PCP Autonomous IV Program Module 2 PRECOURSE PACKAGE

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Purpose

This module will instruct Primary Care Paramedics, through a combination of take home packages, in class practical, and in hospital practical training, how to establish intravenous access. The paramedic taking the IV/IO access module will learn standing orders, indications, complications, anatomy, physiology, and become practically proficient in IV cannulation.

Components

1. Theoretical: This component will consist of a take home package, which the paramedic will have to be intimately familiar with on the first day of class. It will also contain a take home theoretical test, to self-test his or her knowledge prior to attending class.

2. Theoretical testing: On the training day, the paramedic will be tested on his or her knowledge of the take home package. The Passing mark is 80%. Those not achieving 80% must return to a future class and will not be able to continue that day.

3. In Class Practical: This consists of theory review and practical instruction using IV practice limbs.

4. In Hospital Practical: This is the practical component where paramedics use their knowledge to initiate IV cannulation in Day Surgery, Emergency Departments and other clinical settings to gain practical knowledge and experience.

Certification

As with other skills, yearly certification of IV cannulation will be required by the Medical Director. This may be achieved through a skills inventory (database review) and/or include writing a pre-test, and starting an IV with BHP assessment.

OBJECTIVES

In completing this module, the PCP will:

Effective

Maintain a patient's dignity at all times

Use appropriate language

Maintain patient confidentiality

Demonstrate ethical behaviour

Function as a patient advocate

Function within the scope of practice defined by provincial regulating agencies and local medical control

Explain to the patient, when asked, "patient rights", and be mindful of those rights on the role of provider

Work collaboratively with other members of the healthcare team

Accept and deliver constructive feedback

Demonstrate reasonable and prudent judgement

Practice effective problem solving skills

Cognitive

Be familiar with the anatomy and physiology of both upper and lower extremities, as related to IV cannulation.

Identify pathophysiology of the immune and cardiovascular system, hypovolemia, hypo perfusion and shock.

Be able to relate factors that effect vasodilation.

Relate indications and contraindications for IV cannulation.

Describe the properties of Normal Saline, its uses and overdose symptomology

Describe circumstances where a “bolus” of NS may be required

Have knowledge of Base hospital policies and provincial ALS standards with regard to IV cannulation.

PSYCHOMOTOR

SIMULATED

Demonstrate the selection of appropriate equipment for given situations

Demonstrate proper technique in “flushing” an IV line with natural saline

Identify criteria for vein selection

Demonstrate aseptic techniques required for IV and intraosseous infusions

Identify steps required to secure IV cannula and IV tubing

“Troubleshooting” difficult IVs including removing air bubbles, and checking for IV patency.

Demonstrate competence in giving infusions under pressure

Calculate IV “drip rates”

Identify “interstitial” IVs

Demonstrate the skill of infusing non-Colloids and Volume Expanders

CLINICAL

Demonstrate proper technique in intravenous access

Rights of the Patient

Any patient may refuse any treatment for any reason at any time.

Some patients may refuse simply because they are afraid of needles or for complex reasons such as religious beliefs. The paramedic must balance the need for an IV with the person’s wishes. If the patient refuses because of a fear of needles, and the IV/IO is a necessity, it is best to talk the patient into the treatment with reasoning such as it “only lasts a moment” or the “needle part” does not stay in. The cannula that stays in is soft and flexible.

People with religious objections may require further assurances. Religious orders such as Jehovah’s Witnesses object to the introduction of whole blood, packed red cells, white blood cells, plasma or platelets. They will accept non-blood replacement fluids like hetastarch and crystalloids. If questioned, the fluid being instilled is Normal Saline, a non-blood product (see composition of N/S in equipment section of this package).

Implied consent with the unconscious Jehovah’s Witness patient has been ruled on by the Ontario Supreme Court. Jehovah’s Witnesses carrying a dated, witnessed card stating their intentions are to be honoured even after unconsciousness.

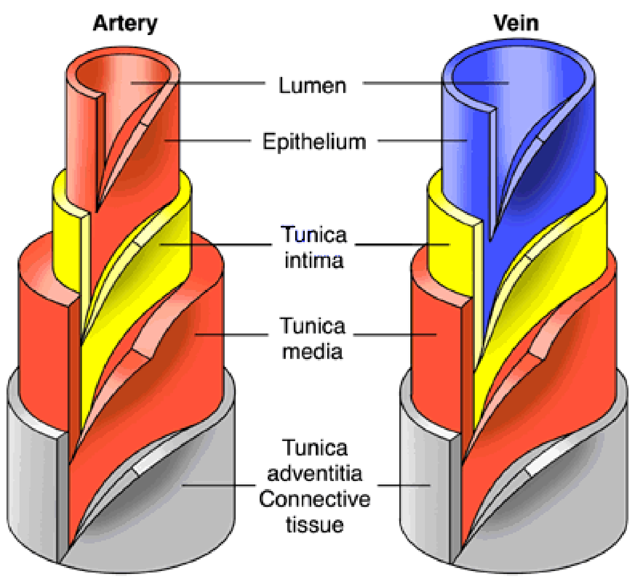
Anatomy Relevant to Intravenous Starts

Definitions

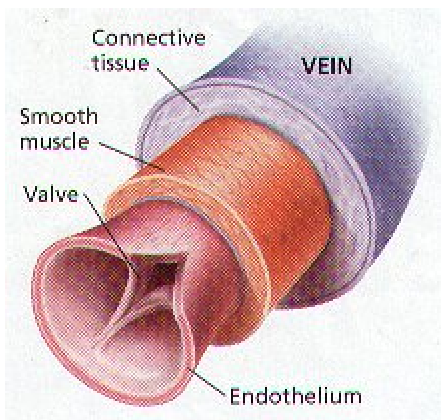
An intravenous refers to the cannulation of a vein in order to introduce *fluid*, *blood* or *medication* in to the circulatory system

VEINS, by definition deliver un-oxygenated blood (at relatively low pressures) back to the heart and lungs for re-oxygenation and distribution. Veins are superficial in nature, located just below the subcutaneous tissue, making them ideal for cannulation. On successful cannulation of a vein, blood should look dark and flow slowly to IV cannula “window”.

ARTERIES, by definition, deliver oxygenated blood (at a higher pressure than veins) to the body. Arteries are thick walled, deeply inset vessels that should not be cannulated by prehospital care providers. If cannulated, the blood will appear bright red and fill the IV cannula window rapidly. If inadvertently accessed, remove the cannula; apply a sterile dressing with firm pressure over the site for five minutes.



VALVES: medium to large veins use a structure called a valve to help move blood against gravity, toward the heart. These valves consist of folds in the tunica intima, which act in the same manner as the semi lunar valves in the heart. The valves overlap, and when blood attempts to flow backward at diastole, the valves occlude the vein. There are many valves in a section of vein, and the number of valves generally increases with need (The number of valves in the lower extremities are greater than the number in the upper extremities).



