Managing the Acutely Ill Child

Michael Tremlett
Department of Anaesthetics
James Cook Hospital
Middlesbrough

Outline:

1. **Overview**
   - **Why do children die?**
   - Organisation of acute care of children in UK.

2. *"I'm an adult intensivist. What has management of seriously ill children got to do with me?"*

Why you are important in the care of children presenting with life threatening illness

3. Cases to consider– it could be you.

- **Conditions where make a difference and are experts**
  - **Sepsis**
  - **Airway Infections**

World perspective:

7.6 Million children die in the World before their 5th birthday

- **(40%) die in first month of life.**
  - **Prematurity – 14%**
  - **Birth Asphyxia – 9%**
  - **Sepsis / meningitis – 5%**
  - Congenital abnormality -4%

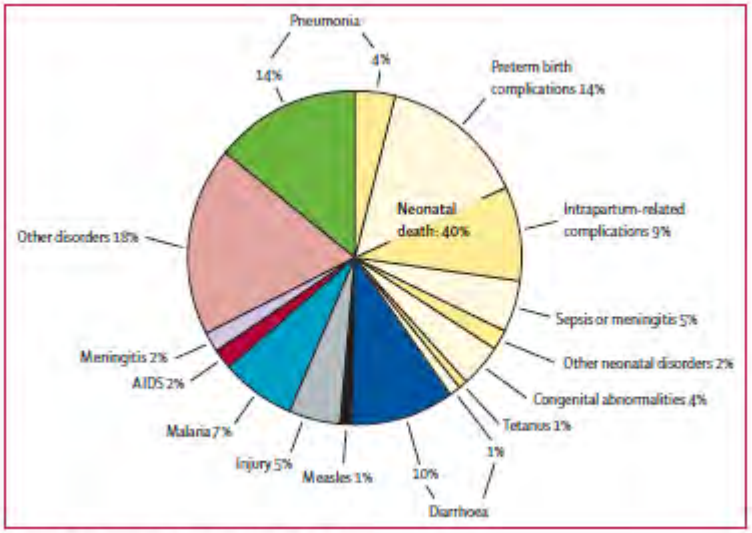


Figure 2: Global causes of childhood deaths in 2010

Global, regional, and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000

Li Liu, Hope L Johnson, Simon Cousens, Jamie Perin, Susana Scott, Joy E Lawn, Igor Rudan, Harry Campbell, Richard Cibulskis, Mengying Li, Colin Mathers, Robert E Black, for the Child Health Epidemiology Reference Group of WHO and UNICEF

Lancet 2012; 379: 2151–61

World perspective:

7.6 Million children died in World before their 5th birthday

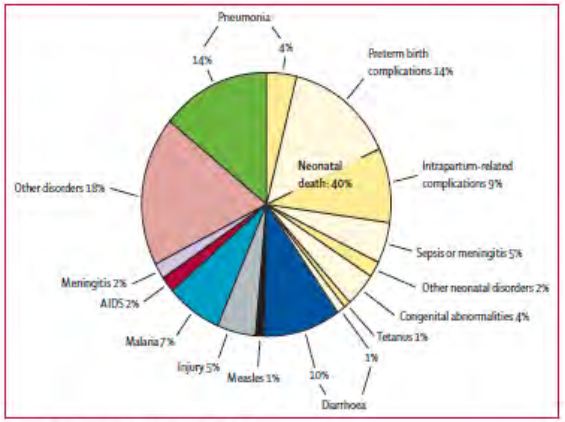


Figure 2: Global causes of childhood deaths in 2010

- **4.9 Million (64%) = Infectious cause**
  - **Pneumonia = 1.3M (18%)**
  - **Diarrhoea = 0.8M (10%)**
  - **Malaria = 0.6M (7%)**
  - AIDS = 0.2M (2%) Meningitis =0.2M (2%)

- Non Infectious causes (36%)
  - Injury = 5%

Global, regional, and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000

Li Liu, Hope L Johnson, Simon Cousens, Jamie Perin, Susana Scott, Joy E Lawn, Igor Rudan, Harry Campbell, Richard Cibulskis, Mengying Li, Colin Mathers, Robert E Black, for the Child Health Epidemiology Reference Group of WHO and UNICEF

Lancet 2012; 379: 2151–61

Why Children die?
European perspective:

Causes of death of children aged 1-14 years in 15 pre 2004 EU countries:

- **Other (Congenital and neurological problems) = 36%**
- **Injury / Poisoning = 25%**
- **Cancer = 27%**

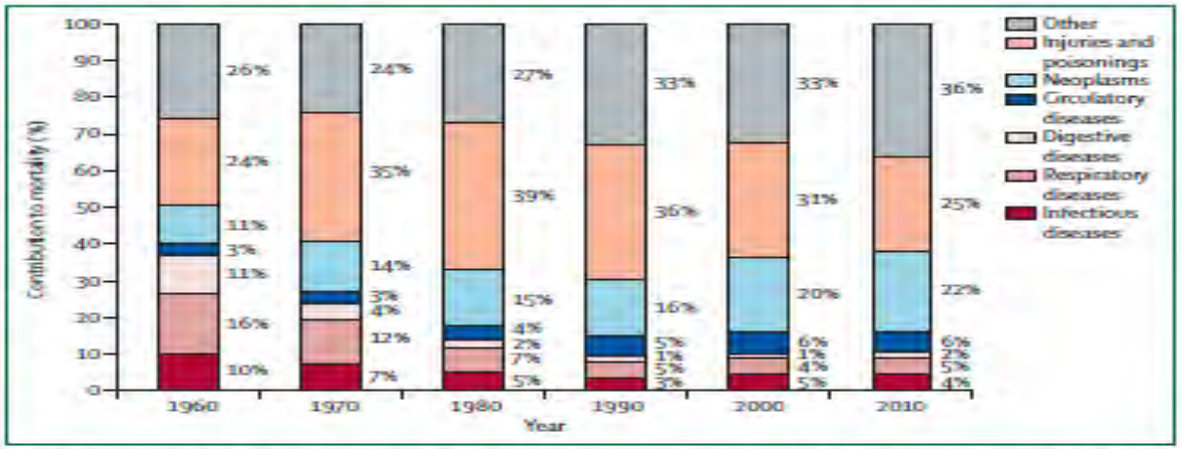


Figure 2: Shifting relative causes of mortality in children aged 1-14 years in the 15 pre-2004 countries of the European Union, 1960–2010

Source: WHO Mortality Database, 2012.[1]

Why children die; a British perspective
Death rates (England + Wales)

- Child Mortality rate (2012) =**11 per 100,000** population

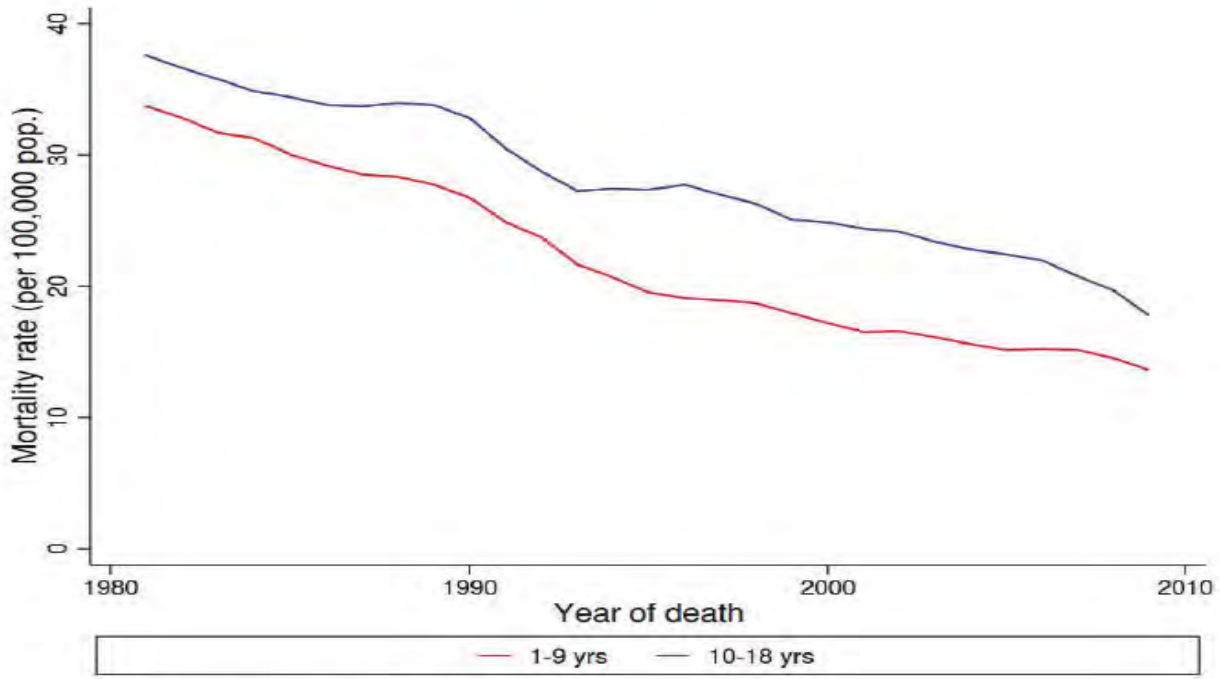
Causes:

- Other (Congenital / neurological) = 23%
- Cancer = 23%
- Trauma / poisoning = 18%
- Respiratory (asthma / pneumonias) = 9%

10% of the deaths in children aged <5 years in UK = Sepsis

Why children die; a British perspective
Changes over time:

Figure 3.1: Smoothed child mortality rates by year and age group, UK 1980-2010



Three year moving averages have been applied

Child Health Reviews - UK
Clinical Outcome Review Programme

Overview of child deaths in the four UK countries

Report
September 2013

UCL

RCPCH
Royal College of Paediatrics and Child Health

Why children die; a comparison with Europe:

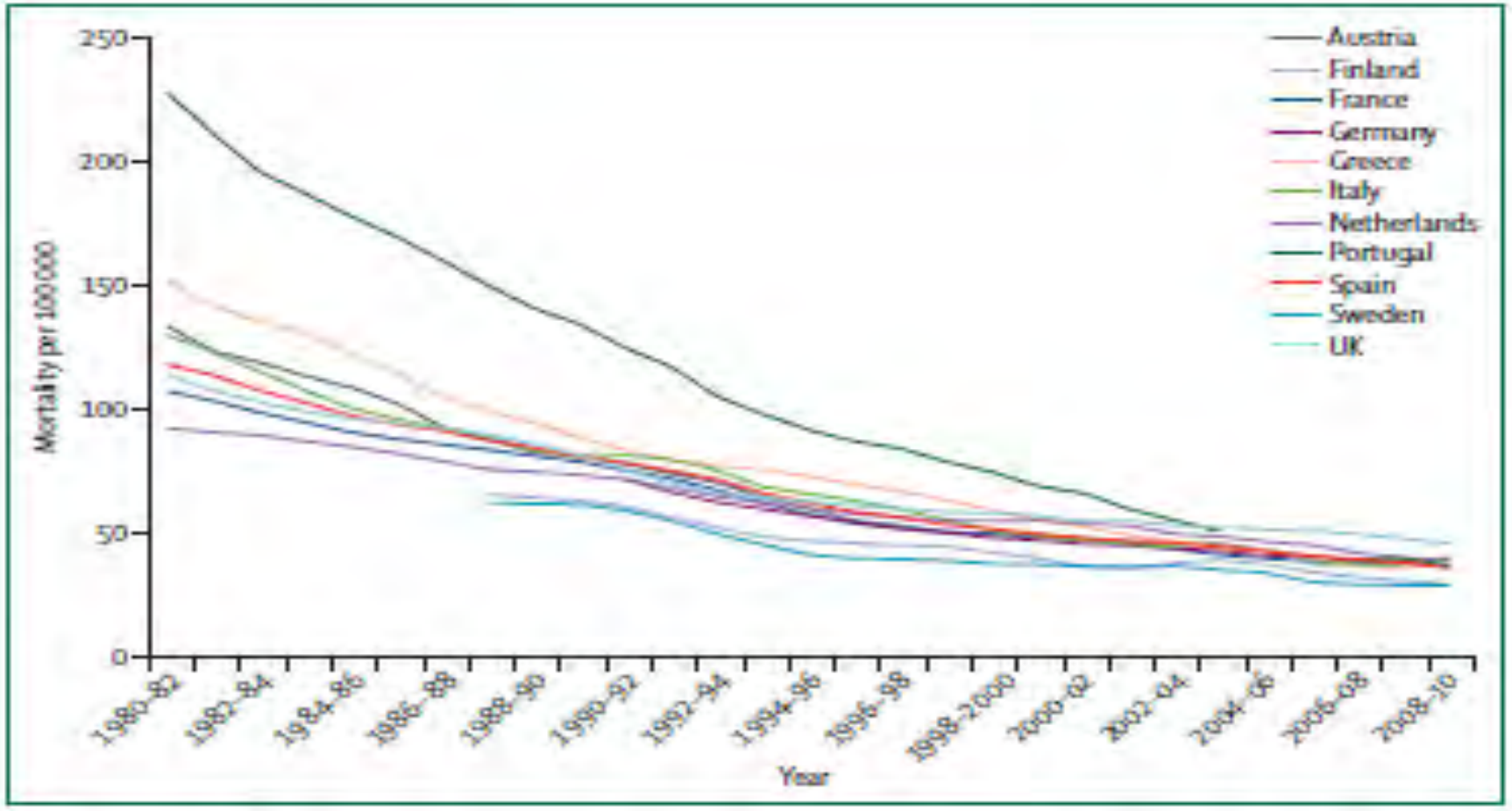


Figure 1: Trends in mortality in children aged 0–14 years in 11 European Union countries, 1980–2010
Source: WHO Mortality Database, 2012.[1] Data are directly standardised rates.

