Bleeding and Shock

EMS Continuing Education
Technician through Technician-Advanced Paramedic

Consistent with the
National Occupational Competency Profiles
as developed by
Paramedic Association of Canada
and
"An Alternate Route to Maintenance of Licensure"
as developed by Manitoba Health

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Disclaimer

These documents were developed for improved accessibility to "An Alternative Route to Maintenance of Licensure" for all paramedics in Manitoba. Regional implementation of Alternate Route is at the discretion of the local EMS Director.

This is a supportive document to the National Occupational Competency Profiles and "An Alternative Route to Maintenance of Licensure." It is not the intent that this package be used as a stand-alone teaching tool. It is understood that the user has prior learning in this subject area, and that this document is strictly for supplemental continuing medical education. To this end, the Paramedic Association of Manitoba assumes no responsibility for the completeness of information contained within this package.

It is neither the intent of this package to supercede local or provincial protocols, nor to assume responsibility for patient care issues pertaining to the information found herein. Always follow local or provincial guidelines in the care and treatment of any patient.

This package is to be used in conjunction with accepted models for education delivery and assessment, as outlined in "An Alternative Route to Maintenance of Licensure".

This document was designed to encompass all licensed training levels in the province Technician, Technician-Paramedic, Technician-Advanced Paramedic. Paramedics are encouraged to read beyond their training levels. However, the written test will only be administered at the paramedic's current level of practice.

All packages have been reviewed by the Paramedic Association of Manitoba's Educational Subcommittee and physician(s) for medical content.

As the industry of EMS is as dynamic as individual patient care, the profession is constantly evolving to deliver enhanced patient care through education and standards. The Paramedic Association of Manitoba would like to thank those practitioners instrumental in the creation, distribution, and maintenance of these packages. Through your efforts, our patient care improves.

This document will be amended in as timely a manner as possible to reflect changes to the National Occupational Competency Profiles, provincial protocols/Emergency Treatment Guidelines, or the Cognitive Elements outlined in the Alternate Route document.

Any comments, suggestions, errors, omissions, or questions regarding this document may be referred to info@paramedicsofmanitoba.ca , attention Director of Education and Standards.

Conventions Used in this Manual

Black lettering without a border is used to denote information appropriate to the Technician Level and above.

Text with the single striped border on the left is information appropriate to Technician-Paramedic and above.

Text with the double striped border on the left is information appropriate to Technician-Advanced Paramedic and above.

Table of Contents

Introduction

The purpose of this module is to review structure, function and control of the circulatory system, to understand the mechanisms of shock, to be able to classify and recognize all stages of shock, and finally to understand the importance of quick recognition and appropriate management of shock.

Objectives include:

- Cardiovascular system
- External bleeding
- Internal bleeding
- Shock

Anatomy and physiology of the cardiovascular system

The cardiovascular system serves to provide the body with an adequate blood supply. This blood delivers oxygen and nutrients, hormones, and antibodies to the body's tissues and removes waste products. Furthermore, the vascular system also helps to regulate body temperature, fluid balance, and blood pressure. The cardiovascular system consists of the heart, blood vessels, and blood.

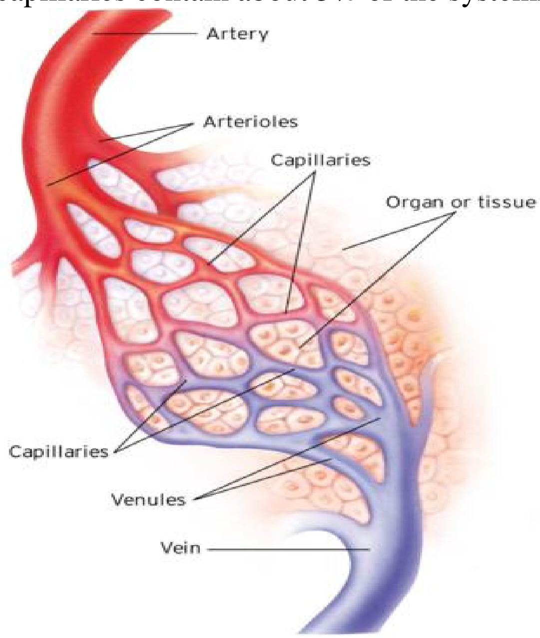
The heart is a muscular organ with a single purpose - to pump blood to supply oxygen-enriched red blood cells to the tissues of the body. The heart is divided down the middle into two sides (left and right) by a wall called the septum. Each side of the heart has an atrium (upper chamber), and a ventricle (lower chamber). Blood leaves each of the four chambers of the heart through a one-way valve. These valves keep the blood moving through the circulatory system in the proper direction. The largest valve is the aortic valve, lying between the left ventricle and the aorta. The aorta, the body's main artery, receives the blood ejected from the left ventricle and delivers it to all the other arteries so that they can carry oxygenated blood to the tissues of the body.

The right side of the heart receives deoxygenated blood from the veins of the body. Blood enters into the right atrium from the vena cavae, which then fill the right ventricle via the tricuspid valve. During contraction of the right ventricle, blood flows into the pulmonary artery via the pulmonic semilunar valve and the pulmonary circulation, where the blood is oxygenated. The left side of the heart receives oxygenated blood from the lungs through the pulmonary veins. Blood enters into the left atrium, and then passes into the left ventricle via the mitral or bicuspid valve. This ventricle of the heart is more muscular than the other because it must pump blood into the aorta and all the other arteries of the body.

The heart contains more than muscle tissue. The heart's electrical system, which is distributed throughout the entire heart, controls heart rate and enables the atria and ventricles to work together. Normal electrical impulses begin in the sinus node, just above the atria. The impulses travel across both atria, causing them to contract. Between the atria and the ventricles, the impulses cross over a bridge of special electrical tissue called the atrioventricular (AV) node. Here the signal is slowed down for about one tenth to two tenths of a second to allow blood time to pass from the atria to the ventricles. The impulses then exit the AV node and spread throughout both ventricles via the purkinje fibres and the bundle of his, causing the ventricular muscle cells to contract.

The systemic circulation is composed of arteries, veins, capillaries and blood. The blood vessels are a closed system of tubes through which blood flows. Arteries and arterioles take blood away from the heart. Arteries have three layers and are thicker and stronger than the other vessels in the body. The middle layer contains smooth muscle and a large amount of elastic fibers. The two most important properties of the arteries are elasticity (the ability to stretch) and contractility (the ability to constrict). The arterial walls become thicker, more muscular, and less elastic as the arteries branch into smaller vessels (arterioles). This smooth muscle in the wall of the artery allows for contraction and relaxation of the vessel; hence vasoconstriction (getting smaller) and vasodilation (getting larger). The arterial system is a high pressure system and contains about 20% of the systemic circulation.

The capillaries are distributors. The vessel walls are composed of a single layer of tissue. This thin wall serves to facilitate the exchange of gases, nutrients and wastes between the tissues and the blood supply. The blood flow at this level is slow which also serves to enhance exchange. Capillaries contain no smooth muscle and therefore lack the ability to actively vasodilate or vasoconstrict. At the origin of the capillary is a precapillary sphincter which acts as a stopcock to control the amount of blood entering the capillary. The capillaries contain about 5% of the systemic circulation.



Perfusion occurs when blood circulates through tissues or an organ, to provide the necessary oxygen and nutrients and remove waste products.

The veins are similar to the arteries, in that they contain the same three layers as the arteries, but when compared to the arteries they have much thinner walls and fewer elastic fibers. Because of these characteristics the veins are very distensible. Their diameters change passively, in response to small changes in internal pressure. Hence, veins are able to receive large volumes of blood with minimal increases in pressure. The veins not only act as conduits to channel blood from the capillaries to the heart, they have the ability to adjust their total capacity to accommodate variations in the total blood volume. The venous system is a low pressure system.

About 75% of the blood volume is found in the venous system. Of this amount, the majority is found in the veins of the systemic organs (mostly areas like the skin and less essential organs). This reservoir is largely stored blood and is known as the peripheral venous pool. A second, similar reservoir is known as the central venous pool and is comprised of the great veins of the thorax and right atrium. When the peripheral veins constrict (due to stress or exertion) blood that has been stored in the peripheral venous pool is mobilized and enters the central venous pool returning to the heart. This serves to enhance cardiac filling. This system of distributing the blood volume has important implications for the body when it is in a shock situation.

Blood is a viscous fluid which is heavier than water and constitutes about 8% of body weight. Average blood volume in an adult is between 4 and 6 litres. It serves to transport oxygen, carbon dioxide, nutrients, waste products, hormones and enzymes. It serves to regulate pH though buffer systems and protects against toxins and foreign microbes through special combat cells. Because of the large water content in the blood, it serves to regulate body temperature and control the water content of the cells. Finally blood prevents the loss of body fluids through clotting.