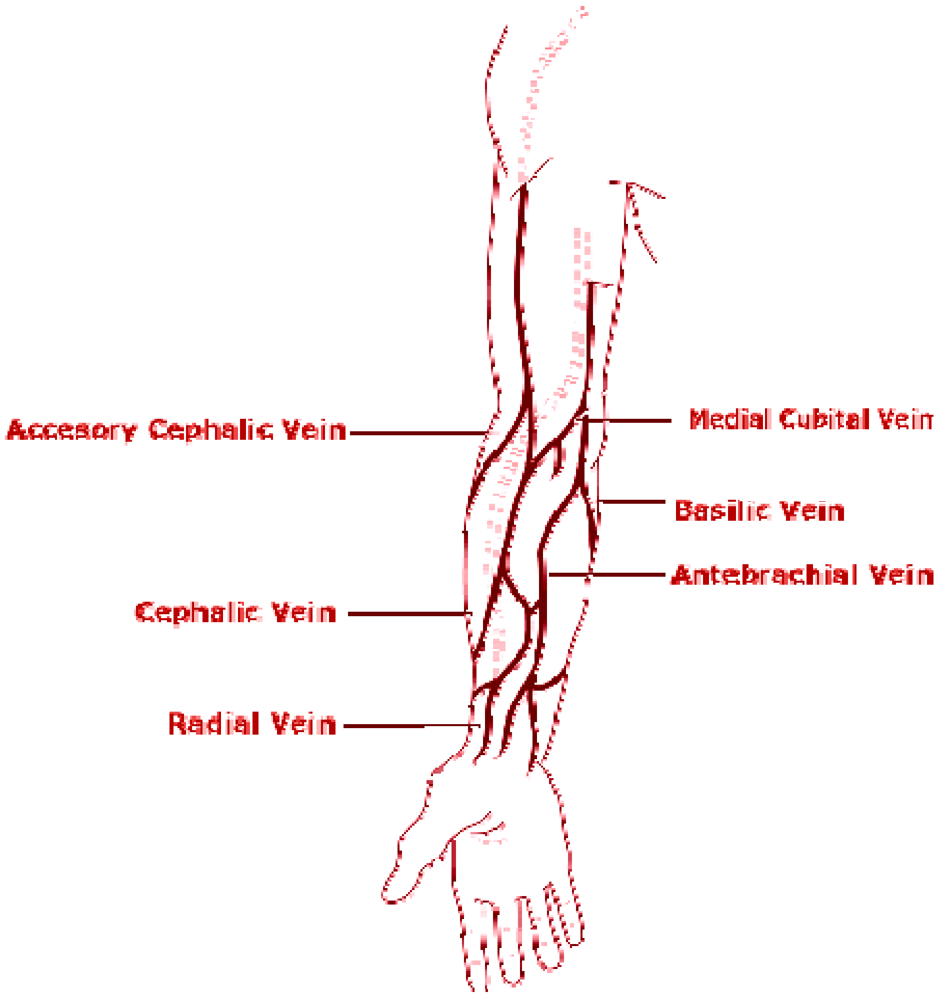
With age, these valves can become “incompetent”, resulting in backflow and damage to the distal structures. This is called a varicose vein. The area is generally reddened and edematous. With sufficient damage, the vein can develop stagnant areas, and blood clots may develop. Therefore, cannulating a varicose vein should be avoided.

Valves can also become “stenotic”. They do not open or close fully. It allows blood to flow backward and impedes distal blood flow. The paramedic cannulating a vein distal to a stenotic valve will find it difficult to advance the cannula past it, and if the cannula stops short of the valve, the flow of IV fluid will be diminished or blocked. A stenotic valve can generally be identified as a small (1-2 mm) raised and enlarged section in the vein. When palpated, it is harder than the rest of the vein.

Veins of the Upper Extremity

Proximal Cephalic, Basilic and Median Cubital Veins

- Most commonly referred to as "antecubital veins"
- Are large and usually very prominent, even without a tourniquet
- Normally reserved for venipuncture and emergency IV infusions (e.g. necessity to give large quantities of fluid or blood products due to burns, hypovolemia, and shock states)
- Reserve for short term/emergency use, due to it being at a moveable joint
- Readily accepts large # 14, 16, 18 IV catheters
- Care should be taken not to cannulate the brachial artery or any of the numerous nerve endings in the area
- Site most successfully cannulated **during** transport



<u>Distal Basilic Vein</u>

- Runs along the ulnar aspect of the arm
- Large and prominent in males
- Often overlooked due to its location on the underside of the arm
- This vein is prone to “rolling”, making cannulation for difficult
- Best cannulated with the arm in an “arm wrestling stance”
- Best cannulated with # 18, 20 catheters

Distal Cephalic Vein

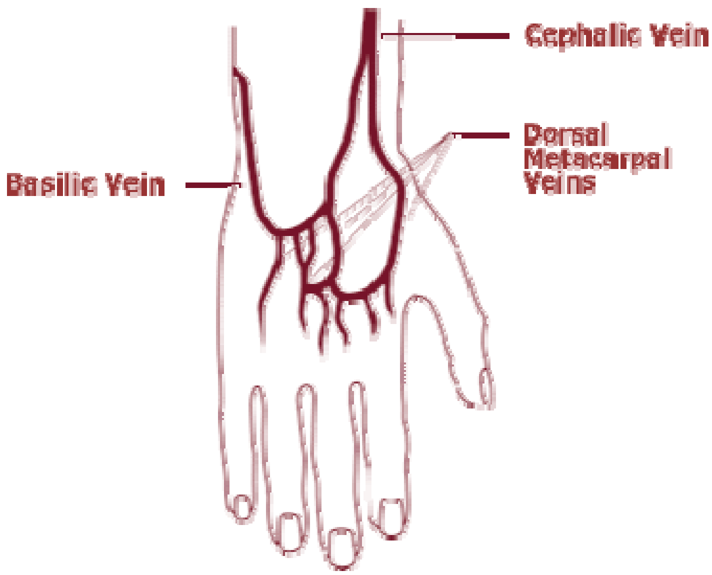
- Runs along the radial aspect (thumb side) of the arm
- Bones of the forearm provide natural splint
- Is a medium sized vein; ideal, for example, for long term infusion of antibiotics, non emergency cardiac medication
- Sometimes difficult to cannulate due to it's tendency to roll, and the need to cannulate around the thumb and thanar prominence
- Best accessed with a #18, 20 catheter

Medial Ante Brachial Vein

- Runs down the center of the anterior aspect of the forearm
- Medium sized vein
- Easily visualized, difficult to palpate
- Does not tend to roll
- **DO NOT** cannulate the extreme distal end of this vein due to the numerous nerve endings, moveable joint (impossible to secure) and extreme pain caused
- Appropriately cannulated with a #18, 20 catheter

