TRACHEAL SUCTION OF THE MECHANICALLY VENTILATED NEONATE

TARGET AUDIENCE	Neonatal Service in NHS Lanarkshire
PATIENT GROUP	Mechanically ventilated neonates on the neonatal unit

Clinical Guidelines Summary

- Tracheal suction is necessary to maintain the patency of a tracheal tube (1,9). However tracheal suction is not without risk and therefore should only be carried out when required and not as a routine intervention (1,4,7,10).

- Pre-oxygenation with 100% is not recommended unless clinically indicated, an increase of 10%-20% for 30-60 seconds prior to suction event if required to maintain targeted oxygen saturations is usually sufficient (4,7,22).

- The size of suction catheter should not occlude more than 70% of the tracheal tube, this equates to double the size of the tracheal tube (size 3 tracheal tube would use size 6 suction catheter) (22). However the smallest size of suction catheter that should be used is a size 6 (unless size 2.0 ETT in situ then it should be 5fr) as the 5fr suction catheter is likely to require more suction passes to efficiently clear the secretions, resulting in loss of lung volume.

- A negative pressure of 50-100mmHg is recommended which is the equivalent of around 10kPa (4,7) but should not exceed 15kPa (26). Inappropriate catheter selection and/or high vacuum pressures can cause large negative tracheal pressures leading to atelectasis, loss of lung volume and mucosal trauma (3,14,27).

- **A visual step-by-step guide is available on pages 9-17.**

Contents

Background

Infants frequently require the use of an artificial airway and mechanical ventilation to support respiration and maintain oxygenation, especially when they are born prematurely [4]. Tracheal tubes form artificial airways which bypass the normal physiological processes providing an easy route for microbial invasion [5,6] and may increase mucous production as a result of irritation generated in the airway mucosa [4,7]. Poor or absent cough caused by prematurity, sedation, paralysis or disease can result in impaired secretion clearance leading to lung collapse, consolidation and ventilator associated pneumonia (VAP) [8]. Therefore, tracheal suction is required to prevent airway obstruction whilst optimising oxygenation and ventilation [1,9]. Clifton-Koeppel [1] suggests that due to the small sizes of tracheal tubes used within neonatal units, suction is especially critical to avoid tube obstruction from mucous and debris.

Suctioning can be described as the mechanical aspiration of secretions from an artificial airway [5,10]. Cone et al [11] suggest that suctioning of a tracheal tube is one of the most common nursing procedures with infants who are ventilated. However this procedure is associated with numerous potential complications [7,9,10-15]. Complications include; bradycardia due to vagal nerve stimulation; hypoxemia which may result in cardiovascular instability leading to hypotension and even cardiac arrest; pulmonary hypertension; raised intracranial pressure (ICP) with increased cerebral blood flow; bleeding caused by mucosal trauma; infection; atelectasis; loss of lung volume; bronchospasm; infection; pneumothorax and severe anxiety, pain and distress to the patient which can result in a cardiovascular stress response or accidental extubation [1-5,8-11,13,16-21].

Indications for Suctioning

Tracheal suction should only be performed when necessary [1,4,7,10] and not as a routine intervention [5] but following a comprehensive clinical assessment [3]. Indications for tracheal

suction include; visible secretions in tracheal tube; audible secretions on auscultation; increased work of breathing; reduced oxygen saturations; increased carbon dioxide level; the presence of a saw tooth pattern in pressure volume waveform; decreased tidal volumes when using pressure control ventilation; increased pressures when using volume controlled ventilation; reduced chest wall vibration when oscillated; suspected aspiration of gastric or upper airway secretions [1,3,6,22]. Inefficient suctioning can result in the obstruction of the tracheal tube, the need for re-intubation resulting in atelectasis [1].