Why children die: a comparison with Europe.

	Mortality (directly standardised rate)	Yearly excess deaths compared with Sweden
Sweden	29·27	0
Luxembourg	26·50	0
Finland	30·27	9
Spain	37·40	545
Greece	37·86	135
Germany	37·88	815
Italy	38·07	683
France	38·25	962
Austria	39·09	106
Ireland	39·78	98
Netherlands	40·66	292
Portugal	40·73	176
Denmark	42·69	121
UK	47·73	1951
Belgium	47·77	304

Source: WHO Mortality Database, 2012.[7] Directly standardised rate data show all-cause mortality per 100 000 children aged 0–14 years and are 5 year means for 2006–10, except for France and Luxembourg (2005–09), Denmark (2002–06), Belgium (1998–99; 2004–06), Italy (2003; 2006–09), and Portugal (2003; 2007–10). Data for excess deaths are absolute numbers. An estimated 6198 deaths would have been avoided if the child mortality rate across the 15 pre-2004 countries of the European Union was the same as that in Sweden.

Table: **Child mortality rates in the 15 pre-2004 countries of the European Union and excess child deaths compared with Sweden**

UK:

Mortality:

- **132,874 excess person years of life lost by premature mortality**

Morbidity:

- **Diabetes control (HbA1C<7.5)**
  - **UK = 16% Germany = 34%**

UK Trauma mortality = very low in European terms (excellent prevention strategy + Trauma centralisation)

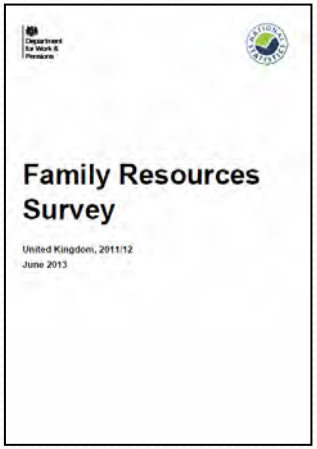
Excess Mortality / morbidity = most noticeable in Medical Paediatrics

Why are our results so poor when compared to other European Countries?

Multifactorial:

- **Social Deprivation**
  Many children in UK living in Poverty
- **Organisation of Care**
- **Staff Training**

Social Deprivation (Income Inequality):



Children living in relative income poverty in UK = 3.5Million out of a total of 13.1 Million children.

- 27% of all children in $UK_{DWP2013}$
- (38% children in Middlesbrough)

Burden of (financial) poverty falls disproportionately on children.

- 23% of total UK population in poverty versus 27% of children
- Incidence poverty in Netherlands population = 15%

Poverty = is about a lack of resources

1. Financial (money)
2. Human Capital (education opportunity)
3. Social capital (positive / trustful communities)

Social Deprivation:

Strong correlation between all health outcomes (except incidence of cancer) and social deprivation

Examples:

Health: **Health Inequality**

- Infant mortality = 10% higher in low income vs high income families
- Life expectancy = 8 years less for Social Class V versus Social Class I
- Most deprived are 13 times more likely to die from trauma / poisoning

Education:

- By age of 3 years, poorer children are on average 5 months behind educational attainment of wealthier peers
- By age of 14 years, gap in attainment = equivalent to 5 terms.

Organisation of Care for the acutely Ill Child in UK:

Number of Units in UK with open access (24/7) for Paediatric assessment / admission:

Emergency Medicine Departments: = 287[1]

In patient paediatric units = 218[2]

Inadequate numbers of trained Paediatricians to adequately staff this number of Acute Open Access Units

Sources:

1 College of Emergency Medicine – personal communication (2011)

2. RCPCH. Facing the future (2011)

Organisation of care for the Acutely Ill Child

Facing the Future (RCPCH 2011 and 2013):

Set minimum standards for Acute General Paediatric Services

- Acute admissions must be seen by Consultant or middle Grade (ST4+) within 4 hours of admission
- All Acute Admissions must be seen by Consultant or equivalent within 24 hours of admission.
- 8 Others

Audited whether being me (April 2013)t:

- 4 hour standard = not met 22% Units
- 24 hour rule not met 12% Units
- Consultant Presence during peak times – evenings = 11% Units, Weekends = 6% Units

Unachievable with:

1. Present numbers of Acute units
2. European Working Time Directive Compliance
3. Present Consultant and trainee numbers

Conclusion:

"Service in present form unsustainable."

"Doing nothing is simply not an option"

Reconfiguration urgently required

Minimum required = close or change 32 Acute units to Short Stay Assessment Units

Training of the Workforce who care for Children:

First contact providers:

- General Practitioners
  - UK – post graduate paediatric training = uncommon
    - <20% new GPs
  - Sweden – compulsory (at least 6 months paediatrics or obstetrics

- Acute Paediatricians:
  - Majority undertake no Paediatric Intensive Care Medicine
  - Multiple small units = limited ability maintain skills

Measures of UK Health Effectiveness:

(Combined measure of service organisation + staff training)

Death rates from conditions amenable to healthcare = useful measure of **Effectiveness of a Healthcare System.**

Pneumonia mortality:

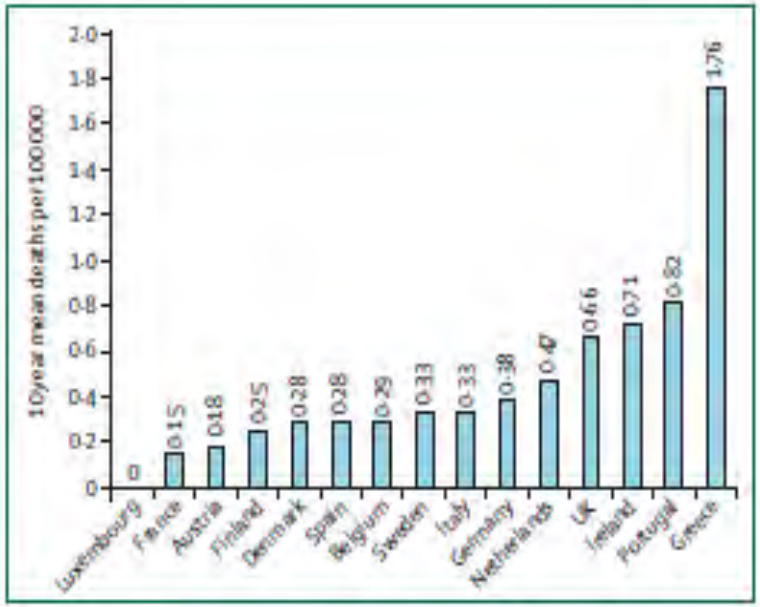


Figure 4: Deaths from pneumonia in children aged 0–14 years in the 15 pre-2004 countries of the European Union

Source: WHO European Mortality Database, 2012.[76] Data are directly standardised rates. 10 years means are for 2000–10, except for data for Belgium (2004–06); Denmark (2000–06); France, Greece, and Italy (2000–09); and Portugal (2000–04 and 2007–10).

Asthma Mortality:

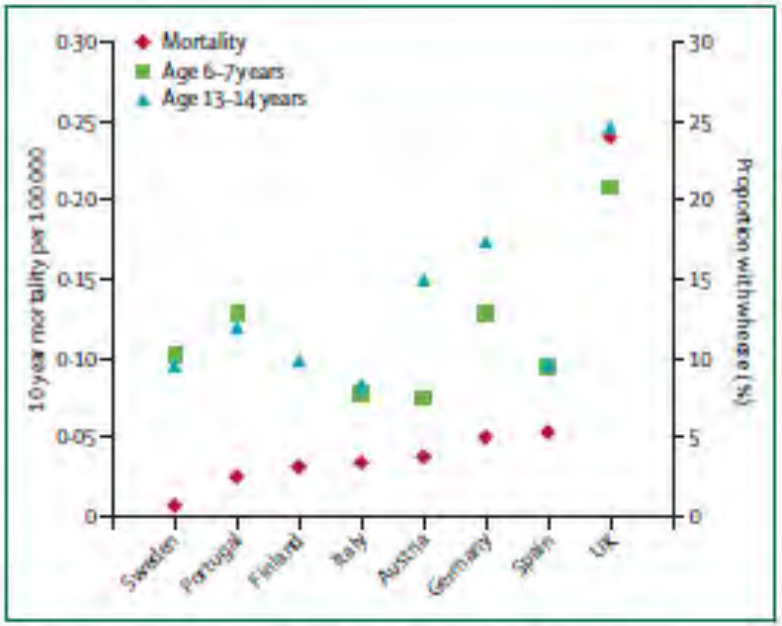


Figure 5: Asthma mortality rate in children aged 0–14 years, and proportion aged 6–7 and 13–14 years with wheeze, in eight western European countries

Source: WHO European Mortality Database,[13] 2012, and Anderson and Colleagues.[14] Data are for 2000–10, except for data for Belgium (2004–06); Denmark (2000–06); France, Greece, and Italy (2000–09); and Portugal (2000–04; 2007–10) Mortality data are directly standardised rates.

Strategies to improve child health and health services for children in UK:

UK known to have a problem with child health outcomes for many years:

Fit for the Future. The Report of the Committee on CHILD HEALTH SERVICES 1976.

Prof Donald Court
Professor of Child Health 1954 -72, Newcastle-upon-Tyne

"Our findings have given us profound anxiety about the present state of child health in this country, about the short comings of the services and those working in them and the prospects for new generations if they grow up in the same deprived physical and emotional circumstances as many children today contend with."

"Twenty years ago (1950) this country had one of the lowest rates of infant mortality, but since then we have fallen behind other countries, France, Japan, Switzerland among them."

Disadvantage:

"There is now extensive evidence that adverse social and family environment leads to more frequent and more serious illness and adversely affects educational achievement and personal behaviour."

Outline:

1. **Overview**
   - **UK deaths =**
     - **Congenital,**
     - **Cancer,**
     - **Trauma**
     - **10% =sepsis**

Many deaths unavoidable but outcomes from medical illness worse than comparative countries

Profound Social inequality, medical training structure, hospital paediatric organisation disadvantageous to good outcomes

Outline:

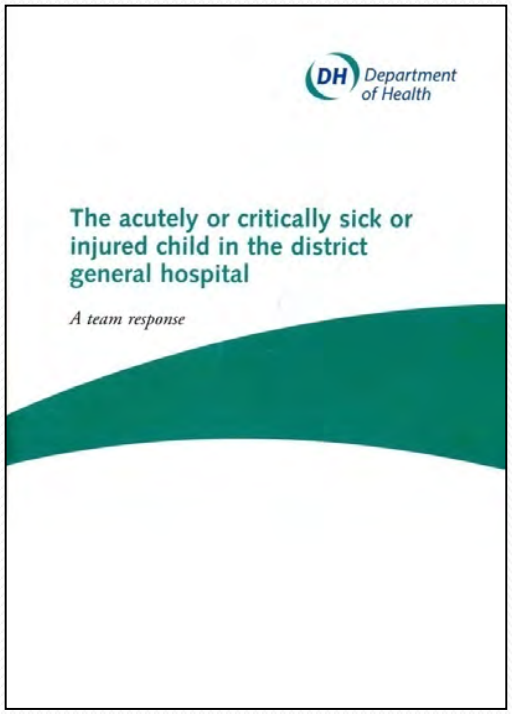
1. **Overview** (set the scene)
   - **Why do children die?**
   - Critique of UK paediatric health provision

2. *"I'm an adult intensivist. What this got to do with me?"*

Why you are important in the care of children with life threatening illness

3. Two cases – it could be you.

"I am an Adult Intensivist. What has this got to do with Me?"

