

# ***CARDIAC ARREST: Knowing Your Hs and Ts***

***2.0 Contact Hours***

***Presented by:***

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# CARDIAC ARREST: Knowing Your Hs and Ts

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## OBJECTIVES

After completing this course, the learner will be able to:

- I. Name the 6 Hs and 5 Ts.
- II. Describe how each of the Hs and Ts could cause cardiac arrest.
- III. Recognize the clinical presentation of a patient in cardiac arrest from one of the Hs and Ts.
- IV. Effectively manage patient care based on the cause of cardiac arrest.

### *I. Cardiac Arrest*

Cardiac arrest is essentially the complete cessation of the ability of the heart to function mechanically, to beat. As a result, the body can not maintain an effective oxygen delivery system and oxygen can not be delivered to the cells. Cerebral hypoxia results from hypoperfusion of the brain, leading to loss of consciousness and cardiac arrest.

Lack of the heart to beat causes the absence of a pulse. While it is important to check all pulses, the patient can have absent peripheral pulses with a significant drop in BP, so it is important to check the carotid pulse in the arrested patient. Besides the presence of a carotid pulse, other signs of circulation include: cough, gasping, color, twitching, and movement.

When checking the patient for electrical activity remember that cardiac arrest is determined by the presence of a pulse versus electrical activity. When CPR is stopped for a rhythm check, that patient will display one of the following four cardiac rhythms:

- Ventricular Fibrillation (VF/VFib): This IS a shockable rhythm
- Ventricular Tachycardia (VT/VTach): This IS a shockable rhythm
- Asystole: This is NOT a shockable rhythm
- Pulseless Electrical Activity (PEA): This is NOT a shockable rhythm

CPR should be performed and ACLS drugs should be administered until the patient's pulse returns or the patient is pronounced dead. While CPR is being performed, patients should be treated (as best as possible) for whichever reversible disease process caused the arrest. The reversible causes of cardiac arrest are known as the "Hs and Ts."

Note: After greater than 5 minutes of untreated cardiac arrest, permanent brain injury is likely.

## II. The Hs and Ts

<b>Hs</b>	<b>Ts</b>
Hypovolemia	Tablets/Toxins
Hypoxia	Tamponade
Hydrogen Ions	Tension Pneumothorax
Hyper/hypokalemia	Thrombosis (MI)
Hypothermia	Trauma
Hyper/hypoglycemia	

### Hs:

#### - Hypovolemia

Hypovolemia is usually the result of a severe decrease in circulating volume likely related to bleeding, anaphylaxis, and/or fluid shifts out of the intravascular space. The heart rhythm most likely noted in a patient in cardiac arrest secondary to hypovolemia is PEA (pulseless electrical activity). The best way to resuscitate this patient is IV fluid repletion at a 3:1 ration (300mLs of fluid per 100mLs of fluid lost), blood transfusion, and/or control bleeding (treat the source of fluid loss).

#### IMMEDIATE REVIEW:

##### -Hypovolemia:

- Description: Decreased circulating volume
- Likely Causes: bleeding, anaphylaxis, fluid shifts
- Rhythm: PEA
- Treatment: IVF, blood transfusion, control fluid loss

#### -Hypoxia

Hypoxia describes a patient with decreased oxygen delivery to the vital organs (heart, lung, brain) causing a change in the patient's medical condition. Hypoxia can be caused by many different medical conditions including, but not limited to: respiratory depression, CHF with fluid volume overload, asthma exacerbation, pneumonia, and COPD. The cardiac rhythms seen most often in patients with cardiac arrest secondary to hypoxia include: PEA, asystole, ventricular fibrillation, and ventricular tachycardia. Treatment for patients in hypoxic cardiac arrest include: oxygen delivery, adequate ventilation, and optimal CPR.

#### IMMEDIATE REVIEW:

##### -Hypoxia:

- Description: Decreased O2 delivery to cells
- Likely causes: asthma/COPD exacerbation, CHF with fluid volume overload, respiratory depression
- Rhythm: PEA, asystole, Vfib, Vtach

-Treatment: O<sub>2</sub> delivery, ventilation, good chest compressions during CPR

### -Hydrogen Ions

“Hydrogen Ions” is the term that begins with “h” used to describe a patient in an acidotic state, with a pH of <7.35. Normal pH values are 7.35 to 7.45 with values < 7.35 signifying acidosis and >7.45 signifying alkalosis. When reading ABG results, CO<sub>2</sub> is considered the “acidic value” and HCO<sub>3</sub> is considered the “basic value.” Therefore, if you have a patient with a high CO<sub>2</sub> and a low pH they are clearly acidotic. Eventually the HCO<sub>3</sub> value will rise as the body tries to compensate for the change and to regulate pH.

