

- Peri-intubation cardiac arrest (PICA) is an infrequent but catastrophic event. It is reported as occurring in 1 in 160 intubations of critically ill children in regional hospitals in the latest NAP7<sup>1</sup> report from the RCOA in the UK 2023 with a mortality in this cohort of 38%. Broader literature reports a PICA occurrence in critically ill children of 3.9%.
- Early recognition of children at risk, precautionary intervention before, during and after the procedure, and consultant led multi disciplinary teamwork from Paediatrics/ICU/Anaesthesiology is recommended to reduce the risk of arrest and increase the chances of successful ROSC
- Use of cognitive aids such as intubation checklists and standardized induction formularies are recommended
- This guide aims to outline an approach to the care of the critically ill child requiring intubation based on these principles & recommendations

## Risk Factors of Paediatric PICA

- Significant hypotension for age (see box)
- Clinical concern for cardiac dysfunction (signs of shock, concern for myocarditis, congenital heart disease)
- Hypoxaemia (sats <90%) not corrected with supplemental O<sub>2</sub>
- Severe metabolic acidosis (pH <7.1)
- Post return of spontaneous circulation following arrest
- Status Asthmaticus requiring intubation

## Airway / Ventilation Preparation

- Discuss optimal location for intubation in as safe and familiar a place as possible (this may mean not moving the child if this will add excessive time or if they are critically unwell)
- Assemble the most senior airway management team available. This may be a combination of anaesthesiology/intensive care/paediatric/neonatal senior medical staff
- Utilise the pre-intubation checklist overleaf as a time-out to ensure all equipment is available & clear team roles assigned
- Use full monitoring including **waveform capnography** throughout
- Use an appropriately sized **cuffed ETT** where possible i.e. 0.5mm smaller than uncuffed for age/weight (see IPATS guide)
- Anticipate hypoxaemia and airway difficulties. Have video laryngoscope, stylets etc. available and be attentive ++ to optimal positioning of patient
- As a rule, pre oxygenate patients. Complex cyanotic heart pts can be discussed with PICU if concerns re same

## Cardiovascular Preparation

Prior to induction of anaesthesia:

- Ensure patient has been adequately fluid resuscitated with balanced crystalloid (or pRBC in case of trauma)
- If patient remains fluid responsive, consider giving 5-10ml/kg bolus just before induction
- Connect & consider starting an adrenaline infusion at low dose (0.05mcg/kg/min) (peripheral IV or IO is acceptable)
- Ca. Gluconate (0.1mmol/Kg max 4.5mmol) to achieve iCa >1.2 can be a useful inotropic agent in infants & small children
- Prepare arrest dose 1:10,000 adrenaline (10mcg/kg = 0.1ml/kg) ideally on 3 way tap ready for administration
- Have push-dose pressor available in case of hypotension (low dose adrenaline / ephedrine / phenylephrine see overleaf)
- Patient should have defibrillation pads applied & staff should be familiar with Defib use & review APLS defib algorithms
- Prepare pt specific resuscitation medications i.e. Amiodarone, Atropine, sodium bicarbonate, calcium in case of arrest

## Induction of Anaesthesia / Neurological Preparation

- Ketamine 1-2mg/kg + Rocuronium 1mg/kg is the standard recommended choice of induction during paediatric critical care retrieval and in UK & Irish Paediatric Intensive Care units. Fentanyl 2mcg/kg (titrated upwards as req.) is also reasonable
- It is strongly advised that **propofol and volatile anaesthetic agents are NOT used** in this scenario as they have been associated with an increased risk of cardiac arrest in children in critical condition
- Infusion of morphine 20—30mcg/kg/hr + midazolam 2mcg/kg/min is usually sufficient to maintain sedation following intubation. Higher doses of morphine alone may be sufficient if there is significant hypotension & concerns re deleterious effect of midazolam.

Significant Hypotension (BP <5 <sup>th</sup> centile)		
Age	MAP	SBP
<b>Neonate</b>	<CGA	<60
<b>0-6months</b>	<45	<70
<b>&gt;6mo – 2yrs</b>	<55	<80
<b>&gt;2yrs – 10yr</b>	<65	<90
<b>&gt;10yrs</b>	<65	<100

### Intubation Equipment Check

Face mask & Anaesthetic circuit	<input type="checkbox"/>	Stylet +/- Bougie	<input type="checkbox"/>
Wall O <sub>2</sub> set to 10-15L	<input type="checkbox"/>	Syringe for cuff	<input type="checkbox"/>
Yankauer Suction set to optimal level	<input type="checkbox"/>	ETT is lubricated	<input type="checkbox"/>
Guedel Airway	<input type="checkbox"/>	Stethoscope	<input type="checkbox"/>
Laryngoscope (preferably VL) (check light)	<input type="checkbox"/>	ETT tapes cut	<input type="checkbox"/>
Cuffed ETT (check cuff) (+ 1 size above and below chosen size)	<input type="checkbox"/>	Emergency airway adjuncts i.e. LMA available	<input type="checkbox"/>