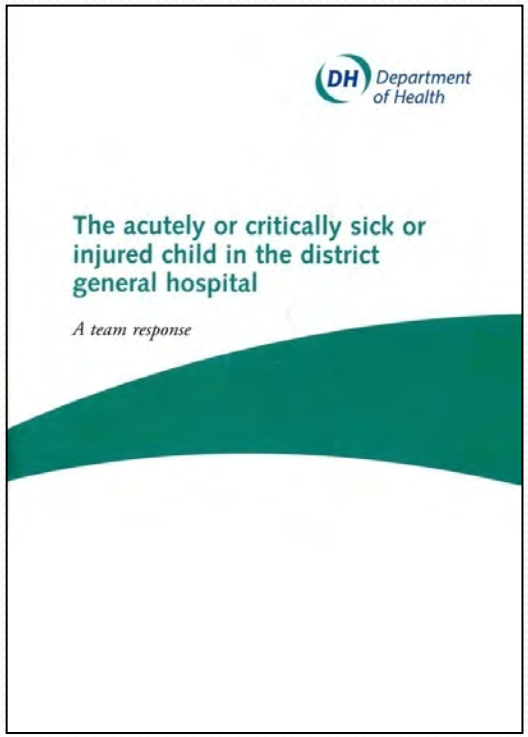


Tanner Report (Dept of Health 2006):

- Most recent DoH document on organiastion of care for critically sick children
- Whole systems review of organisation of care

Working group with representatives from multiple organisations

"I am an Adult Intensivist. What has this got to do with Me?"



- Tanner Report (DoH 2006):

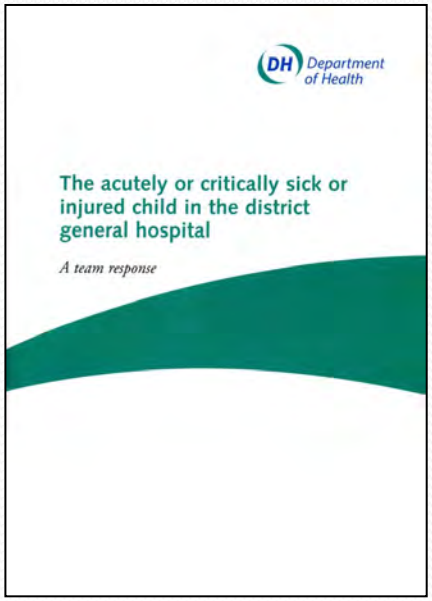
Considered the whole pathway of care from home to PICU

<u>Resuscitation / Stabilisation:</u>

- Team (as a minimum) =
  - Consultant Paediatrician or Paediatric A+E Consultant
  - An Anaesthetist or an Intensivist
  - Nurse

Team Competencies more important than professional label / affiliation

I am an Adult Intensivist. What has this got to do with me?



In the Report:

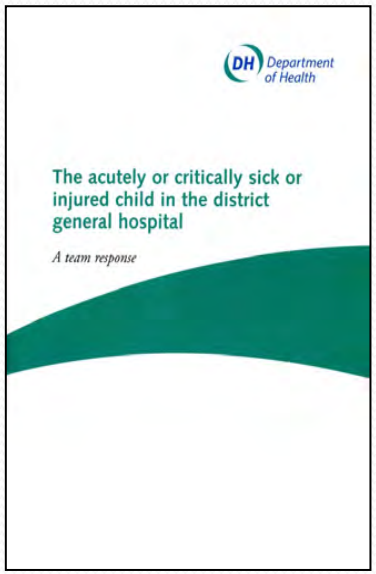
Report =written at a time when:

- substantial amount paediatric surgery done in DGHs
- many DGH anaesthetists had a regular, on going paediatric practice.

Since report written:

- DGH paediatric anaesthetic caseload fallen ((? by 30%)
- Change in the division of responsibilities between CCM and Anaesthesia (with respect to adults with life threatening illness)

I am an Adult Intensivist. What has this got to do with Me?"



Skills needed in the **resuscitation** and **stabilisation** of the critically ill or injured child

- Airway skills
- Establishment of ventilation
- Establishing iv access
- Correction of poor perfusion (acidaemia)

"Intensivists could be a valuable resource in assisting paediatricians and emergency department practitioners."

IBTICM recommends that:

"an intensivist with an adult medicine background who intends a DGH career should undertake three months' training in a PICU during the 12 months' higher specialist training."

1.7.3.

Outline

1. Overview
   - Why do children die?
   - Critique of UK paediatric health provision

2. *"I'm an adult intensivist. What this got to do with me?"*

Why you are important in the care of children with life threatening illness

- ***In a situation outside a tertiary paediatric centre where a seriously ill child will commonly present, very few paediatricians will have skills necessary to provide all aspects of care***

- **As intensivists (although working out of your comfort zone) you have many of the skills to compliment your paediatric colleague in a team.**

3. Cases to consider – it could be you.

Core of presentation:

Acutely ill children:

- that may present to any open access A+E Dept!
- area where most likely to be expected to assist but least comfortable
- **Reasonable evidence that changes in care will deliver improved outcomes**
  - Evidence of room for improved outcomes = possible
- Not focus on major trauma
  - Outcomes in UK are good by European standards
  - Centralised to Paediatric Major Trauma Centres
  - You feel comfortable with trauma


Si corpus meum crudi ig-
ni, caritate amor non ha-
beam, nihil utilitatis, &c
Smith
O Lord strengthen them.
Cranmer
Latimer
Ridley
Father of Heaven re-
ceive my soul.
Master Ridley, I will re-
member your suit.

Personal View (Heresy)

“Children are little Adults”

- Focus on commonality approach seriously ill adults + children
- Highlight important areas of difference between adults and children

Case 1 History.

Called by Paediatricians to assist in care of In Patient:

Charlotte

Age = 23 mths (11kg) Previously well

Admitted 12 hrs ago --- Temp (37^6 C), malaise, vomiting.
No obvious Primary focus

Observed and investigations

Condition changed:

- Rigor + Raised temperature
- Drowsy

Case 1 Major illness: Examination.

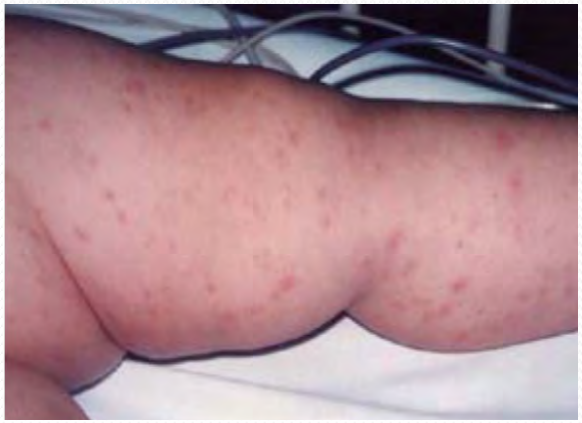
A Whimpering

B RR = 34/min
SaO2 = 100% on high flow oxygen

C Pulse = 170
Cap refill = 4s (BP=50/15)
Cold below knees

D V (on AVPU)
No signs of meningeal irritation

E Non blanching rash on legs



Case 1 Major Illness: Initial Resuscitation:

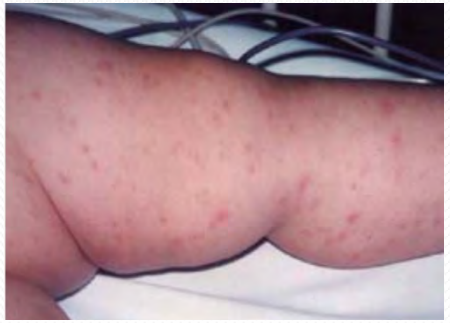
Presumptive Diagnosis = **SEPSIS**

Management so far:

- Two iv cannulae in place
- Fluid resuscitation (40mls/kg)

Bloods

- FBC, CRP, U+E, glucose
- Blood Cultures, PCR meningocoocal
- Requires Broad spectrum antibiotics (Ceftriaxone)
- **Glucostix = 1.2mmol/l** (2mls/kg 10% glucose)



What are <u>you</u> going to do next?

Differences in Children 1: Normal values and practicalities

Normal values:

- Definitions tachycardia / tachypnoea = age dependent

Age:	Respiratory rate /min	Heart rate /min
< 1 year	30-60	100-160
1-2 years	24-40	90-150
2-5 years	22-34	80-140
6-12 years	18-30	70-120
>12 years	12-16	60-100

- Lower limit of systolic Blood Pressure (5th Centile):

  0-1 month = 60mmHg,

  1 month to 1 year = 70mmHg

  1-10 years = 70 +(2 x age in years)

Practicalities:

- Establishment of invasive monitoring in children (awake or asleep) can be difficult

Differences in Children 2:
Definitions of Sepsis in Children are different

Septic Shock

- = A Clinically Diagnosis in children (not cellular based)

- **Abnormal Temperature (<36C or >38.5C)**

  +

- **Signs of inadequate tissue perfusion (any of the following)**
  - Decreased / altered mental state
  - Prolonged Capillary Refill
  - Diminished or bounding pulses
  - Decreased Urine Output (<1ml/kg/hour)

Hypotension (very, very late sign in children) is not necessary for the clinical diagnosis of septic shock in children

Differences in Children 3:
Definitions of Sepsis in Children are different

Primary cardiovascular pathological derangement in sepsis in children = different from adults

- **Children = reduced Oxygen delivery to tissues**
  - **major cause = profound hypovolaemia**

- Adults = reduced oxygen extraction at tissue level

Differences in Children 4. Haemodynamic changes in shock:

ARTICLE

Distinct Hemodynamic Patterns of Septic Shock at Presentation to Pediatric Intensive Care

Joe Brierley, MA[a,b], Mark J. Peters, PhD[a,b]

[a]Paediatric Intensive Care Unit and Neonatal Intensive Care Unit, Great Ormond Street Hospital for Children, London, England; [b]Critical Care Group, Portex Unit, Institute of Child Health, London, England

Haemodynamic changes in septic shock in children even after fluid resuscitation are different from adults

Observational study of children with suspected fluid resistant shock (minimum 40mls/kg)

Predominant Haemodynamic picture:

- **Community acquired sepsis:**
  - **Low or Normal Cardiac Index** (<3.3 l/min/m² or 3.3-5.5)
  - 12 of 14 patients
  - **Cold Shock**
  - Capillary refill >3secs, reduced peripheral pulses, narrow pulse pressure

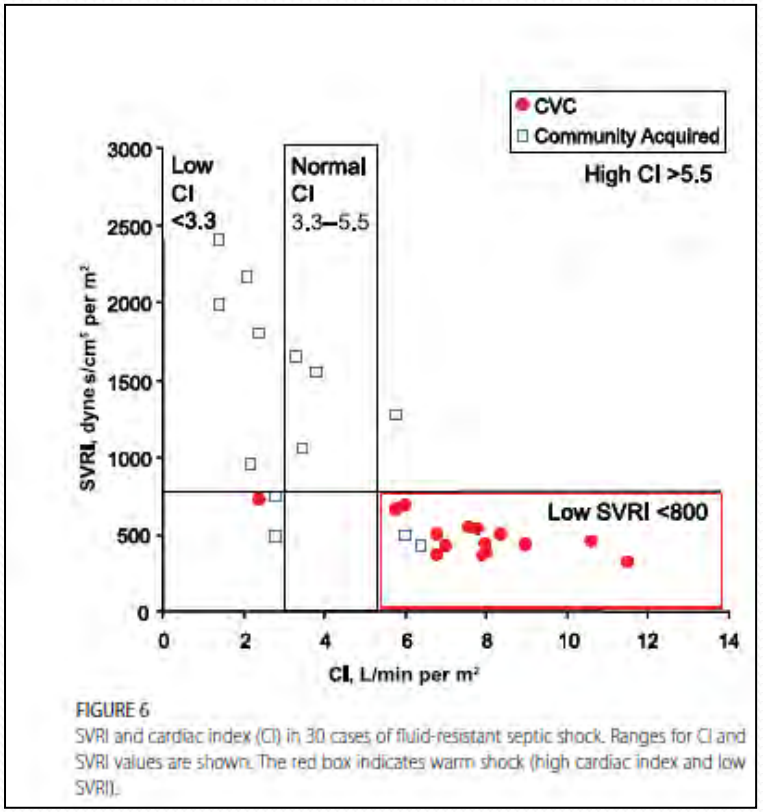


FIGURE 6
SVRI and cardiac index (CI) in 30 cases of fluid-resistant septic shock. Ranges for CI and SVRI values are shown. The red box indicates warm shock (high cardiac index and low SVRI).