The same is true for alkalosis. If the patient has a high HCO<sub>3</sub> level and a low pH they are alkalotic and the CO<sub>2</sub> value will rise as the body compensates. (Note: The patient is in a fully compensated acidosis or alkalosis only after the pH value is within normal limits.) In order to determine whether the acidosis or alkalosis is caused from respiratory distress or metabolic disturbances you will need to review the entire ABG and consider the patient’s physiologic state.

In the case of cardiac arrest, the patient’s acidosis is likely to be caused by shock, diabetic ketoacidosis (DKA), renal failure, and overdose. Acidosis is likely to result in asystole or pulseless electrical activity (PEA) in the case of severe acidosis. Treatment will require proper ventilation, the use of good CPR with compressions, and the use of NaHCO<sub>3</sub> as buffer treatment because the body will likely not be able to compensate quickly enough.

### IMMEDIATE REVIEW

#### -Hydrogen Ions:

- Description: Abnormal body pH of < 7.35 resulting in acidosis.
- Likely causes: shock, DKA, renal failure, OD
- Rhythm: asystole, PEA
- Treatment: proper ventilation, good CPR, NaHCO<sub>3</sub> as buffer

### -Hyperkalemia or hypokalemia

Hyperkalemia is a serum potassium value greater than 5.0 and hypokalemia is a serum potassium value less than 3.5. Likely causes of hyperkalemia include missed dialysis and/or renal failure and the signs and symptoms include muscle weakness, nausea, vomiting, and a broad QRS complex. Hypokalemia can be caused by excessive fluid loss through the GI system (diarrhea, vomiting) and malnutrition. Signs and symptoms of hypokalemia include depressed T waves, U waves, and a long QT complex possibly progressing to Torsades de Points. Abnormal cardiac rhythms caused by changes in potassium include PEA and asystole for the hyperkalemia patient and ventricular fibrillation (VFib/VF), pulseless ventricular tachycardia (PVT), or asystole for the hypokalemic patient. Treatment for hyperkalemia includes the administration of

calcium (calcium gluconate or calcium chloride), sodium bicarbonate, or the combination of IV glucose and IV insulin. In treating hyperkalemia, calcium and sodium bicarbonate are used to prevent the patient from the onset of VFib and should be administered quickly if the patient shows significant EKG changes. The insulin/glucose combination is used to shift potassium out of the extracellular space and back into the cell, where it belongs. The only treatment for hypokalemia is the administration of potassium. Potassium can be administered orally or intravenously. Be aware that oral preparations of potassium come in both immediate and extended release. Also, prior to administering IV potassium check the protocol for your hospital as it is known to be caustic to the veins and should be administered slowly.

IMMEDIATE REVIEW:

-Hyperkalemia/hypokalemia:

- Description: Hyperkalemia: serum potassium > 5.0  
Hypokalemia: serum potassium < 3.5
- Likely causes: Hyperkalemia: missed dialysis, renal failure  
Hypokalemia: diarrhea, N/V, malnutrition
- Rhythm: Hyperkalemia: PEA/asystole  
Hypokalemia: VFib/PVT/asystole
- Treatment: Hyperkalemia: calcium, NaHCO<sub>3</sub>, glucose/insulin  
Hypokalemia: Administer potassium

-Hypothermia

Hypothermia is a body core temperature < 35 degrees Celsius (95 degrees Fahrenheit) and occurs frequently in patients with traumatic injury who experience rapid fluid volume loss and receive large fluid volume resuscitation. It can also occur as the result of drowning in cold water or homelessness during the winter months. Hypothermic patients are likely to experience PEA or asystole and should be treated using warmed IVF, re-warming through cardiac bypass, and/or lavage of major body cavities (thorax, abdomen/peritoneum, bladder) with warmed fluid. Note: Defibrillation does not work when the body's core temperature is less than 30 degrees Celsius (86 degrees Fahrenheit), at this temperature; CPR is the only resuscitation technique that should be used until the patient's core temperature rises. Remember!: "The patient is not dead until they are warm and dead"

IMMEDIATE REVIEW:

-Hypothermia:

- Description: Core temperature < 35 degrees Celsius
- Likely causes: traumatic injury with large amount of blood loss, rapid IVF resuscitation, drowning, homelessness
- Rhythm: PEA, asystole
- Treatment: warmed IVF, lavage with warm fluid, cardiac bypass

