Septic Shock management in the Paediatric Emergency Department

May 2013
Elliot Long
The plan

• Evidence (or lack of...)

• Guidelines

• Implementation

• What we do at RCH
  What we could do better
EGDT

• Rivers Protocol
  • Adult study of 263 patients in septic shock
  • Compared “standard care” with targeted care (CVP, MAP, Hb, ScvO2) over first 6 hours
  • Reduction in mortality from 46.5% to 30.5%
  • EGDT group received more fluid in first 6 hours (no difference at 72 hours) more PRBC and more inotr
  • First study to show that EARLY and TARGETED therapy in septic shock improves outcome

Rivers NEJM 2001
Supplemental oxygen ± endotracheal intubation and mechanical ventilation

Central venous and arterial catheterization

Sedation, paralysis (if intubated), or both

CVP
- <8 mm Hg: Crystalloid
- 8–12 mm Hg: Colloid
- ≥65 and ≤90 mm Hg

MAP
- <65 mm Hg: Vasoactive agents
- >90 mm Hg

ScvO₂
- <70%: Transfusion of red cells until hematocrit ≥30%
- ≥70%

Goals achieved
- No
- Yes: Hospital admission

No

≥70%: Inotropic agents

<70%
• Concerns re:
  
  • Adequacy of CVP as a marker of volume responsive low cardiac output
  
  • Liberal fluid resuscitation a risk factor for ALI/ARDS?
    • No difference rate of early intubation between EGDT and control, fewer late intubation in EGDT
  
  • High transfusion rate (64% vs 19% in control) - ? Risk for nosocomial infection, ALI, mortality
  
  • Low ScvO2 (49%), high mortality (46.5%) in control group
Rivers protocol applicable to Paediatrics?

- Central line often not inserted during initial resuscitation - CVP, ScvO2 unknown
- Optimal Hb in paediatric septic shock unknown
- Pathophysiology of sepsis different in children - myocardial dysfunction more common than vasomotor dysfunction
- Showed early and goal directed resuscitation improved survival in adult septic shock - what goals should be targeted in paediatrics?
• Update 2002 practice parameter
  • Based on “best clinical practice” and expert opinion

• Incorporates evidence for
  • Validity, efficacy of 2002 guideline
  • New treatment and outcome studies
Recognize decreased mental status and perfusion. Begin high flow O₂. Establish IV/IO access.

**Initial resuscitation:** Push boluses of 20 cc/kg isotonic saline or colloid up to & over 60 cc/kg until perfusion improves or unless rales or hepatomegaly develop. Correct hypoglycemia & hypocalcemia. Begin antibiotics.

**shock not reversed?**

**Fluid refractory shock:** Begin inotrope IV/IO. Use atropine/ketamine IV/IO/IM to obtain central access & airway if needed. Reverse cold shock by titrating central dopamine or, if resistant, titrate central epinephrine. Reverse warm shock by titrating central norepinephrine.

**shock not reversed?**

**Catecholamine resistant shock:** Begin hydrocortisone if at risk for absolute adrenal insufficiency.

Monitor CVP in PICU, attain normal MAP-CVP & ScvO₂ > 70%.

**Cold shock with normal blood pressure:**
1. Titrate fluid & epinephrine, ScvO₂ > 70%, Hgb > 10 g/dL.
2. If ScvO₂ still < 70% Add vasodilator with volume loading (nitrovasodilators, milrinone, imrinone, & others) Consider levosimendan

**Cold shock with low blood pressure:**
1. Titrate fluid & epinephrine, ScvO₂ > 70%, Hgb > 10 g/dL.
2. If still hypotensive consider norepinephrine
3. If ScvO₂ still < 70% consider dobutamine, milrinone, enoximone or levosimendan

**Warm shock with low blood pressure:**
1. Titrate fluid & norepinephrine, ScvO₂ > 70%.
2. If still hypotensive consider vasopressin, terlipressin or angiotensin
3. If ScvO₂ still < 70% consider low dose epinephrine

**Persistent catecholamine resistant shock:** Rule out and correct pericardial effusion, pneumothorax, & intra-abdominal pressure >12 mmHg. Consider pulmonary artery, PICCO, or FATD catheter, &/or doppler ultrasound to guide fluid, inotrope, vasopressor, vasodilator and hormonal therapies. Goal C.I. > 3.3 & < 6.0 L/min/m²

**shock not reversed?**

**Refractory shock:** ECMO
Recognize decreased mental status and perfusion.
Begin high flow O₂. Establish IV/IO access.

Initial resuscitation: Push boluses of 20 cc/kg isotonic saline or colloid up to & over 60 cc/kg until perfusion improves or unless rales or hepatomegaly develop.
Correct hypoglycemia & hypocalcemia. Begin antibiotics.

