ACI NSW Agency for Clinical Innovation

ICCMU Intensive Care Coordination & Monitoring Unit

IC Manual
best practice guidelines for intensive care

Suctioning an Adult ICU Patient with an Artificial Airway:
A Clinical Practice Guideline

Guideline provenance

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Disclaimer

- This clinical practice guideline (CPG) is aimed at providing clinicians working in NSW hospitals' intensive care units (ICU) with recommendations to frame the development of policies and procedures related to the suctioning practices in adult ICUs.
- This CPG is a revision of 2007 suction guideline and includes: 1) an update of the evidence base; 2) an evaluation of how this literature applies to the NSW intensive care context; 3) the extensive clinical knowledge of the guideline development network members (GDN); and 4) a consensus development process.
- The CPG is not intended to replace the critical evaluation processes that underpin the development of local policy and procedure nor does it replace a clinician's judgment in an individual case.
- Users of this CPG must critically evaluate this CPG as it relates to local circumstances and any changes in the literature that may have occurred since the dates of the literature review conducted. In addition, NSW Health clinicians must review NSW State Government policy documents to identify any directives that may relate to this clinical practice.
- These guidelines are intended for use in NSW acute care facilities.
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FOREWORD

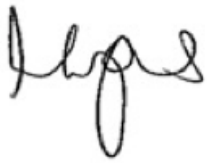
Suctioning a tracheal tube is a frequent and integral activity of airway management in an adult intensive care unit.

The potential for haemodynamic, respiratory and neurological compromise is significant with this procedure, which needs to be carefully undertaken based on best practice principles in a way that minimises the impact on the critically ill patient.

The purpose of this guideline is to provide intensive care clinicians with evidence and best practice recommendations and guidance on suctioning critically ill adult patients with an artificial airway.

Developed under the auspices of the Intensive Care Best Practice Manual Project, this guideline highlights the ability of the Agency for Clinical Innovation (ACI) to facilitate strong working relationships with clinicians as well other executive branches of the Ministry.

On behalf of the ACI, I would like to thank Susan Pearce, Chief Nursing and Midwifery Officer for providing state executive sponsorship for the project and funds for the Project Officer. I would also like to extend my appreciation to the LHD executives for facilitating the participation of LHD staff in developing these guidelines, which I commend to you the clinicians of NSW.



Dr Nigel Lyons
Chief Executive, Agency for Clinical Innovation

ABOUT THE ACI

The Agency for Clinical Innovation (ACI) works with clinicians, consumers and managers to design and promote better healthcare for NSW. It does this by:

- Service redesign and evaluation – applying redesign methodology to assist healthcare providers and consumers to review and improve the quality, effectiveness and efficiency of services.
- Specialist advice on healthcare innovation – advising on the development, evaluation and adoption of healthcare innovations from optimal use through to disinvestment.
- Initiatives including Guidelines and Models of Care – developing a range of evidence-based healthcare improvement initiatives to benefit the NSW health system.
- Implementation support – working with ACI Networks, consumers and healthcare providers to assist delivery of healthcare innovations into practice across metropolitan and rural NSW.
- Knowledge sharing – partnering with healthcare providers to support collaboration, learning capability and knowledge sharing on healthcare innovation and improvement.
- Continuous capability building – working with healthcare providers to build capability in redesign, project management and change management through the Centre for Healthcare Redesign.

ACI Clinical Networks, Taskforces and Institutes provide a unique forum for people to collaborate across clinical specialties and regional and service boundaries to develop successful healthcare innovations.

A priority for the ACI is identifying unwarranted variation in clinical practice and working in partnership with healthcare providers to develop mechanisms to improve clinical practice and patient care.

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CNC = Clinical Nurse Consultant, PT = Physiotherapist, CNE = Clinical Nurse Educator,
CNS = Clinical Nurse Specialist.

All network members completed a 'Declaration of Interest' form based on NHMRC guidelines.
The Guideline Development Network members declared no conflicts of interest.

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Suctioning of a tracheal tube is a frequent and integral activity of airway management in an adult intensive care unit. Airway suctioning can have deleterious effects on the patient's physiological variables. The variability in pathophysiology between patients requiring mechanical ventilation and the potential adverse effects of the procedure require that suctioning be customised to individual patients. This guideline has been developed to provide clinicians with recommendations to guide the development of local policy/procedures in relation to suction through an artificial airway in critically ill adult patients in NSW acute care facilities. The guideline should be seen as a resource document. This document is an update from the 2007 Intensive Care Coordination & Monitoring Unit (ICCMU) Guideline: Suctioning an Adult with a Tracheal Tube [1].

Changes from previous guideline

Subglottic suctioning technique has been added because there is high level evidence supporting this practice for the prevention of ventilator-associated pneumonia (VAP) [2-5].

SECTION	RECOMMENDATION	GOR
	Assessment	
1	Assessment of the patient to identify the need to suction a tracheal tube should be continuous with chest auscultation performed every two hours or more frequently as indicated by clinical signs such as those mentioned in recommendation 2.	Consensus
2.	The decision to suction a tracheal tube must be made on the basis of the clinical need to maintain the patency of the tracheobronchial tree. A tracheal tube should only be suctioned when clinically indicated by signs which could include: i. visible, palpable or audible secretions (such as sputum, gastric or upper airway contents or blood) ii. respiratory: desaturation, rising peak inspiratory pressure (during volume-controlled mechanical ventilation/modes), decreasing tidal volume (during pressure-controlled ventilation/modes), increased respiratory rate, increased work of breathing or coarse breath sounds on auscultation iii. cardiovascular: increased heart rate and blood pressure iv. other: restless/agitated or diaphoretic patient v. a saw-tooth pattern on a flow-volume loop or expiratory flow-time waveform as illustrated on the ventilator graphics.	C
3.	Prior to suctioning, consideration should be given to the potential complications and contraindications in individual patients (see Table 2).	Consensus
4.	To reduce patient anxiety and to promote patient understanding of, and compliance with, the suctioning procedure patients should be given clear information regarding the suction procedure including: the need for suction, the consequences of not suctioning when it is required and the effects of suctioning. Furthermore, this information should be repeated with each suction procedure as some patients may not recall previous instructions.	Consensus

Table continues on page 2

Table continued from page 1

SECTION	RECOMMENDATION	GOR
5.	Patient assessment before, during and post suction should include an evaluation of the effects on the patient's pre-suction signs and symptoms. This should include monitoring of cardiac rate and rhythm, blood pressure, pulse oximetry, airway reactivity, tidal volumes, peak airway pressures, or intracranial pressure (see Table 3).	Consensus
6.	Some patient groups require constant/continuous monitoring of ECG and pulse oximetry before, during and post suctioning. (See Table 3)	Consensus
7.	Documentation of the assessment and suction procedure must occur.	Consensus
	Clinical practice	
8.	The size of the suction catheter should be less than half the internal diameter of the tracheal tube.	D
9.	The total suction procedure (from insertion to removal of catheter) should take a maximum of 15 seconds with negative pressure applied continuously as the catheter is being withdrawn from the tracheal tube.	D
10.	In patients considered at high risk of adverse events, trauma to, and stimulation of, the carina should be minimised to prevent complications. Therefore, the suction catheter should only be inserted down a tracheal tube until it just emerges out of the lumen of the tube .	Consensus
11.	In patients not considered at high risk of adverse events, the suction catheter may be passed until either a point of resistance is felt or a cough is stimulated, then the catheter should be withdrawn 1-2cm prior to continuous suction.	Consensus
12.	The maximum occluded suction pressure should be limited to - 80 to 150mmHg (20kPa) for OSS and CSS. The wall outlet should have a high pressure gauge attached.	Consensus
13.	If a patient has high oxygen and PEEP requirements and/or is known to de-saturate to clinically significant levels, pre-oxygenation should be considered.	B
14.	If pre-oxygenating, use the ventilator capability to deliver 100% oxygen.	B
15.	To prevent the occurrence of adverse events, bolus instillation of normal saline should not be routinely used prior to suctioning.	C
16.	Closed suction catheter systems should be used as the system of choice for patients with an ETT or tracheostomy who require suction.	C
17.	Closed suction catheter systems should be changed as per manufacturer's instructions.	D
18.	Closed suction systems should be cleaned as per the manufacturers' instructions to maintain patency and minimise colonisation.	Consensus
19.	Hyperinflation should not be performed on a routine basis prior to suctioning.	B
20.	Tracheal tubes with subglottic suction capability should be used for mechanically ventilated patients who are expected to be ventilated > 72hours.	B
21.	If a tracheal tube does not have subglottic suction capability, a Y-catheter should be used to remove "above the cuff" secretions.	Consensus

Table continues on page 3

Table continued from page 2

SECTION	RECOMMENDATION	GOR
	Infection prevention	
22.	Standard precautions require the use of PPE to prevent contamination and mucosal or conjunctival splash injuries, and is mandatory while suctioning a patient. This must include goggles and mask or face shield/gloves and gown/ apron as per NSW 2007 Infection Control Policy.	PD 2007_036 page 7
23.	Clinicians must adhere to the Five Moments of Hand Hygiene.	PD2010_058
24.	When using OSS technique an aseptic non-touch technique must be used.	Consensus
25.	Clinicians should perform a risk assessment for specific droplet and airborne precautions prior to suction.	Consensus
	Governance	
26..	Each LHD should use this guideline to develop site-specific procedures to address suction practice.	D
27.	To ensure optimal patient outcomes, hospitals should periodically evaluate practice against this guideline.	D
28.	Hospitals should ensure that clinicians who perform this procedure are competent or are directly supervised by a competent clinician.	D
29.	Individual feedback should be provided to improve development of competency in tracheal suction.	D
30.	Where possible, tailored performance in a simulated setting could be useful in teaching and assessing practice of this skill.	D