Pediatrics (2008) 122; 752-9

Differences in Children 4. Haemodynamic changes in shock:

ARTICLE

Distinct Hemodynamic Patterns of Septic Shock at Presentation to Pediatric Intensive Care

Joe Brierley, MA[a,b], Mark J. Peters, PhD[a,b]

[a]Paediatric Intensive Care Unit and Neonatal Intensive Care Unit, Great Ormond Street Hospital for Children, London, England; [b]Critical Care Group, Portex Unit, Institute of Child Health, London, England

Observational study of children with suspected fluid resistant shock (minimum 40mls/kg)

Predominant Haemo-dynamic picture:

- **Central venous catheter associated infection:**
  - High Cardiac Index (>5.5 l/min/m²)
  - Low Systemic Vascular Resistance Index (, 800 dyne s/cm³ per m²)
  - 15 of 16 patients
  - **Warm Shock**
  - Instantaneous Capillary refill, bounding peripheral pulses, warm to edges

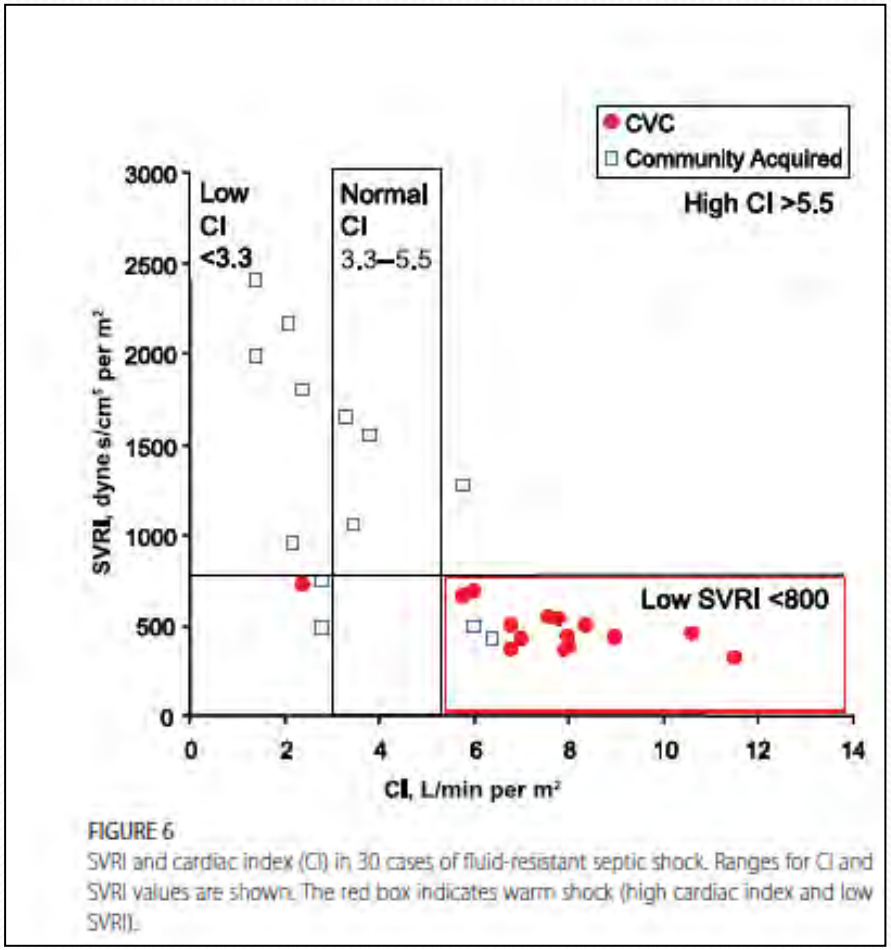


FIGURE 6
SVRI and cardiac index (CI) in 30 cases of fluid-resistant septic shock. Ranges for CI and SVRI values are shown. The red box indicates warm shock (high cardiac index and low SVRI).

Pediatrics (2008) 122; 752-9

Differences in Children 5.
Treatment goals in Resuscitation:

Because of difficulties of undertaking invasive haemodynamic access **Resuscitation Goals** and **Management Guidelines** in paediatrics focus on clinical goals rather than biochemical / invasive hemodynamic ones initially.

Resuscitation Goals in first hour:

- Maintain airway, oxygenation, ventilation (as adult)
- Circulatory goals = more clinical
  - Capillary refill < 2 seconds
  - Normal pulses
  - Warm extremities
  - Normal mental status
  - Urine output > 1ml/kg/hour
  - Normal BP

Less emphasis on CVP, SvO_2 and lactate (adults)

Case 1.
What would you do next?

Clinical details:
Age 23 months

- Abnormal temperature
- Abnormal conscious level
- Pulse= 170 (tachycardia) Resp Rate = 34 / min (Tachypnoea)
- Signs of poor Poor Tissue perfusion
  - Capillary refill / cool peripheries despite 40mls/kg fluid

Key Treatments already done as adult = Cultures, Antibiotics, Fluid boluses.
Key treatment already done as child = Hypoglycaemia corrected

Diagnosis = Septic Shock
Typical Paediatric picture **"Cold shock"**

Despite 40mls/kg fluid not achieved our clinical goals (capillary refill < 2 seconds etc)

Case 1.
What would you do next?

Patient has received 40mls/kg High flow Oxygen in place
On Assessment = Patient is still shocked
Pulse =170, Cap refill = 4s, Cold peripheries
(Clinical goals not reached)

How should we resuscitate further?

- **Further fluid resuscitation?**
  - Which ones?
  - How much?
  - When do we stop?

- **Inotropic support**
  - Which ones?
  - When?
  - Which routes?

- **Intubate and ventilate**
  - When should we do it?
  - Which drugs should I use?

Case 1.
What would you do next?

Clinical details:
Age 23 mths

- Abnormal temperature Abnormal conscious level
- Pulse= 170 (tachycardia) Resp Rate = 34 / min (Tachypnoea)
- Poor Capillary refill / cool peripheries despite 40mls/kg fluid

Key Treatments already done as adult = Cultures, Antibiotics, Fluid boluses.
Key treatment already done as child = Hypoglycaemia corrected

What is the diagnosis?

Diagnosis = Septic Shock ("Cold shock")

- Abnormal temperature + signs inadequate tissue perfusion

More than this =

- Fluid resistant septic shock

Case 1.
What would you do next?

Clinical details:
Age 23 mths

- Abnormal temperature Abnormal conscious level
- Pulse= 170 (tachycardia) Resp Rate = 34 / min (Tachypnoea)
- Poor Capillary refill / cool peripheries despite 40mls/kg fluid

Key Treatments already done as adult = Cultures, Antibiotics, Fluid boluses.
Key treatment already done as child = Hypoglycaemia corrected

Diagnosis = Fluid resistant Septic Shock ("Cold shock")

Primary abnormality = Hypovolaemia

Give fluids until clinical evidence fluid overload

1. **Further fluid resuscitation- 20mls /kg boluses Crystalloid or Human Albumin solution**
    1. Success judged clinically (pulse /cap refill / respiratory rate)
    2. Continue giving fluids until get Crepitations in chest / liver enlargement

Case 1.
What would you do next?

Diagnosis = Fluid resistant Septic Shock ("Cold shock")

1. Further fluid resuscitation- 20mls /kg boluses Crystalloid or Human Albumin solution

2. **Commence Inotrope early**
   1. **Dopamine (10mcg/kg/min) or Adrenaline 0.1mcg/kg/min**
   2. **May be commenced peripherally or Inter osseous (IO)**

Inotrope preparation and infusion rates

Inotrope	Infusion (mg in 50mls)	Dose	Dose range
Dopamine (PVL)	3 x weight (kg) mg	1ml/hr=1mcg/kg/min	5 – 15mcg/kg/min
Dopamine (CVL)	30 x weight (kg) mg	1ml/hr=10mcg/kg/min	5 – 15mcg/kg/min
Adrenaline (CVL)	0.3 x weight (kg) mg	1ml/hr= 0.1mcg/kg/min	0.1 – 2mcg/kg/min
Norad (CVL)	0.3 x weight (kg) mg	1ml/hr=0.1mcg/kg/min	0.1 – 2mcg/kg/min
Milrinone (either)*	1.5 x weight (kg) mg	1ml/hr=0.1mcg/kg/min	0.3 – 1mcg/kg/min

* no loading dose CVL = central line PVL = peripheral line

Case 1.
What would you do next?

Diagnosis = Fluid resistant Septic Shock ("Cold shock")

1. Further fluid resuscitation- 20mls /kg boluses Crystalloid or Human Albumin solution

2. **Commence Inotrope early**
   1. **Dopamine (10mcg/kg/min) or Adrenaline 0.1mcg/kg/min**
   2. **May be commenced peripherally or Inter osseous (IO)**

3. **Prepare to intubate the patient at this point (40-60mls/kg) –need invasive access**
   1. **To give inotropes centrally**
   2. **Provide numbers to guide stabilisation phase**

- MUST have inotrope running before induction of anaesthesia
  - Ketamine 1-2mg/kg iv.
  - Cuffed versus uncuffed tube

Case 1.
What would you do next?

45 minutes post call:

