

BLS-2015-Shock

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INTRODUCTION

You are called to the scene of a 65-year-old male who is complaining of feeling lightheaded. When you arrive, you find your patient in his bedroom, with skin pale and cool to the touch. He states he is experiencing nausea and abdominal pain. You assess his vital signs and find his blood pressure 70P, heart rate 130, and respiratory rate 22.

What's wrong with this patient? There are many possibilities. He may have a GI bleed, an abdominal aneurysm, a ruptured spleen, sepsis, or anaphylaxis. Your exam and history may provide some clues, but two things are clear. The patient is SICK and the patient is in shock.

What is shock and how can you start treating it, even before you figure out the cause? In the 1800s, shock was described as *"a rude unhinging of the machinery of life"* (Dr. Sam Gross, 1852) and *"a momentary pause in the act of death"* (Dr. John Warren, 1895). These eloquent descriptions foreshadow the dire consequences of shock and illustrate the vital importance of understanding its causes and treatment.

Learning Objectives

At the end of this overview, you will be able to:

- Define shock and describe its pathophysiology
- Describe the progression of shock from compensated through irreversible
- Identify the causes of shock and describe differences in presentation
- Identify indications for doing a postural blood pressure assessment
- Describe general treatment for shock and specific treatments for different types of shock
- Recognize special considerations for certain populations, specifically pediatric and geriatric patients, with respect to shock diagnosis and treatment

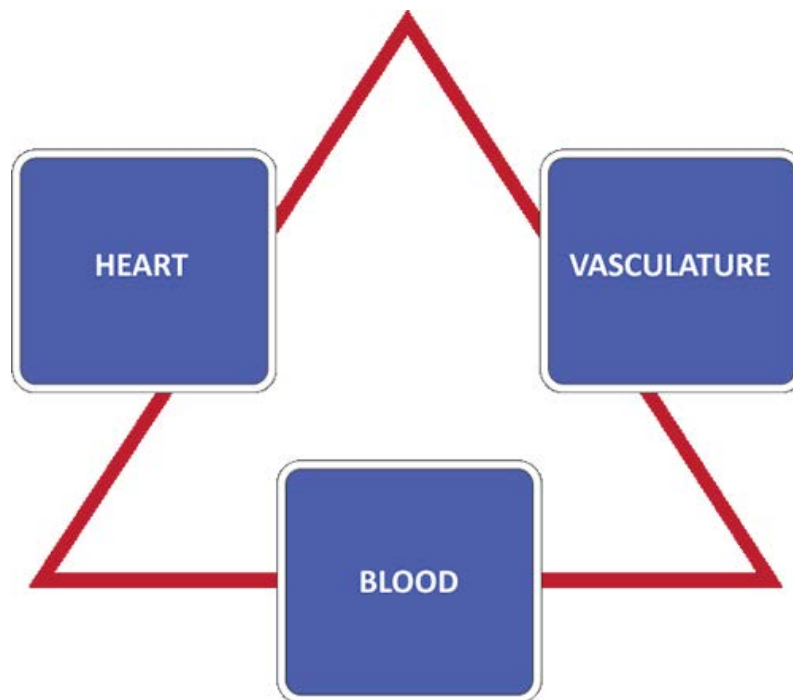
PATHOPHYSIOLOGY

Normal Perfusion

In its simplest form, **shock is inadequate tissue perfusion**. This means that oxygenated blood can no longer reach the tissues and the cells to support normal metabolism.

Normal body function requires that cells receive a sufficient supply of oxygen, glucose, and nutrients to produce energy. Metabolism of oxygen and nutrients produce waste products, such as carbon dioxide, which must be removed. This interchange of oxygen and carbon dioxide, nutrients and waste products, is known as **perfusion**.

Adequate tissue perfusion requires that three legs of a perfusion triangle all be functioning: the heart, the vasculature (*veins and arteries*), and oxygenated blood.



