GUIDELINE

Surfactant Therapy

Scope (Staff):	Nursing and Medical Staff
Scope (Area):	NICU KEMH, NICU PCH, 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.

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Contents

Aim

This guideline covers the indications for surfactant therapy in neonates, the method of administration and procedural instructions.

Risk

Failure to follow standardised management in the treatment of RDS in eligible infants may lead to a delay in surfactant therapy.

Background

Surfactant therapy is essential in the management of Respiratory Distress Syndrome (RDS) as it reduces pneumothorax and improves survival. It is given to minimise atelectasis and reduce the work of breathing. This outcome is achieved by reducing the surface tension and promoting alveolar stability during expiration

Prophylactic use of surfactant refers to a strategy of providing exogenous surfactant at birth to infants at risk for RDS, with the aim of preventing severe RDS from developing. Selective or rescue use of surfactant refers to a strategy of providing exogenous surfactant to infants with established RDS. With high rates of antenatal steroid before birth and with the possibility of earlier CPAP the benefit of prophylactic surfactant is questionable. If surfactant therapy is to be given it should be given as early as possible in the disease process with a demonstrable impact on clinical outcome.

Indications

- If intubation is required as part of stabilisation in a preterm infant with RDS, then surfactant should be given as soon as possible
- RDS in an infant (of any gestation) when FiO2 on CPAP is >0.3.
- Consider in meconium aspiration syndrome (MAS) although evidence of benefit is lacking
- Consider in ventilated neonates with pulmonary haemorrhage.

Surfactant preparations

- Both European and Canadian national guidelines recommend the use of a porcine [Curosurf] (as opposed to) bovine [Survanta] derived surfactant. This preparation volume allows a larger dose of key surfactant proteins to be given and the porcine surfactants offers a survival advantage at the higher dose.
- Few studies have definitively proven an advantage of a particular animal-based surfactant. Bovine surfactant may have a cost advantage.

Refer to the Neonatal Medication Protocols for details of the dose and method of administration of surfactant, Survanta / Curosurf.

Surfactant administration

ETT Intubation

- Administration of surfactant is a dynamic process involving anticipated responsive changes to mechanical ventilation alongside administration of the surfactant.
- Medical Staff should be present immediately before, during and for at least the first 5 minutes after surfactant administration to alter ventilation settings as required (ventilator rate, peak inspiratory pressure, FiO_2 and inspiratory time settings).

- Bolus administration of surfactant induces a transient marked increase in airway resistance that may precipitate airway occlusion, bradycardia and hypoxia. Judicious precautionary increases in driving pressure (PIP) and inspiratory time prior to surfactant administration and continuous adjustment of these parameters in response to flow monitoring and/or observation of the surfactant fluid column in the tracheal tube reduces the incidence and severity of this complication.
- Continuation of volume guarantee throughout the administration of surfactant (with retention of the flow sensor in the circuit) will ensure any increase in ventilator settings do not cause additional lung damage.
- Infants who receive surfactant in the delivery suite should be commenced on volume guarantee as soon as they arrive in the intensive care unit.
- Reassess ventilator settings every 15 minutes for an hour, then hourly thereafter. Note changes in SaO_2, V_T, and minute volume (MV). Peak inspiratory pressure on volume guarantee should be sufficient to generate adequate tidal volumes.
- Curosurf improves oxygenation and lung compliance more rapidly than Survanta. Increase in lung volume is an indication of improved lung compliance. Reduction in ventilatory settings may be required within 5 minutes of administration.
- Adverse reactions to surfactant administration include
  - transient hypoxia and bradycardia,
  - endotracheal tube blockage and air leaks.
  - Hypoxia and bradycardia are usually the result of tube blockage.
  - If there is significant desaturation or bradycardia, stop the administration temporarily and make appropriate changes to the ventilator to ensure the surfactant fluid column in the tracheal tube advances distally and that flow is re-established.
- Surfactant administration is a minimum two-person procedure, one must be neonatal trained. The infant must have cardio-respiratory monitoring throughout. A third person is ideally present, with the sole responsibility for continuous adjustment of the ventilator during the procedure.

Equipment required

- Trachmac Device; size FG 5 for size 2, 2.5, 3, 3.5 endotracheal tubes
- Tracheal tube (size 2, 2.5, 3, 3.5 as required)
- Warmed surfactant (Survanta or Curosurf as determined by consultant)
- 10 mL syringe, drawing up needle and alcohol wipe

Surfactant administration in the delivery suite **WITHOUT** flow-volume monitoring

1. Place the infant in the supine position. The base of the warmer or incubator is to remain flat throughout.
2. Remove the blue connector from the endotracheal tube and attach the appropriate adaptor and Trachmac device. Reconnect endotracheal tube to ventilator.
3. Draw up the prescribed surfactant volume, add 1 mL of air. Ensure that the air is at the plunger end of the syringe. Attach syringe to luer lock connector of Trachmac.