### -Hyperglycemia/Hypoglycemia

Hyperglycemia is an increased blood glucose level greater than 120 mg/dL with a significant rise in blood sugar, > 250 mg/dL being needed to cause diabetic ketoacidosis (DKA) to where the patient's pH falls below 7.30. Hypoglycemia is a decrease in blood glucose level to less than 60 mg/dL which will not cause DKA but will cause a decrease in the patient's level of consciousness. Likely causes for hyperglycemia include DKA, HHNK (hyperglycemia hyperosmolar non-ketotic), poor diet, and an ineffective medication regimen. Patients in DKA are often noncompliant with medication and/or diet. Likely causes of hypoglycemia may include skipping meals while continuing medication or too much insulin. The treatment for hyperglycemia includes intravenous fluid (normal saline) and insulin administration. Patient's in DKA often require an insulin drip with D5 Water to slowly correct acidosis. Treatment for hypoglycemia includes PO intake of foods high in glucose (orange juice, sugar, etc.) if the patient can take PO or IV administration of D50. While both hyperglycemia and hypoglycemia are very dangerous for the patient, hypoglycemia is the more acute of the two because after LOC it can progress to seizure and possible brain damage because glucose is the only substance that can provide energy to sustain brain activity.

#### IMMEDIATE REVIEW:

##### -Hyper/hypo-glycemia:

-Description: Blood sugar <60 or >120 mg/dL

-Likely causes:

hyperglycemia: poor diet, poor medication regimen

hypoglycemia: skipping meals, too much insulin

-Treatment:

hyperglycemia: NS, insulin

hypoglycemia: PO intake, IV D50

#### **Ts:**

### -Tablets/Toxins

"Tablets/toxins" is the term used to describe a patient who has possibly overdosed, had a medication reaction, or is a substance abuser. In this case it is important to note the patient's medical history for repeated suicide attempts through overdose or substance abuse. Also note the environment in which the patient was found for items around the patient. In the case where toxins/tablets are the expected source of the patient's cardiac arrest ensure that a urine and serum toxicology studies are sent immediately. Medications likely to cause cardiac arrest in over use are: tricyclic antidepressants, beta blockers, Ca channel blockers, Digoxin, Aspirin, and Tylenol. Street drugs likely to cause cardiac arrest when used include: alcohol, cocaine, and heroin. Patients who overdose are likely to have PEA arrest, asystolic arrest, pulseless VTach, or ventricular fibrillation depending on the amount and substance used. Treatment for overdose includes use of the antidote, IV fluid administration, vasopressors, and cardiac bypass if necessary.

IMMEDIATE REVIEW:-Tablets/Toxins

- Description: overdose, medication reaction, substance abuse
- Likely causes: medication, street drugs
- Rhythm: PEA, asystole, PVT, VF
- Treatment: administer antidote, IVF, vasopressors, cardiac bypass

-Tamponade (Cardiac)

Cardiac tamponade is the build up of fluid, pus, blood, clots, or gas in the pericardium to the point where the heart can not function mechanically (beat). The build up of substances in the pericardium can often be attributed to: pericardial effusion, traumatic injury, or rupture. When substances build up within the pericardium the pressure builds and creates too tight of a space for the heart to move, causing cardiac compression. Rapid or slow compression of all chambers of the heart will eventually lead to decreased venous return. Patients who experience cardiac tamponade are likely to display: narrowing pulse pressures, muffled heart sounds (possible pericardial rub), EKG changes, tachycardia, dyspnea on exertion, air hunger, jugular venous distention, hypotension, and extremities that are cool to touch. The treatment for cardiac tamponade is a pericardiocentesis in which a needle is inserted into the pericardium to drain the fluid/air causing the obstruction. In a patient whose pericardium filled slowly, it is possible to drain as much as two liters of fluid. In more extreme cases it may be necessary to perform a thoracotomy, in which the pericardium is cut to release the fluid. If possible, try to avoid using mechanical ventilation on patients with cardiac tamponade, as it may cause a greater decrease in cardiac output.

IMMEDIATE REVIEW:-Tamponade (Cardiac):

- Description: A build up of fluid or air in the pericardium
- Likely Causes: pleural effusion, trauma, vessel rupture
- Rhythm: PEA
- Treatment: pericardiocentesis, thoracotomy

-Tension Pneumothorax

Tension pneumothorax occurs when injured tissue creates a one-way valve allowing air into the pleural cavity but not out. When this occurs it creates a build up of air (or blood in the cause of a hemothorax) in the pleural cavity causing lung collapse on the affected side. As the pneumothorax progresses pressure can build up and cause a mediastinal shift towards the unaffected side, leading to a “kink” in the greater vessels (especially the vena cava) causing a significant decrease in blood return to the heart. Likely causes of a tension pneumothorax include: traumatic injury (blunt or penetrating), barotrauma from mechanical ventilation (as with increased PEEP), central line placement (in the subclavian or internal jugular vein), and/or CPR. Patients with a tension pneumothorax are likely to display signs and symptoms of: air hunger, hypoxia, JVD,

tracheal shift away from the midline, anxiety, tachypnea, tachycardia, and decrease breath sounds on the affected side. Treatment for tension pneumothorax includes placing the patient on 100% O<sub>2</sub> (consider delivering 15L O<sub>2</sub> per non-rebreather) and a needle thorocotomy if needed. A needle thorocotomy involves placing a needle into the 2<sup>nd</sup> intercostal space, midclavicular line, to release the pressure. After the needle thorocotomy is performed a thorocostomy tube should be placed.