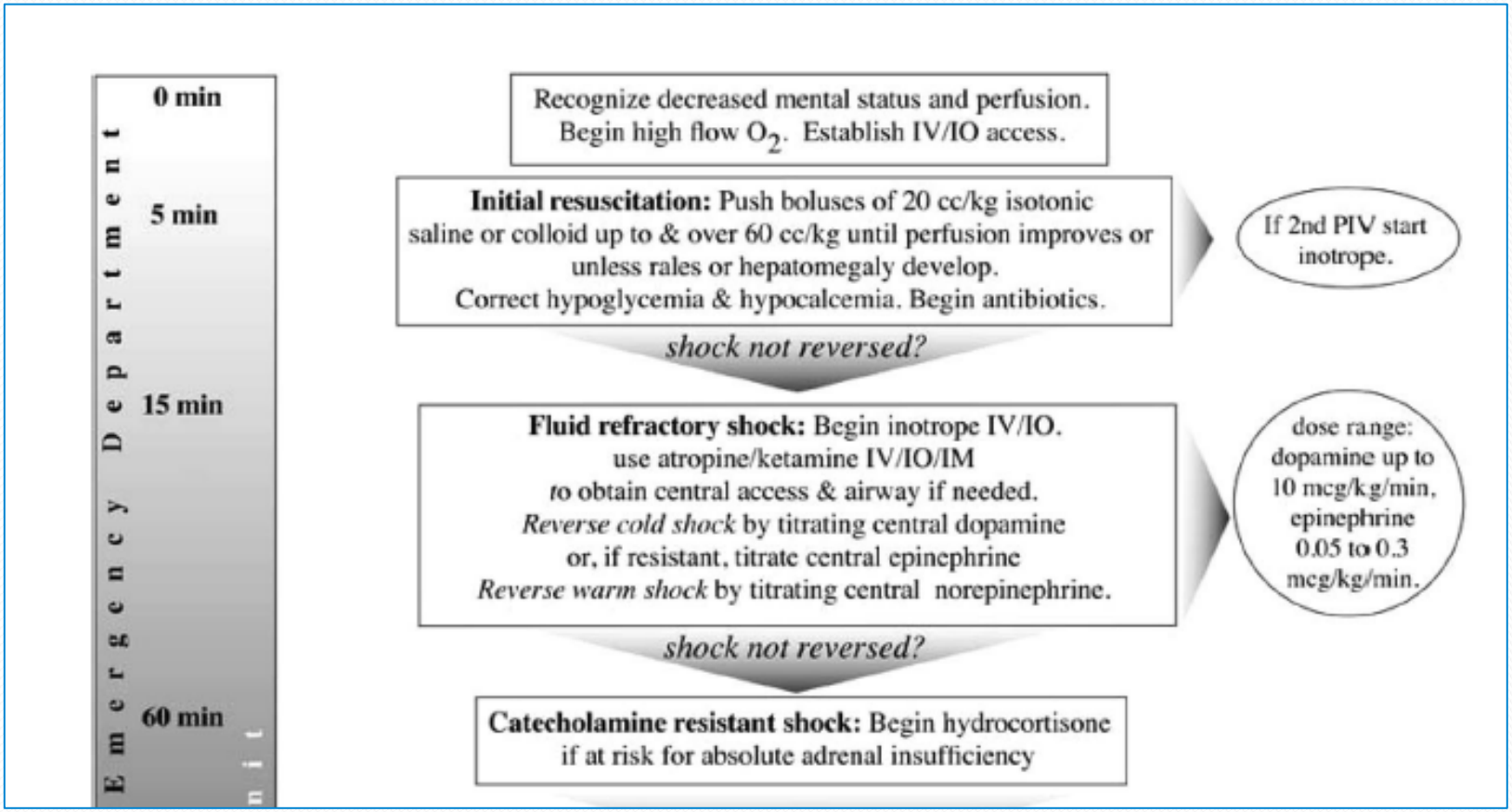
- A = Intubated
- B = Ventilated (Pressures 20/5 Rate 30/ min FiO2 =0.5)
- C = Pulse 175 regular ST, persistent temperature gradient, Cap refill = 4 seconds BP = 60/

  On dopamine 10mcg/kg/min peripherally

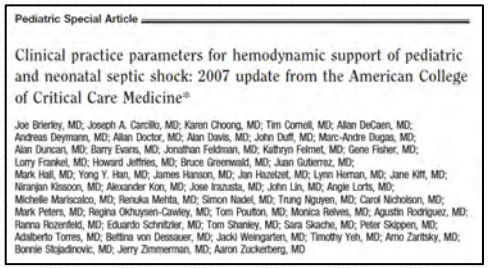
Next Steps:

- Insert arterial and central line
- Commence catecholamine centrally (Adrenaline @ 0.1mcg/kg/min)
- Consider hydrocortisone if at risk adrenal insufficiency

Practical Treatment of Septic Shock in a child (first 6 hours): Resuscitation:



Brierley J et al. Crit Care Medicine (2009) 37; 666-688


Pediatric Special Article

Clinical practice parameters for hemodynamic support of pediatric and neonatal septic shock: 2007 update from the American College of Critical Care Medicine*

Joe Brierley, MD; Joseph A. Carcillo, MD; Karen Choong, MD; Tim Cornell, MD; Allan DeCaen, MD; Andreas Deymann, MD; Allan Doctor, MD; Alan Davis, MD; John Duff, MD; Marc-Andre Dugas, MD; Alan Duncan, MD; Barry Evans, MD; Jonathan Feldman, MD; Kathryn Felmet, MD; Gene Fisher, MD; Lorry Frankel, MD; Howard Jeffries, MD; Bruce Greenwald, MD; Juan Gutierrez, MD; Mark Hall, MD; Yong Y. Han, MD; James Hanson, MD; Jan Hazelzet, MD; Lynn Hernan, MD; Jane Kitt, MD; Niranjan Kissoon, MD; Alexander Kon, MD; Jose Irazusta, MD; John Lin, MD; Angie Lorts, MD; Michelle Mariscalco, MD; Renuka Mehta, MD; Simon Nadel, MD; Trung Nguyen, MD; Carol Nicholson, MD; Mark Peters, MD; Regina Okhuysen-Cawley, MD; Tom Poulton, MD; Monica Reives, MD; Agustin Rodriguez, MD; Ranna Rozenfeld, MD; Eduardo Schnitzler, MD; Tom Shanley, MD; Sara Skache, MD; Peter Skippen, MD; Adalberto Torres, MD; Bettina von Dessauer, MD; Jacki Weingarten, MD; Timothy Yeh, MD; Arno Zaritsky, MD; Bonnie Stojadinovic, MD; Jerry Zimmerman, MD; Aaron Zuckerberg, MD

Practical Treatment of Septic Shock in a child (first hour): Stabilisation:

After first hour advice from Paediatric Regional Centre on subsequent management to stabilise patient.

- Therapeutic end points remain clinical
  - Normal pulses with no differential
  - Capillary refill < 2 seconds
  - Urine output > 1 ml/kg/hour
  - Normal mental status
- Normal mean arterial pressure
- **Adequate oxygen delivery (ScvO2 > 70%)**
- Normal cardiac output

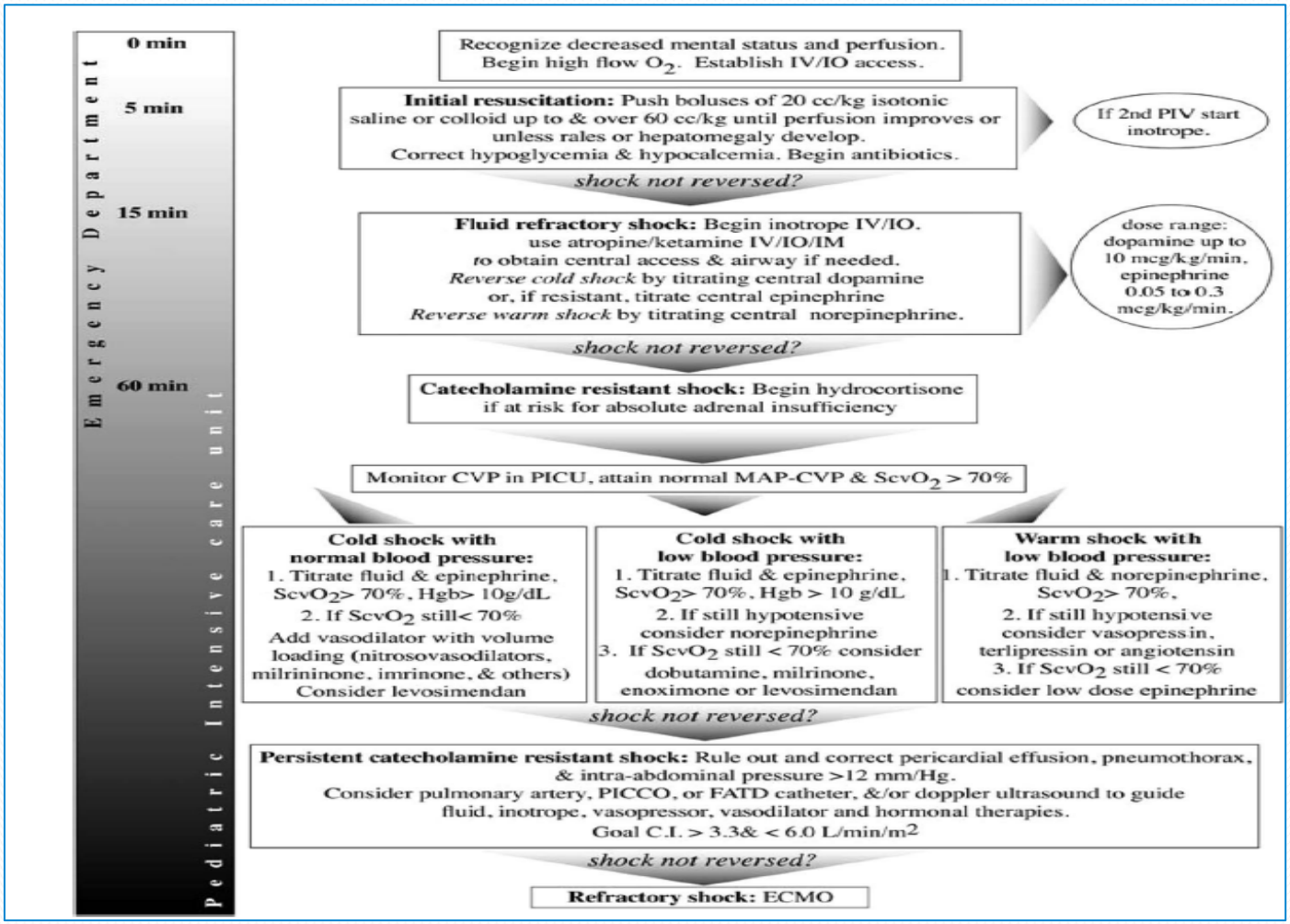
Practical Treatment of Septic Shock in a child (first 6 hours): Resuscitation / stabilisation:

ACCM 2007 Guidelines (Update of 2002 guidelines).

Pediatric Special Article

Clinical practice parameters for hemodynamic support of pediatric and neonatal septic shock: 2007 update from the American College of Critical Care Medicine*

Joe Brierley, MD; Joseph A. Carcillo, MD; Karen Choong, MD; Tim Cornell, MD; Allan DeCaen, MD; Andreas Deymann, MD; Allan Doctor, MD; Alan Davis, MD; John Duff, MD; Marc-Andre Dugas, MD; Alan Duncan, MD; Barry Evans, MD; Jonathan Feldman, MD; Kathryn Felmet, MD; Gene Fisher, MD; Lorry Frankel, MD; Howard Jeffries, MD; Bruce Greenwald, MD; Juan Gutierrez, MD; Mark Hall, MD; Yong Y. Han, MD; James Hanson, MD; Jan Hazelzet, MD; Lynn Heman, MD; Jane Kitt, MD; Niranjan Kissoon, MD; Alexander Kon, MD; Jose Irazusta, MD; John Lin, MD; Angie Lorts, MD; Michelle Mariscalco, MD; Renuka Mehta, MD; Simon Nadel, MD; Trung Nguyen, MD; Carol Nicholson, MD; Mark Peters, MD; Regina Okhuysen-Cawley, MD; Tom Poulton, MD; Monica Reives, MD; Agustin Rodriguez, MD; Ranna Rozenfeld, MD; Eduardo Schnitzler, MD; Tom Shanley, MD; Sara Skache, MD; Peter Skippen, MD; Adalberto Torres, MD; Bettina von Dessauer, MD; Jacki Weingarten, MD; Timothy Yeh, MD; Arno Zaritsky, MD; Bonnie Stojadinovic, MD; Jerry Zimmerman, MD; Aaron Zuckerberg, MD



Case 1 Septic Shock:
Progress and outcome:

Retrieval at 6 hours:

Received 100mls/kg fluid given
(40mls/kg saline, 30mls/kg HAS, 20mls/kg FFP, 10mls/kg blood)

Intubated / ventilated (35%O2 pressures 22/7)

CVS Pulse = 184/min BP= 93/41 Cap refill = 3 secs
Passing urine
(A line / CVP)

Blood culture = Streptococcus pyogenes

D = Toxic Shock syndrome

Survived intact

Summary:
Management of Septic shock in Children

Key Points:

- **Identify Septic Shock early.**
  - **Many children have triad of temperature, tachycardia and vasodilatation.**
  - **Look altered mental status and poor peripheral perfusion**
- **Early blood cultures + appropriate broad spectrum antibiotics**
- **Aggressive fluid resuscitation (crystalloid / albumin) to clinical end points**
- **Start inotropes early (Dopamine / Adrenaline) peripherally if central access not readily available.**

  Move to adrenaline centrally if dopamine resistant.
- **Intubation / ventilation once received 40-60mls/kg iv**

Sepsis in Children

Where is the evidence that this approach works?

