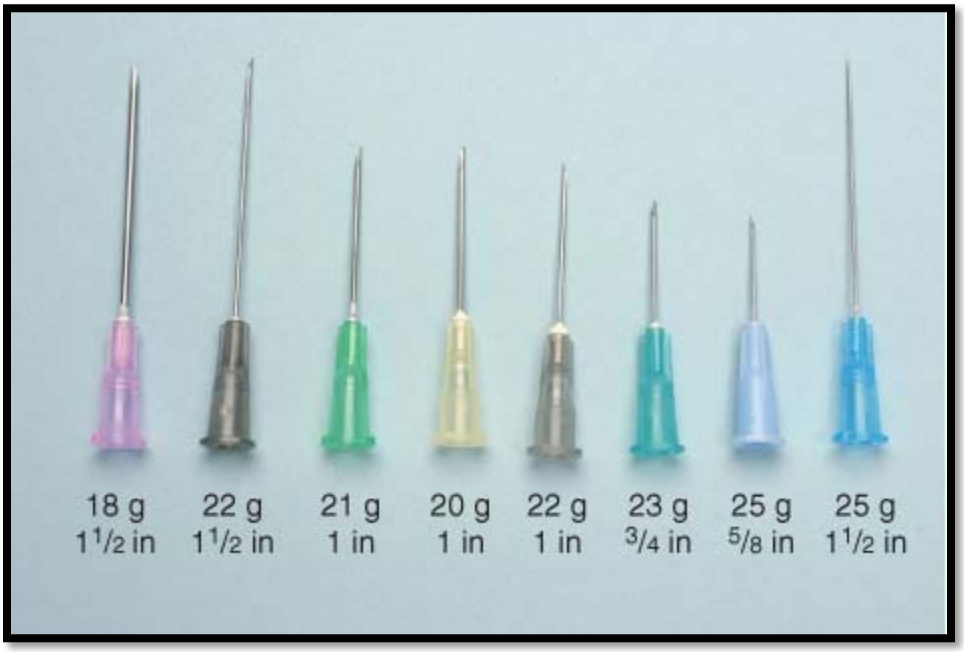


Figure 2: Needle gauges

For more information on needle length and gauges, you can refer to **Appendix A**; *Vaccine Administration: Needle Gauge and Length* developed by the Centre for Disease Control and Prevention which outlines recommendations for needle gauges and lengths.

Syringes

Syringes are made to be single use and are designed as either **Luer-Lok** or **non Luer-Lok**. Non Luer-Lok syringes use needles or needleless devices that slip onto the tip of the syringe. Luer-Lok syringes use standard needles or needleless devices that are twisted onto the tip and lock themselves into place (Perry et al., 2020). A Luer-Lok syringe is preferred as it helps prevent the accidental removal of the needle from the syringe. It also allows the syringe to be connected to a needleless connector on an IV line or subcutaneous butterfly which reduces the risk of a needle stick injury.

Figure 3: Luer-Lok (twists into place) vs non Luer-Lok (slips onto the tip)

A syringe has three parts; the **barrel** which is the body of the syringe containing the calibrations for measurement and holds the solution, the **plunger** which is used to pull or push the solution in the barrel out or in, and the **tip** which is where you attach the needle to.

Syringes also come in a variety of sizes, ranging from 0.5mls to 60mls. Syringe selection must be based on choosing the smallest syringe size possible to improve accuracy of the medication preparation (Perry et al., 2020). Subcutaneous and intramuscular injections generally use a 1 to 3ml syringe.

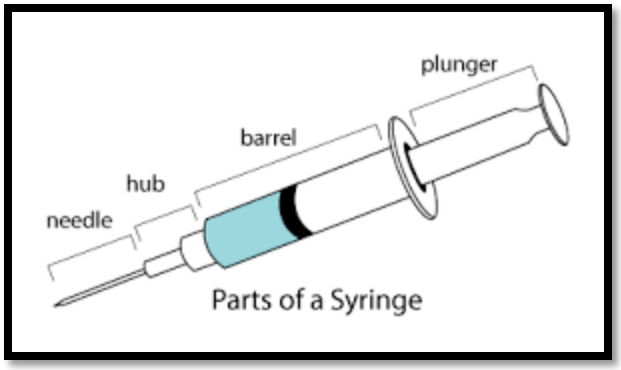


Figure 4: Parts of a syringe

Syringes are usually marked using a scale of tenths of a milliliter; however, tuberculin (TB) syringes are marked using a scale of hundredths of a milliliter as they are used for very small amounts of medication. Insulin syringes hold between 0.3 to 1ml and are calibrated in units. Each milliliter of solution contains 100 units of insulin.

Disposable Injection Units

Some injectable medications are also available in single-dose, prefilled, disposable syringes. These devices mean you do not need to prepare the dose. However, it is always important to check the medication and dose carefully because prefilled syringes can look quite similar (Perry et al., 2020). The benefits of disposable injection units are that the dose has already been prepared and it reduces the risk of needle stick injuries.

Figure 5: Prefilled syringes

SAFETY GUIDELINES

Safety is an important consideration when administering parenteral medications, both for the client and the nursing professional. There is increased risk associated with this method of medication delivery such as infection and formation of an emboli, therefore these medications must be prepared with accuracy to ensure clients safety (Vega et al., 2015). Additionally, these medications create an increased risk for nursing professionals such as exposure to hazardous agents and injuries from needle sticks.

As always, nursing professionals must follow the 10 rights of medication administration and perform their 3 checks prior to administering any medication. To increase client comfort, nursing professionals must ensure they insert the needle at the appropriate angle and do so swiftly and confidently. Once the needle has entered the body tissue you should hold the syringe steady to prevent any tissue damage and slowly and smoothly inject the medication. Once the medication has been administered, withdraw the needle using the same angle you inserted with. Then gently apply a gauze or bandage if any bleeding occurs. It is also important to rotate injection sites for those clients who will receive multiple injections.

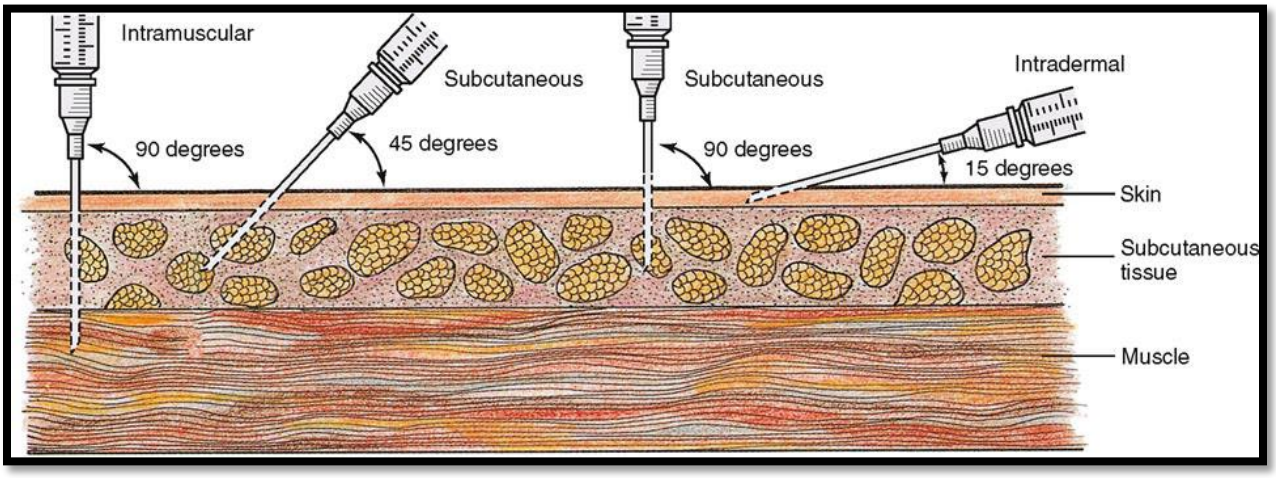


Figure 6: Angles of insertion for parenteral medication administration

Infection Control

The prevention of infection must always be a priority for nursing professionals for every nursing intervention they perform. When administering medications using the parenteral route, nursing professionals must ensure they are employing sterile techniques.

