MRI Unit Protocols for Ventilation and Monitoring

Scope (Staff):	Nursing and Medical Staff
Scope (Area):	PCH NICU / KEMH NICU/ NETS WA

Child Safe Organisation Statement of Commitment

CAHS commits to being a child safe organisation by applying the National Principles for Child Safe Organisations. This is a commitment to a strong culture supported by robust policies and procedures to reduce the likelihood of harm to children and young people.

This document should be read in conjunction with this disclaimer

Contents

Aim

To outline the safe process for transferring infants to MRI from the neonatal units

Risk

Unstable infants being transferred for MRI are at risk of deterioration if there is inadequate preparation and planning prior to transfer. Risk is reduced if a standardised protocol is followed.

Key Points

- Ensure parents are aware of the procedure and have consented. Verbal consent is acceptable if written consent is not possible. At KEMH use the WNHS 'Neonatal MRI Consent Form' available from the MRI Unit KEMH.
- Staff accompanying ventilated infants to MRI must be neonatal trained
- Staff must have completed the MRI safety site specific e-Learning package, be familiar with all transport equipment and how to escalate for a deteriorating patient.
    - MyLearning - [NMHS] WNHS MRI Safety (001) [NMHS] WNHS MRI Safety (001) (health.wa.gov.au)
    - Medical Imaging KEMH - for the Neonatal MRI Imaging Request and Consent form
    - MyLearning - [PCH] iMRI Safety [PCH] iMRI Safety (health.wa.gov.au)
    - Medical Imaging PCH - MRI Request Form
- Infants with implanted device **cannot** have an MRI scan – pigtail drain, stents, screws, clips.
- Stable infants on CPAP can have an MRI, the BabyPac ventilator provides a flow of 10l/min which cannot be adjusted. Infants on CPAP that are having bradycardia/desaturations should be discussed with the neonatal consultant as to whether to increase respiratory support to ET ventilation or postpone MRI scan until more stable.
- Infants on HHF are **unable** to have an MRI due to the incompatibility of HHF equipment for the scanner. Options should be discussed with the neonatal consultant as to whether to increase respiratory support to CPAP or postpone MRI scan until off respiratory support.

Essential MRI preparation (See Appendix 1: Equipment)

- Ensure the MRI team is aware of any infection risk and PPE requirements
- All metal must be removed – clothing with metal poppers/zips, some IV connectors, ECG leads and toggle on Neohelp/ CPAP hat.
- Visual observation inside the scanner is difficult. Monitoring MUST be continuous during the MRI even for stable infants.
- An MRI scan may take up to an hour. Some infants may have difficulty maintaining temperature so dress appropriately and consider hat, neowrap. A Neohelp is not compatible with MRI scanner (unless toggle is removed).
- All infusions must be disconnected and reconnected in an aseptic technique using 2% chlorhexidine/70% alcohol wipes with red combi stops attached to the open ends.

- Extension tubing for low flow nasal oxygen is available in the MRI dept
- Take resuscitation equipment (Laerdel bag and mask with stethoscope).
- Documentation
    - Take medical notes, current observation chart, completed MRI Checklist
    - Document all observations, tolerance of procedure and any comments as relevant

Transfer of stable/non-ventilated infants to MRI

- MRI scans for stable infants are usually 'feed and wrap' which takes advantage of the fact that infants usually fall asleep after a feed and removes the need for sedation or a general anaesthetic. Generally, feed ½ hour prior to going to MRI.
- Transport the infant to MRI in the theatre cot (PCH), their own cot or on a warmer.

Transfer of ventilated/CPAP infants to MRI

- Preparation for transfer requires **45 minutes.** Commence preparation 1 hour prior to the booking time, extra staff should be allocated to help with the preparation and transport if needed. Transport the infant to MRI on their own warmer.
- Ventilated and CPAP infants must be accompanied by a Dr. Monitoring MUST be continuous - ECG/ SpO_2/ IABP/NIBP. Ensure monitor is always visible and alarm limits set
- Medical handover of the patient MUST occur from the treating team to the transport team with history and current clinical status. Ensure neonate is haemodynamically stable prior to leaving the unit.
- Team time out prior to departure from the ward with discussion about the transfer with role allocations and any anticipated issues discussed/unexpected deterioration. i.e. What is the escalation plan?
- Take a self-inflating bag-valve-mask (BVM) i.e. Laerdal bag, with correct sized face mask