No Randomised Controlled Trials in children of aggressive fluid therapy in septic shock in the developed World

Only one study showing aggressive fluid administration in first hour = beneficial

Post hoc Observational Study

- 34 children admitted from the ER of DC Children's Hospital, Washington

Compared children who had received in first hour:
Group 1 = < 20 mls/kg
Group 2 = 20-40 mls/kg
Group 3 = > 40mls/kg

Carcillo et al. Role of early fluid resuscitation in pediatric septic shock. JAMA (1991) 266; 1241-1245.

Role of Early Fluid Resuscitation in Pediatric Septic Shock

Joseph A. Carcillo, MD; Alan L. Davis, MD; Arno Zaritsky, MD

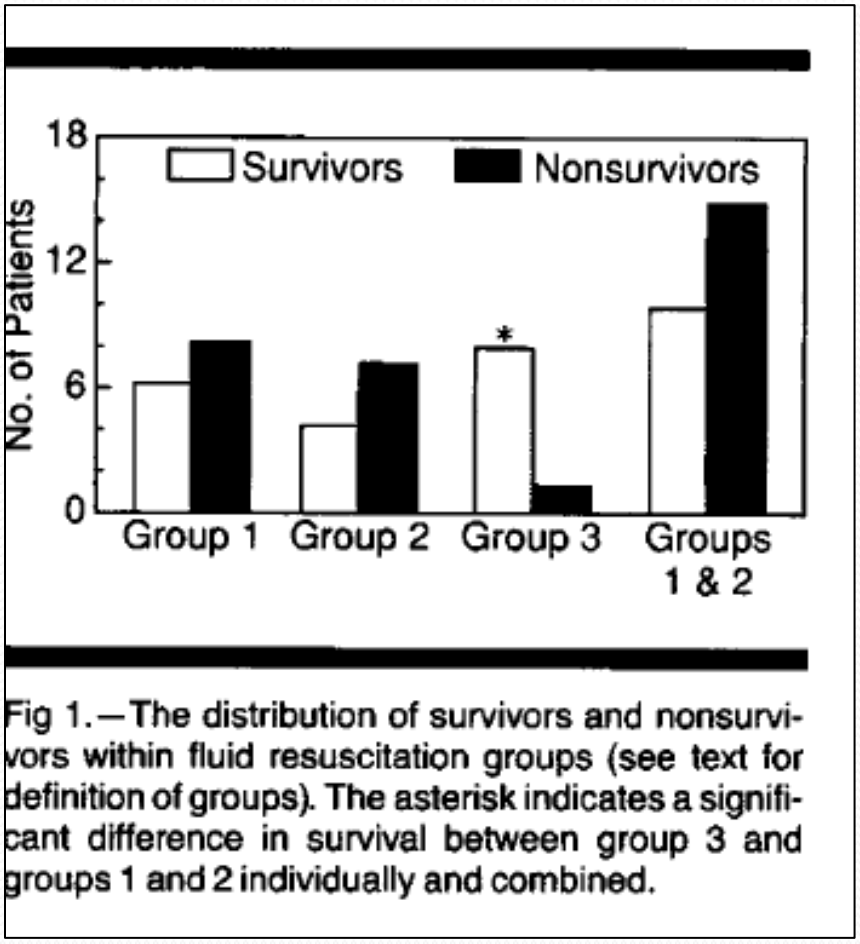


Fig 1.—The distribution of survivors and nonsurvivors within fluid resuscitation groups (see text for definition of groups). The asterisk indicates a significant difference in survival between group 3 and groups 1 and 2 individually and combined.

- Patients received fluid load based on clinical assessment
- No increase in ARDS in Group 3.

Carcillo et al. Role of early fluid resuscitation in pediatric septic shock. JAMA (1991) 266; 1241-1245.

Sepsis in Children
Where is the evidence that this approach works?

Early Reversal of Pediatric-Neonatal Septic Shock by Community Physicians Is Associated With Improved Outcome

Yong Y. Han, Joseph A. Carcillo, Michelle A. Dragotta, Debra M. Bills, R. Scott Watson, Mark E. Westerman and Richard A. Orr

Pediatrics 2003;112;793

Setting = Community hospitals around Pittsburgh, USA.

Review of outcomes of 91 infants and children presenting in sepsis

Compared children who received care based on ACCM-PALS Guidelines (2002)versus those who did not.
followed in 30% children.
Mortality:

- 8% where guidelines followed,
- 38% when not.

Sepsis in Children
Where is the evidence that this approach works?

Research

Open Access

Improved survival of children with sepsis and purpura: effects of age, gender, and era

Martine Maat[1], Corinne MP Buysse[2], Marieke Emonts[1], Lodewijk Spanjaard[3], Koen FM Joosten[2], Ronald de Groot[4] and Jan A Hazelzet[2]

[1]Department of Paediatrics, Division of Infectious Diseases and Immunology, Erasmus MC-Sophia Children's Hospital, University Medical Center, Dr. Molewaterplein 60, 3015 GJ Rotterdam, The Netherlands
[2]Department of Paediatrics, Division of Paediatric Intensive Care, Erasmus MC-Sophia Children's Hospital, University Medical Center, Dr. Molewaterplein 60, 3015 GJ Rotterdam, The Netherlands
[3]Netherlands Reference Laboratory for Bacterial Meningitis, Department of Medical Microbiology, Academic Medical Center Amsterdam, Meibergdreef 15, 1100 DD Amsterdam, The Netherlands
[4]Department of Paediatrics, University Medical Center St. Radboud, Geert Grooteplein 10, 6500 HB Nijmegen, The Netherlands

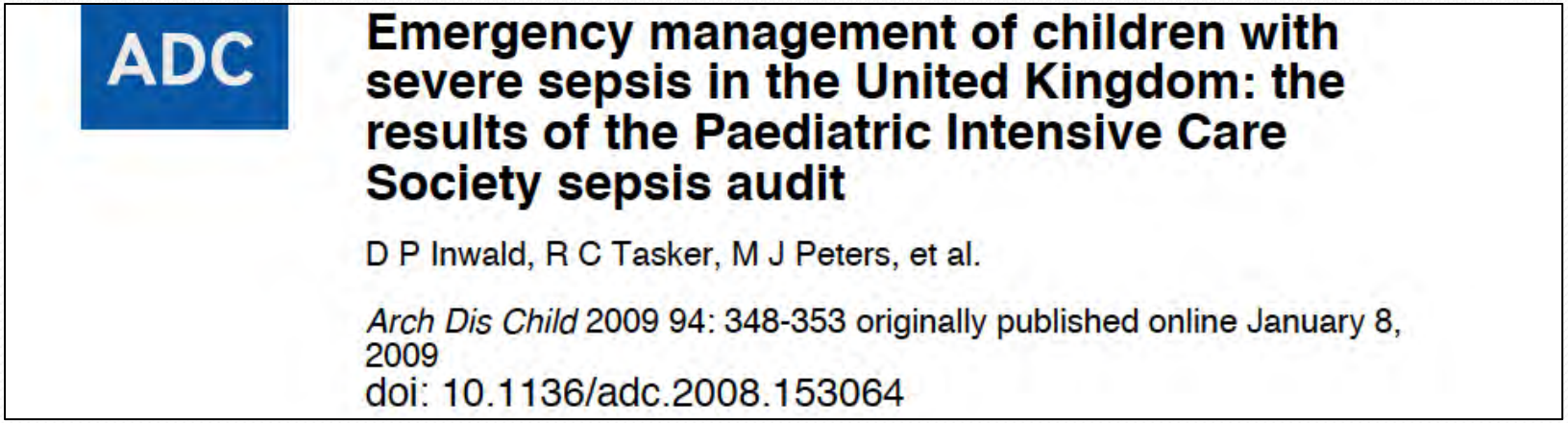
Corresponding author: Jan A Hazelzet, j.a.hazelzet@erasmusmc.nl

Received: 18 Jun 2007 Revisions requested: 18 Jul 2007 Published: 16 Oct 2007

Critical Care 2007, 11:R112 (doi:10.1186/cc6161)

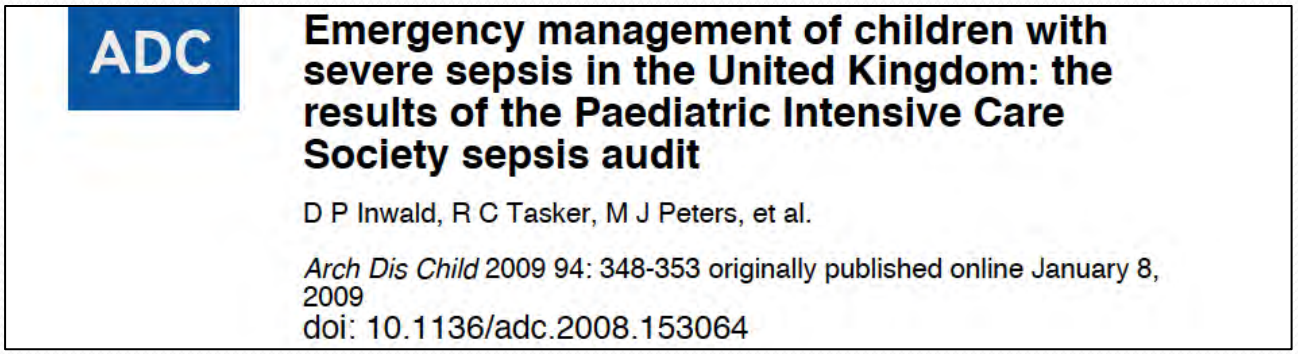
- Sophia Children's Hospital, Rotterdam (Tertiary Paediatric Centre):
- Change of practice Audit:
  - Fall in death rate from severe sepsis + purpura from 20% to 1% with introduction of guidelines

Sepsis in Children.
How are we doing in UK?



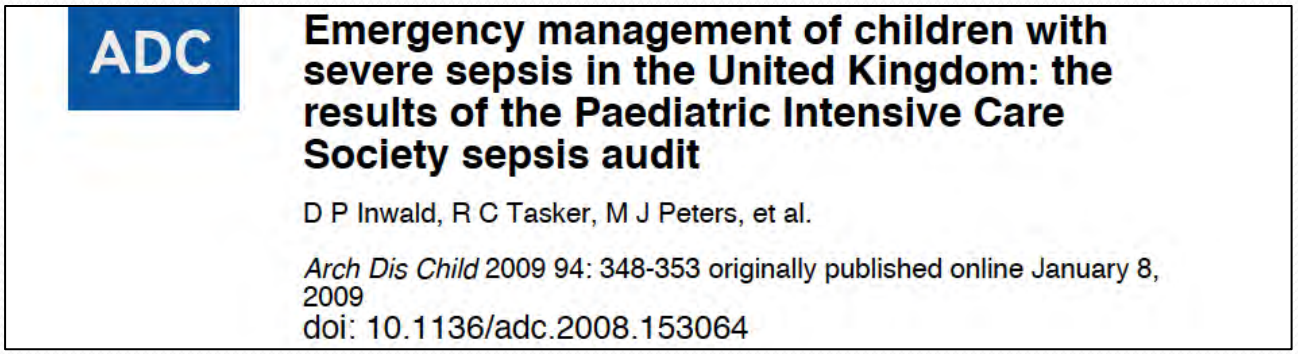
- Observational Study
- All children in UK referred to 17 PICUs + 2 Transport services with provisional diagnosis of Sepsis (SIRS + possible infection)
- December 2006 – May 2007
- Looked at whether ACCM –PALS (or APLS) resuscitation guidelines followed pre –arrival Retrieval team

Sepsis in Children.
How are we doing in UK?



- 200 children diagnosis confirmed
- Median Age = 13.6 months (IQR 3-40months)
- 107 children had or developed severe septic shock
- 17% (34) children died
- Median Retrieval Time = 7.6 hours (IQR 5 – 12 hours)

Sepsis in Children.
How are we doing in UK?



Analysis of 107 children with severe septic shock:

- 20% - Did not receive >60mls/kg fluid despite persistent shock
- 15% - Inotropes not started despite shock being fluid refractory
- 23% - Catecholamine not started despite being non responsive to Dopamine

GUIDELINES ONLY FOLLOWED IN 36% OF PATIENTS

Sepsis in Children
What affects outcome in UK?