Hand hygiene is our best defense against infection and must be performed prior to administering a parenteral medication and in between clients. It is also important to prevent the contamination of the needle and syringe. The needle or syringe must always remain sterile and to prevent contamination you should:

- Avoid letting the needle touch unsterile surfaces (outer edges of ampoules or vials, surface of needle cap, surface of counter);
- Always keep the needle covered when not in use and use scoop-cap method to avoid needle stick injuries;

- Avoid touching the length of the plunger; and
- Keep the tip of the syringe sterile by covering with cap or needle (Doyle & McCutcheon, 2015).

Before administering the injection, cleanse the client's skin with an alcohol swab using a circular motion for 15 seconds and allow the area to air dry for 30 seconds (Perry et al., 2020). If the client's skin is visibly soiled, use soap and water to cleanse the skin. Always cleanse from the center of the site and then move outwards.

If drawing up the medication from an ampoule, never let the ampoule sit open to avoid contamination of the medication (Perry et al., 2020). Once opened, the medication should be withdrawn quickly and discard of the ampoule appropriately. If there is medication left over in the ampoule, perform a waste with another nursing professional.

Single use syringes and needles must always be used for each client. Nursing professionals should also always check the packaging to ensure it is intact and verify the expiry date. Once the medication has been administered, promptly discard of the needle and syringe into a sharp's container as a single unit (do not remove needle from syringe).

Needle Stick Prevention

Nursing professionals must also ensure their own safety when administering parenteral medications. The main risk for nursing professionals is experiencing a needle-stick injury. Most often these injuries occur when nursing professionals recap needles, inappropriate handling of IV lines and needles, or from leaving needles at the bedside (Perry et al., 2020).

Using safe needle devices is one of the best defenses against needle stick injuries for health care workers. A sharp with engineered sharps injury protection (SESIP) is a device that is designed to prevent needle-stick injuries. Some examples of this include blunt end cannulas and safety syringes that contain a plastic guard which slips over the needle as it is withdrawn from the skin.

Figure 7: Needle with protective guard

Figure 8: Retractable needle

The following are recommendations to follow to prevent needle stick injuries:

- Use sharps with engineered sharps injury protection (SESIP) safety devices;
- Never recap a needle after administration;
- Have a plan for safe handling and disposal of sharps ahead of time;
- Immediately dispose of needles into sharps container;
- Attend education sessions regarding blood-borne pathogens and follow all recommendations for infection prevention; and
- Participate in the selection and evaluation of SESIP devices within your workplace when possible (Perry et al., 2020).

SUBCUTANEOUS INJECTIONS

A subcutaneous injection is done by inserting the needle through the dermis and delivering the medication into the subcutaneous tissue. The subcutaneous tissues contain less blood vessels than muscles do, therefor medications delivered via this route take longer to absorb (Perry et al., 2020). Common medications delivered via this route are insulin and heparin. Generally, the maximum amount delivered subcutaneously **does not exceed 2mls**.

Subcutaneous injections can be administered to various sites including the outer area of the upper arms, the abdomen, the front of the thigh, or the upper area of the buttock behind the hip bone. The primary injection site for subcutaneous medication administration is the abdomen. The abdomen absorbs medication the fastest, followed by the arm, thigh, and the buttocks. For those who receive multiple injections (i.e., diabetics), sites should be rotated to avoid complications such as **lipohypertrophy,** which can cause incomplete medication absorption (Kim & De Jesus, 2022). For insulin injections, a diagram specifying the injection rotation can be found in the client's chart.

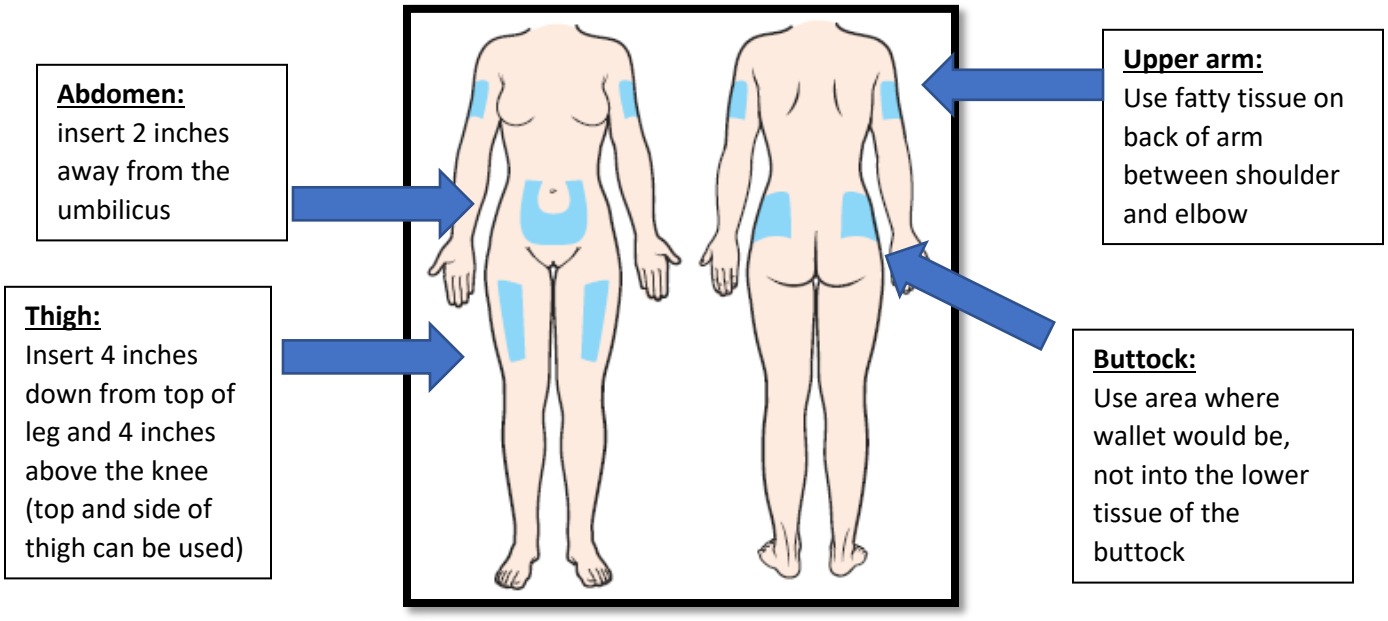


Figure 9: Subcutaneous injection sites

Clients often experience discomfort with subcutaneous injections as the tissues located here have pain receptors and the tissue is also sensitive to irritating solutions and large volumes of medications. Whichever site is used, it should be free of skin lesions, bony prominences, and large underlying muscles or nerves (Perry et al., 2020).

In general, a 25-gauge, 5/8-inch needle is used and inserted at a 45-degree angle, or a ½-inch needle inserted at a 90-degree angle for average adult clients. To help ensure that the medication reaches the subcutaneous tissue follow this rule: *if you can grasp 2 inches of tissue, insert at 90 degrees; if you can only grasp 1 inch of tissue, insert at a 45-degree angle.*

For obese clients, pinch the tissue and use a longer needle to insert past the fatty tissue at the base of the skin fold. Clients who are very thin often do not have enough tissue for subcutaneous injections, therefore the upper abdomen is usually the best site for these clients.

