Implementing less invasive surfactant administration on a neonatal unit

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ABSTRACT

There is increasing evidence reflected in both UK 2019 NICE and European guidelines suggesting that less invasive surfactant administration (LISA) reduces the need for mechanical ventilation and reduces the combined outcome of death or bronchopulmonary dysplasia, and is now the optimal method for surfactant delivery in spontaneously breathing babies. Despite this, uptake in England has been slow compared with Europe. This quality improvement project outlines the process of implementing LISA in a neonatal intensive care unit over a 2-year period, the barriers and challenges which were encountered, and how they were overcome.

SUMMARY

Less invasive surfactant administration (LISA) is a method of administering surfactant using tracheal catheterisation in infants with respiratory distress syndrome. Surfactant administration improves clinical outcome and is needed in the majority of babies born <33 weeks' gestation.[1 2]

Increasing evidence, reflected in both UK 2019 NICE and European guidelines, suggests that LISA reduces the need for mechanical ventilation and reduces the combined outcomes of death or bronchopulmonary dysplasia (BPD) and is now the optimal method for surfactant delivery in spontaneously breathing babies.[3–5]

PROBLEM

The uptake of LISA in England has been slow compared with Europe.[6 7] Identified barriers include lack of familiarity with the procedure, perceived lack of benefit when compared with more well-known methods and concerns over procedure-associated discomfort.[8]

While the technique is widely known, it is still being introduced into regular practice and, in beginning of 2018, was not used on our unit due to the aforementioned barriers plus lack of specific equipment.

AIMS

To safely introduce LISA as a standard method for surfactant administration for suitable babies on a neonatal intensive care unit in the UK, which cares for babies ≥22 weeks' gestation, by June 2020.

MAKING A CASE FOR CHANGE

We engaged local stakeholders (clinicians, nurses, individuals involved in the procurement pathway, governance department) to canvas opinion and discuss barriers to change. We liaised with neonatal units regularly performing LISA to obtain advice and guidance and involved relevant companies manufacturing specific equipment. Following this, we wrote a guideline which was reviewed and agreed by the consultant team and disseminated to the wider neonatal team via regular educational sessions.

YOUR IMPROVEMENTS

We commenced the project in early 2018, staff attended teaching sessions and participated in simulated scenarios prior to implementation. All babies receiving LISA over the next 2 years (June 2018–June 2020) were audited. Data were collected retrospectively using case notes and BadgerNet electronic record system.

Multiple challenges were identified throughout the process and addressed (figure 1).

We based our practice on the Hobart method of tracheal catheterisation[9] with a specific guidable, semi-rigid catheter (LISAcath; Chiesi Farmaceutici S.p.A.). The surfactant is given slowly over 3–5 min via the LISAcath to a spontaneously breathing baby, causing surfactant diffusion throughout the lungs. To

