Bradford Teaching Hospitals NHS
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Clinical Guideline: Adult airway suctioning

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BTHFT CLINICAL GUIDELINE: ADULT AIRWAY SUCTIONING

For use in	Any clinical area where a patient's respiratory status suggests they may require airway suction.
By	Any qualified member of staff who is caring for the patient they think may require suction and is deemed competent in the technique
For	All adult patients in which suction may be indicated ♦ The spontaneously breathing patient ♦ The intubated/ ventilated patient ♦ The patient breathing through a tracheostomy tube

Distribution list

- Intranet
- Physiotherapy Department (BRI)

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Quick Reference Guide

Catheter size

Suction catheter size = (ETT/tracheostomy size – 2) x 2

If thick secretions: (ETT/tracheostomy size – 1) x 2 = MAXIMUM size

Minitracheostomy: size 10

NP or oral (guedal) airways: size 10 or 12

Suction Pressures

Up to 20KPa (150mmHg)

Amount of time to suction

15 seconds

Continuous suction

Continuous suction, only on withdrawal of the catheter

Airway

If no ET tube/tracheostomy/LMA/mini-tracheostomy, then nasopharyngeal suction should be chosen over oropharyngeal, as long as no contraindications exist.

Preoxygenation

In ventilated patients who are already hypoxic ($PaO_2 < 8$).
In ventilated patients who are known to have significant cardiovascular instability or desaturate with other interventions.
In self-ventilating patients who need oropharyngeal or nasopharyngeal suction (unless high levels of oxygen are contraindicated).

Use of saline instillation

Not to be used routinely. There may be benefits of saline instillation, in terms of volume of sputum produced when used in conjunction with physiotherapy techniques (small volumes: 2mls).

Recommendations

Rationale for the recommendations

Suctioning is an invasive and potentially hazardous procedure. This guideline has been constructed to assist clinical staff in all aspects of airway suction in adult patients. Recommendations have been graded upon systematic review of the evidence base, clinical expertise and consensus opinion.

Broad recommendations

- Suction should not be performed on a routine basis.
- A thorough assessment of the patient should be performed before proceeding to suction a patient, in view of the potential hazards. Assessment should be ongoing throughout and after the suction procedure to assess patient response.
- Discussion with other clinical colleagues and disciplines is recommended if the clinician is unsure whether suction is indicated.
- Communication with the patient and relatives is paramount, together with explanation of the proposed procedure (including sensations likely to be felt).
- Informed consent should be gained where possible.
- Patient tolerance should be considered at all times.

Evidence Base

This clinical practice guideline contains a full list of references used.
Database searches were undertaken, and included:

- Cochrane Database
- Ovid Online
- AMED
- CINAHL
- MEDLINE
- EMBASE
- ProQuest

Open Suction Procedure
ET tube/tracheostomy/minitracheostomy

(n.b. suction via an ETT should be undertaken with a closed suction system where possible)

Action	Rationale
Refer to patient's care plan to review previous episodes of suctioning i.e. size of catheter, depth suctioned, description of secretions cleared and patient tolerance of procedure.	To promote continuity of care and minimize adverse effects of suctioning.
Determine whether a sputum sample is needed for culture and sensitivity.	To deliver appropriate treatment as soon as possible.
Follow BTHFT guidelines regarding identification of the patient.	To ensure correct patient identified for procedure.
Obtain informed consent if possible.	In line with BTHFT policy.
Explain procedure to patient and ensure upright position if possible.	To obtain the patient's cooperation. The procedure can be unpleasant and frightening.
Wash hands with soap and water or alcohol gel, and put on appropriate PPE, considering use of eye protection and face mask.	To minimise risk of cross infection.
If the patient has a fenestrated tracheostomy tube, ensure a non-fenestrated inner tube is in situ.	Suction via a fenestrated inner tube may result in the catheter passing through the fenestration and causing trauma to the tracheal wall.
Determine baseline observations of the patient (HR, RR, BP, SpO_2 and, if ventilated, tidal volume and peak pressure)	To set baseline.
If patient is oxygen dependent, consider pre-oxygenation for 3 minutes.	To minimise the risk of acute hypoxia.
Check the suction pressure is set to correct level (up to 20KPa).	To reduce risk of atelectasis and hypoxia.
Select the correct catheter size for the airway being used: (size of ET tube/tracheostomy – 2) x2 = catheter size Minitracheostomy = size 10	To reduce the risk of hypoxia and ensure effective suction.
Open the end of the catheter pack and attach the catheter to the suction tubing, touching the pack or coloured part only. Keep the rest of the catheter in the sterile packet.	To reduce the risk of transferring infection to the catheter and to keep the catheter as clean as possible.
Place a sterile disposable glove on the dominant hand.	To minimise risk of infection to the patient.
Support the ET tube or tracheostomy with the gloved non-dominant hand.	To stabilise the airway during suction, prevent accidental extubation, and reduce patient discomfort.
Remove the catheter from the sleeve with the	To prepare the patient again.

'sterile' hand and inform the patient that suction is about to occur and that it will make them cough.	
Gently introduce the catheter into the airway until the patient coughs, or resistance is felt. If resistance is felt, withdraw the catheter approximately 1 cm before applying suction. Slowly withdraw the catheter applying continuous suction.	Gentleness is essential, damage to the tracheal mucosa can lead to trauma and infection. The catheter is inserted *without* applying suction to reduce the risk of trauma.
Do not suction for more than 15 seconds.	Prolonged suction may result in acute hypoxia, cardiac arrythmias, mucosal trauma, infection, and the patient experiencing a feeling of choking.
Wrap the catheter around the dominant hand, then pull back the sterile glove over the soiled catheter and discard into orange clinical waste bin.	To protect from infection and ensure each catheter is only used once to reduce infection risk.
Ensure the oxygen/ventilation source is reapplied immediately.	To allow the patient to re-oxygenate post suction.
Monitor the patient throughout the procedure, and check observations (HR, RR, BP, SpO_2 and if ventilated, tidal volume and peak pressure) afterwards. Seek help in the event of patient deterioration.	To ensure patient safety and clinical condition is stable/improving.
Flush the suction tubing with sterile water.	To reduce risk of infection and ensure the tubing stays patent.
Reassess the patient to identify whether further suction is needed. Always allow the patient time to recover between each suction.	To review whether further suction is needed and allow the patient to stabilize post suction.
If procedure needs repeating, use new sterile catheter and glove.	Maximises effectiveness of procedure and minimises risk of cross infection.
Wash hands with soap and water or alcohol handgel.	To minimize risk of infection.
Record in the patient's care plan size of catheter used, depth of suction, nature of secretions and any complications/patient's response to suctioning. Also record whether a sample has been sent for culture and sensitivity.	Promotes continuity of care and prevents duplication of tests.

Nasopharyngeal Suction Procedure

Action	Rationale
Refer to patient's care plan to review previous episodes of suctioning i.e. size of catheter, depth suctioned, description of secretions cleared and patient tolerance of procedure.	To promote continuity of care and minimize adverse effects of suctioning.
Determine whether a sputum sample is needed for culture and sensitivity.	To deliver appropriate treatment as soon as possible.
Follow BTHFT guidelines regarding identification of the patient.	To ensure correct patient identified for procedure.
Obtain informed consent if possible.	In line with BTHFT policy.
Explain procedure to patient and ensure upright position, plus a degree of cervical extension if possible.	To obtain the patient's cooperation and to help him or her relax. The procedure can be unpleasant and frightening. Head tilt will encourage catheter to be passed down trachea.
Wash hands with soap and water or alcohol handgel, and put on appropriate PPE, considering eye protection and face-mask.	To minimise risk of cross infection.
Determine baseline observations of the patient (HR, RR, BP, SpO_2)	To set baseline and assess patient's cardiorespiratory status.
If patient is oxygen dependent consider pre-oxygenation for 3 minutes.	To minimise the risk of acute hypoxia.
Check the suction pressure is set to correct level (up to 20KPa).	To reduce risk of atelectasis and hypoxia.
Select the correct catheter size for the airway being used (size 10 or 12).	To reduce the risk of hypoxia and ensure effective suction.
If repeated NP suction is envisaged, insert an NP airway (see guide for insertion).	To limit trauma to the nasal cavity.
Open the end of the catheter pack and attach the catheter to the suction tubing, touching the pack or coloured part only. Keep the rest of the catheter in the sterile packet.	To reduce the risk of transferring infection to the catheter and to keep the catheter as clean as possible.
Place an individually packaged, sterile disposable glove on the dominant hand.	To minimise risk of infection to the patient.
Remove the catheter from the sleeve with the 'sterile' hand and inform the patient that suction is about to occur and it will make them cough.	To prepare the patient again.
Lubricate the catheter tip with lubricating gel (e.g. aquagel).	To improve ease of passage of catheter.
Gently introduce the catheter into the nostril	Gentleness is essential, damage to the