Metacarpal Veins

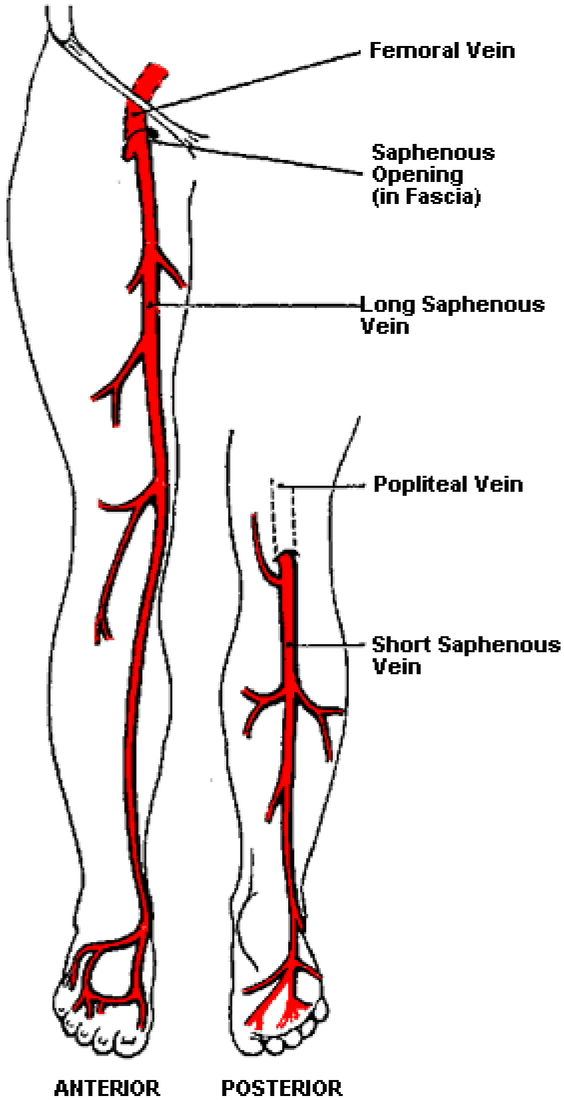
- Located in the back of the hand
- Small to medium sized veins
- Ideal for long term /TKVO therapy
- Positional IV if catheter is located too far back on the hand/wrist
- Best cannulated with a #18, 20 or 22 catheter



Digital Veins

- Small veins, located in the fingers (not generally used in the prehospital setting)
- Area of last resort as it is positional, painful and difficult to secure
- Cannulated only with # 22 catheter

Veins of the Lower Extremities



Great Saphenous Vein

- Mid calf to the internal malleolus
- Large vein
- Cannulation limits patient's mobility
- Moderate risk of keep vein thrombosis
- Risk of impaired circulation in the lower leg and foot

Dorsal Venous Network

- Located on the dorsal surface (top) of the foot
- Medium sized to small veins
- Painful access
- Increased risk of DVT

Factors Influencing Vasodilation/Vasoconstriction

There are many factors, which influence vasoconstriction and vasodilation, all of which affect the pressures inside. Manipulating the pressure upward is what makes IV cannulation easier. Natural influences can conversely make IV starts more difficult through vasoconstriction or collapse.

Vasodilation

- *Tourniquet* - application of a tourniquet constricts the flow of blood at the afferent end of the vein, mechanically enlarging and expanding the vessel. A tourniquet may consist of a blood pressure cuff or a soft rubber band.
- *Gravity* – lowering the limb below the level of the heart dilates veins as the force of gravity pulls blood into dependant areas. Use this in conjunction with a tourniquet.
- *Mechanical Stimulation* – “flicking” fingers or gentle “slapping” with 2 fingers over the venipuncture site produces a short lived venous dilation.
- *Muscular Activity* – opening and closing the fist is the most popular method.
- *Application of Heat* – applying heat for 10 minutes will increase blood flow to the area, causing vasodilation of arteries and veins in the area.

- *Volume Loading* – patients in CHF or women during pregnancy have increased intravascular blood volume. Patients with these conditions generally do not require further mechanical methods.

Vasoconstriction

- *Gravity* – raising the limb above the level of the heart reduces the blood flow and induces vasoconstriction. This factor is already employed by the paramedic as a means to control bleeding.

- *Cold* – Application of cold packs reduces flow to the affected region, and induces vasoconstriction. This is useful to the paramedic wanting to reduce the swelling of missed IV attempts, and the prevention of haematomas. Hypothermic patients should be warmed prior to attempting IVs due to the difficulty in cannulating a shivering, vasoconstricted patient.

- *Hypovolemia & Shock* – the body's natural mechanism in dealing with a decreased circulating blood volume is to shunt blood from the periphery to the core, making cannulation of a peripheral vein difficult. The paramedic should recognize the need to increase circulating volume rapidly and attempt to cannulate a large, antecubital vein.

- *Vasovagal Response* – fear or anxiety may trigger a vasovagal response, resulting in an undesirable vasodilation, drop in BP and syncopal symptoms. Pain and anxiety from further IV sticks may increase these symptoms. Patients may identify this at first contact, saying "People have a hard time getting blood from me". This may be reversed with decreasing their anxiety, confidence shown by the paramedic, and a calm demeanour.

Physiology Relevant to IV Starts

There are some basic principles, which affect the flow of blood through the circulatory system. It is the interrelationships between these factors, which regulate blood pressure, blood flow, and play a vital role in the function of the circulatory system.

- *Viscosity* – viscosity is the measure of the resistance of a liquid to flow. In other words, as the viscosity of liquid increases, so does the pressure required to force it to flow. The viscosity of blood is largely influenced by the amount of hematocrit (blood cells e.g. RBCs, WBCs).

- *Laminar and Turbulent Flow in Vessels* – laminar flow describes the flow of blood, or a fluid, through a smooth walled vessel. It flows slowest where the blood makes contact with a vessel wall, and fastest toward the center (where there is little resistance). Laminar flow is interrupted, and becomes turbulent, when it comes into contact with a constriction, sharp bend in a vessel or a rough surface. Turbulent blood flow is what makes it possible to auscultate a blood pressure (the paramedic hears the turbulent blood flow at the antecubita when the vessels are compressed with a BP cuff).

- *Blood Pressure* – BP is a measure of the force blood exerts against the vessel walls. It can be measured by auscultating and occluding a blood vessel, or by inserting a cannula into an artery and connecting an electronic pressure transducer to it. This commonly referred to as an ART (or arterial) line.

Rate of Blood Flow – The rate of blood flow is measured by the amount of blood that passes through a specific amount of blood vessel (or organ), and is usually measured in Litres per Minute.

