# ANMC NICU Surfactant Administration Guideline

1. Background: Surfactant deficiency is the primary cause of infant respiratory distress syndrome. Exogenous surfactant administration lowers the alveolar surface tension, stabilizing the alveoli and avoiding alveolar collapse at the end of expiration, thus improving gas exchange throughout the respiratory cycle.

2. Purpose: This guideline is meant to standardize the administration of exogenous surfactant for the treatment of infant respiratory distress syndrome using evidence-based medicine. This guideline is focused on rescue surfactant therapy, the treatment most commonly used in our level 2 NICU population.

3. Scope: This guideline applies to neonates cared for in the ANMC NICU.

4. Indications for surfactant administration:
   a. General indications:
      i. Respiratory failure associated with surfactant deficiency.
      ii. Respiratory failure associated with secondary surfactant deficiency in late preterm and term neonates with meconium aspiration syndrome, pneumonia/sepsis, and pulmonary hemorrhage.
      iii. Infants of diabetic mothers can have a relative surfactant deficiency, even when late preterm or term.
   b. Specific indications: Based on the infant respiratory distress algorithm (Appendix C), if an infant is not able to wean below 40% on CPAP with a PEEP of 7 (maximum time for this trial should be around 2 to 3 hours), consider surfactant administration.

5. Optimal timeframe for surfactant administration:
   a. The optimal time for rescue surfactant administration is within 2 to 6 hours of birth.
   b. In general, the literature does not support giving a first dose of surfactant past about 24 hours of life.
   c. It is generally no longer indicated to administer surfactant after 36 hours of life.

6. When to consider transferring to a level 3 NICU for surfactant administration instead of administering surfactant in the ANMC NICU:
   a. FiO2 requirement well above threshold for giving surfactant.
   b. When extubation after surfactant administration is expected to be very unlikely (a capillary blood gas with pH < 7.2 or a pCO2 > 60 may indicate enough ventilatory failure making extubation after the procedure unlikely).
   c. Pneumothorax.
   d. Other pulmonary or airway anomaly making intubation for surfactant administration more complex.
   e. A quickly deteriorating infant.
   f. Not enough staff present comfortable in the surfactant administration procedure.

7. Adverse reactions to and complications of surfactant administration:
   a. Desaturation
   b. Apnea
   c. Bradycardia
   d. Hyperinflation
   e. Pneumothorax
   f. Infection

8. Consent for surfactant administration:
   a. Verbal informed consent is required unless a parent is unavailable or unreachable.
   b. Written consent is not required for surfactant administration.

9. Chest x-ray prior to surfactant administration:
   a. Confirms clinical diagnosis of infant respiratory distress syndrome.
   b. Rules out other causes of respiratory distress.
   c. Confirms absence of a pneumothorax prior to the surfactant administration procedure.

10. Procedural sedation/Rapid sequence intubation is recommended for surfactant administration:
    a. Intubation is a painful procedure. Appropriate analgesia and sedation improves the neonate's tolerance of the procedure and significantly increases success of the procedure.
    b. In general, medications with rapid onset and short duration of action are preferable and recommended.
    c. Use of a vagolytic is strongly recommended.
    d. Use of an analgesic is strongly recommended.
    e. Use of a paralytic agent is optional in cases where more sedation is required. It is important to always have a paralytic agent drawn up and ready when giving fentanyl in case of chest wall rigidity.
    f. Use of benzodiazepines in preterm infants is not recommended. Use of benzodiazepines in term infants should be done with extreme caution. In neonates (especially preterm infants), benzodiazepines have a long half-life, can cause hypotension, and can cause decreased cerebral blood flow velocity. Also, injectable lorazepam and diazepam contain undesirable excipients such as benzyl alcohol and propylene glycol.
    g. In general, after the surfactant administration procedure, if an infant's respiratory drive is lost/partially lost due to sedation, it is preferable to ventilate through the ETT or bag-mask-ventilate if the ETT has already been removed than giving the infant the opioid reversal agent naloxone.
    h. Medications and dosing:
        i. Vagolytic
            1. Atropine 0.02 mg/kg IV (onset of action is 1 to 2 minutes, duration of effect is 0.5 to 2 hours).
                a. There is no longer a recommendation to give a minimum dose of atropine (a common past practice).
        ii. Analgesics
            1. Fentanyl 2 mcg/kg IV given slowly over 3 to 5 minutes (onset of action is almost immediately, duration of effect is 30 to 60 minutes) – STRONGLY PREFERRED OVER MORPHINE.
                a. Chest wall rigidity is a risk if given too quickly.
                b. Chest wall rigidity can be treated with a paralytic or naloxone.
                c. If a second dose of fentanyl is required, use 1 mcg/kg IV given over 3 to 5 minutes.
            2. Morphine 0.05 mg/kg IV (onset of action is at 5 minutes, peak effect is at 15 minutes, duration of effect is 3 to 5 hours).
        iii. Paralytic
            1. Rocuronium 0.6 to 1.2 mg/kg IV (onset of action is 1 to 2 minutes, duration of effect is 20 to 40 minutes).
                a. If a paralytic is used, after the surfactant has been administered, the team should leave the infant intubated and plan to bag ventilate the infant for the duration of the paralytic's effect, as above.
        iv. Atropine, fentanyl, morphine, and rocuronium are stocked in the Pediatrics Pyxis.

