

**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 and fluid balance, along with their actions, effects and complications.

Shock

Shock- inadequate tissue perfusion to meet metabolic needs of tissues.

Shock- etiologic categories

- Hypovolemic
- Distributive
- Cardiogenic

Shock- etiologic categories

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

Shock- etiologic categories

- Distributive shock- blood pressure loss due to fluid distribution outside intravascular space or vasodilation.
 - ◆ third spacing
 - ◆ vasoactive drugs, toxins ==> systemic vasodilation

Link to article on shock

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

Shock- etiologic categories

- Distributive shock
 - ◆ third spacing
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 - ◆ anaphylaxis

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 - ◆ anaphylaxis
 - ◆ neurogenic vasodilation
 - ◆ sepsis

Shock- etiologic categories

- Cardiogenic- ineffective cardiac pump
 - ◆ myocardial infarction
 - ◆ cardiomyopathy
 - ◆ mechanical anomalies
 - f* valvular disease
 - f* septal defects- high output failure
 - f* obstructive defects

Shock- General Manifestations

- Hypotension- $P_{sys} < 90$ mm Hg
- Tachycardia
- Slow capillary refill
- CNS signs- vertigo, syncope, coma
- Pallor
- Oliguria, anuria
- Decreased transcutaneous PO₂- very early sign

Shock- Specific Manifestations

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

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 - ◆ elevated Hb, Hct
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- Third spacing
 - ◆ anasarca
 - ◆ pulmonary edema

Shock- Specific Manifestations

- Anaphylactic
 - ◆ pruritus (itching)
 - ◆ urticaria (hives)
 - ◆ laryngospasm
 - ◆ bronchospasm
 - ◆ history of medication, insect bite, etc.

Shock- Specific Manifestations

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

Shock- Specific Manifestations

- Septic
 - ◆ signs of infection- fever, etc.
 - ◆ increased cardiac output (QT)
 - ◆ decreased C(a-v)DO₂

Shock- Complications

- Acute respiratory distress syndrome (ARDS)
- Multiple organ system failure
 - ◆ cardiac
 - ◆ hepatic
 - ◆ renal
 - ◆ gastrointestinal

Shock- Complications

- Acute respiratory distress syndrome (ARDS)
- Multiple organ system failure
- Hypoxic-ischemic encephalopathy (HIE) ==> increased intracranial pressure (ICP)

Link to information on HIE
<http://www.emedicine.com/ped/topic149.htm>

Management of Shock

Hypovolemic- Fluid Replacement

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

Hypovolemic- Fluid Replacement

- 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- Fluid Replacement

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

Hypovolemic- Fluid Replacement

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

Hypovolemic- Fluid Replacement

- Crystalloids- some loss to interstitial (third) space
 - ◆ Used 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- Fluid Replacement

- Crystalloid solutions
 - ◆ Ringer's solution
 - f* NaCl
 - f* MgCl₂
 - f* Na₂HPO₄
 - f* NaHCO₃

Hypovolemic- Fluid Replacement

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

Hypovolemic- Fluid Replacement

- Monitoring fluid volume
 - ◆ mucosa- wet or dry
 - ◆ capillary refill
 - ◆ blood pressure
 - ◆ CVP
 - ◆ PCWP
 - ◆ urine output
 - ◆ weight

Complications of Fluids

- Blood products
 - ◆ Serum sickness
 - ◆ Leftward shift in HbO₂ curve- stored blood
 - ◆ Acquired infections- HIV

Complications of Fluids

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

Shock- Management

- Anaphylactic
 - ◆ Epinephrine
 - f* vasoconstriction
 - f* bronchodilation
 - ◆ Diphenhydramine (Benadryl)
 - ◆ Steroids, e.g., hydrocortisone

Shock- Management

- distributive shock- septic, neurogenic
 - ◆ vasopressors
 - f* dopamine
 - f* norepinephrine
 - f* neosynephrine
 - ◆ antibiotics for infection

Shock- Management

- distributive shock- toxins, drugs
 - ◆ vasopressors
 - ◆ removal of toxin, drug
 - f* diuresis
 - f* dialysis
 - f* antidote, antitoxin

Shock- Management

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

Complications of Vasopressors

- necrosis of peripheral tissues
- renal failure
- hypertension
- increased myocardial workload

Buffer Therapy

Buffer Therapy

- Purpose- to reverse acid-base imbalance, usually acidemia

Buffer Therapy

- NaHCO₃
 - action- provides HCO₃⁻ ==>
$$[H^+] + [HCO_3^-] ==> H_2O + CO_2 ==>$$

depends on ventilation to excrete CO₂

Buffer Therapy

- NaHCO₃- complications
 - ◆ Respiratory acidemia if CO₂ not excreted
 - ◆ Metabolic alkalemia (overdose)
 - ◆ Hyponatremia
 - ◆ Cerebral edema

Buffer Therapy

- NaHCO₃- contraindications-
 - ◆ pH >7.20
 - ◆ severe hyponatremia, often associated with renal failure

Buffer Therapy

- NaHCO₃- administration titrated with blood pH

$$HCO_3 \text{ (mEq)} = \text{kg} * (15 - \text{observed } HCO_3^-) * 0.5$$

Buffer

- Tris-hydroxymethyl aminomethane-THAM (Tromethamine)- reverses acidemia without excretion of CO₂
 - ◆ Action- organic proton acceptor

Buffer

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

Buffer

- THAM
 - ◆ Complications
 - f* apnea
 - f* hypoglycemia
 - f* hypokalemia
 - f* alkalosis
 - f* tissue necrosis from infiltration.
 - f* do not use in renal failure

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* NaHCO₃
 - f* THAM
 - f* acetate
 - f* PO₄

Buffer

- Tribonat- advantages
 - ◆ minimal effect on PCO₂
 - ◆ minimal overcorrection risk
 - ◆ less Na than NaHCO₃
 - ◆ no tissue irritability

Summary & Review

- ^ Shock categories
 - ◆ hypovolemic
 - ◆ distributive
 - ◆ cardiogenic
- ^ Shock- manifestations
 - ◆ general
 - ◆ category- specific

Summary & Review

- ^ Shock management
 - ◆ fluid replacement
 - ◆ vasopressors
 - ◆ cardiotonics
- ^ Buffers
 - ◆ NaHCO₃
 - ◆ THAM
 - ◆ Tribonat

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.

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