Pre-oxygenation

Pre-oxygenation using 100% oxygen in neonates has been associated with retinopathy of prematurity, alveolar and tracheobronchial changes, lung parenchyma, oxidative stress leading to inflammatory responses [7], chronic lung disease and periventricular leukomalacia with the potential for long term sequale, [4,23] therefore is not recommended unless clinically indicated [1]. Pre-oxygenation should instead be based on the individual patient and should be increased in accordance with clinical need to maintain targeted saturation levels [7]. Gonzalez-Cabello et al [24] and Pritchard et al [23] suggest that a 20% increase in oxygen is likely as effective as hyper oxygenation with 100% oxygen, however it is recognised that an increase of up to 10% for 30-60 seconds is sufficient for most neonates [4,7,22]. This is also the case with patients with duct dependent systemic perfusion or balanced circulation who will usually need low inspired oxygen to prevent pulmonary over circulation and systemic hypo perfusion [25]. Inspired oxygen can then be weaned based on individual patient parameters [26].

Suction Catheter Size

Ideally the suction catheter should not occlude more that 50% of the tracheal tube [3,5,22]. Gonclaves et al [7] recognise that this may be difficult with low birth weight infants due to narrow tracheal tubes. The AARC [22] recommend that the suction catheter should not occlude more than 70% of the internal diameter. This equates to a suction catheter double the size of the tracheal tube, however the smallest size possible to effectively clear secretions should be utilised. For a size 2.0 ETT a size 5fr should be utilised, for larger tubes the smallest suction catheter size should be a 6fr as use of a 5fr will likely result in more suction passes to clear secretions possibly leading to atelectasis. Suction vacuum pressure should be set as low as possible to effectively clear secretions [22]. A negative pressure of 50-100mmHg is recommended which is the equivalent of around 10kPa [4,7] but should not exceed 15kPa [26]. Inappropriate catheter selection and/or high vacuum pressures can cause large negative tracheal pressures leading to atelectasis, loss of lung volume and mucosal trauma [3,14,27].

Depth of Insertion

There are no known benefits to performing deep tracheal suction which is related to an increased risk of mucosal trauma, inflammatory changes, focal epithelial loss, damage to the

carina and erosion of the distal tracheal tissue [1,3,22,28] therefore shallow suctioning is recommended in order to reduce these risks [1,22,29]. Morrow and Argent [3] recommend that the suction catheter should only be passed to the end of the tracheal tube which can be determined by direct measurement. Length is determined by using the centimetre markings on the ETT and adding the additional space of the ETT connector [26].

Saline Instillation

It is hypothesized that normal saline instillation may loosen secretions, increase the amount of secretions removed, and aid in the removal of tenacious secretions however there is insufficient evidence to support this hypothesis [22]. Caruso et al [30] believe that normal saline instillation prior to tracheal suction may be associated with decreased incidence of microbiological proven VAP. However, the majority of authors do not consider the instillation of normal saline to be beneficial and may actually be harmful to patients [3,5,10,31-34]. Therefore, instillation of normal saline prior to tracheal suction should not be routine practice [22,31]. Clifton-Koeppel [1] suggest that normal saline may be useful as a lubricant to allow the suction catheter to pass more easily, however the volume of saline required would be very small. There are very few studies regarding the volume of saline to be used however anecdotal evidence suggests volumes of 0.1-0.2ml/kg [4,7]. Effective humidification of the ventilator circuit prevents the build up of thick, tenacious secretions thus reducing the need for instillation of normal saline [33,34].

Preparation of Equipment

Procedure	Rationale
Equipment should be checked at beginning of each shift	To ensure equipment readily available if suction required quickly
Vacuum generator set at 10kPa which can be checked by occluding suction tubing	To minimise risk of mucosal damage and loss of lung volume caused by high suction pressures
Suction tubing of appropriate length and cut at appropriate width	To ensure tubing reaches patient and suction catheter fits snugly into tubing
Suction catheters available in various sizes appropriate to patient and tracheal tube size. Suction catheter should be determined by doubling the internal diameter of the tracheal tube e.g.: size 3.0 tube should be suctioned with size 6fr catheter. Ideally select smallest suction catheter to efficiently remove secretions. Smallest size of suction catheter utilised should be a size 6fr except when size 2.0 ETT in use then size 5f should be used. Where possible smaller size of suction catheter should also be available	Smallest suction catheter should be used to minimise risk of mucosal trauma and loss of lung volume resulting in atelectasis Range of suction catheters available in case of reduced patency of tracheal tube which may require smaller suction catheter. Conversely thicker secretions may require a larger size of catheter. Different sizes of suction catheters may also be required for suctioning of different orifices.
Checked and functioning Neopuff/ambu-bag	To ensure patient can be hand ventilated if required during suction procedure
Personal protective equipment (PPE) should include appropriate face mask, apron and gloves. Eye protection/visor if required as per infection control guidelines. Hand washing should be undertaken prior to procedure	As per local infection control policy
Ensure assistance available	To ensure safety of patient during and following suction procedure

