Rigshospitalet
Department of CardioThoracic Anesthesia

REGION H

Pediatric Sepsis

The Why's and The What's

Conflicts of interest

- Trained Anesthesiologist
  - Sub Specialised in Pediatric Anesthesia and Intensive Care
  - 2010-2016 PICU at AUH with casemix of children 2y + and/or CHD

- Financial Disclosures…None

Outline-Why?

- Sepsis Still Has a High Mortality(5-30%)
- Sepsis is Still Under Recognised
- Sepsis Protocols Significantly Improves Outcome
- Sepsis Pathophysiology is Poorly Understood

Case 1.
T-0min
18mth girl 11kg. ER

- HR 195, CRT 4sec, RR 55,Tp 38,9, ”Sleepy”, URTI 2-3days
  - IV acces
  - Lab samples
  - AB
  - Fluid?

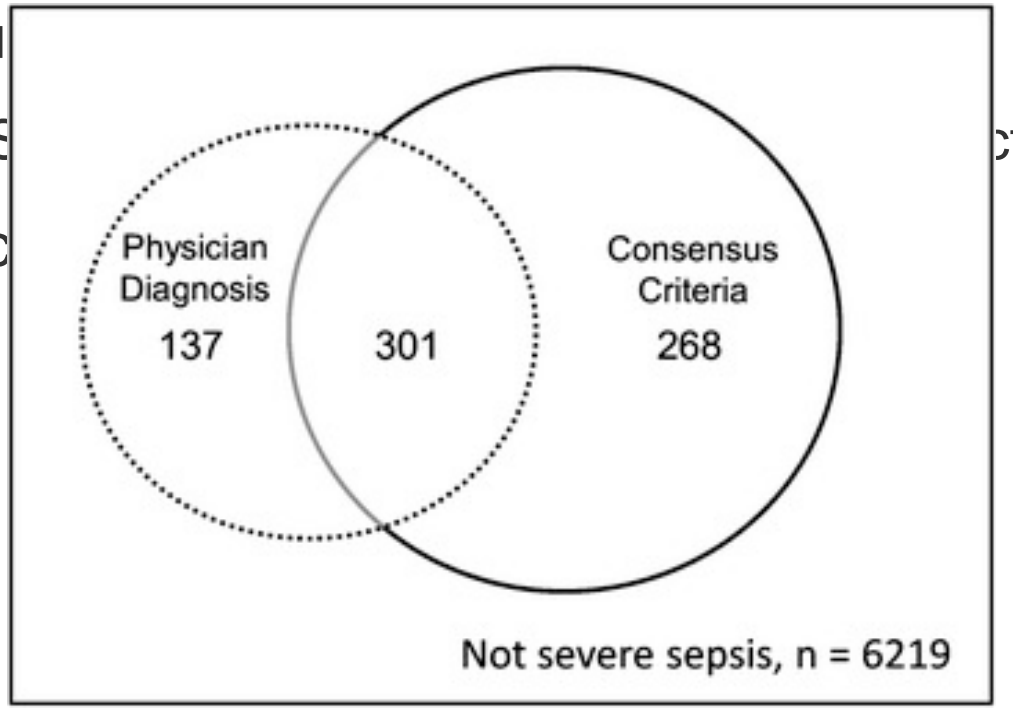
Case 1.
T-0min
18mth girl ER

- Lab:
  - ABG(cap) pH 7,3, CO_2 4,1kpa, O_2 12 kpa, Lac 2, BE -7
  - Crp 257, Leuc. 2,4

- Plts 578, Creatinine 175 mmol/L

SPROUT
(The Sepsis PRevalence, OUtcomes, and Therapies)