on inspiration, directing the catheter towards the opposite eye. If obstruction is encountered, withdraw a small amount and gently reinsert, never use any force to push the catheter down. If an NP airway is in situ, the catheter will follow the path of the airway.	tracheal mucosa can lead to trauma and infection. The catheter is inserted *without* applying suction to reduce the risk of trauma.
Remove catheter if misdirection into the oesophagus is suspected (e.g. obvious swallow reflex, gagging, absence of cough, suctioning of gastric contents)	To ensure effective procedure and prevent infection.
Insert the catheter until the patient coughs, or resistance is felt. If resistance is felt, withdraw the catheter approximately 1 cm before applying suction. Slowly withdraw the catheter applying continuous suction.	To reduce risk of trauma.
Do not suction for more than 15 seconds.	Prolonged suction may result in acute hypoxia, cardiac arrythmias, mucosal trauma, infection, and the patient experiencing a feeling of choking.
Wrap the catheter around the dominant hand, then pull back the sterile glove over the soiled catheter and discard into orange clinical waste bin.	To protect from infection and ensure each catheter is only used once to reduce infection risk.
Ensure the oxygen/ventilation source is reapplied immediately.	To allow the patient to re-oxygenate post suction.
Monitor the patient throughout the procedure, and check and check observations (HR, RR, BP, SpO_2) afterwards. Seek help in the event of patient deterioration.	To ensure patient safety and clinical condition is stable/improving.
Reassess the patient to identify whether further suction is needed. Always allow the patient time to recover between each suction.	To review whether further suction is needed and allow the patient to stabilise post suction.
If procedure needs repeating, use new sterile catheter and glove.	Maximises effectiveness of procedure and minimises risk of cross infection.
Wash hands with soap and water or alcohol gel.	To minimize risk of infection.
Record in the patient's care plan size of catheter used, depth of suction, nature of secretions and any complications/patient's response to suctioning. Also record whether a sample has been sent for culture and sensitivity.	Promotes continuity of care and prevents duplication of tests.

Oropharyngeal Suction Procedure

Action	Rationale
Refer to patient's care plan to review previous episodes of suctioning i.e. size of catheter, depth suctioned, description of secretions cleared and patient tolerance of procedure.	To promote continuity of care and minimize adverse effects of suctioning.
Determine whether a sputum sample is needed for culture and sensitivity.	To deliver appropriate treatment as soon as possible.
Follow BTHFT guidelines regarding identification of the patient.	To ensure correct patient identified for procedure.
Obtain informed consent if possible.	In line with BTHFT policy.
Explain procedure to patient and ensure upright position if possible.	To obtain the patient's cooperation and to help him or her relax. The procedure can be unpleasant and frightening.
Wash hands with soap and water or alcohol handgel, and put on appropriate PPE, considering appropriate eye protection and face mask.	To minimise risk of cross infection.
Determine baseline observations of the patient (HR, RR, BP, SpO_2)	To set baseline and assess patient's cardiorespiratory status.
If patient is oxygen dependent, consider pre-oxygenation for 3 minutes.	To minimise the risk of acute hypoxia.
Check the suction pressure is set to correct level (up to 20KPa).	To reduce risk of atelectasis and hypoxia.
Select the correct catheter size for the airway being used (size 10 or 12).	To reduce the risk of hypoxia and ensure effective suction.
Insert an Oropharyngeal airway (see guide for insertion).	To provide a patent route for the passage of the catheter.
Open the end of the catheter pack and attach the catheter to the suction tubing, touching the pack or coloured part only. Keep the rest of the catheter in the sterile packet.	To reduce the risk of transferring infection to the catheter and to keep the catheter as clean as possible.
Place an individually packaged, sterile disposable glove on the dominant hand.	To minimise risk of infection to the patient.
Remove the catheter from the sleeve with the 'sterile' hand and inform the patient that suction is about to occur and it will make them cough.	To prepare the patient again.
Gently introduce the catheter into the oropharyngeal airway on inspiration. If obstruction is encountered, withdraw a small amount and gently reinsert, never use any force to push the catheter down.	Gentleness is essential, damage to the tracheal mucosa can lead to trauma and infection. The catheter is inserted *without* applying suction to reduce the risk of trauma.

Remove catheter if misdirection into the oesophagus is suspected (e.g. obvious swallow reflex, gagging, absence of cough, suctioning of gastric contents).	To ensure effective procedure and reduce infection.
Insert the catheter until the patient coughs, or resistance is felt. If resistance is felt, withdraw the catheter approximately 1 cm before applying suction. Slowly withdraw the catheter applying continuous suction.	To reduce risk of trauma.
Do not suction for more than 15 seconds.	Prolonged suction may result in acute hypoxia, cardiac arrythmias, mucosal trauma, infection, and the patient experiencing a feeling of choking.
Wrap the catheter around the dominant hand, then pull back the sterile glove over the soiled catheter and discard into orange clinical waste bin.	To protect from infection and ensure each catheter is only used once to reduce infection risk.
Ensure the oxygen/ventilation source is reapplied immediately.	To allow the patient to re-oxygenate post suction.
Monitor the patient throughout the procedure, and check and check observations (HR, RR, BP, SpO_2) afterwards. Seek help in the event of patient deterioration.	To ensure patient safety and clinical condition is stable/improving.
Reassess the patient to identify whether further suction is needed. Always allow the patient time to recover between each suction.	To review whether further suction is needed and the patient is stable.
If procedure needs repeating, use new sterile catheter and glove.	Maximises effectiveness of procedure and minimises risk of cross infection.
Wash hands with soap and water or alcohol gel.	To minimize risk of infection.
Record in the patient's care plan size of catheter used, depth of suction, nature of secretions and any complications/patient's response to suctioning. Also record whether a sample has been sent for culture and sensitivity.	Promotes continuity of care and prevents duplication of tests.

Closed Suction Procedure
ET tube or tracheostomy

Action	Rationale
Refer to patient's care plan to review previous episodes of suctioning i.e. size of catheter, depth suctioned, description of secretions cleared and patient tolerance of procedure.	To promote continuity of care and minimize adverse effects of suctioning.
Determine whether a sputum sample is needed for culture and sensitivity.	To deliver appropriate treatment as soon as possible.
Follow BTHFT guidelines regarding identification of the patient.	To ensure correct patient identified for procedure.
Obtain informed consent if possible.	In line with BTHFT policy.
Explain procedure to patient (even if sedated) and ensure upright position if possible.	To obtain the patient's cooperation and to help him or her relax. The procedure can be unpleasant and frightening.
Wash hands with soap and water or alcohol handgel, and put on disposable plastic apron and disposable gloves.	To minimise risk of cross infection.
If the patient has a fenestrated tracheostomy, ensure a non-fenestrated inner tube is in situ.	Suction via a fenestrated inner tube may result in the catheter passing through the fenestration and causing trauma to the tracheal wall.
Determine baseline observations of the patient (HR, RR, BP, SpO_2 and if ventilated, tidal volume and peak pressure)	To set baseline and assess patient's cardiorespiratory status.
If patient is oxygen dependent, consider pre-oxygenation for 3 minutes.	To minimise the risk of acute hypoxia.
Check the suction pressure is set to correct level (up to 20KPa).	To reduce risk of atelectasis and hypoxia.
Ensure the suction control port is unlocked on the closed suction system.	To ensure system working correctly and suction will be effective.
Ensure the correct catheter size for the airway is being used - maximum: (size of ET tube/tracheostomy – 2) x2 = catheter size	To reduce the risk of hypoxia and ensure effective suction.
Support the ET tube or tracheostomy with the gloved non-dominant hand.	To stabilise the airway during suction, prevent accidental extubation, and reduce patient discomfort.
Inform the patient that suction is about to occur and it will make them cough.	To prepare the patient again.
Gently introduce the catheter into the airway until the patient coughs, or resistance is felt. As the catheter is introduced, pull the plastic sheath back to prevent it bunching up.	Gentleness is essential, damage to the tracheal mucosa can lead to trauma and infection. The catheter is inserted *without* applying suction to reduce the risk of trauma.