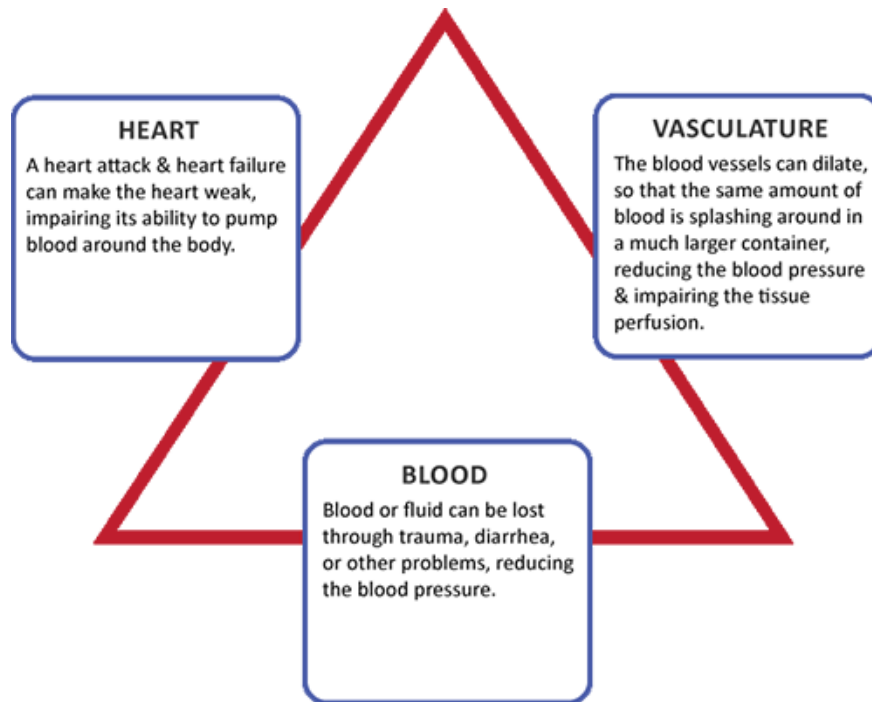
Adequate Tissue Perfusion

Inadequate Tissue Perfusion

If any of the three legs of the perfusion triangle fail, perfusion suffers. There are many ways this can happen:

- **Heart:** A heart attack and heart failure can make the heart weak, impairing its ability to pump blood around the body
- **Vasculature:** The blood vessels can dilate, so that the same volume of blood is present in a much larger container, reducing the blood pressure and impairing tissue perfusion

- **Blood:** Blood or fluid can be lost, through trauma, diarrhea, or other problems, reducing the blood pressure



Perfusion Triangle, detail

Whatever the cause, the cells don't take this insult lying down. Although oxygen and glucose allow for the most efficient production of energy (*a process called aerobic metabolism*), there is another option. In anaerobic metabolism (*without oxygen*), cells continue to produce energy and metabolize. But there are problems with this backup system. It doesn't produce as much energy and it does produce metabolic byproducts, such as certain acids, that may be harmful. It isn't a good long-term solution to poor perfusion.

The body can also respond to inadequate tissue perfusion on a higher level. It can shunt blood from areas that are less sensitive, such as the skin and GI tract, and divert it to more critical organs, such as the brain and kidneys.

These responses, from anaerobic metabolism to shunting, are designed to help the body survive a short period of stress. However, over time, these responses can cause additional problems. For example, the byproducts of anaerobic metabolism can make a shock patient acidotic. Shunting of blood away from some tissues can cause those tissues to die. Each of these consequences brings the patient in shock further along the continuum towards death. Let's explore how this happens and how we can intercede.

PROGRESSION

Consider our patient from the introduction. Let's imagine he has a ruptured aortic aneurysm. As blood seeps from his aorta, his blood volume and blood pressure begin to fall. Receptors throughout the body are activated, setting in motion a series of mechanisms designed to maintain the blood pressure at normal levels. These compensatory mechanisms include:

- Increased heart rate.
- Peripheral vasoconstriction – constriction of the small blood vessels in the skin to concentrate blood to the core, resulting in cool, pale skin.

Other mechanisms, which are harder to observe, occur within the body.

- The heart contracts more forcefully.
- The body releases hormones that cause the kidney to conserve water.
- The body may even redistribute blood from places like the spleen into the vasculature.