Glossary

AACN.....American Association of Critical Care Nurses

AARC.....American Association for Respiratory Care

ABG.....Arterial blood gas

ACCCN.....Australian College of Critical Care Nurses

ACI.....Agency for Clinical Innovation

ALI.....Acute lung injury

ANTT.....Aseptic non-touch technique

ANZICS.....Australia & New Zealand Intensive Care Society

APA.....Australian Physiotherapy Association

ARDS.....Acute respiratory distress syndrome

CFU.....Colony forming units

CNC.....Clinical Nurse Consultant

CNE.....Clinical Nurse Educator

CPG.....Clinical Practice Guideline

CSS.....Closed suction system

CVS.....Cardiovascular system

DET.....Data extraction tool

EBP.....Evidence-based practice

ECG.....Electro-cardiogram

ECMO.....Extracorporeal membraneous oxygenation (ECMO)

EF.....Ejection fraction

EELV.....End expiratory lung volume

ES.....Endotracheal suction

ETS.....Endotracheal suction

ETT.....Endotracheal tube

EVP.....External validation panel

FiO2.....Fraction of inspired oxygen

Fr/FG.....French gauge

FRC.....Functional residual capacity

GDN.....Guideline development network

HFOV.....High frequency oscillating ventilation

IABP.....Intra-aortic balloon pump

ICCMU.....NSW Intensive Care Coordination and Monitoring Unit

ICP.....Intracranial pressure

ICU.....Intensive care unit

INR.....International normalised ratio

ITS.....Interrupted time series

ITS/XO.....Interrupted time series/cross-over design study

LHD.....Local Health District

LR.....Literature review

MA.....Meta-analysis

MHI.....Manual hyperinflation

MIAS.....Minimally invasive airway suction

MoH.....Ministry of Health NSW

MV.....Mechanical ventilation

NIPPV.....Non-invasive positive pressure ventilation

NIV.....Non-invasive ventilation

NTT.....Nasotracheal tube

NHMRC.....National Health & Medical Research Council

NaMO.....Nursing and Midwifery Office (at NSW MoH)

OS.....Observational study

OSS.....Open suction system

PaO2/PO2...Partial pressure of arterial oxygen

Paw.....Airway pressure

PEEP.....Positive end expiratory pressure

PICOT.....Population of interest-intervention-comparison-outcome-time

PPE.....Personal protective equipment

PRCT.....Prospective randomised controlled trial

PRISMA.....Preferred reporting items for systematic reviews and meta-analyses

Pre-post.....Convenience sample size

PT.....Physiotherapist

RCT.....Randomised control trial

RN.....Registered Nurse

SaO2.....Saturation of oxygen in arterial blood

SpO2.....Oxygen saturation by pulse oximetry, peripheral oxygen saturation, percutaneous

SCRM.....Single-case repeated measure design

SIGN.....Scottish Intercollegiate Guideline Network

SR.....Systematic review

TT.....Tracheal tube

VAP.....Ventilator associated pneumonia

Vt.....Tidal volume

VHI.....Ventilator hyperinflation

WHS.....Work health and safety

2. INTRODUCTION

Suctioning of a tracheal tube is a frequent, fundamental and clinically significant practice in adult intensive care which carries the risk of adverse events. The variability of pathophysiology between patients requiring mechanical ventilation and the potential adverse effects of the procedure requires that suctioning be customised to the individual patient. The 2007 ICCMU Guideline: Suctioning an Adult with a Tracheal Tube [1] was updated following a comprehensive literature review and evaluation of current practice. The guideline will assist practitioners to develop local policy regarding tracheal suctioning of an artificial airway.

Scope

The importance of suctioning a tracheal tube

Tracheal suction is an important procedure in the management of adults with artificial airways. Tracheal suction through an artificial airway (endotracheal, tracheostomy, or nasotracheal tube) bypasses the normal protective mechanisms such as the cough reflex that the upper airways provide. An artificial airway refers to the plastic tube inserted via the nose, mouth or trachea and located into the trachea of the patient. The major indications for insertion of an artificial airway include:

- to secure or maintain a patent airway
- to assist in the delivery of mechanical ventilatory support, and where non-invasive ventilation (NIV) has failed
- to facilitate the removal of tracheal secretions
- to aid in the management of multi-organ failure/sepsis
- to reduce the risk of aspiration where patients are unable to protect their own airway (neurological, unconscious)
- to deliver high concentrations of oxygen.

Critically ill patients often have an increase in the production of mucous and an impaired ability to clear secretions. If secretions are not cleared effectively then the patient may be at risk of infection, atelectasis and alveolar collapse [6]. Appropriate management of the patient with an artificial airway can have an impact on reducing complications (such as the development of ventilator-associated pneumonia (VAP), length of ICU stay, duration of mechanical ventilation and mortality and morbidity [7, 8].

Tracheal suction is required to maintain a patent airway and assist with preventing hypoxia, infection and atelectasis from retention of sputum. Complications such as hypoxia, cardiac dysrhythmias and mucosal damage have been associated with tracheal suctioning [9]. Appropriate and competent suctioning technique is important in minimising risk and adverse events. The guideline is relevant for practitioners who perform tracheal suction on patients with artificial airways. This includes patients who are mechanically ventilated; those being weaned from mechanical ventilation; and patients with an artificial airway in a ward. Although this guideline addresses the suctioning requirements of most intubated patients, it does not address the specific needs of special patient groups such as patients with intra-cranial hypertension, severe lung injury, or on unconventional modes of ventilation such as high frequency oscillating ventilation (HFOV) or extra corporeal membranous oxygenation (ECMO). Consistent high-level evidence exists supporting the practice of subglottic suctioning as an important component for the prevention of VAP [2-5]. Recommendations regarding subglottic suctioning technique are now included in this guideline as they were not included in the previous version of this document.

Target clinicians

It is intended that this guideline be used by clinicians responsible for suctioning a critically ill adult with an artificial airway. It is assumed that users of this guideline have knowledge of respiratory anatomy and physiology and the purpose of artificial airways including endotracheal tubes (ETT), tracheostomy tubes (TT) and nasotracheal tubes (NTT).

How the guideline was developed

This guideline was developed by the suction guideline development network (GDN) comprising senior nursing clinicians, senior ICU physiotherapists and academics as part of the NSW ICCMU Best Practice Project. We were unable to recruit a consumer to participate in the development or review phases. A systematic literature review was undertaken (see Appendix 1). Recommendations for practice were revised at a consensus meeting held in December 2012. Here, the 2007 recommendations were revised to reflect where new evidence was identified. Following this meeting, narratives were developed to explain recommendations. In March 2013, GDN consensus was undertaken using Survey Monkey. In May 2013, an external validation panel (EVP) was convened also using Survey Monkey. In both of these phases, a 1-9 Likert scale was used with a median of ≥ 7 used as agreement. We were unable to recruit a consumer to be part of the review process. In July, broader organisational consultation was undertaken with distribution via ACI networks.

How to use the guideline

This guideline is provided as a tool to inform the development of local practices in NSW acute care facilities. It should be used in conjunction with other processes normally used to develop practice guidelines, which may include: local audit of practice and outcomes; review of relevant literature; and reference to other practice guidelines. While a concerted effort was made to include relevant literature, other studies may have been published since this guideline was written and these should be identified, reviewed and considered for inclusion. This guideline should be critically evaluated like all identified literature.

Level of evidence taxonomy and how consensus opinion was developed

The Australian NHMRC [10] levels of evidence were used to grade the recommendations (Table 1). Where suitable research evidence was not available, the GDN members formulated a recommendation based on their clinical experience and the NSW survey of practice. These recommendations were then voted upon using a 1-9 (Disagree 1-3, Neutral 4-6 and Agree 7-9) Likert scale with consensus agreement set as a median of 7.

Table 1 NHMRC Grading of recommendation

GRADE OF RECOMMENDATION	DESCRIPTION
A	Body of evidence can be trusted to guide practice
B	Body of evidence can be trusted to guide practice in most situations
C	Body of evidence provides some support for recommendation/s but care should be taken in its application
D	Body of evidence is weak and recommendation must be applied with caution
Consensus	Where no evidence could be applied consensus opinion developed by: • formulation of recommendation through discussion • assignment of agreement by individual participants (Likert 1-9) • consensus set at median of 7

3. RECOMMENDATIONS FOR PRACTICE

Suctioning of a tracheal tube is a frequent, fundamental and clinically significant practice in adult intensive care for those who are mechanically ventilated. The variability of pathophysiology between patients requiring mechanical ventilation and the potential adverse effects of the procedure require that suctioning be customised to the individual patient.

This section of the guideline is organised into five sections with the recommendation statement/s followed by a supportive narrative, which includes a brief summary of the evidence where available. The five domains of the CPG are:

- Assessment
- Clinical practice
- Infection prevention
- Workplace health and safety
- Governance

Figure 1: Chest auscultation is an integral component of suction practices.

Assessment

Clinical indications on the need for suction

SECTION	RECOMMENDATION	GOR
	Assessment	
1	Assessment of the patient to identify the need to suction a tracheal tube should be continuous with chest auscultation performed every two hours or more frequently as indicated by clinical signs such as those mentioned in recommendation 2.	Consensus
2.	The decision to suction a tracheal tube must be made on the basis of the clinical need to maintain the patency of the tracheobronchial tree. A tracheal tube should only be suctioned when clinically indicated by signs which could include: i. visible, palpable or audible secretions (such as sputum, gastric or upper airway contents or blood) ii. respiratory: desaturation, rising peak inspiratory pressure (during volume-controlled mechanical ventilation/modes), decreasing tidal volume (during pressure-controlled ventilation/modes), increased respiratory rate, increased work of breathing or coarse breath sounds on auscultation iii. cardiovascular: increased heart rate and blood pressure iv. other: restless/agitated or diaphoretic patient v. a saw-tooth pattern on a flow-volume loop or expiratory flow-time waveform as illustrated on the ventilator graphics.	C

SECTION	RECOMMENDATION	GOR
	Assessment	
3.	Prior to suctioning, consideration should be given to the potential complications and contraindications in individual patients (see Table 2).	Consensus
4.	To reduce patient anxiety and to promote patient understanding of, and compliance with, the suctioning procedure patients should be given clear information regarding the suction procedure including: the need for suction, the consequences of not suctioning when it is required and the effects of suctioning. Furthermore, this information should be repeated with each suction procedure as some patients may not recall previous instructions.	Consensus
5.	Patient assessment before, during and post suction should include an evaluation of the effects on the patient's pre-suction signs and symptoms. This should include monitoring of cardiac rate and rhythm, blood pressure, pulse oximetry, airway reactivity, tidal volumes, peak airway pressures, or intracranial pressure (see Table 3).	Consensus
6.	Some patient groups require constant/continuous monitoring of ECG and pulse oximetry before, during and post suctioning. (See Table 3)	Consensus
7.	Documentation of the assessment and suction procedure must occur.	Consensus

Suctioning is an uncomfortable and distressing procedure for the critically ill adult with an artificial airway. Nonetheless, tracheal tube suction may be necessary to clear secretions, maintain airway patency and to optimise oxygenation and ventilation.