Coagulation Cascade

Differences between arterial, venous and capillary bleeding

Injuries and some illnesses can disrupt blood vessels and cause bleeding. Typically, bleeding from an open artery is bright red (high in oxygen) and spurts in time with the pulse. The pressure that causes the blood to spurt also makes this type of bleeding difficult to control. As the amount of blood circulating in the body drops so does the patient's blood pressure.

Blood from an open vein is much darker (low in oxygen) and flows steadily. Because it is under less pressure most venous blood does not spurt and is easier to manage.

Bleeding from damaged capillary vessels is dark red and oozes from a wound steadily but slowly. It may clot spontaneously.

Components and function of blood:

Plasma

- The sticky yellow fluid that carries the blood cells and nutrients
- Transports cellular waste material to the organs of excretion
- It contains most of the compounds needed to produce a blood clot

Red Blood Cells (Erythrocytes)

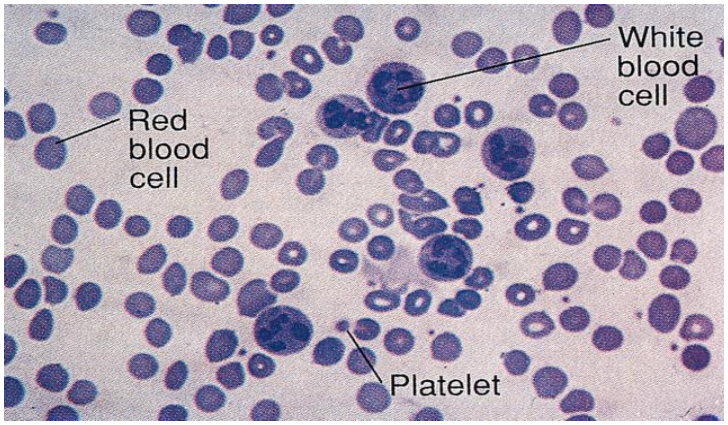
- The hemoglobin on these cells gives blood its characteristic red color
- Hemoglobin allows the cells to pick up and transport oxygen to the body tissues and carbon dioxide and remove about 20% carbon dioxide from the tissues

White Blood Cells (Leukocytes)

- Serve as the defense mechanism of the body, to combat infection
- Produce antibodies

Platelets (Thrombocytes)

- Cells in the blood that are essential in the clotting process



Body Substance Isolation (Routine Practices)

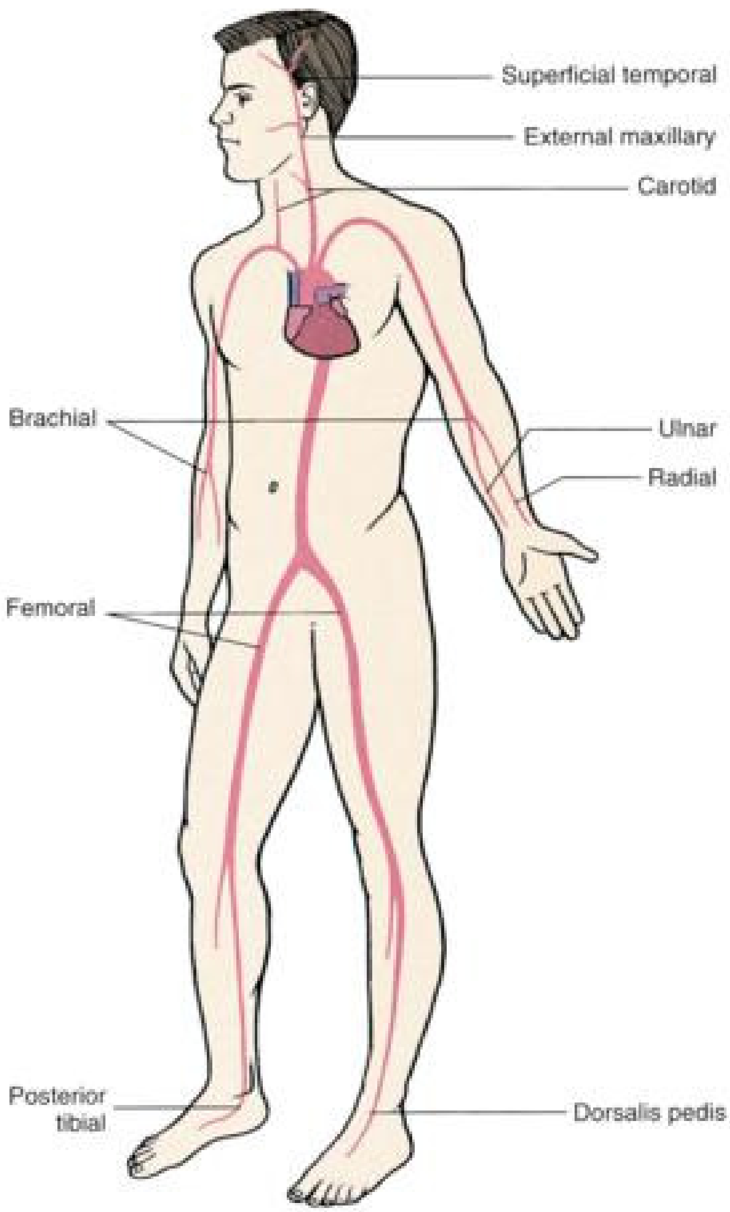
For many years, guidelines have required EMS personnel to take steps to protect themselves against diseases transmitted through blood. This is known as taking Universal Precautions. More recently the term Body Substance Isolation (BSI) has been used. BSI is an isolation strategy designed to prevent the transmission of potential pathogens between patients. BSI goes a step beyond Universal Precautions and assumes all body substances potentially infectious. For example, feces, nasal secretions, sputum, sweat, tears, urine and vomitus would also be considered infectious.
The current term used in Canada is Routine Practices. Routine Practices integrates the major features of Universal Precautions and BSI. This strategy applies to blood and all body fluids except sweat, regardless of whether or not they contain visible blood. Hand-washing is recommended after glove removal regardless of whether or not hands are visibly soiled.

Methods of controlling external bleeding

During the primary survey, control any identified major bleeding by:

- Immediately applying ***direct pressure*** using a gloved hand or sterile dressing.
- Having the patient ***rest*** the injured area and ***elevating*** the limb, when appropriate. Using pressure points proximal to the wound, if bleeding is not controlled by direct pressure.
- ***Pressure points***. If a wound continues to bleed despite use of direct local pressure, you should elevate the extremity and place additional pressure over a proximal pulse point. The larger the blood vessel that is involved in the bleed (injury), the more likely it is that use of a pulse point will need to occur. A pulse point, or pressure point, is a spot where a blood vessel lies near a bone. This technique is also useful if you have no material on hand to use for a dressing. Because a wound usually draws blood from more than one major artery, proximal compression of a major artery

rarely stops bleeding completely, but it helps to slow the loss of blood. You must be thoroughly familiar with the location of the pulse points for this to work.



- If bleeding persists apply additional dressings and pressure dressings as needed in layers.
- Use a tourniquet when no other methods are successful (last resort).
- Never remove a dressing or pressure dressing once applied (as it disrupts the clot formation).
- It is important to estimate blood loss (whenever possible), taking into consideration soaked towels, pools of blood, carpet stains, etc.

Application of a Tourniquet

- Application of a tourniquet should only be considered as a last resort in the control of external bleeding.
- Tourniquets may only be used on extremities.
- Load and go should be immediately initiated.
- The tourniquet should be made from wide material such as a 7 to 10 centimeter (3-4 inch) wide cravat or a blood pressure cuff.
- Prior to application distal circulatory and neurological status must be assessed.
- The tourniquet should be applied as proximal to the injury site as possible.
- If the injury is anywhere below the knee, the tourniquet should be applied above the knee just enough to stop bleeding.
- If a blood pressure cuff is used it should be inflated to 30 mm Hg above the systolic pressure.
- Bleeding, distal circulation and neurological status must be re-evaluated after application of the tourniquet.
- A tourniquet may be released:
  - If transport time from the point when the tourniquet was applied will be greater than two hours.
  - For three to five minutes every thirty minutes to allow distal circulation.
  - The first release of the tourniquet may be done after the tourniquet has been in place for two hours and then every thirty minutes thereafter.
  - Other methods of bleed control must be used while tourniquet is released (direct pressure, elevation, pressure points)
- Direct pressure, elevation, and pressure points should be used to control bleeding during the tourniquet release time.
- Time of tourniquet application, any release, and re-application must be documented.
- Health care staff at the receiving facility must be aware the patient has a tourniquet in place.
- Document notification of tourniquet's presence to health care staff on patient care report.

