



- 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 NAP7¹ 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 (BP <5 th centile)		
Significant hypotension for age (see box)	Age	MAP	SBP
 Clinical concern for cardiac dysfunction (signs of shock, concern for myocarditis, congenital heart disease) 	Neonate	<cga< th=""><th><60</th></cga<>	<60
 Hypoxaemia (sats <90%) not corrected with supplemental O2 	O-6months	<45	<70
 Severe metabolic acidosis (pH <7.1) Post return of spontaneous circulation following arrest 	>6mo – 2yrs	<55	<80
Status Asthmaticus requiring intubation	>2yrs – 10yr	<65	<90
Airway / Ventilation Preparation	>10yrs	<65	<100

- Discuss optimal location for intubation in as safe and familiar a place as possible (this may mean <u>not</u> 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.



Potential Peri-Intubation Cardiac Arrest INTUBATION CHECKLIST

Call PICU: 1800 222 378



Intubation Equipment Check					
Face mask & Anaesthetic circuit		Stylet +/- Bougie			
Wall 0_2 set to 10-15L		Syringe for cuff			
Yankauer Suction set to optimal level		ETT is lubricated			
Guedel Airway		Stethoscope			
Laryngoscope (preferably VL) (check light)		ETT tapes cut			
Cuffed ETT (check cuff) (+ 1 size above and below chosen size)		Emergency airway adjuncts i.e. LMA available			
P	atient Pi	reparation			
History of previous intubation?		Adrenaline infusion running if possible			
Preoxygenate all patients unless clear contraindication		Push dose pressor of choice available			
Review fasting status & aspirate NGT		Induction Drugs: Ketamine 1-2mg/kg + Rocuronium 1mg/kg (or Fentanyl + Roc)			
Careful attention to head positioning		Resuscitation medications drawn up: Adrenaline/Amiodarone (if V. arrhythmia)			
IV access assessed		Defibrillator pads in place			
Administer 5-10ml/kg Hartmanns bolus unless contraindicated i.e. heart failure		APLS algorithms available in case of arrest			
Patient monitoring		Post intubation considerations	5		
Sats & ECG with good trace on both		Ventilator is ready to use with settings complete			
Waveform capnography inline & available	e				
BP cuff set to auto q3min		i.e. morphine + midazolam infusions			
QRS is audible		Radiology briefed re need for portable CXR			
Team Briefing					
 Team lead identified & assigns roles: Intubator Airway assistant Medication administrator Medication preparation CPR providers (ideally x2) 		Outline plan A for intubation Ideally have a plan B & C if airway difficulties arise Ensure parents aware of high-risk nature			
 Defibrillator user Scribe 		of the intubation			

Respiratory Support tools							
Pre-Intubation Checklist		Intubati Equipment Guide	on Sizing	Paediatric Ventilation Guide	Inv Ventila <	vasive tion 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 CHI - SCI infusion table CII All medication dosing/route information can be found on the CHI 'Clinibee' app							
CHI SCI Standard Concentrations PICU/Theatre: CONTINUOUS INFUSIONS AND LOADING DOSES (Version 4 Feb 2019)							
Drug	Category	Weight Band	SCI (Normal)	Diluent	Usual Dose Range Default Dose and Rate Calcul Usual Dose Range All Weights in kg - rounding ca		se and Rate Calculator in kg - rounding can occur
Adrenaline	Cardio	All ≤5kg >5 - ≤10kg All >10kg	1mg/50mL 3mg/50mL 6mg/50mL	Glucose 5%w/v NaCl 0.9%w/v Glucose 10%w/v	0 -0.1microgram/kg/min	0.05microgram/kg/ min	0.15 x Wt 0.05 x Wt 0.025 x Wt
Noradrenaline	Cardio	All ≤5kg >5 - ≤10kg All >10kg	1mg/50mL 3mg/50mL 6mg/50mL	Glucose 5%w/v NaCl 0.9%w/v	0 -0.1microgram/kg/min	0.05microgram/kg/ min	0.15 x Wt 0.05 x Wt 0.025 x Wt
Midazolam (Large volume neat solution may be given using 250ml empty bag	CNS	≤2.5kg >2.5 - ≤5kg	10mg/50mL 25mg/50mL	Glucose 5%w/v NaCl 0.9%w/v	Sedation: 0-4microgram/kg/min	1microgram/kg/min	0.3 x Wt 0.12 x Wt
for patients > 20kg)		>5 - ≤10kg >10- ≤20kg >20kg	50mg/50mL 50mg/50mL 100mg/50mL	Glucose 10%w/v	Status Epilep: 0-24microgram/kg/min		0.06 x Wt 0.06 x Wt 0.03 x Wt
Morphine	CNS	≤2.5kg >2.5 - ≤5kg >5 - ≤10kg >10 - ≤20kg >20kg	2.5mg/50mL 5mg/50mL 10mg/50mL 20mg/50mL 50mg/50mL	Glucose 5%w/v NaCl 0.9%w/v Glucose 10%w/v	Neonate: 0-20microgram/kg/hr >1mth old: 0-40microgram/kg/hr	20microgram/kg/hr	0.4 x Wt 0.2 x Wt 0.1 x Wt 0.05 x Wt 0.02 x Wt
		F	requently us	ed intermitten	tmedications		