There are a number of potential adverse effects, however, on several body systems including:

1) respiratory (e.g. reduction in lung volumes, hypoxia, and alveolar collapse, introduction of infection and trauma to the trachea);
2) cardiovascular (e.g. bradycardia, hypotension, and hypertension); and
3) neurological (e.g. increase in intracranial pressure and reduction in cerebral blood flow).

Despite the relative frequency of this procedure the body of evidence is limited. Three systematic reviews (SR) and a literature review (LR) consistently found evidence supporting suctioning only when clinically indicated because of the potential complications associated with the procedure [9, 11-13] and this is congruent with local clinical practice. The recommendation is therefore to suction only when clinically indicated.

Table 2: Hazards and complications of suctioning

SYSTEM	HAZARDS/COMPLICATIONS	PATIENTS AT RISK
Respiratory	• Decrease in dynamic lung compliance and FRC • Atelectasis • Hypoxia/hypoxaemia • Tissue trauma to the tracheal and/or bronchial mucosa • Bronchoconstriction/bronchospasm	• Acute pulmonary haemorrhage • ALI/PEEP dependent/high O_2 requirements • Lack of cough reflex • High risk of bronchospasm/reactive airways
Cardiac	• Hypertension • Hypotension • Cardiac dysrhythmias	• Unstable CVS
Neurological	• Changes in cerebral blood flow and increased ICP	• Unstable/high ICP • Spinal injury with autonomic dysreflexia
Haematological		• Coagulopathy i.e. platelets <20, INR>2.5
Infection Prevention	• Increased microbial colonization of lower airways	• Immunocompromised

Table adapted from AARC (2010) Clinical Practice Guidelines

ALI = acute lung injury, CVS = cardiovascular system, FRC= functional residual capacity, ICP = Intracranial pressure INR = International normalised ratio, O_2 = oxygen, PEEP = Positive end expiratory pressure

There have been seven new studies since 2006 investigating/reporting indications for suctioning, assessment pre/during/after suctioning events and minimisation of adverse effects. This includes four systematic reviews (SR), one LR, one interrupted time series (ITS), and one prospective observational study (OS) resulting in 'C' rating (LIII studies) [9, 11, 13-17].

Indications:

A prospective observational study examined the value of a number of clinical signs (including patient agitation, SpO_2 fall, respiratory sounds, changes in respiratory pattern and a 'saw-tooth' pattern on the flow-volume loop) as indicators of retained secretions in a cohort of 66 consecutive ventilated patients [18]. In this group, only a saw-tooth pattern and respiratory sounds appeared to be of value. However, for two-thirds of patients there was only one observer who was not blinded to outcomes, limiting the value of these findings. There have been no new studies since this landmark research. Two SRs [9, 11] and one LR [13] consistently support this recommendation. Identification of these clinical signs will require the use of flow-volume loop analysis and/or expiratory-flow time waveform for assessment when suctioning is indicated and the clinician to constantly review the patient and ventilator. The recommendation is to suction as indicated represented by a saw-tooth pattern on ventilator graphics OR based upon the clinician's respiratory assessment as per Recommendation 2.

Using mechanical ventilator waveforms to assist with patient assessment

Practice point 1: Assessment of the need for suctioning

Feature

- saw-tooth pattern on flow-time waveform and flow/volume loop

Possible causes

- secretion build-up in large airways, ETT/tracheostomy tube
- condensate in ventilator circuit

Practice point 2: Assessment of tube patency and large airway obstruction using the expiratory flow waveform

Basic things to know about the expiratory flow curve

- should be triangular in shape
- expiratory flow should be complete between 1 to 2 seconds
- 80% of tidal volume should be expired in the first 1 second of expiration

Obstruction to the small airways, large airways and endotracheal tube/ tracheostomy tube will result in changes to the expiratory flow curve. This practice point addresses the changes that may be seen with significant obstruction to large airways and endotracheal/tracheostomy tube.

1. Loose secretion build-up in endotracheal tube.
   Note saw-tooth pattern on the pressure, flow and flow/volume waveforms.

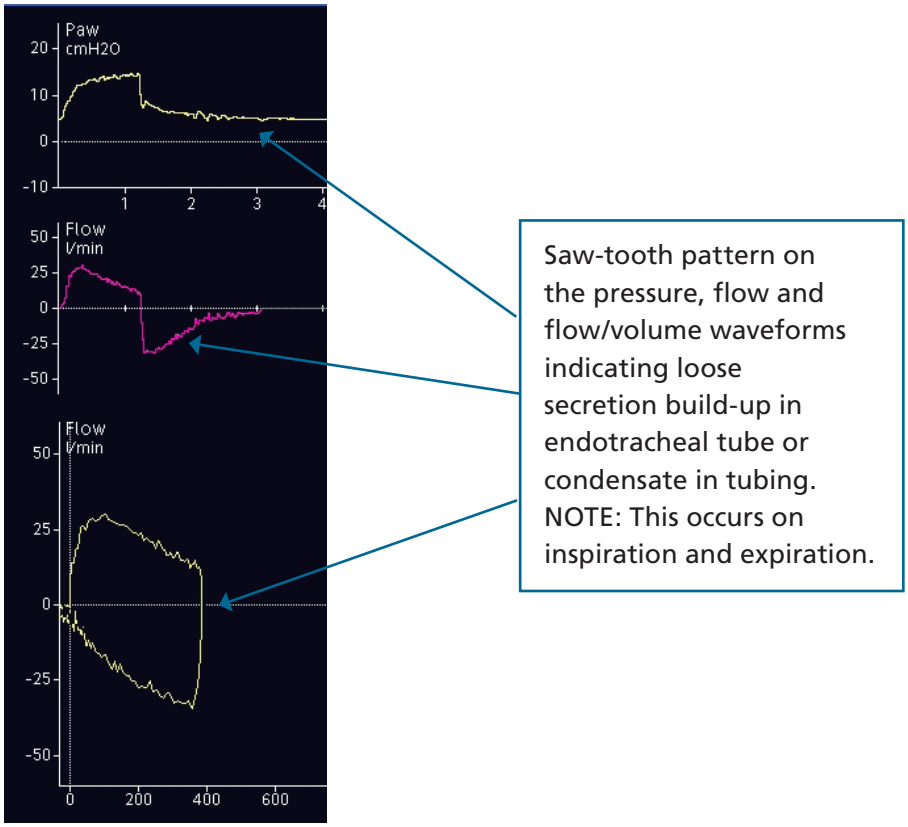


Figure 2: Saw-tooth pattern on pressure waveform (top), flow waveform (middle), and flow-volume loop (bottom). (ventilator graphics courtesy of Prince of Wales Adult ICU)

2. Severe fixed obstruction caused by secretion build-up within tracheostomy tube inner cannula. Resolved by removal/replacement of inner cannula. Note fixed expiratory flow and prolonged expiratory flow. There is also evidence of failure to expire all the tidal volume i.e. gas trapping.

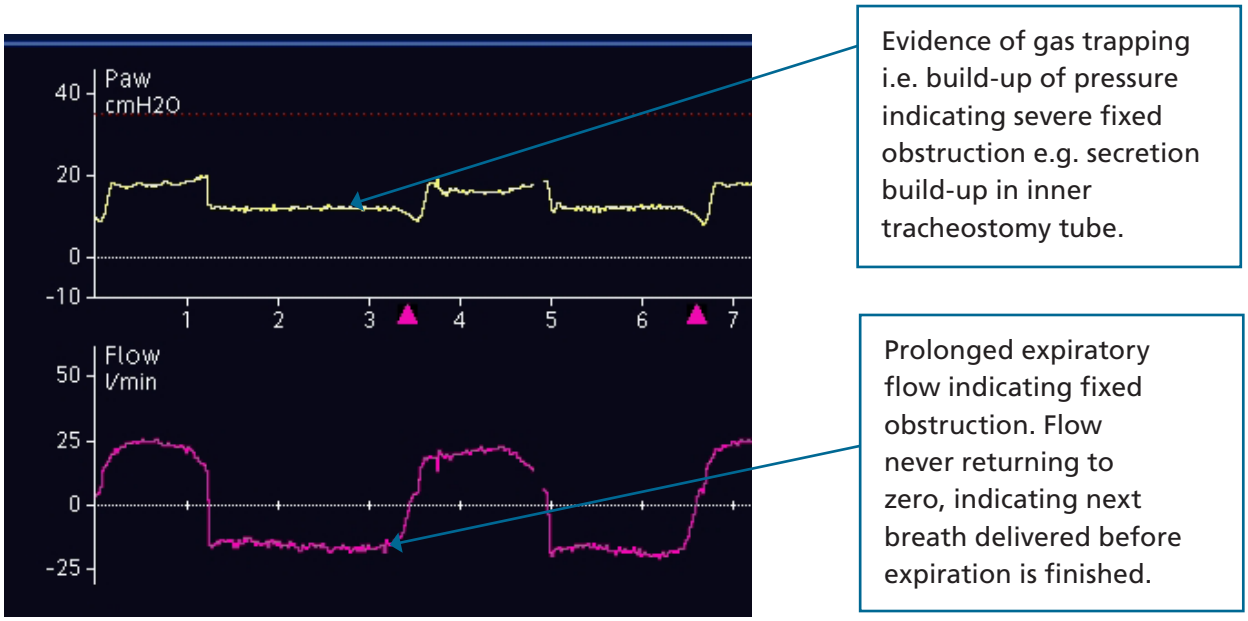


Figure 3: Fixed obstruction on pressure (top) and flow (bottom) waveform.
(ventilator graphics courtesy of Prince of Wales Adult ICU)

3. Partial occlusion of ETT caused by tube kinking. Note prolonged expiration i.e. less than 80% of tidal volume expired in first 1 second of expiration.