If resistance is felt, withdraw the catheter approximately 1 cm before applying suction. If the catheter has gradations on it, note the level reached on suction and record the number. Slowly withdraw the catheter applying continuous suction, ensuring the ET tube or tracheostomy is being stabilised throughout.	Noting the gradation on the catheter reached when the patient coughs will minimise further trauma on suctioning if all staff are informed of what level to take catheter to.
Ensure complete withdrawal of suction catheter.	Incomplete withdrawal of catheter can increase airway resistance
Do not suction for more than 15 seconds.	Prolonged suction may result in acute hypoxia, cardiac arrythmias, mucosal trauma, infection, and the patient experiencing a feeling of choking.
After **each** suction, use the vial of saline to flush the catheter.	To protect from infection and ensure the catheter is ready for the next suction (closed suction systems can be used for up to 72 hours if flushed after each pass of the catheter).
Monitor the patient throughout the procedure, and check observations (HR, RR, BP, SpO_2 and if ventilated, tidal volume and peak pressure) afterwards. Seek help in the event of patient deterioration.	To ensure clinical condition is stable.
Reassess the patient to identify whether further suction is needed. Always allow the patient time to recover between each suction.	To review whether further suction is needed and the patient is stable.
Wash hands with soap and water or alcohol gel.	To minimize risk of infection.
Record in the patient's care plan size of catheter used, depth of suction, nature of secretions and any complications/patient's response to suctioning. Also record whether a sample has been sent for culture and sensitivity.	Promotes continuity of care and prevents duplication of tests.

AIRWAY SUCTIONING

1.0 Introduction

Airway suctioning removes excess secretions from the respiratory tract by the insertion of a suction catheter and the application of a negative pressure. Although a relatively uncomplicated procedure to perform, which requires little in the way of sophisticated equipment, it is associated with well documented undesirable side effects (Young 1984, Brochard et al 1991, Judson et al 1994, Glass et al 1995, Blackwood 1998, Leur et al 2003, Fernandez et al 2004, Lasocki et al 2006, Jongerden et al 2007, Heinze et al 2008, Vanner and Bick 2008).

A patient who requires suction may be ventilated in an intensive care unit, spontaneously breathing in a ward setting or even in the community outside the hospital environment.

It is beyond the remit of this document to be able to provide guidelines for every possible suctioning event, and therefore it is a guideline for suction in generic terms, for adult patients only. Day et al (2002) stated that 'it is essential that members of staff performing suction are taught the correct technique and that clinical guidelines are in place to ensure that practice is up to date'. These guidelines do not pre-empt sound clinical decision-making. Clinicians must pay close attention to patient oxygenation levels, haemodynamic status and responses to suctioning, especially if patients are unstable or have thick and tenacious secretions.

This guideline is intended to be a comprehensive text covering all aspects of airway suctioning. It is acknowledged that further research is required into the many aspects of suctioning. This document presents research and expert consensus opinion up to current day (July 2017) in an attempt to make suction as safe and least distressing for the patient as possible.

Physiology and mechanics of airway clearance

Removal of bronchial secretions is necessary for effective gaseous exchange in the lungs. The removal of these secretions is normally carried out subconsciously by the action of cilia which are present in the upper and lower respiratory tract, as far down as the terminal bronchioles. A covering of mucus further aids the removal of foreign matter from the lungs. The mixture of mucus and debris is swept up by the cilia in a cephalic direction, to a point where it is either expectorated or swallowed. The action of this mucociliary escalator provides an effective defence mechanism for the respiratory tract. The normal mechanism of secretion removal is the cough reflex.

Cough is not only a symptom, but is the lungs' primary defence mechanism. It serves two functions:

a) To prevent foreign material entering the airways
b) To clear foreign material or excess secretions from the airways (Clarke et al 1988, Ashurst 1992, Pingleton 2000).

For a cough to be effective, the following must occur:

- A pre-cough inhalation volume of 85-90% of total lung capacity
- Closure of the glottis by the vocal cord adductors
- Expiratory force against the closed glottis to increase intrathoracic pressure.

An adult normal cough peak flow ranges from 360 to 1200 litres/minute (Chatwin et al 2008), however this may be compromised acutely, for example, by infection or pain, or chronically, in patients with long-term conditions such as neuromuscular disease. This is also of major clinical significance in a critical care setting, where, due to the patient's condition and/or the presence of endotracheal (ET) or tracheostomy tubes, the system is compromised. Endotracheal intubation disrupts the mucociliary escalator and predisposes the patient to infection, which can further increase the volume and tenacity of secretions. Various pollutants (e.g. cigarette smoke, anaesthetic agents), bacteria, or viral infections may also reduce the efficiency of the cough mechanism.

2.0 Definition of airway suction

Suction involves the removal of airway secretions, by artificial means, using an applied negative pressure. It is performed in a patient who is unable to independently clear their bronchial secretions, for example:

- Spontaneously breathing patients with sputum retention due to
  - Unconsciousness
  - Semiconsciousness
  - Ineffective cough
  - Impaired mucociliary action
- Intubated/ ventilated patients
- Patients with tracheostomies, who are unable to expectorate via the tracheostomy tube

3.0 Indications for airway suction

"The inability to clear secretions when there is audible or visible evidence of secretions in the large or central airways that persist in spite of the patient's best cough effort." (AARC 2004)

The primary indication for suctioning is for *secretion removal* (Young 1988, Macmillan 1995, Swartz et al 1996, Brookes 1999, Shah et al 2005, Branson 2007).
It is well documented that suction should only be carried out as indicated after thorough assessment and *not* on a routine basis (Judson et al 1994, Glass et al 1995, Gugielminotti et al 2000, Lindgren et al 2004, Branson 2007, Pedersen et al 2009, AARC 2010), but regular assessment should be undertaken, rather than waiting for the patient to deteriorate.

The nature and quantity of airway secretions, obvious coughing, medical state, thorough physical assessment (involving auscultation, palpation, percussion note, work of breathing, patient feedback etc.) and noting of critical observations (e.g. PaO_2, SpO_2, respiratory rate) will determine the frequency and indication for suctioning. Wood (1998) added that there may be as much risk from not suctioning in terms of ET/ tracheostomy tube blockage. Routine suction may actually stimulate mucus production, possibly due to mucosal trauma to the airways (Glass et al 1995). The ventilator display screen (if available) may demonstrate some useful indications that may suggest the presence of secretions requiring suction.

- An intubated patient may show a rise in peak pressures on the ventilator if volume controlled or a reduction in tidal volumes if pressure controlled (Plevak and Ward1997).

- A saw-tooth appearance to a flow-volume loop may be present on ventilators that have this facility. This would only be available if the patient was receiving assistance through the ventilator in some form e.g. SIMV or CPAP mode. Attention must be paid to ensuring ventilator tubing is rid of condensate as a saw tooth appearance to the flow volume loop could be produced by this problem also.

Other indications for performing suction include: -

- Suspected aspiration of gastric contents (if the patient is unable to cough effectively)
- The need to obtain a sputum specimen to identify pneumonia, other pulmonary infection or for sputum cytology (if the patient is unable to cough and provide a sputum sample independently)
- Terminal care patient who is distressed by upper respiratory secretions and is unable to self expectorate.

4.0 Contraindications to airway suctioning

4.1 Endotracheal suction

The AARC Clinical Practice Guideline (2010) for endotracheal suctioning of mechanically ventilated adults with artificial airways states that 'endotracheal suction is a necessary procedure for patients with artificial airways. Most contraindications are relative to the patients' risk of developing adverse reactions or worsening clinical condition as a result of the procedure, therefore, there is no absolute contraindication. Some situations may present more of a precaution: raised ICP, cardiac instability, CSF leak, severe bronchospasm, vagal sensitivity and pulmonary oedema, frank haemoptysis or coagulopathy.

4.2 Nasopharyngeal suction

- Head injury, basal skull fracture, cerebrospinal fluid leakage
- Maxillo-facial surgery/trauma
- Recent oesophageal or tracheal surgery
- Tracheo-oesophageal fistula
- Severe coagulation defects or unexplained frank haemoptysis
- Laryngospasm (stridor)
- Nasal bleeding
- Occluded nasal passages
- Severe bronchospasm

4.3 Oropharyngeal suction

- Orofacial surgery/trauma
- Recent oesophageal or tracheal surgery
- Acute neck, facial or head injury
- Severe coagulation defects or unexplained frank haemoptysis
- Laryngospasm (stridor)
- Also caution should be exercised to prevent gagging on the airway
- Severe bronchospasm

If, considering the above contra indications, oral or nasal suction is felt to be necessary for the patient with a high oesophageal or tracheal anastomosis, it is imperative this is discussed with the Consultant Surgeon. It may be safe to pass the catheter to the end of the inserted oral or nasal airway and still be effective.

Patient tolerance should be considered at all times. If suction causes a patient to become increasingly distressed and their condition is terminal, suction should be ceased and alternative methods for managing secretions sought (e.g. hyacin).

