

The Alberta College of Paramedics



Alberta Occupational Competency Profile (AOCP)
Upgrade “Gap” Training Program

Emergency Medical Technician (EMT)

Intravenous Therapy Module

Study Guide

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Acknowledgements & General Information

INTRODUCTION

The overall goal of this program is to provide standardized upgrade “gap” education to ensure that all regulated practitioners of the Alberta College of Paramedics (College) meet the *Health Professions Act*, Paramedic Regulation and the scope of practice as defined by the Alberta Occupational Competency Profiles (AOCP) for the profession.

The Alberta Occupational Competency Profiles (AOCP) were developed through the facilitation of Dr. Bill DuPerron of Alberta Health and Wellness. Many College regulated practitioners were involved in compiling and organizing information about the roles and functions of paramedics, emergency medical technicians and emergency medical responders into the Profile.

The completion of the AOCP for the College is an important milestone for the profession. The document is a result of a collaborative partnership with the College and Alberta Health and Wellness plus the work and effort of members of the College.

The Competency Profile describes the vast expanse of competencies in Alberta at the present time as well as additional changes in scope of practice, which are identified in the Upgrade “Gap” Training Program. Each module in the “Gap” Training Program covers the additional competencies for a specific Competency Cluster as identified in the AOCP for each of the three disciplines regulated by the College. The Profile includes the knowledge, skills, attitudes, and judgments related to a variety of roles held by registered practitioners of the College.

BACKGROUND

The Health Professions Act (HPA) governs all regulated health professions in Alberta. The HPA was passed by the Alberta Legislature in May 1999 and in December 2001 the Order in Council proclaiming the Health Professions Act was signed by the Lieutenant Governor.

The HPA replaces a regulatory system (the *Health Disciplines Act*) that included multiple statutes that had different registration, continuing competence and investigation and disciplinary processes. Under the HPA, previous legislated exclusive scopes of practice will be eliminated and replaced with an “overlapping scope of practice” model based on restricted activities. Restricted activities are health services that only authorized persons may provide.

STRUCTURE OF THE HPA

The HPA will deal with processes such as registration, continuing competence, professional conduct, restricted activities, investigation and discipline that apply to all the professions. Each of the 28 professions will have their own regulation that will address in detail, profession specific areas such as required qualifications for entry into the profession. The Paramedic profession is expecting to be governed by the HPA in the near future.

ABOUT THE AOCP

Most of the competencies have been learned in basic education; other competencies have been acquired through advanced education, on the job training, and experience. All EMRs, EMTs and EMT-Ps have the basic competencies; however, competency on the job will vary depending on job requirements, and policy and procedure of the employing agency.

The Profile provides a cumulative view of the competencies within the Scope of Practice and within the general and specialized areas of that practice.

The College has developed the following educational module for upgrading the knowledge and skills of registered practitioners to meet the Alberta Occupational Competency Profiles (AOCP), the new Regulation and scope of practice.

HISTORY OF THE PROCESS

On March 4, 2000, the Paramedic Association of Canada adopted the National Occupational Competency Profile (NOCP), which included both a new classification and generic competencies for four professional designation levels of Paramedicine.

On March 22, 2000, the Alberta College of Paramedics' Council made the commitment that the Alberta College of Paramedics AOCP would meet or exceed the NOCP.

ACKNOWLEDGEMENTS

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About the Authors (Portage College)

Portage College (formerly Alberta Vocational Center, Lac La Biche) was established in 1968. The College currently offers over 30 certificate and diploma programs in six areas of study: Business, Human Services, Native Cultural Arts, Trades and Technical, Health and Wellness and Academic Upgrading. Over 1800 students are served annually through campuses in 13 northern Alberta communities, with another 1,300 taking short term or customized training programs each year.

Portage College has been offering prehospital care training program since the mid 1980s. Portage College is currently approved by the Alberta College of Paramedics for the following Paramedicine programs:

Emergency Medical Responder (EMR)
Emergency Medical Technician (EMT)
Emergency Medical Technologist-Paramedic (EMT-P)

Disclaimer

Portage College and the Alberta College of Paramedics have attempted to ensure that the information is in context relevant to the practitioner and is as concise as possible. Portage College has used a variety of resource materials in order to provide a solid base of up-to-date information.

If any of the information contained within this module contradicts the direction you have received from your employer/medical director, the policy of your employer should take precedence over the information in this module.

As a regulated practitioner of the Alberta College of Paramedics, while under the *Health Disciplines Act*, you may only deliver health services which fall within your scope of practice and is in accordance with the provisions of the *Health Disciplines Act* or the *Health Professions Act* when the HPA is implemented.

Any content contained in this module that is beyond your scope or not within your current competence does not authorize you to deliver those health services. That is, if a given health service is not within your scope of practice and/or you have not yet attained the competency, you may not deliver that health service.

Alberta Occupational Competency Profile (AOCP)

Training Program

Learning Goal

This educational training is intended to review and upgrade the competencies of The Alberta College of Paramedics registered practitioners in order to meet the requirements of the new regulation under the Health Professions Act (2000) including the Alberta Occupational Competency Profile (AOCP) and scope of practice.

Program Objective

To provide standardized education to registered practitioners to ensure that all regulated practitioners of the Alberta College of Paramedics meet the regulation and defined scope of practice for the profession.

Program Format

The Alberta Occupational Competency Profile (AOCP) training program will combine independent study modules and scheduled lab skills assessment sessions. Certification will be granted on successful completion of all program requirements.

Independent Study Modules

There are five EMT – AOCP continuing education modules to be completed:

1. Pharmacology
2. Airway Management
3. Trauma & MCI
4. IV Therapy
5. Cardiac Monitoring

Lab Skill Assessment

All skills identified for each module will be assessed during the lab skills assessment for that module.

