

Care of Ventilated Infant in Newborn Intensive Care Unit (NICU)

Procedure Responsibilities and Authorisation

Department Responsible for Procedure	NICU
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Target Audience	Staff working in NICU
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Procedure Review History

Version	Updated by	Date Updated	Description of Changes
4	Chad Pagdanganan	July 2017	3-yearly update
5	Richard Pagdanganan	Jan 2021	3-yearly update
5.1	Richard Pagdanganan	Nov 2021	Added information about OxyGenie

Care of Ventilated Infant in Newborn Intensive Care Unit (NICU)

1 Overview

1.1 Purpose

To provide safe assisted ventilation which facilitates optimum gas exchange to correct hypoxemia, maintain adequate alveolar performance and decrease work of breathing.

1.2 Scope

Waikato District Health Board (DHB) staff working in NICU.

1.3 Patient Group

Neonates and infants in NICU

1.4 Definitions

Acrocyanosis	A condition marked by bluish or purple colouring of the hands and feet, caused by slow circulation.
FiO₂	Fraction of inspired oxygen
IPPV	Intermittent Positive Pressure Ventilation
Mechanical Ventilation	It is one of the most common therapies in the Neonatal Intensive Care Unit and is associated with increased morbidity and mortality. It is a type of respiratory support that uses mechanical assistance via endotracheal (ET) tube/tracheostomy for infants with respiratory failure, pulmonary insufficiency, need for surfactant administration, severe apnoea and bradycardia episodes cardiovascular support, neurologic disorder, chemical or medical respiratory depression, and pre/post- surgery. The main goal of mechanical ventilation is to provide adequate oxygenation and ventilation with the most minimal ventilation possible.
Neonatal Emergency Medication Sheet (NEMS)	The emergency medication chart for each infant in Level 3 in which dosages of resuscitation and intubation drugs are pre-calculated based on infant's birth weight or current weight.
Medical staff	The medical staff in NICU includes CNS (Clinical Nurse Specialist), NNP (Nurse Practitioner Neonatology), Registrar and Paediatrician.
OxyGenie®	is a complex piece of software that can control the oxygen delivered to a sick baby whilst on a life-support ventilator. It is a responsive, safe and most importantly, effective. It managed to maximise the time SpO ₂ spent within a target range of 5%; it looked at many different inputs to determine an action; it analysed the inputs every second and could make as many changes as necessary and it reacted well when it experienced sudden changes in baby saturation.
RDS	Respiratory Distress Syndrome is a common breathing disorder that affects newborns. RDS occurs most often in babies born preterm, affecting nearly all newborns who are born before 28 weeks of pregnancy due to surfactant deficiency. Less often, RDS can affect

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	full term newborns. Symptoms include rapid, shallow breathing and a sharp, pulling-in of the chest below and between the ribs with each breath.
SPO₂	Peripheral capillary oxygen saturation, is an estimate of arterial oxygen saturation (SaO ₂).

2 Clinical Management

2.1 Competency required

Registered nurse who has completed Level 3 (Intensive Care) ventilator orientation

2.2 Equipment

- Ventilator & gas source
- Humidifier
- Sterile water
- Emergency equipment
 - Suction equipment
 - Emergency trolley
 - Neonatal Emergency Medication Sheet (NEMS)
 - Neopuff™ + appropriately sized mask
 - Anaesthetic bag + pressure gauge (in each Emergency trolley or by the bedside as needed)
 - Stethoscope

2.3 Procedure

2.3.1 Preparations

- Provide an open, honest communication with the family and explain the procedure. This is necessary for reducing their anxiety.
- Ensure that the emergency equipment is functioning and always readily available. Check the emergency trolley/s each shift, and after use and replace used items.
- Ensure NEMS is available and current.
- Provide a safe environment for the infants in the unit and regulate the infection control policies (e.g. hand washing, visiting policies).

