Shock in the Pediatric Patient

Initial Assessment
&
Interventions

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Objectives

- Compare and contrast the 4 main types of shock in the pediatric patient
- Given a case scenario, identify the type of shock based the ABC assessment, and discuss the initial treatment priorities



Response to "Pediatric unknown" Call

Kids are Special

- One size does NOT fit all!
  - Variable weight and height
  - Smaller body mass
    - Organs closer together- high risk for multi-organ injury
    - Kinetic energy has more profound impact
  - Bone are more flexible
    - Significant injuries easier to miss
  - Don't understand cause & effect
    - Harm or risk

~~Children are just small adults~~

Know the main differences in anatomy and how they would affect responses to illness

Do not go by memory-carry a reference for:

Weight estimation
Vital signs
Equipment sizes
Medications
&
Review review review…



Definition of Shock

- Critical mismatch of the delicate balance between cellular needs (demand) and perfusion (delivery)



Pediatric Definition of Shock

Tachycardia +Poor Perfusion

=

SHOCK



Note that Pediatric patients can be in severe shock and still have normal blood pressure!

DO2

- Its all about delivery of oxygen/ nutrients to the cell
- Oxygen delivery is the amount of oxygen transported from the pulmonary system to the microcirculation
- In healthy individuals:
  - Oxygen consumption = Oxygen delivery

SHOCK

- When the metabolic demand is greater than the metabolic delivery, shock occurs
- If delivery is less than need, than shock occurs
- The definition of shock does NOT depend on blood pressure

Simply Put……

Tachycardia + Poor Perfusion =

SHOCK

All etiologies of shock cause imbalance of metabolic demand vs. metabolic need

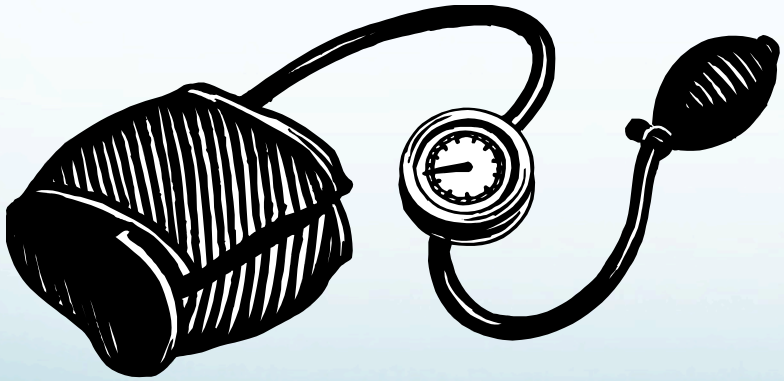
Cardiovascular VS

- **HR**
  - Know norms for pediatric patients
  - Know extremes
    - 180, 220
    - < 60
- **B/P**
  - Choose proper equipment
  - Recognize children can be in shock, with a WNL B/P

Blood Pressure

	Lowest acceptable Systolic pressure
0 – 28 days	60
1 month – 1 year	70
1 year+	70 + (2 x age in years)

Pediatric patients can be in severe shock and still have normal blood pressure!