Poiseuille's Law

According to Poiseuille's law, the flow of blood is dramatically increased when the radius of the blood vessel is increased. Conversely, a small decrease in the size of a blood vessel, results in a dramatic decrease in blood flow. Additionally, an increase in viscosity, or an increase in vessel length decreases blood flow.

Law of LaPlace

The Law of LaPlace helps to explain the phenomenon known as Critical Closing Pressure. The law states that the force that stretches the vascular wall is proportional to the diameter of the vessel, times the blood pressure. As the pressure in the vessel decreases, the vessel wall size also decreases. Some minimum pressure is required to keep the blood vessel open; if the pressure falls so that the force is below the minimum required, the vessel will collapse. Conditions causing collapse may include shock states.

Conversely, the development of aneurisms may be explained. As the diameter increases, the force applied to the vessel wall also increases, even with a constant pressure. If an artery has a weakened wall, and it develops a "bulge", the force applied to that area is greater than any other section of the artery, because the diameter is larger. A negative feedback loop follows (i.e. the larger the weakened area becomes, the more force applied to it, resulting in a larger bulge, resulting in more force being applied…)

Vascular Compliance

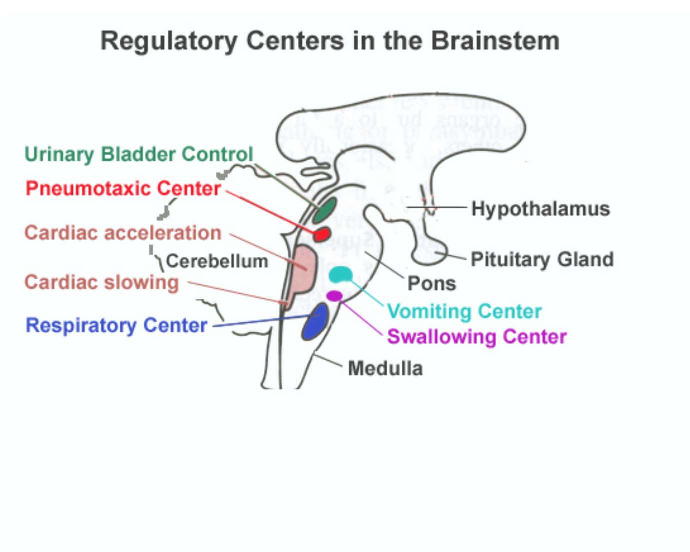
Vascular compliance is the tendency of a blood vessel volume to increase as the pressure increases. Venous compliance is greater than arterial compliance by a large margin. This high compliance results in the body using the venous system as a storage area.

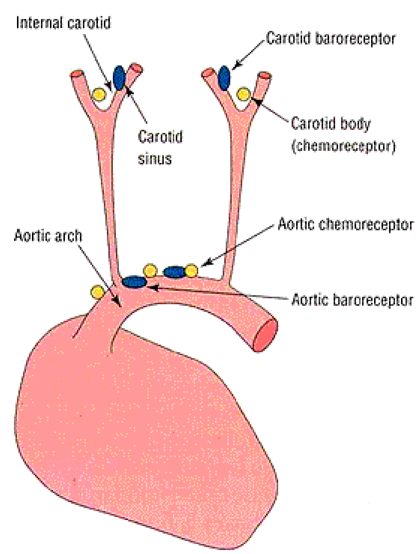
Systemic Circulation

System circulation will, depending on vessel type, location, and size, have different pressure in them. Also, because the heart is pulsatile, pressure will vary during systole and diastole.

The aorta, which has a large diameter and is close to the heart, loses very little pressure. Its systolic pressure is 120mmHg and diastolic is 80mmHg. As blood flows through the arteries, capillaries and veins, the pressure progresses toward 0mmHg, or even lower by the time it returns to the right atrium.

Blood pressure is centrally regulated by the nervous system; namely the vasomotor center of the Medulla Oblongata. Baroreceptors, Pressoreceptors and Chemoreceptors in major vessels in both the arterial and venous circulatory systems are sensitive to stretch, shrinkage or abnormal blood gases. On reception of abnormal readings, messages are transmitted to the cardio-regulatory and vasomotor centres.





In the case of low BP, sympathetic stimulation increases heart rate, vasoconstricts peripheral vessels.

Increased BP results in, again, cardio regulatory centres in the medulla, being notified. Vasodilation and increased parasympathetic vagal innervation of the heart results. The heart rate falls and blood pressure returns to normal.

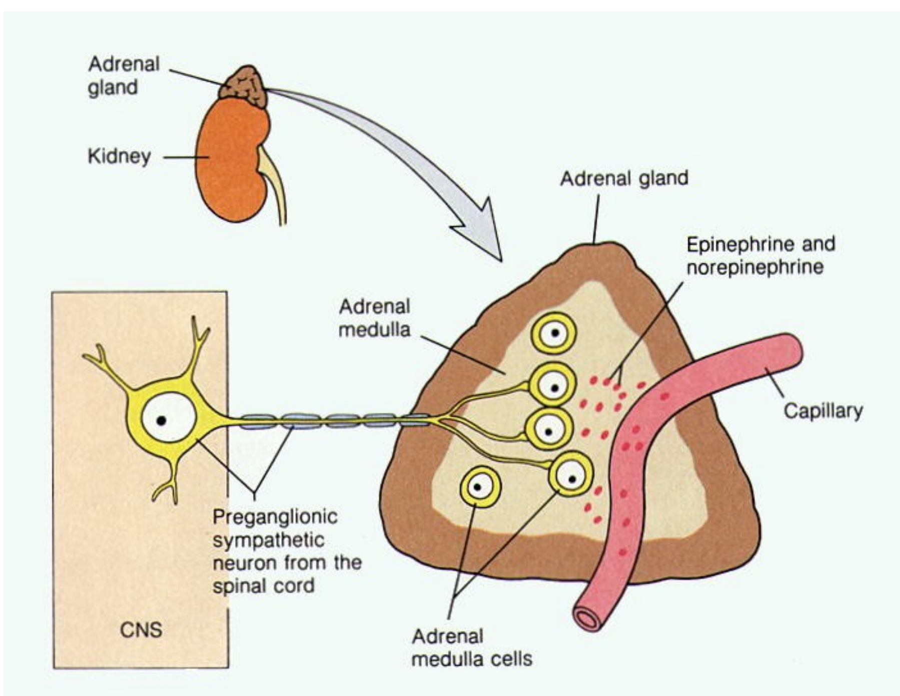
Chemoreceptors react to low oxygen levels, high levels of carbon dioxide or abnormal blood pH. These act under "emergency" conditions, most notably, if BP falls below 80-mmHg or oxygen levels in the blood falls markedly.