MRI 'BabyPac' Ventilator

The BabyPac is currently the only MRI-compatible ventilator. It is a pressure-controlled ventilator which will provide a flow of 10l/min which cannot be adjusted. It cannot use Volume Guarantee – see Appendix 2 for ventilator functions and Appendix 3 for assembly and set up and use

- Confirm the ETT is taped securely in the correct position. Restrap as necessary.
- Perform ETT suction prior to departure if needed
- Set the ventilator and check function prior to connecting to the infant. Take enough oxygen to last for 2 hours plus extra for any delays

- Connect ventilator to infant for 5-10 minutes prior to departure to ensure tolerance. Take a blood gas if necessary. Capnography must be continuously monitored if available.

Medications/Infusions

- Intravenous access taped securely with a spare port easily accessible so extra medication/ contrast can be given if required. Consider taking additional fluid boluses with you for haemodynamically unstable infants.
- Can any infusions be ceased temporarily during the MRI? E.g., lipids. Can a sideline of dextrose be used instead of TPN to avoid it being disconnected?
- Label extension lines at each side of the connection nearest the patient end and at the patient end of the extension line closest to syringe. Check there is sufficient volume in the syringes.
- Ensure infants who are muscle relaxed/sedated have received adequate doses prior to departing. Take extra doses of resuscitation/ intubation/ sedation/ muscle relaxants as necessary. All drugs and infusions MUST be labelled.

On arrival to MRI

- On arrival to MRI anteroom, plug in warmer and infusion pumps to wall and connect oxygen/ air to wall supply. Warmer cannot go into MRI room
- Check patient ID and consent form / checklist with MRI staff
- MRI staff will check you and the infant are ‘MRI safe.’ Empty pockets, remove ID badge, jewellery, and watch.
- Discuss with MRI staff about the transfer plan into the scanner, decide role allocations and discuss any anticipated issues
- The infusion pumps stay outside the MRI room. Disconnect infusions nearest patient end. Cap patient and infusion ends with red combi stops. Disconnect arterial line and inotropes last. Infusions will be fed through ‘hole in wall’ ready to connect to patient
- Ventilated infants:
    - With the infant still on the warmer the Doctor will disconnect from BabyPac and ventilate infant using self-inflating bag. MRI staff & nurse will transfer BabyPac to MRI room, connect to gas supply and nurse will re-set the ventilator, check function and ensure alarms are functioning.
    - When the ventilator on and checked, nurse will remove SpO_2 probe and ECG leads and two people are to carry the infant into scanner room whilst the Dr maintains ventilation with the self-inflating bag. Observe closely as not monitored.

