

Keeping kids safe during critical illness

Simon Craig^{1,2}, Annie Moulden¹, Megan Barnett¹, Deana Lynn¹

¹Monash Children's Hospital, ²Monash University, ³Royal Children's Hospital, Melbourne

For every 1000 emergency department presentations in children, only one or two are likely to need critical interventions. Recent studies illustrate the rarity of paediatric critical illness.

- Royal Children's Hospital in Melbourne reported 71 intubations in approximately 82,000 visits to their ED in 2013.(1)
- The Emergency Department of Cincinnati Children's Hospital found that of 90,000 presentations, only 194 patients received a "critical procedure". In the study, the authors also found that 61% of emergency attendings (specialists) did not perform a single critical procedure during a 12-month period.(2)

Critical illness in paediatrics is a rare and stressful event. Even staff working in busy tertiary paediatric emergency departments have only occasional exposure. The rarity of critical illness almost guarantees that any rural provider has even less experience, and much less chance to call for assistance. **This** resuscitation may be the first "real" one they have done for 12 months.

The stakes are high. Equipment may be unfamiliar. Straightforward interventions such as intravenous access may be difficult. The presence of distressed family members may be distracting.

It is within this error-prone environment that the treating team must safely calculate, dilute and administer medications. Mathematics – even simple multiplication and division – is much more difficult when you are stressed!

It is unsurprising that, according to a recent Australian review:

"Drug dosage errors were found to occur during resuscitation in emergency departments, inpatient settings and out of hospital."(3)

"Mistakes are more likely to occur, for example, drug calculations, ten-fold errors, when clinicians operate **under heightened conditions of stress, such as during resuscitation.**"(3)

The factors that may lead to drug calculation errors include problems with weight estimation, dosing errors, calculation errors, dilution errors, prescribing and communication errors, administration errors, stress, and fatigue.(4)

There are various resources available that ameliorate many of these risks. Some are electronic resources, such as smartphone apps. There are many examples, which include PediCalc, PediStat, PediSafe, PEMSoft, PALS, APLS, etc.

Although many of these provide drug dose information, they rarely provide information related to dilution and administration. In addition, it is unusual for all staff in a particular hospital to choose the same apps, and even less common for a hospital pharmacy to endorse a particular product. Although it is reassuring to have information at your fingertips, would it actually be used during a resuscitation? What happens if you are attempting intravenous access or intubation? Do you give your phone to somebody else?

Other options are computer-based calculators that require the user to enter a weight before providing a specific set of instructions. Some examples include those produced by

- [Princess Margaret's Hospital for Children, Western Australia](#)
- [North West and North Wales Paediatric Transport Service](#)
- [Starship Children's Hospital, Auckland, New Zealand](#)

The [Broselow tape](#) has been available since the 1980s, and provides doses and other suggestions for endotracheal tube and other equipment sizes, however, has little information on medication dilution. Recently, the [eBroselow](#) reference tool has been introduced, which provides much more information, and can integrate with other hospital information systems.

Our hospital's resuscitation committee has introduced a "Paediatric Emergency Medication Book". It was developed with the input of emergency physicians, pharmacists, anaesthetists, paediatric intensivists, paediatricians, and experienced nursing staff from all relevant areas.

Available online (selected pages) and in hard-copy, the book is designed to provide clinicians with a weight-based guide to:

- signs of clinical instability / MET call criteria
- medication doses in resuscitation situations (cardiac arrest, intubation)
- endotracheal tube size and positioning
- emergency management of seizures, asthma, anaphylaxis, and electrolyte disorders.

Information is provided in a user-friendly, colour-coded layout. Tables and highlighting provide easy access to medication doses, appropriate dilution, and volumes to be administered.