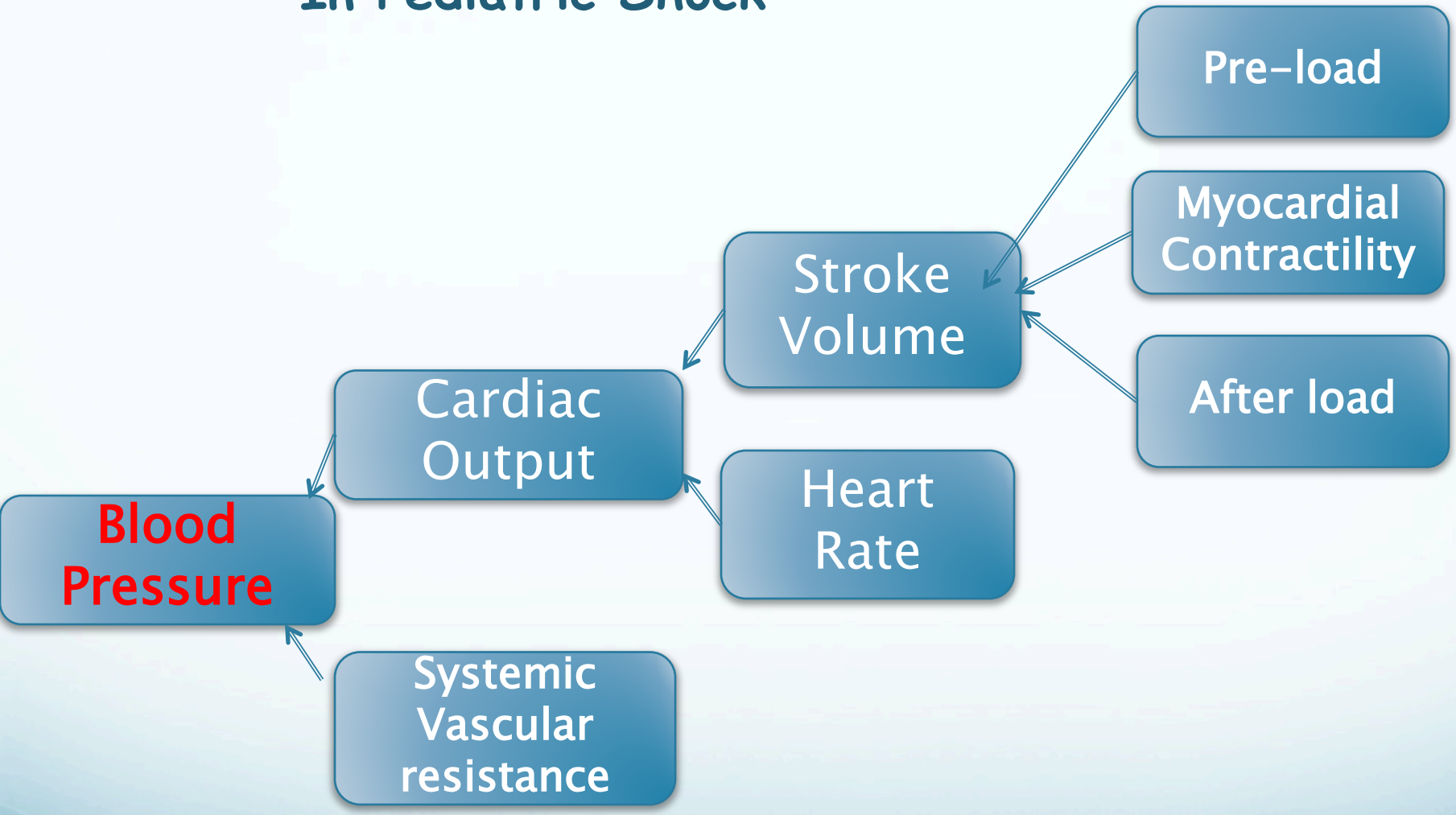


Classification of Shock

- Severity
  - **Compensated**= Not hypotensive
    - Minimally acceptable SBP:
      - 1 year and older: 70 + 2(Age) up until 90 sys BP
  - **Hypotensive**
- Etiology
  - Hypovolemic
  - Distributive
  - Cardiogenic
  - Obstructive



Hemodynamic Compensation Factors In Pediatric Shock



General Goals of Shock Management: Improve DO2

1. Optimize O_2 content & delivery
2. Improve volume and distribution of cardiac output
3. Reduce O2 demand
4. Correct metabolic derangements
   - ❑ Hypoglycemia
   - ❑ Hypocalcemia
   - ❑ Hyperkalemia
   - ❑ Metabolic acidosis
5. **PREVENT CARDIAC ARREST**

I. Hypovolemic Shock- Intravascular Volume Loss

- **Hemorrhagic**
  - Trauma
  - Surgery
  - GI bleed
- **Non Hemorrhagic**
  - Intravascular
    - GI
  - Interstitial
    - Burn
    - Sepsis
    - Ascites
    - Nephrotic syndrome

Hypovolemic
Non Hemorrhagic or Hemorrhagic.