Exam

Mastery of the each module's content will be assessed through multiple-choice exams during the lab sessions. These exams are open book and can be found in each module following the module summary.

EMT – Intravenous Therapy

This module meets the following competencies of the Alberta Occupational Competency Profile (AOCP).

I-10 Perform Intravenous Therapy

- I-10-1 Demonstrate the knowledge and ability to monitor peripheral intravenous.
- I-10-2 Demonstrate the knowledge and ability to perform intravenous therapy:
 - Peripheral intravenous line.
- I-10-3 Demonstrate knowledge and ability to initiate and maintain intravenous therapy:
 - Crystalloids:
 - Isotonic Solutions (N/S, R/L)
 - Hypotonic Solutions (D5W)
- I-10-4 Demonstrate knowledge and ability to calculate infusion drip rates and fluid boluses.

Intravenous Therapy Module Overview

Introduction

The human body is made up of 50 - 60% water. The balance between water, plasma and electrolytes is essential to maintaining homeostasis within the body. Understanding this balance is paramount for the EMT to assess and manage fluid and electrolyte disturbances. This module discusses the importance of IV therapy when caring for our patients.

Learning Objectives

Upon completion of this module the EMT will be able to:

1. Define the types of solutions used for intravenous therapy.
2. Describe the indications and complications of intravenous therapy.
3. Discuss and perform intravenous cannulation.

Learning Activities

Recommended Resources

Each module identifies specific content students must cover to meet the module learning objectives.

Key Terms

Students are to define the *Key Terms* identified for each learning objective.

Exam

Mastery of the module content will be assessed through a multiple-choice exam during the lab sessions. This exam is open book and can be found in this module following the module summary.

Lab Skills Practice

Students are to review the skills identified in the *Lab Skills Checklist* provided in Appendix A. Review of these checklists is essential preparation for the lab skill assessments, which are mandatory for successful completion of this module.

Objective 1

Define the Solutions Used for Intravenous Therapy

Electrolytes

Electrolytes are chemical substances which, when dissolved in water separate into electrically charged particles called ions. Positively charged ions are called cations and negatively charged ions are called anions. Electrolytes are important in regulating water balance, acid-base balance, enzyme reactions and neuromuscular activity. This is essential in maintaining normal metabolism and homeostasis. The following table shows the major ions found in extracellular and intracellular fluid.

<u>Cations</u>	<u>Anions</u>
positively charged	negatively charged
Na ⁺ = Sodium	Cl ⁻ = Chloride
K ⁺ = Potassium	HCO ⁻ = Bicarbonate
Ca ⁺ = Calcium	
Mg ⁺ = Magnesium	

Solutions

A **solution** is a liquid preparation of one or more soluble chemical substances usually dissolved in water. The solutions the EMT needs to be concerned with are solutions suitable for intravenous therapy. These intravenous solutions are composed of ions and water.

Solutes are substances

Liquids are solvents

Ions are the electrolytes (solutes)

Water is the solvent

These intravenous solutions are commonly referred to as crystalloids. Crystalloids are true solutions that pass through semipermeable membranes. An example is dextrose 5% in water (D₅W), Normal Saline (NS) and Lactated Ringers (RL).

Colloidal particles do not pass through semipermeable membranes. They are referred to as plasma expanders. The EMT does not deal with colloids or blood products.

Please Note: The EMT will only administer crystalloid solutions when administering intravenous therapy.

Body Compartments

The adult body is made up of 50 - 60% water held in two major "compartments" which are referred to as the *intracellular* (within the cell) and *extracellular* (outside the cell) *spaces*. Both of these spaces contain fluid.

Intracellular Fluid (ICF):

- within the cell
- ~40% of total body weight
- comprised mostly of water

Extracellular Fluid (ECF):

- outside the cell
- ~20% of total body weight
- comprised mostly of intravascular fluid (plasma) and interstitial fluid (tissue fluid)

Transportation of Fluid and Electrolytes

All the fluid in the body is continuously moving. There is blood circulating through the vasculature and there is also movement between the capillaries and body cells. There are several methods the body uses to transport the fluids, nutrients and wastes between the compartments. Some molecules cross the cell membrane while others are blocked. This is called a semipermeable membrane. Substances cross the semipermeable membrane by passive transport or active transport.

Passive transport (does not require energy). There are three types of passive transport:

- *Diffusion* is the movement of solutes from areas of higher concentration to areas of lower concentration across a semipermeable membrane down a concentration gradient
- *Filtration* is the movement of fluids and electrolytes in response to hydrostatic pressure. Hydrostatic pressure is the movement of substances from areas of greater pressure to areas of lesser pressure
- *Osmosis* is the movement of water from areas of lower solute concentration to areas of higher solute concentration across a semipermeable membrane. Water is a special component of the body; it does not recognize any membrane as an obstacle. Diffusion of water occurs in any direction at all times

When dealing with intravenous solutions, the process of osmosis is clinically important because of the effect intravenous solutions can have on the balance between the extracellular and intracellular fluids. A change in this balance creates osmotic pressures.

Osmotic pressure is the pressure required to stop or change the flow of water across a semipermeable membrane. The relative concentration of solutes on either side of the membrane determines the osmotic pressure. Whether a cell swells or shrinks depends on which side of the cell membrane the higher concentrate exists.

Isotonic Solutions are solutions of equal concentration therefore the cell size does not change.

Hypertonic Solutions have a greater solute concentration than the intracellular concentration. Water will move towards a hypertonic solution causing body cells to shrink. This occurs because water has a net movement out of the cell to try to equalize the osmotic pressure. The cell shrinks as the water moves out of the cell.

Hypotonic Solutions have a lower solute concentration than the intracellular concentration. Water will move away from a hypotonic solution causing body cells to swell. This occurs because the body cells have a higher osmotic pressure and water moves into them to try to equalize the osmotic pressure. When this occurs the cells will expand.