6 kg

McDonagh Childrens Hospital

IM Administration for atropine 0.6 mL 1:10,000 (large ampoule)

MET Call Criteria

Respiratory rate (1/min)	< 20	> 75
Heart rate (bpm)	< 100	> 185
Systolic blood pressure (mmHg)	< 60	

Resuscitation

Adrenaline (IV cardiac arrest)	10 micrograms/kg	60 micrograms	of 1:10,000 (large ampoule)	0.6 mL
Fluid bolus	20 mL/kg		of Sodium chloride 0.9%	120 mL
Glucose (10%)	2.5 mL/kg		of Glucose 10%	15 mL
DC shock	4 J/kg		Use paediatric pads	20 Joules
Metaraminol	10 micrograms/kg	60 micrograms	10 mg (1 ampoule) in 100 mL bag. Draw up 10 mL. OR dilute 1mg (0.1 mL) in 10mL.	0.6 mL
Phenylephrine	5 micrograms/kg	30 micrograms	10 mg (1 ampoule) in 1 Use bag. Draw up 10 mL.	3 mL
Adrenaline ("Tense bulb" dose)	1 microgram/kg	6 micrograms	Dilute 0.6 mL of a 10,000 Adrenaline (large ampoule) to total volume of 10 mL.	1 mL
Atropine	30 micrograms/kg	120 micrograms	Dilute 600 micrograms to 6 mL.	1.2 mL
Amiodarone	5 mg/kg		Can dilute to 5 - 30 mL using Sodium 5% Give over 5 mins in emergency, otherwise over 20-30 minutes.	30 mg
Adenosine (1st dose)	0.1 mg/kg	0.6 mg		2 mL
Adenosine (2nd dose)	0.2 mg/kg	1.2 mg	Dilute 3 mg (3 mL) of adenosine to total volume of 10 mL.	4 mL
Adenosine (3rd dose)	0.3 mg/kg	1.8 mg		6 mL

Intubation

ET tube size (uncuffed) (cm)	3.5	Depth of ETT insertion	10 cm to lip	LMA size	1.5
ET tube size (cuffed) (cm)	N/A		12 cm to nose		

Induction agents

Ketamine	2-4 mg/kg	6 - 12 mg		Dilute 200mg in 20 mL OR dilute 100mg in 10mL	0.6 - 1.2 mL
Propofol	3-4 mg/kg	6 - 12 mg	Risk CVS ↓	Unadvised	0.6 - 1.2 mL
Thiopentone	2-7 mg/kg	15 - 30 mg	Risk CVS ↓	Reconstitute 500mg in 20 mL water for injection	0.6 - 1.2 mL
Fentanyl	2-5 micrograms/kg	12 micrograms	Risk Resp ↓	Dilute 100 micrograms to 10 mL	1.2 mL
Morphine	0.1 mg/kg	0.6 mg	Risk Resp ↓	Dilute 10 mg to 10 mL	0.6 mL
Midazolam	0.1 mg/kg	0.6 mg	Risk Resp ↓	Dilute 5 mg to 5 mL	0.6 mL

Paralytic agents

Suxamethonium	3 mg/kg	18 mg		Dilute 100 mg to 10 mL	3.6 mL
Rocuronium	1.2 mg/kg	7.2 mg		unadvised	0.72 mL
Vecuronium	0.1 mg/kg	0.6 mg		Reconstitute 10 mg in 10 mL water for injection	0.6 mL
Pancuronium	0.1 mg/kg	0.6 mg		Dilute 4mg to 4mL	0.6 mL
Atracurium	0.5 mg/kg	3 mg		Dilute 20mg to 20mL	1.2 mL
Sugammadex	16 mg/kg	96 mg		Dilute 200mg to 8mL (25 mg/mL)	3.6 mL

All dilutions with Sodium chloride 0.9% unless otherwise specified.

Edition 1
Due for review 2016

6 kg

McDonagh Childrens Hospital

Seizures / Neurology (see seizure flowchart)

Midazolam	0.25 mg/kg IV or IM	IV / IM	0.8 mg
Clozapem	Child dose	IV	0.5 mg
Diazepam	0.25 mg/kg	IV	1.5 mg
Phenytoin	20 mg/kg	IV	120 mg
Levetiracetam	20 mg/kg	IV	120 mg
Phenobarbitone	20 mg/kg	IV	120 mg
Pyridoxine		IV	50-100 mg
Maresinol 20%	0.5g/kg (2.5 mL/kg)	IV	15 mL
Sodium chloride 3% ("Hypertonic Saline")	3 mL/kg	IV	18 mL

Unadvised (preferred). May dilute up to maximum of 20mL. Give over 30-60 minutes
Dilute to at least 8 mL; give over 15 min
Dilute to at least 1:10; give over 30 minutes
In consultation with neurology
For raised ICP
Over 15 minutes for raised ICP