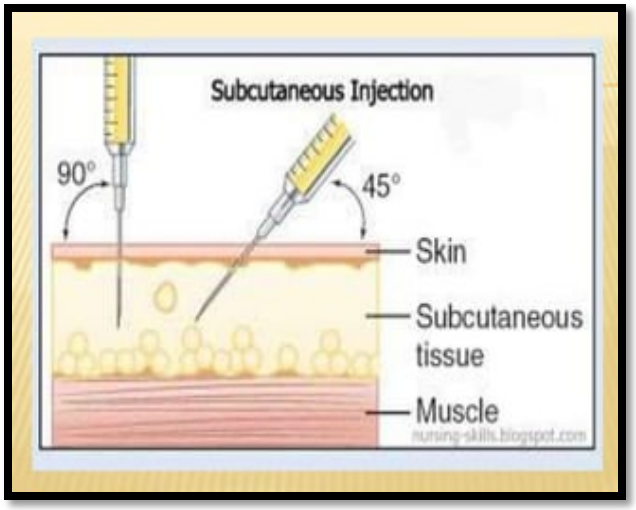


Figure 10: Subcutaneous angle of insertion

Please see Appendix B: *Subcutaneous Injection Skills Check*.

INTRAMUSCULAR INJECTIONS

An intramuscular injection is done by inserting the needle through the dermis, subcutaneous layer, and into the muscle. The medication gets injected into the deep muscle tissue which has a rich blood supply. This allows the medication to be absorbed much faster than the subcutaneous route (Perry et al., 2020). Some common medications delivered via the intramuscular route include **hormonal agents** such as testosterone, **biologicals** such as vaccines or toxoids, and some **antibiotics** such as streptomycin (Gutierrez & Munakomi, 2022). Amounts injected intramuscularly generally do not exceed 2mls but may go up to 4mls. If the amount is greater than 2mls, a larger muscle should be used, or the dose should be given using more than one injection.

The angle of insertion is 90 degrees, and the muscle is less sensitive to irritating and viscous medications. For multiple injections, sites should be rotated to decrease the risk of hypertrophy. Intramuscular injections can be administered into various muscles including the ventrogluteal, vastus lateralis, deltoid, and rectus femoris.

Ventrogluteal Site

The ventrogluteal muscle is located deep and away from major nerves and blood vessels, which makes it the preferred and safest site for all adults, children, and infants (Perry et al., 2020***). The exception to this is children (under 3 years old) and infants receiving immunizations as the muscle is not yet fully developed; therefor for immunizations delivered intramuscularly the vastus lateralis muscle should be used.***

To locate this muscle, have the client lie in either the supine or lateral position. Place the palm of your hand over the greater trochanter of the client's hip with your wrist almost perpendicular to the femur. Use your right hand for the left hip, and the left hand for the right hip. Point your thumb towards the client's groin, your index finger on the greater iliac spine and your middle finger extended to the iliac crest. The injection is made in the center of the "V" that is formed between your index and middle finger.

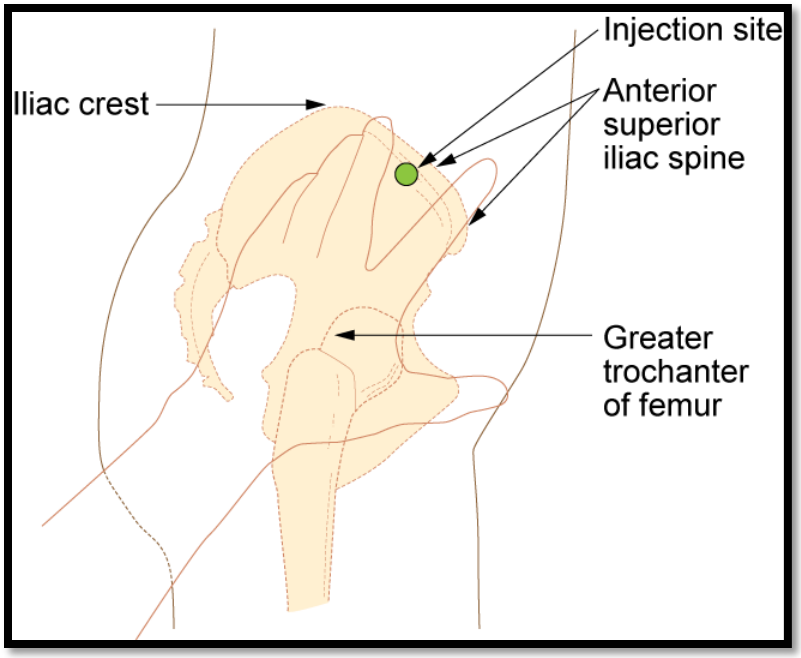


Figure 11: Ventrogluteal site

Vastus Lateralis Site

The vastus lateralis muscle is thick and well developed and is another viable site for adults. It is also the preferred site for immunizations to infants, and toddlers. This muscle provides safe and rapid absorption and is located away from nerves and blood vessels.

This muscle is located one hand breadth above the knee and one hand breadth below the greater trochanter of the femur. Use the outer middle third of the muscle to inject the medication (Perry et al., 2020).

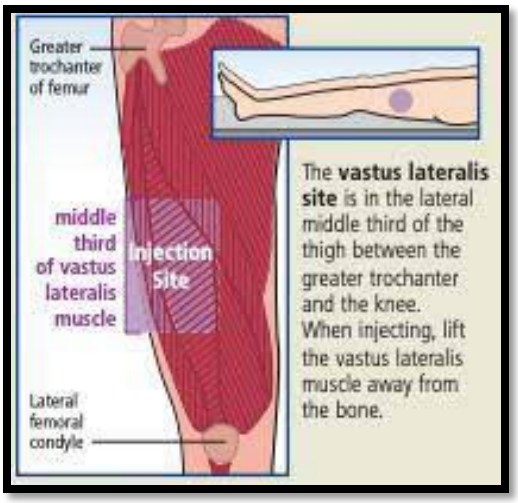


Figure 12: Vastus Lateralis

Dorsogluteal Site

The dorsogluteal site is not a preferred site due to its close proximity to the sciatic nerve and major blood vessels. If used, it is in the upper, outer quadrant within the buttocks and 5 to 7.5cm below the iliac crest (Gutierrez et al., 2022).

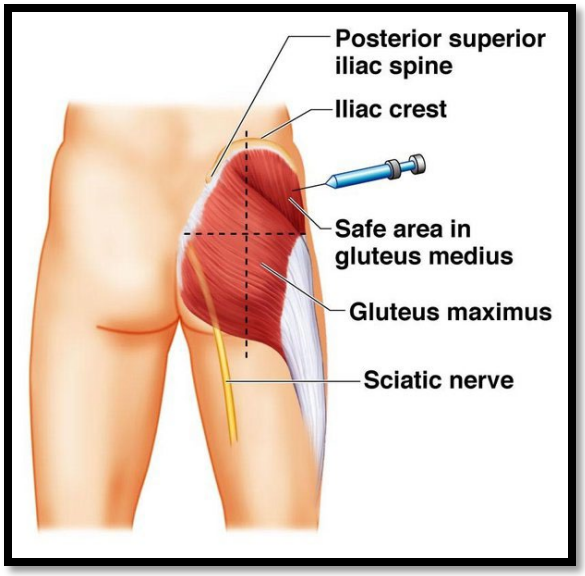


Figure 13: Dorsogluteal site

Deltoid Site

The deltoid muscle is easily accessible and used most often for injections related to immunization. However, this muscle is not well developed in many adults and poses a risk for injury due to the axillary, radial, brachial, and ulnar nerves and the brachial artery that lies within the upper arm under the triceps and along the humerus (Perry et al., 2020). This muscle is used to deliver small amounts of a medication and is not to exceed 2mls.