### Patient Preparation

History of previous intubation?	<input type="checkbox"/>	Adrenaline infusion running if possible	<input type="checkbox"/>
Preoxygenate all patients unless clear contraindication	<input type="checkbox"/>	Push dose pressor of choice available	<input type="checkbox"/>
Review fasting status & aspirate NGT	<input type="checkbox"/>	Induction Drugs: Ketamine 1-2mg/kg + Rocuronium 1mg/kg (or Fentanyl + Roc)	<input type="checkbox"/>
Careful attention to head positioning	<input type="checkbox"/>	Resuscitation medications drawn up: Adrenaline/Amiodarone (if V. arrhythmia)	<input type="checkbox"/>
IV access assessed	<input type="checkbox"/>	Defibrillator pads in place	<input type="checkbox"/>
Administer 5-10ml/kg Hartmanns bolus unless contraindicated i.e. heart failure	<input type="checkbox"/>	APLS algorithms available in case of arrest	<input type="checkbox"/>

### Patient monitoring

Sats & ECG with good trace on both	<input type="checkbox"/>	Ventilator is ready to use with settings complete	<input type="checkbox"/>
Waveform capnography inline & available	<input type="checkbox"/>	Post induction sedation is prepared i.e. morphine + midazolam infusions	<input type="checkbox"/>
BP cuff set to auto q3min	<input type="checkbox"/>	Radiology briefed re need for portable CXR	<input type="checkbox"/>
QRS is audible	<input type="checkbox"/>		

### Post intubation considerations

Team lead identified & assigns roles: 1. Intubator 2. Airway assistant 3. Medication administrator 4. Medication preparation 5. CPR providers (ideally x2) 6. Defibrillator user 7. Scribe	<input type="checkbox"/>	Outline plan A for intubation	<input type="checkbox"/>
		Ideally have a plan B & C if airway difficulties arise	<input type="checkbox"/>
		Ensure parents aware of high-risk nature of the intubation	<input type="checkbox"/>

## Respiratory Support tools



Pre-Intubation  
Checklist



Intubation  
Equipment Sizing  
Guide



Paediatric  
Ventilation Guide



Invasive  
Ventilation setup  
<15Kg



Invasive  
Ventilation setup  
>15Kg

## Critical Infusions

These infusions are a guide to those commonly used. Choice of medication, dose and route lie with the medically responsible clinician



NON- SCI  
infusion table



CHI - SCI infusion  
table

C1

All medication  
dosing/route  
information can be  
found on the CHI  
'Clinibee' app

CHI SCI Standard Concentrations PICU/Theatre:					Rate Calc (mL/hour)	Required Dose =	Default Rate (mL/hour)
CONTINUOUS INFUSIONS AND LOADING DOSES (Version 4 Feb 2019)						Default Start Dose	
Drug	Category	Weight Band	SCI (Normal)	Diluent	Usual Dose Range	Default Dose and Rate Calculator	
Adrenaline <i>Central</i>	Cardio	All ≤5kg	1mg/50mL	Glucose 5%w/v	0 - 0.2 microgram/kg/min	0.05microgram/kg/min	0.15 x Wt
		>5 - ≤10kg	3mg/50mL	NaCl 0.9%w/v			0.05 x Wt
		All >10Kg	6mg/50mL	Glucose 10%w/v			0.025 x Wt
Adrenaline <i>(peripheral)</i>	Cardio	All ≤10Kg	1mg/50mL	Glucose 5%w/v	0 - 0.2 microgram/kg/min	0.05microgram/kg/min	0.15 x Wt
		>10Kg	3mg/50mL	NaCl 0.9%			0.05 x Wt
Noradrenaline <i>Peripheral administration can be as per Adrenaline</i>	Cardio	All ≤5kg	1mg/50mL	Glucose 5%w/v	0 - 0.2 microgram/kg/min	0.05microgram/kg/min	0.15 x Wt
		>5 - ≤10kg	3mg/50mL	NaCl 0.9%w/v			0.05 x Wt
		>10Kg	6mg/50mL				0.025 x Wt
Midazolam	CNS	≤2.5kg	10mg/50mL	Glucose 5%w/v	Sedation:	1microgram/kg/min	0.3 x Wt
		>2.5 - ≤5kg	25mg/50mL	NaCl 0.9%w/v	0-4microgram/kg/min		0.12 x Wt
		>5 - ≤10kg	50mg/50mL	Glucose 10%w/v			0.06 x Wt
		10-20Kg	50mg/50ml				0.06 x Wt
		>20Kg	100mg/50				0.03 x Wt
Morphine	CNS	≤2.5kg	2.5mg/50mL	Glucose 5%w/v	Neonate:	20microgram/kg/hr	0.4 x Wt
		>2.5 - ≤5kg	5mg/50mL	NaCl 0.9%w/v	0-20microgram/kg/hr		0.2 x Wt
		>5 - ≤10kg	10mg/50mL	Glucose 10%w/v			0.1 x Wt
		10-20Kg	20mg/50ml		>1mth old:0-40microgram/kg/hr		0.05 x Wt
		>20Kg	50mg/50mL				0.02 x Wt