1. The **insertion distance** for the Trachmac is determined by the length of the ETT to the cut-off point plus 5 cm. (Note the colour band before the number for easier visualisation).
2. Insert the catheter & as soon as the colour appears in the **"window area"** of the Trachmac catheter - stop advancing the catheter (the tip will be at the end of the ETT to within 0.5 cm beyond the end of the ETT.
3. Instil ½ of dose over 5-10 s. Withdraw the trachmac catheter from the ETT as the peak inspiratory pressure is increased by 3 cmH_2O from pre-surfactant settings.
4. On or immediately after withdrawal of the Trachmac catheter administer 2 slow manual inflations (2-3 s) and observe the surfactant fluid column. If the fluid column does not move distally (toward the lung), increase peak inspiratory pressure by another 3 cmH_2O and repeat the 2 manual inflations until surfactant fluid column moves distally and chest rise/fall is observed (max 30 cmH_2O PIP).
5. Return to routine mechanical ventilation, wait until vital signs are stable, adjusting PIP and inspiratory time as surfactant is cleared and distributed to the lung. (Inspiratory time will need to increase immediately after surfactant then decrease as fluid clears from the airway. Instil 2nd aliquot of surfactant followed by air to clear surfactant from catheter.
6. Withdraw the Trachmac catheter from the ETT as above and repeat manual inflation procedure as required.
7. Remove syringe and replace combi stop to connector.

1. Ensure volume guarantee ventilation on transfer to a ventilator in the intensive care unit with adequate Pmax to generate set tidal volume.
2. Consider non-invasive respiratory monitoring on arrival to NICU Trancutaneous or end tidal CO2 monitoring. These values should be used as a trend and corroborated with blood gas analysis. ETCO2 may not be advantageous in extreme preterms owing to the dead space involved in the device
3. Subsequent blood gases as ordered.
4. Leave Trachmac device *in situ* for 2nd dose (if used) then discard.
5. Change to Ballard suction device after second administration of surfactant is complete.
6. Following administration, position prone if stable/practical.
7. Complete documentation.

Surfactant administration in the neonatal unit **WITH** flow-volume monitoring

1. Place the infant in the supine position. The base of the warmer or incubator is to remain flat throughout. Transcutaneous monitoring (TCM'S) advisable.
2. Leave flow sensor in place but keep elevated above the baby to reduce reflux of surfactant into the sensor (should be replaced after procedure if it becomes contaminated with surfactant).
3. Ensure the infant is on a volume targeted/volume-guarantee mode of ventilation and increase the backup PIP to at least 3 cmH_2O above the current required PIP to achieve target volume.
4. Remove the blue connector from the endotracheal tube and attach the appropriate adaptor and Trachmac device. Reconnect endotracheal tube to ventilator.
5. Draw up the prescribed surfactant volume, add 1 mL of air. Ensure that the air is at the plunger end of the syringe. Attach syringe to luer lock connector of Trachmac.

1. The **insertion distance** for the Trachmac is determined by the length of the ETT to the cut-off point plus 5 cm. (Note the colour band before the number for easier visualisation).
2. Insert the catheter & as soon as the colour appears in the **"window area"** of the Trachmac catheter - stop advancing the catheter (the tip will be at the end of the ETT to within 0.5 cm beyond the end of the ETT.
3. Instil ½ of dose over 5-10 s. Withdraw the Trachmac catheter from the ETT.
4. Allow routine ventilation to resume and confirm re-establishment of airflow with the flow monitoring. Adjust inspiratory time as required to ensure complete delivery of inspiratory flow (longer inspiratory times are required until the surfactant has cleared from the airways).
5. Wait until vital signs are stable.
6. Instil 2nd aliquot of surfactant followed by air to clear surfactant from catheter.
7. Withdraw the trachmac catheter from the ETT as above and repeat steps 4-6.
8. Remove syringe and replace combi stop to connector.

1. Volume guarantee should be administered at 4 – 6mls/kg. Ensure Pmax is set to allow achievement of tidal volume.
2. Subsequent blood gases as ordered.
3. Leave Trachmac device *in situ* for 2nd dose if required then discard.
4. Change to Ballard suction device after second administration of surfactant is complete.
5. Following administration, position prone if stable/practical.
6. Complete documentation.