Internal Bleeding and Shock

Internal Bleeding

Internal bleeding can be very serious, especially because you might not be aware that it is happening. Injury or damage to internal organs commonly results in extensive internal bleeding, which can cause hypovolemic shock before you realize the extent of blood loss. A person with a bleeding stomach ulcer may lose a large amount of blood very quickly. Similarly, a person who has a lacerated liver or a ruptured spleen may lose a considerable amount of blood within the abdomen. Yet, the patient has no outward signs of bleeding.
Broken bones, especially broken ribs, also may cause serious internal blood loss. Sometimes this bleeding extends into the chest cavity and the soft tissues of the chest wall. A broken femur can easily result in the loss of 1L or more of blood into the soft tissues of the thigh. Often, the only signs of such bleeding are local swelling and bruising due to the accumulation of blood around the ends of the broken bone.

You must always be alert to the possibility of internal bleeding and assess the patient for related signs and symptoms, particularly if the mechanism of injury is severe. If you suspect that a patient is bleeding internally, you should promptly transport him or her to the hospital.

Mechanism of Injury

Internal bleeding is possible whenever the mechanism of injury suggests that severe forces affected the abdomen and/or the chest. These forces include rapid acceleration, rapid deceleration, shearing, or compression. Internal bleeding commonly occurs as a result of falls, blast injuries, and automobile or motorcycle crashes, whether the patient is a pedestrian, driver, or passenger.

As you assess a patient, look for signs of injury over the chest or abdomen, including contusions, abrasions, lacerations, or other signs of injury or deformity. You should always suspect internal bleeding in a patient who has a penetrating injury, such as a knife or gunshot wound.

Nature of Illness

Non-traumatic internal bleeding can lead to shock just as easily as bleeding caused by trauma. Internal bleeding can occur in the abdomen as a result of inflammatory bowel disease, an aneurysm, a ruptured ectopic pregnancy, or other medical conditions. Abdominal pain and distention are common in these situations but are not always present. In older patients, dizziness, faintness, or weakness may be the first sign of non-traumatic internal bleeding. Ulcers or other gastrointestinal problems may cause vomiting of blood or bloody diarrhea.

It is not as important for you to know the specific organ or condition involved as it is to recognize that the patient is in shock and respond appropriately.

Signs and Symptoms

The most common symptom of internal abdominal bleeding is acute abdominal pain. Another common sign is bruising around the abdomen. This can occur with or without trauma. Bruising is also called contusion or ecchymosis. A hematoma, a mass of blood in the soft tissues beneath the skin, indicates bleeding into soft tissues and may be the result of either a minor or a severe injury.

Bleeding, however slight, from any body opening is serious. It usually indicates internal bleeding that is not easy to see or control. Bright red bleeding from the mouth, or rectum (hematochezia) or blood in the urine (hematuria) may suggest serious internal injury or disease. Non-menstrual vaginal bleeding is always significant.

Other signs and symptoms of internal bleeding in both trauma and medical patients include the following:

- **Hematemesis.** This is vomited blood. It may be bright red or dark red, or if the blood has been partially digested, it may look like coffee ground vomitus.
- **Melena.** This is a black, foul-smelling, tarry stool that contains digested blood.
- **Hemoptysis.** This is bright red blood that is coughed up by the patient.
- Pain, tenderness, bruising, or swelling (TRD).
- Hematochezia – bright red blood in the stool indicates a lower GI bleed

The following signs and symptoms may mean that a closed fracture is causing bleeding.

- Pain, tenderness, bruising, or swelling.
- Broken ribs, bruises over the lower chest, or a rigid, distended abdomen.

In addition to the previously listed signs and symptoms, the following may indicate a lacerated spleen or liver. Patients with an injury to either organ may have referred pain in the right shoulder (liver) or left shoulder (spleen). You should suspect internal abdominal bleeding in a patient with referred pain.

The first sign of hypovolemic shock (hypoperfusion) is a change in mental status, such as anxiety, restlessness, or combativeness. In non-trauma patients, weakness, faintness, or dizziness on standing is another early sign. Changes in skin color, or pallor, are seen often in both trauma and medical patients. Later signs of hypoperfusion suggesting internal bleeding include the following:

- Tachycardia
- Weakness, fainting, or dizziness at rest
- Thirst
- Nausea and vomiting
- Cool, moist (clammy) skin

- Shallow, rapid breathing
- Dull eyes
- Slightly dilated pupils that are slow to respond to light (sluggish)
- Capillary refill in infants and children of more than 2 seconds
- Weak, rapid (thready) pulse
- Decreasing blood pressure
- Altered level of consciousness

Patients with these signs and symptoms are at risk. Some may be in danger. Even if their bleeding stops, it could begin again at any moment. It could also be a sign their blood volume is too low to bleed anymore. Therefore, prompt transport is necessary.

Emergency Medical Care

Controlling internal bleeding or bleeding from the major organs usually requires surgery or other procedures that must be done in the hospital. Your role in these cases is to keep the patient still to promote clot formation and to provide high-flow oxygen and prompt transport. However, you can usually control internal bleeding of the extremities by splinting the extremity. You should never use a tourniquet to control the bleeding from closed, internal, soft-tissue injuries.

Follow these steps to care for patients with possible internal bleeding:

- Follow BSI techniques.
- Maintain the airway with cervical spine immobilization if the mechanism of injury suggests the possibility of spinal injury.
- Administer high-flow oxygen and provide artificial ventilation as necessary.
- Control all obvious external bleeding.
- Treat suspected internal bleeding in an extremity by applying a splint.
- Monitor and record the vital signs at least every 5 minutes.
- Give the patient nothing (not even small sips of water) by mouth.
- In non-trauma patients, elevate the patient's legs 6" to 12" to help the blood return to the vital organs (can elevate with LSB if no suspicion of head injuries).
- Keep the patient warm.
- Provide immediate transport for all patients with signs and symptoms of shock (hypoperfusion).
- Initiate intravenous therapy if within scope, and titrate appropriately (Tech-P)

Shock

Shock – An abnormal condition of inadequate blood flow to the body's peripheral tissues associated with life threatening cellular dysfunction: also known as Hypoperfusion (Syndrome).

The Pathophysiological Progression of Shock

The shock state progresses through three stages.

- The Compensatory Stage
- The Decompensated (Progressive) Stage
- The Irreversible (Refractory) Stage

The Compensatory Stage

In this stage cardiac output is decreased. To combat this and to restore cardiac output, the body activates compensatory mechanisms. These mechanisms are nervous, hormonal, and chemical.

Within seconds of detecting the loss of cardiac output, the brain activates the sympathetic branch of the autonomic nervous system. The heart is stimulated to beat faster and harder. Blood vessels to the essential organs i.e.; heart, brain etc. are vasodilated to increase their blood supply. Blood vessels going to non essential areas such as the skin, digestive tract, and kidneys are vasoconstricted to shunt blood to priority organs.

As a follow up to the activation of the sympathetic nervous system, the body releases potent chemicals in an attempt to restore cardiac output. The adrenal glands release epinephrine which causes potent vasoconstriction of both veins and arteries. This vasoconstriction increases blood pressure and facilitates venous return to the right side of the heart.

To summarize, in the compensatory stage of shock, the body recognizes it has a problem and initiates compensatory sympathetic mechanisms in an attempt to maintain cardiac output.

Clinical Findings in Compensatory Shock

Blood Pressure - the blood pressure may be normal with possibly an elevated diastolic reading due to systemic arteriolar vasoconstriction (systolic may also be increased in end stage compensatory shock) .
Heart Rate - the heart rate is increased because of sympathetic stimulation. A sinus tachycardia occurs. Depending on the degree of shock and compensatory mechanisms a heart rate of 100 to 150 could be expected.
Skin - the skin is cool, pale, and clammy as a result of peripheral vasoconstriction and increased sweat gland activity.

Level of Consciousness - as the patient enters into the compensatory phase the patient may be restless and anxious. In the latter phase of the compensatory stage the level of consciousness may decrease due to decreased blood supply to the brain. The patient may present as confused and lethargic.
Respirations - may be rapid and shallow with a rate up to two times the normal.
Pupils - may be dilated, but will react to light.

The Decompensated (Progressive) Stage

If the shock is not reversed during the compensatory phase the mechanisms initiated during the compensatory stage to restore the cardiac output begin to have detrimental effects on the patient. This is due to the fact that prolonged and severe vasoconstriction has adverse effects on cellular function, capillary dynamics and specific organ systems.
Because of arteriolar vasoconstriction capillary blood flow is decreased, and oxygen delivery to the cells is reduced. This results in build up and eventual release of toxins from the cells into the tissue. With these toxic changes in the tissue environment, the pre-capillary sphincters open causing a fluid shift from the vascular compartment into the cellular beds. The end result is a loss of circulating blood volume that results in decreased venous return and reduced cardiac output. The patient further deteriorates, but no significant permanent damage is done if treated promptly and reversed.