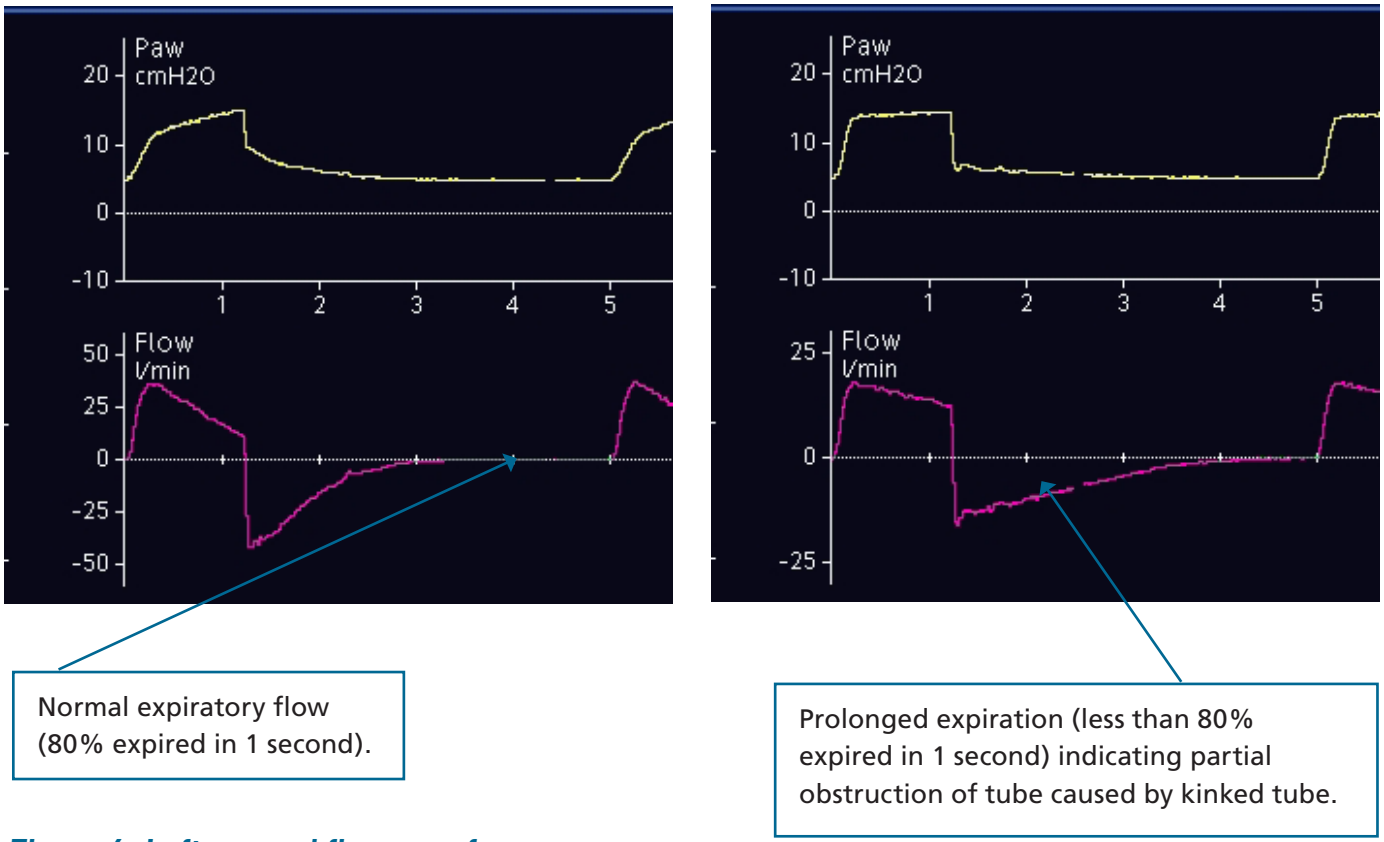


Figure 4: Left: normal flow waveform
Right: partial ETT occlusion on pressure (top) and flow (bottom) waveform
(ventilator graphics courtesy of Prince of Wales Adult ICU)

Considerations prior to suction:

Prior to suctioning consideration should be given to the potential complications and contraindications in individual patients (see **Table 2**). Monitoring of baseline physiological variables such as respiratory, ventilator, cardiovascular, and neurological parameters should be undertaken by the clinician. In a descriptive study, suctioning has been identified by patients as causing anxiety and discomfort [19]. To reduce patient anxiety and to promote patient understanding of and compliance with suctioning, patients must be given clear information regarding the suction procedure including: need for suction, consequences of not suctioning when it is required and effects of suctioning. Explain that the procedure is likely to be uncomfortable, but will be brief and that the procedure may need to be done more than once. This information should be repeated because patients may not recall previous instructions [20]. If the clinician's perceive this procedure is causing undue discomfort or distress to the patient, then clinicians should align this procedure with sedation if prescribed.

Table 3: Assessment pre/during/post suction/outcome measures

PHYSIOLOGICAL VARIABLE	PRE-SUCTION	DURING SUCTION	POST-SUCTION OUTCOME MEASURES
RESPIRATORY			
Breath sounds	√	√	Nil added (I)
SpO2	√	√	Improved (I) *
RR	√	√	Improved (I)
Pattern of breathing	√	√	Improved (I)
Sputum colour	√	√	Document
Sputum amount	√	√	Document
Sputum viscosity	√	√	Document
Palpation	√		√ (I)
ABGs	√		>20mins (D) #
VENTILATOR PARAMETERS			
Saw-tooth pattern	√		Absent (I)
Tidal volume	√		Increased (I)
Peak airway pressure	√		Decreased (I)
Compliance	√		Increased (I)
CARDIOVASCULAR			
ECG rate (HR)	√	√	Baseline (D)
ECG rhythm	√	√	Baseline (D)
BP	√	√	Baseline (D)
MAP	√	√	Baseline (D)
NEUROLOGICAL			
ICP	As indicated	As indicated	As indicated (I)

BP = blood pressure, (D) delayed improvement >10mins, ECG = electrocardiogram, ICP = intracranial pressure, (I) immediate improvement <10mins, MAP = mean arterial pressure, RR = respiratory rate, SpO_2 = percutaneous oxygen saturation * may be delayed in patients with impaired circulation, # ABGs are not routinely required post suctioning.

Monitoring effects:

The effects of the suction procedure on the patient must be evaluated before, during and after the procedure (see **Table 3**). Patients most at risk of adverse events (see **Table 2**) may require more diligent monitoring by the clinician and a lower threshold for terminating the procedure may be required because of the increased risk of adverse events. These changes can be transient or sustained and this may influence the clinician's decision to continue or terminate the procedure. This recommendation is based on the clinical experience of the group members and achieved consensus.

Documentation:

Documentation should occur:

i) following assessment of the patient, identifying the indication(s) for suctioning

ii) following suction.

The documentation at a minimum is to include:

- physical assessment of the patient pre and post-suctioning (see **recommendation 5**)
- patient tolerance of suctioning procedure
- if pre-oxygenation was used
- results/product of suctioning (including amount, colour and viscosity of secretions).

A thorough clinician's assessment would be performed at the beginning of each shift, which may identify indications for a suction to be performed. Periodic assessment throughout the day may also identify the need for artificial airway suction, such as the performance of second hourly auscultation or ventilator observations. Documentation of adverse events during the suctioning procedure should also occur, particularly, sustained changes in physiological parameters. Some critical care areas may have respiratory assessment charts with documentation of the suction procedure; either paper or computerised, in which suction can be documented with mandatory fields and annotations concerning adverse events can be added.

A recommendation concerning the minimum time between suctions was deleted after internal validation and before external validation occurred. It was considered that it was contradictory to recommend a minimum time when the consensus of the group was to suction only when indicated. It was also felt that tube patency could be assessed in other ways, such as ventilator graphics, other than passing a suction catheter down an artificial airway.

Clinical practice

The suction catheter

SECTION	RECOMMENDATION	GOR
	Clinical practice	
8.	The size of the suction catheter should be less than half the internal diameter of the tracheal tube.	D
9.	The total suction procedure (from insertion to removal of catheter) should take a maximum of 15 seconds with negative pressure applied continuously as the catheter is being withdrawn from the tracheal tube.	D
10.	In patients considered at high risk of adverse events, trauma to, and stimulation of, the carina should be minimised to prevent complications. Therefore, the suction catheter should only be inserted down a tracheal tube until it just emerges out of the lumen of the tube (see Table 2).	Consensus
11.	In patients not considered at high risk of adverse events, the suction catheter may be passed until either a point of resistance is felt or a cough is stimulated, then the catheter should be withdrawn 1-2cm prior to continuous suction.	Consensus
12.	The maximum occluded suction pressure should be limited to - 80 to 150mmHg (20kPa) for OSS and CSS. The wall outlet should have a high pressure gauge attached.	Consensus

The size of the suction catheter and the duration of suctioning (i.e. application of negative pressure) will directly influence the volume of secretions removed, however, there are potential adverse effects on respiratory function. In agreement with previous research, an SR, an LR and an interrupted time series/ crossover design (ITS/XO) consistently support limiting the diameter of the suction catheter to less than 50% of the internal diameter of the tracheal tube [9, 13, 21].

Two SRs and one LR consistently found continuous suctioning on withdrawal of the catheter prevented the high initial flows that are generated with intermittent suction [9, 11, 13]. Some of the research this recommendation is based on is dated and no new research has been pursued in this area. The recommendation is to apply continuous suction upon withdrawal of the catheter.

The above three reviews consistently agreed on use of a minimally invasive airway suction (MIAS) technique but again there is no new evidence in this field and some of this research pertains to neonates, not adults [9, 11, 13].