5.0 Routes for airway suction

- ET tube
- Tracheostomy
- Minitracheostomy
- Oropharyngeal via an airway
- Nasopharyngeal with or without an airway

N.b. Minitracheostomies have been shown to be effective in preventing or dealing with retained secretions (Preston et al 1986), but are not without risk. Complications appear largely related to insertion technique. Risks include bleeding, surgical emphysema, and misplacement.
The maximum size suction catheter that can be passed down a minitracheostomy is a size 10, which may be too small if secretions are very tenacious. Nevertheless, they can be extremely useful in a number of patients, for example as a step down from full tracheostomy tube, and can prevent further deterioration.

6.0 Catheter size and design

ET tube/Tracheostomy: (size of airway – 2) x 2

Oropharyngeal airway or nasopharyngeal airway: size 10 or 12

A suction catheter should not occlude more than half the diameter of the airway, endotracheal or tracheostomy tube (Kuzenski 1978, Young 1984, Casey 1989, AARC 2010). This ensures less of a vacuum effect when applying negative pressure, in an attempt to reduce suction-induced atelectasis and hypoxia.

Occasionally it is necessary to use a proportionally larger diameter of catheter, especially if secretions are viscous, but this must be done with care (Lindgren et al 2004, Copnell et al 2009).
A greater amount of air may be evacuated with larger catheters with less ability to entrain ambient replacement air, thus the risk of hypoxia and suction induced atelectasis may be increased (Young 1984).

Almgren et al (2004) highlighted the importance of correct catheter size, comparing the effects of a size 12FG suction catheter with a size 14FG (using ET tubes of size 7.5 and 8 mm) in animal models. They found adverse effects of suctioning could be minimised if a size 12 suction catheter was used. Vanner and Bick (2008) support the findings, demonstrating that with suction catheters less than half the diameter of

the airway, tracheal pressure will not fall to less than 2mmHg below atmospheric pressure (even using suction pressures up to 500mmHg), which they state would not cause adverse consequences.

ET tube size (adult)	Catheter size
5.0	8
6.0	8
7.0	10
8.0	12
9.0	14

Recommended suction catheter sizes (Vanner and Bick 2008)

Odell et al (1993) suggested the following formula, using the size of the ET tube or tracheostomy tube as a guide for deciding which size of suction catheter to use:

(ETT – 2) x 2
e.g. size 8 ETT = (8 – 2) x 2 = size 12 catheter

However, Pedersen et al (2009) suggest that it is more logical to recommend the suction catheter should occlude less than half the internal lumen of the ET tube, rather than half the diameter. They reason that the negative pressure in the lungs is minimised because the space in the tube that allows air to pass to the lungs during suctioning correlates to tube lumen. The following guide for sizing suction catheters is recommended:

Suction catheter size (FG) = (ET tube size – 1) x 2

In patients with thick secretions, this sizing guide may be more useful.

A catheter should also be:

- Sterile
- Flexible and clear so secretions are easily visible
- Multi-holed/side-holed to reduce trauma compared to single or double-holed catheters

(Sackner et al 1973, Reigal 1985, Czarnick et al 1991, Macmillan 1995, Shah et al 2005).

Catheters with beaded tips tended to cause less mucosal trauma (Czarnick 1991). Catheters with larger side holes, that are not parallel to each other, may improve suction efficiency (Shah et al 2005).

7.0 Suction pressures

up to 20KPa (150 mmHg)

Experimental data to support quoted pressure levels is lacking for endotracheal suctioning of mechanically ventilated adults with artificial airways (AARC Clinical

Practice Guidelines 1993; Pedersen et al in 2009). What follows are evidence-based suggestions in an effort to gain some consensus of opinion.

70 - 100 mmHg (9.3 - 13.3kPa) in adults (Young 1984)
80 - 120 mmHg (10.7 - 16kPa) in adults (Fiorentini 1992, Carroll 1989)
97.5-120 mmHg (13 – 16kPa) in adults (Allen 1988, Lippincot 1990)
101-120 mmHg (13.3 – 16kPa) in adults (Brookes 1999)

To convert mmHg to kPa: mmHg = kPa x 7.5 (Hough 1996).

The actual negative pressure applied to the lungs is also dependent on catheter to airway ratio; duration of procedure; and the volume/viscosity of the secretions.
The lowest possible effective pressure should be used (80 – 120 mmHg), but up to 200mmHg can be used if the catheter is appropriately sized (Pedersen et al 2009). Negative model airway pressures have been induced by suctioning through small size ETT's (7-8mm internal diameter) with large size catheters (14-16) (Espen et al 2016).

If secretions are thick or tenacious, the diameter of catheter should be increased, rather than the pressure used.

Highly excessive pressures continuously being used in suction practices has been recorded in the literature. Celik and Elbas (2000) reported patients in their study were being suctioned with a minimum suction pressure of 300mmHg (twice the recommended negative pressure). Also they found that 82.6% of nurses in the study were applying negative pressure during insertion of the catheter as well as withdrawal, also a practice not recommended.
Czarnick et al (1991) found there were incidences of trauma evident in both intermittent and continuous suction; however, they used suction pressures of 200mmHg, even after quoting authors who had found pressures in excess of 200mmHg caused more tracheal damage. It may have been difficult to say reliably whether it was the suction technique (intermittent versus continuous) or the set pressure that caused the trauma.
Further literature reviews to 2017 have yielded little extra evidence regarding recommended safe suction pressures. Brookes (1999) in her survey of suction practice found virtually no professional (physiotherapist, nurse or respiratory therapist) quoted using pressures in excess of 200mmHg for secretion removal.

Resistance in a suction system directly affects the flow rate - the smaller the catheter size the greater the resistance, however route and type of secretions determine catheter size. While not as significant as the catheter size, the length of tubing also affects the flow rate (Young 1984, Carroll 1989, Czarnick 1991).

Using large-bore tubing between the catheter and the collection bottle and between the collection bottle and the suction apparatus can decrease resistance.

Manometers should be used to measure suction pressure, although Donald (2000) concluded from her study that even having a manometer in the circuit did not stop unsafe pressures being used in suction.

Catheters without a built in control valve and which attach directly to the vacuum source are potentially dangerous to use, as they need to be firmly pinched to prevent the negative pressure being transmitted to the catheter tip during insertion. If this is

not performed effectively it results in a maximum pressure build up, which is suddenly relayed to the airway on release causing trauma (Young 1984). Either the catheter itself or the suction tubing should have a vacuum breaker, so that negative pressure builds up only when the valve is occluded (a suction control device can be used in the circuit if required to act as a vacuum breaker).

Catheters or suction equipment which do not possess a vacuum breaking system/suction control device, are not recommended.

7.1 Yankaur suction

It is often the agreed practice to use Yankaur suction to remove oropharyngeal secretions.
Ashurst (1992) suggested the use of lower suction pressures (37.5 – 75mmHg/ 5 – 10kPa) to remove oral secretions should be advocated, to prevent damage to delicate oral tissue and recommended soft plastic catheters.

Caution should be exercised when using a Yankaur to clear oral secretions. Attention should be given to avoid using too high suction pressures and to prevent trauma to delicate oral tissues. A pressure of 37.5 - 75mmHg or 5 - 10kPa has been suggested (Ashurst 1992).

8.0 Length of suction time.

Less than 15 seconds

Length of suction time should be 15 seconds (and should not exceed 30 seconds) (Young 1984, Jongerden et al 2007, Pedersen et al 2009, AARC 2010, Dave et al 2011). George (1983) in an observational study found a fall in PaO_2 occurred even after a suction duration of 5 seconds. Half the observed drop in PaO_2 could be attributed to the apnoea alone, regardless of the suction (animal study).

Closed circuit suction in ventilated patients should be used to prevent disconnection from the ventilator and maintain some effect of PEEP and assistance from the ventilator in term of pressures (see later section on closed suction). Suction time should ideally not exceed 15 seconds in adults. Suction should occur for long enough to effectively remove secretions, but short enough not to increase the risk of hypoxia.

9.0 Continuous versus intermittent suction

Continuous suction recommended

The data available appears to suggest that both continuous and intermittent suction produce trauma to the mucosa (Czarnick et al 1991).
Stenqvist et al (2001) demonstrated the potential adverse effects of using intermittent suction in closed circuit suctioning on a test model, with high pressures (50KPa). They found the steady state suction flow through a size 12 and size 14FG closed circuit catheter was more than twice the normal minute ventilation provided by the ventilator. When the on/ off switch was depressed, the initial suction capacity for the

first 2-4 seconds was up to 700ml/second. With this in mind it is possible to completely empty the lungs of more than the tidal volume, each time the switch is pressed during intermittent suctioning. Effects were more pronounced when the ventilator was programmed with a volume-controlled mode.