- PP stu
  - <2 S
- 6995 c



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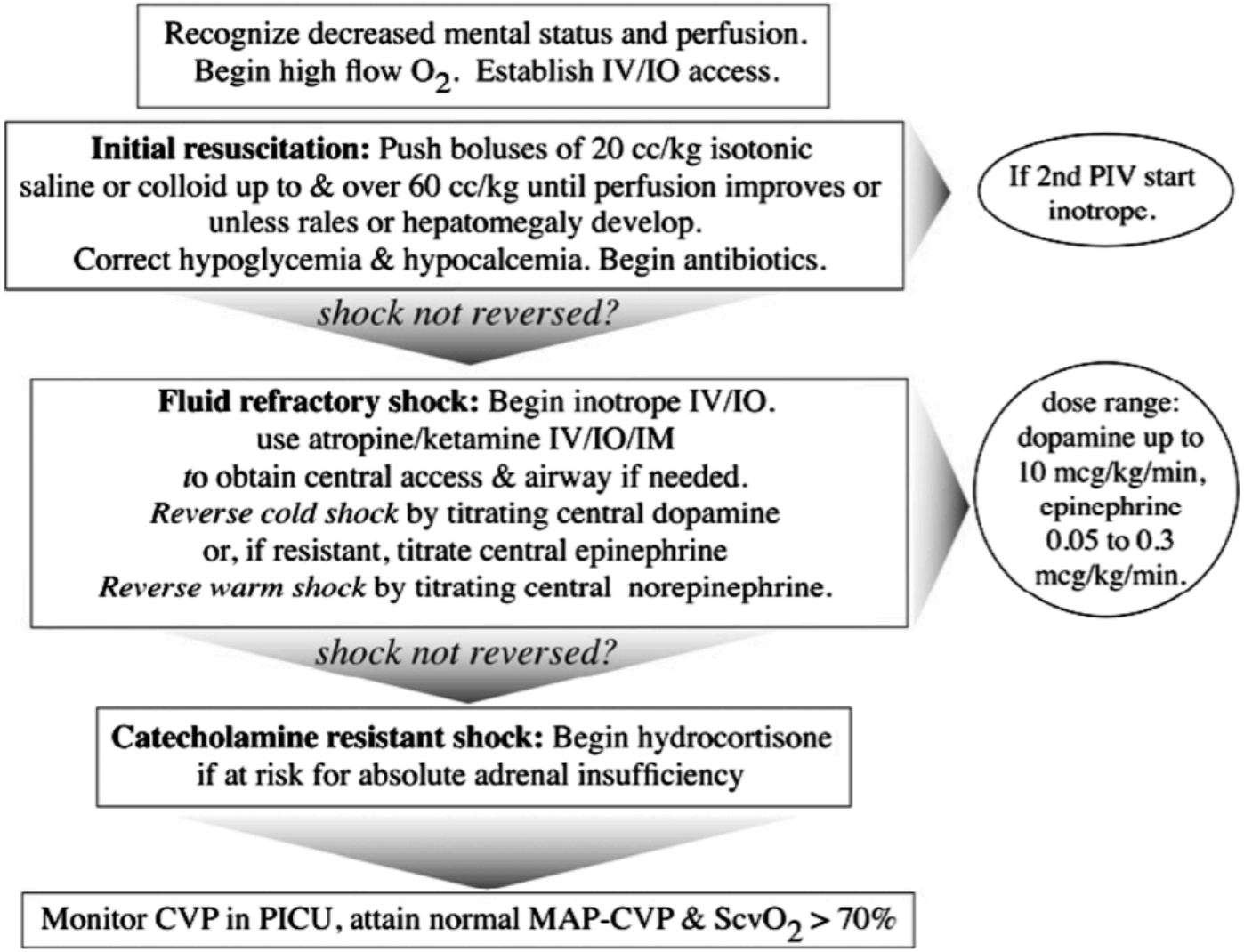
Crit Care. 2015; 19(1): 325.

