Guideline for children with suspected or confirmed Myocarditis / Cardiomyopathy in a Regional Paediatric Centre

Call PICU: 1800 222 378

- Acute cardiac failure as a result of myocarditis or cardiomyopathy is a diagnosis that often requires a high index of suspicion due to its ability to present with a variety of signs and symptoms.
- These children are often highly unstable and require careful but timely stabilization and transfer with good communication between paediatric/intensive care medicine and cardiology at all times.
- Early discussion with PICU & Cardiology via the 1800 222 378 referral line is essential

Recognition (common in bold)

Symptoms

- **Breathlessness**, **fatigue**, poor feeding, **fever**
- Chest pain, syncope, palpitations
- Loss of appetite, **abdominal pain**, vomiting
- Recent viral illness / FHx of sudden cardiac death

Signs

- **Resting tachycardia**
- **Gallop rhythm**
- Pallor, **cool peripheries** +/- weak pulses
- Hypotension
- Palpable liver edge, oedema

First Line Diagnostics / Findings

- **Continuous full cardiac monitoring** – HR/BP/Sats
- **12 lead ECG-** usually abnormal – common findings:
  - Low voltage QRS
  - Heart block (can vary from 1st to 3rd degree)
  - Atrial and/or ventricular ectopy
  - Tachyarrhythmia
  - Ischaemic changes (ST ↑, Twave inversion
- **Bloods**
  - **Blood gas** –N.B. lactate, iCa^{2+} & $HC03^{-}$
  - **Troponin**, CK-MB, **BNP** – usually elevated
  - Blood cultures should be sent
- **CXR** – may show Pul. oedema, cardiomegaly

Formal paediatric ECHO may not readily available but point of care ultrasound can be extremely useful in providing a basic assessment of ventricular function + effusions – Adult ED/ICU/Anaesthesiology staff may have sufficient skills to do same

Initial Stabilisation & Management – *Guided by Cardiology/PICU*

Respiratory

- High flow nasal cannula may provide additional CVS support. 2L/kg/min up to 15Kg and 30L/min >15Kg are recommended starting flows. Titrate Fi02 for sats between 94-98%
- Due to the high risk of cardiovascular collapse during intubation, if additional respiratory support is required and the patient is neurologically stable, NIV is recommended as the next step in support. See links to guides overleaf. Guidance can be provided by PICU / IPATS consultant
- If intubation is required, please perform IPATS intubation checklist, prepare resuscitation medications and liaise with PICU before proceeding whenever possible

Circulation

- Minimum of 2 Peripheral lines. CVC & Arterial line desirable but not essential. Avoid RIJ cannulation if possible (for ECMO)
- V. cautious approach to fluid resuscitation (5ml/kg aliquots - **if at all**)
- Prepare milrinone & adrenaline infusions (see guide overleaf). Discuss timing and doses with PICU/Cardiology
- IV Furosemide and electrolyte correction (potassium / calcium / magnesium) may also be requested
- Patient should have defibrillation pads applied & staff should be familiar with Defib use & review APLS defib algorithms

GI / GU

- 2/3 maintenance fluids of 0.9% NaCl + 5% Dex are recommended. Pt should be fasting + NGT inserted on free drainage
- Urinary catheter should be inserted, and hourly assessment of U/O recorded - aiming for 1ml/kg/hr

Pain / Sedation

- Treat pain with paracetamol +/- low dose opioids (avoid NSAIDS if renal dysfunction evident)
- If sedation required for procedures, consider Ketamine 0.25-0.5mg/kg or Fentanyl 0.5-1mcg/kg boluses titrated to effect
- For intubation, recommend using lower than standard doses – (Ketamine 1mg/kg or fentanyl 2-3mcg/kg) + NMB
- Post intubation – maintain sedation with morphine 10-20mcg/kg/hr +/- midazolam 1-2mcg/kg/min & titrate to effect

Additional medications

- All patients should receive IV cefotaxime 50mg/kg 6hrly for broad spectrum cover pending cultures
- IVIG and/or corticosteroids may be requested by the accepting Cardiology/PICU consultant
- Specific antiviral therapy may be useful if EBV or HSV associated myocarditis is specifically suspected

Emergency Medications / Interventions – Please turn over page

Respiratory Support

NIV setup Guide Respireo 3-20Kg

NIV setup Guide MiniME2 >20Kg

Pre-Intubation Checklist

Intubation Equipment Sizing Guide

Invasive Ventilation setup <15Kg

Paediatric Ventilation Guide

Critical Cardiac Infusions

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

SCI infusion table

NON- SCI infusion table

CHI Critical care infusion dosing and formulation guides available via QR codes. Please ensure correct guide is used