There is some evidence to suggest (especially when using closed circuit suction) by using continuous suction, the generation of potentially adverse high levels of initial negative pressure can be avoided.

10.0 Recommended number of passes of a catheter

Time should be allowed in between each pass in order to regain oxygen levels, assess the patients' respiratory symptoms and any hazardous effects. Reassessment following the suction process should assist in making the decision as to whether further suction is needed.

If performing open suction, a new sterile catheter and glove should be used for each suction undertaken.
It cannot be stated how many suction events should occur for each patient. Secretion volume, patients' haemodynamic/respiratory stability, patients tolerance, and accurate assessment of the situation will determine how many passes are appropriate. It should be remembered that each subsequent pass of a catheter could adversely affect critical observations such as PaO_2, SvO_2, cerebral blood flow velocity, ICP, arterial pressure or cardiac output (Walsh et al 1989, Stone et al 1991, Mancinelli Van Atta et al 1992).

11.0 Pre and post oxygenation

In ventilated patients who are already hypoxic (PaO_2 < 8).

In ventilated patients who are known to have significant cardiovascular instability or desaturate with other interventions.
In self-ventilating patients who need oropharyngeal or nasopharyngeal suction (unless high levels of oxygen are contraindicated).

There is little consistency in the literature regarding accurate description of preoxygenation and the period of time the patient should be hyperoxygenated. However, it is agreed that it is especially indicated in all patients who are already hypoxic or are being ventilated to prevent further suction induced hypoxia (Brown et al 1983, DARE 2003, Oh and Seo 2003, Sole and Bennett 2011).
Ventilated patients demonstrate marked desaturation when suctioned with an open system, despite preoxygenation with 100% O_2 for ten minutes, compared to an insignificant desaturation, if any, when closed suction is used (Lasocki et al 2006), although Akerman's work (2013) contends this. It may be the disconnection from the ventilator, rather than the act of suction itself that is the main determinant of hypoxaemia. Open endotracheal suctioning may impair gas exchange and decrease lung compliance in ARF patients receiving mechanical ventilation under both pressure controlled and volume controlled modes, but endotracheal suctioning effects on gas exchange were more severe and longer-lasting under pressure controlled modes (Xiao-Wei et al 2015).

Compared to no intervention, in intubated patients, preoxygenation with 100% O_2 has been shown to decrease the occurrence of suction-induced hypoxaemia by 35%, whilst combining pre- and post-oxygenation at this level hypoxaemia can be reduced by 49% (Oh and Seo 2003). This meta-analysis also concluded that a combination of hyperoxygenation plus ventilator hyperinflation can reduce the occurrence of hypoxaemia by 55%, compared to no interventions. However, caution should be taken with hyperinflation due to risk of barotrauma and patient discomfort (Pedersen et al 2009).
Bourgault et al (2006) found reduced cardiovascular instability with suction if PaO_2 was maintained $\geq$10.6 KPa in intubated patients, and they recommend hyperoxygenation with 100% O_2 for a minimum of one minute prior to suction.
In a non-intubated patient, asking the patient to take several deep breaths before commencing suction is beneficial, either utilising facial oxygen, oxygen through a tracheal mask for patients spontaneously breathing through a tracheostomy/laryngectomy stoma, or room air.

Preoxygenation with the maximum amount of oxygen that can be achieved by their specific delivery device for at least a minute pre suctioning may be useful e.g. FiO_2 0.6 for aquamist system, 15l O_2 for non-rebreathe mask, and FiO_2 of 1.0 on mechanical ventilation.

Caution should be taken when oxygenating spontaneously breathing patients with known oxygen-induced CO2 retention. Rogge et al (1989) found positive results pre oxygenating COPD patients utilising oxygen levels of only 20% above the set level on the ventilator. This questions whether preoxygenation with 100% oxygen is strictly necessary. An incremental approach to increasing oxygen in these patients should be taken until desired level is achieved.

12.0 Sodium Chloride (saline) irrigation

The best interventions to manage thick secretions are humidification, hydration, mucolytics and mobilisation (Halm et al 2008).

Controversy exists over the use of normal saline for irrigation purposes during suctioning (Pedersen et al 2009). There is little robust literature to support the use of saline instillation prior to suction (Caparros et al 2014, AARC 2010). Branson (2007) states “saline instillation to thin secretions is, at best, unsupported and, at worst, dangerous”, however, Paratz and Stockton (2009) demonstrated there is insufficient good quality evidence to support or dismiss the use of saline irrigation.
Problems with specific patients groups, varying incomparable methodologies and small patient numbers make generalisation/meta-analyses and comparison of research results difficult (Niell 2001). Reasons either anecdotally or experimentally quoted in the literature for the use of saline instillation are:

- To facilitate the suctioning of tenacious secretions
- To stimulate the cough reflex
- To lubricate the suction catheter

Deleterious effects on recovery of oxygen saturations or arterial oxygenation following boluses of varying amounts of saline compared to no saline instillation have been reported (Ackerman and Gugerty 1990, Ackerman 1993, Ackerman and Mick 1998, Kinloch 1999 , Halm et al 2008), but it is unclear whether these are clinically significant.

Adverse effects on the level of dyspnoea of the alert older patient receiving ventilation as compared to suction without saline have been shown (O'Neal et al 2001). Patients with tracheostomies on 0-15l/min O2, served as their own controls and underwent three different suctioning manoeuvres in a controlled, randomised order, receiving no hyperinflation, pre oxygenation or hyperventilation. There was a significant rest period of 80 minutes between each testing period with a different amount of saline/ no saline. No preoxygenation prior to suctioning was given, and three suctioning procedures with only 15 seconds between each pass occurred, with each testing period, regardless of volume of secretions.
The worst effects on SaO_2 or PaO_2 occurred with the instillation of *increasing* volumes of saline (e.g. 5 or 10mls) (Stone et al 1991).
Other studies have shown adverse effects on SvO_2 of patients upon instillation of saline for suction (Kinloch et al 1999). They found that SvO_2 levels after suctioning decreased 17% below baseline for patients in the saline instillation group and 9% for the non-saline group. Recovery time for return to baseline levels of SvO_2 was twice as long for the saline instillation group compared to the non- saline group

Mucus, which is continually being produced by the body, tends to line the inside of artificial airways easily and quickly. The amount used varies with age, size of airway and reason for intubation. Saline may help to loosen viscid secretions from the airway but will not thin secretions. Although mucus is 95% water, it becomes a semi-solid when formed and incorporates further liquid poorly. Even after vigorous shaking in vitro, mucus and saline do not mix (Connoly 1995), therefore saline does not thin secretions. Some studies suggest that greater material is aspirated with the instillation of saline, but this could be due to the cough stimulated by this procedure (Odell et al 1993). Further research is needed in this area.

Hagler and Traver (1994) investigated ETT's removed from patients who had undergone a period of ventilation of at least 48 hours. Each ETT was used in a random order for both saline instillation and suction catheter insertion. Any material dislodged by these techniques was collected and analysed. The results demonstrated that the level of bacterial colonies dislodged was 5 times higher with saline instillation than with insertion of the catheter alone. (60 000 compared to 310 000 colonies). The amount of saline used in instillation was 5 ccs. This evidence suggests the increased risk of nosocomial infection by dislodging bacteria into the lower airways. It is yet to be proven whether this would lead to an increased rate of nosocomial or lower respiratory infection in humans however.

Schreuder and Jones (2004) demonstrated the beneficial effects of saline instillation together with physiotherapy on yield of wet sputum rate as compared to no saline and physiotherapy. No adverse effects were demonstrated on SaO_2 during this study. Numbers were small (only 8), but the results warrant further study into this area. As demonstrated it may be the context in which saline instillation is performed which will determine its appropriateness and effectiveness.

Suggested course of action for saline instillation
Do **not** routinely instil saline for suctioning purposes. If it were felt that saline irrigation is necessary in order to assist aspiration of sputum, it would appear prudent to use small volumes (2mls).

There may be benefits of saline instillation in terms of volume of sputum produced when used in conjunction with physiotherapy techniques.

It may be useful to consider pre - oxygenation of patients who it is thought instillation of saline is necessary to effectively remove further secretions. This may counteract the effect of oxygen depletion that saline instillation is often reported to precipitate.

13.0 The adverse effects of suction.

A good suction technique, with low pressures and the smallest appropriate catheter size will minimise adverse effects.