Severe Sepsis/Shock,

7. SEPTISK SHOCK HOS BØRN

Forfattere: Lasse Høgh Andersen, Niels Risør Hammer, Rolf Dall, Jakob Gjedsted, Kaare Engell Lundstrøm
Korrespondance: *lasse.andersen@dadlnet.dk*

Later that night



- Not enough fluid in circuit
  - Sepsis
  - Haemorrhage
  - Dehydration
  - Maldistribution – ‘third spacing’ – many causes
- Pump failure
  - Sepsis
  - Cardiomyopathy/ myocarditis
  - Arrythmia
- Inadequate oxygen carrying capacity
  - Anaemia
  - CO poisoning
- Very low circuit resistance
  - Sepsis
  - AVM

Case 1.
T-30 min.
18 mth girl PICU

- HR 175, RR 45, CRT 4,5s, ”Sleeping” , Tp 35,8, Sat 92%
  - Art-line? CVC? Inotrope?

- **A**
- **B**
- **C**

What happens behind the doors -at the PICU?

- **A**: Airway handling
  - Oxygen supplementation
  - CPAP
  - Tracheal intubation
    - Work of breathing
    - Placing a Central line/Arterial line/catheter
    - Protection of airway

What happens behind the doors -at the PICU?

- **A:** Airway – Therapeutic targets
  - Safe Airway
  - Sat > 95%
  - Normal RR

What happens behind the doors -at the PICU?

- **B:** Breathing
  - Optimizing Oxygenation
  - Reducing Oxygen Comsumption
  - Compensating Metabolic Acidosis(partially)
  - Pressure Ventilation for Pulmonary Edema
  - Decrease in Work of Breathing

What happens behind the doors -at the PICU?

- **B:** Breathing – Therapeutic targets
  - Normal ABG

What happens behind the doors -at the PICU?

- **C:** Circulation
  - Re-evaluate fluid status
    - ECHO point of care/Specialized Pediatric Echo
    - Liver size, Rales, Jugular Venous Stasis
  - Invasive monitoring
    - Art. Line, CVC
    - Vasopressor and/or Inotropic support.

What happens behind the doors -at the PICU?

- **C:** Circulation – Therapeutic targets
  - Normal for Age -
    - Pulse, CRT<2s and BP
  - Restore Organ Perfusion
    - Diuresis
    - Liverfunction
    - Cerebral Perfusion

Case 1.
T – 45min
18mth girl PICU

- In S-Ketamine sedation
  - Art line
  - Central line
  - Bladder Catheter

Case 1.
T – 60min.
18mth girl PICU

- Status
  - CNS: Response to pain only
  - Resp: Binasal CPAP, FiO_2 0,8, RR 65, Rales
    - ABG pH 7,19, PCO_2 7,1, PO_2 9,5, Lactate 5, BE -11
  - Circ: P 190, BP 60/35, Dopamine 10 Mikr/kg/min, Mottled
    - SvO_2 62, Hgb 6,1mmol/L
  - Ren: Duresis 5ml/h

Airway Handling in Pediatric Sepsis

-The evidence

- ”Dry” Oxygen Supplementation
  - No Evidence (African study under way)
- High Flow Nasal Cannula
  - No evidence (small series and 4 x Cochrane)
- Binasal CPAP
  - No evidence in sepsis (African study under way)
- Tracheal Intubation
  - No Evidence (Rescue Therapy)

B - Mechanical Ventilation

The Evidence

- None, Escape Therapy.

- RCT?