- S/S related to ▼ **in preload = ▼ in DO2**
  - Often tachypneic, tachycardic, compensatory increased contractility, poor perfusion/ delayed cap refill, cool skin, decreased pulses, altered mental status

Hypovolemic

1. **Optimize O2 content in the blood**
   - High concentration of FIO2
   - Consider mechanical ventilation if needed to correct V Q mismatch
   - Consider ***PRBC's*** IF **H/H ↓**

2. **Improve volume & distribution of CO**
   - **Give volume**
     - 20cc/ kg crystalloid
     - 10cc/kg PRBC' s on going hemorrhage, or poor response to 2-3 crystalloid boluses
   - Look for ongoing volume loss

Treatment Goals Cont

3. **Reduce O2 demand**
   - Treat fever
   - Ventilatory support if needed

4. **Correct metabolic derangements**
   - Hypoglycemia
   - Hypocalcaemia
   - Hyperkalemia
   - Metabolic acidosis= give **volume**







8-lb Newborn = 3.64-kg
Total circulating volume = 364-cc
100cc/KG
Soda can= 335 cc/ml

60-lb Child = 27-kg
TV = 2.2-L
2-L Soda bottle

125-lb Adult = 56kg
TV = 4.5 L
two 2-L Soda bottles

II: Distributive Shock

- Types of Distributive Shock
  - Septic
  - Anaphylactic
  - Neurogenic

Distributive Shock- Treatment Goals

1. **Optimize O2 content in the blood**

   High concentration of FIO2

   - Consider mechanical ventilation if needed to correct V Q mismatch
   - Consider PRBC's in H/ H ↓

2. **Improve volume & distribution of CO:** ***restore hemodynamic instability***

   - Give volume
   - Overcome dilated vascular space-
     - Vasopressors
     - Vasopressors- Goal- SVO2 > 70%

Treatment Goals for Distributive Shock Cont.

3. **Reduce O2, metabolic demand**
   - Treat fever
4. **Correct metabolic derangements**
   - Hypoglycemia
   - Hypocalcemia
   - Hyperkalemia
   - Metabolic acidosis
     - Volume
     - Vasopressors
     - Ventilation
     - ?Alkalinization
5. **PREVENT CARDIAC ARREST**

Distributive- Septic Shock



Definitions

SIRS= Systemic inflammatory process

Sepsis + SIRS in the presence of infection

Septic Shock = Sepsis & cardiovascular dysfunction

Systemic Inflammatory Response Syndrome "SIRS"

The presence of fever &/ or abnormal WBC and at least one of the following:

- Tachycardia
- Tachypnea
- Sepsis is SIRS + infection

Sepsis = SIRS + Infection

Mechanism

- Infectious organisms and their by-products/endotoxins trigger immune and inflammatory cascades (vasodilation)
- Vaso/ venodilation caused by cytokine release damages vessel lining > increased cell permeability (capillary leak)
- DIC (which is why some septic pts need blood transfusions)

↓ in preload + ↑ vasodilatation + capillary leak = ↓ in DO2

Treatment: Distributive- Septic Shock

1. Optimize O2 content in the blood

- High concentration of FIO2
  - Consider mechanical ventilation if needed to correct V Q mismatch
  - Consider PRBC's in H/ H ↓

2. Improve volume & distribution of CO: ***restore hemodynamic instability***

- Give volume
- Overcome dilated vascular space-
  - Vasopressors

Vasopressors- Goal- SVO2 > 70%

Normotensive: Dopamine
Warm/ vasodilated ↓ BP- Norepi
Cold/vasoconstricted hypotensive- epinephrine

Septic Shock- Treatment goals cont

3. **Reduce O2 demand**
   - Treat fever
   - Identify and control infection
4. **Correct metabolic derangements**
   - Hypoglycemia-
   - Hypocalcemia
   - Hyperkalemia
   - Metabolic acidosis

PREVENT CARDIAC ARREST

- Continuous monitoring and frequent reassessments as sepsis can be a combination of distributive, hypovolemic, cardiogenic and obstructive (DIC) shock, all of which can lead to cardiac arrest
- Etomidate for intubation??