## Frequently used intermittent medications

Doses for quick reference only – please prescribe using the CHI 'CLINIBEE' app or after direct consultation with accepting consultant

**Fluid Bolus:** Hartmann's Solution 5-10ml/kg

**Ca Gluconate 10% w/v:** 0.1mmol/kg (max 4.5mmol) (Target iCa of 1.2-1.4)

**Hydrocortisone:** 2mg/kg (max up to 100mg)

**Synchronised D/C Shock:** 1-2J/kg

**Atropine** – 20mcg/kg (min dose 100mcg, max 600mcg)

### In case of cardiac arrest

**Adrenaline IV/IO** 10mcg/kg (0.1ml/kg 1:10,000)

**Amiodarone** – (VT/VF after shock 3&5) - 5mg/kg

**NON synchronised D/C shock** – VT/VF 4J/kg

**AED** – Paediatric attenuated if 1-8yrs / Adult >8yr

## Useful Checklists & Resources



Stabilisation of  
child in Adult ICU



PICU Referral  
Tool



Pre-Departure  
Checklist



P37 Activation  
Guide

## Airway / Ventilation Considerations

Appropriately sized cuffed ETT well secured with spare intubation set available	<input type="checkbox"/>	ETCO <sub>2</sub> in ventilation circuit and visible on transport monitor – targeting 4.5-6Kpa for majority of children	<input type="checkbox"/>
NGT inserted and attached to bile bag for drainage	<input type="checkbox"/>	Oxygen titrated to achieve O <sub>2</sub> sats between 94-98% - <u>avoid hypoxia AND hyperoxia</u>	<input type="checkbox"/>
CXR performed & ETT & NGT position reviewed	<input type="checkbox"/>	<b>Permissive hypercapnoea and hypoxia may be required in ARDS – discuss with IPATS/PICU Consultant if concerns</b>	
Vent set to achieve 6-8ml/kg/min Tv + RR to keep ETCO <sub>2</sub> in target. PEEP typically set to 5cmH <sub>2</sub> O.	<input type="checkbox"/>	Appropriately sized ETT suction catheters available (uncuffed ETT size x2 = Catheter French (Ch))	<input type="checkbox"/>
Blood gas (cap/ven/art) checked once on transport ventilator. Blood glucose reviewed.	<input type="checkbox"/>	Sufficient O <sub>2</sub> for transfer – see Calculator ipats.ie	<input type="checkbox"/>
		Appropriately sized Ambu bag as backup to MIE	<input type="checkbox"/>

## Circulation Considerations

**It is always recommended that cardiac arrest medications are brought in addition to, and kept separate from, those suggested below**

Working Vascular Access x2 (IV/IO)	<input type="checkbox"/>	If patient is already on an inotrope – discuss with PICU re additional inotrope to bring on transfer	<input type="checkbox"/>
Continuous ECG monitoring on transport monitor	<input type="checkbox"/>	<b>Push dose pressors:</b> (to correct hypotension) Choice & dose at discretion of medically responsible consultant.	<input type="checkbox"/>
NIBP set to auto q3-5min if art line unavailable	<input type="checkbox"/>	1. Adrenaline 1:100,000 Add 1ml Adrenaline 1:1000 to 100ml NS = 10mcg/ml solution ( <u>label clearly</u> ) Dose - 0.1ml/kg = 1microgram/kg per dose	
Maintain <b>minimum systolic BP/MAP ≥ 5<sup>th</sup> centile</b> – see page 1 of guide for table	<input type="checkbox"/>	2. Ephedrine diluted to conc. of 3mg/ml –as per Clinibee: Dose – 1-12yr = 500micrograms/kg Dose - >12yr = 3-7.5miligrams <b>IPATS Suggestion: Doses 100-200mcg/kg up to 3-6mg typically sufficient – Titrate with great care</b>	
Rescue fluid available – Hartmann's Solution	<input type="checkbox"/>	3. Phenylephrine 100mcg/ml - as per Clinibee: Dose - >1mo - 12yrs = 5-20micrograms/kg (max 500mcg) Dose - >12yrs = 100-500micrograms <b>IPATS Suggestion: Doses 1-2mcg/kg up to 50-100mcg typically sufficient – Titrate with great care</b>	
Have first line inotrope prepared and connected to patient	<input type="checkbox"/>		
Ensure patient has defib pads in place & team have reviewed dose/defib use	<input type="checkbox"/>		

