The nurse’s role in a suxamethonium-based neonatal rapid sequence intubation

Despite several undesirable side-effects, suxamethonium is widely used for rapid sequence intubation (RSI) in neonates due to its fast onset and short-acting nature. This article highlights some pertinent issues surrounding the use of suxamethonium within the neonatal environment from the perspective of a nurse. The nurse’s role in assisting with a suxamethonium RSI will be discussed, as will the nursing skills required to help manage any adverse side-effects.

A note on nomenclature: Rapid sequence intubation (RSI) is a technique whereby drugs are administered in rapid succession to facilitate endotracheal intubation. RSI is distinct from rapid sequence induction (also abbreviated to RSI) in which general anaesthesia is induced to facilitate rapid securing of the airway in patients at high risk of aspiration.

Keywords
suxamethonium; neonate; nursing; administration; rapid sequence intubation; side-effect

Key points
1. Suxamethonium is the most commonly used paralytic agent for neonatal RSI due to its rapid onset and short duration of action.
2. Neonatal nurses provide an important role before, during and after the intubation process.
3. Neonatal nurses are in a unique position to help identify and manage the side-effects of suxamethonium.
4. Nurses should possess sound knowledge of the drugs they administer.

A note on nomenclature: Rapid sequence intubation (RSI) involves administration of a sedative (an induction agent) immediately followed by a neuromuscular blocking agent to induce unconsciousness in an infant requiring immediate airway intervention. Suxamethonium, also known as succinylcholine, is a depolarising neuromuscular blockade that induces muscle relaxation for a short period of time prior to intubation. Due to its rapid onset and short half-life, its use is widely accepted within neonatal units for infants requiring RSI. The primary aim of RSI is to provide optimum intubation conditions thereby maximising success with the first attempt; suxamethonium creates superior intubation conditions compared to other neuromuscular blocking agents.

Suxamethonium can be administered intramuscularly but it is most commonly given intravenously, usually following the administration of an analgesic and a vagolytic drug. The combination of drugs used for RSI tends to differ nationally within neonatal units.

As part of their duty of care to patients, nurses should understand the nature of any drugs they administer and thereby comply with the Nursing and Midwifery Council (NMC) code of conduct. However historically, their knowledge of the drugs they administer is unsatisfactory.

Research is available on suxamethonium and its use in neonatal RSI from the clinician’s perspective but there is very little involving that of the nurse. Based on anecdotal evidence and observations made in clinical practice, the author investigated the nursing knowledge of suxamethonium by distributing an electronic survey to six neonatal units across the UK. The findings showed that:
■ 44% of responding neonatal nurses could not accurately identify the known side-effects
■ 41% said they would feel uncomfortable should an infant experience an adverse side-effect following the administration of suxamethonium
■ 19% admitted feeling uncomfortable when administering suxamethonium.

Pharmacology of suxamethonium
Pharmacodynamics
Suxamethonium is made up of two acetylcholine molecules that are joined together. These molecules bind to the nicotinic acetylcholine receptors within muscles causing them to depolarise and contract. Such contractions can be witnessed in the clinical setting as muscle fasciculation or ‘twitching’ of the body. In order for the muscles to regain their normal function, the membrane potential must be reset before further depolarisation can happen. Therefore the muscles remain floppy and relaxed until this happens.

Pharmacokinetics
There are key differences in neonates compared to adults:
■ The dose of suxamethonium needs to be higher in infants due to the large amount of extracellular fluid creating a greater volume of distribution.
■ Episodes of bradycardia are more common due to high vagal tone.
■ Suxamethonium is broken down by the enzyme pseudocholinesterase and this is...
relatively deficient in neonates, resulting in delayed metabolism of the drug.  ■ Premature neonates have immature renal and hepatic systems and little or no fat stores, resulting in reduced metabolism and excretion of suxamethonium.

**RSI and the role of the nurse**

Until recently intubation has been the role of the paediatrician or neonatologist but advanced neonatal nurse practitioners (ANNPs) are now adopting this advanced skill as part of their extended role15. The majority of neonatal intensive care units (NICUs) in the USA and the UK do not perform neonatal RSI routinely and many health professionals feel uncomfortable with the RSI procedure and administering RSI medication. Nurses are frequently involved in the intubation process and can be of valuable assistance throughout the procedure while upholding the ethical responsibility of being the patient’s advocate. Therefore it is important to define the nurse’s role throughout the intubation process and explain what is involved at each step to ensure that the first intubation attempt is successful.