The role of healthcare delivery in the outcome of meningococcal disease in children: case-control study of fatal and non-fatal cases

Nelly Ninis, Claire Phillips, Linda Bailey, Jon I Pollock, Simon Nadel, Joseph Britto, Ian Maconochie, Andrew Winrow, Pietro G Coen, Robert Booy, Michael Levin

Case control study of comparing children who lived and died with meningococcal sepsis:

Three independent factors linked to poor outcome:

- Failure to recognise complications (altered mental status, respiratory failure etc)
- Lack of Consultant supervision
- **Failure to start an inotrope when required**
  - Odds Ratio Death = 24

British Medical Journal (2005) 330;

Sepsis in special situations.
1. In first month of life.

Patient 2:

Brian:
Uneventful term delivery Discharge at 24 hours
Represented 5 days old
C/O Poor feeding

O/E:
Hypothermic
Pulse = 200 (tachycardia)
Respiratory rate = 70/min (tachypnoea)
Capillary Refill = 5 seconds

Should a child of this age have the same approach?

Sepsis in special situations.
1. In first month of life.

Conclusions:

Picture very similar to first child

- Tachycardia, tachypnoea, poor capillary refill

Neonate:

Two other diagnosis to consider which give similar picture:

- **Duct dependent congenital heart disease**
  - ? Cardiac Murmurs, ? Femoral pulses (Coarctation)
  - Treatment = Prostaglandin E1 infusion @ 10ng/kg/min + Intubation and Ventilation.
- **Inborn error of metabolism**
  - Raised serum Ammonia levels, Consanguinity, Family H/O Infant or Neonatal death
  - Multiple (congenital abn of Urea cycle or organic acidaemias)
  - 10% Dextrose Infusion + Specialist advice

Sepsis in special situations.
2. In the Developing World.

Kalifi district hospital, Kenya

Mohammed Aged 2 years

- Unwell for several days.
- Febrile illness and prostration (unable to sit up)

O/E: Temperature

Pulse = 170 Poor capillary refill Cool peripheries

Increased work of breathing

By initial definition – temperature + abnormal tissue perfusion = Septic Shock

Management?

Sepsis in special situations.
2. In the Developing World.

Management?

Remember – major cause of death in children in Africa = sepsis

- Antibiotics
- Anti malarials if film positive
- Consider transfusion if severely anaemic (Hb< 5g/%)

- Aggressive fluid therapy as western world (not widely done in Africa)?
- (Inotropic agents / ventilation not available)

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

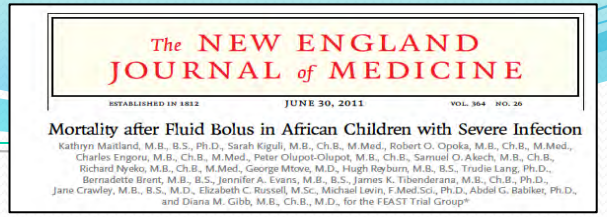
Kathryn Maitland, M.B., B.S., Ph.D., Sarah Kiguli, M.B., Ch.B., M.Med., Robert O. Opoka, M.B., Ch.B., M.Med., Charles Engoru, M.B., Ch.B., M.Med., Peter Olupot-Olupot, M.B., Ch.B., Samuel O. Akech, M.B., Ch.B., Richard Nyeko, M.B., Ch.B., M.Med., George Mtove, M.D., Hugh Reyburn, M.B., B.S., Trudie Lang, 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*

Kathryn Maitland

Professor of Paediatric Infectious Disease

Imperial College, London / Kalifi Kenya

Multicentre, open randomised, controlled study.


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*

To assess:
The effectiveness of Fluid Expansion as Supportive Therapy

Population:

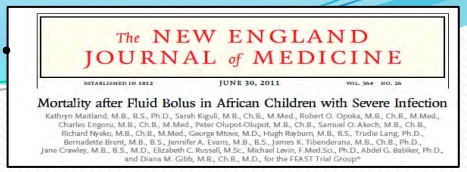
- Children aged 2 months to 12 years presenting in compensated shock
- Must have:
  - **severe febrile illness** +
  - **Impaired perfusion** (cap refill >3secs, lower limb temperature gradient, weak radial pulses) +
  - **Systemic effects of reduced perfusion** (increased work of breathing and / or altered level of consciousness (prostration / coma)
- (Excluded if gastroenteritis , severe malnutrition, non infectious cause for shock, severe hypotension)

Site = Six District Hospital in East Africa

Randomised to receive in first hour in addition to maintenance fluids:
20mls/kg 0.9% Saline vs 20mls/kg 5% HAS vs No bolus fluid
Further bolus at 1 hour if impaired perfusion still present

End point = Death rate at 48 hours

Multicentre, open randomised, controlled study.


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

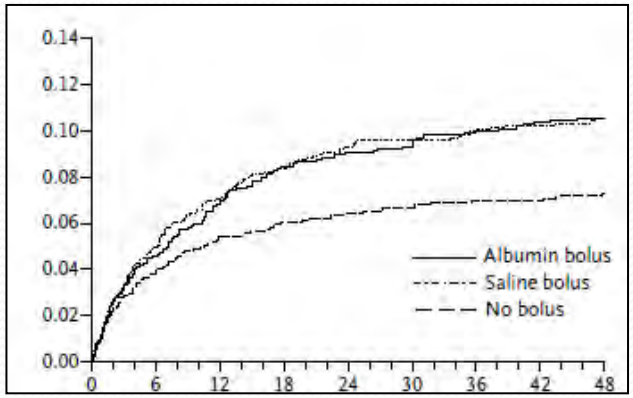
Kathryn Maitland, M.B., B.S., Ph.D., Sarah Kiguli, M.B., Ch.B., M.Med., Robert O. Opoka, M.B., Ch.B., M.Med., Charles Engoru, M.B., Ch.B., M.Med., Peter Olupot-Olupot, M.B., Ch.B., Samuel O. Akech, M.B., Ch.B., Richard Nyeko, M.B., Ch.B., M.Med., George Mtoro, M.D., Hugh Reyburn, M.B., B.S., Trudie Lang, 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*

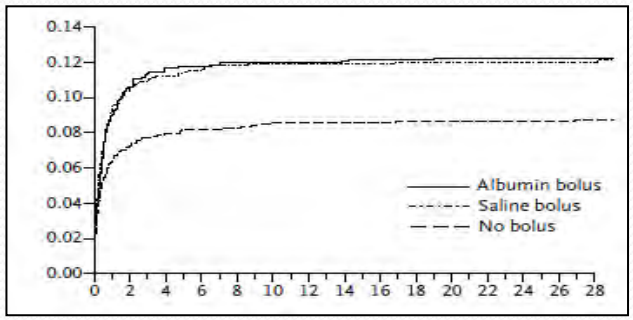
To assess:

The effectiveness of Fluid Expansion as Supportive Therapy

Results:

	Number of patients	Number died by 48hours	% who died by 48 hours
Control	1044	76	7.3%
Saline	1047	110	10.5%
Human Albumin solution 5%	1050	111	10.6%





Fluid bolus therapy = associated with 3.3% increase risk of death at 48 hrs.

Implications of Study:

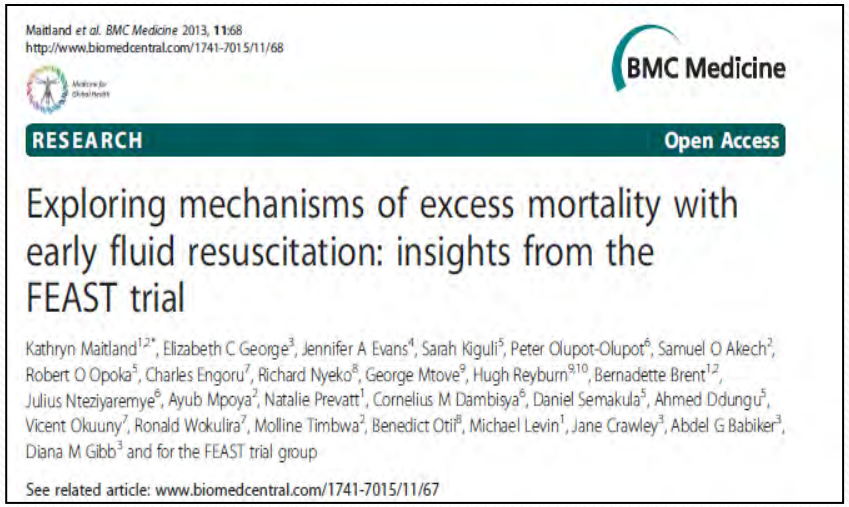
- Controversial
- Relevance to developed world

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*



Maitland et al. BMC Medicine 2013, 11:68
http://www.biomedcentral.com/1741-7015/11/68

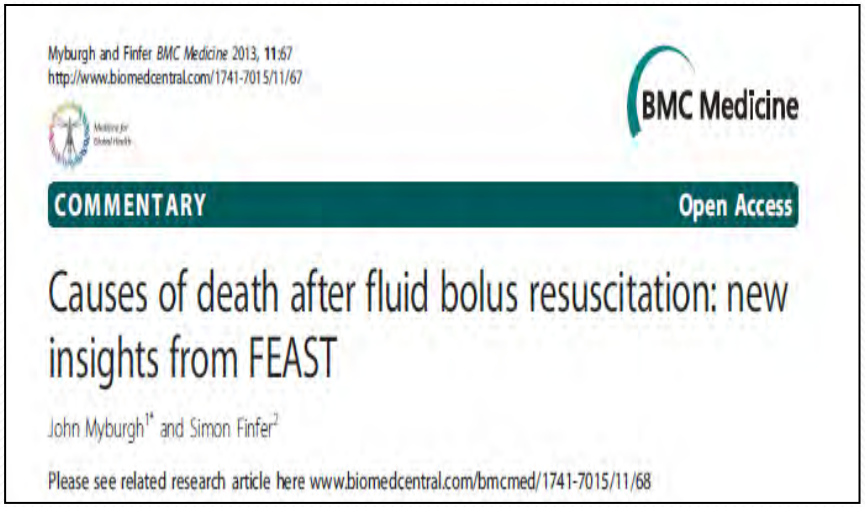
BMC Medicine

RESEARCH Open Access

Exploring mechanisms of excess mortality with early fluid resuscitation: insights from the FEAST trial

Kathryn Maitland[1,2*], Elizabeth C George[3], Jennifer A Evans[4], Sarah Kiguli[5], Peter Olupot-Olupot[6], Samuel O Akech[2], Robert O Opoka[5], Charles Engoru[7], Richard Nyeko[8], George Mtove[9], Hugh Reyburn[9,10], Bernadette Brent[1,2], Julius Nteziyaremye[6], Ayub Mpoya[2], Natalie Prevatt[1], Cornelius M Dambisya[6], Daniel Semakula[5], Ahmed Ddungu[5], Vicent Okuuny[7], Ronald Wokulira[7], Molline Timbwa[2], Benedict Oti[8], Michael Levin[1], Jane Crawley[3], Abdel G Babiker[3], Diana M Gibb[3] and for the FEAST trial group

See related article: www.biomedcentral.com/1741-7015/11/67



Myburgh and Finfer BMC Medicine 2013, 11:67
http://www.biomedcentral.com/1741-7015/11/67

BMC Medicine

COMMENTARY Open Access

Causes of death after fluid bolus resuscitation: new insights from FEAST

John Myburgh[1*] and Simon Finfer[2]

Please see related research article here www.biomedcentral.com/bmcmed/1741-7015/11/68

South Thames Retrieval Service Guideline

Meningococcal sepsis (early management)

South Thames RETRIEVAL SERVICE

Initial Intervention

- Intravenous access x 2 quickly
- Intraosseus if iv difficult
- Baseline FBC, clotting, B/C, U&E, PCR, gas, Xmatch
- Antibiotics early. Ceftriaxone 80mg/kg over 30 mins
- Evaluate level of consciousness and pupils

Initial resuscitation

- High flow O_2. Maintain saturation >95%
- Shocked – tachycardia / poor pulses / obtunded / low BP
- Push 20mls/kg crystalloid[2] bolus and review HR / BP
- Repeat 20mls x 2 crystalloid bolus if no response

Intubate NOW if

1. Fluid refractory shock* (shock despite >40-60mls/kg)
2. Altered level of consciousness
3. Signs of raised ICP
4. Hypoxia

*Fluid refractory shock

- Start peripheral dopamine 10mcg/kg/minute
- Titrate to response (max 15mcg/kg/min)
- Intubate and ventilate : expect decompensation