Documented length of tracheal tube and readily available tape measure	To enable direct measurement and reduce damage to trachea caused by deep suctioning

Assessment

Tracheal suction should be carried out following a comprehensive assessment of the baby. **Tracheal suction should not be carried out routinely** if there is no clinical indication to support it.

Indications	Rationale
Visible or audible secretions in ETT heard on auscultation.	To clear mucocillary secretions and maintain patency of ETT, ensuring optimal oxygenation and ventilation
Fall in oxygen saturations or pO_2 on blood gas analysis.	
Rise in end-tidal CO_2 or $pC0_2$ in blood gas analysis.	
Decreased tidal volumes on ventilator when using pressure controlled ventilation.	
Increased peak inspiratory pressure to maintain set tidal volumes when using volume controlled ventilation	
Suspected aspiration of gastric contents	
Increased work of breathing	

This list is not exhaustive but includes general nursing considerations. Tracheal suction may be an urgent requirement and should be undertaken immediately if this is the case.

Patient and Parent Preparation

Preparation aims to minimise potential adverse effects.

Procedure	**Rationale**
Explain procedure to family if present	To reduce anxiety and stress
Assess coping strategies and need for additional – analgesia (consider use of sucrose/EBM applied to cotton bud if procedure non-emergent, dosing as per sucrose guidelines). Consider use of containment hold/swaddling.	Ensure patient safety and optimise baby's comfort and compliance

Non-pharmacological pain management strategies such as a containment hold and swaddling have been proven to reduce procedural pain, eliminate stress and promote comfort therefore can be utilised if required [1,2].

Task

Procedure	**Rationale**
This procedure requires appropriately trained staff with assistance readily available	Ensures patient safety
Prepare equipment, self and patient as previously discussed	See previous
Monitoring should include pulse oximetry, end tidal CO_2 (if available) and clinical observation of baby. Increase oxygen if required to achieve desired saturations.	To ensure patient safety and monitor adverse affects To reduce risk of hypoxia during suction
Measure suction catheter against pre-cut tape measure (tape measure cut to documented length of ETT) or identify length on suction catheter if using suction catheter with centimetre markings	To ensure suction catheter inserted to correct depth without causing damage to the carina

Disconnect from ventilator and advance suction catheter to pre-determined length. Apply suction on withdrawal only. Remove catheter from tracheal tube in one smooth motion lasting <5secs	To minimise time without ventilation therefore reducing the risk of hypoxia, hypercapnia and loss of lung volume
Re-connect to ventilator and post-oxygenate until oxygen levels within normal parameters	To reduce risk of hypoxia
Procedure should be repeated as few times as possible while efficiently removing secretions	Ensures patency of tracheal tube while minimising trauma
If suctioning different orifices i.e.: nasal or oral, a new suction catheter should be used	To prevent cross infection
Re-assess baby, post oxygenate with increased oxygen if required once suction procedure completed.	To prevent hypoxia
Reassess baby's breath sounds, oxygen saturations and tidal volumes. Wean oxygen back gradually to baseline if saturations acceptable	To assess efficacy of procedure To prevent hyperoxaemia
Dispose of equipment and wash hands as per hospital policy	To prevent cross infection

The baby should be **closely** monitored throughout procedure for adverse effects.

Saline instillation has proven controversial. **Routine** use of saline is **not recommended**, however in individual circumstances where the baby has thick tenacious secretions measured volumes of saline may be useful. Minimal amount of saline to be effective should be used and volume documented (see page 15).