Active transport is the movement of substances across a cell membrane against a concentration gradient using **adenosine triphosphate (ATP)** as an energy source.

Intravenous Solutions

	Description	Indications	Precautions	Dosage
Lactated Ringers	- isotonic - containing Na ⁺ K ⁺ Cl ⁻ Ca ⁺⁺ and Lactate	- hypovolemia - dehydration from burns or infection - trauma, fractures	- CHF patients - isolated head trauma - renal disease - overload	- maintain systolic BP of 100 mm/Hg for shock
5% Dextrose in Water (D5W)	- hypotonic	- TKVO - route for drug administration	- do not use in head injuries, increased ICP, renal failure, pulmonary edema, or cerebral edema.	- to be infused slowly
Normal Saline (0.9% sodium chloride in water)	- isotonic -most common prehospital IV solution	- hypovolemia - diabetic ketoacidosis - trauma - heat exhaustion - TKVO - route for drug admin.	- electrolyte imbalance - over hydration	- can be infused quickly

Objective 1: Key Terms

- Solution
- Intracellular
- Extracellular
- Passive transport
- Active transport
- Diffusion
- Filtration
- Osmosis
- Osmotic pressure
- Isotonic solution
- Hypertonic solution
- Hypotonic solution
- Adenosine triphosphate (ATP)

Objective 2

Describe the Indications and Complications for Intravenous Therapy

Indications

The balance between the intake and output of fluids and electrolytes is an important factor in maintaining the homeostasis of the body. The infusion of IV fluids can be used to:

- Replace the body's fluid and electrolytes when these have been lost. The EMT must consider that fluid administration is only a temporary resuscitation method as fluid lost often exceeds potential fluid replacement
- Restore acid-base balance
- Provide an avenue for medication administration when it is expected. Remember that access may be more difficult to obtain at a later time
- Replace vitamins, proteins, calories, electrolytes and fluid in a patient who cannot maintain an adequate intake by mouth

For hypotensive trauma patients (hypovolemia/hemorrhage)

The IV recommended is:

- 14 g – 16 g catheter preferred (18 g acceptable)
- Standard 10 gtt/ml set
- Bolus of 250 ml to 500 ml then reassess BP and lungs fields
- End point: up to 20 ml/kg or systolic BP of 90 mmHg with no overload
- 0.9% NaCl or Lactated Ringers solution (It is recommended as a standard of care that you initiate x2 IV lines for a patient who has lost or is losing a large volume of blood)

For hypotensive medical patients (in absence of pulmonary edema)

The IV recommended is:

- 14 g - 18 g catheter
- Standard 10 gtt/ml (drop/ml) set
- Bolus of 250 ml to 500 ml then reassess BP and lungs fields
- End point: up to 20 ml/kg or systolic BP of 90 - 100 mmHg with no overload
- 0.9% NaCl

Cardiac Patient (chest pain, hemodynamically stable)

The IV recommended is:

- 18 g – 22 g catheter
- Standard 10 gtt/ml set
- TKVO (50 ml -75 ml/hr)
- 0.9% NaCl

Altered Level of Consciousness (NYD or unknown etiology)

The IV recommended is:

- 16 g – 18 g catheter
- Standard 10 gtt/ml set
- TKVO (50 ml -75 ml/h)
- 0.9% NaCl

Dyspnea / Shortness of Breath (hemodynamically stable)

The IV recommended is:

- 16 g – 20 g catheter
- Standard 10 gtt/ml set
- TKVO (50 ml -75 ml/hr)
- 0.9% NaCl

Please Note:

- “The use of large amounts of IV fluids in the setting of uncontrolled internal hemorrhage may also increase internal bleeding and mortality. IV fluids increase the blood pressure (like PASG) but fluids may also dilute clotting factors. IV fluids carry no oxygen and are not a replacement for red blood cells. Early blood transfusion is very important in severe cases of hemorrhagic shock”¹
- “Any delay in providing rapid transport of these patients should not occur unless absolutely unavoidable, as in the case of a patient requiring prolonged extrication”²
- Prehospital care providers generally should limit the fluid administered to 2-3 liters in the field. The EMT should seek Medical Direction before further fluid replacement
- TKVO (To Keep Vein Open) is required when the infusion is intended to provide venous access instead of fluid replacement
- Reduce flow to TKVO (approximately 50 ml -75 ml/hr) if signs and/or symptoms of overload occur at any time
- Maintenance IV is a minimum of 125 ml/hr

1,2 Campbell (2004). Basic Trauma Life Support For Paramedics and Other Advanced Providers, 25th Anniversary Edition, New Jersey: Pearson Prentice Hall Inc.

Complications

Complications are always a possibility when initiating or monitoring IV therapy. It is crucial that the practicing EMT recognize these complications early, should they occur. These complications can be divided into localized and systemic problems. The localized problems are found around the site of the infusion, whereas the systemic problems affect the body as a whole.

Localized Complications

Infiltration - The needle has perforated the vein causing the solution to leak into the interstitial space. Look for swelling, blanching, coldness at the site. Discontinue site and start another IV at an alternate site.

Phlebitis - The needle is irritating the inner lumen of the vein, or the solution is irritating. Look for redness, heat, and swelling at the site, could extend along the course of the vein and can be very painful. Observe the site; if it is causing too much discomfort discontinue.

Thrombus Formation - Blood has been allowed to clot inside or around the lumen of needle. The IV may stop because the solution has run out, there is a kink in the tubing or the bag is not high enough. To prevent this make sure that the solution is always flowing,

Systemic Complications

Pyrogenic Reactions - The infusion has become contaminated with microorganisms or microbial by-products, which could cause abrupt fever, chills, headache, abdominal cramps, vomiting and malaise, hypotension and vascular collapse. Usually occurs about ½ hour after infusion is started. Always check the solution for visible contamination. Discontinue IV and save infusion fluid that was used (for microbial testing). Restart IV at another site using all new solution and equipment. Check vital signs, administer high flow oxygen and transport to the nearest facility.