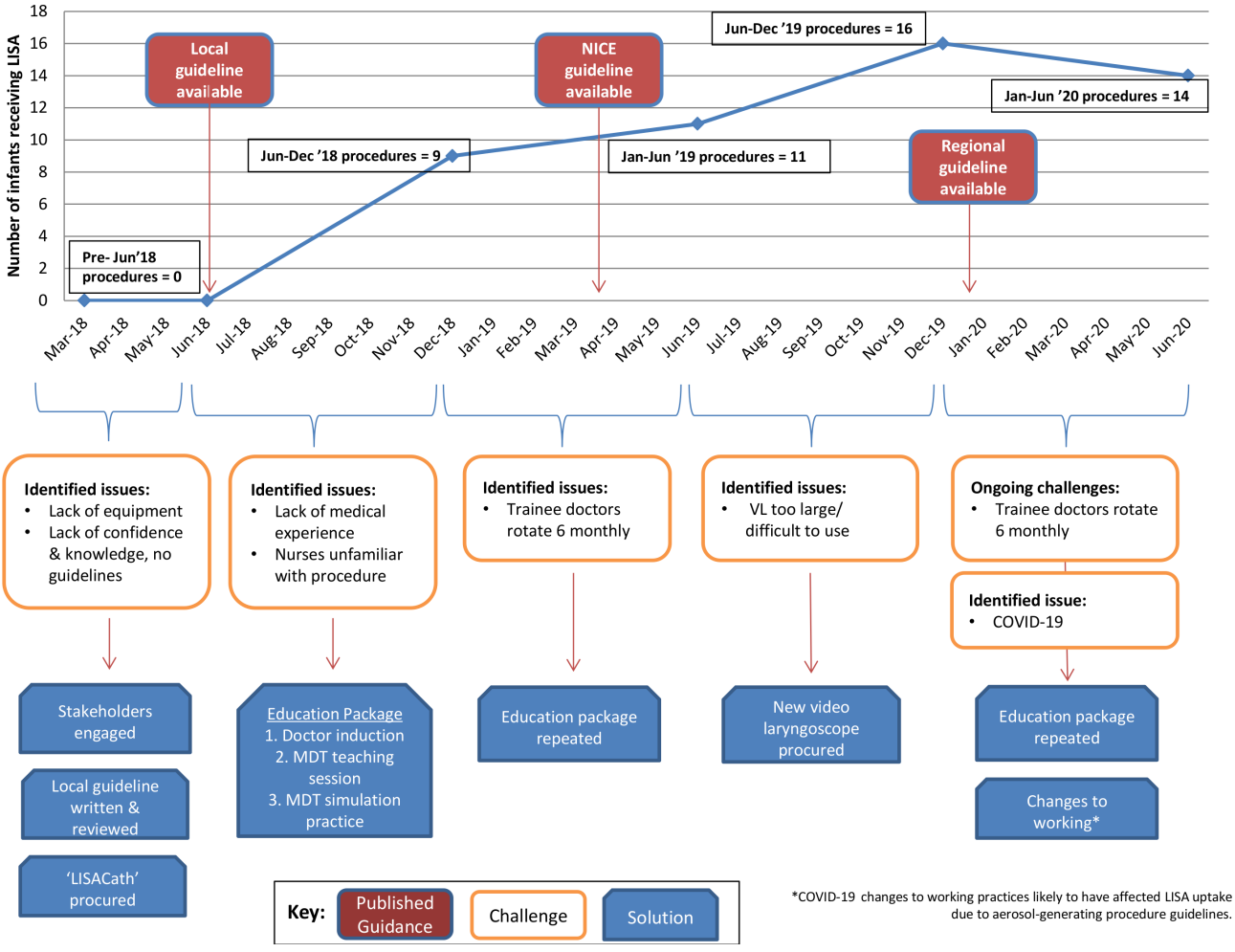

Figure 1 Run diaphragm depicting the implementation of less invasive surfactant administration (LISA). MDT, multidisciplinary team; VL, video laryngoscope.

confirm placement of the catheter through the vocal cords, the use of a video laryngoscope (VL) is gold standard. Following difficulties with existing equipment, we procured a new VL. This technology has also facilitated supervision of junior colleagues, finding that once trained, any member of the medical team can perform LISA successfully (table 1). Similar to other studies, we have found that use of the VL requires regular, specific training, as the view is different to that of a standard laryngoscope.[10]

In response to challenges encountered, we adapted our technique. Using a T-piece extension kit attached to the LISAcath, usually used for flushing an intravenous cannula enabled the assistant to deliver the surfactant at a comfortable distance from the operator (figure 2).

Understanding how the procedure works as a multidisciplinary team is essential. We achieved this through education and multidisciplinary simulation. Listening to our colleagues' concerns, we understood that being confident the baby is not experiencing pain during the procedure is a priority. Allocating a team member to provide non-pharmaceutical comfort care was then done routinely and pre-medication was used if deemed necessary by the most senior clinician present, based on how vigorous the baby appeared, has helped alleviate these concerns.

Patient characteristics and outcomes from the 50 individual babies who have received LISA can be found in table 1.

A major limitation of this method was that the data were collected retrospectively. While no serious adverse events were observed, minor adverse events could have been under-reported from documentation. It also means that defining numerical limits of desaturation and bradycardia were difficult to assess. One baby was noted to have a pneumomediastinum post-LISA on radiograph; however, no imaging was done prior to the procedure.