Distributive Shock



Anaphylactic Shock



Distributive

Anaphylaxis

- Mechanism
  - Acute severe systemic reaction to antigen

- Clinical Assessment
  - Agitation, anxiety
  - Angioedema
  - Respiratory distress
    - stridor/ wheezing/ prolonged expiration
  - Tachycardia, hypotention
  - Uticaria
  - N/ V
  - Abdominal pain

Distributive

Anaphylaxis

1.Optimize O2 content & delivery

- ***Fio2***
- ***Bronchodilators***

- Improve volume and distribution of cardiac output
  - ***IM Epinephrine !***
  - Vasopressors
  - Volume

- Reduce O2 demand & 4. Correct Metabolic derangements

(reverse or block uncontrolled release of allergic response Mediators)

EPINEPHRINE

- Antihistamines
  - H1 blocker/ diphenhydramine
  - H2 blocker/ ranitidine, famotidine
- Corticoid steroids

Distributive

Neurogenic

- Sudden loss of sympathetic tone of smooth muscle; spinal shock, head injury
- S/S: **Bradycardia** + **hypotension**, hypothermia
- Wide pulse pressure, low diastolic B/P, diaphragmatic breathing

- Initial tx:
  - ABC's
  - Position pt **flat** or **head down**
  - Volume
  - Warm, or cool as needed
  - Vasopressors if needed

Neurogenic Shock

Hypotension - Decrease in Blood Pressure
Bradycardia - Slow heart rate
Warm, dry extremities
Peripheral vasodilation and venous pooling
Poikilothermia (Cold Body)
Decreased cardiac output (with cervical or high thoracic injury)

III: Cardiogenic Shock

Pump Failure




L



Cardiogenic Shock

↓ SV + ↓ CO = ↓ **DO2**

- CHD, Post ischemic event, acquired HD, sepsis, cardiac tamponade, drugs, rhythm disturbances (SVT)

- **Clinical Assessment**
  - AMS
  - ↑ RR, ↑ WOB, crackles/ rales,
  - ↑ HR, ? Gallop/ S3, narrow pulse pressure
  - Hepatomegaly, cardiomegaly

Treatment Goals: Cardiogenic Shock

1. **Optimize O2 content in the blood**
   - –High concentration of FIO2
   - –Consider mechanical ventilation if needed to correct V Q mismatch & decrease cardiac work load
   - –Consider PRBC's in ↓ H/H
2. **Improve volume & distribution of CO/ increase ventricular output and cardiac function**
   - –Consider ***cautious*** slow infusion of 5-10cc/KG observing for response
   - –Expert consultation for proper selection of vasodilator/ phosphdiesterase enzyme inhibitors to improve CO with minimal increase on myocardial O2 demand
   - –Consider ECLS if other methods ineffective