- Mucosal trauma (e.g. haemorrhage, ulceration)
- Pneumothorax
- Bronchospasm
- Atelectasis, especially in infants
- Introduction of infection
- Arrhythmias } these can
- Bradycardias } lead to a
- Vasovagal stimulation } cardiac arrest
- Hypoxaemia/hypoxia
- Anxiety to patient
- Respiratory arrest
- Pulmonary haemorrhage
- Disturbance/breakdown of anastomosis
- Raised intracranial pressure
- Hypotension/hypertension
- Interruption of mechanical ventilation
- Gagging/vomiting (particularly with oropharyngeal)

(Young 1984, Carroll 1988, Young 1988, Noll et al 1990, Ashurst 1992, Fiorentini 1992, AARC Clinical Practice Guidelines 1993, Odell et al 1993, Copnell & Fergusson 1995, Glass & Grap 1995, Macmillan 1995, Blackwood 1998, Bourgault et al 2006, Subriana et al 2007, Copnell et al 2008)

13.1 Mucosal damage

Mucosal haemorrhage and erosion occur frequently in the suctioned patient. Suction catheters may elevate the mucosa when suction is applied, sucking the mucosa into the catheter holes; this immediately produces areas of haemorrhage and a point for infection and ulceration.

The type and size of suction catheter (Vanner and Bick 2008), the technique employed in the procedure, the duration of the suctioning, the vigour of catheter insertion and repetition of the procedure can all contribute to the trauma of the delicate mucosa of the tracheobronchial tree (Shah et al 2005).

Mucosal damage will interfere with mucociliary transport, while poor humidification of the airway may also predispose to trauma (Fiorentini 1992, Young 1984). Small amounts of blood in the tracheal aspirate are not uncommon, but the presence of frank blood should be viewed as ominous (Salyer 1990).

13.2 Pneumothoraces

There have been reports of pneumothoraces in patients following suctioning. Those more at risk are COPD patients with bullae. Medical staff should therefore be aware that coughing in response to suction, or the presence of bronchospasm might prompt the rupture of a bulla with resultant pneumothorax. Lower negative pressures will reduce the risk.

13.3 Bronchospasm

The insertion of the catheter into the airways is irritating and can induce bronchospasm resulting in higher airway resistance. This is usually transient, but can be quite severe and may be manifested by increased wheezing or increased airway pressures required for ventilation. Reassessment after each pass of a catheter is therefore vital.

13.4 Atelectasis

If part of the airways system is occluded, alveoli served by that airway tend to collapse as gases in them are absorbed, particularly if the oxygen content is high (absorption atelectasis). Something similar occurs when a catheter is impacted in an airway, but air may actually be sucked out of the alveoli, collapsing them and causing atelectasis. This may persist some time after the procedure is finished. Heinze et al (2008) have shown that absolute FRC values are reduced at twenty minutes after suctioning ventilated patients with both open and closed systems, although they did use catheters larger than recommended (size 14 FG with 7.5 or 8 mm ET tubes) at 200mmHg pressure. Fernandez et al (2004) also demonstrated significant reduction in lung volume during suction, but this returned to pre-suction levels within ten minutes.

It is essential that the catheter be of the appropriate size. This will allow atmospheric air to be drawn in around the catheter during suctioning, and so prevent atelectasis. If the airway is completely occluded by the catheter and suction is applied while advancing the catheter causing impaction, atelectasis will occur in that part of the lung served by the airway (Carroll 1989, Fiorentini 1992).

Almgren et al (2004) during a randomised study concluded that ETT suction causes lung collapse leading to impaired gas exchange. They concluded the effect is more severe and persistent in pressure controlled ventilation than in volume controlled ventilation. In this study, only small levels of PEEP were used ($3cmH_2O$). This makes drawing conclusions for higher levels of PEEP more difficult.

13.5 Infection

A critically ill patient with an endotracheal or tracheostomy tube is already vulnerable due to bypassing of the natural antimicrobial defence mechanisms in the upper airway. Other factors that may lead to infection are the patients debilitated condition, the use of antibiotics (which alter normal flora and encourage resistance), and trauma to the mucous membrane (Fiorentini 1992, Carroll 1988).

The risk of infection can be greatly reduced by adherence to an accepted protocol/guideline for suctioning procedures. Thorough hand-washing will also serve to minimise risk.

Flushing the closed suction system after each pass of the catheter will reduce risk of infection.

13.6 Cardiac arrhythmias

Cardiac arrhythmias may be produced by vagal inhibition resulting from reflexes triggered by stimulation of afferent vagal fibres in the pharynx, oesophagus or respiratory tract. Respiratory arrhythmias may be explained by the fact that many respiratory reflexes are mediated by the vagus nerves. Strong vagal responses will result in inhibition of breathing or even apnoea.

Close monitoring of vital signs before, during and after suction is required to detect any breathing problems, arrhythmias or haemodynamic compromise. Preoxygenation prior to suction can help to alleviate the problems of suction induced hypoxia

Bourgault et al (2006) report that closed suction techniques have a lower impact on heart rate, blood pressure and the autonomic nervous system than open systems.

13.7 Hypoxia and Hypoxaemia

Hypoxia refers to a deficiency of oxygen at tissue level. (Tortora & Anagnostakos 1987).
Hypoxaemia refers to a deficiency of oxygen at blood level, and is defined as a partial pressure of arterial oxygen (PaO_2) that is below the patients' baseline (Mancinelli-Van Atta & Beck 1992).

Both hypoxia and hypoxaemia are common side effects of airway suctioning (Lindgren et al 2004, Lasocki et al 2006). Endotracheal suctioning can reduce tissue oxygenation by interrupting the oxygen supply whilst increasing oxygen consumption (Clark et al 1990). This results in the activation of numerous compensatory mechanisms in an attempt to improve tissue oxygenation. These include hypoxic vasoconstriction, use of accessory muscles of respiration, elevated heart rate and an increased arteriovenous oxygen extraction (shunting).
A study by Baun et al (2002) suggested exercising caution when using closed circuit suction with high levels of PEEP ($10cmH_2O$) on patients with cardiovascular instability. They found that the combination of PEEP and closed circuit suction lead to greater adverse effects on mean arterial pressure, left and right atrial pressure and intrathoracic pressure. They argued that analysis of SaO_2 during the procedure was inadequate for patients with cardiovascular compromise. Their results did indeed indicate the greater adverse change in parameters noted above, however, a single level of high PEEP ($10cmH_2O$) was used. It must be considered that open suction may be even more detrimental to these patients due to need for disconnection from invasive ventilation.

14.0 Infection Prevention and Control

Hand hygiene is the single most important infection prevention and control measure used to protect patients, as well as staff, from the risk of infection (refer to the Standard Precautions Protocol). Clean gloves and disposable aprons should be worn for any suctioning procedure, plus a sterile glove for open suction. Masks and eye protection are needed where there is a risk that the procedure is likely to generate sprays of respiratory secretions, and are essential with patients with suspected or proven respiratory illness requiring isolation (refer to the Source Isolation Policy for information on personal protective equipment).

15.0 Privacy and Dignity

Patient's privacy, dignity and respect must be maintained at all times. Curtains should be closed appropriately, and at the wish of the patient.

16.0 Consent/ patient preparation

Various authors have recounted their own experiences of undergoing the suction process and have highlighted the extreme unpleasantness of the technique. Sawyer (1997) described his experience of suction as the closest he had come to ‘hell on earth’, suggesting that some staff’s techniques were better than others. He also stated that:

'In the hands of a skilled, yet sensitive practitioner suctioning need not be more than a very necessary discomfort'.

For this reason, if patients can in any way communicate, consent needs to be sought in order to undertake the process. Respect should also be given to the heavily sedated/ paralysed patient in terms of explanation of the procedure also.

Always inform the patient of the proposed procedure whatever their conscious level - what you are doing, why and how long it will take and attempt to gain consent. Reassure your patients**.** Preparatory information about the sensations frequently experienced during a threatening event lowers distress and is more effective than the usual practice of describing the procedure (Fiorentini 1992)

For spontaneously breathing patients ongoing consent should always be sought and the procedure abandoned if undue distress is being caused. The patient should be informed of their right to decline physiotherapy at any stage without prejudicing their future care (CSP Core Standards 2000).

17.0 Suction Procedures

Note: All patients at BTHFT on invasive ventilation will have a closed suction system in Critical Care areas.

Equipment required for ET tube, tracheostomy and minitracheostomy suction

- Clean gloves and apron should be worn
- Functioning suction unit
- Sterile gloves (open suction)
- Sterile catheters (single use sterile catheters (open) or closed circuit suction catheters of appropriate size)
- Eye/ face protection should be worn where there is a risk of blood, body fluids, secretions and excretions splashing into the face and eyes. Mask type will depend on if using open or closed system (see Infection Prevention and Control section)
- Sterile water to flush suction tubing
- Oxygen supply, with appropriate delivery device
- A suction control device, whether attached to suction tubing or on catheter itself
- Orange clinical waste bag
- Sterile sodium chloride for irrigation of closed circuit suction (or instillation if necessary)
- Manometer

17.1 Open Suction via ET tube (if closed suction not available)/tracheostomy/ minitracheostomy

See pages 6 - 7 for procedure

The consensus of opinion of the American College of Physicians is that a sterile technique is mandatory during ETT suction performed in the acute setting. A no-touch technique should be adopted to minimize the transfer of any residual bacteria left on the hands after hand washing, with a sterile disposable glove on the hand holding the suction catheter (Mallet and Doherty 2000).