Clinical Findings in Decompensated Shock

Blood Pressure - the blood pressure begins to plummet. The pulse pressure (the difference between the diastolic and systolic pressures) decreases (<30 mmHg is significant warning).
Heart Rate - the heart rate continues to increase and may exceed 150 beats per minute. Peripheral pulses will be rapid and thready and may in fact be absent.
Skin - the skin will be cold and clammy and in specific areas (lips, ear lobes, and nail beds) it may be cyanotic.
Level of Consciousness - the level of consciousness is severely altered. The patient may present with bizarre, inappropriate behavior or may be lethargic and unresponsive.
Respirations - the patient will be obviously short of breath and the respirations will be shallow.
Pupils - the pupils will be dilated and sluggish to react.

The Irreversible Stage

The irreversible stage is often referred to as the refractory or end stage shock. In this phase the patient has failed to respond to any form of therapy and is pre-cardiac arrest. Cells have begun to die and downward spiral begins. Cell death = organ death = organ failure = system failure = death. Once a patient reaches this stage of shock, permanent damage and most likely death occurs.

Clinical Findings of Irreversible Shock

Blood Pressure - except for brief periods the patient will not sustain any blood pressure.
Heart Rate - patient will have no peripheral pulses and the rate could be fast, slow, or irregular.
Skin - will be cold, cyanosed, or mottled.
Level of Consciousness - patient will be unconscious and unresponsive
Respirations - may be slow, deep, rapid and shallow, irregular or even absent.
Pupils - will be fixed and dilated.

General Management for Shock

Assessments and management of shock uses the following guidelines. Special considerations are included in the specific classification of shock.

- Personal protective equipment should be utilized as appropriate.
- Body substance isolation techniques and equipment should be utilized as appropriate.
- Perform a primary survey.
- Administer high concentration oxygen by non-rebreathe mask.
- Control external bleeding (see Internal and External Bleeding Guideline).
- Consider load and go.
- Obtain as thorough a history as possible.
- Handle the patient gently.
- Prevent the loss of body heat.
- Perform a secondary survey.
- Position the patient in the supine position.
- Elevate legs if hypotensive and injuries permit.
- If the patient is immobilized on a long backboard (or similar device), the foot of the backboard can be raised.
- The patient must be monitored closely for respiratory compromise, vomiting or regurgitation.
- Treat shock with intravenous fluids if EMS personnel's scope of practice permits and they are certified to do so.
  - Refer to intravenous cannulation and infusion protocol.
- Treat any injuries.
- Repeat and record vital signs at regular intervals (5-15 mins.) or when there is a change in the patient's status.
- Do not allow patient to exert him/herself, e.g. walking, standing unassisted to the stretcher.
- Reassure the patient. Give nothing by mouth.
- Assist ventilations if required.
- Maintain high concentration oxygen delivery to the patient.
- Load and go should be initiated.
- On scene times should be kept to a minimum. Treat other conditions en route.
- Transport the patient to the nearest appropriate health care facility.
- Notify the receiving health care facility of the patient's status as soon as possible.
- Monitor the patient closely for changes in status.

- Additional surveys and treatments should be conducted en route.
- Document all actions including the decision to initiate load and go.
- Report all findings to the receiving facility staff, and document on the patient care report.

General Signs of Shock

- Pale, cool, clammy skin
- Increase BP developing to decrease BP
- Weak, tachycardic pulse
- Shallow, tachypnea
- Altered LOC (anxiety, fear, restlessness, confusion, sudden LOC)
- Thirst
- Cyanosis
- N/V
- Weak, absent radial pulse
- Dilated pupils, eyes not focusing

The Classification of Shock

There are many classifications models for shock. For the purpose of this discussion we will identify five.

- Hypovolemic Shock
- Cardiogenic Shock
- Neurogenic Shock
- Septic Shock
- Anaphylactic Shock

Hypovolemic Shock

Hypovolemic shock is an emergent condition in which severe blood and/or fluid loss makes the heart unable to present enough blood to the body. Develops when the intravascular blood volume is decreased in relation to the size of the intravascular compartment (ie: veins and arteries). Hypovolemic shock is usually associated with volume deficits in excess of 15%. Losses of blood volume can either be internal or external. Internal losses may be associated with such events as G.I. bleeds, AAA's, or internal hemorrhages secondary to trauma.

External losses are associated with blood loss (most common), in the case of trauma and bleeding disorders; plasma, in the case of burns; body fluid, in the case of excessive perspiration, vomiting, and diarrhea. The pathophysiology of hypovolemic shock is that when the intravascular volume is reduced, venous return is reduced, cardiac output decreases, and the blood pressure drops. The end result is poor tissue perfusion which can lead to organ failure.

Signs and symptoms of hypovolemic shock may include:

- tachycardia
- altered mental status
- delayed capillary refill
- skin tenting
- dry mouth and mucous membranes

➢ May be triggered by events other than the loss of blood and may be due to other fluid or plasma loss.

- vomiting or diarrhea
- plasma loss due to burns
- diabetic ketoacidosis

➢ May also develop from blood loss not visible to external assessment.

- examples of this hidden blood loss may include:
    - aneurysm rupture
    - ectopic pregnancy
    - internal bleeding
    - AAA
    - GI bleed

➢ Mechanisms of injury and thorough history assessment may provide information on the development of hidden hemorrhagic shock.

Management includes:

- suspect blood loss, even if not visible
- control any visible bleeding
- estimate blood and/or fluid loss
- monitor closely for circulatory collapse or decreased respiratory effort
- replace blood loss with intravenous fluids if within scope and Technician-Paramedic is certified to do so.

Cardiogenic Shock

Cardiogenic shock is due to the impaired ability of the heart to pump the blood. Cardiogenic shock is usually the result of severe left ventricular failure, secondary to acute myocardial infarction or congestive heart failure. The hypotension that accompanies this form of shock aggravates the situation by decreasing coronary perfusion. With decreased coronary perfusion, the heart muscle becomes even more damaged, thus establishing a vicious cycle that ultimately results in complete pump failure.

Other causes of cardiogenic shock are:

➢ pericardial tamponade
➢ tension pneumothorax
➢ penetrating trauma to heart
➢ SVC pressure (pregnant women)

During cardiogenic shock, the activation of compensatory mechanisms can actually worsen the situation. When the peripheral resistance increases in an attempt to maintain blood pressure, the myocardial workload increases. This, in turn, increases the myocardial oxygen demand, further aggravating myocardial ischemia and infarction. Cardiac output is further depressed.

While the most common cause of cardiogenic shock is severe left ventricular failure, a number of other factors can have the same clinical manifestation. These include chronic progressive heart disease, such as cardiomyopathy, rupture of the papillary heart muscles or interventricular septum, and end-stage valvular disease (mitral stenosis or aortic regurgitation). Most patients who experience cardiogenic shock will have normal blood volume. However, some patients will be hypovolemic from an excessive use of prescribed diuretics or the severe diaphoresis that accompanies some acute cardiac events. Patients may also experience relative hypovolemia (neurogenic shock) from the vasodilatory (blood vessel dilation) effects of drugs such as nitroglycerin.

Signs and symptoms of cardiogenic shock may include:

- evidence of pulmonary edema on chest auscultation
- frothy sputum
- patient in upright position, using accessory muscles of respiration
- weak, rapid or irregular pulse
- peripheral edema may be present in dependent extremities

- Past medical history may include cardiac, respiratory, renal disease or recent chest trauma.
- Medications may include diuretics (e.g. furosemide, hydrochlorothiazide) or cardiovascular drugs (e.g. digoxin, ACE inhibitor).
  - the patient may not be taking medications appropriately
- If chest pain or dyspnea is present, obtain and record pertinent medical history regarding chest pain or congestive heart failure (see Chest Pain or Congestive Heart Failure Guidelines).

Management includes:

- If hypotension due to cardiogenic shock is suspected and the patient exhibits signs and symptoms of congestive heart failure with pulmonary edema:
  - Place the patient in as supine a position as the patient will tolerate OR in a semi-sitting position adequate for ventilation.
- If hypotension due to cardiogenic shock is suspected and the patient exhibits signs and symptoms of congestive heart failure **with no** pulmonary edema:
  - Place the patient supine with the patient's legs either in line with the patient's body or elevated slightly as tolerated.

Neurogenic Shock

Neurogenic shock may be described as inadequate peripheral resistance due to widespread vasodilation. With this inappropriate vasodilation, a disproportionate amount of blood collects in the capillary bed. This reduces venous return, cardiac output, and arterial blood pressure. Neurogenic shock is most commonly due to an injury that results in severe spinal cord injury or total transection of the cord. Other causes of neurogenic shock include: central nervous system injury, septicemia from bacterial infection, anaphylactic reaction, insulin overdose, and Addisonian crisis (a disorder of the adrenal glands). In neurogenic shock there is an absence of the sympathetic response.

- Suspect with spinal injuries.
- Assess for possible warm, dry, flushed skin (below the spinal injury).
- Pulse rate may not be elevated.
- Be prepared to assist ventilations due to loss of respiratory muscle function.

Management as per shock treatment guidelines (stated earlier under heading: “General Management of Shock”).