To locate this muscle, ask the client to relax their arm and expose the upper area of the arm. Place your fingers on the client's shoulder and palpate the lower edge of the acromion process. Once you locate the acromion process, place your index and middle finger on the landmark, creating an inverted triangle. The injection site is located 1-2 inches below the acromion process in the center of the triangle.

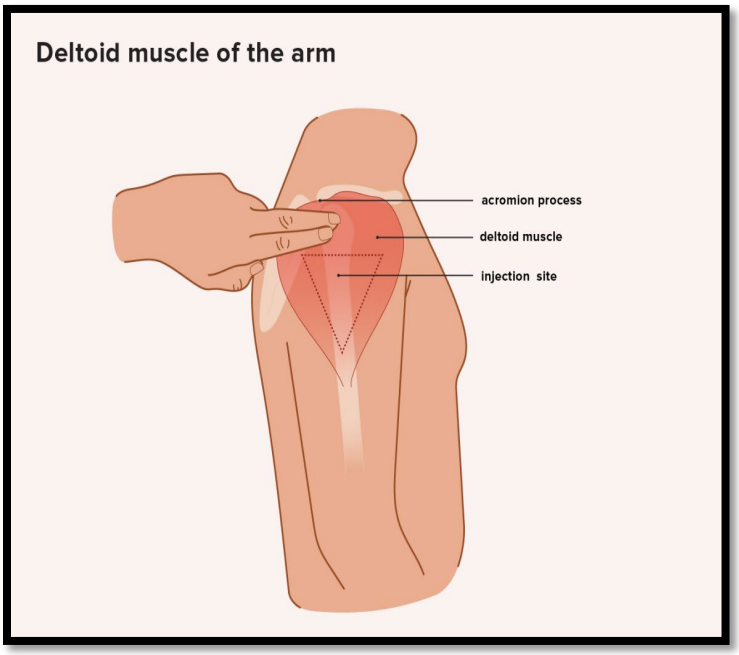


Figure 14: Deltoid site

Z Track Method

The Z track method is a technique used to pull the skin during an injection and is recommended for injections that are irritating to the skin or for medications that may stain the skin. It also helps prevent medication from leaking into the subcutaneous tissue by sealing the medication into the muscle (Perry et al., 2020).

To perform the Z track method, pull the skin and subcutaneous tissue to one side by 1 – 1/12 inches and hold in position until you have administered the injection. This will seal the injection track and "lock" the medication into the muscle.

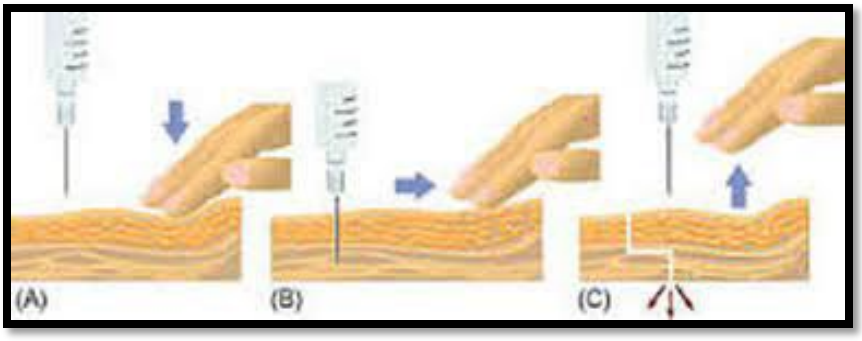


Figure 15: Z-Track Method

Special Considerations

When administering via the intramuscular route, there are several considerations to be aware of such as:

- Never inject a medication into a sensitive muscle; if a muscle is "twitching" do not use it as the nerve could trigger a sharp pain;
- If more than 5mls needs to be injected into a muscle, divide the dose into two separate injections;
- Encourage clients to relax during injections as a relaxed muscle is less painful;
- Elderly clients may bleed more easily due to less skin elasticity; a small bandage may need to be applied. Clients on blood thinners may also bleed after an injection;
- Elderly clients with decreased muscle mass may absorb medications more quickly than expected;
- Ensure you rotate injection sites as not doing so may cause medications to not be fully absorbed and reduce the therapeutic effect; and
- Ensure you are using a long enough needle to access the muscle. If accidentally inserted into the subcutaneous tissue, it can be irritating and lead to abscesses.

Please see Appendix C: *Intramuscular Injection Skills Check*

INTRADERMAL INJECTIONS

Intradermal injections are mainly used for skin testing (allergies and tuberculin screening) or for treatments such as immunotherapy for diagnosed allergies. Medications injected via this route are potent which is why they are only injected into the dermis where blood supply is reduced and the absorption is slow (Perry et al., 2020). The intradermal route has the longest absorption time of all parenteral routes (Doyle & McCutcheon, 2015).

Administrations done intradermally are normally done with a tuberculin syringe or a very small needle with a 27-gauge needle and length of 3/8 – 5/8 inches. The angle of insertion is only 5 -15 degrees and only small amounts (0.01-0.1ml) are injected. The ideal sites are the inner forearm and upper back, under the scapula (Doyle et al., 2015).

When performing skin testing you are required to visually inspect the site. If a "bleb" does not occur or blood appears after the needle is withdrawn, it may mean that the medication has entered the subcutaneous tissue. If this occurs, the results will not be valid.

Figure 16: Intradermal injection

PREPARING MEDICATIONS FROM AMPOULES & VIALS

Administering medications via the parenteral route often requires you to withdraw the medication from an ampoule or vial. **Ampoules** contain a single dose of a medication in liquid form. They are made of glass with a prescored neck that is broken off to access the medication (Perry et al., 2020). Medication is then withdrawn from the ampoule using a filtered needle, which prevents any glass particles from being withdraw with the medication. Never inject a medication using a filtered needle. After withdrawing the medication, change it to an appropriate-size needle for injection.

A **vial** is a single or multi-dose plastic or glass container which is topped with a rubber seal. Once a single dose vial is opened, you must discard it regardless of the amount of medication that is used. A multi-dose vial, however, can be used several times for a single client only (Perry et al., 2020). When using a multi-dose vial, you must write the date that it was opened on the vial label. Vials may contain liquid or dry forms of medication. When a medication is supplied in a dry form, the label on the vial will specify the solvent or diluent to use to dissolve the medication and the amount to use. Normal saline or sterile water is most often used.

To withdraw medications from a vial, air must be injected into the vial first. Some medications provided in a vial may require the use of a filter needle to withdraw the medication. Always check employer policies and package inserts from the manufacturer to verify. Before inserting the needle, wipe the top of the seal with an alcohol swab and allow it to dry. Inject the same amount of air as the medication dose, invert the vial and keep the bevel of the needle below the fluid level. Allow air pressure from the vial to gradually fill the syringe with the desired dose of the medication. Remove needle from the vial and ensure there are no air bubbles. Before injecting the medication, change the needle to an appropriate size.

INTRAVENOUS MEDICATION ADMINISTRATION

Delivering medications intravenously (IV) involves administering a medication directly into a client's vein. There are various ways to administer IV medications such as by primary IV infusions, piggyback, volume controlled, and mini-infusion pumps.

These medications are most often given through a peripheral line or saline lock, buy may also be administered via direct IV (IV Push) or through an implanted vascular access port or central line. The upper extremities are the preferred sites for IV medication administration as they pose a lower risk for thrombophlebitis and thrombosis than the lower extremities (Kim et al., 2022).

Indications for IV Medication Administration

The primary indication for administering medications intravenously is to ensure a rapid systemic response to the medication. IV medication administration is the fastest route to deliver medications and therefor these medications become immediately available to the body. This will help ensure that the therapeutic response will be reached quickly.