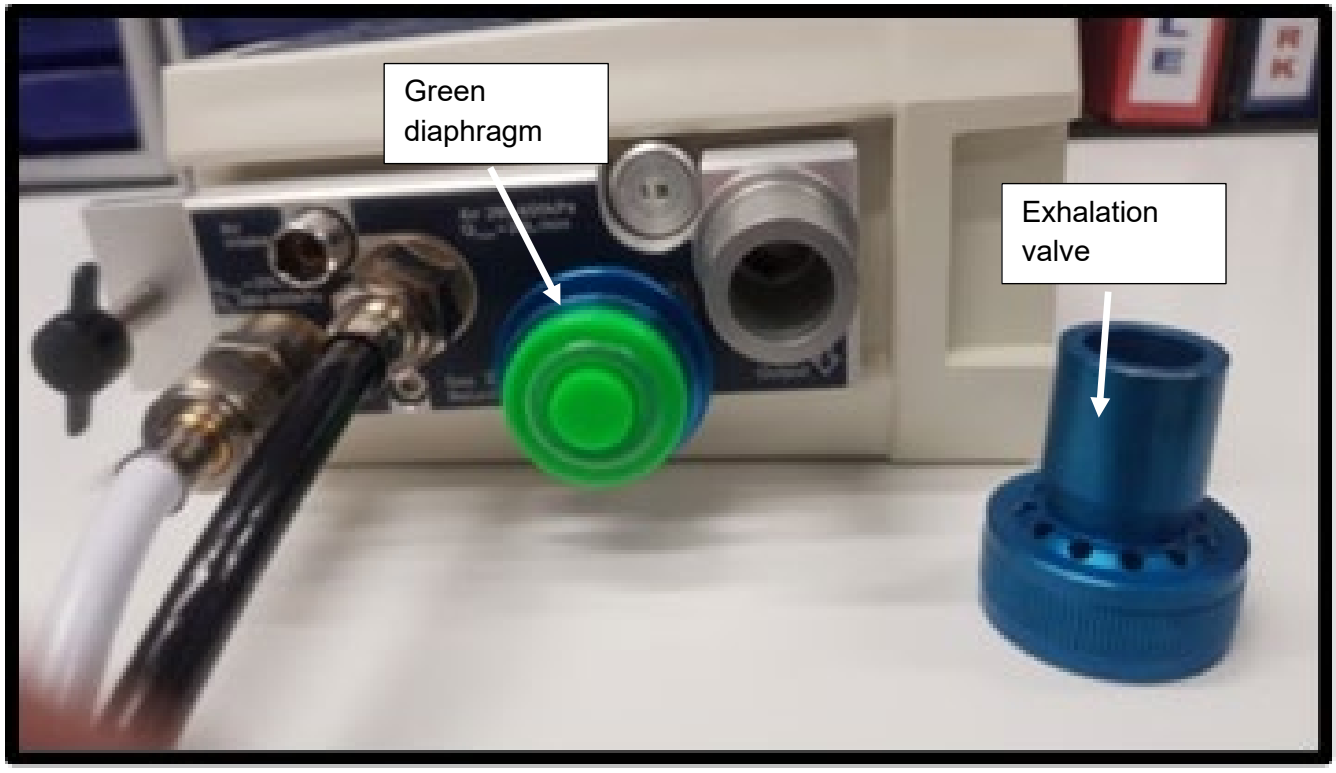
    - Place the infant into the Bean Bag and reconnect to BabyPac and attach to the MRI monitor (SaO2 probe only) May need strappit to help secure and improve wave trace.
- CPAP infants:
    - Remove the hat toggle prior to going into the scanner. Dr to have self-inflating bag and mask ready to support respiration
- Reconnect all infusions (arterial line and inotropes first)
- When infant settled, stable and positioned on the bean bag remove extra air creating a secure and firm 'nest'
- Prior to leaving the room, perform airway check, ensure ETT/CPAP is secure, monitoring is adequate before leaving the room
- **CONTINUOUSLY WATCH** the monitor during the MRI as alarms cannot be heard from outside the MRI room.
- Prepare equipment ready for when MRI scan completed:
    - Warmer plugged in and heater on
    - Enough oxygen/air in the cylinders for transport back to the ward.
    - New ECG leads /SpO_2 probe/ sheets/warm blankets

After MRI scan is complete

- Disconnect IV/arterial infusions. Cap patient and IV line ends with red combi stops. Leave arterial line and inotropes until last
- Doctor will ventilate infant using self-inflating bag while ventilator disconnected, taken out of MRI room and re-set on the warmer. Nurse to re-set, check ventilator settings and ensure alarms are functioning
- Two people to carry infant out of MRI room onto pre-warmed warmer, reconnect ventilator and monitoring.
- Pass infusions back through hole in wall whilst maintaining asepsis (arterial and inotropes first). Extra extension lines can be discarded prior to reconnection.
- Perform airway check, ensure ETT/CPAP is secure, monitoring is adequate, and baby is stable before leaving to return to NICU
- Document the procedure including all observations on return to ward and any complications.

Care of Ventilator and Circuit post procedure (reprocessing)

PCH	KEMH
1. Disconnect and dispose of the ventilator circuit. 2. Remove green diaphragm from the exhalation valve. Send diaphragm and exhalation valve to CSSD for urgent sterilisation. 3. Wipe over ventilator with Clinell wipes, replace the green diaphragm and restock a new ventilator circuit and supplies to the wire basket in the Compactus in 3B. See CAHS Infection Control Policy: Reprocessing of Reusable Medical Devices (RMD's) CAHS.INFECTCTRL.MedicalDevicesProperties	1. Disconnect the ventilator circuit and remove green diaphragm from the exhalation valve. 2. Send the circuit, diaphragm, and exhalation valve to CSSD for urgent sterilisation 3. Wipe over ventilator with Clinell wipes, replace the green diaphragm and prepare a clean ventilator circuit. Replace in the Compactus See WNHS Infection Prevention and Management Manual: Reprocessing of Reusable medical devices