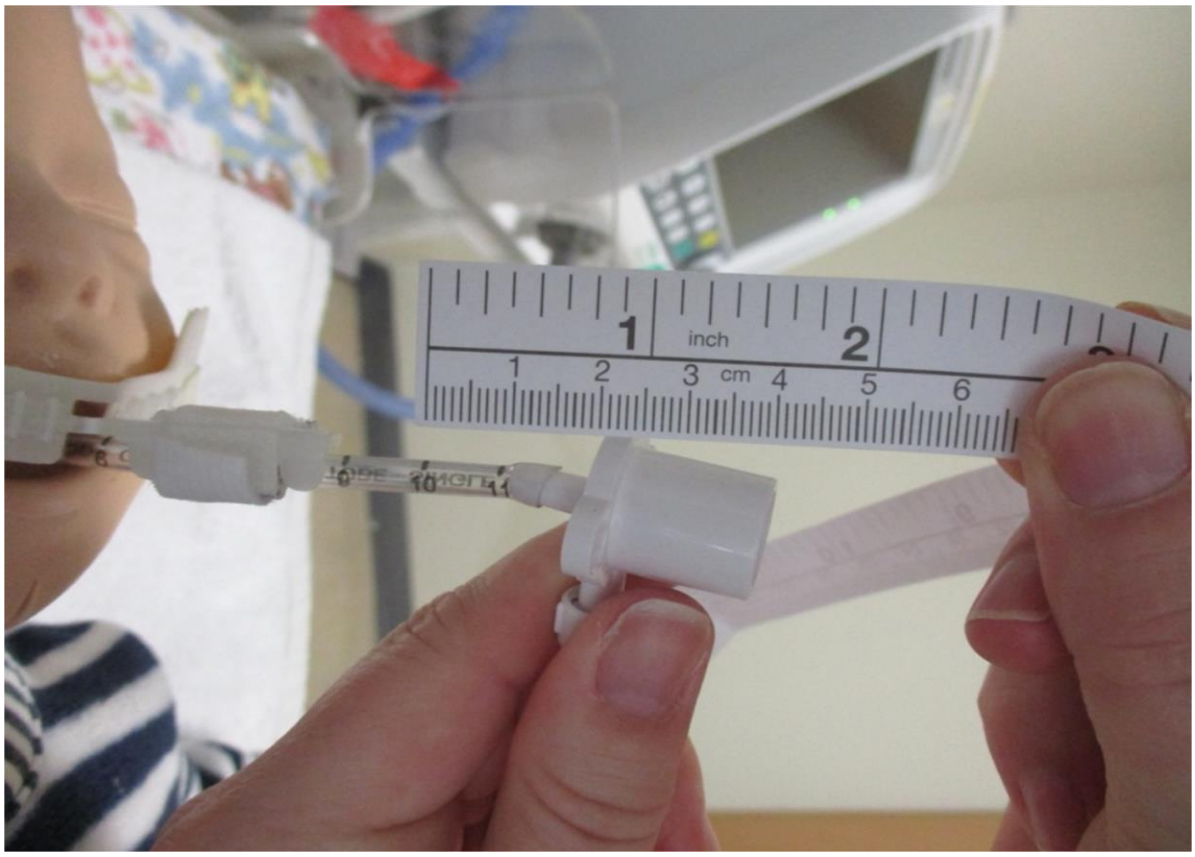
There are no absolute contraindications to tracheal suction however special consideration should be given when frank pulmonary edema or haemorrhage is present

Visual Step-By-Step Guide to Tracheal Suction

Step 1.