Note: a sterile open suction technique is advocated at BTHFT as agreed by the Infection Prevention and Control Team.

17.2 Nasopharyngeal/Oropharyngeal Suction

See pages 8 – 11 for procedure

To date (2017), there are no studies to identify the optimal route of suction when the patient does not have an ET tube, tracheostomy, or minitracheostomy.
Nasopharyngeal and oropharyngeal airways may both be used, but due to high risk of gag, and therefore vomiting, in the conscious or semiconscious patient with oropharyngeal airways, a nasopharyngeal airway is advocated if the patient has no contraindications.

Nasopharyngeal and oropharyngeal suction should only be undertaken when other less invasive techniques have proved unsuccessful, and where secretions are causing physiological deterioration and/or patient distress.

Equipment required for nasopharyngeal or oropharyngeal suction

As for ET tube/tracheostomy/minitracheostomy, but also:

- Appropriate airway for choice of route and correct size (nasopharyngeal or oropharyngeal)
- Sterile lubricating jelly from a single use sachet
- Eye protection and face-masks for patients isolated with suspected or proven illness requiring respiratory isolation.

17.2.1 Nasopharyngeal (NP) suction procedure

See pages 8 – 9 for procedure

NP airway sizes available for adults at BTHFT are 6.0mm, 6.5mm, 7.0mm, 7.5mm, 8.0mm.
An NP airway should be used if frequent suctioning (e.g. more than 2 or 3 catheter passes) is to be carried out via the nasal airway to limit trauma to the nasal cavity. This method tends to be better tolerated by responsive patients than oropharyngeal airways.

There are no guidelines to suggest the safe duration of time that a single NP airway can be left in situ. It may be possible that excessive pressure caused by the NP airway in close contact could possibly lead to ulceration of the mucous membranes (consensus statement), and therefore an NP airway should be left in situ for no more than 48 hours, but could be left longer if the distress to the patient caused by changing the airway outweighs the risk of potential problems.

To insert an NP airway, common practice appears to be inserting these devices in sitting with the head and neck slightly extended as in the figures. Consensus opinion appears to be that they are rarely inserted in supine, possibly due to risk of aspiration if the insertion procedure causes the patient to 'gag'.

At BTHFT, Sherwood medical NP airways are used, which do not require a safety pin to protect against inhalation.

Procedure for insertion of a NP airway (Resuscitation Council UK, Intermediate Life Support Manual, 2006)

- **i.** Check for patency of the right nostril. (Try the right nostril first. If obstruction is met, remove the tube and try the left nostril).
- **ii.** Lubricate the airway thoroughly using sterile lubricating jelly, ideally from a single use sachet.
- **iii.** Insert the airway bevel end first, vertically along the floor of the nose with a slight twisting action, if any obstruction is felt, remove the tube and try the left nostril. The tip should eventually lie in the pharynx behind the tongue.
- **iv.** When fully inserted the flange should lie at the level of the nostrils.
- **v.** Once in place, check the patency of the airway and adequacy of ventilation by looking, listening and feeling.

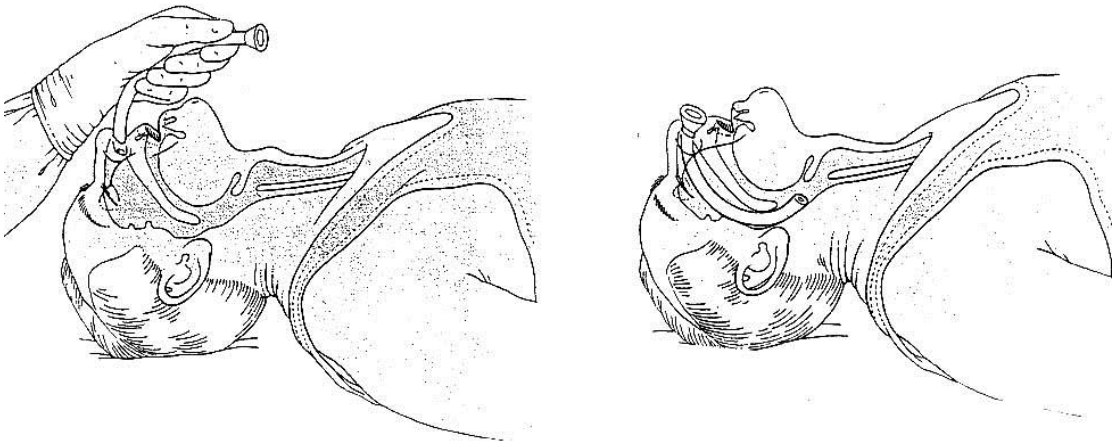


Diagram reproduced from Resuscitation Council UK (1998) Advanced life support manual.

If the nasopharyngeal tube is too long it may stimulate laryngeal or glossopharyngeal reflexes to produce laryngospasm and vomiting.
To measure the correct length of airway size, measure the airway against the distance between the patient's tragus and nares (consensus opinion).

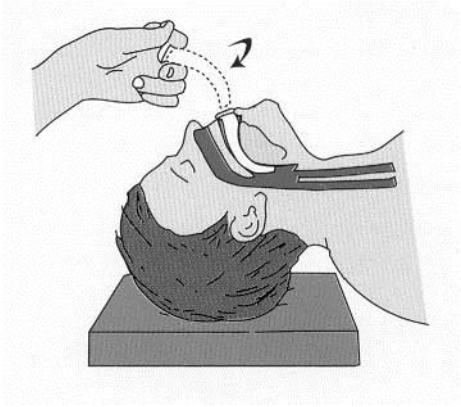
17.2.2 Oropharyngeal suction procedure

See pages 10 – 11 for procedure

Insertion of an oropharyngeal (Guedel) airway for an adult requiring oropharyngeal suction:

For adults, most common guedel airway sizes used are 2 (green), 3 (orange), or 4 (red). Measure from mandibular angle to lips (coloured section of airway should be at level of patient's teeth).

i. Insert appropriately sized airway into mouth. Insert airway curved end upwards (see diagram) and then rotate 180° inwards when about 2/3 of the way in into place. Assistance may be required to hold the airway in place



Insert airway curved end upwards for adults

Diagram reproduced from Resuscitation Council UK (1998) Advanced life support manual.

17.3 Closed circuit suction

See pages 12 – 13 for procedure

Closed circuit suction provides the ability to suction without disconnecting the patient from ventilation, especially advantageous in those who have high ventilatory requirements (Ashurst 1992, Branson et al 1999). Ease of use, less time involved and better patient tolerance due to fewer physiological disturbacnces have alos been reported (Espen et al 2016). However, other often assumed advantages (reduced incidence of ventilator acquired pneumonia (VAP), lower costs, decreased bacterial contamination and improved patient outcome) are not supported by robust scientific evidence (Subriana et al 2007; Akerman et al 2013). Indeed, there has been shown that there is a significant increase in bacterial colonisation with closed suction compared to open (Subriana et al 2007; Akerman et al 2013), and complete rinsing of closed suction systems after each catheter pass are needed to prevent this.
Closed suction has been shown to cause fewer physiologic disturbances, but it has been questioned whether these are clinically relevant (Jongerden et al 2007) and further work by this group in 2012 did not show any difference in cardio-vascular parameters when comparing open and closed suction systems in intubated patients. However, in a Cochrane review (Subriana et al 2007), cardiac dysrhythmias, desaturation and tidal volume are significantly worsened by open suction compared to closed.

Local practice is to change the closed suction system every 72 hours. (Ballard Trach Care 72 hours closed suction system for adults – Kimberly-Clark)

Closed circuit suction addresses many of the problems associated with endotracheal suction - there is no need for disconnection from the ventilator, reducing the risk of hypoxaemia and possible haemodynamic instability (Ashurst 1992, Blackwood 1998, Lasocki et al 2006). Baun et al (2002) found greater deleterious changes in cardiovascular measurements (right and left atrial pressures, intrathoracic pressures, cardiac shunt and mean arterial pressure), especially when PEEP ($10cmH_2O$) was also applied. SaO_2 however, remained significantly higher upon completion of suctioning using closed circuit suctioning with or without PEEP compared with open suctioning. Maggiore et al (2003) found when disconnecting patients with acute lung injury from the ventilator for suction, alveolar recruitment decreased, whereas with closed circuit suction it remained unchanged.
Substantial losses in lung volume have been noted when using open suction systems in ventilated patients with 'mild to moderate lung failure', compared to closed systems (Fernandez et al 2004), plus in a mechanical model (Espen 2017). These losses, however, reversed rapidly and there was no significant arterial oxygen desaturation.