## Sedation / Neurosurgical Considerations

### Post intubation sedation:

In view of likely myocardial depression & simultaneous need for deep sedation for neuroprotection we recommend:

Morphine 20-40mcg/kg/hr **AND**

Midazolam 2-5mcg/kg/min **AND**

Intermittent neuromuscular blockade

### Suggested bolus CNS medications for transfer

Use & dose at discretion of medically responsible consultant.  
Dose titration recommended if haemodynamically unstable

1. Ketamine 0.5-2 milligrams/kg
2. Fentanyl 1-2micrograms/kg
3. Rocuronium - 0.6-1.2 milligrams/kg

## Further reading / Resources

1. NAP7 2023 Chapter 27 – Paediatric perioperative cardiac arrest. 7th National Audit Project of the Royal College of Anaesthetists dealing with perioperative cardiac arrest in adults and children [https://www.rcoa.ac.uk/sites/default/files/documents/2023-11/NAP7\\_Chapter%2027\\_FINAL.pdf](https://www.rcoa.ac.uk/sites/default/files/documents/2023-11/NAP7_Chapter%2027_FINAL.pdf)
2. Pokrajac N, Sbiroli E, Hollenbach KA, Kohn MA, Contreras E, Murray M. Risk Factors for Peri-intubation Cardiac Arrest in a Pediatric Emergency Department. *Pediatr Emerg Care*. 2022 Jan 1;38(1):e126-e131. doi: 10.1097/PEC.0000000000002171. PMID: 32576791.
3. Heidi M. Herrick et al. Reducing Severe Tracheal Intubation Events Through an Individualized Airway Bundle. *Pediatrics* October 2021; 148 (4): e2020035899. 10.1542/peds.2020-035899 <https://publications.aap.org/pediatrics/article/148/4/e2020035899/183308/Reducing-Severe-Tracheal-Intubation-Events-Through>
4. Esangbedo ID, Yu P, Brandewie K, Ebraheem M, Rahman AKMF, and Byrnes J (2023) Cardiac arrest during endotracheal intubation of children with systolic dysfunction. *Cardiology in the Young* 33: 532–538. doi: 10.1017/S1047951122001160. <https://www.cambridge.org/core/services/aop-cambridge-core/content/view/AEA22B2EC0E805A30406A363E44D44DF/S1047951122001160a.pdf/cardiac-arrest-during-endotracheal-intubation-of-children-with-systolic-dysfunction.pdf>
5. Hoehn, Erin & Dean, Preston & Lautz, Andrew & Frey, Mary & Cabrera-Thurman, Mary & Geis, Gary & Stalets, Erika & Zackoff, Matthew & Pham, Tena & Maxwell, Andrea & Vukovic, Adam & Kerrey, Benjamin. (2020). Peri-Intubation Cardiac Arrest in the Pediatric Emergency Department: A Novel System of Care. *Pediatric Quality & Safety*. 5. e365. 10.1097/pq9.0000000000000365. [https://www.researchgate.net/publication/346421499\\_Peri-Intubation\\_Cardiac\\_Arrest\\_in\\_the\\_Pediatric\\_Emergency\\_Department\\_A\\_Novel\\_System\\_of\\_Care](https://www.researchgate.net/publication/346421499_Peri-Intubation_Cardiac_Arrest_in_the_Pediatric_Emergency_Department_A_Novel_System_of_Care)
6. Conway JA et al; National Emergency Airway Registry for Children (NEAR4KIDS) and for the Pediatric Acute Lung Injury and Sepsis Investigators (PALISI). Ketamine Use for Tracheal Intubation in Critically Ill Children Is Associated With a Lower Occurrence of Adverse Hemodynamic Events. *Crit Care Med*. 2020 Jun;48(6):e489-e497. doi: 10.1097/CCM.0000000000004314. PMID: 32317603. <https://pubmed.ncbi.nlm.nih.gov/32317603/>
7. <https://pccsociety.uk/wp-content/uploads/2020/04/Paediatric-Critical-Care-alternative-medicines-v1.0.pdf>
8. <https://cats.nhs.uk/wp-content/uploads/guideline-intubation.pdf>

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<b>Related Documents:</b>	
<p>The Irish Paediatric Acute Transport Service (IPATS) in conjunction has produced this pragmatic support tool with the PICU departments in CHI. It has been designed for nurses, doctors and ambulance staff to refer to in the emergency care of critically ill children.</p> <p>This guideline represents the views of IPATS and was produced after careful consideration of available evidence in conjunction with clinical expertise and experience. The guidance does not override the individual responsibility of healthcare professionals to make decisions appropriate to the circumstances of the individual patient</p>	