Alternative methods of surfactant administration

The avoidance of unnecessary mechanical ventilation has been a central principle in modern neonatal respiratory support. Several different techniques are available to

administer surfactant. All require substantial experience and training. The provision of surfactant should be part of a comprehensive approach, which should avoid unnecessary intervention as much as possible.

There are a numerous studies including systematic reviews, meta-analysis and network studies which have suggested that surfactant administration via a thin catheter (Less invasive surfactant therapy (LISA) or Minimally Invasive Surfactant Therapy (MIST)) is associated with reduced risk of death or BPD, less intubation in the first 72 h and reduced incidence of major complications and in hospital mortality.

INtubate, SURfactant, Extubate (INSURE) Procedure

Indications

Any non-intubated infants with clinical signs of RDS or other evidence of RDS like abnormal gas (respiratory acidosis), worsening FiO_2 requirement or abnormal CXR/ lung ultrasound can be considered for the procedure.

- Eligible infants should have good respiratory effort
- Preferably less than 6 hours old (earlier the age of INSURE better the outcomes)
- Infants that may **not** be good candidates for INSURE include:
  - Intubated at birth for apnoeas/poor respiratory effort, unless strong respiratory efforts established after appropriate resuscitation
  - Neonates who have received extensive resuscitation
  - Any associated medical issues e.g., Anaemia, Hydrops
- SR or Consultant to supervise administration of appropriate dose of surfactant and to remain in the Neonatal ICU for 30 minutes following extubation.
- Ventilate using the Neopuff until stable, transitioning to breathing with Neopuff CPAP support as soon as possible. Keep ventilator as a standby.

Procedure

- HR & saturations are stable. No apnoea's.
- Premedication is best avoided as this may cause apnoea in the very preterm neonate after extubation.
- Intubation as per guideline.
- Curosurf/Survanta to be administered in 2 bolus aliquots as per Surfactant administration WITHOUT flow-volume monitoring above.
- Extubate to nCPAP following re-establishment of airflow.
- Confirm accuracy of TcpCO2 with a blood gas at ~ 30 minutes after administration to facilitate early recognition of over- or under-ventilation.

Less Invasive Surfactant Administration (LISA) Procedure

- Surfactant is administered via a thin catheter into the trachea. CPAP support must be continued throughout the procedure.
- The Consultant Neonatologist must approve the procedure as an evolving pattern of respiratory distress may suggest the necessity for an endotracheal intubation and mechanical ventilation.
- Inform parents of procedure.
- This procedure must only be performed by clinicians deemed competent.
- In some instances, the CPAP prongs may obscure the view for laryngoscopy so for the duration of the procedure the infant may need to be managed on HHF.
- A second or even third dose can be given for ongoing respiratory distress at the consultant's discretion after reviewing the outcome of the first dose.

Indications for LISA

Preterm infants with respiratory distress syndrome, ideally less than 6 hours of age with clinical stability on non-invasive ventilatory support with:

- FiO2 ≥0.3 and blood gas suggestive of respiratory acidosis
- Clinical or/and radiological signs of surfactant deficiency

Contraindications for LISA

Absolute

- Congenital diaphragmatic hernia (CDH)
- Congenital pneumonia
- Maxillo-facial, tracheal or known pulmonary malformations
- Meconium aspiration syndrome
- Persistent pulmonary hypertension of the newborn (PPHN)
- Pneumothorax
- Pulmonary haemorrhage
- Pulmonary hypoplasia

Relative

- Severe RDS with high oxygen requirements, severe respiratory acidosis and/or widespread atelectasis on chest x-ray.
- A suggested threshold for intubation being preferable over LISA is FiO2 > 40% in infants <32 weeks gestation and > 50% in infants > 32 weeks gestation.
- Prominent apnoea despite adequate caffeine citrate administration

Equipment

- Equipment as per Intubation Guideline.
- Surfactant Injection catheter size 6Fr

- Surfactant drawn up in a 3mL or 5mL syringe with extra 1-2mL of air to clear the catheter of surfactant post administration
- Video laryngoscope should be first line if operator competent otherwise use a standard laryngoscope.
- McGills forceps (may be required to place catheter through the cords).
- CPAP set up
- Cardiorespiratory monitoring in situ (ECG, SpO2 and NBP)

Premedication

- Oral/buccal breast milk or 24% sucrose
- **Opiate sedation/analgesia is not recommended however,** is at the discretion of the attending Consultant
- **Atropine** (optional), used for sustained bradycardia (can be used post-procedure too)