IMMEDIATE REVIEW:

-Tension pneumothorax:

- Description: Build up of air in the pleural cavity
- Likely Causes: traumatic injury, barotrauma, central line placement, CPR
- Rhythm: PEA
- Treatment: 100% oxygen delivery to patient, needle thorocotomy

-Thrombosis (MI)

In the case of myocardial infarction (MI), the demand that the cardiac muscle has for O<sub>2</sub> exceeds its supply related to blockage of a coronary artery. After a period of time, sustained ischemia leads to irreversible cellular death/tissue necrosis. The area of necrosis (or infarct) is determined by which coronary artery/arteries is/are blocked. The signs and symptoms of MI include, but are not limited to: chest pain (severe, immobilizing, epigastric, or sternal) unrelieved by rest/Nitroglycerin/or change in position, weakness, shortness of breath, nausea/vomiting, dizziness, change in mental status, diaphoresis, increase in blood pressure, and/or tachycardia. The signs and symptoms of MI can be very vague and differ from person to person, and the chest pain can be described in many ways including: heavy, tight, pressure, burning, or constricting. Patients who are likely to experience an MI usually have multiple risk factors for cardiac disease such as: hypertension, diabetes, high cholesterol, significant family history of MI, previous history of MI, and known coronary artery disease. Patients in cardiac arrest from MI are likely to be in VFib or pulseless VTach. Treatments for acute MI are administration of thrombolytics and PCI in the cardiac catheterization laboratory. PCI involves insertion of a balloon into the blocked coronary artery. Once inserted, the balloon is inflated to clear the blockage and a stent is placed to prevent further blockages.

IMMEDIATE REVIEW:

-Thrombosis (MI):

- Description: Blockage of one or more coronary arteries causing sustained ischemia to one or more areas of cardiac muscle
- Likely Causes: history of cardiac risk factors or known cardiac disease
- Rhythm: VF/VT (pulseless)
- Treatment: thrombolytics, PCI

### -Thromboembolism (PE)

Pulmonary embolism occurs when the pulmonary artery is blocked by thrombosis, likely from DVT. A DVT in a lower extremity can “break off” and travel through the blood stream, eventually becoming lodged in the pulmonary artery (PE) or the brain (ischemic stroke). Lethal PEs are usually caused by dislodged thromboses from the femoral or iliac veins. Clinical presentation depends on the size of the occlusion but includes: anxiety, sudden dyspnea, crackles, fever, change in mental status, tachycardia, cough, pleuritic chest pain, and hemoptysis. Other than DVT, causes of PE can include history of atrial fibrillation (in which case the thrombosis originates in the right side of the heart), long bone fracture (fat embolus), and improper IV therapy (air embolus). Patient’s with PE are often found in PEA or asystolic arrest. Treatment for PE includes multiple medication administration of Dopamine, Heparin, and thrombolytics.

#### IMMEDIATE REVIEW:

##### -Thromboembolism (PE):

- Description: Pulmonary artery is blocked by thrombosis
- Likely Causes: DVT, history of AFib, long bone fracture, IV therapy
- Rhythm: PEA, asystole
- Treatment: Dopamine, Heparin, and thrombolytics

### -Trauma

Traumatic injury is likely to cause cardiac arrest as the result of a sudden drop in circulating volume or if the damage caused by the injury is primarily to the heart or greater vessels. Likely causes of traumatic injury include: motor vehicle crash, gunshot wounds (especially in a patient with multiple gunshot wounds to the chest or abdomen), stabbing, and/or blunt trauma. The best treatment for patients with traumatic injury is stabilization in the emergency department for immediate surgical intervention.

#### IMMEDIATE REVIEW:

##### -Trauma:

- Description: Traumatic injury to the body
- Likely Causes: MVC, GSW, stabbing, blunt injury
- Treatment: surgical intervention

**RESOURCES**

Dirksen, S., Heitkemper, M. & Lewis, S. (2004) *Medical-Surgical Nursing 6<sup>th</sup> Edition*.  
St. Louis, MO: Mosby, Inc.

Cardiac Arrest. (n.d.) Retrieved on December 1, 2007, from Wikipedia, The Free  
Encycolpedia at [http://en.wikipedia.org/wiki/Cardiac\\_arrest](http://en.wikipedia.org/wiki/Cardiac_arrest)