DEFINITIONS

- Aerobic metabolism is energy using oxygen into cells.
- Anaerobic metabolism is energy not using oxygen. 18 times less effective than aerobic and produces acids. Results in accumulation of lactic acid.
- Hemorrhage - disruption, or leak, in the vascular system. Results in internal or external bleeding.
- Cardiac Output is amount of output per minute. Heart rate times stroke volume is cardiac output.
- Stroke Volume is the amount ejected in one contraction of heart
- Perfusion means movement
- Hypoperfusion is inadequate movement of blood. Also known as SHOCK.
- SHOCK IS DEFINED AS INADEQUATE TISSUE PERFUSION.
- Hypotension means low BP.
- Pulse Pressure is the difference between the systolic and diastolic numbers.

FICK PRINCIPLE

- Getting oxygen into lungs, into body, into cells, back to lungs and out. If one is not working we fall apart.
Vasculature

- Peripheral vascular resistance is the afterload. Meaning what the heart pumps against. Afterload is a measure of friction between the vessel walls and fluid (viscosity).

- Vessel diameter is the main factor affecting the resistance of blood flow.

- More pre-load results in a greater filling of the ventricles which results in a better stretching of fibers to get a better ejection factor. This is known as Frank Starling law of the heart.

- Pooling of blood is always a concern if shock develops. Under normal conditions over 60% of blood volume is in the venous system.

VESSELS

- Artery is most muscular, carry blood away from heart.

- Capillaries smallest vessels and exchange takes place.

- Vein returns to heart and has valve to prevent back flow.

- Vessels cut transverse will contract to help control bleeding.

- Vessels cut longitudinal or crushed do not allow for normal blood clotting mechanisms.

BLOOD CELLS

- Red Blood Cells – produced in bone marrow and contain hemoglobin that bonds the oxygen.

- White Blood Cells – fight infection.
• Platelets – produce coagulation when in contact with air.

• Plasma is the fluid of blood (55%). Plasma is not a formed element of blood.

EXTERNAL HEMORRHAGE

• Severity depends on source (artery, capillary, venous), degree of vascular disruption, and amount of blood loss.

HOW TO CONTROL BLEEDING

• Even the most severe arterial bleeds only need direct pressure to manage.

• Step 1 - Direct pressure to reduce bleeding into the area.

• Step 2 - Elevate to reduce blood flow to the area.

• Step 3 - Pressure point – pressing down on major artery to the area to reduce blood flow. (brachial in arm and femoral in legs).

• Step 4 - Tourniquet – LAST EFFORT WHEN ALL ELSE FAILS. If I cut my hand off, if I do the first three steps it will take 45 minutes to bleed to death. You should be able to get to a surgeon by then. You can use a tourniquet when the body part is stuck in a machine and you cannot do the first three steps. Or you have a person shot in 10 areas of the body and you cannot plug them all. Tourniquet should be about 4 inches wide (BP cuff is a good thing), labeled as a tourniquet, time it was placed, and placed as close to wound as possible.
- Clarification of new PHTLS/NREMT testing: For a localized trauma injury with major bleeding follow the step by step approach to control bleeding. For Multi-system trauma patients with major bleeding not controlled by direct pressure go to tourniquet to save red blood cells.

INTERNAL HEMORRHAGE

- Blunt or penetrating trauma or acute and chronic illness.

- Blood collects most commonly in one of 4 cavities: chest, abdomen, pelvis or retroperitoneum.

- Melena is black, tarry stools.

- Hematochezia is red blood passing through the rectum.

CAUSES OF SHOCK

- Pump (heart) failure – MI, CHF, drugs, valve damage leaking.

- Container (blood vessels) failure – vessels relax and dilate, BP drops.

- Volume (blood) failure – loss of plasma.

- If hemostasis fails hypotension results.

STAGES OF SHOCK

Stage 1: Vasoconstriction - as volume decreases the precapillary arterioles and postcapillary venules constrict. As this decrease in blood flow to these areas decrease anaerobic metabolism takes over and acid develops. As a result the capillaries begin to leak resulting in more fluid loss. Also blood is shunted from the GI, skin and kidneys.
Stage 2: Capillary and Venule Opening - Precapillary sphincter relaxes. Postcapillary sphincters resist relaxation and remain closed. This causes pooling of blood.

Stage 3: Disseminated Intravascular Coagulation - (refractory shock) still considered reversible in early stage. Blood begins to coagulate in the microcirculation resulting in lack of nutrients to the cells. Anaerobic metabolism takes over and the acid buildup allows Na+ and K+ to enlarge the cells and "washout" and die.

Stage 4: Organ Failure results from "washout" and a delayed death. You might get the BP up but the microcirculation is destroyed.

TYPES OF SHOCK (more than 100 types of shock)

- **Hypovolemic** – loss of volume. Diarrhea, heat stroke, vomiting. Can be caused by peritonitis and endocrine disorders also. A sister shock of hypovolemic is hemorrhagic shock in which the fluid is blood specifically. Hemorrhagic shock is the most common cause of hypovolemic shock.

- **Cardiogenic** – Failure of the heart to pump. Cannot keep cardiac output up. CHF, MI, damage. Most commonly has crackles or wet lungs.