Compensated Shock

As a result of the compensatory mechanisms, the blood pressure stays more or less constant. For that reason, this stage is called **compensated shock**. Your aneurysm patient was at that stage before he called 911.

Signs & Symptoms

Signs and symptoms of compensated shock may include:

- Mild anxiety, restlessness
- Increased heart rate; weak, thready pulse
- Capillary refill greater than 2 seconds (in infants and children)
- Cool, clammy, pale skin
- Nausea, vomiting
- Thirst

Decompensated Shock

Now consider that as he continues to bleed, the compensatory mechanisms are no longer sufficient, his blood pressure falls, and he begins to feel lightheaded. He may have a syncopal episode or find himself on the floor. By the time you arrive, the compensatory mechanisms are maximally activated, yet cannot compensate for his blood loss. When you measure the blood pressure, it is 70P. He is pale, cool, and clammy. As the decreased perfusion affects his brain, he becomes confused and restless. This is decompensated shock.

Signs & Symptoms

- Signs and symptoms of decompensated shock may include:
- Confusion, altered mental status
- Decreasing blood pressure, usually 90 or less (*in an adult*)
- Labored breathing
- Mottled, poorly perfused skin
- Faint or absent peripheral pulses
- Dilated pupils

Irreversible Shock

Your aneurysm patient is now barely able to be aroused. His blood pressure is so low, it is difficult to palpate or auscultate. Although you cannot see it, the poor perfusion has already damaged cells, tissues, and organs throughout the body. Dying cells spill enzymes and toxins into the blood. The heartbeat and breathing patterns become irregular. The kidneys fail, allowing more toxins to accumulate. The final stage in the shock process is irreversible shock, which ends with the death of the patient.

Signs & Symptoms

- Signs of irreversible shock may include:
- Unresponsiveness
- Blood pressure difficult to measure, often 50 or less
- Irregular, often faint respirations
- Absent peripheral pulses
- Dilated, non-reactive pupils

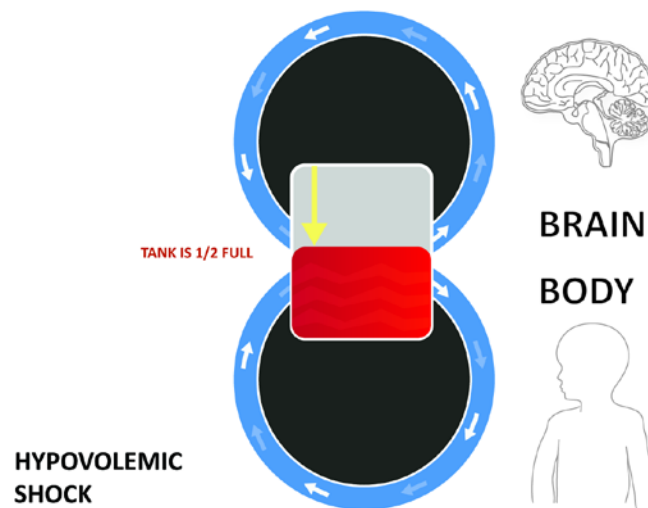
CAUSES OF SHOCK

Shock occurs when body tissues do not receive adequate perfusion with oxygenated blood. There may be a problem with the pump (*heart*), a problem with the pipes (*blood vessels*), or a problem with the fluid (*blood*). Inadequate oxygen will make all the forms of shock worse. There are many ways that shock can be classified. The following list classifies shock by cause.

Low Blood Volume

Hypovolemic shock occurs when there is:

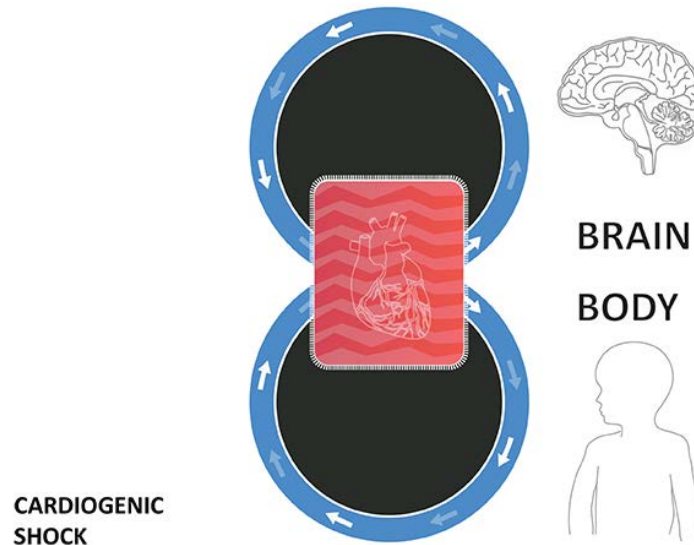
- loss of blood due to trauma, GI bleed, or aneurysm
- loss of fluid through diarrhea or vomiting
- loss of fluid through urine (*for example in diabetics with high blood sugar*)



With low blood volume, the heart is ½ full

Cardiogenic shock occurs when the heart cannot pump effectively as a result of:

- a heart attack
- congestive heart failure
- heart valve problem

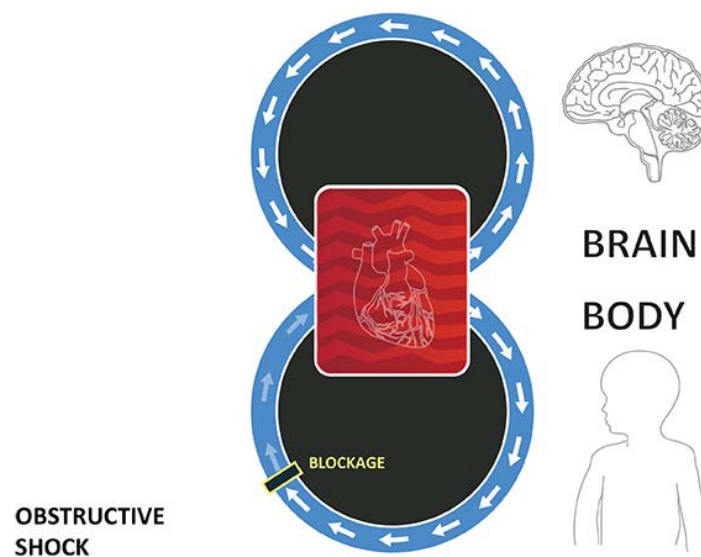


When there is a problem with the heart pump, there is decreased blood flow to the brain and body

Blood Flow Obstruction

Obstructive shock occurs when blood outside the heart is blocked.

- blood in a sac around the heart (*cardiac tamponade*)
- clot in a blood vessel of the lung, preventing blood from returning to the heart (*pulmonary embolus*)

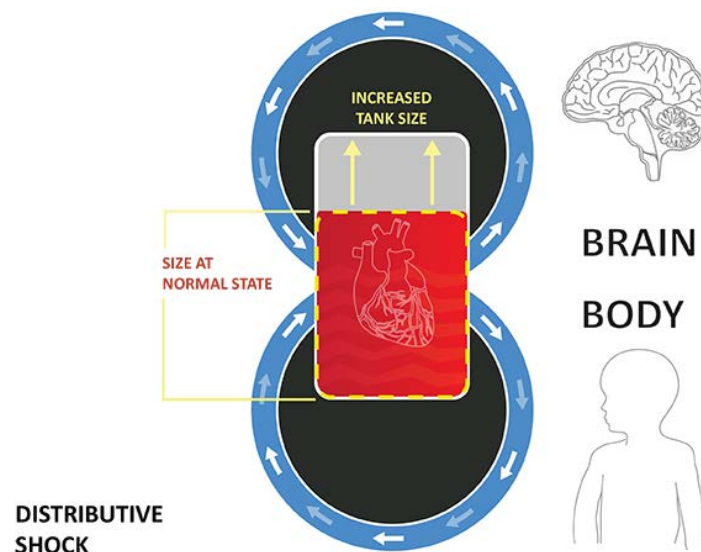


An obstruction to blood flow outside the heart, decreases blood flow back to the heart.