In four recent studies, including two SRs, one LR and one ITS/XO study, there continues to be limited and conflicting evidence regarding the suction pressure that should be applied during the withdrawal of the catheter [9, 11, 13, 16]. A SR continues to recommend an occluded negative pressure (measured by occlusion of the suction tubing) of less than 150mmHg (approximately -200cmH2O) [9]. Expert opinion is that this would require further investigation as absolute values and pressure units of measurement are inconsistent across the literature.

Practice point 3: Suction catheter size

Suction catheter size (Fr) = [ETT size(mm) minus 1] then multiply by 2 (13) or 3FG = 1mm diameter (1FG approx. 0.3mm diameter).

For example, for a size 8 ETT:
Using the first formula, {8 minus 1} then multiply by 2 = 14Fr (this formula will give a slightly larger catheter size), or
Using the second formula half the diameter of 8mm = 4mm. Then multiply this number by 3 = size 12 FG.

Table 4: Pressure (units of measurement) conversions

MMHG	CMH20	KPA
100	135.95	13.3
147.11	200	19.56
150	203.93	19.95
200	271.9	26.65
294.22	400	39
400	543.8	53.5

As consistently reported in two SRs and one LR, stimulation of the carina by the suction catheter has a number of potential adverse effects including patient distress, severe coughing and bradycardia as well as causing damage to the tracheal mucosa [9, 11, 13].

Practice point 4: Suction catheter insertion depth

- For patients deemed at low risk of adverse events it was agreed at the consensus meeting that the suction catheter may be inserted to the point of resistance or until a cough is stimulated. The catheter should then be withdrawn 1-2cm prior to the application of suction to ensure it is not against the airway wall. Suction should then be held continuously as the catheter is slowly withdrawn from the airway. It may be necessary to hold the suction catheter in the same place for a period of time if a large amount of secretions are present. The consensus opinion of the group is that patient participation always be included when possible with active large inspiration and active cough when possible rather than by catheter stimulation.
- To clear secretions from the primary and secondary bronchus into the trachea where they may be removed an intubated patient must cough or provide faster expiratory to inspiratory flow ratios.
- It was agreed to at the consensus meeting that patients who are found to have adverse reactions to suctioning, such as those with unstable CVS, high ICP, lack of cough reflex, coagulopathy or high risk of bronchospasm (see Table 2) should have the stimulation of their carina avoided. This may be achieved by measuring the length of the suction catheter against the length of the ETT or tracheostomy tube and only inserting until the catheter just emerges out of the lumen of the tube. As no cough will be stimulated, the patient may be encouraged to cough to command, or suction may be combined with expiratory vibrations, VHI/MHI, assisted cough or other techniques to increase expiratory flow rates to improve suction effectiveness, limiting the number of required passes.

A recent SR and an LR consistently found that suction time should be limited to a maximum of 10-15 seconds in order to minimise the risk of hypoxia, atelectasis and trauma [9, 13]. It was also recommended that suction should be performed in a continuous manner only as the suction catheter is being removed. This is also the consensus opinion of the group.

No new evidence has been found to support the recommendation in the 2007 guideline limiting the number of passes of the suction catheter to a maximum of three [1]. Clinicians should reassess the need for suctioning based upon assessment of clinical signs and should continuously monitor the patients SpO_2, sustained or transient physiological responses to suctioning and outcome measures (see **Table 3**).

Pre-oxygenation

SECTION	RECOMMENDATION	GOR
13.	If a patient has high oxygen and PEEP requirements and/or is known to de-saturate to clinically significant levels, pre-oxygenation should be considered.	B
14.	If pre-oxygenating, use the ventilator capability to deliver 100% oxygen.	B

Pre-oxygenation prior to suctioning has been a standard of care that is not supported by evidence. Moreover, it may be harmful to patients. This practice was based on the assumption that the delivery of an increased fraction of inspired oxygen via the mechanical ventilator or manual resuscitator would prevent instances of hypoxia during suctioning of intubated and mechanically ventilated patients. While routine pre-oxygenation has often been recommended as a precautionary measure to prevent possible instances of desaturation, it cannot be assumed that the administration of high concentrations of oxygen for this use is without risks. It has been demonstrated that high concentrations of oxygen, even for a few minutes, can lead to the development of absorption atelectasis in healthy individuals [22]. This effect and subsequent loss of lung volume may be particularly deleterious for the critically ill patient and those with acute lung injury.

Two SRs and one LR have not shown any new evidence to support the use of pre-oxygenation as a routine practice [9, 11, 13]. In a prospective observational study, physiologic disturbances caused by open and closed suctioning were compared, demonstrating a slightly higher SpO2 compared to baseline with pre-oxygenation, however, these changes were not clinically significant [14]. Methodological quality and poor study design contributed to weak associations and as there is no new evidence to routinely perform pre-oxygenation during suctioning. The routine use of pre-oxygenation should be avoided in patients who do not require it. Pre-oxygenation is recommended where clinically relevant in patients who are already hypoxic or for patients with compromised cerebral circulation. In all patients, if desaturation occurs, an increase in FiO_2 to 1.0 +/- lung recruitment strategies should be considered. Most ventilators include a facility whereby 100% oxygen can be delivered for a preset period, and less haemodynamic effects have been reported with this method.

Saline instillation

SECTION	RECOMMENDATION	GOR
15.	To prevent the occurrence of adverse events, bolus instillation of normal saline should not be routinely used prior to suctioning.	C

Some critical care areas still practice routine instillation of saline as part of the suctioning procedure. On reviewing two SRs, one randomised controlled trial (RCT), one LR, one ITS, and one single case repeated measures design (SCRM), there continues to be little or no data to indicate that administration of saline during the suction procedure provides any benefit to suctioning, and some evidence that it may be detrimental [11, 13, 23-26]. The administration of saline during the suctioning procedure was evaluated in terms of effect on: haemodynamics, oxygenation, tracheal aspirate yield, ventilator associated pneumonia (VAP) rates and tracheal tube occlusion rates.

Three SRs and one SCRM design reviewed haemodynamic parameters following saline instillation and were consistently unable to identify a statistical significance between administration and non-administration and there appears to be little evidence of serious complications despite some minor changes in heart rate [9, 11, 25, 26] .

Likewise an SR and an RCT of tracheal tube occlusion rates did not differ between administration of saline and non-administration in adult patients undergoing the suction procedure [23, 25].

There is inconsistent and conflicting evidence in regard to oxygenation, as reported in three SRs and one SCRM design. While some have shown a significant decrease in oxygenation following saline administration during suction others have found no difference between saline administration and non-administration [9, 11, 25, 26].

An argument for the use of saline during the suction procedure is that it may facilitate increased removal of tracheal tube secretions. There is inconsistent evidence, documented in a SR and a LR, to either support or refute this theory [13, 25].

In regards to ventilator-associated pneumonia (VAP) there are inconsistent results. An SR indicated no statistical difference in VAP rates in patients receiving saline administration during suctioning [25]. One RCT did indicate a significant reduction in VAP rates in patients receiving saline administration as part of the suctioning procedure [23]. Thus, there is inconsistent evidence in the use of saline to reduce VAP.

An SCRM study reported that adequate hydration, adequate humidification, use of mucolytic agents and effective mobilisation should be instituted prior to the consideration of saline instillation for patients with increased viscosity of their secretions [26].

The recommendation is: to prevent the occurrence of adverse events, bolus instillation of normal saline should not be routinely used prior to suctioning.

Open versus closed suction

SECTION	RECOMMENDATION	GOR
16.	Closed suction catheter systems should be used as the system of choice for patients with an ETT, NTT or tracheostomy who require suction.	C
17.	Closed suction catheter systems should be changed as per manufacturer's instructions.	D
18.	Closed suction systems should be cleaned as per the manufacturers' instructions to maintain patency and minimise colonisation.	Consensus

Open suction systems (OSS) refer to a single-use catheter inserted into the artificial airway either by disconnecting the ventilator tubing or via a swivel connector. Closed suction systems (CSS) enable patients to be suctioned by a suction catheter enclosed within a plastic sleeve, without the need for ventilator disconnection [9].

Table 5: Summary of research on open vs. closed suction systems

System	Variable	OSS	Neither	CSS
Respiratory	Oxygenation [27, 28]		✓	
	End expiratory lung volume [27]			✓
	Sputum clearance [12]		✓	
Cardiac	Haemodynamics [28, 29]		✓	
Infection	Ventilator-associated pneumonia [12, 27, 30-35]		✓	
	Environmental contamination [30, 36]		✓	
	Tube colonisation [12, 34]	✓		
Outcomes	Length of ventilation [12, 31, 34]		✓	
	Length of stay [12, 31, 34]		✓	
	Patient mortality [12, 31, 34]		✓	
Costs	Costs < 4 days [27, 31, 32, 35]	✓		
	Costs > 4 days [12, 33]			✓

✓ indicates where the balance of evidence was in 2012.

Ventilator-associated pneumonia (VAP) incidence: VAP has been defined as pneumonia occurring > 48/24 – 72/24 after ETT intubation [37] and has been reported to prolong length of stay, increase medical costs, and result in higher mortality rates [38]. Five SRs and one crossover RCT found the incidence of VAP to be independent of the use of either open or closed suction systems [11, 39-42]. (Refer to **Table 5**). A meta-analysis of nine RCTs also found no difference between patients managed with open and closed suction systems for the incidence of VAP, patient length of ICU stay or for patient mortality [42].

Endotracheal tube (ETT) colonisation: The bulk of existing evidence, regarding colonisation of the tube, as distinct from VAP incidence, weakly favours the use of OSS (**Table 5**). An SR found greater respiratory tract and ETT colonisation in CSS than OSS [42], while a Cochrane SR found a significantly increased risk of 49% for CSS ETT tube bacterial colonisation over OSS [12, 17].