Check suction pressure set at 10kPa by occluding tubing

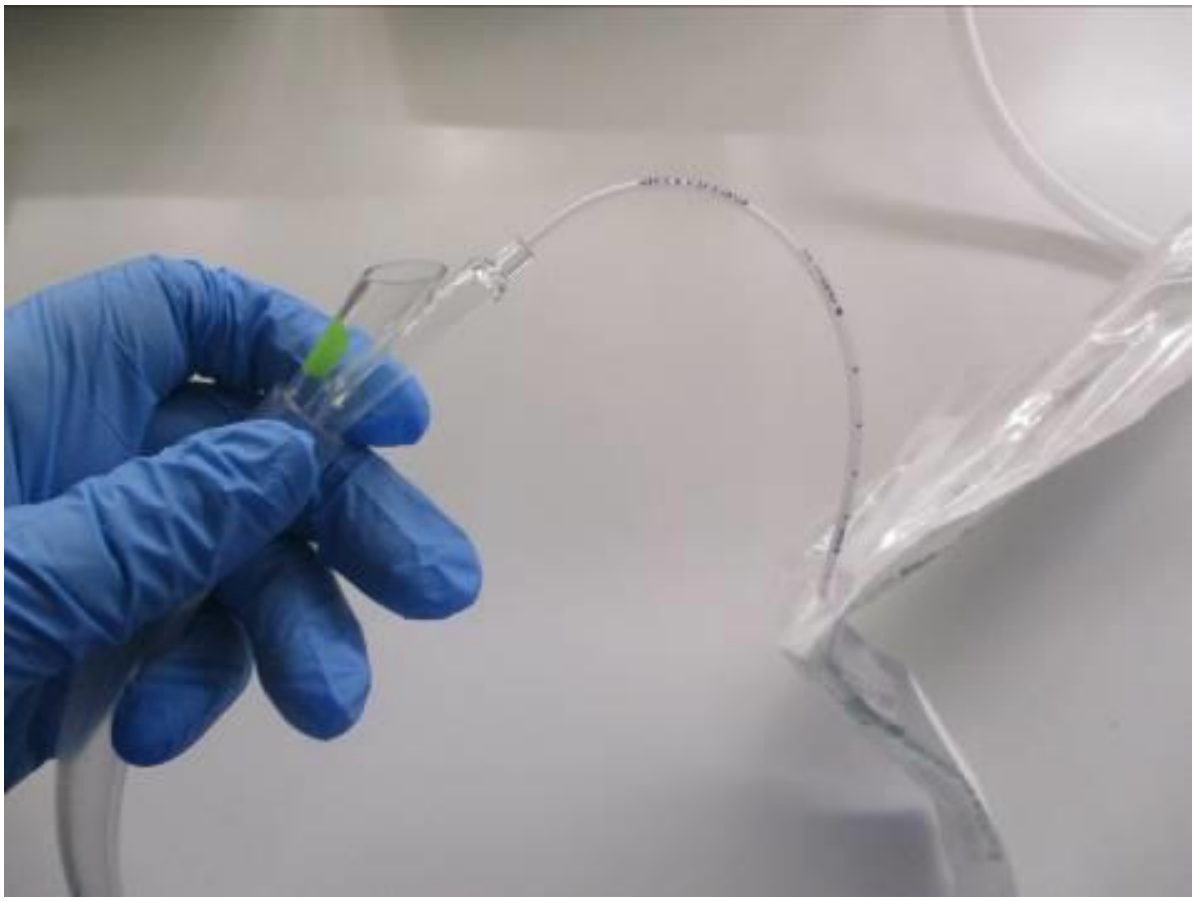
Step 2.



Ensure depth of suction is documented by using above method to calculate depth.

10cm (any visible marking on ETT) + 4 cm (length from ETT marking to end of portex) =14cm (depth of suction)

Step 3



Select appropriate sized suction catheter and connect to suction tubing ensuring snug fit