Changes in Blood Vessels

Distributive shock occurs when the distribution of blood changes. The blood vessels dilate, so that the same amount of blood must fill a much larger container. This causes the blood pressure to drop. There are many types of distributive shock.

- **Spinal or Neurogenic Shock** – A spinal cord injury causes reflex vasodilatation.
- **Anaphylactic Shock** – An allergic reaction causes blood vessels to dilate.
- **Septic Shock** – A bacterial infection produces toxins that dilate the blood vessels.
- **Psychogenic Shock** - Emotional or other factors which cause a neurologic response that temporarily dilates the blood vessels.



Vasodilation causes blood to circulate through a bigger tank, and blood pressure decreases

Changes in Oxygen

Respiratory shock occurs when there is a problem with oxygen delivery to the cells

- insufficient oxygen due to damage to lung tissue (*for example a flail chest*)
- insufficient oxygen due to competition from carbon monoxide
- cellular poisons such as cyanide that prevent cells from using oxygen

With so many types of shock, it is clear that not all shock presents in the same way. As pre-hospital care professionals we recognize that a patient with an aneurysm who is hypotensive with pale, cool, clammy skin is SICK. But some types of shock look different. A person in anaphylactic shock may have warm, reddish skin with hives, while a person in septic shock may be hot to the touch and even have a fever.

Your careful assessment of the patient and your index of suspicion will help you recognize these less typical presentations of shock.

CASE STUDIES

Case Study 1: Hypovolemic Shock

You respond to a report of a 20-year-old female who was a restrained driver of a small car struck on the driver's side by a pickup truck. There is significant intrusion on the driver's side. Your patient is awake, alert, and anxious, complaining of pain on her left side. There is no obvious bleeding. She has a good radial pulse. Her skin is cool and dry.

You extricate your patient onto a backboard. Her first set of vital signs are blood pressure 136/86, heart rate 132, and respiratory rate 20.

Is this patient in shock? She might be. While her blood pressure is normal, the mechanism of injury is significant, and her elevated heart rate and cool skin are concerning.

Over the next few minutes, the patient becomes slightly restless and complains that she feels short of breath. Her vitals are now blood pressure 132/90, heart rate 144, and respiratory rate 22. Her skin is cool and damp.

Although she is still not hypotensive, this patient is clearly progressing down the shock pathway. She may be bleeding from a lacerated spleen, a fractured pelvis, or other injuries leading to shock due to low blood volume. Early recognition and treatment can save her life. In addition to a backboard, c-collar, and rapid extrication, she needs a pelvic wrap, blanket to conserve warmth, oxygen, ALS treatment of IV fluid and possibly airway management, and rapid transport to a trauma center.

Case Study 2: Septic Shock

You are called to a nursing home to evaluate an 80-year-old male with a decreased level of consciousness. The staff tell you that the patient, who is normally alert and oriented, has been increasingly confused over the last 24 hours, and today he would not wake up for breakfast. The patient has a history of strokes, high blood pressure, and urinary tract infections.

You find the patient lying in bed. He opens his eyes when you touch him, but does not speak and does not follow commands. His vital signs are blood pressure 88P, heart rate 148, and respiratory rate 26. His skin is flushed and hot to the touch.

What is the cause of this patient's shock? Based on his previous history, he may have a urinary tract infection (*UTI*). Untreated, the bacteria that cause UTIs can invade the bloodstream and produce toxins that damage cells throughout the body. Blood vessels become leaky and lose their ability to constrict. The loss of fluid and the expanded size of the container mean that the blood pressure falls.

Fever often accompanies septic shock, especially in the beginning. However, as body systems begin to break down, the temperature often falls. Some septic patients are actually hypothermic.

Septic shock is as much of an emergency as hypovolemic shock. The septic patient needs prompt transport to a facility that can provide IV fluids, antibiotics, and intensive care.

Case Study 3: Psychogenic Shock

You are called to see a 36-year-old unconscious female. You arrive at a blood donation center to find your patient lying on a donation bed, alert and oriented. The blood donation staff says they were explaining the process to her when she stated she felt dizzy and proceeded to pass out. They state that her initial vitals were blood pressure 70P, heart rate 48, and respiratory rate 22. She is now awake and alert with vitals blood pressure 122P, heart rate 90, and respiratory rate 12. She states she feels much better now.