11. Acceptable number of intubation attempts for surfactant administration:
    a. Evidence supports that one person should attempt intubation no more than two times.
    b. It is reasonable that if the first person attempting intubation is not successful, a second qualified person can attempt intubation, also no more than two times.
    c. If after four attempts at intubation (or less if the infant does not tolerate the procedure), consider transferring infant to a level 3 NICU for a higher level of care.

12. Preparing the surfactant for administration (can be done by a pharmacist, an RN, or an RT):
    a. Curosurf® dosing is 2.5 mL/kg per ETT (please note this dose is specific to the brand Curosurf®).
    b. Each vial contains 1.5 mL. Vials are stored in the NICU Pyxis refrigerator and in central pharmacy.
    c. Warm each vial by gently rolling between the palms.
    d. Swirl or gently turn upside down to ensure uniform suspension.
    e. DO NOT SHAKE the surfactant (it will create foamy bubbles).
    f. Visually inspect the surfactant for discoloration (the suspension should be white to creamy white).
    g. Each single-use vial of Curosurf® should be entered only once. Discard any prepared doses that are not used.
    h. Divide the surfactant into two aliquots (one for each lung, so each aliquot is 1.25 mL/kg).
    i. Draw up 1 to 2 mL of air behind the surfactant in each syringe.

j. If a second dose of surfactant is given, the dose is generally half of the first dose.
k. See package insert and speak with the pharmacist for any questions about preparing the Curosurf® for administration.
l. Curosurf® is a porcine derived product.

13. Supplies for surfactant administration:
    a. Oxygen source
    b. Colorimetric CO2 detector
    c. Anesthesia bag and appropriate size mask
    d. Endotracheal tubes (2) and stylet
    e. Laryngoscope
    f. Suction with 8Fr suction catheter
    g. Two 3 or 5 mL syringes and blunt fill needles (for the surfactant)
    h. KimVent Multi-Access Catheter kit

14. Before the procedure: The team should walk through the checklist (Appendix A), which includes walking through the surfactant administration procedure (Appendix B) prior to starting the surfactant administration procedure (Appendix B).

References:

1. Blackburn, S.T., et al. *Maternal, Fetal, & Neonatal Physiology*, 2007. St. Louis, Missouri, USA: Saunders Elsevier.
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3. Ghodrat, M. et al. Lung Surfactants, 2006. *American Journal of Health-System Pharmacology*, *63*:1504-21.
4. Steven M. Donn, J.D. Surfactant Replacement Therapy in the Neonate: Beyond Respiratory Distress Syndrome, 2009. *Respiratory Care*, *54*(9):1203-8.
5. Kumar, P., et al. Clinical Report—Premedication for Nonemergency Endotracheal Intubation in the Neonate, 2010. *Pediatrics*, 125(2):608-15.
6. Polin, R.A., et al. Surfactant Replacement Therapy for Preterm and Term Neonates with Respiratory Distress, 2014. Pediatrics, 133(1):156-63.
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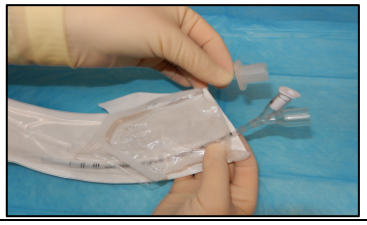
8. Curosurf (poractant alfa) User's Guide, 2019. Chiesi Farmaceutici S.p.A.