Pulmonary Embolism - An obstruction within the pulmonary artery from a clot or foreign substance such as part of the IV cannula, results in an interruption of blood supply to an area of the lung. The patient may present with sudden, sharp, non-radiating chest pain, dyspnea, cyanosis, tachycardia and/or hemoptysis. Check vital signs, administer high flow oxygen and transport to the nearest facility.

Air Embolism - Air has enters the vein and travels to the pulmonary circulation. The patient would present with sudden dyspnea, cyanosis, chest pain, hypotension, tachycardia and loss of consciousness. Always check the infusion line for air bubbles. To prevent this, always change or discontinue the infusion before the container becomes empty. If you suspect air embolism place the patient on his left side with his head down. Air will rise into the right atrium and allow blood to pass into the lungs. Check vital signs, administer high flow oxygen and transport to the nearest facility.

Pulmonary Edema – An over load of fluid possibly from infusion of fluid too rapidly. The pulmonary vasculature is receiving more blood from the right ventricle than the left ventricle can remove. Fluid leaks through the capillary walls into the alveolar sacs and into the bronchials. Monitor vital signs, especially lung sounds, and watch for dyspnea, tachycardia, frothy white or blood tinged sputum, restlessness and anxiety. Slow the infusion down to TKVO, administer oxygen, attempt to ventilate with BVM, transport the patient full fowlers to the nearest facility ASAP.

Again, these are a few systemic complications to be aware of while transporting a patient with an IV. If you suspect any of these, monitor and treat the patient, reduce the flow rate to TKVO (unless stated otherwise) and document accordingly. If the IV must be discontinued, another one should be started at an alternate site to maintain venous access.

Objective 2: Key Terms

- Infiltration
- Phlebitis
- Thrombus
- Pyrogenic reaction
- Pulmonary embolism
- Air embolism
- Pulmonary Edema

Objective 3

Discuss and Perform Intravenous Cannulation

In this objective we will learn to choose the most appropriate vein for the size of catheter, the administration set, and flow rate recommended for that patient. Always start at the distal end of the patient's arm, where in the event of infiltration, you can proceed up the extremity to the next appropriate site.

Selecting an intravenous site

The EMT should use a vein that is:

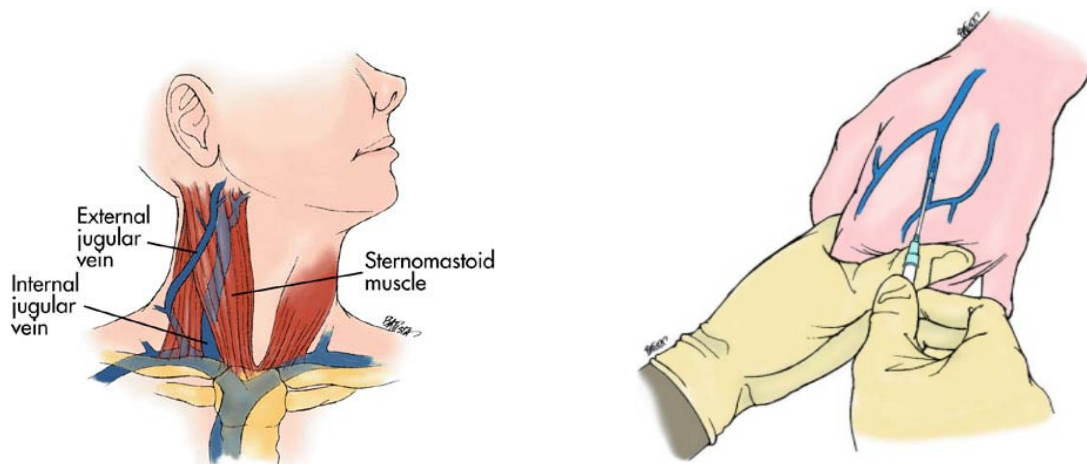
- Fairly straight
- Free of valves at the chosen site
- Well fixed – not “rolling”
- Easily palpated and readily accessible
- Appropriate for the size of catheter and purpose of IV (18 g medication line or 14 g fluid resuscitation)