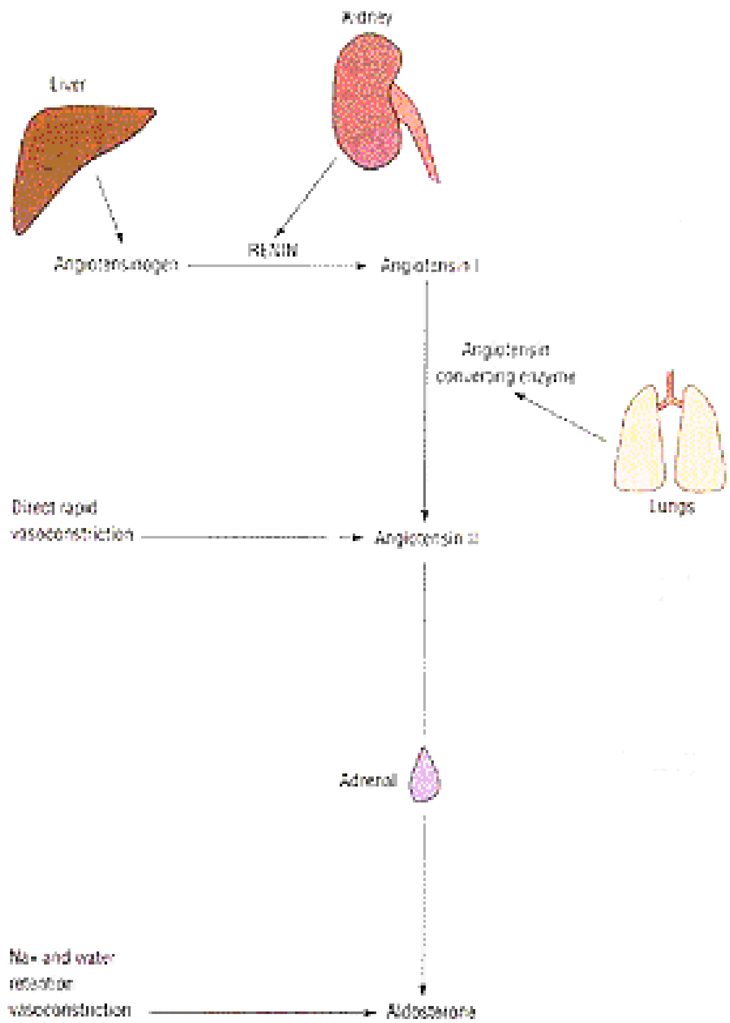
In addition to nervous regulation of arterial pressure, 4 hormonal mechanisms also have influence on blood pressure.

1. Adrenal Medullary Mechanisms – Sympathetic nervous stimulation also acts on the adrenal medulla. Epinephrine and Norepinephrine are secreted, affecting the cardiovascular system by increasing heart rate and causing vasoconstriction.

2. Renin/Angiotensin/Aldosterone Mechanism – On sensing low blood pressure, the kidney secretes an enzyme called "Renin" from juxtoglomerular apparatuses. **Renin** acts on a plasma protein called **Angiotensinogen**, splitting it up.

One of the resultant fragments is called "**Angiotensin I**". Other enzymes in the lung further act to change Angiotensin I into a chain of amino acids called **Angiotensin II**. Angiotensin II causes vasoconstriction of arteries and, to some degree, in veins. Blood pressure rises slightly.





Angiotensin II also stimulates Aldosterone release from the adrenal medulla. Aldosterone decreases the production of urine, again raising blood pressure by retaining volume in the vascular system.

Angiotensin II also stimulates the sensation of thirst, increased salt appetite, and anti diuretic hormone secretion.

3. <u>Vasopressin Mechanism</u> – with low BP or an increase in plasma concentration the neurophypophysis increases the amount of anti diuretic hormone, or vasopressin secreted. The result is vasoconstriction and a decrease in the rate of urine production.

4. Atrial Naturetic Mechanism – Elevated atrial BP results in a release of Atrial Naturetic factor from the atrium of the heart. The substance increases the rate of urine production, decreasing circulatory blood volume, resulting in a lower blood pressure.

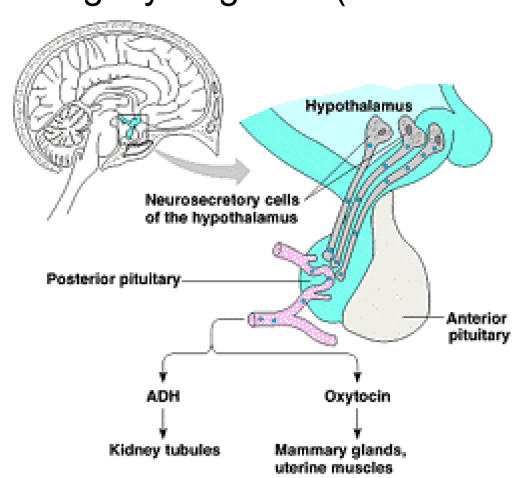
Fluid Components — Intravascular

Intracellular

Interstitial

Circulation	-	Arteries	→	arterioles
	-	Vein	→	Venules

Capillaries – are the place where waste products and nutrients are exchanged in the process called diffusion. Nutrients are pulled from the capillaries and diffuse into the interstitial spaces while waste products are drawn into the capillaries for eventual removal. There are several forces that assist this to happen. Since blood borne proteins tend to be large, they are kept in capillaries, drawing fluid back into the arterial side of the capillaries. This is called Colloid Osmotic Pressure. Pushing fluid into the interstitial (or 3rd space) is hydrostatic pressure (or the force – Blood pressure – exerting pressure from inside the blood vessel itself). The third force exerting influence on fluid balance in capillaries is a slightly negative (in the normal/healthy person) interstitial pressure. The lymphatic circulation creates this.



Edema is the result of decreased plasma protein concentration (resulting in a lack of "pull" of fluid back into the capillaries). It can also result in an increased capillary permeability, resulting in plasma proteins being lost into the interstitial spaces. This pulls more fluid from the capillaries, increasing edema. Edema can also be a result of an increased BP in the capillaries; Hydrostatic Pressure. This last cause may for example result from Cor Pulmonale or a rapid transfusion of fluid.

Fluids & Electrolytes

Body fluids contain dissolved chemicals, divided into 2 separate categories – Electrolytes and Non Electrolytes. Non-Electrolytes are mostly organic compounds like glucose, urea and creatinine. Electrolytes are inorganic compounds (e.g. acids, bases & salts), which have the ability to band together. They are either positively or negatively charged.

Electrolytes have 3 general functions. Many are essential minerals. Secondly, they control movement of water (osmosis) between components (osmosis pulls water from areas of low concentration to areas of high concentration). Finally, they help maintain acid base balance.

The major electrolytes are Sodium (Na^{+}), Chloride (Cl^{-}), Potassium (k^{+}), Calcium (Ca^{++}), Phosphate ($HP0_4^{--}$) and Magnesium (Mg^{++}).