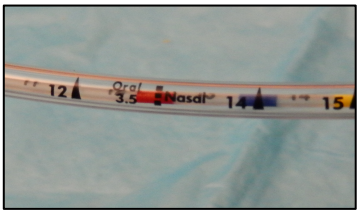
Written: 2/14
Reviewed/Revised: 11/17, 1/21
Approved by MCH CCBG: 2/21

Appendix A: Pre-Procedure Checklist

- ☐ Pediatrician has obtained verbal informed consent from infant's parent (unless the parent is unavailable or unreachable).
- ☐ Pediatrician has reviewed the chest x-ray.
- ☐ Pediatrician confirms the diagnosis/indication for administration of surfactant.
- ☐ Team pauses together to perform a time out.
- ☐ Intravenous access is secure.
- ☐ Assign individual roles: Airway/intubation, medication and surfactant administrator, auscultator/person aware of vital signs, and recorder.
- ☐ Ask whether the Respiratory Therapist is credentialed in neonatal intubation at ANMC and whether they can take on the airway/intubation role if needed. If they are not/cannot, pause procedure and consider who else is available to back up this role.
- ☐ Discuss the plan for analgesia/sedation.
- ☐ All medications for sedation/RSI are drawn up and labeled.
- ☐ Surfactant is drawn up into two syringes.
- ☐ Review the supplies that will be used for surfactant administration.
- ☐ Review how the KimVent Multi-Access Catheter works with the endotracheal tube.
- ☐ Walk through the surfactant administration procedure with the team, step by step (Appendix B).
- ☐ When the infant and team are ready, proceed with the surfactant administration procedure.

Appendix B: Surfactant Administration Procedure

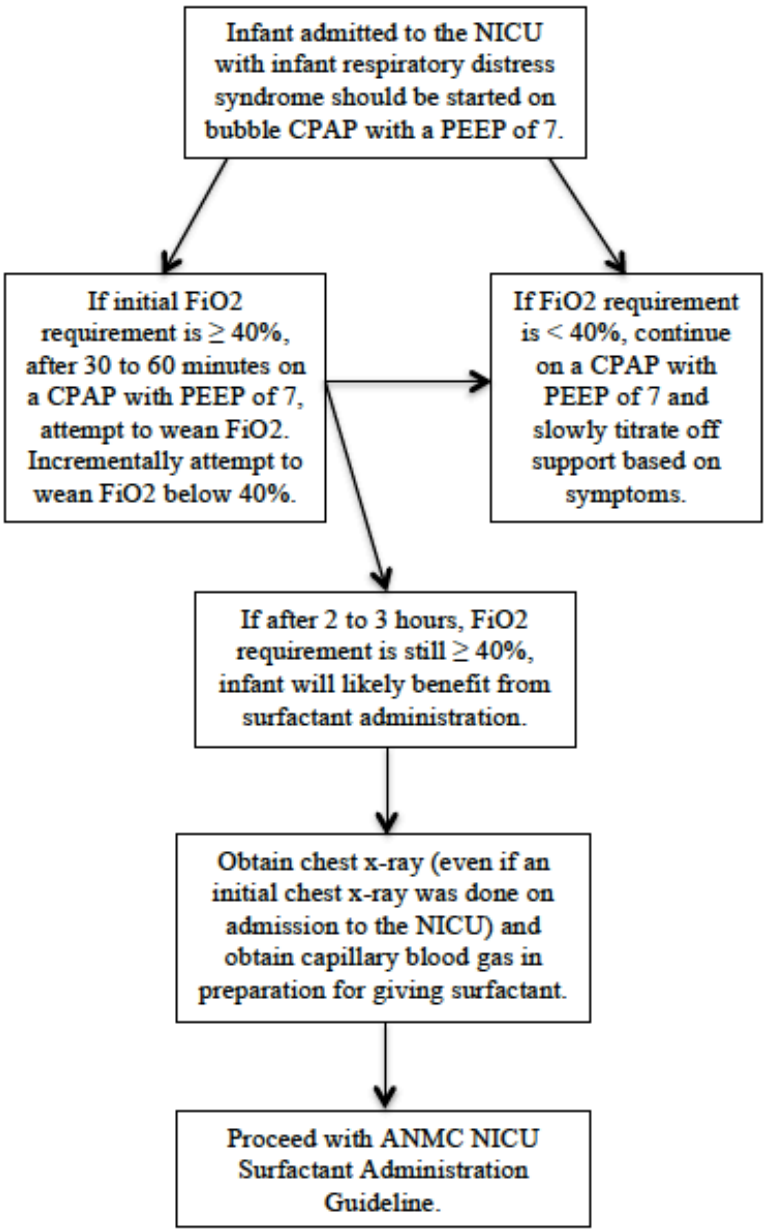
| | Process | Rationale |
|---|---|---|
| 1. | Hold the appropriate size endotracheal tube Y-adaptor from the KimVent Multi-Access Catheter kit at the bedside.<br><br>Place the white plug into the smaller side of the Y-adaptor (the medication delivery port). | Plan to replace the single adaptor on the endotracheal tube with the Y-adaptor following intubation. *<br><br>Placing the plug in the Y-adapter allows PPV prior to administration of surfactant (otherwise air would go out the medication administration port). |
| 2. | Confirm surfactant is drawn up in two aliquots and ready for administration.<br><br>Confirm 1 to 2 mL of air is pulled up "behind" each dose. | Ensures accurate dosage for each lung.<br><br>Following the medication with 1 to 2 mL of air ensures the entire dose is delivered. |
| 3. | Analgesia/sedation medications are given per the team's plan and enough time is allowed to for the medications to be effective based on the pharmacokinetics of the medications used. | Appropriate analgesia/sedation during this procedure will improve the infant's experience and increase the likelihood of procedure success. |
| 4. | Intubation:<br>1. Intubating provider maintains sterility.<br>2. Pre-oxygenate by using "blow-by oxygen" or PPV to bring saturations up to the "high 90% range."<br>3. Consider "blow-by oxygen, NC, or HFNC during procedure to protect infant's tolerance of the procedure.<br>4. Each intubation attempt is limited to 30 seconds.<br>5. Confirm endotracheal tube placement with auscultation and colorimetric $CO_2$ detector. | Reduces risk of contamination/infection. Pre-oxygenation before intubation will protect infant's tolerance of the procedure.<br><br>If team agrees ETT is in good placement, a chest x-ray is not required. |
| 5. | After intubation, replace the single adaptor on the endotracheal tube with the Y-adaptor from the KimVent Multi-Access Catheter kit.<br>  | Adapter allows for PPV and medication delivery through the same ETT.<br><br>*Some teams may chose to perform this step prior to intubation to reduce the risk of extubation while placing the Y-adaptor. It is the preference of the ANMC Respiratory Therapy team at the time that this guideline was written to do this step after intubation. |
| 6. | Remove the white plug in the medication delivery port of the Y-adapter. Remove the blue cap on the surfactant delivery catheter and place the sterile catheter tip into the access port of the Y-adapter.<br>  | |