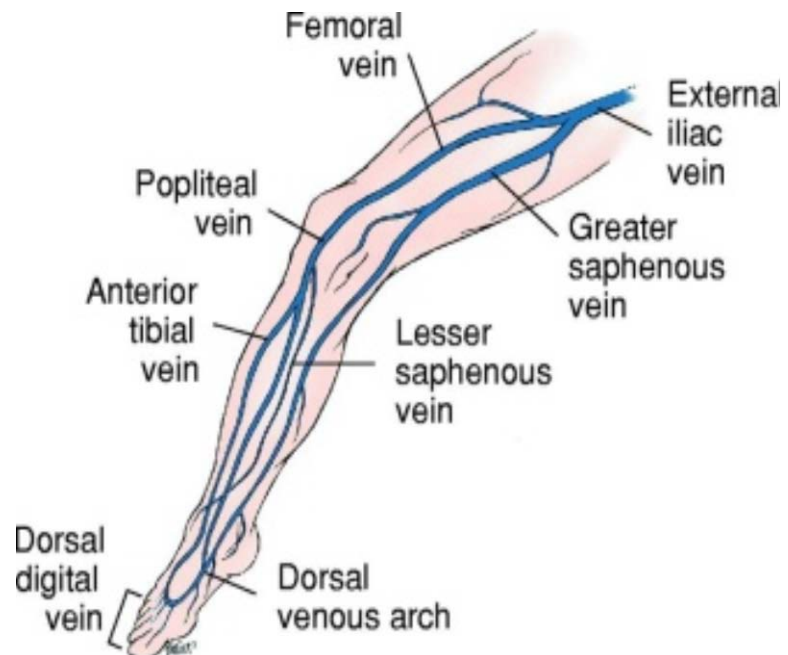
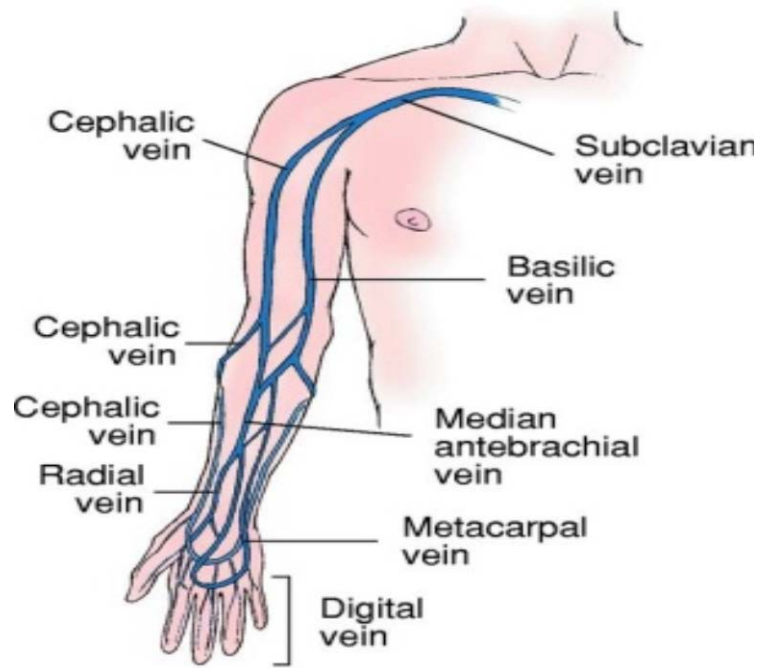
As a rule: Veins lying over joints, vein bifurcation (the “y” of a vein where it branches off and where valves are present), swollen or injured extremities and areas where there is arterial involvement should be avoided as IV sites. When valves are present you will see small bumps in the vein.

In non-critical patients, the distal veins of the hand and arm are often used as the preferred IV sites. Start at the distal end of the upper extremity and look for an available vein. If this IV attempt is unsuccessful, remove the catheter, control the bleeding with pressure and look for a site proximal to the site of the failed attempt.

In critical patients and/or cardiac arrest patients, the antecubital (AC) fossa or the external jugular vein are the preferred sites because they offer close access to the central circulation.

Mosby's EMT-I





Mosby's EMT-I

Types of IV Catheters

There are two common types of catheters used in the prehospital setting that are available in a variety of gauges.

1. **Over-the-needle catheters** – Most common catheter used in the prehospital setting. A flexible catheter over a hollow, stainless steel needle. The needle and catheter are inserted; the needle is removed leaving the catheter in place.
2. **Butterfly needle** - A stainless steel hollow needle is inserted into the vein and taped in place. Not common in the prehospital setting.

Sizes of IV Catheters

- 14 Gauge – Used for patients in shock, cardiac arrest or volume replacement for trauma patients.
- 16 Gauge – Used for patients in shock, cardiac arrest or volume replacement for trauma patients.
- 18 Gauge – Used for patients who may require blood or when administering D₅₀W.
- 20 Gauge – Most commonly used for non-critical patients or routine IV therapy.
- 22 Gauge – Used for infants, toddlers, children, adolescents, and the elderly.
- 24 Gauge – Used mainly for neonates, infants, small children and the elderly

Intravenous Administration Sets

There are several different administration sets available to prehospital providers. The most common administration sets used are the 10, 15, and 60 gtt sets. These numbers represent the number of drops it takes to make 1 ml of solution. Each of these administration sets will consist of a drip chamber, flow regulator, tubing and medication ports.

- **Micro** Drop set (60 gtt/ ml solution set)
- **Macro** Drop Set (10 gtt/ml solution set)

Saline Locks

The saline lock is becoming increasingly popular in the prehospital setting. These are known as an intermittent infusion device and typically a “Luer-lock” tip is used to prevent accidental loosening of the cap from the catheter hub. Common brand names for these devices are “P-R-N Adapters”. These devices maintain a route for medication administration, are cost effective and aid in patient comfort. Once in place, the device should be flushed with a syringe with a minimum of 3 ml of **bacteriostatic Normal Saline** while slowly withdrawing the needle, in order to “lock” it and prevent clotting at the hub. These devices must be flushed with normal saline to ensure vein patency prior to any medication or solution being administered.



Saline Lock

IV Drip Rate Calculation

EMT's are responsible for monitoring the flow rate of the IV. It is very important to be able to calculate the proper drip rate, otherwise we risk the possibility of fluid overloading our patients.

10 drop per ml administration set

100 ml/hr.....17 gtt/min.
 125 ml/hr.....21 gtt/min.
 150 ml/hr.....25 gtt/min.
 175 ml/hr.....29 gtt/min.
 200 ml/hr.....33 gtt/min.
 225 ml/hr.....38 gtt/min.
 250 ml/hr.....42 gtt/min.
 300 ml/hr.....50 gtt/min.

60 drop per ml administration set

30 ml/hr.....30 gtt/min.
 45 ml/hr.....45 gtt/min.
 60 ml/hr60 gtt/min.
 75 ml/hr.....75 gtt/min.
 100 ml/hr.....100 gtt/min.
 125 ml/hr.....125 gtt/min.