LEARNING AND NEXT STEPS

Key learning points

- Multidisciplinary learning and simulated practice is essential in implementing change.
- LISA can be performed safely and by any member of the medical team, provided supervision by someone with airway expertise is available.

Table 1 Patient characteristics and outcomes of infants who received LISA

Total babies	n=50
Median gestation, weeks (range)	31 (25–37)
Median birth weight, g (range)	1490 (620–3840)
Gender	
Male	29 (58%)
Female	21 (42%)
Median age at time of procedure (range)	6.5 hours (0–51)
Type of respiratory support prior to LISA	
High flow	44 (88%)
Continuous positive airway pressure	5 (10%)
Bi-level positive airway pressure	1 (2%)
Median pre-procedure oxygen requirement (FiO_2) (range)	0.4 (0.28–0.7)
Median post-procedure oxygen requirement (FiO_2) (range)	0.26 (0.21–0.45)
Median dose of surfactant, mg/kg (range)	200 (107–308)
Comfort	
Premedication (atropine and fentanyl)	29 (58%)
Non-pharmaceutical (swaddle±sucrose)	21 (42%)
Use of videolaryngoscope	30 (60%)
Team member performing LISA	
Tier 1 (ST1-3/SHO)	16 (32%)
ANNP/ACP	10 (20%)
Tier 2 (ST4-8/Registrar)	21 (42%)
Consultant	3 (6%)
Procedure taken over by a more senior colleague	7 (14%)
Adverse events	
Apnoea requiring positive pressure ventilation	7 (14%)
Technical difficulties requiring >2 attempts	3 (6%)
Bradycardia	2 (4%)
Mild trauma	2 (4%)
Pneumomediastinum	1 (2%)
Minor pulmonary haemorrhage	1 (2%)
Failure (requiring intubation within 48 hours post-LISA or inability to perform LISA procedure)	10 (20%)
Late intubation	8 (16%)
Technical	2 (4%) converted to intubation
Babies requiring a second dose of surfactant	5 (10%) (all via intubation, not LISA)
Chronic lung disease (oxygen requirement at 36 weeks' corrected gestational age)	8/45 (18%)*

*Babies >34 weeks excluded.

†Recorded 1–2 hours post-procedure.

FiO_2, fractional inspired oxygen concentration; LISA, less invasive surfactant administration.

The updated regional guideline (available as online supplemental file) states that LISA should be considered for babies <33 weeks, in ≥30% oxygen. We continue to refine the optimum patient characteristics as new evidence is made available.

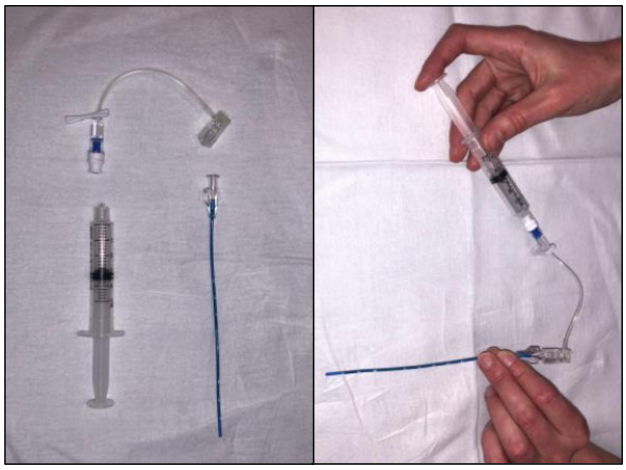

Figure 2 T-piece extension kit attached to the LISAcath.

Based on the previous routine unit practices, the majority of the babies in this cohort would have been ventilated to receive surfactant. The improvement measure is a short-term reduction in ventilator days, which may consequently reduce long-term BPD rates. However, with confounding respiratory support trends like increasing high-flow use and small numbers in our cohort, it may take a few years to see this impact.

Using a prospective data collection for each LISA episode may allow adverse events to be better characterised.

In the future, we aim to perform LISA on delivery suite as part of initial stabilisation. This will require widening staff education, reviewing equipment and using simulation to identify additional challenges.