C- Circulatory support

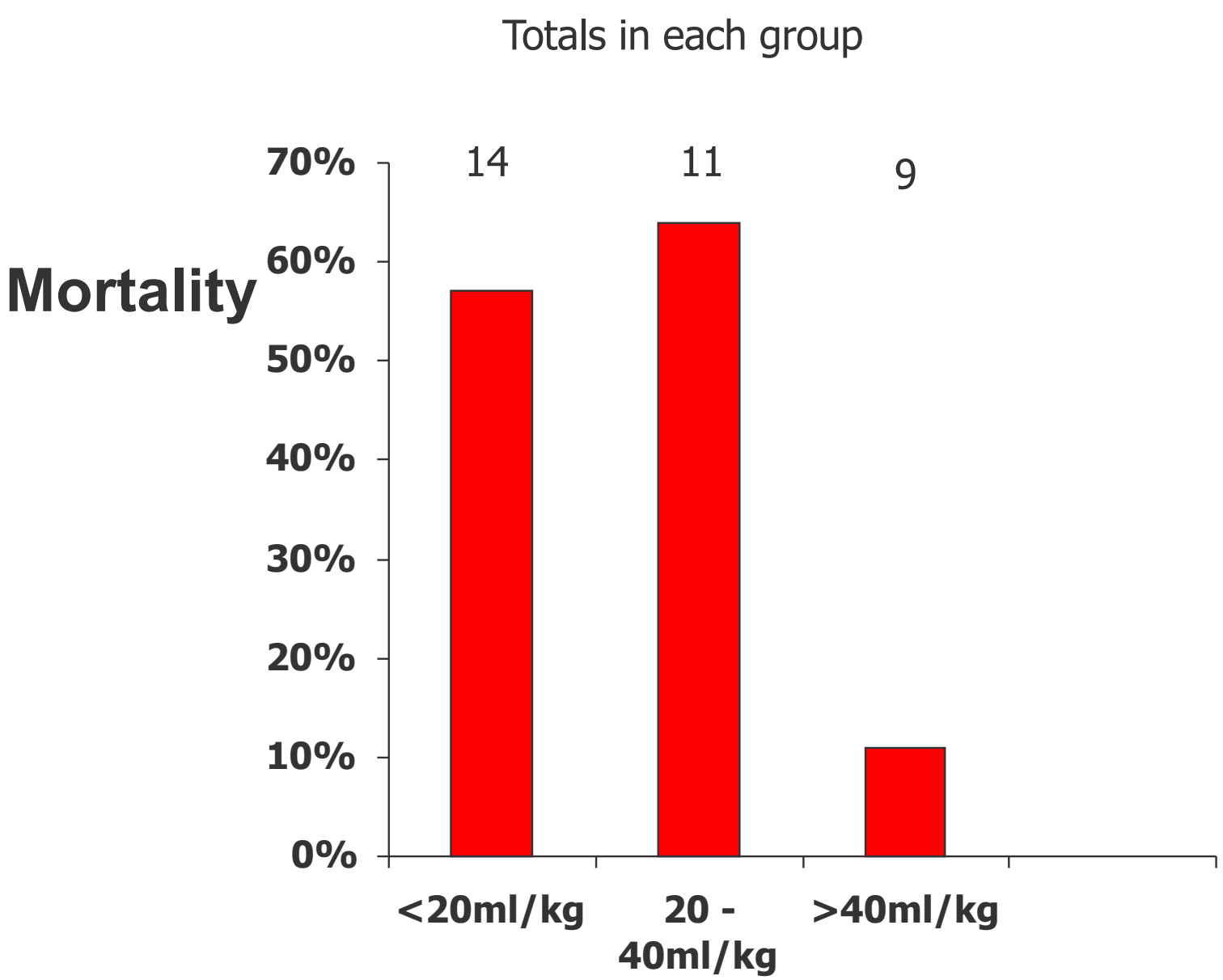
The Evidence

- Fluid boluses
  - Some, but mostly extrapolated from adult.(ACCM/PALS)
    - FEAST trial?
- Inotropes/Vasopressors
  - Late Initiation Associated With Worse Outcome
  - New Studies on the Way with Choice of Pressors