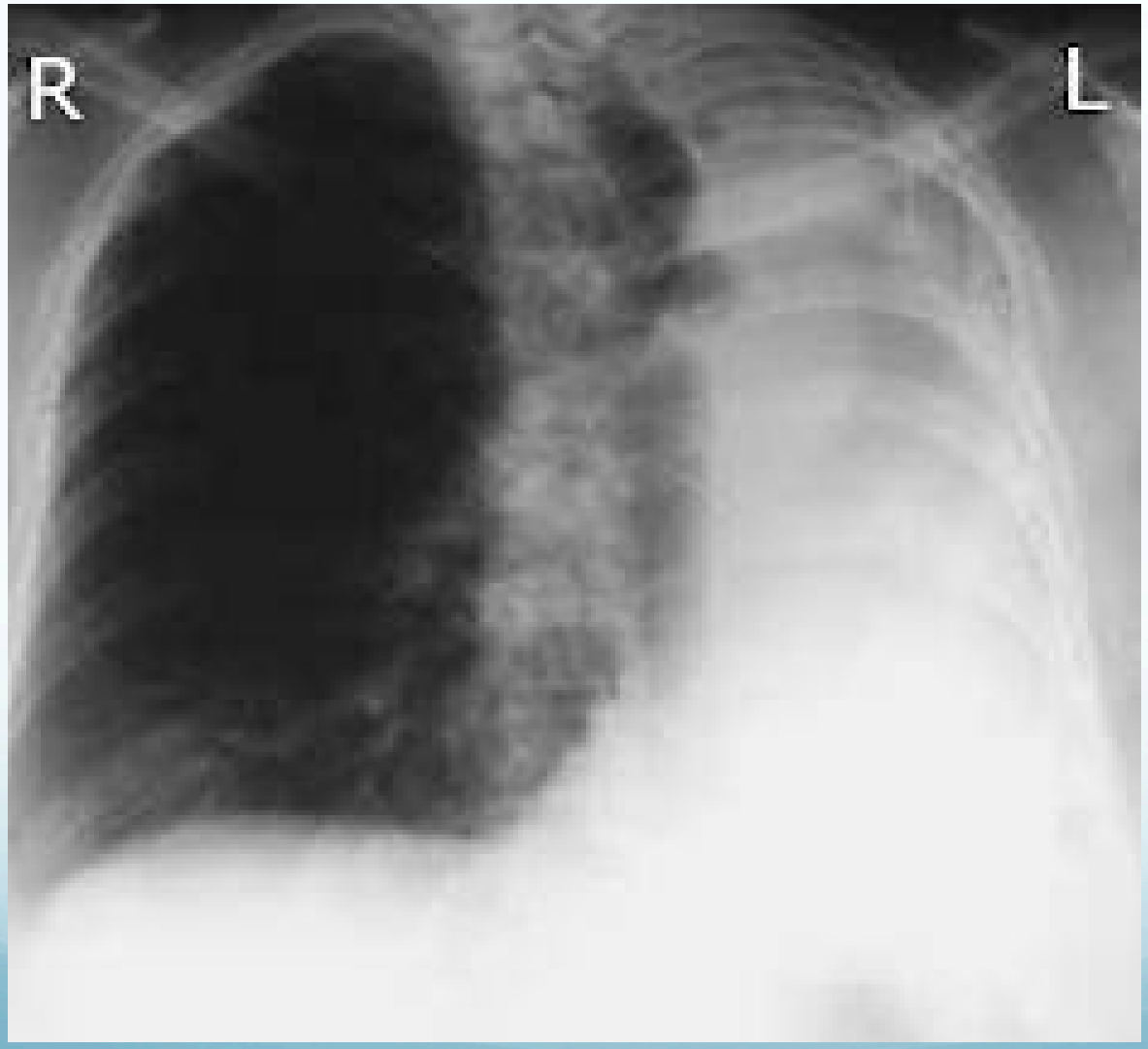
Treatment Goals

Cardiogenic Shock

1. **Optimize O2 content in the blood**
   - –High concentration of FIO2
   - –Consider mechanical ventilation if needed to correct V Q mismatch & decrease cardiac work load
   - –Consider PRBC's in ↓ H/H
2. **Improve volume & distribution of CO/ increase ventricular output and cardiac function**
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IV: Obstructive Shock

Physical Obstruction of Circulation



Obstructive Shock

- Ductal Dependent Lesions
- Tension Pneumothorax
- Cardiac Tamponade
- Pulmonary Embolism

Obstructive Shock

Treatment

- **CHD/ Ductal Dependent Lesions**:
  - ABC's, Expert Consult, PGE, (prepare for apnea)
- **Tension Pneumothorax**
  - Needle Decompress
  - Chest Tube
- **Cardiac Tamponade**
  - Pericardiocentesis
  - Fluid boluses simultaneously
- **Pulmonary Embolism**
  - Fluid bolus prn, ? Thrombolytics, consult

As if it were that easy …….

- Septic can also cause….
  - –Cardiogenic
  - –Hypovolemic
  - –Obstructive (DIC)
  - –Can be viral, fungal, parasitic
  - –Antibiotic resistant
- Miscellaneous
  - –MSOF

As an aside….

