

# Shock, Fluid & Buffer Therapy

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## Learning Objectives

- ◆ Describe the etiologies, manifestations and management of shock.
- ◆ Identify specific agents used to maintain blood pressure, fluid balance and pH, along with their actions, effects and complications.

# Categories & Complications

## Shock

- △ Definition- inadequate perfusion of tissues to meet metabolic requirements.
  - ◆ anaerobic metabolism- lactate
  - ◆ release of intracellular substances to system
  - ◆ accumulation of metabolic wastes

## Categories

- Hypovolemic
- Distributive
- Cardiogenic

## Hypovolemic shock

- Blood volume loss
  - ◆ Hemorrhage
  - ◆ Burns
  - ◆ Dehydration
    - f* heat exhaustion
    - f* diarrhea, vomiting
    - f* inadequate intake

**Distributive shock**

^ blood pressure loss due to fluid distribution outside intravascular space or vasodilation.

◆ third spacing- water in interstitial space

*f* infusion with crystalloids

*f* plasma protein deficit

Link to article on shock

<http://www.emedicine.com/med/topic2114.htm>

**Distributive shock**

◆ third spacing

◆ vasoactive drugs or toxins ==> systemic vasodilation

◆ anaphylaxis- allergic response

◆ neurogenic vasodilation- loss of sympathetic tone

◆ sepsis

**Cardiogenic shock**

➤ Ineffective cardiac pump

◆ myocardial infarction- loss of contractile tissue

◆ cardiomyopathy- ventricular dilation, loss of contractility

◆ mechanical abnormalities

*f* valvular disease

*f* septal defects- high output failure

*f* obstructive defects

**Complications**

➤ Acute respiratory distress syndrome (ARDS)

➤ Multiple organ system failure

◆ cardiac

◆ hepatic

◆ renal

◆ gastrointestinal

**Complications**

^ Hypoxic-ischemic encephalopathy (HIE)

◆ increased intracranial pressure (ICP)

◆ when ICP equals mean arterial pressure, cerebral perfusion pressure equals zero.

Link to information on HIE

<http://www.emedicine.com/ped/topic149.htm>

**Manifestations**

**General Manifestations**

- Hypotension- Psys < 90 mm Hg
- Tachycardia
- Slow capillary refill
- CNS signs- vertigo, syncope, coma
- Pallor
- Oliguria, anuria
- Decreased transcutaneous PO<sub>2</sub>

Link to article on transcutaneous PO<sub>2</sub> and shock  
<http://pediatrics.aappublications.org/cgi/content/abstract/65/5/88>

**Specific Manifestations**

- Hemorrhagic
  - ◆ low Hb, Hct
  - ◆ decreased CVP
- Dehydration
  - ◆ elevated Hb, Hct
  - ◆ decreased CVP

**Specific Manifestations**

- Anaphylactic
  - ◆ history of bite, ingestion
  - ◆ pruritus (itching)
  - ◆ urticaria (hives)
  - ◆ laryngospasm
  - ◆ bronchospasm

Link to information on anaphylaxis  
<http://www.nlm.nih.gov/medlineplus/ency/article/000844.htm>

**Specific Manifestations**

- ◆ urticaria (hives)

Link to picture of hives

<http://intermountainhealthcare.org/images/general/careseries/hives.jpg>

Link to another picture of hives

<http://www.homestead-farm.net/photos/2005-June4/14-bee%20hives.jpg>

**Specific Manifestations**

- Septic
  - ◆ signs of infection- fever, etc.
  - ◆ increased cardiac output (QT)
  - ◆ decreased C(a-v)DO<sub>2</sub>

**Shock- Specific Manifestations**

- Cardiogenic
  - ◆ signs of MI
  - ◆ pulmonary edema
  - ◆ elevated PCWP (>25 mm Hg)

Link to article on cardiogenic shock  
<http://www.emedicine.com/med/topic285.htm>

## Management of Shock

### Hypovolemic shock

- Vasopressors contraindicated for hypovolemia because of physiologic vasoconstriction
- Replacement of the specific fluids lost to circulation is necessary

### Hypovolemic shock

- Blood products- hemorrhage
  - ◆ whole blood
  - ◆ plasma
  - ◆ packed red blood cells