Formula

$$\text{Drops per minute} = \frac{\text{volume to be infused} \times \text{drop set size}}{\text{Amount of Time}}$$

Examples:

You require 250 ml in an hour using a Macro (10 gtt/ml) set:

$$\frac{250 \text{ ml/hr} \times 10 \text{ gtt/ml}}{60 \text{ min/hr}} = 42 \text{ gtt/min}$$

You require 60 ml in an hour using a Micro (60 gtt/ml) set:

$$\frac{60 \text{ ml/hr} \times 60 \text{ gtt/ml}}{60 \text{ min/hr}} = 60 \text{ gtt/min}$$

Procedure for starting an IV

Priming the IV line

Prior to preparing the patient for IV insertion you need to prepare your equipment. The first step is to attach your tubing to the IV solution and *prime* your line. Remove the tubing from the package, stretch it out and close the roller clamp. Remove the blue protective covering from the port on the IV bag and invert the bag. Remove the cover from the spike end on the IV tubing being careful not to contaminate the spike or the port on the bag. Carefully insert the spike into the port until it sits flush with the port. Hang the bag and squeeze the drip chamber until the solution is to the line or approximately half full. Next, holding the free end of the tubing over a garbage bag or container, fully open the roller clamp to allow the fluid to fill the tubing. If air is present in the line it can be removed by flicking the line with your finger tip or tapping with a pen. This will move the air up the line to the drip chamber. It is important to ensure that there is no significant amount of air in the IV line as this can potentially cause an air embolus which can be a life threatening complication for the patient.

Preparing for cannulation

As with all procedures, the practitioner must wear appropriate PPE. Choose the IV catheter according to the purpose and site of cannulation as outlined earlier in this objective. Ensure you have an alcohol swab, at least four pieces of tape torn, with at least one of them being 1" wide, a tourniquet, 2x2 gauze, and transparent dressing if your service uses this. Explain the procedure to the patient.

For IV starts on the limbs, apply the tourniquet to the limb approximately 4 inches above the desired cannulation site. Carefully evaluate the veins for straightness, valves (bumps) or bifurcations (area where the veins fork into two). Touch the vein to ensure that it does not easily roll away from pressure. Cannulation of rolling veins, veins with valves or a bifurcation at or close to the puncture site are not likely to result in a successful IV start. Permanently damage can be sustained to a valve by forcing the catheter through it, therefore avoiding valves is the best practice. Selection of the vein is based on the purpose of the IV as discussed earlier in this module. Palpate the vessel to ensure there is *no pulse*.

Catheter Insertion

With the bevel of the needle up for adults and down for pediatrics and elderly, insert the IV needle and catheter at a 15 to 30 degree angle to the site and towards the heart. Advance the needle until flashback is noted in the flash chamber of the IV catheter. Continue to advance the needle an additional 1 - 2 mm to ensure the catheter is in the vein. Next, lower the angle to approximately 15 degrees and slowly advance the catheter off of the needle. Pressure must be applied over the catheter, not over the insertion site, prior to completely withdrawing the needle or bleeding will occur. Connect the IV tubing that you primed earlier by gently inserting it into the end of the IV catheter and twisting the collar to lock it in place. Release the tourniquet and any manual pressure immediately after connecting the tubing. Gently hold the catheter in place, open the roller clamp to observe flow at the drip chamber of the tubing. Observe the insertion site to ensure the fluid is not

pooling under the skin (interstitially). If the fluid is flowing freely and there is no immediate swelling around the insertion site, proceed to tape the catheter and tubing in place. The catheter is usually taped using a chevron if it has wings or the crossover method if it does not have wings. These methods will be demonstrated during the lab session for this module. If your service uses transparent dressings such as Opsite™ or Tegaderm™, they should be placed over the catheter hub being careful not to tape directly over the connection between the hub and the IV tubing. Secure the tubing to the patient's body at two places above the insertion site. To ensure that the IV doesn't get caught or accidentally pulled out, the tubing should be looped and secured with tape above the IV site. Once the IV is secured, set the flow rate according to protocol or the Physician's orders.

External Jugular Vein Cannulation

Although external jugular vein cannulation is considered a peripheral IV line, it should not be the first choice for an IV. The route to central circulation is not as direct as the antecubital vein, it is difficult to fully stabilize, and extravasation of fluids into the tissues in this area is a more serious complication than at other peripheral sites. Place the patient supine in a head down position to distend the external jugular vein. The external jugular vein begins near the angle of the mandible and extends across the sternocleidomastoid muscles. Ensure you palpate the vein to ensure there is no pulse prior to cannulating. To help prevent infection cleanse the area with an alcohol swab or other approved product in a circular motion starting from the intended puncture site and moving out. Align the cannula in the direction of the vein with the point aimed at the ipsilateral shoulder. If possible, occlude the vein by lightly pressing a finger on the vein just above the clavicle. Puncture the vein midway between the angle of the jaw and midclavicular line and watch for flashback in the catheter hub ¹. Once flashback has been obtained, advance another 2 mm and continue to advance the catheter while withdrawing the needle. Apply pressure over the catheter prior to completely removing the needle or bleeding will occur. While holding the catheter in place, connect the tubing to the hub and open the roller clamp to check for flow. Secure the catheter and tubing in place.



¹ ACLS Principles and Practice, 2003, American Heart Association



Monitoring the IV

Monitor the IV by ensuring flow rate remains as set, check site and limb for any signs of complications. Ensure the IV bag does not run dry or that air has entered the IV line during infusion.

To change an IV bag, select the appropriate solution and check for color, clarity, concentration and expiration date. Close the roller clamp on the IV line, and remove the empty bag off of the spike being careful not to contaminate the spike. Remove the blue protective covering from the port on the new IV bag and spike the bag as discussed earlier. Re-hang the bag, ensure the drip chamber is half full and open the roller clamp to resume flow. Reset the flow rate as appropriate.