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2.3.2 Care of the ET tube

a) Position of the ET tube

- Apply duoderm as a base tape to protect the infant's skin before securing the ET tube at the correct position
- Use sleek tape for nasal tube or Elastoplast for oral tube. [Refer to NICU Medical Procedure Endotracheal Tube Taping: Nasal & Oral in Newborn Intensive Care Unit \(NICU\) \(2727\).](#)
- After confirming the ET tube by x-ray, document the length of ET tube at the nares/lips, on NICU intubation chart.
- For x-rays of any baby who is $\leq 1000\text{g}$ and/or $\text{GA} \leq 28$ Weeks refer to NICU Medical Procedure [ELBW Baby Care & IVH Bundle For Infants with Expected Birth Weight < 1000g and/or GA < 28 Weeks in Newborn Intensive Care Unit \(NICU\) \(6240\).](#)
- Cut the end of the tube with appropriate length to reduce dead space.
- Calculate the length of the suction catheter and document on the NICU intubation chart.
- Refer to the infant's intubation chart to note the length of the ET tube in case the ET tube dislodge.
- Observe for any evidence of ET tube slipping, moving in and out, or tape loosening.
- Request medical staff to re-tape as necessary to prevent accidental dislodgement or extubation.
- Closely observe the position of the ET tube, e.g. more than 1cm from its desired position may indicate extubation or placement in the right main-stem bronchus.
- Position the infant in a supine/lateral/prone position depending on clinical condition of the infant, with the head in a neutral midline position.
- Be aware that the tube moves with the chin and can move several centimetres with head flexion/extension.
- Use a neck roll or folded flannel to support the ET tube to avoid the tube to be dragged.
- Two nurses are required when turning the infant, or lifting for an x-ray.

b) Maintaining patent airway and other considerations

- Position the infants with head in neutral midline position.
- Maintain airway humidification, and record temperature of inspired gas as shown on the temperature panel on the humidifier hourly, which is pre-set achieve 36.7 °C.

Doc ID:	0432	Version:	05.1	Issue Date:	15 DEC 2021	Review Date:	15 MAR 2024
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- Provide the correct humidification temperature to prevent complications due to under/over humidification, and to maintain the integrity of the airway mucociliary function.
- **NOTE:** If humidification of inspired gases is not appropriately addressed, ciliary dysfunction, inflammation and necrosis of the ciliated pulmonary epithelium, retention of dried secretions, atelectasis, bacterial infiltration of the pulmonary mucosa, and pneumonia may occur.
- If medically advised, leave the gastric tube on free drainage if baby is nil by mouth and aspirate every four hours to relieve gaseous distension of the abdomen.

c) Suctioning of the ET tube

- Check suction equipment at the beginning of each shift.
- Suctioning is not a routine practice; the need to suction should be assessed on an individual basis.
- The amount of secretions will be disease related, e.g. infants with early stage of respiratory distress syndrome (RDS) and those with most types of congenital heart disease will have minimal mucous and will require less suctioning in the initial 1-2 days.
- Delay ET suction for 12 hours or longer post administration of Curosurf, if possible, to ensure absorption of the surfactant.
- Criteria for suctioning includes:
 - Evidence of secretions (audible/visible)
 - Changes in vital signs
 - Changes in oxygenation SpO₂ or pCO₂
 - Restlessness, irritable and agitated
 - Decreased air entry
 - Radiological change such as lung consolidation
- Stop continuous feeding before suctioning.
- Use saline lavage as indicated because saline can cause deterioration if used in excess.
- **NB:** Loose secretions may not need saline.
- Some infants may require an increased fraction of inspired oxygen (FiO₂) before and after suctioning to maintain SpO₂ and prevent hypoxia. However, hyperoxygenation is not a routine practice for every infant. Each infant should be assessed individually regarding whether this is necessary. This is determined by the infant's clinical condition, response to ETT suction, and length of time it takes for the infant to recover post suction.
- In-line suction catheter is used to allow ventilation to continue because the use of in-line suction catheter is associated with a decreased risk of infection and smaller changes in the cerebral blood flow.