Environmental contamination: Studies highlight variation of health worker clinical practice according to the type of suction system in use. One prospective crossover design RCT found OSS groups to be better than CSS for the use of hand hygiene, glove, mask and eye protection by staff pre suction (100% OSS Vs. 91% CSS), [39].
In one pre/post convenience sample study of a patient population with multi-drug resistant pathogens, CSS use was found to be preferable for decreasing glove and airway equipment contamination during tracheal suction (74% OSS vs. 6% CSS) [43].

End expiratory lung volume: An SR explored the impact of open and closed systems on patient end expiratory lung volume (EELV) [11]. This paper reports dated evidence only, based on a study by Cereda [44] supporting the use of CSS for the preservation of EELV. A recent randomised crossover trial [45], showed that while CSS minimised lung volume loss, there was a statistically significant longer time to recovery of pre-suction EELV.

Oxygenation: CSS has been found to be advantageous for patient oxygenation in the specific scenario of pre-oxygenated acute lung injury patients if followed by a recruitment manoeuvre immediately post suction [16]. Methodological quality of this study is questionable as procedures were inconsistently applied. [16]. A systematic review and a crossover trial [45] found no difference in patient oxygenation with either open or closed suction system use, regardless of pre-oxygenation prior to the suction procedure [11].

Sputum clearance: One interrupted time series provides weak evidence for better sputum clearance with open systems [16], while an SR has shown no difference in the quantity of secretion removal between open or closed systems used [17].

Haemodynamics: An SR (11) and an observational study [14] both found little effect on heart rate, mean arterial blood pressure
or saturated peripheral venous oxygen content (SpO_2) on the patient with the use of either open or closed suction systems.

Patient outcome: Patient outcome measures investigated include duration of mechanical ventilation, length of ICU stay, and mortality. Across all three indicators no difference was found within 2 x systematic reviews [11, 17], and 1 x RCT (46). One meta-analysis found a higher association between CSS and MV duration [42].

Costs: Use of disposable suction catheters for OSS in short-term ventilation (i.e. < 4 days) was found to be less expensive than CSS [14, 39, 40, 42, 46] although this data did not consider costs of sterile gloves and increased nursing time in OSS. CSS was found to be more cost effective for patients ventilated > 4 days [40]. One SR also found savings in nursing time with CSS use for patients ventilated for greater than four days. These findings were attributable to two personnel required for patient disconnection from the circuit if using open suction (ref Subriana). A SR of 28 RCTs of randomised cross over trials found no difference between the cost of systems whether closed suction catheters were changed 24/24 - 48/24.

Hyperinflation

SECTION	RECOMMENDATION	GOR
19.	Hyperinflation should not be performed on a routine basis prior to suctioning.	B

The adverse effects of hyperinflation including significant increases/decreases in mean arterial pressure, cardiac output, pulmonary artery pressure and pulmonary airway pressure have been well described in the literature [47]. Recent evidence contained in two SRs [9, 11] and one LR [13] consistently supports the 2007 (1) recommendation that hyperinflation should not be performed on a routine basis prior to suctioning.

Hyperinflation using a manual resuscitator bag or the ventilator has been used as a method of both hyper oxygenation and as a lung recruitment manoeuvre. It has been recognised that there may be occasions where hyperinflation during suctioning is clinically warranted, for example sputum plug, excessive secretions or volume loss as evidenced on a CXR due to lobar or lung collapse. In this instance, hyperinflation is used by clinicians as a therapeutic intervention. This can be performed either manually or via a ventilator depending on level of PEEP. Manual (MHI) or ventilator hyperinflation (VHI) results in increased lung compliance in patients on MV and decreased airway resistance in patients with VAP [11, 13, 48].

Above cuff/subglottic suction

SECTION	RECOMMENDATION	GOR
20.	Tracheal tubes with subglottic suction capability should be used for mechanically ventilated patients who are expected to be ventilated >72hours.	B
21.	If a tracheal tube does not have subglottic suction capability, a Y-catheter should be used to remove "above the cuff" secretions.	Consensus

The mouth and oropharynx become colonised with pathogenic organisms after ICU admission. The main condition necessary for the development of ventilator-associated pneumonia (VAP) is the aspiration of small amounts (micro-aspiration) of secretions past the cuff of an endotracheal or tracheostomy tube. Factors such as impaired laryngeal function (e.g. trans-laryngeal tube), diminished upper airway reflexes, gastroesophageal dysfunction, passive regurgitation of gastric contents, continuous enteral feeding and supine body position are associated with the development of VAP. [49].

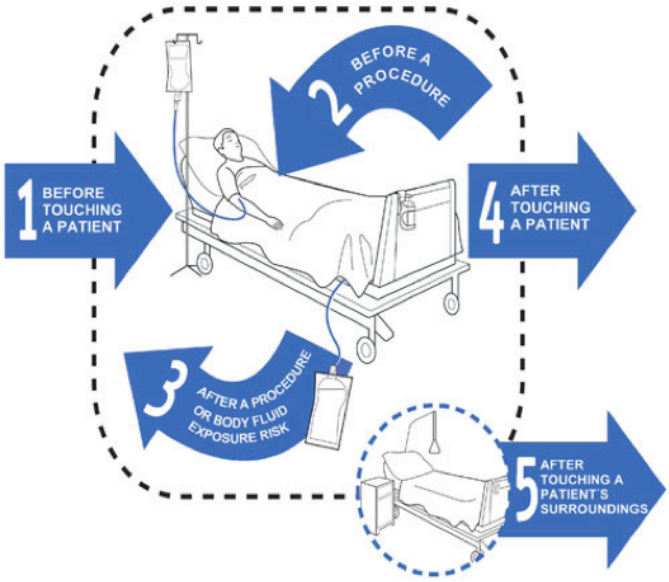
A 2008 evidenced-based clinical practice guideline strongly recommended the use of subglottic secretion drainage when patients were expected to require mechanical ventilation for greater than 72 hours. [4]. This recommendation was based upon the review of five good quality studies and took into account the increased availability of tubes designed for subglottic suction. A recent systematic review and meta-analysis consistently supports the earlier recommendations. This meta-analysis included 13 randomised controlled trials of the effect of subglottic suction on the development of VAP and reported an overall risk ratio for subglottic suction versus standard care of 0.55 with no heterogeneity [5]. This meta-analysis also suggested that subglottic secretion removal may be associated with reduced duration of mechanical ventilation and intensive care length of stay. In two RCTs, both continuous and intermittent subglottic secretion drainage have been associated with reduction of the incidence of VAP. [2, 3]. There is no evidence to support a recommendation regarding the method of subglottic secretion removal (continuous or intermittent).

Infection prevention

SECTION	RECOMMENDATION	GOR
22.	Standard precautions require the use of PPE to prevent contamination and mucosal or conjunctival splash injuries and is mandatory while suctioning a patient. This must include goggles and mask or face shield/gloves and gown/ apron as per NSW 2007 Infection Control Policy.	PD 2007_036 page 7
23.	Clinicians must adhere to the Five Moments of Hand Hygiene.	PD2010_058
24.	When using OSS technique an aseptic non-touch technique must be used.	Consensus
25.	Clinicians should perform a risk assessment for specific droplet and airborne precautions prior to suction.	Consensus

Hand hygiene

The NSW Health Hand Hygiene Policy (PD2010_058) states that all staff must perform hand hygiene as per the 5 Moments for Hand Hygiene (http://www.hha.org.au/). Hand hygiene must occur on entering the patient bed area; prior to donning gloves to perform the suctioning procedure; on completion of the suctioning procedure following glove removal and on leaving the patient bed area.



'Based on the 'My 5 moments for Hand Hygiene', URL: http://www.who.int/gpsc/5may/background/5moments/en/index.html © World Health Organization 2009. All rights reserved.'

NSW Ministry of Health policies

Prevention of infection is an important aspect of any clinical practice guideline. Users are directed to the following policy directives covering infection control. Local policy must also be consulted.

1. Infection Control Policy - http://www0.health.nsw.gov.au/policies/pd/2007/PD2007_036.html
2. Infection Control Policy: Prevention & Management of Multi-Resistant Organisms (MRO) http://www0.health.nsw.gov.au/policies/pd/2007/PD2007_084.html
3. Hand Hygiene Policy http://www0.health.nsw.gov.au/policies/pd/2010/pdf/PD2010_058.pdf
4. Australian Guidelines for the Prevention and Control of Infection in Health Care http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/cd33_complete.pdf

Personal protective equipment

The Australian Guidelines for the Prevention and Control of Infection in Health Care and the NSW Infection Control Policy (PD2007_036) state that all procedures that generate or have the potential to generate secretions or excretions require that either a face shield or a mask worn with protective goggles is to be used by healthcare workers.

Therefore, the use of personal protective equipment (PPE) to prevent mucosal or conjunctival splash injury is mandatory while suctioning the patient (both open and closed suction). This must include mask and goggles or face shield; gloves and gown/apron.

Suctioning of the artificial airway is to be completed using a clean technique for closed system suction and aseptic non-touch technique for [50] for open suction to minimise the potential for introduction of exogenous organisms into the respiratory tract of the critically ill patient. This is consistently supported by an SR [9] and an LR [13].

Table 6: Recommended PPE for CSS and OSS

Equipment	Closed system suctioning	Open suctioning
Mask/goggles or face shield	Yes	Yes
Gown/apron	Yes	Yes
Gloves	Non – Sterile	Sterile
Suction catheter	Closed system catheter changed as per manufactures' recommendations	• Sterile suction catheter • Discarded post procedure
Field	Clean	Aseptic

Workplace health and safety

Prevention of work injury is an important aspect of any clinical practice guideline. Users are directed to the following policy directives covering work health and safety. Local policy must also be consulted.

NSW Work Health and Safety Act 2011 http://www.legislation.nsw.gov.au/maintop/view/inforce/act+10+2011+cd+0+N

The NSW Work Health and Safety Act 2011 states that organisations must eliminate risks to the health and safety of workers where at all possible. When it is not possible to eliminate risks, the risk must be minimised as far as reasonably practicable. Organisations must provide appropriate PPE for use by staff. Staff have a responsibility to use that PPE according to policy.