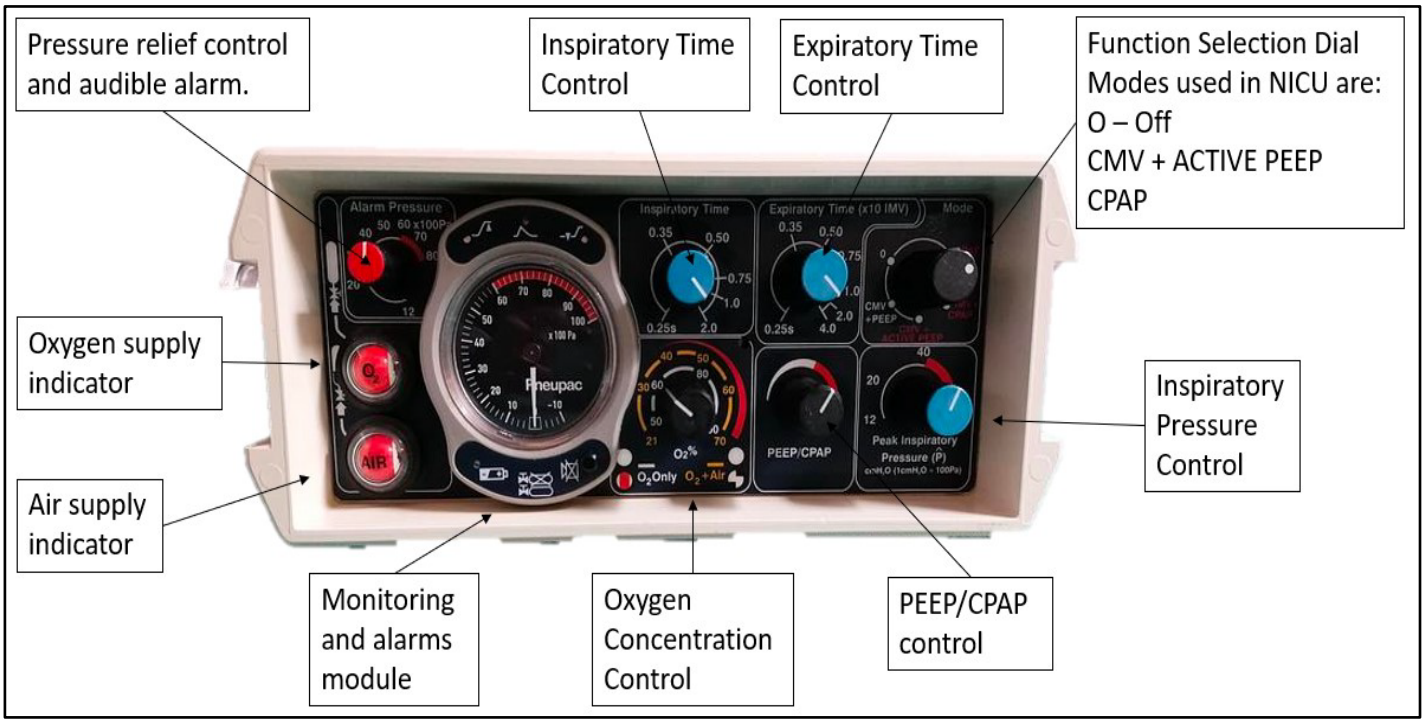


Appendix 1: Equipment Required

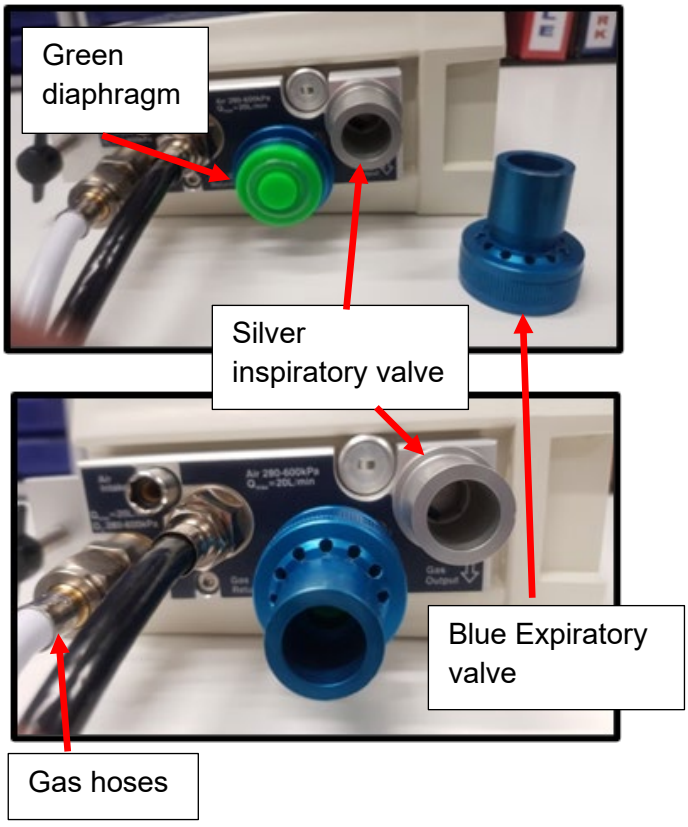
EQUIPMENT	PCH	KEMH	COMMENTS
BABYPAC VENTILATOR	Stored in Compactus		See Appendix 2 for circuit set up and how to use
VENTILATOR CIRCUIT	Biomedical International Double Limb circuit Disposable	Non-disposable circuit	
MONITOR	Phillips X3 monitor from bedside	Phillips X3 monitor from bedside	RAD 5 - used for SV infants **only**
INTUBATION AND RESUSCITATION EQUIPMENT	Red roll (kept in compactus on 3B)	Intubation box on resuscitaire	
LAERDAL BAG AND MASK AND STETHOSCOPE	Take from cot side		
HUMIDI-VENT	Attach at Y-piece of circuit between the ETT and circuit		Circuit NOT humidified
INFUSIONS	Add 3 long extension lines = **total of 4**	Add 4 long extension lines = **total of 5**	