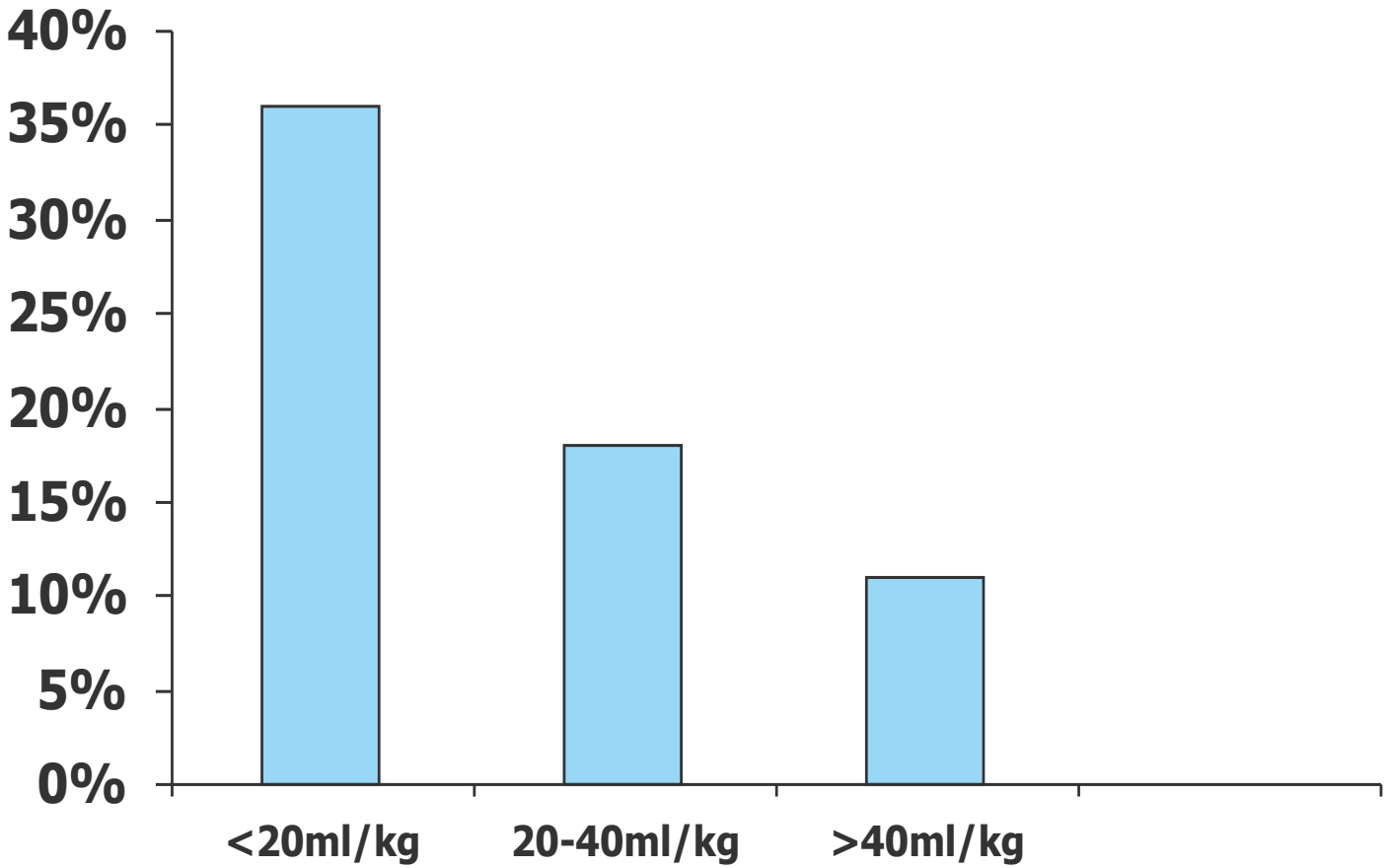
Role of Early fluid resuscitation in pediatric septic shock