The worker has an obligation under the NSW Work Health and Safety Act 2011 to;

i) take all reasonable care for their own safety

ii) take care that their acts or omissions do not adversely affect the health and safety of other persons

iii) comply with any reasonable instruction they are given.

Governance

SECTION	RECOMMENDATION	GOR
26.	Each LHD should use this guideline to develop site-specific procedures to address suction practice.	D
27.	To ensure optimal patient outcomes, hospitals should periodically evaluate practice against this guideline.	D
28.	Hospitals should ensure that clinicians who perform this procedure are competent or are directly supervised by a competent clinician.	D
29.	Individual feedback should be provided to improve development of competency in tracheal suction.	D
30.	Where possible, tailored performance in a simulated setting could be useful in teaching and assessing practice of this skill.	D

There is limited evidence on effective strategies to improve clinical suctioning practices. Current research evidence suggests that there is variation between nursing and physiotherapy knowledge and the practice of endotracheal suctioning. To reduce variability in practice, site-specific procedures and auditing of practice need to be developed.

The following should be included within an education program:

- use of individualised feedback in the context of a simulation setting to achieve the greatest effect [51]
- increased awareness of complications related to suction [51, 52]
- analysis for need to suction, clinical indicators, reassessing the patient post procedure and reinforcement of infection guidelines [9, 13, 51, 52].

4. IMPLEMENTATION TOOLS

Areas of educational need for the clinician were identified with the development of this guideline.

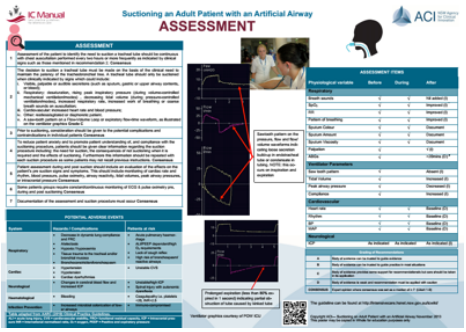
Clinicians caring for the critically ill client are required to implement evidence-based practice (EBP) into their daily management of these patients. It is a challenge for the clinician to keep up to date with all facets of care of the critically ill patient and the development of these guidelines will help to overcome some of these problems.

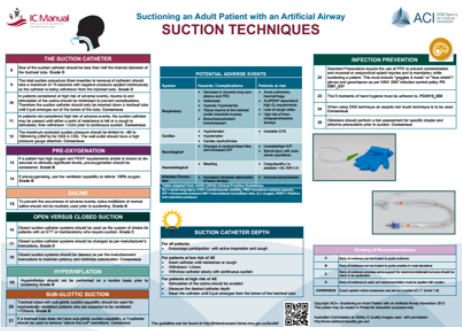
Clinical Nurse Consultants, Clinical Nurse Educators, Registered Nurses, and Senior Physiotherapists who work with the critically ill patient can help act as educational champions to:

1. educate the clinician's ability to identify the need for suction
2. demonstrate competent suctioning skills (being excellent role models), and
3. assess the clinician's ability to competently perform this skill.

The implementation tools that will be designed include:

- An A3 poster (see below) which can be printed a A4
- Go to the ICCMU website via www.aci.health.nsw.gov.au/networks/intensive-care and look for ***Intensive Care Manual.***





- A competency checklist template (to be adapted by LHD) (See Appendix 8)
- A series of videos available via the ACI Vimeo channel. These are:
  1. Overview
  2. Indications & Assessment
  3. Saline Instillation
  4. The Suction catheter
  5. Open & closed suction systems
  6. Preoxygenation and Hyperinflation
- Look for the ***Intensive Care Manual*** under ***Albums*** at http://vimeo.com/user10508752/albums

5. GUIDELINE DEVELOPMENT PROCESS

- September 2011 – Project initiated
- January 2012 – Letter of request for applications requesting nomination of participants for NSW Intensive Care – Best Practice manual – standardising and improving care.
- Early April 2012 – Nominations of group members proposed by LHD CEs/LDONS/allied health managers.
- Late April 2012 - Applications were processed and successful applicants were notified by email.
- May 10 and 11, 2012 – Two-day training and education by Project Manager and team.
- June 2012 – November 2012
  - Identification of scope of guideline
  - Systematic literature reviews.
- December 2012 – Consensus meeting.
- January 2013 – Narrative writing and formulation/ refinement of recommendations for practice.
- March 2013 – Round 1 consensus
  - Internal validation via Survey Monkey
  - Guideline document refined to reflect results of feedback.
- May 2013 – External validation.
- June and July 2013 – Development of implementation tools.
- June/July 2013 – Professional organisation consultation.
- September 2013 – Guideline launch.

6. APPENDICES

Appendix 1: Systematic literature process

A systematic literature review was undertaken between June and November 2012.

PICO question:

What is the optimal method of suctioning the critically ill adult with an artificial airway that minimises patient discomfort and the adverse effects of hypoxia, mucosal damage, alveolar de-recruitment and nosocomial pneumonia?

Minor questions:

1. What is the optimum suction pressure to minimise adverse effects of alveolar de-recruitment, hypoxaemia and haemodynamic parameters?
2. How far down a tracheal tube should the suction catheter be passed that minimises patient complications of tracheal mucosal damage, patient discomfort and autonomic effects?
3. What size suction catheter should be used to minimise the adverse effects of alveolar de-recruitment, hypoxaemia and haemodynamic parameters
4. What conditions should determine the frequency of suctioning?
5.. Which suction method results in the greatest sputum yield?
6. Which suction methods result in reduced cross contamination?
7.. What suctioning practices reduce incidence of ventilator-associated pneumonia?
8.. Does subglottic suction reduce the incidence of ventilator-associated pneumonia?
9.. Is subglottic suction cost effective?
10. Is the closed suction system cost effective?
11. Effective sputum removal from the patients airway when suctioning an artificial airway?

    Which suction practices reduce mortality, ICU LOS and ventilation days?
12. What clinical practices minimise the adverse effects of hypoxaemia and haemodynamic parameters?
13. Should normal saline instillation be used to facilitate sputum removal from the patient's airway when suctioning an artificial airway?
14. Is pre-oxygenation before and/or after suction procedures required to prevent clinically significant hypoxemia in patients with artificial airways? If so, what is the optimal method of pre-oxygenation?
15. Is hyperinflation before and/or after suction procedures required to prevent clinically significant hypoxemia and/or de-recruitment in patients with artificial airways? If so, what is the optimal method of hyperinflation for maintaining oxygenation and sputum removal?

Years: 2006-June2012

Databases: Pubmed, CINAHL and Cochrane; with Scholar google used to track citations from 2007 guideline

Inclusion: Aged > 14years; research

Exclusion: literature reviews that did not include an explicit methods section;

Article review – articles were reviewed by two members of the guideline team using a standardised data extraction tool which incorporated quality criterion specific to study type; disputes between reviewers were mediated by Program Manager.

Appendix 2: NHMRC levels of evidence

Level	Intervention
I	A systematic review of level II studies
II	A randomised controlled trial
III-1	A pseudo-randomised controlled trial
III-2	A comparative study with concurrent controls: • non-randomised, experimental trial • cohort study • case-control study • interrupted time series with a control group
III-3	A comparative study without concurrent controls: • historical control study • two or more single arm study • interrupted time series without a parallel control group
IV	Case series with either post-test or pre-test/post-test outcomes
GPG	Guidelines from international organisation

Appendix 3: NHMRC grading of evidence base for recommendations

Component	A: Excellent	B: Good	C: Satisfactory	D: Poor
Evidence base[1]	One or more level I studies with low risk of bias or several level II studies with a low risk of bias	One or two level II studies with a low risk of bias or an SR/ several level III studies with a low risk of bias	One or two level III studies with a low risk of bias, or level I or II studies with a moderate risk of bias	Level IV studies, or level I to III studies/ SRs with a high risk of bias
Consistency[2]	All studies consistent	Most studies consistent and inconsistency may be explained	Some inconsistency reflecting genuine uncertainty around clinical question	Evidence is inconsistent
Clinical impact	Very large	Substantial	Moderate	Slight or restricted
Generalisability	Population/s studied in body of evidence are the same as the target population for the guideline	Population/s studied in the body of evidence are similar to the target population for the guideline	Population/s studied in body of evidence differ to target population for guideline but it is clinically sensible to apply this evidence to target population[3]	Population/s studied in body of evidence differ to target population and hard to judge whether it is sensible to generalise to target population
Applicability	Directly applicable to Australian healthcare context	Applicable to Australian healthcare context with few caveats	Probably applicable to Australian healthcare context with some caveats	Not applicable to Australian healthcare context

[1] Level of evidence determined from the NHMRC evidence hierarchy – Table 3, Part B.
[2] If there is only one study, rank this component as 'not applicable'.
[3] For example, results in adults that are clinically sensible to apply to children or psychosocial outcomes for one cancer that may be applicable to patients with another cancer.

Appendix 4: Author information

Section name	Primary author	Literature review	Recommendation development (D) refinement (R)
Suction indications, and assessment pre, during and after suction	K Rose C Zimbiti M Boyle	L Armstrong S Bayliss J Caldwell W Chaseling K Johnson K Rose	K Rose C Zimbiti M Boyle W Chaseling Expert group (R)
The suction catheter	N Thackray J Caldwell	S Bayliss J Caldwell W Chaseling K Rose N Thackray	W Chaseling N Thackray (D) J Caldwell (D)
Pre-oxygenation	N Reddy W Chaseling	W Chaseling	N Reddy W Chaseling Expert group (R)
Saline instillation	S Lowe	W Chaseling K Johnson S Bayliss N Thackray	S Lowe Expert group (R)
Closed suction	K Johnson S Bayliss	S Lowe S Bayliss W Chaseling N Thackray K Rose C Chung N Reddy L Armstrong J Caldwell	K Johnson S Bayliss (R)
Hyperinflation	N Reddy W Chaseling	W Chaseling K Johnson	N Reddy W Chaseling
Above cuff/subglottic suction	M Boyle	M Boyle S Bayliss	Expert group (R)
Infection control	J Masters	J Masters	
Governance, competence, education	C Chung	L Armstrong N Thackray W Chaseling S Bayliss K Johnson	W Chaseling Expert group (R)
General coordination of CPG development	K Rolls / J Masters		

Appendix 5: Consensus round 1 (Survey Monkey results)

Health professional group		Clinical specialty	
Nurse	8	Academic	1
		CNC	2
Physiotherapist	5	Acting CNC	1
Infection control personnel (ICP)	2	CNE	2
		CNS	1
		RN	1
		Senior Physiotherapist	5
		ICP	2
Total	15	Total	15

- For recommendation 1, a statement/sentence was removed to reflect a more positive affirmation. The opening sentence was thus removed:

  "Due to the potential for adverse effects, suctioning a tracheal tube should not be carried out on a routine basis."