Drug	Wt / Age	Loading Dose IV	Maintenance Dose IV
Amiodarone	<60Kg	5mg/kg (max 300mg)	5-15microgram/kg/min **Compatible with Glucose 5% w/v only**
Amiodarone	>60kg	300mg	If No load given - 50mg/hr for 24hr (max 1.2g/dy) If Load given - 40mg/hr for 23hr (max 1.2g/dy) **Compatible with Glucose 5% w/v only**
Lidocaine	<12yrs	0.5 – 1mg/Kg	0.6 – 3mg/kg/hr
Lidocaine	≥ 12yrs	50 - 100mg	Infuse at 240mg/hr for 30minutes, then 120mg/hr for 2hr, then 60mg/hr

CHI CONTINUOUS INFUSIONS AND LOADING DOSES – SCI library pumps

CHI Ver 4 Feb 2019 - Continuous (PICU/Theatre)

Rate Calc (mL/hour) = Required Dose x Default Rate (mL/hour) / Default Start Dose

Default Dose and Rate Calculator

All Weights in kg - rounding can occur

Drug	Weight Band	SCI (Normal)	Diluent	Usual Dose Range	Default Start Dose	Default Rate (mL/hr)
Adrenaline	All ≤5kg	1mg/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
	>5 - ≤10kg	3mg/50mL				0.05 x Wt
	All >10kg	6mg/50mL				0.025 x Wt
Milrinone	All ≤5kg	5mg/50mL	Glucose 5%w/v NaCl 0.9%w/v	0.25-0.75 microgram/kg/min	0.5microgram/kg/min	0.3 x Wt
	>5 - ≤10kg	10mg/50mL				0.15 x Wt
	>10 - ≤20kg	20mg/50mL				0.075 x Wt
	>20kg	50mg/50mL (Neat)				0.03 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
Furosemide: 0.25 – 1mg/kg IV
Ca Gluconate 10% w/v: 0.11mmol/kg (max 4.5mmol)
Magnesium correction: 0.2mmol/kg (max 4mmol)
Sodium Bicarbonate 8.4%: 1mmol/kg (1ml/kg)
Cefotaxime: 50mg/kg q6hr IV (max 3g/dose)
Intravenous Immunoglobulin: 2g/kg
Synchronised D/C Shock: 1-2J/kg

In case of cardiac arrest

Adrenaline IV/IO/IM 10mcg/kg (0.1ml/kg 1:10,000)
Amiodarone – (VT/VF after shock 3&5) - 5mg/kg
Atropine – 20mcg/kg (min dose 100mcg, max 600mcg)
Magnesium (if torsade suspected) 50mg/kg – max 2g
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

Time Critical Pre-Departure Checklist

Child with acute myocarditis/cardiomyopathy

To be completed by referring team prior to departure

Contact with the accepting PICU intensivist via

1800 222 378 for advice during transfer

IPATS Irish Paediatric Acute Transport Service

CCRS Critical Care & Retrieval Services

Airway / Ventilation Considerations

Intubated Child:

- ☐ Appropriate Sized ETT & NGT well secured
- ☐ CXR performed & ETT & NGT position reviewed
- ☐ $ETCO_2$ & O_2 sats visible on transport monitor targeting ETC02 4.5-6Kpa & Sats 94-98%
- ☐ Appropriately sized ETT suction catheters available (uncuffed ETT size x2 = Catheter French) i.e. 3.5 cuffed ETT has same internal diameter as a 4.0 uncuffed ETT ∴ (4 x 2) = 8 F suction catheter

Child on NIV/HFNCC:

- ☐ NGT inserted and attached to bile bag for drainage
- ☐ Appropriate size intubation equipment available for transfer
- ☐ HFNCC: Suggest 2L/Kg/min ≤15Kg. 30L/min >15Kg
- ☐ CPAP: Suggest starting at low PEEP 3/4cmH_20 for tolerance and inc. as required to PEEP of 5-7cmH_20

Please ensure a blood gas (cap/venous/arterial) is measured once on transport ventilator
Please use the IPATS oxygen calculator to ensure sufficient oxygen for the transfer

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 no art line
  Please do not delay transfer for art line insertion
- ☐ Individualised approach to BP management. Discuss targets with PICU/Cardiology before departure
- ☐ Maintenance & rescue fluid available
- ☐ **Adrenaline and milrinone infusions** prepared and connected to patient even if not immediately required.
- ☐ If on Adrenaline – call PICU re additional inotrope to prepare– likely Noradrenaline

☐ **Push dose pressors:** (to correct hypotension)
Choice & dose at discretion of medically responsible consultant.
Caution recommended with use of pure alpha agonists in this context – adrenaline usually first line.