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







Potential Peri-Intubation Cardiac Arrest Pre-Departure Checklist



Contact with the accepting PICU intensivist/IPATS consultant via 1800 222 378 for advice

Airway / Ventilation Considerations					
Appropriately sized cuffed ETT well secured with spare intubation set available NGT inserted and attached to bile bag for drainage CXR performed & ETT & NGT position reviewed Vent set to achieve 6-8ml/kg/min Tv + RR to keep ETCO ₂ in target. PEEP typically set to 5cmH ₂ O. Blood gas (cap/yep/art) checked once on	ETC02 in ventilation circuit and visible on transport monitor – targeting 4.5-6Kpa for majority of children Oxygen titrated to achieve 02 sats between 94-98% - avoid hypoxia AND hyperoxia Permissive hypercapnoea and hypoxia may be required in ARDS – discuss with IPATS/PICU Consultant if concerns Appropriately sized ETT suction catheters available (uncuffed ETT size x2 = Catheter French (Ch) Sufficient O2 for transfer – see Calculator ipats.ie				
transport ventilator. Blood glucose reviewed.	Appropriately sized Ambu bag as backup to MIE				
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) □ Continuous ECG monitoring on transport monitor □ NIBP set to auto q3-5min if art line unavailable □ Maintain minimum systolic BP/MAP ≥ □ 5 th centile – see page 1 of guide for table □ Rescue fluid available – Hartmann's Solution □ Have first line inotrope prepared and connected to patient □ Ensure patient has defib pads in place & team have reviewed dose/defib use □	If patient is already on an inotrope – discuss with PICU re additional inotrope to bring on transfer Push dose pressors: (to correct hypotension) Choice & dose at discretion of medically responsible consultant. 1. Adrenaline 1:100,000 Add 1ml Adrenaline 1:1000 to 100ml NS = 10mcg/ml solution (label clearly) Dose - 0.1ml/kg = 1microgram/kg per dose 2. Ephedrine diluted to conc. of 3mg/ml –as per Clinibee: Dose - 1-12yr = 500micrograms/kg Dose - >12yr = 3-7.5miligrams IPATS Suggestion: Doses 100-200mcg/kg up to 3-6mg typically sufficient – <u>Titrate with great care</u> 3. Phenylephrine 100mcg/ml - as per Clinibee: Dose - >1mo - 12yrs = 5-20micrograms/kg (max 500mcg) Dose - >12yrs = 100-500micrograms IPATS Suggestion: Doses 1-2mcg/kg up to 50-100mcg typically sufficient – <u>Titrate with great care</u>				
Sedation / Neurosurgical Considerations					
Post intubation sedation : In view of likely myocardial depression & simultaneous need for deep sedation for neuroprotection we recommend:	Suggested bolus CNS medications for transfer Use & dose at discretion of medically responsible consultant. Dose titration recommended if haemodynamically unstable				

- Morphine 20-40mcg/kg/hr **AND** Midazolam 2-5mcg/kg/min **AND** Intermittent neuromuscular blockade
- 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
- 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.00000000002171. 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 <u>https://publications.aap.org/pediatrics/article/148/4/e2020035899/183308/Reducing-Severe-Tracheal-Intubation-Events-Through</u>
- 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. <u>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</u>
- 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/pq9.000000000000365. <u>https://www.researchgate.net/publication/346421499 Peri-</u> <u>Intubation Cardiac Arrest in the Pediatric Emergency Department A Novel System of Care</u>
- 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 III Children Is Associated With a Lower Occurrence of Adverse Hemodynamic Events. Crit Care Med. 2020 Jun;48(6):e489-e497. doi: 10.1097/CCM.00000000004314. PMID: 32317603. <u>https://pubmed.ncbi.nlm.nih.gov/32317603/</u>
- 7. <u>https://pccsociety.uk/wp-content/uploads/2020/04/Paediatric-Critical-Care-alternative-medicines-v1.0.pdf</u>
- 8. https://cats.nhs.uk/wp-content/uploads/guideline-intubation.pdf





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Related Documents:				

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.

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