Medications delivered intravenously also make it easier to control the actual amount of medication being delivered to the body which makes it easier to maintain drug levels in the blood to initiate the therapeutic response. This route is also ideal when medications are too irritating to tissues to be given

by other parenteral routes or if medications are poorly absorbed in the gastrointestinal tract (Kim et al., 2022).

Safety Alert!

As IV medications are delivered immediately, this can result in clients experiencing severe adverse reactions if they are administered too quickly.

IV medications become available in the blood stream immediately, therefore nursing professionals must verify the prescribed rate of administration to ensure that the medication is given over the appropriate time.

Advantages & Disadvantages of IV Medication Administration

There are several advantages and disadvantages to delivering medications intravenously that are outlined in the table below:

Advantages	Disadvantages
Delivery of immediate, fast-acting therapeutic effect (essential for emergencies such as cardiac arrest or narcotic overdose).	Once delivered, it cannot be retrieved and there is little opportunity to stop an injection if an adverse reaction or error occurs. If given too quickly it can cause harm or death.
Medications can be prepared quickly and given over a shorter period.	Toxic or adverse reactions can occur immediately.
Requires minimal dilution for some medications, which is desirable for client's own fluid restrictions.	Extravasation of certain medications into surrounding tissues can cause nerve damage, sloughing, and scarring
Minimal to no discomfort for client's compared to subcutaneous and intramuscular injections.	Increased risk of phlebitis with highly concentrated medications.
Provide an alternative for medications that may not be absorbed by the GI tract or for clients who are NPO or unconscious.	Higher risk for infusion reactions due to the rapid peak of onset.

Adapted from Doyle et al., 2015

Compatibility

When administering medications intravenously, it is imperative that they are delivered with a compatible fluid. If the fluid and medication are incompatible, an undesirable reaction will occur between the fluid and the medications.

There are two types of incompatibilities associated with intravenous medication administration:

- Physical: Occurs when there are changes in color, viscosity, precipitation (i.e., formation of crystals), cloudiness of solution, or release of gases.
- Chemical: Occurs when there is a degradation of more than 10% of molecular alteration and is related to the temperature and pH of the drug solution (Paes, Moreira, Moreira, & Martins, 2017).

To avoid incompatibility, medications and solutions that are to be mixed should have similar pH values. Additionally, you should follow these rules and refer to any compatibility charts available through your employer:

- Only use solutions that are recommended for medications (Compatibility charts);
- Never mix solutions with blood, blood products, or TPN; and
- Always ensure medications are compatible with the primary infusion solution.

Complications

Continuous assessment of IV sites is required throughout a client's infusion therapy. Despite the many benefits of infusion therapy, complications can arise that LPNs need to be aware of to provide safe client care.

Phlebitis / Thrombophlebitis

Phlebitis is the most frequent and under-reported complication of infusion therapy. Phlebitis is the inflammation of the vein related to a chemical and/or mechanical irritation. **Thrombophlebitis** occurs when a blood clot in the vein causes inflammation.

Mechanical irritation may be caused by the cannula rubbing and irritating the vein or using a catheter that is too large for the site. **Chemical irritation** may occur due to medications being administered with a high alkaline, acidic, or hypertonic solution.

Phlebitis can be dangerous as blood clots can form and result in **emboli**.

To avoid a chemical irritation, LPNs should refer to facility guidelines for administering IV medications with the appropriate amount and rate of solution for infusion.

Signs & Symptoms:

- Pain/Tenderness
- Erythema
- Edema
- Warmth
- Red streak
- Venous "cording" (hardening)

Figure 17: Phlebitis

Interventions:

If thrombophlebitis is suspected, **do not** *flush the line as it may cause the clot to enter the vein further.*

- Stop the infusion and remove the IV
- Apply warm compress to the site, elevate the arm to reduce swelling
- Document the findings and actions in the client's chart
- If infusion is still required, restart in a new site using a new administration set

Infiltration / Interstitial

Infiltration occurs when a non-vesicant solution (intravenous fluid) unintentionally enters the surrounding spaces around the insertion site. This may be due to the cannula dislodging or perforating the wall of the vein.

Signs & Symptoms:

- Swelling around the site (result of fluid leaking)
- Cool to touch
- Skin looks blanched, "tight", or "taut"
- Pain/tenderness
- Decreased flow rate of the IV or IV may completely stop flowing
- IV pump alarming frequently

Figure 18: Infiltration

Interventions:

- Stop the infusion and remove the IV
- Raise the extremity to reduce swelling
- May wrap extremity in warm, moist towel for 20 minutes
- Document findings and actions in the client's chart
- If infusion is still required, restart in a new site using a new administration set

Extravasation

Extravasation occurs when a vesicant solution or medication leaks into the surrounding tissues. A **vesicant** is a drug that has corrosive properties which has the potential to cause tissue damage. Injuries resulting from extravasation range from erythematous reactions to skin sloughing and necrosis. The severity is dependent on the type, concentration, and volume of fluid infiltrated into the interstitial tissue.

Signs & Symptoms:

- Pain, tenderness, or discomfort
- Edema at, above, or below the insertion site
- Blanching of area around the insertion site
- Change in skin temperature at the insertion site
- Burning/stinging at the insertion site
- Redness followed by blistering, necrosis, and ulceration
- Feeling of tightness below the site

Figure 19: Extravasation

Interventions:

- Stop the infusion
- Notify the authorizing prescriber and administer an antidote according to facility procedure
- Elevate the affected limb, apply heat or cold – do not apply pressure to the site
- Document the findings and actions in the client's

*Do **not** remove the IV until it has been assessed by a physician/NP as medication/antidote for tissue damage may be administered though the IV.*

Infection

A local infection occurring at the insertion site most commonly occurs two to three days after the IV has been initiated. They are often referred to as **Catheter Related Blood Stream Infections** (CR-BSI). These infections are preventable by using strict aseptic techniques and changing administration sets according to facility procedures.

Signs & Symptoms:

- Purulent drainage from the site
- Erythema
- Edema
- Elevated body temperature
- Cellulitis

Interventions:

- Stop the infusion and remove the IV
- Apply a warm compress to the site
- If purulent drainage is noted, send a culture of the site and catheter to microbiology (as ordered) for diagnosis

Hematoma

Hematomas are the result of a collection of blood in the tissue that can be caused by unsuccessful attempts at insertion or lacerating the vein wall.

Signs & Symptoms:

- Raised area of ecchymosis
- Swelling
- Pain/tenderness
- Occasional bleeding at the site

Interventions:

- Stop the transfusion and remove the IV
- Elevate the limb and apply direct pressure with sterile gauze
- Apply a cold compress

Methods of IV Administration

There are different methods of administration when using infusion therapy. Despite the method, all medication administration done by transfusion must be prepared using aseptic technique.

Primary IV Infusion

Primary IV infusions are mainly prescribed to restore or maintain hydration and electrolyte status for clients. They are typically administered using an IV pump as this is the safest method of administration (Ernstmeyer & Christman, 2022).

Figure 20: Primary IV Infusion

With this method, medications are diluted in a large volume of compatible IV fluid such as normal saline or Lactated Ringers. Diluting the medication in a compatible fluid reduces the risk of side effects or adverse reactions.

A common example of this method would be administering potassium chloride or vitamins that are mixed into the main IV solution bag and run continuously. The medication gets injected into the IV bag by pharmacy or the nursing professional prior to hanging the solution.

When medications are added to an IV solution a label indicating the medication must be placed onto the bag.

Volume Controlled

These are small containers that attach just below the primary infusion bag and involves administering the medication in a small amount of compatible IV fluid. They are most often used for children and older adults when the volume administered is critical and must be carefully monitored.

The advantages for using this method include:

- Reduces the risk of rapid-dose infusion by IV push;
- Allows for the administration of medications that are stable for a limited period of time in solution (i.e., antibiotics); and
- It allows for control of IV fluid intake.