See video of Hobart method: https://www.youtube.com/watch?v=ULHyMFpK5GA

Procedure Steps

LISA Briefing and Preparation

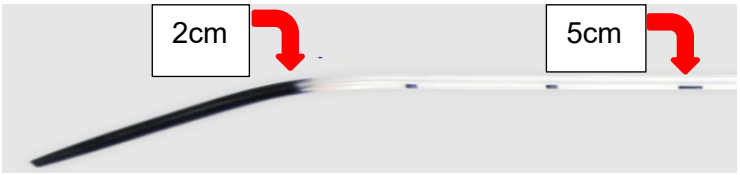
• LISA Criteria (Inclusion/Exclusion) and Consultant aware. Notify parents.
• Assign roles to clinical staff
  ○ Team Leader
  ○ Airway Lead (LISA performer)
  ○ Airway Assistant
  ○ Medication Nurse/Circulatory Nurse/Scribe
• Escalation Plan discussed. (1st attempt of catheterisation unsuccessful; 2nd attempt to be attended by SR/ consultant. Discuss further attempts with the Consultant).
• Position infant supine and maintain thermal care
• Intravenous access secure and functioning
• Orogastric tube in situ and gastric contents aspirated

Equipment and Medications
• All equipment is present, working and placed on sterile towel • Medications are prescribed and drawn up if relevant

Procedure

Prior to the procedure “Intubation Checklist and Team Time Out”

1. Airway Lead to don PPE, surgical face mask, protective eye wear and gloves and instructs if and when premedication to be administered.
2. Perform videolaryngoscopy and insert the LISA catheter through the vocal cords, up to the desired length of 2cms (or if <28 weeks 1.5cm). Uninterrupted CPAP to remain insitu during LISA catheter insertion. If the nasal CPAP is in the way of the laryngoscope, reposition it whilst visualizing the cords (then replace CPAP before administering the surfactant).



3. Once the catheter is seen passing through the cords, hold the catheter securely, note markings at the lip, withdraw the laryngoscope ensuring the catheter remains in-situ.
4. The catheter is pinch held at the lip by the Airway Lead and the surfactant syringe is attached to the catheter by the Airway Assistant who administers the surfactant in 3 aliquots over 2-3 minutes with a 10 second pause in between. Clear the surfactant from the catheter by flushing air to clear the line then remove the catheter.
5. Keep the infants mouth held shut to maintain CPAP throughout the administration. Surfactant dispersal from the trachea is driven by the infants spontaneous breathing which is supported by the uninterrupted CPAP.
6. Aspirate OGT mid-surfactant delivery and at the end
7. Titrate FiO_2 to maintain oxygen saturations between 90- 95% throughout the procedure.

Troubleshooting during the procedure

- Hypoxia or bradycardia
  - reduce the rate of surfactant administration and consider atropine
- Prolonged bradycardia, hypoxia or apnoea
  - **STOP** the procedure, commence positive pressure ventilation plus or minus intubation. Consider administering Atropine for persistent bradycardia
- Reflux of surfactant and irregular breathing, hypoxia or bradycardia
  - reduce the rate of surfactant administration
- If a large amount of surfactant refluxes into the pharynx
  - pause and maintain non-invasive respiratory support (nasal CPAP), ensure the mouth is closed. Encourage spontaneous breathing with gentle stimulation to redirect surfactant into lungs.
- Avoid applying suction unless there is evidence of ongoing airway obstruction (apnoea/hypoxia or bradycardia).

Post Procedure

- Continue CPAP and monitor work of breathing and oxygen saturations to ensure non-invasive ventilatory support is effective. A blood gas should be performed 60 mins post surfactant administration
- Aspirate OGT looking for surfactant reflux into the stomach
- Nurse prone with minimal handling (but still allowing appropriate first skin to skin care) refer to Skin to Skin Holding guideline and Parenting in the Neonatal Unit guideline.
- Update parents regarding the procedure
- Complete documentation including problem list and clinical notes.
- Reduce FiO_2 slowly; as per the O_2 target saturations. An improvement in breathing mechanics and reduction in oxygen requirement is expected within hours of the procedure.
- If the baby develops an increasing oxygen requirement, a pneumothorax should be excluded. A further dose of surfactant should be considered and could be administered by LISA if not contraindicated. However, if there is an increased work of breathing, persistently high oxygen requirements, respiratory acidosis, or severe RDS on chest x-ray the infant should be intubated and ventilated prior to the repeat dose of surfactant

Related CAHS internal policies, procedures and guidelines
Neonatal Clinical Guideline • Intubation • Skin to Skin Holding • Parenting in the Neonatal Unit Neonatal Medication Protocols • Survanta • Curosurf • Atropine

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