If the drip chamber has emptied and there is air in the tubing, you must remove the air before it flows into the patient. The most common way of removing air from IV tubing is to use a small gauge needle, swab the injection port distal to the air, insert the needle into the injection port leaving the hub end open, open the roller clamp slowly and allow the air to come out of the needle at the injection port. Once all the air is removed, withdraw the needle and discarded and reset the IV flow rate. Another way of removing air from the tubing is to replace the whole line. First prime the line with IV solution, apply pressure to the IV site over the catheter, not the hub, remove the old tubing, discarded, and attach the new tubing. Reset the flow rate.

Troubleshooting an IV that isn't flowing

1. Make sure the tourniquet is off.
2. Check IV insertion site for infiltration.
3. Check clamps/slide locks to see they are open.
4. Ensure there is fluid in the IV bag.
5. Make sure the line is not restricted or pinched, and that patient is not laying on it.

6. Inspect *venipuncture* site and establish if IV catheter is “*positional*”. Gently lift on the hub to see if flow improves. The EMT may need to place a small gauze pad under the hub to maintain an adequate flow rate.
7. If the drip chamber is full, close the flow clamp, temporarily invert the IV bag and squeeze the chamber until it is about half full. Reopen the clamp to establish flow.
8. Raise the bag higher above the insertion site; lower the patient’s arm position.
9. Lower the bag below the IV insertion site and look for free blood return into the IV tubing.
10. Gently compress the IV bag.
11. Close the drip chamber valve and wrap the tubing around a penlight to compress it. Reopen the valve to see if the flow has improved.

Discontinuing the IV

In the event the IV goes interstitial or other complications arise that requires the IV be discontinued, the practitioner needs to know how to do this properly. The first step is to prepare your supplies. You should have gauze, tape and a band aid ready for use. Explain the procedure to the patient. Close the roller valve on the IV tubing. Remove all tape and transparent dressings being careful when removing the tape over the catheter so you do not inadvertently pull it out. Place the gauze over the insertion site and press down gently while removing the catheter by pulling it straight out by the hub. Apply firm pressure over the insertion site to stop bleeding and reduce the chance of bruising (maintain for about 1 minute). Discard the IV set up as per protocol for biohazardous items. Once the bleeding has stopped, place the band aid over the site.

Documentation

Documentation of the IV is very important, as it is an invasive procedure and can affect the patient’s immediate status as well as long-term treatment decisions. Proper documentation must include the time started or attempted, the type of solution used, the size of the catheter, the flow rate, the location of *all* attempts and successful starts, and the amount of fluid infused. In the event that the IV is being used to provide fluid resuscitation, the patient response along with regular vital signs must be documented. The lungs must also be monitored in all patients with an IV to ensure it is not causing pulmonary edema from fluid overload. In the event the IV is discontinued in the field this must also be documented along with the reason why.

Objective 3: Key Terms

- Macro
- Micro
- Saline Locks
- Bacteriostatic Normal Saline
- Prime
- Venipuncture
- Positional

Summary

IV therapy is one of the most invasive procedures an EMT performs. To maintain homeostasis, we must establish a balance among all systems of the body. As EMT's we are often the first providers on scene and provide the first line of action in restoring homeostasis. The safe and timely administration of IV fluid is one of the most important actions we can take in this respect. Proficiency with all aspects of IV therapy, with regard to assessment, decision-making and technique are very important skills for the EMT. These skills require practice and ongoing theory review to maintain competence.

Exam

1. A positively charged ion is known as:
 - a. Anion
 - b. Cation
 - c. Proion
 - d. Negion

2. 0.9% sodium chloride is a(n) _____ solution:
 - a. Osmotic
 - b. Hypotonic
 - c. Hypertonic
 - d. Isotonic

3. Which type of transport requires energy to move substances across a cell membrane:
 - a. Passive Transport
 - b. Osmosis
 - c. Diffusion
 - d. Active Transport

4. The movement of water from areas of lower solute concentration to areas of higher solute concentration across a semipermeable membrane is called:
 - a. Diffusion
 - b. Filtration
 - c. Osmosis
 - d. Facilitated diffusion

5. Extracellular fluid is:
 - a. Makes up for approximately 40% water
 - b. Fluid within the cells
 - c. Comprised mostly of intravascular fluid (plasma) and interstitial fluid (tissue fluid)
 - d. Has oxygen carrying capabilities.

6. Which of the following is an indication for starting an IV:
 - a. Restore acid-base balance
 - b. Fluid replacement
 - c. Access for med administration
 - d. All of the above

7. Which of the following is not a sign of infiltration:
 - a. Coldness at the site
 - b. Swelling
 - c. Blanching
 - d. Red rash

8. The recommended gauge of needle for hypotensive patients caused by hypovolemia is:
 - a. 20 - 24 gauge
 - b. 18 - 22 gauge
 - c. 16 - 20 gauge
 - d. 14 - 18 gauge

9. The recommended position for a patient with an air embolism is:
 - a. Head down feet up
 - b. Lying on their left side with the head lowered
 - c. Supine
 - d. Right lateral recumbent

10. If you are instructed to administer an IV TKVO, how much fluid would you infuse:
 - a. 100 – 150 ml/hr
 - b. 50 – 75 ml/hr
 - c. 250 – 30 ml/hr
 - d. 25 – 50 ml/hr

11. An IV is started with a macrodrip administration set. You have been instructed to infuse 500 ml of solution over the next hour. The IV solution should be infused at a rate of how many drops per minute:
 - a. 125 gtt/min
 - b. 85 gtt/min
 - c. 50 gtt/min
 - d. 100 gtt/min

12. You are to infuse 1.5 liters of Normal Saline over the next 2 hours using a macro drop set. How many drops per minute will you give:
 - a. 250 gtt/min
 - b. 125 gtt/min
 - c. 85 gtt/min
 - d. 150 gtt/min