**Preparation**

This may be divided into four categories:

i) **Patient**

Neonates commonly have their stomachs aspirated prior to intubation. Monitoring of the infant must be in place throughout the intubation procedure. Suxamethonium can cause apnoeic and bradycardic episodes therefore the heart rate and blood oxygen saturation (SpO₂) should be monitored carefully. The patient must be easily accessible in order to efficiently carry out intubation. An umbilical catheter or venous cannula should be inserted and patency confirmed before intubation can be attempted. This is to ensure that any drugs administered will effectively enter the infant’s venous circulation and not delay the intubation process. It may be wise to insert two peripheral cannulae so that, if one should fail, there remains another in situ.

It should be possible to ventilate the infant with a mask to ensure airway patency prior to inducing paralysis. Therefore, if the infant has any dysmorphic facial features (e.g., retrognathia and micrognathia) that might make airway management challenging, suxamethonium must be given with caution17.

It is important throughout the preparation process that the infant is kept warm to prevent further respiratory distress from developing. This may cause the infant’s glucose and oxygen demand to increase, thereby exacerbating the already compromised infant.

ii) **Drugs**

The procedure for medications should follow the neonatal unit’s protocol; the preparation of drugs and the checking process must be followed in line with local unit policy. Most neonatal units use a combination of drugs, which may include suxamethonium, atropine and morphine or fentanyl. It is not uncommon for nurses to administer these drugs, therefore as the final link in the ‘checking process’ there should be awareness of why these drugs are being given, the effects they may have on the neonate and any reasons why these drugs may not be given. Any allergies or contraindications should be confirmed prior to the administration of any drugs.

iii) **Equipment**

The neonatal nurse may assist in preparing the equipment necessary for intubation, which may include the following:

- Laryngoscope handle
- Straight (Miller) blades, sizes 0, 00 (premature) and 1 (neonatal)
- Introducer/stylet
- Endotracheal tube (ETT, sizes 2, 2.5, 3, 3.5mm) and syringe (if tube is cuffed)
- Tape/tie for securing ETT
- Catheter mount
- Heat and moisture exchange filter
- End tidal CO₂ detector
- Bag valve mask and T-piece device
- Suctioning equipment
- Mechanical ventilator and catheter mount
- Spare batteries and scissors (desirable)

iv) **Environment (including staff)**

The environment surrounding the neonate must be conducive for carrying out intubation. Only health professionals who need to be present should be allowed to assist and observe. The role of each health professional should be clarified before intubation commences16 – it may help if each member of the team states his or her responsibilities before the process begins.

**Preoxygenation**

This is carried out via a bag valve mask and T-piece device. This helps to increase the infant’s reserve of oxygen, which is imperative during the cessation of oxygen while intubation is attempted16.

Preoxygenation is especially important when administering suxamethonium due to the apnoeic episodes and bradycardia. The neonatal nurse may be required to administer oxygen to the infant; therefore it is important to make sure the mask is placed securely over the infant’s nose and mouth to avoid leakage of oxygen.

**Premedication**

Atropine is administered to prevent bradycardia during intubation and during the administration of suxamethonium. When suxamethonium is used to induce paralysis, analgesic medications (e.g., fentanyl, morphine) are widely used to reduce pain and discomfort. However, it has been suggested that for neonatal RSI, use of analgesic is optional, although unless airway management is critical it is unlikely to be withheld15. Medications and their usual dosages that may be given include:

- **Atropine** 20µg/kg IV administered over one minute
- **Fentanyl** 3¼µg/kg IV administered slowly over 30 seconds
- **Suxamethonium** 2mg/kg IV rapid injection13
- **Morphine** (if used) should be administered at 100 µg/kg by slow injection followed by atropine and suxamethonium. Following the administration of each drug, the line should be flushed with 0.9% sodium chloride to avoid any incompatible drugs coming into contact with each other17.

**Considerations**

1. Fentanyl should be given slowly due to the risk of chest wall rigidity.
2. Morphine and fentanyl can cause respiratory depression.
3. In theory, pain scoring is important before, during and after intubation. In reality, it is impractical to assess pain during the intubation as the procedure should be performed quickly and without delay.
4. If atropine is not having the desired effect, ensure adequate oxygenation and ventilation are in place. Remember, bradycardia during RSI can be down to:
   - vagal stimulation during laryngoscopy
   - suxamethonium
   - hypoxia.
Paralysis and sedation

Sedation may be given especially if the infant appears agitated. Suxamethonium has a rapid onset of action and when administered for paralysis it should be given rapidly, while continuously monitoring the infant for adverse side-effects and changes in vital signs. The infant should be given ventilation breaths during the administration of suxamethonium because the diaphragm and abdominal muscles will be paralysed.