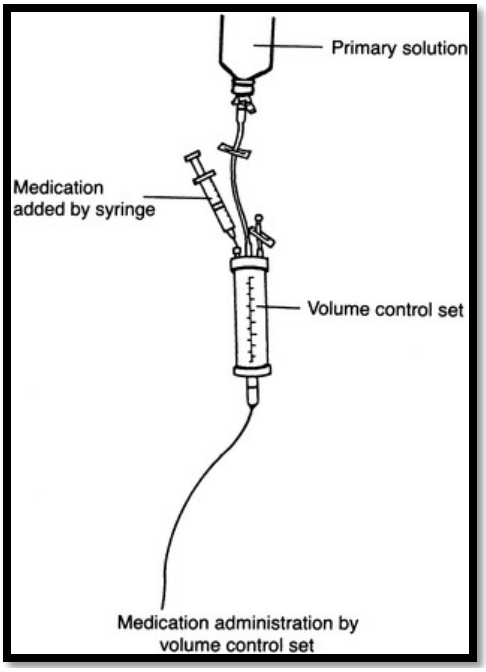


Figure 21: Volume controlled infusion

IV Piggyback (IVPB)

When a medication is to be delivered IV Piggyback, you will see it written as IVPB. A piggyback is a small IV bag (25-250mls) that is connected to a short line of tubing that connects to the upper Y-port of the primary infusion line (Perry et al., 2020). The IV Piggyback is always hung *higher* than the primary infusion bag and is labeled with the appropriate medication additive label.

With this set up, the primary infusion does not run while the compatible piggyback medication is being infused. The primary line's port contains a back-check valve that automatically stops the flow of the primary infusion when the piggyback is running. After the piggyback solution infuses, the back-check valve opens, and the primary infusion begins to flow again.

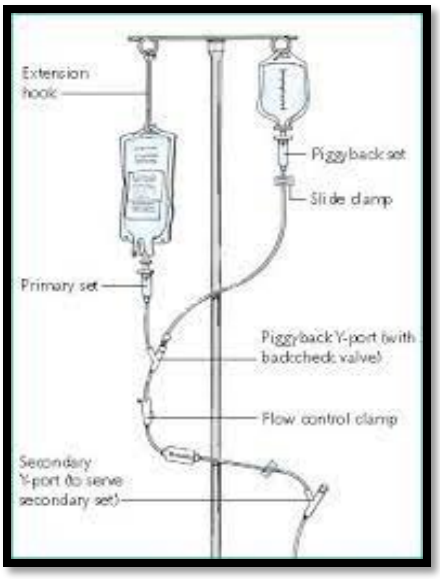


Figure 22: Piggyback Method

Mini-Infusion Pump

A mini-infusion pump is battery operated and delivers a medication in very small amounts of fluid within controlled infusion times using standard syringes. Common examples include PCA pumps or antibiotic pumps. These pumps are set to deliver a certain amount of medication hourly. Medications such as narcotics, are set for clients to administer a set amount themselves every hour (PRN).

Figure 23: Mini-Infusion Pump

Intravenous Calculations

If a medication calculation is required, the health professional administering the medication must be the one performing the calculation. Which calculation method you use is dependent on the delivery method.

Calculating for Large Volume Infusions (by gravity)

For this medication delivery, the medication is added to a large volume bag such as 500 or 100mls, and with each hour that passes, the client receives a small amount of medication with the hourly fluid.

To perform this calculation, you need the following:

- The volume to be infused within a given time frame (i.e., 100mls/hour); and
- The drop factor for the infusion set (i.e., 10 drops/minutes).

Formula:

$$\frac{Volume\ to\ be\ infused\ (ml)}{Time\ (minutes)}\ x\ Drop\ Factor\ = Flow\ rate\ in\ gtts/min$$

Example:

40mEq of KCL has been added to 1000ml bag of 0.45% NaCl

The prescriber has ordered an hourly rate of 125ml. The drop factor is 10 gtts/min.

$$\frac{125\ (mL)}{60\ (minutes)}\ x\ 10\ = 21 gtts/min$$

***Note:* A fraction of a drop is not possible to administer, therefor you always round your answer to the nearest whole number. In this example, the exact calculation is 20.8, however, we round up to 21.**

This calculation is for a gravity drip. If the infusion was on a pump, you would simply set the rate at 125mls/hour.

Calculating Intermittent IV Medication Dose Rates

These medications are normally administered by IVPB through a saline lock, PICC line, or mainline IV. The same formula is used for calculating as large volume infusions. The only difference is that the amount of time that a medication mini bag is to run is very specific. Therefore, rather than always using 60 minutes on the bottom of the formula, the exact time in minutes is recommended.

Example:

Gentamycin 200mg is mixed in 50mls of 0.9% NaCl and is to infuse over 20 minutes. Secondary medication sets are 10gtts/min drop factor. Calculate the rate.

If run by gravity, this would be the calculation:

$$\frac{50\ (amount\ in\ mini\ bag)}{20\ (minutes)}\ x\ 10\ = 25 gtts/min$$

If this was being run on an IV pump:

- There are 60 minutes in an hour
- Divide 60 by 20, so you know there are 3 sets of 20 in one hour
- Multiply the volume to be administered by 3
- 50 x 3 = 150
- This gives you the rate to program the pump = 150mls/hour
- At this rate, 50mls will be infused in 20 minutes

Calculating Flow Rate for an Infusion Pump

As infusion pumps do not have a calibrated drop factor, the flow rate depends on the volume of fluid ordered and the time of infusion. The time is also always done in hours, rather than minutes for infusion pumps.

Formula:

$$\frac{Volume\ (mL)}{Time\ (hours)} = Flow\ rate\ in\ mL/hr$$

Example:

1200mL D5W is ordered to infuse in 10 hours by infusion pump. Calculate the flow rate in milliliters per hour.

$$\frac{1200\ (mL)}{10\ (hours)} = 120\ mL/hr$$

If you are unsure about calculations, ask a mentor! Always double check your calculations with another nursing professional to ensure accuracy.

Practice Questions

1. Calculate the IV flow rate for 250mL of 0.5% dextrose to be administered over 180 minutes. The infusion set has a drop factor of 30 gtts/minute.

2. The infusion set is adjusted for a drop factor of 15 gtts/mL. Calculate the IV flow rate if 1500mL IV saline is ordered to be infused over 12 hours.

3. 600 mL of an antibiotic is to be infused over 180 minutes by an infusion pump. Calculate the flow rate.

ANSWER KEY

1. 42 gtts/minute
2. 31 gtts/minute
3. 200 mls/hour

INSULIN ADMINISTRATION

Insulin is a hormone produced by the pancreas to control the amount of glucose in the blood. It is also a key regulator of carbohydrates, fats, and protein metabolism and storage. For those living with diabetes mellitus, their pancreas either does not produce enough, or any, insulin or; their body is unable to effectively use the insulin it does produce.

There are two types of diabetes each with its own causes, risk factors, and symptoms. Individuals with **Type I diabetes** do not produce any insulin, therefor they must take insulin daily. Individuals with **Type II diabetes** can produce insulin, however their cells become more resistant to insulin. Those with Type II diabetes are often treated with diet, exercise, and oral hypoglycemics. However, if their diabetes is not well controlled through these methods, they also may be required to take insulin.

Insulin is the hormone used to treat diabetes and it is supplied in vials or as cartridges for injection pens. Insulin is classified by its onset, peak time, and duration of action (Perry et al., 2020). It is important to consider the mechanism of action of the insulin prescribed for the client to prevent hypoglycemia and to optimize results.