Septic Shock

This condition is a type of shock that accompanies a bacterial infection and is often due to the release of endotoxins (poisons) by the bacteria or infected tissues. The toxins are carried by the blood to non-infected areas until the whole body is affected. The toxins then damage the vessel walls throughout the body, causing them to become leaky and unable to constrict well. Widespread dilation of vessels, in combination with the loss of plasma through the injured vessel walls, results in shock.

Septic shock is a complex problem. First, there is an insufficient volume of fluid in the container, because much of the blood has leaked out of the vascular system into the interstitial spaces (hypovolemia). Second, the fluid that has leaked out often collects in the respiratory system, interfering with ventilation. Third, there is a larger-than-normal vascular bed (due to systemic vasodilation) to contain the smaller-than-normal volume of intravascular fluid.

Septic shock is almost always a complication of some very serious illness, injury or surgery.

Signs and symptoms include:

- warm skin (cool extremities)
- tachycardia
- low blood pressure
- low urine output

Management of these patients includes:

- Obtain a history, particularly that of recent infection or febrile illness, recent surgery.
- Monitor closely for circulatory collapse or decreased respiratory effort.
- Transport promptly.
- Administer oxygen en route.
- Provide full ventilatory support.

- Elevate legs.
- Keep patient warm.
- Provide antipyretics if the patient has a documented fever and personnel is certified in administration of Acetaminophen

Anaphylactic shock

Anaphylaxis, or anaphylactic shock, occurs when a person reacts violently to a substance to which he or she has been sensitized. Sensitization means becoming sensitive to a substance that did not initially cause a reaction. Do not be misled by a patient who reports no history of allergic reaction to a substance on first or second exposure. Each subsequent exposure after sensitization tends to produce a more severe reaction. Anaphylaxis is a true medical, life-threatening emergency.

Instances that cause severe allergic reactions commonly fall into the following four categories:
Injections (tetanus antitoxin, penicillin)
Stings (honeybee, wasp, yellow jacket, hornet)
Ingestion (shellfish, oral penicillin)
Inhalation (dusts, pollens)

Anaphylactic reactions can develop in minutes or even seconds after contact with the substance to which the patient is allergic. The signs of such allergic reactions are very distinct and not seen with other forms of shock. In anaphylactic shock, there is no loss of blood, no vascular damage, and only a slight possibility of direct cardiac muscular injury. Instead, there is widespread vascular dilation. The combination of poor oxygenation and poor perfusion in anaphylactic shock may easily prove fatal.

Signs and symptoms:

- Skin:
  - Flushing, itching, or burning, especially over the face and upper chest
  - Urticaria (hives), which may spread over large areas of the body
  - Edema, especially of the face, tongue, and lips
  - Cyanosis (a bluish cast to the skin resulting from poor oxygenation of circulating blood) of the lips

- Circulatory System:
  - Dilation of peripheral blood vessels (warm, flushed extremities)
  - A drop in blood pressure
  - A weak, barely palpable pulse
  - Pallor
  - Dizziness
  - Fainting and coma

- Respiratory:
  - Sneezing or itching in the nasal passages
  - Tightness in the chest, with a persistent dry cough
  - Wheezing and dyspnea, or difficulty in breathing
  - Secretions of fluid and mucus into the bronchial passages, alveoli, and lung tissue, causing coughing
  - Constriction of the bronchi; difficulty drawing air into the lungs
  - Forced expiration, requiring exertion and accompanied by wheezing
  - Cessation of breathing

Management:

- Anaphylactic shock is a true emergency.
- Administer epinephrine and diphenhydramine if EMS personnel are trained and certified and if the patient is exhibiting signs and symptoms as per Anaphylaxis Protocol.
- High concentration of oxygen should be delivered to the patient.
- Protect airway – keeps close watch for rapid changes
- Be prepared to support respiratory and circulatory functions.
- See Anaphylaxis Guideline.

IV Therapies

Intravenous therapy

Intravenous - means into the vein. Intravenous cannulation is used to gain access to the body's circulation. Intravenous cannulation is indicated (1) to administer fluids, (2) to administer drugs, and (3) to obtain specimens for laboratory determinations.

Intraosseous needle insertion

Intraosseous means into the bone. Medications that are delivered via this route reach the blood through the bone marrow. To get medication into the marrow requires drilling a needle through the bone cortex or using a pre-loaded auto-injector such as the Bone Injection Gun. Because this is painful, the IO route of delivery is used most often in patients who are unconscious as a result of cardiac arrest or extreme shock. Traditionally IO access was reserved for children under the age of six. Due to recent research studies, use of IO access has been approved for adults. It is currently available in Manitoba EMS using the Bone Injection Gun. Please refer to the emergency treatment guidelines and protocols.

Direct Pressure infusion devices

Inline devices include electronic flow-rate regulators that regulate fluid passage by means of infusion pumps that exert pressure on tubing or fluid by pumping against pressure gradients. Drug infusion pumps are also used to administer medications to patient's who need a slow injection of medication (patients undergoing cancer chemotherapy).

Intravenous Maintenance

Receiving the IV cannulated patient

This skill may be given as a TOF by the Medical Director to Technicians. This is within the scope and practice of Technician - Paramedics.

Patient care becomes the attendant's responsibility upon receiving the patient from the sending health facility. With this in mind it is important that the attendant does a pre-transportation assessment of the I.V. cannulated patient. In the presence of the nurse or physician in charge of the patient the following information should be gathered along with the following checks:

- Patient Information
  - Patient's name
  - Diagnosis
  - Reason for transfer.

- I.V. Maintenance
  - Kind/name of solution
  - Labeled if there are additives (not allowed to transport an IV medicated patient)
  - Drip rate (calculated by sending facility)
  - Is solution time labeled
  - How many mls left in bag (if less than 250 ml request that the bag be changed)
  - Based on transportation time, is another bag needed
  - Does label match that of the bag hanging
  - Any leaks, cloudiness, discoloration, precipitate, foreign bodies
  - Check expiry date
  - Is the solution contained in a glass bottle (if yes, request a change to a bag)
  - Roller clamp on tubing correctly
  - I.V. secured to extremity
  - Check IV site for: redness, swelling, temperature, leaks/discharge

Components and functions of IV infusion equipment

The I.V. infusion equipment comprises the following:

- I.V. solution container
- Administration set(s)
- Needles and cannulas
- I.V. fluids

Solution Containers

Plastic Bags

The intravenous solution bags are made of a durable plastic material. In the field, they are preferred over glass containers for the following reasons:

- they are easily stored
- they will not break or shatter
- they prevent air emboli by collapsing upon emptying
- they are small and lightweight

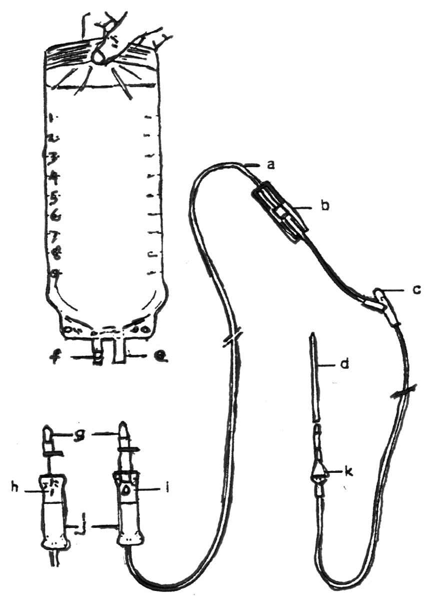
Before using, carefully examine the I.V. bag for pinhead size holes. To do this, gently squeeze the bag to determine any fluid leaks, which would compromise the sterility of the solution.

To read the precise fluid level in a bag, pull the sides taut, then release them before reading the fluid level at eye level.

Administration Set

The administration set must be wrapped in a sterile package. It consists of an IV spike, drip chamber, tubing, flow adjustment valve (roller clamp) and an injection site (medication port).

ADMINISTRATION SET



a. tubing
b. roller clamp
c. injection site (injection or piggy-back)
d. intravenous cannula
e. tubing connector port
f. admixture injection site
g. spike
h. micro-drip set
i. macro-drip set
j. drip chamber
k. flash ball

Tubing

The tubing ("a" on the diagram) is made of a clear pliable plastic, so it is easy to inspect the solution administered for air bubbles or precipitate. The tube is very flexible. The top end of the tube is fitted with a spike, or a piercing pin, which is inserted into the solution container. The bottom end of the tube is attached to the catheter or needle.

Drip Chamber

The drip chamber ("j" on the diagram) is found beneath the piercing pin or spike. The I.V. solution being administered accumulates in the drip chamber. As the fluid flows into this chamber one drop at a time, it allows the attendant to monitor the rate of fluid administration by counting the drops falling into the chamber per minute.

The drop size varies according to the type of set used: large drops with macro-drip (10-15 gtts/ml) and small drops with the micro-drip (60 gtts/ml). Attendant must find out which set is required before setting up the I.V. line.