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- Change in-line suction catheter weekly or as needed and place provided sticker determining next change.
- **NOTE:** If using Nitric Oxide Therapy and/or High Frequency Ventilation, the in-line suction catheter is changed only if absolutely necessary, e.g. leakage, blocked catheter or plastic markings are unable to be seen through the catheter sleeve.
- Use of infant's NICU intubation chart to ensure correct measurement of the length of suction catheter. Suction catheter should not advance further than the distance of the ET tube.
- Ensure suction pressure is set at 80-100mmHg.
- Limit each suctioning duration to 5-10 seconds. The suction catheter should be withdrawn slowly at a consistent speed until the black mark on the catheter appears in the viewing window. Do not take the suction straight out in one quick motion.
- For suctioning any baby who is $\leq 1000\text{g}$ and/or $\text{GA} \leq 28$ Weeks refer to NICU Medical Procedure ELBW Baby Care & IVH Bundle For Infants with Expected Birth Weight < 1000g and/or GA < 28 Weeks) in Newborn Intensive Care Unit (NICU) (6240).

Rationale: To reduce the risk of complications such as hypoxia, bradycardia, barotraumas, changes in blood pressure, alternations in cerebral blood flow, intraventricular haemorrhage, tracheal damage, atelectasis, infection, and pneumothorax.

Note: Occasionally if very thick secretions cannot be cleared with in-line suction two person open suction procedure may be required. The assisting nurse will disconnect the infant from the ventilator and instil lavage if indicated, reconnects briefly. The nurse then uses suction catheter to suction down ET tube using the predetermined length to clear secretions. The infant may need to be bagged in between suctioning.

d) Monitoring and documentation

- Document and report any changes on the infant's condition to the medical staff.
- Observe the general state of the infant
 - Awake, crying if ventilated.
 - Assess infant's pain and sedation status using Neonatal Pain Agitation and Sedation Scale (N-PASS)
- Colour: Pallor, Cyanosis, Jaundice

Note: Acrocyanosis is a normal finding among new born infants.

- Mouth and nose
- Secretions: amount, colour, and consistency.

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- Document the frequency of suctioning.
- Respiratory status
 - Is the baby comfortable while breathing?
 - Signs of respiratory distress: retractions, nasal flaring or indrawing.
 - Respiratory rate.
 - Chest movement: symmetrical?
 - With accidental extubation, chest movement may not be seen or may be decreased.
- Listen to breath sounds.

Rationale:

- To determine differences in the left and right lung fields, e.g. suspecting pneumothorax.
- To detect any slipping of the ET tube into the right bronchus
- To ensure ET tube is in the correct position after repositioning of the infant
- To assess effectiveness of intervention, e.g. after suctioning
- Bilateral and equal air entry on auscultation?
- Fine course crackles?
- Abnormal sounds?

e) Continuous monitoring and hourly recording

- i) Cardiorespiratory monitor
- ii) Continuous blood pressure (BP) if arterial line is available, or cuff BP as ordered by the medical staff, e.g. 1-4 hourly
- iii) SpO2 monitoring
- iv) Alarm limits set approximately according to the infant's gestational age and age. [Refer to NICU Medical Procedure Oxygen Therapy for Newborns in NICU \(3115\).](#)

f) Blood gas measurement

- i) Measure blood gas (arterial/capillary) 2-4 hourly as indicated, or 20-60 minutes after change of ventilator settings or after administration of volume, e.g. 0.9% sodium chloride
- ii) Arterial blood gas is more reliable in obtaining an accurate pO₂ value. When arterial line is not available, capillary samples are useful for measuring pCO₂ and pH values.

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g) Adjusting FiO₂ level:

When adjusting FiO₂, make small changes at a time, e.g. 5-10%, and allow time for the infant to respond to reduce the risk of fluctuation of FiO₂ to cerebral and retinal blood flow.