☐

1. Adrenaline **1:100,000**
   Add 1ml Adrenaline 1:1,000 to 99ml NS
   = 10mcg/ml solution (label clearly)
   Dose - 0.1ml/kg = 1mcg/kg per dose
2. Ephedrine diluted to conc. of 3mg/ml
   Dose – 1-12yr = 500mcg/kg
   Dose - >12yr = 3-7.5mg
3. Phenylephrine 100mcg/ml
   Dose - >1mo - 12yrs = 5-20mcg/kg
   Dose - >12yrs = 100-500mcg/kg

Additional useful drugs to bring: Doses in green box on prev. page

- Calcium gluconate
- Furosemide

Sedation / Neurosurgical Considerations

Tolerance of NIV or procedural sedation:

☐ If required, intermittent fentanyl 0.5-1mcg/kg or ketamine 0.25-0.5mg/kg can be administered. Low dose infusions of same are also generally well tolerated if required

Intubated Children:

☐ Morphine 20mcg/kg/hr + midazolam 2mcg/kg/min suggested starting doses

Avoid propofol/inhaled anaesthetic agents in all ages in this condition

Suggested bolus CNS medications for transfer

Use & dose at discretion of medically responsible consultant.

Due to reduced cardiac output, please titrate doses and allow additional time for metabolism and eventual effect.

Have push dose pressor of choice available when administering any sedation bolus

☐ **Recommended drugs for intubation include:**
Ketamine 0.5-1mg/kg (titrated/repeated to effect)
Rocuronium 0.6-1.2mg/kg
+/- Fentanyl 1-2mcg/kg (titrated/repeated to effect)

Further reading / Resources

1. **Diagnosis and Management of Myocarditis in Children**
A Scientific Statement From the American Heart Association. Law et al. Circulation. 2021;144:e123–e135
https://www.ahajournals.org/doi/10.1161/CIR.0000000000001001

2. **The Diagnostic and Clinical Approach to Pediatric Myocarditis: A Review of the Current Literature.**
Bejiqi R, Retkoceri R, Maloku A, Mustafa A, Bejiqi H, Bejiqi R. Open Access Maced J Med Sci. 2019 Jan 4;7(1):162-173. doi: 10.3889/oamjms.2019.010. PMID: 30740183; PMCID: PMC6352488.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6352488/

3**. Acute Myocarditis and Pericarditis in Children.**
Hari Tunuguntla, Aamir Jeewa, Susan W. Denfield. *Pediatr Rev* January 2019; 40 (1): 14–25
https://publications.aap.org/pediatricsinreview/article-abstract/40/1/14/35218/Acute-Myocarditis-and-Pericarditis-in-Children?redirectedFrom=fulltext

4. **2022 AHA/ACC/HFSA Guideline for the Management of Heart Failure: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines**
Heidenreich et al. Circulation. 2022;145:e895–e1032.
https://www.ahajournals.org/doi/10.1161/CIR.0000000000001063

5. **Presentation, Diagnosis, and Medical Management of Heart Failure in Children: Canadian Cardiovascular Society Guidelines**.
Kantor et al. Canadian Journal of Cardiology 29 (2013) 1535-1552
https://ccs.ca/app/uploads/2021/01/Pediatric_Heart_Failure_Guidelines_-_Kantor_-_CJC_2013.pdf

6. **Children's Hospital of Philadelphia Emergency Department, ICU, and Inpatient Clinical Pathway for Children with Suspected Acute Heart Failure.**
J. Rosano et al. Revised Feb 2023.
https://www.chop.edu/clinical-pathway/heart-failure-suspected-clinical-pathway

7. **The International Society for Heart and Lung Transplantation Guidelines for the management of pediatric heart failure: Executive summary**
Kirk et al. ISHLT Guidelines. Volume 33, Issue 9, P888-909, SEPTEMBER 2014
https://www.jhltonline.org/article/S1053-2498(14)01156-5/fulltext#secsect0350

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Related Documents:	

The Irish Paediatric Acute Transport Service (IPATS) in conjunction has produced this pragmatic support tool with the PICU & Cardiology 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