Protection, positioning and placement with proof

The nurse may be asked to help position the infant prior to intubation. This may be carried out by rolling a small blanket and placing it underneath the infant’s shoulders to help facilitate the ‘sniffing’ position.

Before the tube is secured in place, placement needs to be confirmed with a carbon dioxide detector and auscultation of both lungs must indicate effective bilateral air entry. This may be seen by the chest rising and falling symmetrically. The nurse may be ideally suited to monitor and observe the infant for signs of deterioration. The doctor should be verbally informed of the status of the infant’s vital signs and physical observations.

The period of laryngoscopy is a crucial one, during which the patient is accruing an oxygen debt as the infant is neither self-ventilating nor externally ventilated. At this point, even the most experienced clinician may become task focused and it is imperative that the nurse ensures a two-way dialogue is in place. The nurse needs to keep the clinician updated with the patient’s condition, but also needs to be kept up-to-date by the operator regarding the laryngoscopy. This may include details regarding the view of the vocal cords, difficult or soiled airway, etc. If this information is not forthcoming the clinician should be prompted to supply it as only then is the nurse best placed to be the patient’s advocate and ensure that the oxygen debt does not become too large.

Post-intubation management

The nurse is often required to prepare the ventilator, adjust the settings accordingly and attach the ETT to the ventilator. The ventilator settings demonstrated in Table 1 may be used for a neonate experiencing acute respiratory distress syndrome (ARDS) prior to intubation. The nurse may be required to adjust these settings according to the infant’s response to ventilation, which may be demonstrated by changes in blood oxygen saturation or transcutaneous arterial saturation values. Arterial or capillary blood gas monitoring must be carried out frequently for signs of respiratory improvement/deterioration. The term ‘frequently’ is not defined within the literature and should be left to the clinician’s judgement. Always monitor 15 minutes after a change is made to any ventilator setting. Observation and monitoring of the infant for signs of stabilisation and deterioration should be a continuous process.

Once the infant is stabilised, it is important to promote developmental care to ensure comfort, reduce stress and improve neonatal survival. Nesting and containment of the infant should take place, ensuring that the infant’s body can be clearly observed.

The history of events and actions taken should be documented methodically and accurately. Contemporaneous record keeping is important to ensure sound communication between health professionals and to plan the infant’s future care effectively.

It may not be the role of the nurse to explain to the parents the procedure or the outcome following intubation. However, it is the nurse’s role to support fellow team members and help to inform and relieve parents of any concerns they may have. By involving the parents and discussing the outcome of the intubation process, family-centred care is promoted and maintained.

Management of side-effects – the nurse’s role

Between 1967 and early 2013, there were 1,094 suxamethonium-reported reactions within the UK, with 551 of these being reported as adverse drug reactions and 68 of these being fatal. This represents approximately 1.5 fatalities and 12 reactions per year. However, it is not possible to identify how many of these occurred within the neonatal or paediatric population.

Although suxamethonium is the favoured choice of muscle relaxant in neonates, it can exhibit several unwanted side-effects (Table 2), some of which are due to the infant’s physiological response to the drug, such as muscle fasciculations. Other side-effects are reported as common, eg bradycardiac episodes. Hyperkalaemia and malignant hyperthermia are reported as rare but potentially fatal. It should be noted that neonates requiring intubation may have known or undiagnosed congenital abnormalities, cardiomyopathies or other co-morbid factors that increase the potential risk of experiencing an adverse reaction following the administration of suxamethonium. Therefore every infant undergoing a suxamethonium-based RSI should be monitored closely for these reasons.

The neonatal nurse plays a critical role in monitoring the infant for abnormal signs and symptoms before, during and after the intubation process. Nurses spend a lot of time with their patients and they are in a unique position to identify any observational changes in a neonate. Should the infant experience adverse side-effects the neonatal nurse may manage the side-effects according to Table 2.

Table: Proposed ventilation settings based on an infant previously experiencing ARDS. Note: The fraction of inspired oxygen (FiO2) is dependent upon the infant’s response to ventilation parameters, the existing supply and the demand for oxygen. Key: PIP = peak inspiratory pressure (determined by adequate chest wall movement), PEEP = positive end expiratory pressure.