NOTE: SLE600 has OxyGenie®, the medical team will decide if this can be used on the baby. If the patient is on OxyGenie® and needs an immediate increase in FiO₂ you can override this mode.

h) Care of infants with peripheral arterial line (PAL) or umbilical arterial catheter (UAC) as per NICU procedures

- i) Alarms must be turned on all the time to detect complications, e.g. haemorrhage, disconnections, occlusions or deterioration
- ii) Observe hourly the colour and perfusion of the toes/fingers distal to the insertion site of PAL, skin breakdown, and infiltration of the site.
- iii) Observe the perfusion and colour of buttocks during nappy change for baby who has UAC insitu and more frequently if change is noted in the perfusion or colour of the lower limbs .
- iv) Calibrate (i.e. zero) the transducer at every shift to ensure proper functioning of the arterial line/UAC.

i) Monitor temperature:

- i) Check and record the infant's axillary temperature 4-hourly or more often as required, e.g. 1-2 hourly, to detect temperature instability.
- ii) Record and report if peripheral temperature <35 °C.

Monitor any changes in the peripheral temperature as per [NICU Nursing Procedure Peripheral temperature Monitoring of Infants in Newborn Intensive Care unit \(2895\)](#). Changes in peripheral temperature may be due to handling, significant event or deterioration of infant's condition resulted in reduced cardiac output and poor peripheral perfusion.

- iii) Check and record infant's BP, core temperature, incubator/radiant warmer setting, position of the temperature probes to ensure correct probe positioning and accurate measurement.

j) Maintain accurate fluid balance record

- i) Measure urine volume, e.g. urine output is poor if <1ml/kg/hr.
- ii) Record bowel motion including amount and characteristics.
- iii) Monitor blood sugar level (BSL) and lactate.

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k) Provide developmental supportive care according to Lippincott procedures.

Rationale:

- i) To facilitate neurological development, minimise stress and pain
- ii) To maximise infant's ability to cope with and recover from clinical procedures.

l) Preventive measures:

- i) Reduce handling time where possible by evaluating all aspects of care.
- ii) Group cares based on the infant's condition and tolerance to handling
- iii) Facilitate family-centred care by negotiating care with the parents according to stability and clinical condition of the infant.
- iv) Teach parents about the signs and symptoms of infant stress and comfort measures that they can provide.
- v) Apply cue based cares - wait for the baby to wake or demonstrate need then perform grouped care.
- vi) Provide pain relief, e.g. give dextrose gel prior to invasive procedure to reduce pain responses.
- vii) Reduce external stimuli from lighting and noise levels.
- viii) Use positioning aids, e.g. nesting, freddy frog to provide containment and maintain infant in a flexion position.
- ix) Use skin barrier, e.g. duoderm to protect skin.
- x) Document infant's behavioural cues.

m) Behavioural measures:

- i) Use facilitated tucking to position infants during painful procedure: hand swaddling technique that holds the infant's extremities fixed and contained close to the trunk.
- ii) If appropriate and safe to perform, provide parents to have skin-to-skin cuddling with their infant who is a stable ventilated infant with no umbilical arterial line.

NOTE: Kangaroo care offers benefits to stable ventilated infants, as long as the procedure is safely practiced.

Rationale:

To promote infant's physiological stability and temperature control and to enhance maternal hormonal response that facilitates breastfeeding.

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n) Sedation:

- i) Administer sedation as prescribed, e.g. fentanyl, morphine, midazolam, or bolus dose of phenobarbitone.
- ii) For a baby who is critically unstable and very sensitive to handling, consider the use of neuroblocking agent, e.g. Vecuronium –eliminate spontaneous breathing efforts that can interfere with the ventilator's action. This will be prescribed by the medical practitioner.
- iii) Monitor BP continuously or hourly cuff BP for infant receiving morphine due to the potential adverse neurologic outcomes that may exist in ventilated infants who receives morphine and has hypotension. Report any changes in BP to medical staff.
- iv) Observe and record the effectiveness of sedation, e.g. vital signs within normal range, infant is settled and not fighting against the ventilator, and stable oxygen saturation and FiO₂. Refer to NICU Nursing Procedure: Neonatal pain and sedation: Assessment and nursing management (1684.)
- v) Observe for side effects of medication:
 - a) Fentanyl: Adverse effects include respiratory depression, chest wall rigidity, dependence, and urinary retention.
 - b) Morphine: Adverse effects include respiratory depression, hypotension, bradycardia, transient hypertonia, ileus, delayed gastric emptying, urinary retention, dependence and seizures.