Sodium is the most abundant positively charged *extra* cellular electrolyte (about 90%). Normal levels of sodium in the blood are 136 – 142 mEq/L. It is necessary for the transmission of impulses through nervous and muscle tissue. It also plays a significant role (depending on its concentration) in fluid & electrolyte balance by contributing most of the osmotic pressure. The kidneys regulate the amount of sodium in the blood stream – excreting excess sodium and conserving it during periods of low concentrations.

High levels of sodium (possibly from large amounts of “Normal Saline” IV fluids, or dehydration) lead to cellular dehydration. Signs and symptoms include thirst, fatigue restlessness agitation and eventually coma states.

Chloride is the most abundant negatively charged *extra* cellular electrolyte. Normal blood concentration is 95 – 103 mEq/L. It moves easily between extra cellular and intracellular compartments, making it an important component in regulating osmotic pressure between components. It also combines with hydrogen to form hydrochloric acid in the gastric mucosal glands.

The kidneys indirectly regulate chloride, as it tends to follow sodium through a natural bonding process.

Potassium is the most abundant positively charged *intra* cellular electrolyte. Normal blood concentration of potassium is very narrow, between 3.8 – 5.8 mEq/L. Potassium is the key element in the functioning of nervous and muscle tissue. Abnormal serum levels affect neuromuscular and cardiac function. Intracellularly, it helps maintain fluid volume in cells. The movement of potassium out of cells is replaced by sodium and hydrogen. This shift of hydrogen ions helps to regulate pH.

The regulation of potassium in the kidney is exactly the opposite of sodium. The hormone that regulates both electrolytes is Aldosterone. When Aldosterone is secreted from the adrenal cortex, sodium is retained and potassium is excreted.

Hypokalemia (or low serum levels of potassium) may result from vomiting, diarrhea, high sodium intake, kidney disease or some types of diuretic therapy. Symptoms include cramps, fatigue, flaccid paralysis, nausea, vomiting, mental confusion, increased urine output, shallow respirations and changes in the ECG (lengthening of the QT interval and flattening of the T-wave).

Calcium

98% of calcium is found in the skeleton and teeth, combined with phosphate. The serum calcium is found both extracellularly and intracellularly (in skeletal muscle). It functions in coagulation, neurotransmitter release, neuromuscular conduction, maintenance of muscle tone and excitability of nervous and muscle tissue.

Low levels of Calcium (hypocalcemia) may be due to calcium loss, reduced calcium intake, elevated phosphate levels (as phosphate levels elevate, calcium levels decrease). Symptoms include numbness or tingling of the fingers, hyperactive reflexes, muscle cramps, tetany and convulsions. It may cause laryngeal muscle spasms that can cause death by asphyxiation.

Phosphate

Primarily found combined with calcium in bones. The remaining amount combines with other substances and structures for many purposes. It is a necessary component in forming nucleic acids, and high-energy compounds, as well as substances that serve as buffers ("The phosphate buffer system").

Magnesium

Magnesium activates enzymes involved in the metabolism of carbohydrates and proteins and triggers a mechanism called the "sodium/potassium pump". It is also important in neuromuscular activity, neural transmission and myocardial functioning.

Movement of Fluid

Fluid movement between the vascular compartment and interstitial space occurs across capillary membranes. Basically, fluid movement depends of 4 different pressures.

1. Blood hydrostatic pressure
2. Interstitial fluid hydrostatic pressure
3. Blood osmotic pressure
4. Interstitial fluid osmotic pressure

Blood Hydrostatic Pressure – is the "blood" pressure within the walls of the capillaries, exerted outward; forcing fluid, plasma and electrolytes into the interstitial spaces.

Interstitial Fluid Hydrostatic Pressure – is the pressure exerted outward by the accumulation of fluid in the interstitial spaces and into capillaries and cells.

Blood Osmotic Pressure – is the “pulling” pressure the plasma proteins exert on fluid in the interstitial spaces. It pulls fluid back into capillaries.

Interstitial fluid Osmotic Pressure – is a “pulling” pressure that electrolytes and other substances exert to pull water into the interstitial spaces.

Fluid movement between the Interstitial and Intracellular Compartments

- Under normal circumstances intracellular and interstitial osmotic pressures are the same.
- Is normally controlled with the movement of Na^+ and k^+ into and out of the cell.
- Concentration changes of Na^+ and k^+ can result in fluid imbalance.
- Over hydration of cells is disruptive to nerve cell function.
- Severe over hydration or water intoxication, produces neurological symptoms ranging from disorientation to death.

Acid Base Balance

- Acid/Base balance is accomplished by controlling the hydrogen concentration of body fluids.
- Normal extra cellular pH is 7.35 – 7.45.
- Keeping this narrow range possible is essential to survival.

The responsibility for maintaining a normal pH depends on 3 major mechanisms.

1. The Buffer system
2. Respirations
3. Kidney Excretion

Buffer systems

- Act as subtle, buffering agents to balance pH using electrolytes, proteins and organic materials to manipulate hydrogen ions.
- Examples are the *Carbonic Acid/Bicarbonate Buffer System*, the *Phosphate Buffer System*, the *Hemoglobin/Oxyhemoglobin Buffer System*, and the *Protein Buffer System*.

Respirations

- An increase in an individual's respiratory rate decreases the amount of carbon dioxide concentration in body fluid, and also raises the blood pH (makes it more basic).
- A decreased respiratory rate increases serum CO_2 concentration, decreasing pH (making it more acidic).
- This is regulated by the respiratory center in the medulla, sensing either an increase or decrease in hydrogen ions (accumulating CO_2 leads to a hydrogen ion increase / low CO_2 levels lead to a low hydrogen level).

Kidney Excretion

- The kidney can directly excrete hydrogen ions in the urine (distal portion of the nephron).

- Through dissociation, bicarbonate ions and sodium ions can be reabsorbed and transported back into the extra cellular fluid; raising body pH.

- If the pH of the body increases, the rate of hydrogen secretion into the nephron decreases. Excess bicarbonate ions are excreted, as a consequence the pH decreases.

<u>Normal Saline</u> – an Isotonic Crystalloid Solution

<u>Actions</u> - Increases circulating volume

- Source of Na^+, Cl^- & H_20

<u>Considerations</u> - Head injury

- Dilutes/warms blood
- Main line for blood transfusion
- To restore intravascular volume
- Initial fluid electrolyte replacement in hypovolemia, dehydration (Na^+ & Cl^- depletion) & burns
- Irrigation, cooling burns (external use)
- Dilutent & vehicle for reconstitution, injection or infusion of most drugs
- Ketoacidosis, diabetes, septic shock, fresh water drowning, crush injuries

<u>Adverse Affects</u>

- Large amounts causes volume overload e.g. pulmonary edema or exacerbation of CHF

- Electrolyte dilution and acid/base imbalance following large infusions

Precautions

- Renal impairment
- CHF
- Pulmonary edema
- Room temperature fluid may induce hypothermia with multiple infusions

Contains

- 900 mg NaCl/100ml
- pH 5.0
- Na^{+} 154 mmol/L
- CL^{-} 154 mmol/L

Supplied

250 ml bags 1000 ml bags

Priming IV Tubing

1. Select the appropriate IV tubing. Inspect the tubing, the roller clamp, the injection ports & the luer lock connector for cracks, use and sterility.