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Neonatal Guidelines 2019–21

The Bedside Clinical Guidelines Partnership
in association with the
West Midlands Neonatal Operational Delivery Network

SURFACTANT REPLACEMENT THERAPY – INCLUDING LESS INVASIVE SURFACTANT ADMINISTRATION (LISA) TECHNIQUE ● 2/4

- Early administration of natural surfactant decreases the risk of acute pulmonary injury and neonatal mortality
- Early CPAP and selective administration of surfactant is preferable to routine intubation and prophylactic surfactant
- Natural surfactant preparations are superior to protein-free synthetic preparations containing only phospholipids for reducing mortality and air leaks
- Poractant alfa (Curosurf®) at 200 mg/kg shows survival advantage compared to beractant or poractant alpha in a dose of 100 mg/kg
- Multiple rescue doses result in greater improvements in oxygenation and ventilatory requirements, a decreased risk of pneumothorax and a trend toward improved survival
- Use of Intubate–Surfactant–Extubate (INSURE) to CPAP or LISA (less invasive surfactant administration) or minimally invasive surfactant treatment (MIST) techniques for early surfactant administration reduce the need for ventilation and improve survival
- see **LISA** section below

INDICATIONS

Prophylaxis (administration ≤15 min of birth)

Babies born <28 weeks' gestation

- **Routine intubation of these babies solely for the purpose of administration of surfactant is not necessary, and a policy of early CPAP with selective surfactant administration is preferred**
- If requiring intubation for respiratory support during resuscitation or if mother has not had antenatal steroids, give surfactant as prophylaxis
- Otherwise, institute early CPAP and administer surfactant selectively as per **Early rescue treatment**

Early rescue treatment

Preterm babies who require invasive ventilation for stabilisation should be given surfactant

Babies born ≤33 weeks' gestation who are not ventilated

- If FiO_2 >0.30, give surfactant using minimally/less invasive technique or after invasive ventilation

Other babies that can be considered for surfactant therapy (after discussion with consultant)

- Ventilated babies with meconium aspiration syndrome (may need repeat dose after 6–8 hr)
- Term babies with pneumonia and less compliant lungs

EQUIPMENT

- Natural surfactant, poractant alfa (Curosurf®) 200 mg/kg (2.5 mL/kg) round to the nearest whole vial (prophylaxis and rescue doses can differ)
- Sterile gloves
- TrachCare Mac™ catheter (do not cut NGT) or specific surfactant administration set

PROCEDURE

Preparation

- Calculate dose of surfactant required and warm to room temperature
- Ensure correct endotracheal tube (ETT) position
- check ETT length at lips
- listen for bilateral air entry and look for chest movement
- if in doubt, ensure ETT in trachea using laryngoscope and adjust to ensure bilateral equal air entry
- chest X-ray not necessary before first dose
- Refer to manufacturer's guidelines and **Neonatal Formulary**
- Invert surfactant vial gently several times, without shaking, to resuspend the material
- Draw up required dose
- Administer via TrachCare Mac™ device or specific surfactant administration pack

Instillation

- With baby supine, instil prescribed dose down ETT
- Wait for recovery of air entry/chest movement and oxygenation between boluses

Post-instillation care

- Do not suction ETT for 8 hr following instillation of surfactant

SURFACTANT REPLACEMENT THERAPY – INCLUDING LESS INVASIVE SURFACTANT ADMINISTRATION (LISA) TECHNIQUE ● 3/4

- Be ready to adjust ventilator/oxygen settings in response to changes in chest movement, tidal volume and oxygen saturation. Use of volume-target ventilation can facilitate responsiveness to rapid changes in lung compliance following surfactant instillation. Be ready to reduce FiO_2 soon after administration of surfactant to avoid hyperoxia
- Take an arterial/capillary blood gas within 30 min

SUBSEQUENT MANAGEMENT

- If baby remains ventilated at FiO_2 >0.3 with mean airway pressure >7 cm H_2O, give further dose of surfactant 6–12 hr after first dose
- Third dose should be given only at request of attending consultant