### Hypovolemic shock

- Colloids- remain in intravascular space
  - ◆ temporary for hemorrhage
  - ◆ manage third spacing by drawing fluid from interstitium

Link to article on colloids vs. crystalloids in shock  
<http://ccforum.com/content/4/S2/S16>

### Hypovolemic Shock

- Colloids- remain in intravascular space
  - ◆ common fluids
    - f* human albumin- research questions its use
    - f* dextran large carbohydrate molecule
    - f* hetastarch (Hespan)

Link to information on hetastarch  
<http://www.ashp.org/mngrphs/AHFS/a382068.htm>

### Hypovolemic- Fluid Replacement

- Crystalloids- much loss to interstitial (third) space
  - ◆ Primary for dehydration, burns
  - ◆ Common fluids
    - f* NaCl- 0.9%, 0.45%
    - f* dextrose- in water or saline
    - f* Ringer's solution
    - f* Ringer's lactate- solution of choice for resuscitation

**Hypovolemic shock**

- Crystalloid solutions
  - ◆ Ringer's solution
    - f NaCl
    - f MgCl<sub>2</sub>
    - f Na<sub>2</sub>HPO<sub>4</sub>
    - f NaHCO<sub>3</sub>

**Hypovolemic shock**

- Dehydration, burns
  - ◆ Ringer's lactate
    - f NaCl
    - f Na lactate
    - f KCl
    - f CaCl

**Hypovolemic shock**

- Monitoring fluid volume
  - ◆ mucosa- wet or dry
  - ◆ skin turgor (except for elderly patients)
  - ◆ capillary refill

**Hypovolemic shock**

- Monitoring fluid volume
  - ◆ blood pressure
  - ◆ CVP
  - ◆ PAOP (PCWP)
  - ◆ urine output
  - ◆ weight

**Complications of Fluids**

- Blood products
  - ◆ Immune reactions; e.g. anaphylaxis
  - ◆ Non-immune reactions; e.g., fluid overload
  - ◆ Infections; e.g., HIV

Link to article on transfusion risks  
<http://www.webmd.com/a-to-z-guides/blood-transfusion-risks-of-blood-transfusion>

**Complications of Fluids**

- Blood products
  - ◆ Immune reactions; e.g. anaphylaxis
  - ◆ Non-immune reactions; e.g., fluid overload
  - ◆ Infections; e.g., HIV
  - ◆ Leftward shift in HbO<sub>2</sub> curve- stored blood
  - ◆ transfusion related acute lung injury (TRALI)

Link to article on TRALI  
[http://www.scbcinfor.org/publications/bulletin\\_v3\\_n1.htm](http://www.scbcinfor.org/publications/bulletin_v3_n1.htm)

**Complications of Fluids**

- **Crystalloids**
  - ◆ reduced colloid osmotic pressure (COP) ==> 3rd spacing
  - ◆ electrolyte, pH imbalance
- **Dextrose (glucose)**
  - ◆ hypercapnia, acidemia
  - ◆ hyperglycemia

**Anaphylactic shock**

- ▲ **Epinephrine**
  - ◆ vasoconstriction
  - f* increase blood pressure
  - f* reverse mucosal edema
  - ◆ bronchodilation

**Anaphylactic shock**

- ▲ **Epinephrine**
- ▲ **Diphenhydramine (Benadryl)**-inhibit action of histamine
- ▲ **Steroids, e.g., hydrocortisone**-helps body cope with stress
- ▲ **Beta-agonist; e.g., albuterol**-bronchospasm

**Distributive shock**

- ▲ **Crystalloids**
- ▲ **Vasopressors**
  - ◆ epinephrine
  - ◆ norepinephrine
  - ◆ dopamine
  - ◆ vasopressin
  - ◆ neosynephrine

**Distributive shock**

- ▲ **septic (distributive) shock**
  - ◆ antibiotics
  - ◆ vasopressin (Pitressin)

Link to article on vasopressin in septic shock  
<http://www.chestjournal.org/cgi/content/full/120/3/989>