| | | |
|---|---|---|
| 7. | Position the infant on her/his right side.<br><br>Pause here to ensure infant's vital signs are stable. | Ensures dosage delivered into right lung.<br><br>With stable vital signs there is reasonable assurance that the ETT is still in the correct position. |
| 8. | Attach one syringe of surfactant onto the administration catheter. Advance catheter into the endotracheal tube until CM marking matches.<br><br>  | Ensures the KimVent Multi-Access Catheter is at the tip of the ETT but does not go beyond the end of the ETT, preventing damage to the bronchus. |
| 9. | The team member administering the surfactant does so in a smooth continuous fashion while the team member on the airway does PPV. The team member monitoring vital signs monitors the infant's response continuously.<br><br>After the surfactant is delivered, the surfactant delivery catheter is withdrawn from the endotracheal tube.<br><br>PPV is continued while the infant remains on the right side for one minute after medication delivery. | Successful surfactant administration requires a whole-team effort.<br><br>Ensures that the surfactant gets to the terminal alveoli. |
| 10. | Reposition infant on her/his left side.<br><br>Pause here to ensure infant's vital signs are stable. | Ensures dosage delivered into left lung.<br><br>With stable vital signs there is reasonable assurance that the ETT is still in the correct position. |
| 11. | Repeat steps 8 and 9. | |
| 12. | At the physician's discretion, extubate infant and place back on respiratory support of choice (typically CPAP).<br><br>Continue to monitor the infant's condition. Vital signs and assessment should be performed every 15 minutes x4, then every hour x2, and then per NICU protocol.<br><br>Closely monitor for infant's changing condition. | Effects of surfactant on lung compliance can be seen as soon as five minutes after surfactant delivery. Close monitor of the infant and adjustment of respiratory support is important. |
| 13. | Expect "wet" lung sounds after surfactant administration.<br><br>Do not suction ETT for one hour after surfactant administration, unless clinically indicated. | This is a typical exam after surfactant.<br><br>To prevent removal of surfactant from the lungs. |

Appendix C: ANMC NICU Treatment Algorithm for Infant Respiratory Distress Syndrome Using Bubble CPAP.

**ANMC NICU Treatment Algorithm for Infant Respiratory Distress Syndrome Using Bubble CPAP**

This algorithm is intended for infants with infant respiratory distress syndrome. Infants with transient tachypnea of the newborn or another cause of respiratory distress may require other strategies for CPAP management.




Rationale: Starting with higher positive pressure improves alveolar distension and oxygenation. Hopeful that starting with higher PEEP will allow FiO2 requirement to be weaned more easily.

In addition to CPAP, use prone position and positions of comfort (arms tucked in, nestling body) to improve infant's outcome.

Rationale: Surfactant administration is most effective within 2 to 6 hours of birth. It is unlikely to be beneficial after 24 hours of life.

Rationale: Ensures no pneumothorax prior to giving surfactant and evaluates for alternative pathophysiology to infant RDS. Evaluating a blood gas can help decide whether there is significant ventilatory failure that may predict failure to extubate after the surfactant administration procedure.