13. The type of catheter most commonly used in the prehospital setting is the _____:
- a. Butterfly needle
 - b. Through the needle catheter
 - c. Over-the-needle catheter
 - d. None of the above
14. Which of the following is a factor that may affect IV flow rates:
- a. Not removing the tourniquet
 - b. The IV bag is lower than the patient
 - c. Drip chamber is full
 - d. All the above
15. To infuse 250 ml of Normal Saline over 2 hours using a micro drop set, how many drops per minute will you infuse:
- a. 50 gtt/min
 - b. 85 gtt/min
 - c. 125 gtt/min
 - d. 150 gtt/min

Glossary of Terms

Objective 1: Key Terms

Solution – A liquid preparation of one or more soluble chemical substances usually dissolved in water

Intracellular – Within a cell or cells

Extracellular – Situated or occurring outside a cell or cells

Passive Transport – The transport of a fluid and/or electrolyte without energy expenditure

Active Transport – The movement of substances across a cell membrane against a concentration gradient using adenosine triphosphate (ATP) as an energy source

Diffusion – the movement of a gas from an area of higher concentration to an area of lower concentration

Filtration – Passage through a filter or through a material that prevents passage of certain molecules

Osmosis – The diffusion of pure solvent across a membrane in response to a concentration gradient, usually from a solution of lesser to one of greater solute concentration

Osmotic Pressure – The amount of pressure necessary to stop the flow of water across the membrane

Isotonic Solution – One having an osmotic pressure the same as that of a standard of reference

Hypertonic Solution – One having an osmotic pressure less than that of a standard of reference

Hypotonic Solution – One having an osmotic pressure greater than that of a standard of reference

Adenosine triphosphate (ATP) – The main energy currency in living cells; used to transfer the chemical energy needed for metabolic reactions.

Objective 2: Key Terms

Infiltration – The pathological accumulation in tissue or cells of substances not normal to them or in amounts in excess of the normal

Phlebitis – Inflammation of a vein

Thrombus – an aggregation blood factors, primarily platelets and fibrin with entrapment of cellular elements, frequently causing vascular obstruction at the point of its formation

Pyrogenic Reaction – The infusion has been contaminated and may cause abrupt fever, chills, headache, abdominal cramps, vomiting and malaise, hypotension and vascular collapse

Pulmonary Embolism – An obstruction within the pulmonary artery from a clot or foreign substance

Air Embolism – Air has entered the vein and traveled to the lungs

Pulmonary Edema - An over load of fluid possibly from infusion of fluid too rapidly

Objective 3: Key Terms

Macro Administration Set – 10 drops/ml solution set

Micro Administration Set – 60 drops/ml solution set

Saline Locks – An intermittent infusion device

Bacteriostatic Normal Saline - Saline solution with antibacterial properties, used to fill Saline Locks between infusions

Prime – To flush the IV tubing with fluid and ensure fluid replaces all air in the tubing in preparation for connection to an IV catheter

Venipuncture – Surgical puncture of a vein

Positional - When an IV catheter is pressing against the vein wall or a valve, flow can be impeded when the limb is in certain positions. With repositioning of the limb the IV flows freely

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APPENDIX A

Lab Skills Checklist

SKILL GUIDELINES - PERIPHERAL IV CANNULATION

- PPE Precautions
- List indications and complications
- Explain procedure to patient
- Prepare equipment & supplies (Solution, quantity, administration set, catheters, tape, swabs etc.)
- Check IV solution (color, clarity, concentration & expiration date)
- Close clamp, spike IV bag, hang, prime line and protect end from contamination
- Determine location for IV, clean area, apply tourniquet
- Remove IV catheter from protector and check catheter for irregularities
- Hold skin taut, bevel of needle up for adults and bevel down for pediatrics and the elderly, at 15 - 30 degree angle, and advance until flash back, lower and advance about ¼ inch/2mm (bevel down in infants and the elderly)
- Advance catheter off needle while holding the needle stationary, occlude vein, withdraw needle and discard in sharps
- Connect hub of IV line to catheter, release tourniquet, open IV line
- Assess for infiltration or bleeding
- Secure hub, loop and secure IV line
- Adjust to desired flow rate
- Reassess patient
- Continued monitoring of patient and intervention for complications
- Properly verbalizes steps to change out solution bag
- Record time, date, needle size, and drop set, type of solution and amount infused

Comments:

Instructor Name & Initials: _____ *Date:* _____

Lab Skill Checklist

SKILL GUIDELINES – EXTERNAL JUGULAR VEIN CANNULATION

- PPE Precautions
- List indications and complications
- Prepare equipment & supplies (Solution, quantity, administration set, catheters, tape, swabs etc.)
- Check IV solution (color, clarity, concentration & expiration date)
- Close clamp, spike IV bag, hang, prime line and protect end from contamination
- Select and visualize external jugular vein
- Explain procedure to patient
- Cleanse the area for IV cannulation
- Place the patient in supine head down position with the head turned 90 degrees away from the insertion site and secure the vein
- Place traction on the vein above the clavicle
- Insert over-the-needle catheter towards the ipsilateral shoulder into the vein halfway between the angle of the jaw and the clavicle
- Observe for blood return
- Advance catheter and withdraws needle
- Attach and secure the IV line appropriately and infuse fluid watching for infiltration
- Record time, date, needle size, and drop set, type of solution and amount infused

Comments:

Instructor Name and Initials: _____ *Date:* _____

Lab Skills Checklist

SKILL GUIDELINES – DISCONTINUING A PERIPHERAL IV

- PPE Precautions
- List indications and complications
- Explain procedure to patient
- Prepare equipment & supplies (Gauze pads, band aid)
- Close roller clamp on IV line
- Remove tape from tubing and hand while securing hub of catheter
- Lightly apply gauze over insertion site
- Grasp hub of catheter and gently withdraw catheter
- Apply firm pressure over site to control bleeding (maintain for at least one minute)
- Apply band aid to site
- Document discontinued IV including amount of fluid infused

Comments:

Instructor Name & Initials: _____ *Date:* _____