Electrolyte abnormalities

Hyperkalaemia	Calcium gluconate 10% 3 mL slow IV (peripheral / central) Calcium chloride 10% 0.6 - 1.2 mL (central) Sulbutamol 2.5mg nebulised	Critical hyponatraemia	Calcium gluconate 10% 3 mL slow IV (peripheral / central)
Glucose 10% 30 mL with Actrapid 0.6 units/hour IV Sodium bicarbonate 8.4% 6 - 18 mL (if available) Do NOT give calcium and bicarbonate at same time	Hyponatraemia	Glucose 10% 30 mL with Actrapid 0.6 units/hour IV Sodium bicarbonate 8.4% 6 - 18 mL (if available) Do NOT give calcium and bicarbonate at same time	500mg (1.2 mL of 50% MgSO ₄) Dilute to at least 8 mL (2/3 volume) Infuse over at least 4 hours

Critical hyponatraemia with seizures:
24 mL of Sodium Chloride 3% over 20 minutes
Do NOT correct more than 8 mmol/L per day

Severe hyponatraemia needing urgent treatment:
Use pre-mixed 100mL bag (isotonic)
Phosphate Chloride 20 mmol in Sodium Chloride 0.25%
1.8 mmol (1.8 mL) over 1 hour using syringe driver

Infusions

Order	1 mL / h is equal to	Starting dose
Prostaglandin (Alprostadil) MCI (Eprema) / KCN (Penderemg)	360 micrograms made up to 50mL (Sodium chloride 0.9%)	20 nanograms/kg/min 0.3 - 5 mL/h (if massive, start at right end of range and anticipate seizures - see for discussion)
Adrenaline / Noradrenaline (Central)	0.9 mg made up to 50mL (Glucose 5%)	0.05 micrograms/kg/min 0.5 - 10 mL/h
Dobutamine	90 mg made up to 50mL (Glucose 5%)	5 micrograms/kg/min 1 - 4 mL/h
Morphine	6 mg made up to 50mL (Glucose 5% - preferred) (See also use Sodium chloride 0.9%)	20 micrograms/kg/hour 1 - 4 mL/h
Midazolam	18 mg made up to 50mL (Glucose 5% - preferred) (See also use Sodium chloride 0.9%)	1 micrograms/kg/min 1 - 4 mL/h

All dilutions with Sodium chloride 0.9% unless otherwise specified.

Version 1
Due for review 2016

The book has laminated pages, is spiral-bound, and can easily be wiped clean. It is designed for use in clinical settings such as on a resuscitation trolley, in theatre, in the emergency department or intensive care.

Our institution has adopted the book throughout all clinical areas that may be faced with paediatric resuscitation. We elected to use a hard-copy rather than electronic copy to ensure availability wherever a resuscitation trolley is located, and to allow for the inevitable spillages of medication and fluids that occur during a busy resuscitation. However, an app is in early stages of development.

APLS Australia are planning to incorporate the use of our book in their courses from early 2015.

Another example of a similar hard-copy resource is that produced by Cincinnati Children's hospital, the "[Paediatric Emergency Dosing Code Book](#)".

Whatever resource you choose to utilise, buy-in and engagement from all clinicians involved in the critical care of children is paramount. Ideally, your hospital should agree on a single resource, and all relevant protocols should be adjusted to reflect this.

A stressful paediatric resuscitation is not the place for disagreements between staff members about the dose or administration of a potentially life-saving medication.

In summary

- Paediatric resuscitation is an uncommon, relatively stressful event.
- Medication calculations in this environment are a source of avoidable error.
- Many resources are available to reduce the risk associated with medication administration to critically ill children.
- Hospitals and health networks should agree on a single resource to use across all clinical areas. Ideally, a national approach should be taken rather than the development of additional local resources.

Recommendations

Widespread uptake of a standardised paediatric emergency medication resource has the potential to reduce variation in practice across rural and remote healthcare settings, and ensure that seriously ill children are able to access the same level of initial care, regardless of where they are initially cared for.

This may translate into improved clinical outcomes, improved management prior to retrieval, and even reduced need for paediatric inter-hospital retrieval.

References

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Presenter

Simon Craig is an emergency physician and Director of Emergency Medicine Training working at Monash Children's Hospital in Melbourne, while also working in West Gippsland Hospital, Warragul. His research interests include medical education, procedural pain and distress, diagnostic testing, and all other aspects of paediatric emergency medicine.