DOCUMENTATION

- For every dose given, document in case notes:
  - indication for surfactant use
  - time of administration
  - dose given
  - condition of baby pre-administration, including measurement of blood gas unless on labour ward when saturations should be noted
  - response to surfactant, including measurement of post-administration blood gas and saturations
  - reason(s) why second dose not given, if applicable
  - reason(s) for giving third dose if administered
- Prescribe surfactant on drug chart

LISA

Definition

- Method using a thin catheter to deliver surfactant in spontaneously breathing preterm infant with respiratory distress syndrome receiving non-invasive ventilator support
  - continue non-invasive ventilator support during procedure

Indication

- Suspected surfactant deficiency leading to respiratory distress syndrome on non-invasive respiratory support as evidenced by:
  - rapidly increasing oxygen requirements
  - FiO_2 >0.3
  - increased work of breathing (exclude pneumothorax by transillumination of chest)
  - <33 weeks' gestation
  - aged <48 hr

Exclusion

- Persistent/worsening respiratory acidosis despite optimal non-invasive ventilation

Equipment

- Laryngoscope/video laryngoscope
- Suction
- Sterile gloves
- LISA catheter (LISAcath®)
- Surfactant, and syringe and needle to draw up surfactant

Drugs

- Fentanyl 0.7 microgram/kg (awake sedation)
- Atropine 20 microgram/kg
- Naloxone 100 microgram/kg (if poor respiratory effort after procedure)

Emergency equipment

- Bag/valve/mask/T-piece
- Oxygen and air
- Stethoscope
- ETTs

SURFACTANT REPLACEMENT THERAPY – INCLUDING LESS INVASIVE SURFACTANT ADMINISTRATION (LISA) TECHNIQUE ● 4/4

Procedure

- Determine and document indication for LISA
- Ensure baby is loaded/on caffeine (spontaneous breathing extremely important for LISA)
- Inform parents (if present)
- Ensure venous access (peripheral cannula)
- Ensure team of 3 for procedure (including at least 1 nurse and 1 doctor)
- Draw up surfactant 200 mg/kg
- Attach T-piece to end of syringe with Luer-lock system
- Wash hands
- Use sterile gloves
- Place baby supine, ensuring incubator doors do not limit movement of laryngoscope
- Minimise heat loss
  - if necessary increase incubator temperature, use blankets, swaddling and transwarmer
- Baby will remain on non-invasive ventilation support (CPAP/HFNC) during procedure – have naso-/orogastric tube *in situ* to help identify oesophagus
- Administer sedation: atropine and fentanyl IV
- Visualise vocal cords using laryngoscope/video laryngoscope (some gentle cricoid pressure may be necessary)
- Insert LISAcath® until required markings (see **Table 1** and **Image 1**)
  - tip should be 1.5 cm below vocal cords
- Other guidance according to gestational age and weight

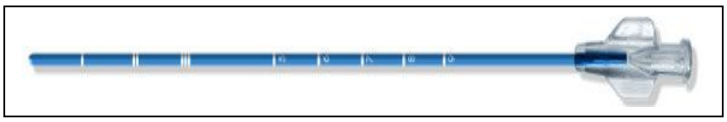
Table 1

Gestational age (weeks)	Current weight (kg)	LISAcath® length at lips (cm)
23–24	0.5–0.6	5.5
25–26	0.7–0.8	6.0
27–29	0.9–1.0	6.5
30–32	1.1–1.4	7.0
32–33	1.5–1.8	7.5

- Close mouth around LISAcath® with your fingers, ensuring not to apply any pressure on soft tissue
- Maintain LISAcath® in midline position to avoid traumatising mucosal lining of trachea

This is not an emergency procedure. Stop if you are having difficulty and consider alternatives

Image 1



- Ask helper to administer surfactant in 4 aliquots very slowly (with gaps of 30 sec over 3–5 min), to avoid surfactant coming back up
- Remove LISAcath® and ensure baby clinically stable with normal cardiorespiratory parameters before repositioning baby and closing incubator
- Following procedure, document:
  - procedure
  - tolerance
  - FiO_2