This person probably had an episode of psychogenic shock or vasovagal syncope. A layperson might say that the patient has fainted or passed out. The trigger may be a person getting an injection, seeing blood, or hearing bad news. The cause is usually a sudden, and temporary, dilation of peripheral blood vessels. The same neurologic reflex that causes vasodilation often also causes a drop in the heart rate.

The sudden vasodilatation and bradycardia mean that there may be insufficient blood going to the brain. The person may lose consciousness, or may lie or fall down. Becoming supine usually restores blood flow to the brain and the person will awaken.

Since there are many causes of syncope, it is important to ensure that the patient has suffered only from this temporary vasodilation and bradycardia, instead of something more serious such as a cardiac arrhythmia. A careful history and exam will help you sort out the cause.

Psychogenic shock is self-correcting. If the blood pressure is still low after the person is supine, place the patient in Trendelenburg. Ensure that the patient didn't injure herself when she fell. Repeat vital signs and document that the blood pressure and heart rate have returned to normal.

PATIENT ASSESSMENT

Because shock can occur from a variety of causes, both traumatic and medical, there is no one-size-fits-all approach to assessing a patient for shock. Here is a general approach that will identify whether a patient is at risk for shock, regardless of the cause.

Scene Size-Up

During the scene size-up, determine the scene is safe and consider the mechanism of injury (*MOI*) and nature of illness (*NOI*).

Initial Assessment

Your initial assessment should include a quick impression of the patient:

- What is the patient's age?
- What is the patient's overall appearance?
- What is the patient's position?
- How acute is the patient's distress?

Determine any immediate life threats, chief complaint if indicated, and whether this patient is SICK or NOT SICK. If you have made the determination of SICK, consider whether additional resources are needed (*ALS or more BLS resources*).

The first part of your hands-on evaluation will assess:

- Responsiveness or level of consciousness
- Airway, breathing and circulation

When checking circulation, pay particular attention to the distal pulse rate and quality. A faint rapid pulse suggests shock, even without confirmation from the blood pressure. If you are unable to feel a distal pulse, check a carotid or femoral pulse. If there are no pulses, begin CPR!

As you are checking the pulse, note the color, temperature, and moisture of the skin. A patient in hypovolemic shock will have pale, cool, and clammy skin, whereas a patient in septic shock may have flushed, warm skin. Check for capillary refill, which may indicate the perfusion of the patient's peripheral tissues.

Rapid Assessment & Focused Physical Exam

Your rapid assessment and focused physical exam will be dictated by the mechanism of injury or nature of illness and the patient presentation. Even if you have a stable patient who is not in shock, pay attention to those aspects of the exam that might indicate a problem later. For example, a stable patient in a motor vehicle crash who is complaining of left-sided tenderness is at risk for a bleeding spleen and possible shock. A patient with widespread urticaria (*hives*) may soon become hypotensive from his allergic reaction.

Vital signs should be taken as part of your physical exam. Consider variables such as age, medications, or anxiety, and how these might affect the vital signs. Repeating vital signs is key to interpreting their significance.

Vital signs include blood pressure, heart rate, respiratory rate, skin signs, blood sugar, and pulse oximetry.

Interpreting Vital Signs – Case Study

You are evaluating an 18-year-old female, restrained driver, who has been involved in a relatively minor motor vehicle crash. She is complaining of pain where the seat belt crossed her chest and is extremely anxious. Her vital signs are blood pressure 130/90, heart rate 136, and respiratory rate 24.

Based on her heart rate of 136, is she in the early stages of shock? She probably is not. In addition to considering the mechanism of injury and performing a careful exam, you should also repeat the vital signs five minutes later. Her second set of vitals are blood pressure 126/80, heart rate 108, and respiratory rate 18.

As you calmed her down, her heart rate decreased. If she was in the early stages of shock, you would expect her heart rate to increase over time.