- **Obstructive shock** is a type of cardiogenic shock and is caused by cardiac tamponade, tension pneumothorax or pulmonary embolism.

- **Septic** – Infection that goes systemic throughout the body. Irritates vessels and they swell and leak plasma making BP drop. Example is pneumonia not treated may go septic. Has FEVER.

- **Anaphylactic** – severe allergic reaction in which vessels leak (hives) to release histamines and the BP goes down as result.
• Neurogenic – spinal cord severed and blood vessels dilate and lose their tone and BP drops. This type of shock is unique because heart rate usually stays between 60-100BPM without adrenaline signs present.

• Psychogenic – NO SUCH THING. THIS IS NOT A TRUE SHOCK. This is known as syncope. Transient lack of blood to the brain so you faint. Self correcting shock.

BLOOD LOSS TO CONSIDER CRITICAL

• Adults can lose 1000cc before it is considered serious.

• Children can lose 500cc before it is considered serious.

• Infants can lose 250cc before it is considered serious.

• Info: cc and mL mean the same.

QUICK BLOOD PRESSURE CHECK

• Adult only.

• Radial pulse at least 80 systolic.

• Femoral pulse at least 70 systolic.

• Carotid pulse at least 60 systolic.
• Core pulses are "central pulses" - carotid, femoral, apical.

• Peripheral pulses are arms and leg pulses.

• Define: Apical is when you listen for the lub-dub of the heart pumping.

THREE PHASES OF SHOCK

• Shock phases are defined by blood pressure.

• Compensated (early) phase BP is above 90 systolic.

• Decompensated (late) phase BP is less than 90 systolic.

• Irreversible phase acid is killing organs because of a lack of tissue perfusion so anaerobic kicks in resulting in acid.

SIGNS AND SYMPTOMS OF SHOCK

• Think of this as a rainbow of signs and symptoms. Up the rainbow is early shock, down the rainbow is late shock and the pot of gold is irreversible.

• Early (compensated) – release adrenaline results in – Restlessness/anxiety, heart rate fast and strong, respirations fast and deep, pupils dilated, sweaty skin. Pt may feel thirsty, and weak.

• Transition between early and late is that the sweat turns cold and clammy because the body shunts blood from skin, arms and legs.
• Late (decompensated) – adrenaline release slows – heart rate fast but weak, respirations fast but shallow, feeling of doom, decreased level of consciousness. delayed capillary refill.

• Irreversible – unresponsive and death or organ failure and die a few days later.

• Orthostatic vital signs (tilt test) - rise in pulse and decrease in BP from lying, sitting to standing. Supports lack of perfusion.

• A good way to categorized compensated versus decompensated shock is using the blood pressure. A low BP always supports decompensate shock and overrides other symptoms of compensation.

CARE FOR SHOCK

• Goal is to maintain oxygenation and perfusion of organs.

• After securing airway next priority is golden hour and load and go.

• First priority of trauma patient is to transport and do all skills enroute. Load and go.

• IV’s short and fat and start at least 2 of them. Also use a pressure bag at 300mmHg to rapid infuses if needed.

• Initial management for most patients in shock is a fluid bolus. Maintain a BP of 80-90mmHg is goal.

• PASG should be applied to stop hemorrhage by tamponading any bleeding vessels in the abdomen, pelvis, or lower extremities.

• Lay flat or elevate legs.
• Cover to keep warn.

• Place on high flow oxygen.

• Keep calm.

**FLUID CARE:**

• General guidelines warrant an isotonic crystalloid fluids only as necessary to maintain perfusion of 80-90mmHg. Try to limit amount of fluid to 3,000 mL.

• Crystalloids are the most common fluid used early. Lactated ringers, normal saline solutions in water. 2/3 of the fluid leaves the vascular space within 1 hour. It takes 3mL for every 1 mL of blood lost.

• Lactated ringers are the fluid of choice for shock. Well balanced and have many chemicals found in blood. LR also contains sodium chloride, potassium and calcium and 28mEq of lactate which helps to buffer the acid.

• Colloids are large molecules and remain in the vascular compartment for a longer time. Examples are whole blood, packed red blood cells, blood plasma.

• Note: In the exam world if a patient has a reaction to a colloid stop the infusion immediately. Fever is most common symptom.
• People think that when placing the PASG blood is forced from the legs to vital chest areas. THIS IS NOT TRUE. Only 250cc is pushed from the legs to the chest. When in late shock the sphincter capillaries cut off flow to skin, legs and arms. These muscle sphincters get tired in time and open. By using PASG the pressure when pumped will help keep the blood from entering the legs once the sphincters relax and reopen. They can also help control major bleeding and help stabilize a fractured pelvis cavity.

• As a paramedic you should inflate both legs then consider the need for the abdominal compartment. SEPTIC is include/exclude the abdominal section; systolic over 100mmHg, abdominal evisceration, pregnant (2/3 trimester), thumper used for CPR, impaled object in chest/abdomen, chest trauma not intubated.

• If medical control directs deflate the abdomen slowly. Then one leg at a time. Monitor pH and BP.

• A rise in temperature will increase pressure within the device. A decrease in temperature will decrease pressure of PASG.

• Fall in atmospheric pressure will result in an increase pressure of the PASG. A rise in atmospheric pressure will result in a decrease in pressure of the PASG.