The macro-drip infusion set is the standard set used. It allows delivery of ten (10) drops per milliliter, enabling infusion of a large fluid volume.

When the care giver wishes only to maintain a TKO (‘to keep open’) or TKVO (‘to keep vein open’) rate, or to provide a readily accessible route for drug administration, the micro-drip infusion set is the set of choice. The micro-drip set is designed to deliver 60 drops per milliliter.

To identify the difference between a macro and a micro-drip infusion set, simply examine the drip chamber. In the micro-drip set, notice the thin needle-like shaft extending down into the drip chamber.

Roller Clamp

The roller clamp ("b" on the diagram) is found below the drip chamber. It can slide easily along the tubing, between the drip chamber and the injection site. The roller clamp valve can be opened or closed. This allows control of the rate of fluid flow.

Injection Site

The injection site ("c" on the diagram) is found at the bottom end of the tubing. It can look like either a "y" or a circular section of rubber. A needle can be inserted at this site for administration of drugs.

Intravenous needles and catheters

The outside diameter of the needle shaft is called the gauge. The larger the gauge number, the smaller the diameter of the shaft. For example, a 23 gauge needle is a very small needle, while a 12 gauge needle is very large.

The inside diameter of the shaft is called the lumen. The I.V. tubing is attached to the hub of the needle. A small needle or catheter will cause less trauma to the vein, allow greater blood flow around the tip and also reduce the risk of phlebitis. A large catheter will allow more rapid flow, so that large volumes can be given quickly when needed.

There are two (2) types of needles available: hollow needles and needles covered with catheters. The over-the-needle catheters are the preferred choice for any patients being transported outside a hospital. They are covered on the outside by a plastic shaft (angiocath). The point of the needle extends beyond the tip of the catheter. After venipuncture, the needle is withdrawn leaving only the plastic sheath in the vein. Since this type of cannula is flexible, it decreases the chances of infiltration.

Needles and cannulas must be kept sterile. In fact, all parts of IV administration must be sterile prior to use therefore each part is packaged individually. If the seal of the package appears to have been broken or if the package appears tampered with in any way, it must be discarded.

I.V. fluids

The most common intravenous solutions used in the field is normal saline. To a lesser extent, some services may still use D5W (5% dextrose in water) or Ringer's lactate.

Volume Control Unit

A volume-control unit is used to deliver controlled doses of medication or fluid over an extended period of time. A patient with this unit in place can only be transported by the attendant if the patient is not receiving medication through it.

The I.V. set with an in-line volume control unit is especially susceptible to changes in the height of the I.V. bag, altering the established drip rate. Due to this fact, great care and close observation of the volume-control unit is required at all times.

For the purpose of patient transport, the operation of the volume-control unit can be simplified since no medications are being infused. Within the health care facility, the use of a volume-control set will differ from that during transportation with an attendant.

Upon receiving the patient, the attendant will:

- Ensure that no less than 50m.l of I.V. fluid is in the fluid chamber;
- Close the upper roller clamp located between the I.V. bag and the fluid chamber ;
- Open the air vent on the fluid chamber;
- Maintain the drip rate by adjusting the lower roller clamp as in a basic I.V. set.

Should it become necessary to add more I.V. fluid to the fluid chamber to maintain the minimum level of 50 ml, the attendant will:

- Raise the I.V. bag, placing it above the level of the upper roller clamp;
- Open the upper roller clamp raising the fluid level to at least 100 ml;
- Close the upper roller clamp;
- Ensure proper drip rate is maintained;
- Document amount of I.V. fluid added to fluid chamber.

Heparin or Saline Lock

**Remove double line - locks are PCP scope

A heparin or saline lock is a peripheral intravenous cannula that has no attached intravenous tubing. These vascular access devices are used to have ready access to peripheral veins for the brief administration of medications or for frequent intravenous therapy on an outpatient basis (e.g., chemotherapy). The cannula is filled with 0.5 to 1.0 ml of a heparin or saline solution to prevent clotting while it is not in use.

To gain access to the peripheral vein, 4 ml of normal saline should be drawn into a syringe. Aseptic technique is used; 2 ml of the normal saline is used to flush the heparin lock reservoir before and after the prescribed medication or intravenous fluid infusion. After intravenous therapy, 0.5 to 1.0 ml of heparin or 3 ml of 0.9% normal saline should be injected into the reservoir to keep the lock patent.

Establishing and troubleshooting a drip rate

The drip rate is established by adjusting the roller clamp until the correct number of gtts/min is obtained. To obtain an accurate reading, the drip rate should be established only when the ambulance is stationary. Checking an established drip rate simply entails the attendant visualizing the drip chamber at eye level and counting the number of drops for 1 minute. If the drip rate remained unchanged then adjusting the rate is not required. If the drip rate is off from the rate requested by the facility then an adjustment is indicated.

With an established I.V. line, slowly open or close the roller clamp to regulate the fluid dripping into the drip chamber. Visualize the drip chamber at eye level. Hold your watch close to the chamber and time the drips for 1 minute. Open or close the clamp as needed to accelerate or slow down the drip.

In establishing a drip rate where the I.V. bag had been changed, first ensure the drip chamber is half full of the solution being infused. This is done by closing the roller clamp and squeezing the drip chamber and releasing. Once this has been accomplished, visualize the drip chamber at eye level and by regulating the drops as described above. Adjust the clamp until the proper gtts/min is achieved.

Should you have difficulty in establishing a flow, the following trouble shooting checks must be performed. The attendant should check:

- If the I.V. bag is high enough
- If there is sufficient fluid in the I.V. container;
- if the patient is lying on the tubing
- That the tubing is firmly connected to the needle and is not leaking
- The position or stability of the limb involved
- That the roller clamp is not defective
- That the tubing is not kinked or stretched
- If the drip chamber is more than half full (if it is, close the roller clamp inverting the bag and chamber squeezing some of the fluid back into the bag)
- That the tape around the infusion site is not too tight
- For venous spasm due to cold or irritating solution (a warm pack placed above the infusion site may relieve this condition)

NOTE: Remember that a drip rate can be easily modified when a patient is being moved; the roller clamp may slip, the patient can make a sudden move or the height of the solution container can change. It is therefore important to verify the flow rate, as well as the entire I.V. line, including the infusion site, as soon as is practical after the patient is loaded or unloaded from the ambulance.

Attendants Limitations

A Manitoba Technician (that is certified via transfer of function in tubes maintenance) or Technician Paramedic is not allowed to:

- Maintain any I.V. that contains medications or blood
- Transport a patient with I.V.'s other than peripheral lines
- Transport an I.V. cannulated patient under the age of ten
- Transport an I.V. cannulated patient with an infusion rate greater than 250 ml per hour
- To start an I.V. infusion, unless a transfer of function has been duly authorized

If a Manitoba attendant, who is not duly qualified to do so, chooses to transport, by himself/herself, a patient that is described above, the attendant himself/herself will bear the brunt of any litigation.

If a Manitoba attendant is called upon to transport a patient of this nature, he/she should refuse the transfer unless a nurse or a physician accompanies the patient.

The law will protect you if you stay within the scope of your certification and training.

A Word of Caution

To ensure your safety, as well as the safety and well being of your patient, it is recommended that you not perform the following skills in a moving vehicle:

- Withdrawing air from the tubing
- Changing the I.V. solution container
- Discontinuing the I.V

Complications of I.V. Therapy

There are certain complications which can result from I.V. therapy which you should be aware of. There are a few rules and procedures to follow when caring for a patient with an I.V. in place. These rules and procedures must be followed at all times when moving or transporting an I.V. cannulated patient. Although the signs and symptoms of some are similar, it is important that you be able to differentiate between them because corrective treatments may vary.

IV. Bag Running Dry

The problem created by having the I.V. bag empty totally is the possibility of introduction of air into the I.V. line when the bag is replaced. If for some reason the bag runs dry and must be replaced, follow these steps:

- Clamp the I.V. tubing
- Replace the I.V. bag
- Refill drip chamber half full
- Open the roller clamp

- Observe the tubing for air (remove as per below)

Air has been introduced into the line

- Close the rollerclamp, stopping fluid flow
- Cleanse the injection site which is distal to the air bubbles with an alcohol swab
- Insert a 21 gauge needle attached to a 10 cc syringe into the injection site
- Slowly open the roller clamp to allow the air bubble to travel down the I.V. tubing
- When the air lock is within eight (8) centimeters (three (3) inches) of the injection port and needle assembly, clamp off the I.V. distal to the injection point
- Gently pull back on the syringe plunger and remove the air and fluid to clear the line
- Remove the needle and syringe and dispose of appropriately
- Release the tubing and set the drip rate
- Reestablish the drip rate

Blood in Tubing

If, during your assessments you become aware of blood in the tubing, you must immediately try to find the cause. Starting at the top check:

- To see if the I.V. bag is empty
- The height of the I.V. bag (too low may cause fluids to stop flowing)
- The drip rate of the solution
- To see if the drip chamber is half full
- To see if there are tubing problems (e.g. tubing is kinked)
- is the catheter against the wall of the vein

If following these checks and subsequent corrective measures prove to be ineffective and the problem still exits, discontinue the I.V. Document all activities. A common cause of blood in I.V. tubing is due to the assessment of blood pressure on the cannulated arm. This can easily be avoided by performing blood pressure assessment on the uncannulated arm.