**Distributive shock**

- ▲ **septic (distributive) shock**
  - ◆ vasopressin (Pitressin)
  - ◆ antibiotics
  - ◆ drotrecogin alfa (Xigris)
    - f* reduces inflammation in sepsis
    - f* antithrombotic- may cause bleeding
    - f* costly
    - f* controversial- need more research

Link to article on drotrecogin alfa in septic shock  
<http://ccforum.com/content/5/S2/S7>

**Distributive shock**

- cause by toxins, drugs
  - ◆ vasopressors
  - ◆ removal of toxin, drug
    - f* diuresis
    - f* dialysis
    - f* antidotes
    - f* antitoxins

**Cardiogenic shock**

- ◆ vasopressors
- ◆ nitrates
- ◆ surgery, angioplasty
- ◆ intra-aortic counterpulsation
- ◆ inotropic agents
  - f* dobutamine
  - f* dopamine
  - f* milrinone (Primacor)

**Complications of vasopressors**

- peripheral tissue necrosis
- renal failure
- hypertension
- increased myocardial work

**Buffer Therapy****Buffer Therapy**

- Purpose- to reverse acid-base imbalance, usually acidemia
- NaHCO<sub>3</sub>- action- provides HCO<sub>3</sub><sup>-</sup>
  - ==> [H<sup>+</sup>] + [HCO<sub>3</sub><sup>-</sup>] ==> H<sub>2</sub>O + CO<sub>2</sub>
  - ==>
- depends on ventilation to excrete CO<sub>2</sub>

**Buffer Therapy**

- NaHCO<sub>3</sub>- complications
  - ◆ Respiratory acidemia if CO<sub>2</sub> not excreted
  - ◆ Metabolic alkalemia (overdose)
  - ◆ Hyponatremia
  - ◆ Cerebral edema

**Buffer Therapy**

- NaHCO<sub>3</sub>- contraindications-
  - ◆ pH >7.20
  - ◆ severe hypernatremia, often associated with renal failure

**Buffer Therapy**

- NaHCO<sub>3</sub>- administration titrated with blood pH

$$\text{HCO}_3 \text{ (mEq)} = \text{kg} * (15 - \text{observed HCO}_3\text{-}) * 0.5$$

**Buffer**

- Tris-hydroxymethyl aminomethane- THAM (Tromethamine)- reverses acidemia without excretion of CO<sub>2</sub>
  - ◆ Action- organic proton acceptor

**Buffer**

- THAM
  - ◆ Indications
    - f* metabolic acidemia with hypernatremia
    - f* acidemia in conjunction with limitations in ventilation- permissive hypercapnia

Link to article on THAM and permissive hypercapnea  
<http://ajrccm.atsjournals.org/cgi/reprint/162/4/1361.pdf>

**Buffer**

- THAM
  - ◆ Complications
    - f* apnea
    - f* hypoglycemia
    - f* hypokalemia
    - f* alkalosis
    - f* tissue necrosis from infiltration

**Buffer**

- THAM
  - ◆ Dosage- ml's of THAM of 0.3M solution = body wt in kg X base deficit in MEq/l

**Buffer**

- Tribonat
  - ◆ Currently used in Europe
  - ◆ Ingredients
    - f* NaHCO<sub>3</sub>
    - f* THAM
    - f* acetate
    - f* PO<sub>4</sub>

**Buffer**

- Tribonat- advantages
  - ◆ minimal effect on PCO<sub>2</sub>
  - ◆ minimal overcorrection risk
  - ◆ less Na than NaHCO<sub>3</sub>
  - ◆ no tissue irritability

**References**

- Alderson P, et al. Human albumin solution for resuscitation and volume expansion in critically ill patients. Cochrane Database of Systematic Reviews 2001. Update Software.
- Bjerneroth G. Tribonat--a comprehensive summary of its properties. Critical Care Medicine. 27(5):1009-13, 1999.
- Kallet RH, et al. The treatment of acidosis in acute lung injury with Tris-hydroxymethyl aminomethane (THAM). Am J Respir Crit Care Med 2000;161:1149-1153.
- Nau R. Desel H. Lassek C. Kolenda H. Prange H. Entry of tromethamine into the cerebrospinal fluid of humans after cerebrovascular events. Clinical Pharmacology & Therapeutics. 66(1):25-32, 1999.