BOLUS INSULINS

Rapid-Acting Insulin (Clear)

Rapid-acting insulin begins working almost immediately inside the body as it has an onset action of 5-15 minutes. This type of insulin should be taken just before or after eating. The peak effect occurs within 1-2 hours and the duration of action is up to 4 hours. This type of insulin quickly drops the blood sugar level and works for a short period of time (Healthwise, 2020).

Examples: NovoRapid, Humalog

Short-Acting / Regular Insulin (Clear)

Short acting insulin also goes to work quickly once injected with an onset action of 15-30 minutes. This type of insulin should also be given at mealtime. The peak effect occurs within 2-5 hours and the duration of action is between 5-8 hours.

Examples: Humulin-R, Novolin ge Toronto

BASAL INSULINS

Intermediate-Acting Insulin (Cloudy)

Intermediate-acting insulin has an onset action of 1-3 hours and peaks between 5-8 hours. The duration of action lasts up to 18 hours. This is often given once daily at bedtime. It is not administered at any time that is specific to meals (CJD, 2018).

Examples: Humulin-N, Novolin ge NPH

Long-Acting Insulins (Clear)

Long-acting insulins have a peak onset of approximately 90 minutes with no set peak time. It's action of duration is approximately 24 hours. This is also often started once daily at bedtime and not given at any time specific to meals (CJD, 2018).

Long-acting insulins such as insulin glargine (Lantus) are only injected once a day. It's duration of action is sustained for 24 hours with no peak times and Lantus must not be mixed with any other insulin.

Example: Lantus, Levemir

PRE-MIXED INSULINS

There are a variety of pre-mixed insulin, and these are primarily used by people with Type II diabetes. Pre-mixed insulin is a combination of short and long-acting insulin. The short-acting portion takes effect within 30 minutes and the long-acting works more gradually for 5-10 hours.

Pre-Mixed Regular Insulin

The onset, peak, and duration of pre-mixed insulins depends on the amount of rapid-acting or short-acting insulin and the amount of intermediate-acting insulin. This insulin is given with one or more meals per day and should be injected 30-45 minutes before the start of a meal.

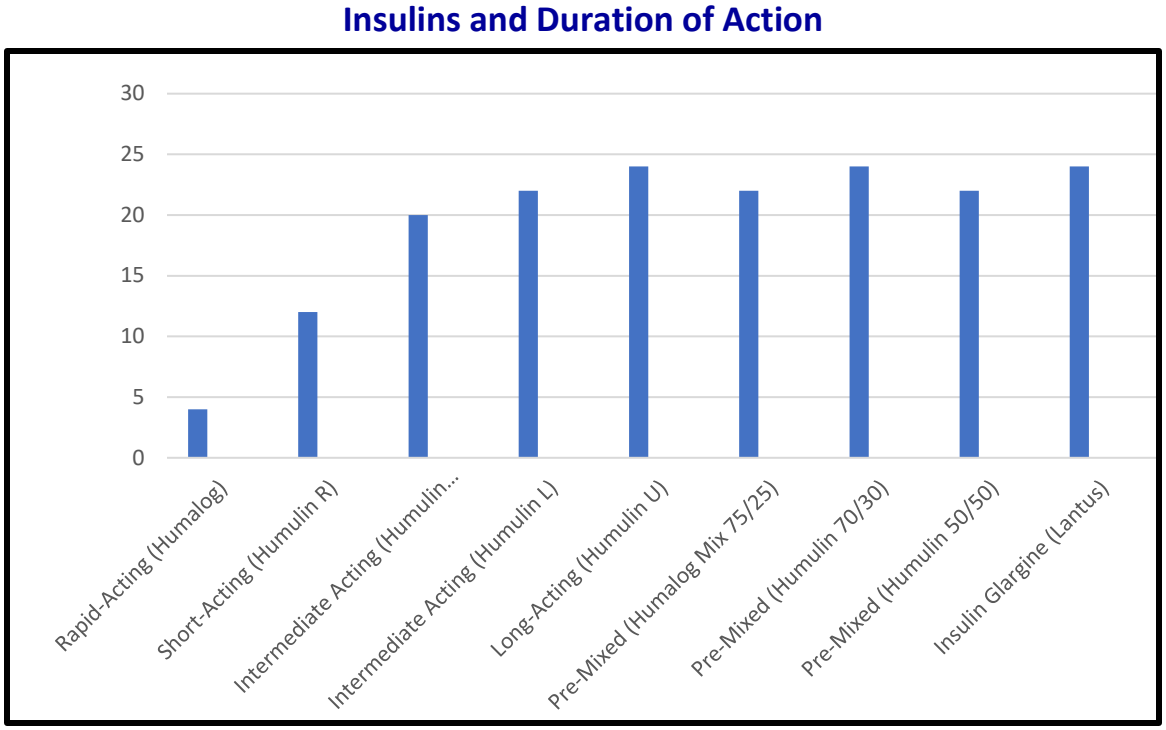
Examples: Humulin 30/70, Novolin ge 30/70,40/60,50/50

Premixed Insulin Analogues

As with pre-mixed regular insulin; the onset, peak, and duration is dependent on the amount of rapid-acting or short-acting insulin and the amount of intermediate-acting insulin. This insulin is given with one or more meals per day and should be injected 0-15 minutes before or after meals.

Examples: Humalog Mix 25, Novomix 30

The following chart summarizes some of the more common insulins and their duration of activity (time is in hours):



Insulin Injection Method & Storage

Insulin is injected subcutaneously using an insulin syringe or an insulin pen. Clients may also have an insulin pump to assist in the management of their illness. You may inject insulin into any of the previously indicated subcutaneous sites in this module; however, the primary site is the abdomen.

Injection sites for insulin should be rotated and you should note the site of injection to ensure site rotation occurs with the health care team. Prior to administering insulin, a blood glucose reading must be performed to detect hypoglycemia.

Insulin should be warmed up prior to administering by rolling the cartridge or vial between your hands. Once a vial is opened, it can be used for one month and stored at room temperature. Unopened insulin should be stored in the refrigerator between 2 – 8 degrees Celsius (Diabetes Canada, 2018). Never store insulin in a freezer or allow it to be exposed to direct sunlight.

Injecting with an Insulin Pen

Administering insulin via an insulin pen is the most common method used. Insulin pens use prefilled insulin cartridges that are loaded into the pen holder. A disposable needle tip is then attached to the end of the pen for injecting.

Not all pens are the same so nursing professionals should always review the operating instructions before use. Generally, instructions for using an insulin pen are:

- Gather supplies of insulin pen and cartridge, disposable needle, and alcohol swab;

- Load the cartridge into the pen (always check the appearance of the insulin, if it is a cloudy insulin you need to mix it by rolling it ten times and then inverting it 10 times);
- Cleanse the tip of the cartridge with an alcohol swab;
- Attach the disposable needle to the pen and remove the cap;
- Prim the pen (2 units) *;
- Cleanse the injection site with an alcohol swab;
- Dial up the dose to be administered;
- Inject into the desired site and compress the dosing button until the dial returns to zero and remove;
- Dispose of needle tip into sharps container and put pen cap back on.

Figure 24: Insulin Pen

*Priming an insulin pen: To prime an insulin pen, dial up approximately 2 -3 units and point the pen upwards. Then compress the dosing button. If no insulin is released, repeat by dialing up another 2-3 units until insulin flows freely from the pen.

MIXING INSULIN

At times you may need to inject two different types of insulin at the same time for better blood sugar control. This would require you to mix the insulins and give in one injection, rather than two separate injections. When drawing insulin from a vial, you need to draw up and inject the amount of air that is equal to the amount of insulin to be administered first.

Mixing two insulins requires combining a short acting insulin (clear) and a long-acting insulin (cloudy). **When mixing insulin, you always go from clear to cloudy.** This means that you are always going to draw up the short acting insulin (clear) first and then the long-acting insulin (cloudy) second.