2. Select the appropriate sized IV bag. Inspect for cloudiness, precipitate and cracks/leakage. Check the expiry date, and ensure the fluid is the proper type (Normal Saline or 0.9% saline).

3. Close the roller clamp.

4. Remove the cap on the IV tubing closest to the drip chamber. Ensure sterility! Remove the plastic tab on the IV bag. Connect the two.

5. Squeeze the drip chamber. Fill it ½ full.

6. Open the roller clamp slightly to advance the fluid down the tubing.

7. When the fluid approaches an injection point, invert the port and strike the port, forcing air out and fluid in. Repeat as many times as needed.

8. Close the roller clamp when <u>all</u> the air is expelled from the tubing.

IV Equipment

- Gloves
- Tourniquet
- Alcohol swabs
- IV cannula
- IV tubing
  - Micro drip
  - Macro drip
  - Blood tubing
  - Buretrol
- Saline lock
- Occlusive dressing
- Tape
- 2 x 2 gauze
- Sharps container

Gloves are an essential part of infection control

IV Catheter

Most needles are made of stainless steel, while the outer cannula is made of Teflon coated plastic to inhibit clot formation. The "sharp", or inner stainless steel trochar is used for ease of insertion. After signs of the needle being in a vein, the trochar is withdrawn. The plastic cannula is radio opaque, meaning the cannula shows up as a ghost image on x-ray, in case of loss of part of the cannula in the patient's circulation. Sizes range from 16, 18, 20, 22 and 24 gauge (smaller the number – the larger the diameter).

IV Tubing

The infusion tubing drip chamber achieves the maximum flow rate when suspended approximately 3 feet above the IV site. This is due to the force of gravity

- **Micro drip** – a micro drip is an IV set which is designed to precisely deliver small volumes of solution over a long time. E.g. CHF patient with microdrip, (60 drops = 1ml).
- **Macro drip** – is an IV set used to deliver moderate volumes of solution over long periods of time. Because of a larger drop size, the time between drops is longer (than a micro drip), the risk of clot formation of the tip of the IV cannula is greater at TKVO rates. The number of drops, depending on the manufacturer, may be 10, 15 or 20 drop = 1 ml.
- **Blood Tubing** – is an IV set with 2 IV ports, one for a crystalloid to prime and maintain flow after blood administration; the other is a port for the blood product. It also contains a large flexible drip chamber with a screen to filter out clots formed in the blood product.
- **Buretrol** – A Buretrol is a large chamber with a measurement scale printed on the side. IV tubing with a buretrol has a roller clasp between the IV fluid and the Buretrol to deliver a set amount of fluid into the chamber and no more. The buretrol chamber is filled hourly to prevent fluid overload in small children.

- **Saline Lock/Heparin Lock** – These locks are used when a continuous infusion is not required, but occasional infusion of IV medications is desired. This lock consists of a short plastic tube (filled with saline or diluted heparin to prevent clotting) and a multi access later injection point.

- **Occlusive dressing** – an occlusive dressing is applied over the site of the IV insertion to provide a barrier to infection. It may consist of a 2 x 2 gauge, a band-aid or a clear adhesive film.

- **Tape** – the cannula, once in place, requires securing. Hypoallergenic tape (e.g. silk or plastic) should be used to secure the cannula and IV tubing to the patient's arm/hand/foot.

- **Alcohol Swabs** – should be used to disinfect the potential IV site. Allow a few seconds for the alcohol to dry prior to venipuncture, as isopropyl alcohol is for external use only.

- **2 x 2 gauze** – depending on the site, some "propping" may be required at the cannula site (usually digital or metacarpal IVs). They are also useful for cleaning the site of any blood that may prove disconcerting to the patient.

- **Tourniquet** – The tourniquet is latex band applied around the arm or leg. It takes advantage of venous circulation to mechanically enlarge the vein making cannulation easier. Remove the tourniquet prior to removal of the stainless steel IV trochar.

- **Sharps Container** – Immediate disposal of the trochar is essential to reduce the risk of accidental needle stick injury to paramedics. Needle stick injuries need to be reported immediately to:

  a) Paramedic Supervisors

  b) The same ER department that the patient has been admitted to

Treatment and/or testing should occur as soon after the exposure as possible.

Guidelines for Catheter Size

# 16	-	Adolescents & Adults Only
	-	Critical Trauma/Burns
	-	Pt's requiring large amount of fluids
# 18	-	Adolescents & Adults Only
	-	Fluid resuscitation
	-	Colloid Infusion
# 20	-	Children, Adults & Adolescents
	-	Most infusions requiring medication, TKVO lines
	-	Smallest size for colloid infusion
# 22	-	Infants, toddlers, children, Adolescents & Adults (especially elderly patients
	-	TKVO infusions
	-	Minor medication needs

IV Starts

1) Start trying IVs (depending on the severity of the pt's problem) distally and work your way proximally.

2) Critical patients, requiring rapid infusions need IVs in large veins.

3) For TKVO infusions, be picky about sites. Palpate, inspect for "valves", crooked veins, or otherwise poor quality veins.

4) Avoid veins around joints for TKVO and potential long-term infusions.

5) Avoid veins in injured arms. Do not start IVs in the same side as radical mastectomies or dialysis fistulas.

6) Elderly patient's hands can have thin, easy tearing skin. They also can have sclerosed, crooked veins. If so, try IVs above the wrist.

IV Starts

1) *Prepare the patient* – explain the need for the IV to the patient, and the brief discomfort that will be encountered. A patient may refuse treatment at any time.

2) *Select the equipment* – prime an IV line with a bag of saline or prepare a saline lock. Select the proper size cannula.

3) *Select a site* – apply a tourniquet. Use proper vasodilation techniques, ensure plenty of light. Ensure patient comfort. Choose an appropriate site.

4) *Don appropriate PPE*

5) *Prepare the site* – cleanse the site in a circular manner at least 5 cm diameter with an alcohol swab. If necessary, shave the arm.

6) *Inspect the cannula* – If there are any imperfections, discard the needle. Separate the cannula and trochar slightly to ensure smooth movement.

7) *Insert the cannula* – at a 30 - 45^{o} angle and slightly to one side of the vein, insert the needle (bevel up). When the end of the trochar enters the vein, a "pop" should be felt, followed by dark coloured blood filling the cannula flash chamber.