- AHA recommendations for SATS after ROSC
- Monitoring of SVO2
- Use of ED US for determining CO

General Volume Administration Guidelines

- **Hypovolemic/ Distributive** (non DKA)
  20cc/kg over *5-10 minutes*
- **Cardiogenic Shock**
  5-10 cc/ kg over *10-20 minutes*
- **Poisonings/ Cardio-Toxins**
  5-10cc/kg over *10-20 minutes*
- **DKA** with adequate BP
  10-20cc/kg over *1 hour*

Remember – Its all about supply and demand



In Summary

Recognize the patient in shock

- –Consider the etiology based on assessment and history
- – Begin treatment based on that etiology and the goal of restoration of DO2
- –Reassess frequently your interventions
  - –Are you on the right track?
  - –Are things changing?

You want to avoid this…..



Practice

Called to a home for infant with "difficulty breathing"
AOS to find 3mth infant in crib. No one speaks English. As you approach the infant, what 3 things are you assessing?

1. Airway- patent
2. Breathing- tachypnea
3. Circulation: Pale

What next?

Hands on A- B- C Assessment

A- ? Patent? Need Adjunct?

B-

- RR- 50
- WOB- slight nasal flaring
- BBS- clear

C- Hands on!

- CRT- > 4 secs
- Pulses> Central- weak, distal almost not palpable
- Skin temp> core- WNL, peripheral > cool from knee down
- HR> 180
- ? B/P

•General- foul smelling diarrhea noted.

•?Physiologic Status?

SHOCK!

- Severity:
  - Hypotensive
- Etiology:
  - Hypovolemic
- Treatment
  - ABC's and VOLUME!
- *Reassessment* after initial volume:
  - Lethargic
  - Spontaneous RR: 40, BBS clear & =
    - HR 170, CRT > 4 sec's

Priorities?

Evidence for the use of restrictive volume of intravenous fluid resuscitation, compared with unrestrictive volume, by presenting illness and outcome.

	Studies	Survival to Hospital Discharge	Need for Transfusion or Diuretics	Need for Rescue Fluid	Mechanical Ventilation or Vasopressor	Time to Resolution of Shock	Total IV Fluids
Severe sepsis/ septic shock	Santhanam 2008; Carcillo 1991	No Benefit	No Benefit	No Studies Available	No Benefit	No Benefit	No Studies Available
Severe malaria	Maitland 2005; Maitland 2005	No Benefit	No Benefit	Harm	No Studies Available	No Benefit	No Benefit
Severe febrile illness with some but not all signs of shock	Maitland 2011; Maitland 2013	Benefit	No Benefit	No Studies Available	No Studies Available	Harm	No Benefit

Allan R. de Caen et al. Circulation. 2015;132:S526-S542

American Heart Association.

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Evidence for the use of noncrystalloid intravenous fluid resuscitation, compared with crystalloid, by presenting illness and outcome.

	Studies	Survival to Hospital Discharge	Need for Other Treatment	Need for Rescue Fluid	Mechanical Ventilation or Vasopres-sor	Time to Resolution of Shock	Total IV Fluids	Hospital Duration of Stay
Severe sepsis/ septic shock	Upadhyay 2005	No Benefit	No Benefit	No Studies Available	No Benefit	No Benefit	No Studies Available	No Studies Available
Severe malaria	Maitland 2003; Maitland 2005	No Studies Available	No Benefit	No Studies Available	No Studies Available	No Benefit	No Studies Available	No Studies Available
Dengue shock	Cifra 2003; Dung 1999; Ngo 2001; Wills 2005	No Benefit	No Benefit	No Benefit	No Studies Available	Benefit	No Benefit	No Benefit
Severe febrile illness with some but not all signs of shock	Maitland 2011	No Benefit	No Benefit	No Benefit	No Studies Available	No Benefit	No Benefit	No Studies Available

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References

- http://emedicine.medscape.com/article/1833578-overview#aw2aab6b2b3
- http://www.edwards.com/eu/Products/mininvasive/Pages/venousoximetryoverview.aspx
- **http://circ.ahajournals.org/content/112/24_suppl/IV-143.full**

Thank you!



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