Postural Vital Signs

Postural vital signs can provide an important clue as to whether a relatively stable patient has sustained volume loss or is in the very early stages of shock. Going from lying to sitting, or sitting to standing, requires a patient to compensate by increasing his heart rate or constricting his blood vessels.

Because postural vital signs are performed to help you decide whether a patient needs further medical evaluation or treatment, they should not be done on a patient who is already known or suspected to be in shock, or who is suffering from a medical condition that already requires ALS evaluation and transport.

Consider postural vital signs in the following stable patients:

- a person with a possible GI bleed or other internal hemorrhage
- a person complaining of weakness, dizziness, or lightheadedness
- a person who has had prolonged vomiting or diarrhea

Postural vital signs are not indicated in the following patients:

- a person who is already hypotensive (supine blood pressure below 90)
- a woman with third trimester bleeding
- a trauma patient
- a person with suspected cardiac chest pain

Postural Signs – Case Study 1

You are evaluating a 25-year-old male who states he has had a GI bug for the last 3 days, with nausea, vomiting, and diarrhea. He called because he felt lightheaded while walking to the bathroom. You're evaluating him in the bedroom, where he is lying supine on the bed. His vitals are blood pressure 118/70, heart rate 90, and respiratory rate 16.

Posturals are indicated for this patient. When you sit the patient up in bed, wait two minutes, and retake his vitals. His blood pressure is 116/72, heart rate 130, and respiratory rate 18. This patient is postural (defined as heart rate increase is greater than 20 beats per minute), suggesting that he is volume depleted from his vomiting and diarrhea. He would benefit from further evaluation and care.

Postural Signs – Case Study 2

You are called to evaluate a 65-year-old female who is complaining of abdominal pain and states she just had an episode of dark liquid stools. She felt lightheaded so she came into the bedroom and lay down on the bed. Her vitals are blood pressure 80/60, heart rate 130, respiratory rate 20.

Posturals are not indicated for this patient. She is already hypotensive from her GI bleed, so there is no benefit to doing postural vital signs, and you may make the patient worse. A patient who is hypotensive should remain in a supine position during treatment and transport. You may consider Trendelenburg position if tolerated.

Patient History

Conduct your SAMPLE history. Your interview of the patient, focusing on signs and symptoms, will be dependent on his or her chief complaint. If you are evaluating a person with pain, such as your aneurysm patient complaining of abdominal pain, you may use OPQRST as your guide:

- Onset
- Provocation
- Quality
- Radiation
- Severity
- Time

You may need to modify this for patients with different complaints. A person with an anaphylactic reaction may be asked about known or possible allergens, previous episodes, and whether or not they took Benadryl or an Epi-pen.

Continuing with SAMPLE, ask about:

- Allergies
- Medications
- Past medical history
- Last meal
- Events leading up to the present illness

Treatment

Appropriate treatment of shock depends on the cause. Determining MOI/NOI followed by SICK/NOT SICK are the first steps.

In all shock patients:

- Monitor ABCs
- Repeat vital signs
- Administer oxygen as appropriate

- Maintain body temperature
- Request ALS evaluation

Specific evaluation and treatment are appropriate for some types of shock.

Hypovolemic Shock (*blood loss, fluid loss from diarrhea, vomiting*)

Trauma

- Control bleeding via direct pressure, bandaging, pressure points, and tourniquet if needed
- Splint fractures to reduce pain and bleeding. Consider a pelvic splint if there is mechanism to suggest possible pelvic injury

Medical

- Determine amount of blood lost if possible (e.g. GI bleed)
- Determine medications that might affect clotting ability (e.g. Coumadin/warfarin)
- If there are no contraindications, position in Trendelenburg

Cardiogenic Shock (Heart attack or CHF)

Patients in cardiogenic shock from CHF or cardiomyopathy may be hypotensive but also short of breath, so they often will not tolerate lying down

- Administer high flow oxygen via non-rebreather
- Consider assisting ventilations with a BVM if patient is nearing respiratory failure
- Keep the dyspneic patient in a seated or semi-seated position

Obstructive shock (cardiac tamponade or pulmonary embolus)