Closed circuit suctioning is the catheter of choice to use in patients who are receiving inhaled agents that cannot be interrupted by ventilator disconnection (e.g nitric oxide, heliox, ribavarin). Patients who require high levels of PEEP and pressure support can have these maintained, and the threat of release of contaminating aerosol like particles into the air is lessened. This is especially important if the patient has a highly contagious infection, like tuberculosis (Branson et al 1999). Despite small numbers and numerous independent variables to the study, Bodai et al (1987) demonstrated closed circuit suction was superior to constant flow insufflation in preventing suction induced hypoxaemia. Larger numbers and less treatment arms would have hopefully further proved the usefulness of closed circuit suction apparatus. Clark et al 1990 demonstrated closed circuit suction prevented a drop in SvO_2 compared to an open suction technique, which resulted in a decrease in SvO_2 from baseline values, requiring 4 minutes to return to baseline values. This is especially useful in patients with sepsis where metabolic demand is high.

One potential negative effect of closed suction has been described by Dave et al (2011) in a bench-top model. They observed aspiration of fluid past the tracheal tube cuff when suction pressure was applied through the closed suction circuit, and the aspiration was worsened by higher suction pressures and longer duration of suction. They did, however, use pressures higher than recommended (200mmHg and 300mmHg). This appears to be the only study which investigates aspiration past the cuff with suction, and therefore there is a need for further investigation into this potentially damaging effect.

There has been some evidence to show that there is discrepancy between aspirate mass obtained with closed and open suction (Lindgren et al 2004, Lasocki et al 2006, Branson 2007, Copnell et al 2007), with increased amount of secretions being cleared when using open suction, compared to closed, at pressures of –200mmHg. Lindgren et al support this, except when CPAP is $0cmH_2O$, when the closed system was as effective as the open. Branson (2007) explains this by stating that if PEEP is being preserved during closed suction, while staff attempt to suction secretions out, the ventilator is blowing them back in. The reasoning given by Lasocki et al (2004) and Lindgren et al (2004) is as follows:

a) the actual negative pressure depends on a pressure gradient between the airway and the distal tip of the suction catheter, and this is different in open and closed systems (in open, the airway pressure level is zero, whilst in closed it is positive, at least equal to the PEEP)

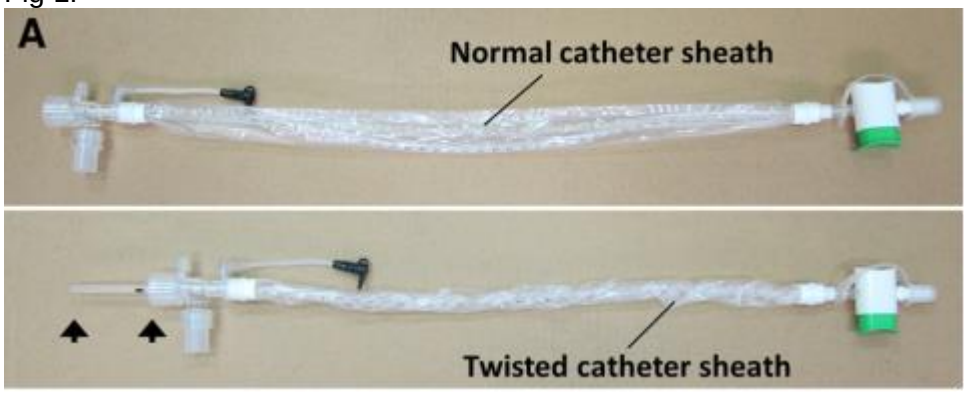
b) in closed suction, the flow delivered by the ventilator to maintain the positive pressure fills the suction catheter and blows the secretions distally
c) gas aspirated from the lungs during open suction moves the secretions towards the catheter

In patients who have a high metabolic demand (e.g. sepsis) it is recommended that a closed circuit suction system be incorporated in an effort to maintain SvO_2 levels in light of the evidence available.

When using closed circuit suction and PEEP in patients with cardiovascular compromise, special attention should be given to cardiovascular measurements before, during and after the suctioning procedure. This is to ensure there have been no deleterious effects to mean arterial pressure, right or left atrial pressures or intrathoracic pressures. Closed circuit suction has been connected with excessive PEEP production, especially in modes of ventilation which are volume controlled (Stenqvist 2001). This should be borne in mind when treating patients on this type of ventilation.

Incomplete withdrawal of the closed suction catheter, possibly as a result of a twisted catheter sheath (Fig 1), has been associated with significantly increased airways resistance, especially in smaller ETT's. This potentially adverse effect could prolong weaning periods and therefore increase ventilator associated complications (Sheng-Yuang Ruan et al 2015).

Fig 1.



18.0 Suctioning the patient with acute lung injury/adult respiratory distress syndrome

The patient with acute lung injury or adult respiratory distress syndrome (ARDS) will require a high level of respiratory support in terms of assisted ventilation. These groups of patients still require accurate chest assessment during this time, with airway suctioning as necessary. Methods should be sought to make the process as risk free as possible.

Greater alveolar derecruitment was found on subjects disconnected from the ventilator when receiving higher levels of PEEP. Higher PEEP levels led the greater alveolar derecruitment and volume loss upon disconnection. Even after a minute, levels of recruitment and thus lung volume and SaO_2 had still not reached those prior to disconnection (Maggiore et al 2003).

Closed circuit suction is the preferred method for performing ET suction on patients with acute lung injury or ARDS. These patients are frequently on high PEEP levels (<10cmH_2O), which, if disconnected from the ventilator cause alveolar derecruitment, volume loss and falls in SaO_2 and PaO_2. These aspects can take a considerable period of time to rectify following reconnection to the ventilator.

Other recruitment techniques, involving supplemental positive pressure manoeuvres during ventilator breaths, may further support maintenance of alveolar recruitment during suctioning. Caution must obviously be practiced for the patient with cardiovascular instability with difficulty adapting to changes in intra-thoracic pressure, plus consideration of lung injury from high ventilator pressures.

19.0 Special considerations for the neurosurgical/ head injured patient.

Caution must be practised when suctioning patients who have suffered neurological insult.

Gemma et al (2002) found that ICP increased significantly with ETT suctioning in patients with "inadequate sedation", although their length of suction time was longer than good practice advises. There were no significant changes in ICP or CPP when patients were adequately sedated (i.e. unable to cough or move). They concluded that in the case of patients with head injury who cough or move during ETT suction, it is strongly recommended deepening the level of sedation before completing the procedure to reduce the risk of adverse effects. Jugular oxygen saturation was also found to decrease with inadequately sedated patients, and remain unchanged for those who could not cough or move.

Hyperoxygenation is paramount for this group of patients as head injury can increase oxygen consumption due to increased metabolic rate. Hypoxia leads to further cerebral oedema and CO2 retention adds to this woeful picture by causing cerebral vasodilatation (Hough 1996).

20.0 Post suctioning

This point is raised by Day et al (2002) in their review as being often understated in the literature. It is quoted that reconnection to oxygen therapy following suctioning should occur within 10 seconds (Adam and Osbourne 1997, Day 2000).
A thorough re-assessment should be made, monitoring vital signs and re-auscultation to assess signs of improvement or deterioration, or further secretions requiring aspiration. If the patient is ventilated, tidal volume and peak pressure should be checked. Attention should be made to patient's comfort and their distress level, and reassurance given.

The number of suctions performed, size of catheter used, type of airway, volume and description of secretions, and the patient's tolerance of the procedure should be recorded.

Abbreviations

ARDS	Adult Respiratory Distress Syndrome
ETT	Endotracheal tube
COPD	Chronic Obstructive Pulmonary Disease
CPAP	Continuous Positive Airway Pressure
cmH_2O	Centimetres of water
FG	French Guage (catheter size)
FiO_2	Fraction indication of oxygen
FRC	Functional Residual Capacity
ICU	Intensive Care Unit
ICP	Intra cranial pressure
KPa	Kilo Pascals
mmHg	Millimetres of mercury
NP	Nasopharyngeal
PEEP	Positive End Expiratory Pressure
SaO_2	arterial oxygen saturations
SvO_2	venous oxygen saturations
SIMV	Synchronised Intermittent Mandatory Ventilation

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