JAMA, 1991;266:1242-1245

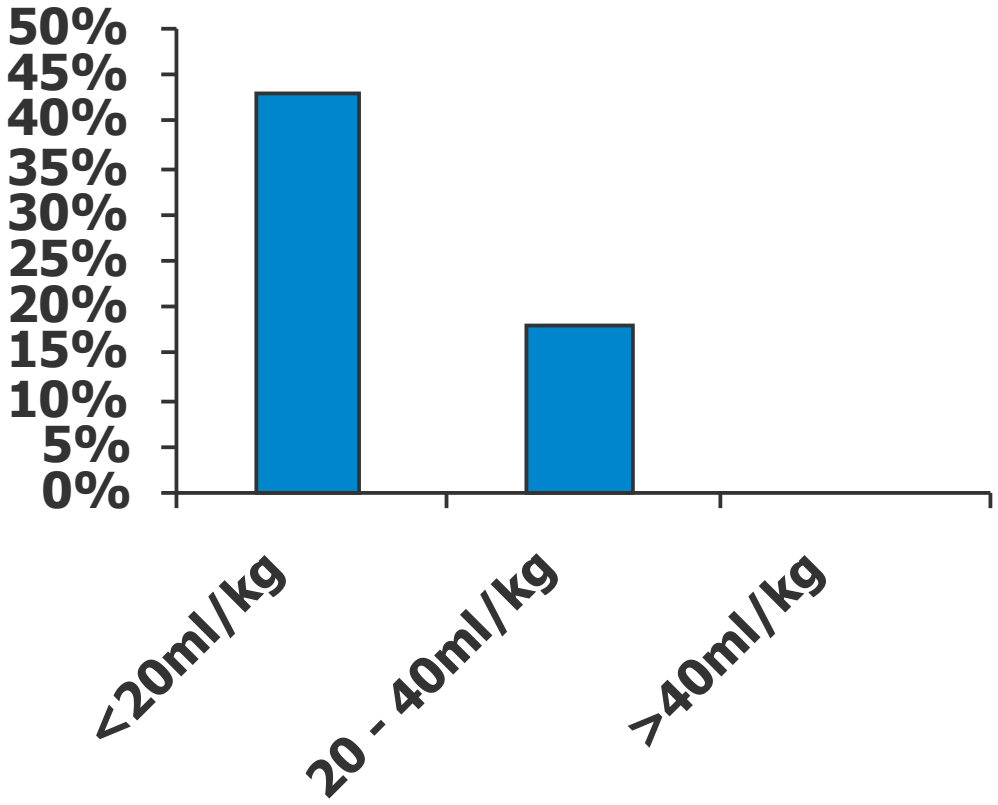
- Retrospective Observational study
- Ped ER in Washington DC Childrens Hospital – PA catheter in situ by 6 hours
- 34 patients – mean age 13.5 months
- Divided into 3 groups by volume received in first hour (post hoc)
  - Group 1 <20ml/kg
  - Group 2 20 – 40ml/kg
  - Group 3 >40ml/kg


Totals in each group
Mortality
70%
60%
50%
40%
30%
20%
10%
0%
14
11
9
<20ml/kg
20 - 40ml/kg
>40ml/kg

ARDS



Hypovolaemia at 6 hours



The NEW ENGLAND JOURNAL of MEDICINE

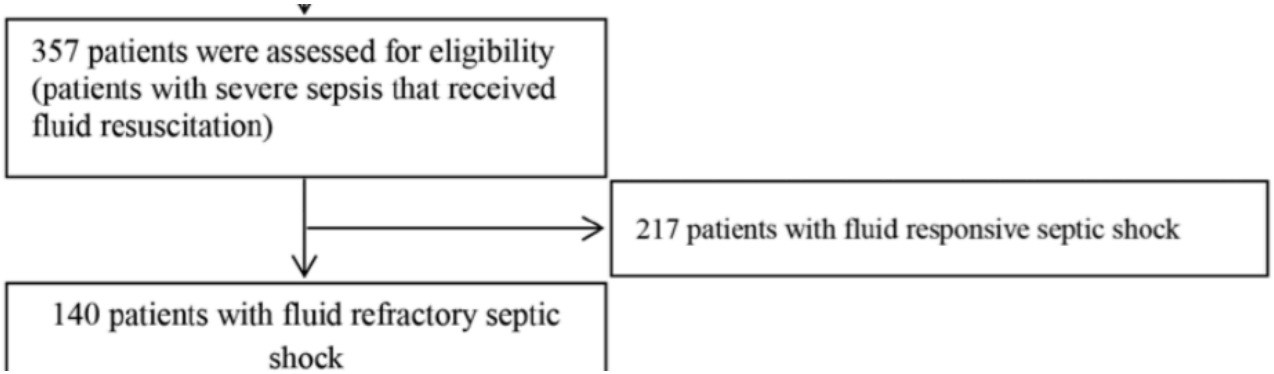
ESTABLISHED IN 1812 JUNE 30, 2011 VOL. 364 NO. 26