	Prime extensions and add to existing infusions. Label at patient end (on either side of connection) and on the patient end of the 1st extension line from the syringe		
RED COMBI STOPS	4 of each required for each infusion – plus some extra Maintain aseptic technique throughout the entire transfer Each line should have a red combi stop added when disconnected. Each line is disconnected and connected twice when transferring in and out of MRI scanner.		
2% CHLORHEXIDINE 70% ALCOHOL SWABS			
VELCRO STRAPPITS	Can be used to loop lines together / securing MRI sats probe		
THERMOREGULATION	Warm clothes, Hat, blankets, Neowrap, Neohelp (**ONLY** if toggle removed)		

Appendix 2: BabyPac 100 ventilator

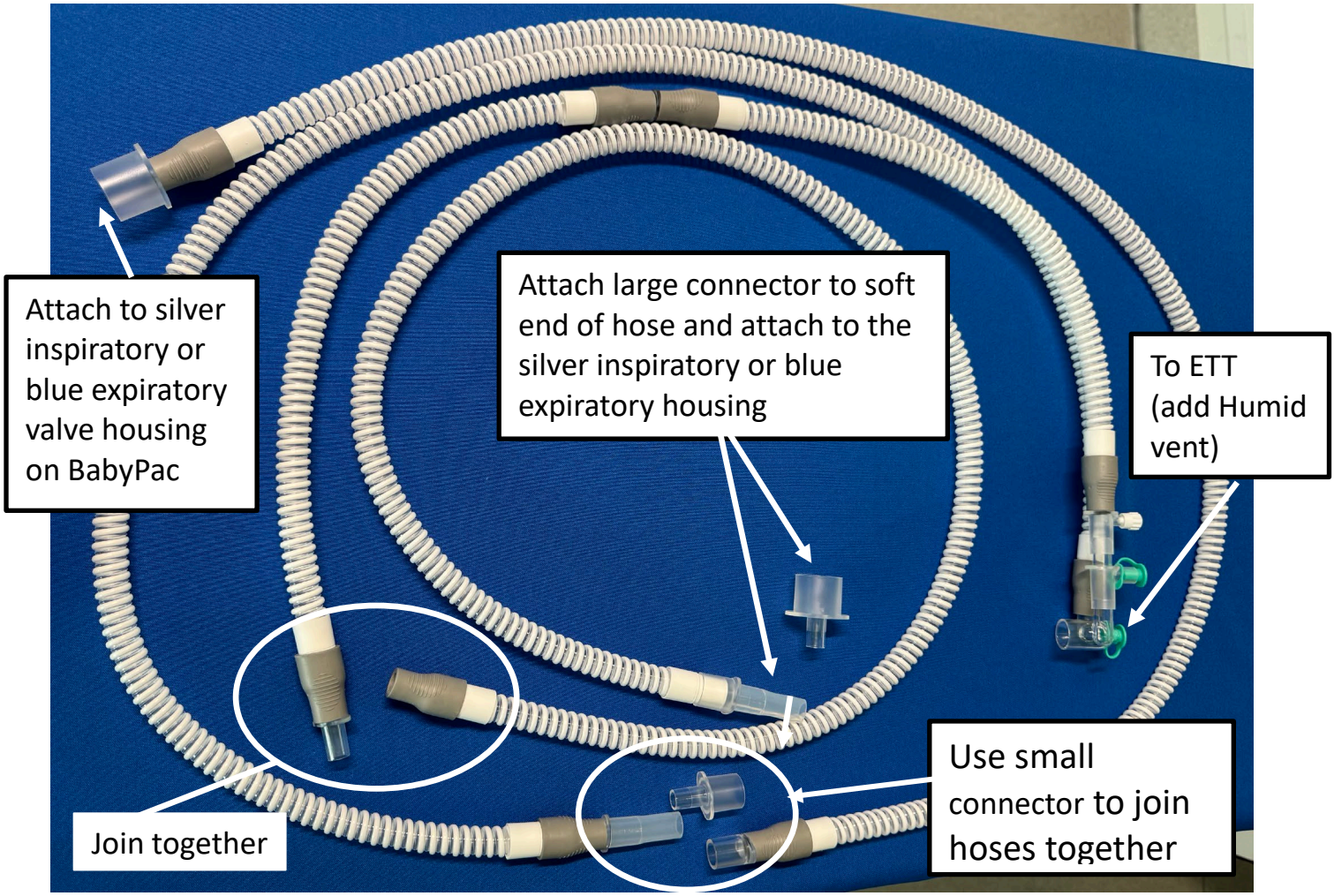
This MRI Compatible ventilator is a time cycled, pressure generator which relies solely on the pressure of the supply gas for its operation. There is a constant gas flow of 10l/min which cannot be changed.