Phlebitis

Phlebitis is the inflammation of the wall of a vein. Signs and symptoms include:

- Burning pain along the vein
- Redness
- Increased skin temperature over the course of the vein
- Swelling

If a patient is suspected of having phlebitis, discontinue the I.V. Apply warm packs to increase fluid absorption. Document all activities.

Infiltration

Infiltration is the escape of the I.V. fluids into the surrounding tissues, which can cause tissue damage and tissue death. The signs and symptoms of infiltration include

- Coolness of the skin around the IV site
- Swelling around the site or the entire limb
- Needle or catheter displacement
- A decrease in flow or no flow in the drip chamber

If a patient is suspected of having infiltration, discontinue the I.V. Apply warm packs to increase fluid absorption. Document all activities.

The following complications, although rarely seen, are potentially life-threatening to the patient:

Pyrogenic Reaction

A pyrogenic reaction is a generalized reaction due to contaminated equipment or solution. The signs and symptoms of pyrogenic reaction occur abruptly, usually within 30 minutes after being exposed to the contaminants, and include:

- Sudden onset of fever
- Severe chills
- Backache, headache
- Nausea, vomiting
- Shock

If a patient is suspected of having a pyrogenic reaction, discontinue the I.V. immediately. Treat for shock. Contact the closest medical facility by radio, describe the situation and proceed directly to this hospital. Document all activities.

Air Embolism

Air embolism occurs when air enters the bloodstream and is carried by the bloodstream until it lodges and obstructs a blood vessel. Signs and symptoms may include:

- Evidence of Shock
- Cyanosis
- Increased pulse rate
- Loss of consciousness

If a patient is suspected of having an air embolism discontinue the I.V. immediately. Lower the patient's head turning them on their left side. Treat for shock. Contact the closest medical facility by radio, describe the situation and proceed directly to this hospital. Document all activities.

Catheter Embolism

Catheter embolism occurs when a piece of the plastic catheter is sheered off and enters the bloodstream. This piece of catheter is carried by the bloodstream until it lodges and obstructs a blood vessel. Signs and symptoms include:

- Discomfort along the vein in which the catheter has entered
- Evidence of Shock
- Cyanosis
- Increased pulse rate
- Loss of consciousness
- Onset of pulmonary edema?

If a patient is suspected of having a catheter embolism, discontinue the I.V. immediately. Lower the patient's head, turning them on their left side. Treat for shock. Contact the closest medical facility by radio, describe the situation and proceed directly to this hospital. Document all activities.

Circulatory Overload

Circulatory overload occurs when too much fluid enters the circulatory system. The signs and symptoms include:

- Elevated blood pressure
- Shortness of breath
- Difficulty in breathing
- Excessive coughing
- Increased respiratory rat;
- Distended neck veins

If a patient is suspected of having circulatory overload reduce the drip rate to TKVO (5 gtts./min. for macro-drip and 30 gtts./min. for micro-drip set). Reposition the patient to a semi-sitting position if not already in this position and administer oxygen. Contact the closest medical facility by radio, describe the situation and proceed directly to this hospital. Document all activities.

If, at any time during the transportation, more than 300 ml of I.V. solution is accidentally infused ahead of the schedule infusion time, then the rate should be turned down to TKVO.

Discontinuing the I.V.

It is important to have properly assessed the need to discontinue the I.V. Should the need arise to discontinue follow these steps:

- Stop the ambulance
- Explain to the patient the need for discontinuing the I.V.
- Gather all the necessary equipment: sterile gauze and adhesive strip
- Put on gloves
- Stabilize the limb and hub
- Loosen all tape on the I.V. site
- Close off roller clamp
- Remove the catheter by hub or needle in the direction of the vein using a smooth, rapid motion
- Apply and maintain pressure with the sterile gauze on the puncture site for 3-5 minutes, inspecting the catheter for completeness
- Dispose of sharps, if any
- Document:
  - Amount of fluid left in bag
  - Amount of fluid the patient received
  - Time the I.V. was discontinued
  - Reason for discontinuing I.V.
  - Any other problems

Documentation

Documentation is a vital component of all patient care. It also is a skill which is the least practiced and improved. It is absolutely imperative that good documentation take place on every call. Transporting the I.V. cannulated patient is no exception. Besides your normal documentation you must chart:

- When the patient was received:
  - Date and time
  - Name, diagnosis, reason for transfer
  - Type of solution
  - Drip rate

- Upon hanging a new bag:
  - Time
  - Amount added

- At the end of the transfer:
  - Time
  - Amount and type infused

- When complications arise:
  - Time
  - Nature of complication
  - Action taken and whether it improved

Any time you chart indicate how the I.V. is proceeding.

Procedure for peripheral intravenous cannulation

This skill may be given as a TOF by the Medical Director to Technician Paramedic's.

- Perform patient assessment and record vital signs.
- Assess that patient meets indications for this protocol.
- Ensure there are no contraindications to use of this protocol.
- Initiate basic life support treatment measures, including supplemental oxygen. These take precedence over using this protocol
- Obtain patient consent if possible. If the patient refuses treatment, intravenous cannulation should not be carried out.
- Carry out intravenous cannulation and establish intravenous infusion based on established method.
- A maximum of two attempts at intravenous cannulation can be made on each patient.
- Further attempts may be made en route, at the discretion of the medical director or from physician on-line medical control.
- Transport should not be delayed to carry out intravenous cannulation and establish an intravenous infusion. Cannulation may be performed while en route.

Cannulation procedure - note maximum of two (2) attempts

- Ensure patient meets criteria.
- Explain procedure to patient.
- Select site - antecutibal fossa preferred for trauma or unstable patients.
- Apply tourniquet.
- Clean area over site with alcohol swabs.
- Prepare intravenous needle with cannula, adhesive tape, and dressing.
- Draw skin taut over vein.
- Insert intravenous needle with cannula, bevel up, through the skin into the vein.
- Carefully remove needle, leaving cannula in vein.
- Once vein successfully cannulated, attach intravenous tubing to cannula.
- Open clamp to ensure flow of intravenous fluid.
- Apply dressing to site.
- Anchor intravenous tubing using tape.
- Label site with date, type and size of cannula, and name of personnel carrying out procedure.
- Regulate rate of infusion.
- See Manitoba Health ETP for indications/contraindications

Procedure for intraosseous needle insertion

- Perform patient assessment and record vital signs.
- Assess that patient meets criteria for this protocol.
- Ensure there are no contraindications to use of this protocol.
- Initiate basic life support treatment measures, including supplemental oxygen. These take precedence over management using this protocol.
- Select the intraosseous cannulation site (refer to manufacturer instructions and/or protocol if using Bone Injection Gun. Immobilize and prepare the extremity.
- Prepare the intraosseous infusion needle, intravenous setup, and appropriate intravenous solution.
- Insert the intraosseous needle in the prescribed method.
- Entrance into the medullary cavity may be signaled by a "pop" or a sudden decrease in resistance.
- Stabilize the intraosseous needle.
- Aspirate using a 5 ml syringe.
- Irrigate with 5 ml of normal saline to clear the needle's lumen.
- Connect an intravenous line and adjust the infusion rate.
- Secure the intraosseous needle with gauze and tape.
- If an intraosseous cannulation attempt is not successful, a load and go should be initiated.

Indications for IO needle insertion

Patient in cardiac arrest or extremis and IV access not obtainable within 90 seconds or 2 failed attempts at an IV line

Contraindications

- Refer to protocols for age restrictions
- Fracture of tibia or femur on selected side.
  - Consider other side if not injured.
- Skin infection or burn at selected site.
- Osteogenesis imperfecta.
- Transport time less than time required to initiate intraosseous line.