Mortality after Fluid Bolus in African Children with Severe Infection

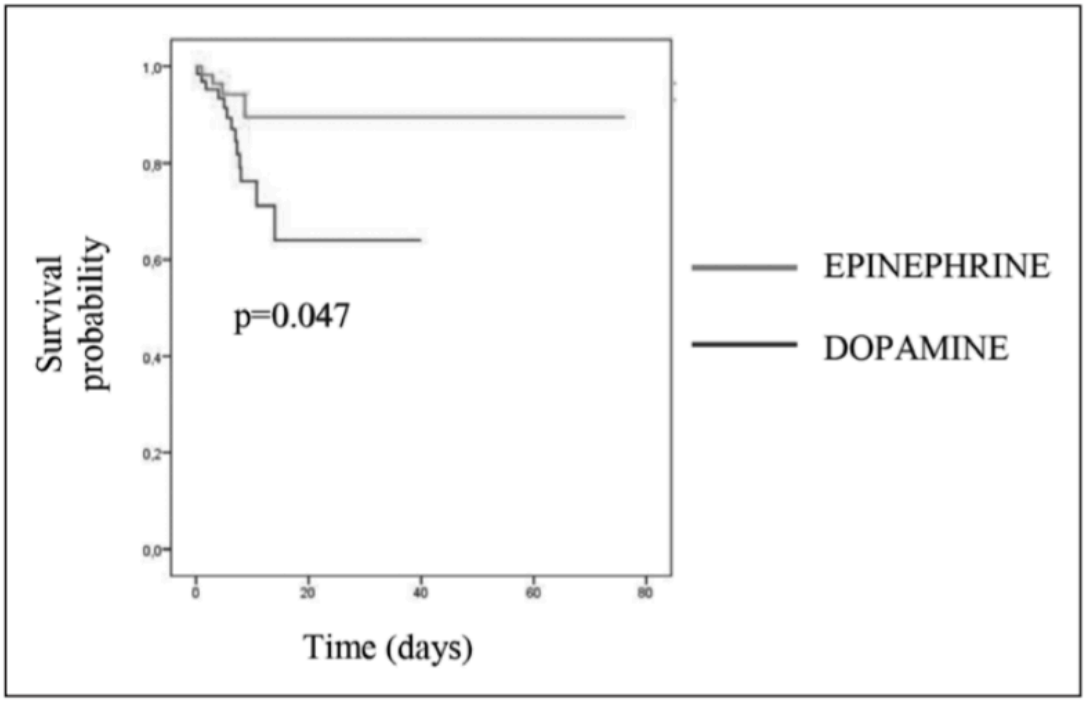
Kathryn Maitland, M.B., B.S., Ph.D., Sarah Kiguli, M.B., Ch.B., M.Med., Robert O. Opoka, M.B., Ch.B., M.Med., Charles Engoru, M.B., Ch.B., M.Med., Peter Olupot-Olupot, M.B., Ch.B., Samuel O. Akech, M.B., Ch.B., Richard Nyeko, M.B., Ch.B., M.Med., George Mtove, M.D., Hugh Reyburn, M.B., B.S., Trudie Lang, Ph.D., Bernadette Brent, M.B., B.S., Jennifer A. Evans, M.B., B.S., James K. Tibenderana, M.B., Ch.B., Ph.D., Jane Crawley, M.B., B.S., M.D., Elizabeth C. Russell, M.Sc., Michael Levin, F.Med.Sci., Ph.D., Abdel G. Babiker, Ph.D., and Diana M. Gibb, M.B., Ch.B., M.D., for the FEAST Trial Group*