- Remove the blue expiratory valve and check there is a green diaphragm in situ.
- Replace the expiratory valve and tighten (finger-tight only)
- The ends of the ventilator circuit connect to the silver and blue valves



Appendix 3: Assembling and setting up the ventilator and circuit



Setting up the BabyPac ventilator

- Attach the BabyPac to the mounting arm on the warmer. Connect circuit as above
- Use oxygen and air cylinders that are full. Turn on and connect BabyPac gas hoses to gas supply (initially check function using wall supply to preserve supply then check function stable using cylinders prior to transfer off the unit)
- Check that visual alarm for supply gas failure has changed from red to white (oxygen) or black and white (air)
- Turn ventilator on by rotating the function selector knob to chosen mode of ventilation.
    - **CMV + Active PEEP – primary mode used in NICU**. Active PEEP gives continuous flow during expiration as well as inspiration. Much more gas is used in this mode, but it is much better for the patient. It **MUST** be on this setting when 70-100% oxygen is needed.
    - **CPAP** – continuous pressure applied during inspiration and expiration to a patient who is spontaneously breathing

- **CMV + PEEP** 2/3rd of the gas flow in the patient circuit during the inspiratory phase is ambient air and compressed gas usage will be most economical as there is no flow during expiration. PEEP is maintained by the patient's expiratory flow passing through the expiratory valve.
- **IMV + CPAP** – Gives an expiratory time 10 times longer than stated. This mode **should not be used** in infants

- The ventilator should commence cycling and all alarm lights flash in turn
- A single burst of high priority audible alarm is given at the same time
- The orange silence indicator should flash for 60 seconds
- Check that the flow is coming from the patient connection port by feeling the flow
- The green cycle indicator light should flash during each inflation as pressure rises
- Set rate - Alter the inspiratory and expiratory time to get desired rate:

T exp = 60/ rate – T insp

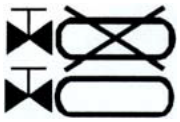
		Rate				
		20	30	40	50	60
Inspiratory time	0.35	2.65	1.65	1.15	0.85	0.65
	0.40	2.60	1.60	1.10	0.8	0.60
	0.45	2.55	1.55	1.05	0.75	0.55
	0.50	2.50	1.50	1.00	0.7	0.50
		Expiratory time				

- Set pressures and occlude the proximal connection port of the patient circuit and check that the pressure dial gives the required reading during the inspiratory phase
- FiO_2 will depend on which gases are connected