NOTE: Consider insertion of indwelling catheter for babies on Fentanyl or Morphine infusion. All babies who are vented or who is receiving a neuromuscular blocking agent require a nurse stay by the baby's bedside for close observation because of the child's inability to breathe or communicate. Also, **do not** fully cover the incubator of vented babies. You need to visualise the baby to prevent self extubation.

o) Emergency management: Use Neopuff™ with blender or the manual breath button for bagging.

Rationale:

Bagging the infants with the Neopuff™

- i) Allows the delivery of controlled inspiratory pressure during Intermittent Positive Pressure Ventilation (IPPV).
- ii) Bagging of infant using manual breath button delivers IPPV at current ventilator setting.

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p) Cleaning of the ventilator

- i) The ventilator should be cleaned every shift using a disinfectant wipe.
- ii) Ventilator change should be done every 7-14 days depending on the model of humidifier and clinical stability of the baby.

NOTE: MR950 humidifier circuit it is rated to 14 days between changes. For the older MR850 humidifier circuit change can be done every 7 days.

- iii) The dirty ventilator should be put in the cleaning room and put a sign e.g. dirty, infectious, COVID

2.4 Potential Complications

- ET tube dislodgement or extubation. Unexpected extubations will require a Datix.
- Observe for signs of extubation
 - Sudden deterioration like apnoea, bradycardia, and desaturations.
 - Audible crying
 - Decreased chest movement
 - Breath sounds in the abdomen upon auscultation
 - Change in skin colour- cyanosis
 - Abdominal distension
- Hypoxia
- Bradycardia
- Barotraumas
- Changes in blood pressure
- Alternations in cerebral blood flow
- Intraventricular haemorrhage
- Tracheal damage
- Atelectasis
- Infection
- Pneumothorax

3 Audit

3.1 Indicators

- Inline suction tubes are changed every 24 hours
- There is documented evidence of physiological investigations as per 2.3.2
- Infants prescribed morphine are monitored as per 2.3.2 (n)

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4 Evidence Base

4.1 Bibliography

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4.2 Associated Waikato DHB Documents

- NICU Drug Manual
- NICU Medical Procedure: [ELBW Baby Care & IVH Bundle For Infants with Expected Birth Weight < 1000g and/or GA < 28 Weeks in Newborn Intensive Care Unit \(NICU\)](#) (6240)
- NICU Medical Procedure: [Oxygen Therapy for Newborns in NICU](#) (3115).
- NICU Nursing Procedure: [Arterial lines: Nursing management and sampling and removal](#) (1638)

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- NICU Nursing Procedure: [Arterial Line: Catheterisation and setup of Umbilical \(UAC\), peripheral arterial \(PAL\) Catheter in NICU](#) (1637)
- NICU Nursing Procedure: [High Frequency Ventilation-Nursing Care of Infant](#) (0396)
- NICU Nursing Procedure: [Peripheral temperature monitoring](#) (2895)
- NICU Nursing Procedure: [Neonatal pain and sedation: Assessment and nursing management](#) (1684)
- Lippincott Procedures: [Skin-to-skin contact, initiating intubated patient, neonatal](#)
- Lippincott Procedures: [Skin-to-skin contact, terminating an encounter, intubated patient, neonatal](#)
- Lippincott Procedures: [Developmental support, neonatal](#)
- Lippincott Procedures: [Endotracheal suctioning, intubated patient, neonatal](#)

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