Insertion Site

Proximal tibia:

- Insert needle 2-3 cm below the proximal tibia tuberosity at a 90° angle to the skin

Application of direct pressure infusion devices to intravenous infusions

Manitoba protocols for infusion pump maintenance:

- Perform patient assessment and record vital signs.
- Assess that patient meets criteria for this protocol.
- Ensure there are no contraindications to use of this protocol.
- At the referring hospital, the hospital staff will draw up the medication to be infused and ensure the infusion pump is functioning properly. The infusion rate will be set based on a written and signed physician's order. The infusion pump will be labeled with the medication name, concentration, and time the infusion was prepared.
- Prior to transport, the EMS personnel will confirm:
  - The physician's written and signed order for the infusion.
  - The medication and concentration being infused.
  - The infusion pump has enough medication for the expected transport time.
  - The infusion tubing is properly connected to a three-way stopcock on the patient's intravenous line.
    - At some facilities, heparin can be infused via a syringe pump without being piggybacked into a running intravenous line.
  - The rate of infusion pump delivery.
  - The infusion is in progress.
  - The volume of infusion already administered.
- If an alarm is displayed during transport, the attendant should attempt to correct the problem. If the problem is corrected, the alarm display message will disappear. If the problem cannot be remedied, the attendant should press the start/stop button to turn the infusion off.
  - If the infused medication is not being piggybacked into a running intravenous line, an infusion of normal saline should be instituted at TKVO.
- Several error messages may appear during the infusion pump operation. Error conditions indicate the pump has detected a possible internal malfunction. If an error message appears, the attendant should turn the pump off and then on again. If the error display message disappears when the pump is turned on again, ensure the medication is infusing at the prescribed rate. If the error message persists, the pump should be turned off. The possible internal error malfunction should be reported to the sending and receiving facilities.
- Upon arrival at the receiving hospital EMS personnel should confirm the volume infused during transport and any additional volume remaining. These volumes should be charted on the patient care report. Inform the receiving hospital of any problems encountered with the infusion, and how they were resolved. Document these problems and their resolution on the Patient care report.

Vascular access devices and central lines

Central venous cannulation may be within the scope of paramedic practice in some advanced life support systems. However, central venous infusion should never be considered as a means of rapid fluid replacement in the prehospital setting. Sites for central venous cannulation include the femoral vein, internal jugular vein, and subclavian vein.

Other types of vascular access devices include atrial catheters, and implantable ports. An atrial catheter is a long, silastic indwelling catheter sometimes used by patients with cancer, gastrointestinal dysfunction, or debilitating diseases and by those who need intermittent intravenous administration of antibiotics, nutritional supplements, or other intravenous medications. Patients are sometimes discharged from the hospital with the catheter in place and are taught to maintain it and to administer various medications and fluid therapies through the device. The atrial catheter is approximately 90 mm long and 1.6 mm in diameter. It is surgically placed in the right atrium under fluoroscopy and local anesthesia. When seen on the patient's chest, the catheter looks like a thin, white cord with a Luer plug attached on the end. It protrudes from a small incision near the clavicle, which is usually covered with a dressing. Atrial catheters should only be used for venous access in emergency situations such as acute fluid loss, pulmonary edema, or cardiac arrest (with appropriate training).

Connecting intravenous lines to the catheter increases the chance of infection and embolism: therefore the catheter should not be used in stable patients.

Implantable ports are venous access devices that are surgically implanted, with the distal end of the catheter inserted into a large central vein. An example of such a device is the Port-A-Cath. The injection end of the catheter is implanted subcutaneously, often on the chest wall, and has a self-sealing septum over a small chamber or reservoir. The tubing extends from the side of the reservoir to the venous insertion point. Each time the implantable port is accessed, the skin must be punctured with a needle, but no daily cleansing is required as it is with partially implanted ports such as the Hickman catheter. Implantable ports should not be used in stable patients.

Administration of blood or blood products

Colloid solutions contain molecules (usually protein) that are too large to pass through the capillary membrane. These solutions exhibit osmotic pressure and remain within the vascular compartment for a considerable time. Examples of colloid solutions are whole blood, plasma, packed red blood cells, and plasma substitutes. Whole blood, packed red blood cells, and plasma generally are reserved for in-hospital use.

Whole blood replacement is sometimes indicated after initial fluid resuscitation with a crystalloid solution in patients who have had a major loss of blood. Whole blood replacement rarely is given. Rather, packed red cells are transfused, and other blood components are transfused as necessary. Whole blood is drawn in a citrate solution to prevent clotting and is refrigerated until needed. According to blood bank regulations, the blood can be stored up to 3 weeks in refrigeration, but clotting factors and platelets deplete progressively. A type and cross match should be obtained when possible before a patient is given blood to determine the patient's ABO group and Rh type and to determine if other antibodies are present that can cause a transfusion reaction.

Centrifugation separates packed red blood cells from the plasma component of blood. Like whole blood, packed red cells must be typed and cross-matched and can be refrigerated for up to 3 weeks. The advantage of packed red blood cells over whole blood is that the volume of hemoglobin per unit is almost twice that of whole blood. In addition, because there is no plasma, circulatory overload is less likely, transfusion reactions are less frequent, and transfusion hepatitis is less common.

Blood plasma is procured by separating the blood cells from the whole citrated blood and can be given without concern for ABO compatibility. It contains fibrinogen, albumin, gamma globulins, hemoagglutinins (an agglutinin that clumps red blood corpuscles), prothrombin (a chemical that is part of the clotting cascade, the precursor of thrombin), other clotting factors, sugars, and salts. Plasma sometimes is used to restore effective blood volume in patients with circulatory failure associated with burns, traumatic shock, and hemorrhage. It more commonly is used to correct clotting deficiencies.

Although plasma substitutes do not increase oxygen-carrying capacity by replacing red blood cells or improve clotting by the addition of plasma protein, they sometimes are used to restore circulating blood volume as an emergency treatment for hypovolemia caused by blood loss. Plasma substitutes such as dextran, plasma protein fraction, and hetastarch have osmotic properties similar to those of plasma. They, therefore, stay in the intravascular space longer than a crystalloid solution. Plasma substitutes do no carry the HIV or hepatitis viruses, do not require typing and cross matching before administration, and are readily available. Their use is appealing; particularly in mass casualty situations when blood products are scarce because susceptible patients can be allergic to some plasma substitutes. However, they do have adverse effects, including increased bleeding tendencies and immune suppression. Emergency vehicles can carry plasma substitutes, but expense and storage problems make them impractical for general use in the prehospital setting.

Pharmacology

Epinephrine (Adrenaline)

Generic Name
Epinephrine

Trade Name
EpiPen Auto-Injector, Ana-kit

Class
- Sympathomimetic

Mechanism of Action
- Direct acting alpha and beta agonist
- Alpha: (bronchial, cutaneous, renal and visceral) arteriolar vasoconstriction
- Beta 1: positive inotropic and chronotropic actions, increases automaticity
- Beta 2: bronchial smooth muscle relaxation (bronchodilation) and dilation of skeletal vasculature.
- inhibits histamine release

Indications
- Cardiac arrest, asystole, electromechnical dissociation, VF unresponsive to initial defibrillation
- Severe bronchospasm, asthma, bronchiolitis
- Anaphylaxis, acute allergic reactions

Contraindications
- Hypertension, hypothermia, pulmonary edema / congestive heart failure, coronary insufficiency, hypovolemic shock

Adverse Reactions
- Hypertension, dysrhythmias, pulmonary edema / congestive heart failure, anxiety, psychomotor agitation, nausea, angina, headache, restlessness

Drug Interactions
- Potentiates other sympathomimetics
- Deactivated by alkaline solutions
- Monoamine oxidase inhibitors (MAOI) and bretylium may potentiate effects of epinephrine

How Supplied
- 1 mg / ml (1:1,000) or 0.1 mg / ml (1:10,000) ampules and prefilled syringes
- Auto-injector EPI-pen 0.5 mg / ml (1:2000)

- 0.01 mg / ml (1:100,000) also available

Dosage and Administration

- Adult
    - Allergic reactions and asthma: 0.3-0.5 mg (0.3-0.5 ml 1:1000) SC
    - Anaphylaxis: 0.3-0.5 mg (3-5 ml 1:10,000) IV
    - Cardiac arrest
    - 1 mg IV push every 3-5 minutes
    - Endotracheal: 2 mg every 3-5 minute
- Pediatric
- Allergic reactions and asthma: 0.01 mg/kg (0.01 ml/kg) SC to maximum of 0.5 mg
    - Cardiac arrest
    - 0.1ml/kg (1:10,000) IV, IO, ET

Duration of Action

- Onset: immediate
- Peak effects: minutes
- Duration: several minutes

Special Considerations

- Pregnancy safety: category C
- Syncope in asthmatic children
- If given via endotracheal tube, may dilute in sterile NS (10 ml in adults)

Reference

"An Alternative Route to Maintenance of Licensure", Manitoba Health Emergency Services, Revised March 14, 2001

Brady Emergency Medical Responder A Skills Approach, Canadian Edition, Keith J. Karren, Brent Q. Hafen, Daniel Limmer, John Mackay, Michelle Mackay Prentice Hall, Inc., 1998

National Occupational Competency Profiles and Curriculum Blueprints, June 29, 2001, Paramedic Association of Canada

AAOS Emergency Care and Transport of the Sick and Injured, Seventh Edition, 1999, Jones and Bartlett.

Manitoba Health Emergency Treatment Guidelines, Manitoba Emergency Services, Revised August 2009

Mosby's Paramedic Textbook, Revised Second Edition, Mike Sanders, Mosby, Inc. 2001