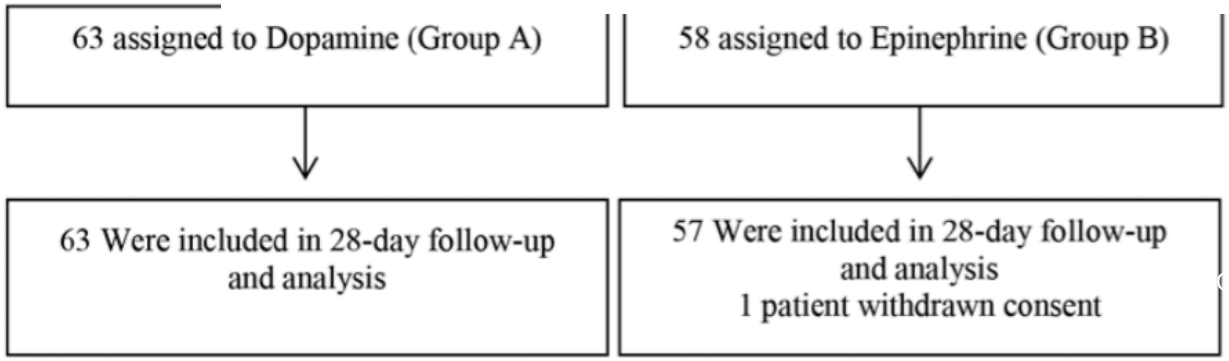
- Lack of inotropes/vasopressors?
- To Little to Late?
- Acid-Base Disorder (Iatrogenic)
- Electrolyte Disorder (Iatrogenic)

Inotropes and Vasopressors



Interventions	57)	p
Time to fluids, hr[a]		0.344[b]
Fluids 1st hr, mL/kg[a]		0.114[b]
Fluids 1st 6 hr, mL/kg[a]		0.787[b]
Antibiotics 1st hr, yes, *n* (		0.167[c]
Time to study drug, hr[a]		0.441[b]
Duration of resuscitation,		0.024[b]
MV, yes, *n* (%)		0.052[c]
MV-free days[a]		0.174[b]
Hydrocortisone for shock		0.680[c]
Renal replacement therap		0.001[c]





Double-Blind Randomized Clinical Trial Comparing Dopamine and Epinephrine in Pediatric Fluid-Refractory Hypotensive Septic Shock.

PCCM Sept 2016 E-pub.

Ramaswamy, Karthik Narayanan MD, DM; Singhi, Sunit MD; Jayashree, Muralidharan MD; Bansal, Arun MD; Nallasamy, Karthi MD, DM

- 60 children 3mth-12y,
  - Fluid Refractory SS
- Randomised to
  - Dopamine 10-15-20 microgr/kg/min
  - Epinephrine 0,1-0,2-0,3 microgr/kg/min
- Outcome
  - Shock Resolution 1h 41% vs 13%
  - Shock resolution 6h 48% vs 29%

Case 1.
T – 180min.
18mth girl PICU

- Status
  - CNS: Sedated(midazolam+Fentanyl)
  - Resp: Mech Vent FiO_2 1,0, PIP 35, PEEP 15
    - ABG pH 7,2, PCO_2 8,2, PO_2 8,1, Lact 9, BE -10
  - Circ: SVT 200, MAP 25, SV_jO_2 55%, Mottled, Epi 0,5 mik/kg/min, NA 0,5m/kg/min
  - Ren: Anuric

Fluid and Vasopressor/Inotropic resistant Septic Shock

Case 1.
T – 180min.
18mth girl PICU

- Adjuvant therapy
  - Corticosteroids..Maybe
  - Vasopressin/Terlipressin…Maybe
  - Methylen Blue...Maybe
  - Milrinone...Maybe
  - Levosimendan...Maybe

Extracorporeal membrane oxygenation for refractory septic shock i

Graeme Ma
Derek Best,

19	0.1	38	Dop10, Nor0.4	No	Yes
20	5	80	Dop10, Nor0.9, Epi0.9, Ca, V	No	No

Sepsis
Take-Home Messages

- Treatment is a Team Efford
- Early Recognition is Essential
- Act and Reevaluate
- Remember the ”Windows of Opportunity”
  - 50% Mortality Within the First 24h
  - 50% Dies Before Transfer