<table>
<thead>
<tr>
<th>Weight of infant</th>
<th>PIP (cmH2O)</th>
<th>PEEP (cmH2O)</th>
<th>Rate (per min)</th>
<th>Tidal volume (ml/kg)</th>
<th>Type of ventilation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1500g</td>
<td>16-18</td>
<td>4-8</td>
<td>30-40</td>
<td>4-6ml/kg (preterm)</td>
<td>Conventional mechanical ventilation (CMV)</td>
</tr>
<tr>
<td>&gt;1500g</td>
<td>20-30</td>
<td></td>
<td></td>
<td>6-10ml/kg</td>
<td></td>
</tr>
</tbody>
</table>

Table: Ventilation parameters, the existing supply and the demand for oxygen.

<table>
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<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Rate</td>
<td>Adjusted according to the infant’s response</td>
</tr>
<tr>
<td>Volume</td>
<td>Adjusted according to the infant’s response</td>
</tr>
<tr>
<td>PEEP</td>
<td>Adjusted to maintain adequate chest wall movement</td>
</tr>
<tr>
<td>FiO2</td>
<td>Adjusted to maintain adequate oxygen saturation</td>
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Therefore every infant undergoing a suxamethonium-based RSI should be monitored closely for these reasons.
Bradycardia | Decreased heart rate below acceptable limits | Stimulation of muscarinic receptors in sinoatrial node | Pre-treatment with atropine. With prolonged bradycardia repeat dose of atropine | MONITOR

Prolonged apnoea | Decreased SpO₂, Increased heart rate and blood pressure, Pallor change | Immature levels of plasma cholinesterase and immature endocrine and liver function | Address oxygen requirement. Consider a nitrous oxide and oxygen blend | ALERT

Muscle fasciculation | Visible twitching of the muscles | Muscles are depolarising and contracting | Usually none required. A non-depolarising muscle relaxant may be given to prevent fasciculations | PREPARE

Hyperkalaemia | Deranged electrocardiogram (ECG) trace | Potassium ions are able to flow easily into extracellular fluid due to opening of acetylcholine receptor ion channels | IV calcium chloride, IV insulin and glucose, Inotropes, Furosemide, Haemodialysis | ACT

Malignant hyperthermia | Labile temperatures, Hypotension, Muscle rigidity, Tachycardia, Increased oxygen requirement and carbon dioxide production, Metabolic acidosis | Body cannot supply oxygen or remove carbon dioxide readily enough to keep up with muscle metabolism | Dantrolene sodium | DOCUMENT

Hypertension or hypotension | Decrease/increase in blood pressure and heart rate | Hypotension – stimulation of vagus nerve and parasympathetic system, Hypertension – stimulation of nicotinic receptors | Hypotension – fluid bolus, vasoconstrictor, inotropes, Antihypertensives | REPORT

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<th>Treatment</th>
<th>Nurse’s role</th>
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TABLE 2 The potential side-effects of suxamethonium administration and the nurse’s role in managing such events.

for. This may involve preparing emergency equipment and drugs nearby.

**Act**: If any interventions are required, be ready to assist colleagues.

**Document**: The history of events should be recorded and documented in line with the NMC code of conduct.

**Report**: Should an adverse reaction be suspected, it should be reported via the yellow card scheme run by the Medicines and Healthcare products Regulatory Agency (MHRA).

**Conclusion**

The nurse’s role in a RSI procedure has not been addressed in current literature, nor has the nurse’s knowledge of suxamethonium – from the results of the electronic survey, it is clear that understanding of suxamethonium is unsatisfactory. This article offers a valuable insight into both. Suxamethonium continues to be the most widely used paralytic drug for neonatal RSI; a sound understanding of the pharmacology of suxamethonium and its accompanying drugs will enable nurses to feel confident in identifying abnormal signs and symptoms in the neonate and understand how to effectively manage an adverse drug reaction. Neonatal nurses are an invaluable member of the intubation team and must strive to be confident in their role and with the drugs they administer in order to flourish and provide optimal care for the neonate. Possible future recommendations:

- An investigation into how confident nurses feel in their role during a neonatal RSI.
- A standardised neonatal checklist would help provide optimal preparation prior to RSI.
- Alternative neuromuscular blockade such as rocuronium appears to be an adequate substitute to suxamethonium as it has very few side effects, however the use of rocuronium for neonatal intubation does require further investigation.

**References**