- High flow oxygen and assist ventilations as needed

Neurogenic Shock (also called "spinal shock," shock resulting from spinal cord injury)

- Cervical collar and backboard
- Use modified jaw thrust for airway management
- Use extreme care in immobilizing and packaging the patient
- Observe respiratory status very closely; some patients in spinal shock will have impaired breathing ability and will need to be ventilated

Anaphylactic shock

- Administer oxygen as appropriate
- Place patient in Trendelenburg if there are no contraindications
- Administer epinephrine if there are no contraindications

Septic shock

- Administer oxygen as appropriate
- Prevent heat loss using blankets. Some septic patients are febrile, but many have below-normal temperatures
- Early notification of the emergency room if the patient is transported BLS

Psychogenic shock

- Keep patient supine, in Trendelenburg if no contraindications
- Remove or diminish the trigger if possible

Respiratory shock

- Provide high-flow oxygen
- Consider assisting with bag-valve-mask ventilation if indicated

Definitive Care

With the exception of psychogenic shock, it is rarely possible for definitive treatment of shock to occur in the field. Most field treatments, whether ALS or BLS, are merely stopgap measures to buy time until the person can be treated in the emergency room, the operating room, or the intensive care unit.

What is the definitive treatment of shock?

- Hypovolemic: replacement of fluids, correction of injury (often in surgery)
- Cardiogenic: diuretic medications to draw fluid away from the lungs if they have pulmonary edema from CHF, other medications to help the heart beat more forcefully, removal of clot if the person is having a heart attack
- Obstructive: removal of fluid from around the heart (cardiac tamponade); decompression of the chest (tension pneumothorax)
- Neurogenic: IV fluids, surgical correction of spinal cord injury if possible
- Anaphylactic: epinephrine, anti-histamines, fluid
- Septic: fluid, antibiotics
- Respiratory: intubation, hyperbaric oxygen (carbon monoxide poisoning), medications to deactivate toxins (cyanide poisoning)

SPECIAL POPULATIONS

Pediatric and geriatric patients require special considerations in assessment of shock.

Pediatric Patients

Pediatric patients who are in shock may transition from appearing relatively well to being profoundly hypotensive very quickly, and the hypotension may be difficult to reverse.

Why do pediatric patients respond this way? Consider a healthy 5-year-old who has sustained a lacerated liver from a motor vehicle crash. This child can easily sustain a very high heart rate and also greatly constrict his vasculature, all of which are compensatory mechanisms that maintain the blood pressure at a near-normal level. By the time these compensatory mechanisms fail and the blood pressure begins to fall, the amount of blood loss may be life-threatening.

Pediatric patients are also at risk because of their smaller blood volume. For example, an average adult may have 4 to 5 liters of blood, but a child, who weighs 80 pounds, may have half that amount. An infant may have less than 10 ounces or 0.3 liters of blood. Children also have a larger body surface-to-volume ratio than adults, so they are more prone to losing body heat, which can worsen shock.

Geriatric Patients

Geriatric patients are at risk of a more rapid onset of shock due to bleeding, sepsis, or dehydration. The compensatory mechanisms are simply not as efficient for several reasons.

- Medications or an aging heart may hinder their body's ability to increase the heart rate in the early stages of shock. Medications such as beta blockers maintain a lower heart rate and older hearts simply cannot beat as fast as a younger one.

- Atherosclerotic blood vessels are unable to constrict. As a result, a smaller blood loss may cause an older person's blood pressure to drop.
- Geriatric responses to shock from other body systems, such as the renal system's conservation of fluid, may not be as brisk as in a young healthy adult.
- Be especially aware of the potential for septic shock in an older person who may have an infection.

SUMMARY

Although the causes and presentation of shock vary, the pathway and endpoint are *(if untreated)* the same – inadequate tissue perfusion leading ultimately to tissue death. As a person progresses from compensated to uncompensated to irreversible shock, the disease process becomes more and more difficult to interrupt.

Some of the most critical interventions occur in the field. If bleeding is not stopped or epinephrine is not administered, a patient in shock may not survive to reach the emergency room. Early recognition and treatment of shock are among the EMT's most important and lifesaving tasks.