INTUBATION

- Early intubation for shock improves outcome
- Most experienced operator to intubate
- Induction of anaesthesia may cause cardiovascular instability : consider ketamine
  - NG tube and aspirate stomach
  - Pre-oxygenate for 3 minutes
  - Ongoing volume resuscitation throughout
  - Peripheral dopamine 10mcg/kg/min infusing
  - Cardiac arrest drugs available
- Avoid nasal intubation if coagulopathic or low platelets
- May require high PEEP if pulmonary oedema

Gain CVL (avoid neck as bleeding risk)
Infuse dopamine centrally
Increase up to 15 mcg/kg/min & reassess

Warm shock
Wide pulse pressure

Start nor-adrenaline @ 0.1 mcg/kg/min
Titrate to response (max 1mcg/kg/min)

Cold shock
Narrow pulse pressure

Start adrenaline @0.1 mcg/kg/min
Titrate to response (max 1mcg/kg/min)

no or minimal response = catecholamine resistant shock

- give IVI hydrocortisone 2mg/kg bolus[4]
- exclude other causes (pericardial effusion, pneumothorax, ongoing blood loss, intracranial event)

low BP, warm shock
-Add adrenaline

low BP, cold shock
-Maximise adrenaline
-Start milrinone (no loading)

normal BP, cold shock
-Start milrinone (no loading)

Risk factors and alerts

- Age < 12 months
- Extensive/ rapidly spreading rash[1]
- Low platelets/ low wbc / coagulopathy :may be normal initially & rapidly change
- Persistent tachycardia despite fluid therapy
- Hypotension is late sign
- Obtundation and depressed level conciousness
- NB 20% have no rash

Persistent tachycardia = under-resuscitation
Aggressive reversal of shock improves outcome
Urgent intervention & reassessment is key

Depressed level of consciousness (LOC)

- Raised ICP: Fluctuating LOC, relative bradycardia, posturing or seizures
- Give osmotherapy 3% saline 3-5 ml/kg (preferable to mannitol as preserved BP)
- Intubate and ventilate (poor airway protection)
- Maintain blood pressure for cerebral perfusion
- Treat seizures (phenytoin). NB: correct Na if hyponatraemia
- Impending herniation: hyperventilate, give further 3 ml/kg 3% saline
- Consider steroids (hydrocortisone 4-8 mg/kg IV over 5 minutes)
- DO NOT PERFORM LUMBAR PUNCTURE [3]

Ongoing support

- Monitor central temp, invasive BP, CVP, ABG, lactate & mixed venous sats
- Ongoing large volume resuscitation often required despite inotropes
- Consider early use of blood products to optimise haemoglobin (maintain Hb > 10g/dl; oxygen delivery) and correct clotting abnormalities
- Persistent tachycardia : cool actively to 36-37C using ice to the head or IVI saline at 4C (produces rapid cooling)
- Correct potassium
  - < 3 mmol/l give 0.5 mmol/kg kcl over 1 hour
  - > 6 mmol/l give Ca gluconate / insulin & dextrose & check CK ASAP – may require urgent CVVH on arrival on unit

Inotrope preparation and infusion rates

Inotrope	Infusion (mg in 50mls)	Dose	Dose range
Dopamine (PVL)	3 x weight (kg) mg	1ml/hr=1mcg/kg/min	5 – 15mcg/kg/min
Dopamine (CVL)	30 x weight (kg) mg	1ml/hr=10mcg/kg/min	5 – 15mcg/kg/min
Adrenaline (CVL)	0.3 x weight (kg) mg	1ml/hr= 0.1mcg/kg/min	0.1 – 2mcg/kg/min
Norad (CVL)	0.3 x weight (kg) mg	1ml/hr=0.1mcg/kg/min	0.1 – 2mcg/kg/min
Milrinone (either)*	1.5 x weight (kg) mg	1ml/hr=0.1mcg/kg/min	0.3 – 1mcg/kg/min

* no loading dose CVL = central line PVL = peripheral line

Public Health

- Inform Public Health of possible meningococcal infection
- Ciprofloxacin prophylaxis for close contacts

References

1. Van den Berghe: Crit Care Med 2003 31, 2, 359-366
2. Carcillo: Crit Care Med 2002:30, 6 1365-783
3. Baines: Arch Dis Child:2000: 83, 510-13
4. Baines: Br J Anaesth 2003:30 1, 72-83
5. Rennick: BMJ 1993: 306, 6883, 953-955

STRS Clinical Guideline
Jan 2007.
Review Jan 2009

Case 2
Respiratory

- Tasmin Male 2yrs 9 months
- 20th January 2014 0130hrs
- Called by Paediatric Consultant Colleague
- **Does this child need intubating and ventilating?**

Case 2
Respiratory

- Previously well child
- Unwell for 4 days
- Came back from nursery with “cough”
- Listless and lethargic since then.
  Off his food
  Today *“not breathing very well”* Working diagnosis = Croup

Treatment:

- Nebulised Budesonide 4 hours ago
- Nebulised adrenaline 10 minutes ago
  No improvement

What are going to do? How do you answer their question?

Case 2
Respiratory

See the child.

Three part clinical assessment

How hard is the child working (**EFFORT** of breathing)?

- Child asleep on bed tolerating oxygen mask close to face
- Respiratory rate = 30/minute regular
- Mild intercostal recession and tracheal tug
- No gross accessory muscle usage
- Quiet inspiratory stridor

Impression?

Case 2
Respiratory

How EFFECTIVE is the work of breathing child (**EFFICACY**)?

- Very poor air entry to auscultation through out chest
- SaO2 = 92% on high flow oxygen
- (Medical treatments no improvement)

EFFECT on other organ system:

- Conscious level (asleep / ? exhausted)
- Heart rate

Impression?

Case 2
Respiratory

Management:

- Mode of transfer to theatre.
- Theatre preparation
- Who you gonna call?

Case 2
Respiratory

Management:

- Mode of transfer to theatre.
- Theatre preparation
- Who you gonna call?

Case 2
Tasmin

Transfer:

- Facemask oxygen on Mum's lap
- Resuscitation / intubation equipment
- Do not try to cannulate
- Cough on journey (brief desaturation)

Case 2
Tasmin

Induction of anaesthesia:

- Gaseous induction (Sevoflorane in Oxygen)
- Laryngoscopy when deep
- Intubation (3mm Microcuff tube) – minimal leak
- Changed to Nasal

Management of infective Upper Airway Obstruction

Assessment:

- **Effort** of breathing
- **Efficacy**
- **Effect** on other organ systems

Induction of anaesthesia:

- Minimal disturbance
- Gaseous induction

The child with blunt trauma to the neck

Shannon

Aged 6 years

Tripped whilst carrying tray of cups up wooden steps striking front of neck on edge of step

Presents to A+E

C/O:

Mild pain on front of neck

The child with blunt trauma to the neck:

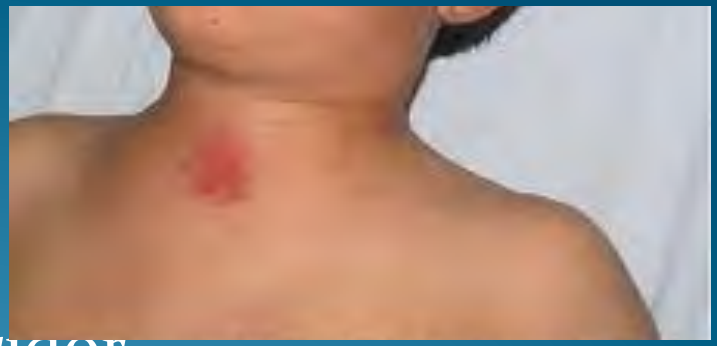
Initial management of Shannon?

O/E:

Able to talk in full sentences

Voice has changed

Surgical emphysema of neck



RR = 15 / minute No Stridor

No Accessory muscle usage

Good Air Entry bilaterally SaO_2 = 99% (Air)

Management?

The child with blunt trauma to the neck:

Initial management:

Key questions to ask:

- Is the airway stable (safe)?
- Is there significant damage to the larynx / upper airway?
- Is their damage to other structures (blood vessels, cervical spine)?

The child with blunt trauma to the neck:

Initial Assessment of an airway:

- **Effort**
  - Respiratory rate
  - Accessory muscle usage
- **Efficacy**
  - Air entry
- **Effectiveness**
  - Peripheral oxygen saturation (SaO_2)
  - Level of Consciousness

The child with blunt trauma to the neck:

Initial management of Shannon:

Key questions to ask:

- Is the airway stable (safe)? YES (at present)
- Is there significant damage to the larynx / upper airway?
- Is their damage to other structures (blood vessels, cervical spine)?

The child with blunt trauma to the neck:

Laryngeal / upper airway injury in children:

- Minor blunt trauma to neck = common
- Significant injuries = uncommon
  - Combination of protective large mandible and short neck
  - Laryngeal and tracheal cartilages in children = soft and pliable and so can sustain greater temporary force without fractures

The child with blunt trauma to the neck:

Laryngeal / upper airway injury in children:

But:

- Beware midline blows with the neck extended

"Significant injuries may present with a surprising lack of clinical signs"

- Voice change / surgical emphysema = suggestive of significant injury

The child with blunt trauma to the neck:

Laryngeal /upper airway injury in children:

In addition:

- **Laryngeal diameter in children = substantially less than an adult larynx**
  - **small amount of narrowing is much more likely to obstruct airway.**
- **Mucosa overlying the cartilage skeleton of the larynx is looser than adults**
  - **more prone to tears, oedema and haematoma**

The child with blunt trauma to the neck:

Initial management of Shannon:

Key questions to ask:

- Is the airway stable (safe)? YES (at present)
- Is there significant damage to the larynx / upper airway? Highly likely
- Is their damage to other structures (blood vessels, cervical spine)? Clinical assessment /investigation

The child with blunt trauma to the neck:

Management of Shannon:

Airway = at present safe but high risk for deterioration
Larynx = likely to be damaged

What would we going to do?

- Imaging?
- Assistance?
- Intubation?

The child with blunt trauma to the neck:

Management of Shannon:

What would we going to do?

Have time to assess further:

May include:

- Investigations
  - Neck x rays / CT
  - Safety in Radiology Dept with unsecured airway?

- Direct visualisation of the upper airway (by ENT):
  - Any age group = Direct laryngoscopy under anaesthesia
  - Upper child = on occasion flexible nasendoscopy awake

The child with blunt trauma to the neck:

Situation changes:

Shannon = Cough +

Develops:

- Sudden onset Shortness of Breath
- Increased Surgical Emphysema

Management?

The child with blunt trauma to the neck:

Reassess ABC:

- Obvious bilateral hyper-resonance

  Diagnosis = Bilateral tension pneumothoraces

  R = decompression and chest drains

Mechanism:

Posterior wall of trachea may be crushed against vertebral column causing tear to posterior membranous wall .

Air dissects into retropharyngeal space and mediastinum +/_ possibly pleural cavities

The child with blunt trauma to the neck:

Reassess ABC:

- Obvious bilateral hyper-resonance
  - Diagnosis = Bilateral tension pneumothoraces
  - R = decompression and chest drains
- Induction of general anaesthesia (Oxygen/ vapour / spontaneous ventilation)
- Surgical examination of larynx + upper airway
  - Direct laryngoscopy
  - Visualisation with Hopkins Rod / Rigid Bronchoscope

The child with blunt trauma to the neck:

- Surgical examination of larynx + upper airway

  Diagnosis = Small tear in mucosa of sub glottic area of larynx posteriorly

  R = 24 hours ventilation + reassess (+/- CT)

Options in Surgical treatment of upper airway trauma:

- Minor Injuries = conservative
- Major injuries =
  - Issue = laryngeal tracheal separation and ET tubes
  - Controversy = how best to secure the airway
    - oral endotracheal intubation vs tracheostomy)
    - Interval surgical airway reconstruction)

The child with blunt trauma to the neck:

Summary:

- Have high index of suspicion
- Look for signs suggesting damage
- Beware associated pneumo - thoraces / mediastinum
- If in doubt ENT examination of airway under direct vision with general anaesthesia.

The child presenting to an accident and Emergency Department with inhaled foreign body or blunt trauma to the neck where there is no Resident ENT :

Management?