If 2nd PIV start inotrope.
Why give fluid?
Evidence for early aggressive fluid resuscitation

• 34 patients correlating volume of fluid administered at 1 and 6 hours with survival
  • Group 1 (<20ml/kg) - 11ml/kg at 1 hour and 71ml/kg at 6 hours (43% survived)
  • Group 2 (20-40ml/kg) - 32ml/kg at 1 hour and 108ml/kg at 6 hours (36% survived)
  • Group 3 (>40ml/kg) - 69ml/kg at 1 hour and 117ml/kg at 6 hours (89% survived)

• No increased risk of ARDS with more volume

Carcillo JAMA 1991
• Similar total volume of fluid administered at 6 hours in groups 2 and 3, suggesting that EARLY administration improves survival
• Retrospective transport database review over 9 year period
• 91 paediatric patients with clinical septic shock
• Shock reversal = normal SBP and CR
• 9-fold improved odds of survival with early shock reversal (PRISM adjusted)
• Every hour of ongoing shock associated with 2x increased risk mortality (PRISM adjusted)
• Initial resuscitation greatest impact on survival

Han Pediatrics 2003
Impact of FEAST

- Mortality after fluid bolus in African Children with severe infection (n=3141)
  - Mortality 10.5% with fluid bolus, 7.3% in standard maintenance fluid group
- Issues:
  - Patient selection
    - 57% malaria parasitaemia, 32% Hb <50
    - 83% respiratory distress, 25% SaO2 <90%
  - Diagnosis of shock
    - One of: severe tachycardia, CR > 3 sec, LL temp gradient, weak rad pulse volume

Maitland NEJM 2011
How much fluid to administer

• PALS/ ACCM- “until rales or hepatomegaly develop”
• Other methods of volume assessment
  • Clinical (HR, CR, LOC, u/o)
  • CVP
  • Passive leg raise / hepatic palpation
  • Arterial pulse pressure variation
  • IVC ultrasound
  • echo
Evidence for early antibiotic administration

- Retrospective adult cohort study, 2154 patients
- Survival 80% with adequate antimicrobial administration within 1 hour of hypotension
- Each hour delay associated with an increased risk of mortality of 7.6%
• Audit of 17 PICU’s
• 107 patients with septic shock
• 8% received care c/w ACCM guideline
  • 21% not given >60ml/kg despite ongoing shock
  • 15% not given dopa/dobu despite fluid refractory shock
  • 23% not given catechol for dopa/dobu refractory shock
  • 30% not given steroid despite catechol resistant shock
Why is implementation so poor?

• Cognitive barriers
  • Is severe sepsis seen as a problem
  • Has there been adequate dissemination of guideline
  • Are goals of ACCM guideline achievable
  • Are we practicing “informed skepticism”

• Process barriers
  • Shock recognition
  • Systems barriers
• Lack of recognition of early shock
• Lack of adequate vascular access
• Shortage of health care providers
  • 2 nurses for 15 (25) patients in ED, 2 for 13 in PICU
• Non-use of goals and treatment protocols
Future Directions

• Institutional audit
• Triage tool for early shock recognition
• Early senior staff review
• Tiered approach- non-invasive and invasive clinical pathways
• Collaboration / frequent review
Implementation of Goal-Directed Therapy for Children With Suspected Sepsis in the Emergency Department

- Implementation of sepsis protocol in ED
  - Triage sepsis recognition tool
  - Improved staffing of resuscitation area
  - Prioritisation of antibiotic
  - Improved graphic vital sign monitoring

- Decreased time to first bolus (56 to 22 min)
- Decreased time to antibiotic administration (130 to 38 min)

Cruz Pediatr 2011
RCH Emergency Audit

• Inclusion criteria:
  • Febrile
  • Haemodynamic instability (requiring a fluid bolus)

• Exclusion criteria
  • Palliative patient

• Information recorded:
  • Demographics, initial obs / lactate, timing of interventions, disposition, outcome
Results - patient characteristics