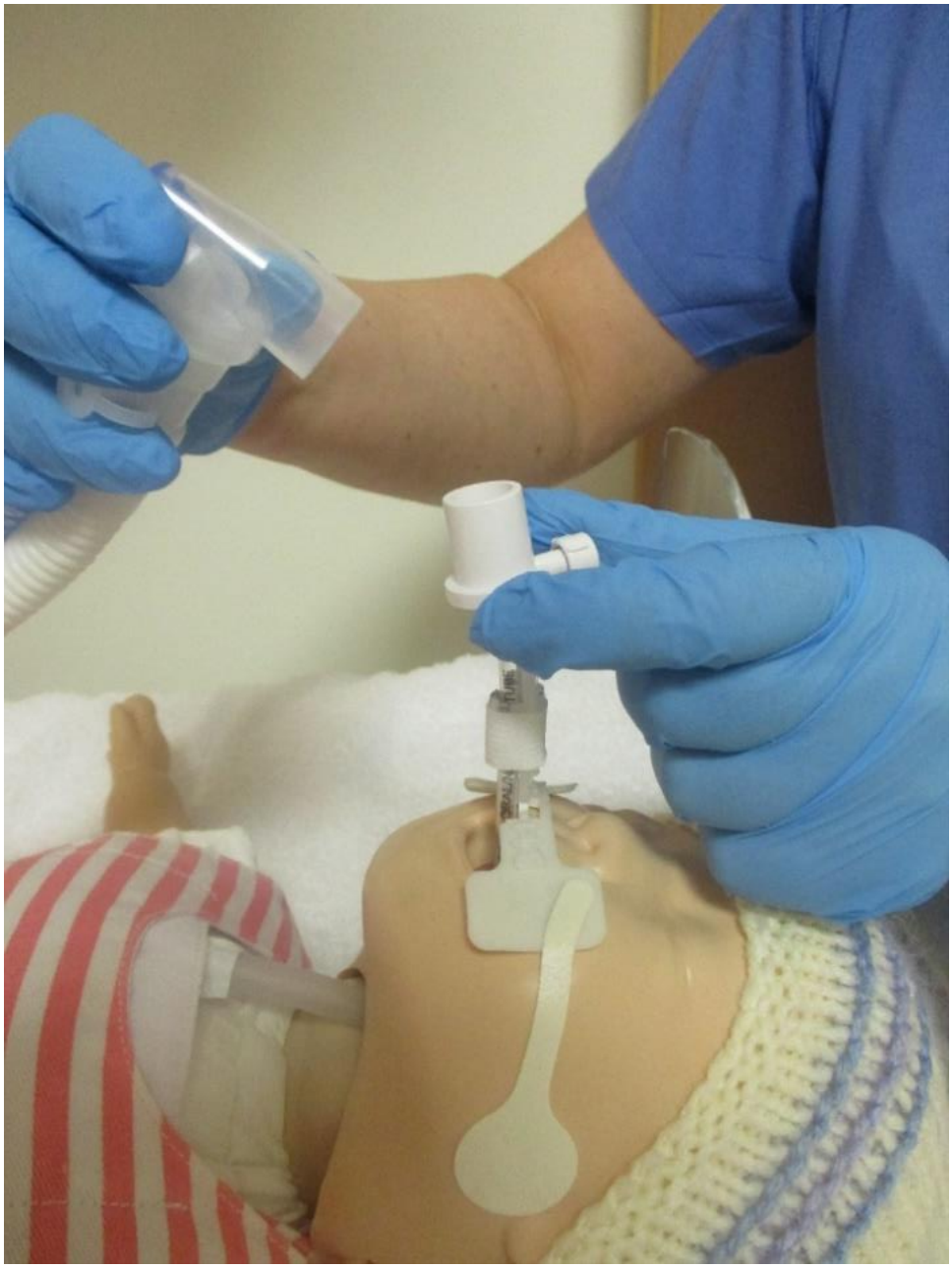
Step 4.

Utilise oxygen flush button on the ventilator **only if required** to maintain oxygen saturations within target range.

Step 4.

Oxygen flush set at 10% above set oxygen. **Default settings in NHSL 10% for 60 seconds as per hospital settings and consultant consensus.** Can be individualised to patient where required but 10-20% for 30-60 seconds is recommendation. Can be used prior to, post suction or both **only if required**. O2 flush can be stopped at any time by pressing button again.

Step 5.



Disconnect ventilator from ETT

Step 6

+

Insert suction catheter into ETT without occluding port on suction catheter to ensure no suction pressure applied

Step 7.

Stop advancing suction catheter once desired depth of suction reached (pre measured as above)

Step 8.

Withdraw suction catheter while applying suction by occluding port on suction catheter

Step 9.

Reconnect to ventilator and ensure vital signs return to acceptable levels. Repeat suction if required following the above steps. Post oxygenate as required.

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Appendices

1. Governance information for Guidance document

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