- The orders of recommendations were changed, recommendation 8, pertaining to the maximum time between suction procedures, was moved to position 2.
- Recommendations 7 and 8, were then combined[7, 8].
- Recommendation 8 wording was altered to reflect feedback from the group hours changed from 8 to 4. This was then subsequently deleted after internal validation and before external validation occurred.
- Recommendation 5 was promoted to recommendation 1 after discussion on Google groups.
- Recommendation 2 (checking for tube patency) was deleted, after internal validation, as the consensus opinion of the group is that:
  - it contradicted recommendation 2 regarding suctioning when indicated
  - passing a catheter to check for tube occlusion was more relevant for checking the position of a tracheostomy tube, i.e. that it is not in a false passage?
  - passing a catheter would entail performing a suction.

"When a patient has minimal suction requirements, a suction catheter should be passed down the tracheal tube at least every 4 hours to evaluate the patency of the tube."

- A recommendation was added regarding documentation of the suction procedure as it had been previously omitted/overlooked.

SUCTION INDICATIONS AND ASSESSMENT PRE, DURING AND AFTER SUCTION								
RECOMMENDATION	1	2	3	4	5	6	7	8
Median (IQR)	9 (8-9)	9 (9-9)	9 (7-9)	8 (7-9)	8 (9-9)	9 (7-9)	7 (5-9)	7 (7-9)

THE SUCTION CATHETER					
RECOMMENDATION	9	10	11	12	13
Median (IQR)	8 (7-9)	8 (7-9)	9 (7-9)	8 (7-9)	8 (7-9)

- Catheter size to ETT size formula changed based on comments from Survey Monkey
- Wording changed to reflect time of total procedure, not just the time suction applied
- Wording changed around on one recommendation to increase consistency of statements

PRE-OXYGENATION			
RECOMMENDATION	14	15	16
Median (IQR)	9 (7.25-9)	9 (7.25-9)	7.5 (7-9)

SALINE INSTILLATION	
RECOMMENDATION	17
Median (IQR)	9 (7-9)

- A recommendation (16) was removed as it was a statement, not a recommendation.

CLOSED SUCTION			
RECOMMENDATION	18	19	20
Median (IQR)	9 (7.5-9)	9 (8.5-9)	9 (8.5-9)

HYPERINFLATION	
RECOMMENDATION	21
Median (IQR)	9 (8.5-9)

ABOVE CUFF/SUBGLOTTIC SUCTION		
RECOMMENDATION	22	23
Median (IQR)	9 (7-9)	7 (7-9)

INFECTION CONTROL					
RECOMMENDATION	24	25	26	27	28
Median (IQR)	9 (7-9)	9 (9-9)	9 (9-9)	9 (9-9)	9 (9-9)

GOVERNANCE/COMPETENCE/EDUCATION					
RECOMMENDATION	29	30	31	32	33
Median (IQR)	9 (9-9)	9 (8-9)	9 (9-9)	9 (9-9)	9 (7-9)

- Please note that recommendation numbers may not reflect the numbers in the final document as recommendations may have been added, deleted or reordered.

Appendix 6: External consensus

This was undertaken in mid to late May 2013.

Health professional group		Clinical specialty		Non-responders	
Infection control personnel (ICP)	1	Mobility	3	ICP (medical professor)	1
Physiotherapist	3	Temperature	2	Mobility (PT)	1
Nurse Educator	1	Central venous access device	2	NIPPV (CNC)	1
Registered Nurse	2	Infection prevention	1	PI (RN)	1
Clinical Nurse Educator	1				
Total	8	Total	8	Total	4

SUCTION INDICATIONS AND ASSESSMENT PRE, DURING AND AFTER SUCTION							
RECOMMENDATION	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Median (IQR)	8 (7-8)	8.5 (7.5-9)	9 (8-9)	9 (8-9)	8 (8-9)	9 (8.5-9)	9 (8.5-9)

THE SUCTION CATHETER					
RECOMMENDATION	**8**	**9**	**10**	**11**	**12**
Median (IQR)	8.5 (7.5-8.75)	9 (8-9)	7.5 (7-7.25)	9 (7.5-9)	7 (5.5-8)

PRE-OXYGENATION		
RECOMMENDATION	**13**	**14**
Median (IQR)	8 (7-8.75)	8.5 (7.5-8.75)

SALINE INSTILLATION	
RECOMMENDATION	**15**
Median (IQR)	8 (6.5-8.75)

CLOSED SUCTION			
RECOMMENDATION	**16**	**17**	**18**
Median (IQR)	9 (8.5-9)	9 (7.5-9)	9 (7.5-9)

HYPERINFLATION	
RECOMMENDATION	**19**
Median (IQR)	8 (7.5-8.75)

ABOVE CUFF/SUBGLOTTIC SUCTION		
RECOMMENDATION	**20**	**21**
Median (IQR)	8 (7.5-8)	7.5 (7-8)

INFECTION CONTROL				
RECOMMENDATION	**22**	**23**	**24**	**25**
Median (IQR)	9 (8.25-9)	9 (8.25-9)	8 (7.25-8)	9 (8-9)

GOVERNANCE/COMPETENCE/EDUCATION					
RECOMMENDATION	**26**	**27**	**28**	**29**	**30**
Median (IQR)	8 (7.25-9)	8 (8-9)	9 (8.25-9)	9 (8-9)	9 (8-9)

Appendix 7: Recommendation change log

Recommendation number at external validation	Recommendation number at internal validation	Reason for change
1	4	Reordered, concerned assessment
2	1	
3	2	
4	3	
5	5	
6	6	
	7	Combined with 8 then deleted
	8	Combined with 7 then deleted
7		Addition re documentation
8	9	
9	10	
10	11	
11	12	
12	13	
13	14	
14	15	
	16	Deleted concerning pre-oxygenation
15	17	
16	18	
17	19	
18	20	
19	21	
20	22	
21	23	
	24	Deleted
22	25	
23	26	
24	27	
25	28	
26	29	
27	30	
28	31	
29	32	
30	33	

Appendix 8: Template for competency checklist

COMPETENCY ASSESSMENT CHECKLIST		
Date competency attended:		
Clinician (RN/PT) name:	Signature:	
Assessor (competent clinician) name:	Signature	
Today's date:	Next assessment date:	
PATIENT PREPARATION (PRIOR TO PATIENT CONTACT) / GOVERNANCE	**×/√**	**COMMENT**
Reads clinical practice guideline, LHD policy and safe work practice		
Observes a competent clinician performing the task		
ASSESSMENT	**×/√**	**COMMENT**
Indications for suction identified.		
Contra-indications and potential complications identified		
Observes baseline physiological variables (Table 3)		
Informs patient of need/effects/consequences, informed consent		
CLINICAL PRACTICE: PRE-OXYGENATION	**×/√**	**COMMENT**
Identifies need to hyperoxygenate, and if appropriate, hyperoxygenate		
CLINICAL PRACTICE: HYPERINFLATION	**×/√**	**COMMENT**
Identify need to hyperinflate e.g. sputum plug		

COMPETENCY ASSESSMENT CHECKLIST		
CLINICAL PRACTICE: INFECTION PREVENTION AND WORK HEALTH AND SAFETY	**×/√**	**COMMENT**
Performs respiratory risk assessment		
Selects relevant equipment, including PPE		
Dons goggles and mask or face shield/apron/gloves as per infection ontrol policy and risk assessment		
Follows the five moments of hand hygiene as appropriate i.e. on entering the patient bed area; prior to donning gloves to perform the suctioning procedure; on completion of the suctioning procedure; following glove removal and on leaving the patient bed area.		
CLINICAL PRACTICE: THE SUCTION CATHETER / PRESSURE / PATIENT RISK	**×/√**	**COMMENT**
Select catheter of appropriate size		
High wall suction turned on, pressure checked by occlusion of suction tubing and kept handy (max -150mmHg)		
Check canister and suction tubing in correct configuration		
Attach suction tubing to catheter, check button is unlocked		
To perform suction procedure: • Stabilise the airway with one hand and advance catheter with the other • Determine depth catheter is required to be inserted (just emerging from lumen of tube or stimulating a cough) • Do not force catheter • Pass catheter down artificial airway to predetermined distance • Withdraw catheter 1-2cms • Suction continuously on withdrawal of catheter • Total suction time not to exceed 15 seconds • Determine if another suction pass required, reassess indications		

Table continues on page 35

Table continued from page 34

COMPETENCY ASSESSMENT CHECKLIST		
CLINICAL PRACTICE: SUB-GLOTTIC	**×/√**	**COMMENT**
Utilise subglottic port to suction above the cuff or Y-catheter to suction above the cuff and oropharynx		
CLINICAL PRACTICE: CLOSED SUCTION	**×/√**	**COMMENT**
Clean closed suction catheter as per manufacturer's instructions		
CLINICAL PRACTICE POST-PROCEDURE: CLOSED SUCTION	**×/√**	**COMMENT**
Reassess physiological variables (**Table 3**)		
Clean and tidy area		
Document in notes/chart: Required components of documentation include: • Include consent (if appropriate) • Assessment (indication for suctioning) • Patient tolerance • Type of suction (open or closed) • Adverse events • Need for pre-oxygenation • Need for saline • Whether subglottal suction was performed • Sterile or clean gloves used (as appropriate) • Suction outcome (amount, colour, viscosity)		

x: Not performed adequately
√: Performed adequately

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