- Included: 56 patients over 6 months
- Excluded: 4
- Male: 30
- Mean age: 3.5 years
  - 25 <1yo
- Malignancy / imunosuppression: 13
- Other chronic disease: 8
- CVAD: 11
Results - timing

• Mean time to initial review: 12 min
• Mean time to IV access: 64 min
• Mean time to initiation of IV Abx: 126 min
• Mean time to initiation of 1st fluid bolus: 89 min
• Mean time to shock reversal: 317 min
Results - fluid resuscitation

- Mean volume of IV fluid administered: **35ml / kg**
- Number of patients receiving >40ml/kg: **28**
- Type of IV fluid used: **NS in all**
- Fluid “bolus” administered by infusion pump: **44**
Results- disposition

- Ward: 37
- ICU: 19
- Mean time to transfer: 422 min
10 patients with initial lactate >4

- Mean volume fluid bolus: 53ml/kg
- Inotrope in ED: 3 (of 5)
- Intubated in ED: 1 (of 3)
- Disposition ICU: 7
Things performed well

• Triage appropriately
• Rapid time to initial review
Areas for improvement

• Time to initial IV access
  • Early senior review
  • ?sepsis team
• Gas (lactate) on all septic patients
• Time to initiation of IV antibiotics
  • Antibiotics on cannulation
• All fluid bolus’ given under pressure
  • “push-pull” / pressure bag
# Early Management of Severe Paediatric Sepsis

## Recognition
- Fever or hypothermia
- Tachycardia
- Tachypnoea +/- hypoxia
- Altered conscious state / unwell appearance
- Hypotension is a late sign

- *Warm* shock – wide pulse pressure, rapid capillary refill
- *Cold* shock – narrow pulse pressure, prolonged capillary refill

Apply oxygen and continuous cardiorespiratory monitoring

## IV Access
- Take blood culture, venous gas and blood glucose
- Insert IO if no IV access within 15 minutes

## Antibiotics
- Give initial antibiotics **on cannulation as a push**
- If no IV/IO access within 30 minutes, give IM Ceftriaxone 50mg/kg
- Once IV access is obtained immediately give full IV antibiotic doses

## IV Fluid
- Initial bolus 20ml/kg
- **Normal Saline** as a push over 5-10 minutes *(not* through infusion pump)
- Monitor vital signs and conscious state
- If required give additional fluid boluses as 4% albumin to a max total vol 40ml/kg

## Inotrope
- If persisting hypotension after 40ml/kg fluid give: **Noradrenaline** (0.05-0.2 mcg/kg/min)
- Consider Dobutamine for cold shock (5-10 mcg/kg/min)
- Inotropes can initially be given via a peripheral IV
- Correct hypocalcaemia, get echocardiograph
Early Management of Severe Paediatric Sepsis

ANTIBIOTICS

• Age < 1 month: **Cefotaxime** 50mg/kg IV + **Benzylpenicillin** 60mg/kg IV
  • Age > 1 month: **Ceftriaxone** 50mg/kg IV (2g) + **Flucloxacillin** 50mg/kg IV (2g)

• For oncology patients with fever and risk of neutropaenia:
  **Piperacillin / Tazobactam** 100mg/kg IV (3g). Amikacin +/- vancomycin if severely unwell / high risk

IV FLUID

• Children needing >40ml/kg fluid boluses should be seen by PICU

INOTROPE

• For peripheral administration:
  Noradrenaline 0.15mg/kg in 500ml 5% dex + 0.9%NaCl
  10ml/hr = 0.05 mcg/kg/min

RESPIRATORY SUPPORT (beyond oxygen)

• In a patient with *normal* conscious state consider non-invasive ventilation
• In a patient with *altered* conscious state consider intubation

FURTHER MANAGEMENT

• If lactate >4mmol/dL: repeat after ~2 hours of resuscitation.
  Progress is reduction in lactate by >10%
• Consider **Ketamine** 0.5-2mg/kg for procedural sedation
• Secondary resuscitation measures should be discussed with PICU

Contact Numbers:

  - PICU ext 52327
  - ED ext 52169
  - Anaesthetics ext 52000
  - MET ext 777

Expires Dec 2015

*Endorsed by RCH CPG committee / ED / PICU
Comments / copies: septic.shock@rch.org.au*
Questions / Comments
Summary

• Get help early for difficult IV access
• Get antibiotics drawn up while you obtain access, give as a push on cannulation
• Take BC and gas on cannulation
• Give all fluid bolus under pressure
• Be cautious giving >40ml/kg bolus fluid