8) *Advancing the cannula* – Decrease the angle of the needle until parallel with the skin. Holding the needle hub securely, advance the plastic cannula over the needle. Alternative,

advance the catheter ¼”, then advance the cannula and trochar until the hub meets the insertion site. *_If you feel resistance, do **NOT** force the cannula_

9) _Release the tourniquet_

10) _Apply an occlusive dressing to secure the cannula_

11) _Withdraw the needle_ – with firm pressure approximately the length of the catheter proximal to the site (and with the IV tubing close), withdraw the needle. Dispose of the trochar immediately in a sharps container.

12) _Connect the IV tubing to the hub of the catheter_ – Open the roller clamp and assess fluid flow in the drip chamber. Check the connections for fluid leakage. Set the flow rate.

13) _Secure the IV tubing (with tape)_

Complications and Troubleshooting IVs

Complications at the IV site

Extravasation/Interstitial IV – is an IV whose cannula has come out of the vein. The fluid leaks out of the IV site and into the interstitial spaces. It is identified by a slow IV drip rate, a puffy appearance surrounding the IV site, (due to the accumulation of fluid), pain at the site (as reported by the patient), fluid leaking from the IV site (not the connection of IV tubing & IV cannula).

IVs can also be checked for patency by momentarily lowering the IV container below the level of the IV insertion site. Blood appearing in the IV tubing indicates a patent IV site/cannula. Interstitial IVs need to be removed and re-sited.

Phlebitis is an irritation and inflammation of the vein & surrounding structures. They may indicate the presence of an infection. IVs with redness & swelling at site should be re-sited. These symptoms are normally seen in long term IV therapy (> 72 hours).

Systemic Complications

Septicaemia, Bacteraemia and Septic shock may occur if signs of local phlebitis are ignored. Watch for large areas of redness involving arms, fever, nausea, vomiting, headache and shock-like states.

Pulmonary Embolism – may occur if a blood clot slips from the IV site and follows the circulatory system to the pulmonary artery. Signs of pulmonary embolism include chest pain, blood tinged sputum, shock.

Air Embolism – occurs when approx. 10 ml of air inadvertently enters the vascular system, reaches the heart and produces cardiac arrest. Smaller amounts may have serious affects. Paramedics should prevent air from entering the vascular system. Most patients may tolerate small bubbles. To ensure air embolus do not occur, always ensure fluid is in the IV bag, that the drip chamber is ½ full and that all connections are tight.

Catheter Embolus – occurs when a portion of the plastic cannula breaks off and flows into the vascular system. Paramedics should check the removed catheter to ensure the bevelled end remains when discontinuing IVs. Treatment includes immediate identification of this condition and application of a tourniquet proximal to the IV site to trap the broken piece.

Troubleshooting

Dislodged IV/Interstitial IV

- Shut off flow
- Remove/discontinue IV
- Apply pressure to site with a gauze pad
- Document appearance of site, amount of fluid left in bag
- Re-site IV proximal to the affected site

Loose IV tubing connection

- ↓ IV flow rate
- Loosen securing tape

- If completely detached, clean both ends with alcohol wipe and reattach
- Clean site/replace tape/occlusive dressing
- Regulate IV rate

Flow Rate Problem

- Check height of tubing drip chamber
- Check level of fluid in bag. Replace the bag at 150 ml remaining
- Check for signs of infiltration
- Ensure the roller clamp is open
- Check the tube for kinking
- Is the cannula near a joint? Does straightening the joint help?
- Adjust tape, apply on arm board
- Is the catheter too small?
- Venous spasm – is the flow rate problem intermittent? (Cold IV fluids?).

Calculating IV rates

The example below illustrates how a paramedic would calculate the flow rate if he or she were ordered to administer 250 ml of normal saline to patient over a period of 1 hour using a 15 drop/ mL administration set.

Calculating the flow rate:

$\underline{mL/hr}$

$$\frac{total\ mL\ to\ be\ given}{total\ time\ (hours)} = \frac{250ml}{1\ hr\ (all\ boluses\ to\ be\ given\ over\ 1\ hr)} = 250ml/hr$$

To more precisely regulate the amount of solution, it is advised that the paramedic calculate the number of drops/min.

$\underline{Drops/\min}$

$$\frac{drops/mL\ (see\ the\ infusion\ set\ packaging)\times amount\ of\ fluid\ to\ be\ infused}{total\ time\ of\ infusion(in\ min)}$$

$$= \frac{15\ drops/mL \times 250mL}{60\ \min}$$

$$= 63\ drops/\min$$

That number may be further divided into 20 or 15 seconds to save time

$$\frac{60\sec}{15\sec} = \frac{63\ drops/\min}{x}$$

$$60\ x = 15\times 63$$

$$x \cong 15\ drops\ in\ 15\ seconds$$

Documentation

In the procedures section of an ACR, the paramedic should document

- Unsuccessful IV attempt: record time, the details of the procedure including location attempted the code and what the result was.

Time	Procedure	Code	Remarks	Initial	No.
1405	IV catheter 20g x 32mm Rt hand	350	Interstitial – catheter removed intact.	MH	2
1406	Dressing applied	100	Bleeding controlled	AB	1

- Successful IV: record time, the details of the procedure including the location used the code, the fluid set hung, and the rate.
- Additionally, the amount infused on-scene and en-route are to be recorded.
- Any adverse reactions/complications

Time	Procedure	Code	Remarks	Initial	No.
1410	IV catheter 18g x 32mm Rt forearm. 1000ml NS.	345	Successful, infusing TKVO.	MH	2
1412	Fluid bolus	351	1600ml bolus initiated	MH	2
1439	Fluid bolus completed	345	1600 ml infused, return to TKVO rate.	MH	2

Pre-Test

1. Indicate a catheter size for the following scenarios

    Unconscious diabetic with a blood sugar of 2.6 mmol/L ______

    Stable chest pain _________

    Unstable patient involved in an MVC (requiring fluid resuscitation) _________

    Fractured tibia/fibula (stable v/s) age 7 _________

2. List 3 reasons for starting an IV.

3. Describe the structure of a vein.

4. Describe characteristics of an interstitial IV.

5. An IV is running at 125 ml/hr. In a macrodrip (15 drops/mL), how many drops/min should you observe?

6. A patient, unstable due to abdominal trauma, requires fluid resuscitation. He weighs 85 kg. His blood pressure is 80/40. His chest is clear.

    a) Describe the relevant Medical Directive(s).

    b) Assuming a full fluid bolus is required; calculate the amount of fluid this patient will initially receive?

    c) Knowing the amount of fluid to be given, at what rate should this bolus be given?

Glossary

Afferent
Anion
Buretrol
Cation
Crystalloid
Colloid
Diastole
DVT
Efferent
Extracellular
Hypertonic
Hypotonic
Intracellular
Ion
Ischial Tuberosity
Isotonic
Positional (IV)
Thenar Prominance
Vasovagal response

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