Example Order:

10 units of Humulin-R (regular insulin) and 15 units of Humulin-N (long-acting insulin).

- Pull plunger down to let 15 units of air in your syringe (cloudy)
- Push the needle through the rubber top of the cloudy insulin vial and push the air into the cloudy insulin vial
- Pull the needle out of the cloudy insulin vial, you are not going to draw any insulin out yet
- Pull the plunger down to let 10 units of air into your syringe (clear)
- Push the needle through the rubber top of the clear insulin vial and push the air into the clear insulin vial
- Keep the needle in the vial and invert the vial upside down. Slowly pull back on the plunger to get 10 units of the clear insulin (Humulin-R). Pull slowly to avoid getting air bubbles in the syringe and then pull the needle out of the vial
- Push the needle through the rubber top of the cloudy insulin vial and invert the vial upside down. Slowly pull back on the plunger to get 15 units of the long-acting (cloudy) insulin.

You should now have 10 units of regular insulin, 15 units of long-acting insulin, for a total of 25 units.

CONCLUSION

Administering medications using the parenteral route requires nursing professionals to be extremely vigilant with their practice. Delivery of medications using the parenteral route is the fastest route, which also means that potential adverse reactions will occur much faster. Nursing professionals must follow all best practice recommendations to avoid errors and continuously monitor their clients for adverse reactions, as they can be more difficult to mitigate once they occur.

Appendix A: Vaccine Administration: Needle Gauge and Length

YOU CALL THE SHOTS

Vaccine Administration: Needle Gauge and Length

Vaccines must reach the desired tissue to provide an optimal immune response and reduce the likelihood of injection-site reactions. Needle selection should be based on the:

- Route
- Age
- Gender and weight for adults *(19 years and older)*
- Injection site

The following table outlines recommended needle gauges and lengths. In addition, clinical judgment should be used when selecting needles to administer injectable vaccines.

Route	Age	Needle gauge and length	Injection site
Subcutaneous injection	**All ages**	23–25-gauge 5/8 inch (16 mm)	Thigh for infants younger than 12 months of age[1]; upper outer triceps area for persons 12 months of age and older
Intramuscular injection	**Neonate, 28 days and younger**	22–25-gauge 5/8 inch (16 mm[2])	Vastus lateralis muscle of anterolateral thigh
	Infants, 1–12 months	22–25-gauge 1 inch (25 mm)	Vastus lateralis muscle of anterolateral thigh
	Toddlers, 1–2 years	22–25-gauge 1–1.25 inches (25–32 mm)	Vastus lateralis muscle of anterolateral thigh[3]
		22–25-gauge 5/8[2]–1 inch (16–25 mm)	Deltoid muscle of arm
	Children, 3–10 years	22–25-gauge 5/8[2]–1 inch (16–25 mm)	Deltoid muscle of arm[3]
		22–25-gauge 1–1.25 inches (25–32 mm)	Vastus lateralis muscle of anterolateral thigh
	Children, 11–18 years	22–25-gauge 5/8[2]–1 inch (16–25 mm)	Deltoid muscle of arm[3,5]
	Adults, 19 years and older ▪ 130 lbs (60 kg) or less ▪ 130–152 lbs (60–70 kg) ▪ Men, 152–260 lbs (70–118 kg) ▪ Women, 152–200 lbs (70–90 kg) ▪ Men, 260 lbs (118 kg) or more ▪ Women, 200 lbs (90 kg) or more	22–25-gauge 1 inch (25 mm[4]) 1 inch (25 mm) 1–1.5 inches (25–38 mm) 1–1.5 inches (25–38 mm) 1.5 inches (38 mm) 1.5 inches (38 mm)	Deltoid muscle of arm[3,5]

[1] May be administered into the upper outer triceps area if necessary
[2] If the skin is stretched tightly and subcutaneous tissues are not bunched
[3] Preferred site
[4] Some experts recommend a 5/8-inch needle for men and women weighing less than 60 kg, if used, skin must be stretched tightly and subcutaneous tissues must not be bunched.
[5] The vastus lateralis muscle in the anterolateral thigh can also be used. Most adolescents and adults will require a 1- to 1.5-inch (25–38 mm) needle to ensure intramuscular administration.

Reference: Advisory Committee on Immunization Practices General Best Practice Guidelines for Immunization. www.cdc.gov/vaccines/hcp/acip-recs/general-recs/administration.html

08/04/20

Appendix B: Subcutaneous Injection Skills Check

Assessment	
Verifies order with MAR ensuring accuracy and completeness.	
Assesses client's condition, including vital signs and medical history	
Reviews medication information including action, purpose, side effects, recommended dose, time of peak onset, and nursing implications.	
Verifies any client allergies	
Verifies client's previous responses towards injections	
Assess sites for injections, choose most appropriate site	
Assess client's knowledge regarding the medication therapy	
Planning/Implementation	
Performs hand hygiene	
Verifies order	
Performs 3 checks and 10 rights of medication administration	
Performs hand hygiene	
Provides privacy	
Assemble equipment on clean work surface	
Explain the procedure to the client	
Expose only the body part needed for injection	
Locate injection site using appropriate landmarking (abdomen, leg, arm)	
Encourage client to relax	
Cleanse area with alcohol swab in a circular motion	
Hold syringe between thumb and forefinger of dominate hand, hold as a dart with palm down	
Administration:	
Inject needle quickly at a 45-degree or 90-degree angle with the appropriate size syringe	
Compress plunger of syringe to inject medication, keep syringe steady	
Once injected, slowly and steadily withdraw the needle	
Apply gentle pressure with cotton ball, **do not massage the site**. Apply bandage if required. **If administering heparin, hold gauze onto site for 30-60 seconds*.	
Dispose of needle into sharps container immediately. Do not recap the needle.	
Perform hand hygiene.	
Stay with client to observe for any allergic reactions	
Document as per facility policy and procedure	
Evaluation:	
Evaluate client 15 -30 minutes following injection and inquire if having any discomfort, pain, burning, or tingling at the site.	
Inspect the site; observe for any bruising or hardening of body tissue	
Observe for client response to the medication	
Document observations and client's response to the medication in the client's chart	

Appendix C: Intramuscular Injection Skills Check

Assessment	
Verifies order with MAR ensuring accuracy and completeness.	
Assesses client's condition, including vital signs and medical history	
Reviews medication information including action, purpose, side effects, recommended dose, time of peak onset, and nursing implications.	
Verifies any client allergies	
Verifies client's previous responses towards injections	
Assess sites for injections, choose most appropriate site	
Assess client's knowledge regarding the medication therapy	
Planning/Implementation	
Performs hand hygiene	
Verifies order	
Performs 3 checks and 10 rights of medication administration	
Performs hand hygiene	
Provides privacy	
Assemble equipment on clean work surface	
Explain the procedure to the client	
Expose only the body part needed for injection	
Locate injection site using appropriate landmarking	
Encourage client to relax the muscle	
Cleanse area with alcohol swab in a circular motion	
Hold syringe between thumb and forefinger of dominate hand, hold as a dart with palm down	
Administration:	
Inject needle quickly at 90-degree angle into the muscle	
Compress plunger of syringe to inject medication, keep syringe steady	
Once injected, slowly and steadily withdraw the needle	
Apply gentle pressure with cotton ball, **do not massage the site**. Apply bandage if required	
Dispose of needle into sharps container immediately. Do not recap the needle.	
Perform hand hygiene.	
Stay with client to observe for any allergic reactions	
Document as per facility policy and procedure	
Evaluation:	
Evaluate client 15 -30 minutes following injection and inquire if having any discomfort, pain, burning, or tingling at the site.	
Inspect the site; observe for any bruising or hardening of body tissue	
Observe for client response to the medication	
Document observations and client's response to the medication in the client's chart	

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