For 21-70% use both oxygen and air cylinders Read oxygen from **yellow** dial	
For 50-100% use only the oxygen cylinder Read oxygen from **white** dial	

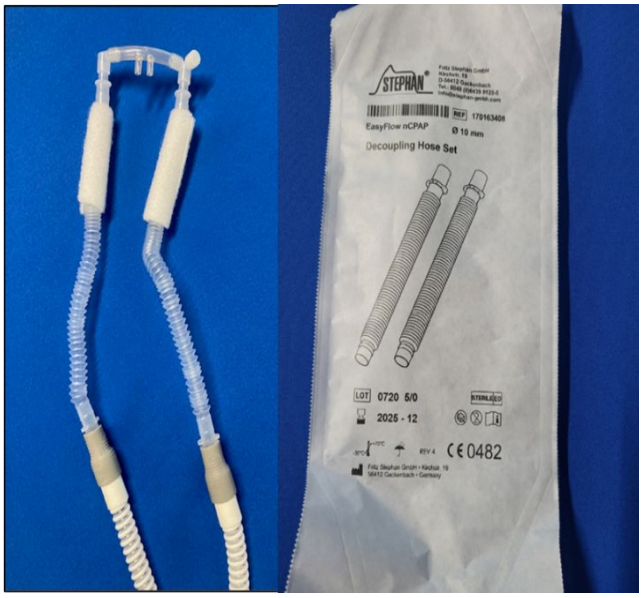
Alarms

- Leave the high pressure limit at 30 cmH_20 and set the PIP at 40 cmH_2O then occlude the proximal port and the pneumatic audible alarm should sound as well as the high pressure visual alarm
- Connect patient to ventilator and check the pressures are correct

	**High inflation pressure visual alarm** – flashed red twice after the high pressure relief valve is used
	**Cycle indicator** – The green light flashed once every time the patient inflation pressure rises through the preset threshold pressure: **This is normal function**
	**Low pressure/ Disconnect Visual Alarm** – the yellow light flashes 30 times/ minute if the 'cycle detect' or 'breathing defect' has not been activated for 10 seconds
	**Single gas operation** – this green light gives a burst of 3 flashes every 30 seconds whenever the ventilator is operating on a single gas supply (oxygen or air only).

CPAP circuit set up

- Set-up the circuit the same as for a ventilated infant
- Disconnect Y-piece from circuit
- Attach decoupling hoses to circuit by using CPAP extenders
- Attach Velcro strips to the patient end of the decoupling hoses
- Attach to CPAP prongs
- Note – the toggle on the CPAP needs to be removed
- To set PEEP, occlude the nasal prongs and dial up the required amount by using the PEEP/CPAP knob



Related CAHS internal policies, procedures and guidelines

Recognising and Responding to Clinical Deterioration (health.wa.gov.au)

Clinical Handover (health.wa.gov.au)

References and related external legislation, policies, and guidelines

- Franco J. Magnetic Resonance Imaging Safety. Radiol Technol. 2020 Mar;91(4):343-356. PMID: 32102862.
- Delacrétaz R, Fischer Fumeaux CJ, Stadelmann C, Rodriguez Trejo A, Destaillats A, Giannoni E. Adverse Events and Associated Factors During Intrahospital Transport of Newborn Infants. J Pediatr. 2022 Jan;240:44-50. doi: 10.1016/j.jpeds.2021.08.074. Epub 2021 Sep 1. PMID: 34480917.

Useful resources (including related forms)

MyLearning - [NMHS] WNHS MRI Safety (001) [NMHS] WNHS MRI Safety (001) (health.wa.gov.au)

MyLearning - [PCH] iMRI Safety [PCH] iMRI Safety (health.wa.gov.au)

MRI Safety Checklist (PCH)

Medical Imaging KEMH - MRI Request Form

Medical Imaging PCH - MRI Request Form

This document can be made available in alternative formats on request.

Document Owner:	Neonatology		
Reviewer / Team:	NETS WA		
Date First Issued:	June 2006	Last Reviewed:	March 2024
Amendment Dates:		Next Review Date:	March 2027
Approved by:	Neonatology Coordinating Group	Date:	26th March 2024
Endorsed by:	Neonatology Coordinating Group		
Standards Applicable:	NSQHS Standards:  Child Safe Standards: 1,10		

Printed or personally saved electronic copies of this document are considered uncontrolled