



Best Practice

Evidence Based Practice Information Sheets for Health Professionals

Tracheal Suctioning of Adults with an Artificial Airway

Acknowledgments

This Best Practice Information Sheet has been based on a systematic review of research published by The Joanna Briggs Institute entitled "Suctioning Adults with an Artificial Airway"¹. The primary references on which this information is based are available in the systematic review report.

Quality of Evidence

The review uncovered a wide range of research relating to the practice of suctioning adults with an artificial airway. The various designs and the lack of homogeneity in the studies meant that the results could not be combined statistically in a meta-analysis.

In reviewing the research, many issues relating to quality or study design were identified:

- Rigorous research design was not utilised in many of the studies,
- Many studies involved only very small numbers of participants,
- Many studies involved reports only from one single centre or institution,
- Reporting of research methods was often inadequate,

This Best Practice Information Sheet Covers the Following Concepts:

- Effects of Suctioning
- Suctioning Techniques
- Oxygenation
- Suctioning Patient Subgroups
- Summary of Evidence
- Recommendations

- Reporting of results was often incomplete.

The search of the literature identified 504 papers that referred to suctioning artificial airways, 95 of which met the inclusion criteria. Eleven were two, three or four group RCT's, 29 were cross over studies, 9 were controlled trials, 7 were case studies, 26 were

Levels of Evidence

All studies were categorised according to the strength of the evidence based on the following classification system.

Level I

Evidence obtained from a systematic review of all relevant randomised controlled trials.

Level II

Evidence obtained from at least one properly designed randomised controlled trial.

Level III.1

Evidence obtained from well designed controlled trials without randomisation.

Level III.2

Evidence obtained from well designed cohort or case control analytic studies preferably from more than one center or research group.

Level III.3

Evidence obtained from multiple time series with or without the intervention. Dramatic results in uncontrolled experiments.

Level IV

Opinion of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees.

descriptive studies, 11 were literature reviews, others were 1 survey and 1 clinical practice guideline.

The methodological weaknesses in some of the studies undermine the validity of their findings. Because of the potential sources of error and design limitations, the results of these studies must be interpreted carefully.

Types of Participants

The systematic review included studies related to adult patients (>15 years) within the acute care hospital setting, with either an endotracheal tube or a tracheostomy tube in situ. The studies included both spontaneously breathing and/or artificially ventilated participants.

Types of Interventions

The review included interventions that are currently employed in the nursing management of patients with an artificial airway, particularly those used to minimise the prevalence of complications associated with suctioning. The specific interventions of interest were:

- Methods used for tracheal suctioning
- The instillation of saline prior to suctioning
- The use of hyperinflation/hyperoxygenation during suctioning
- Techniques used in minimising trauma to the trachea during suctioning
- Techniques used in promoting the prevention of infection.

Types of Outcome Measures

The review included outcome measures that could potentially reflect the complications of suctioning. Specific outcome measures of interest were:

- Changes to PaO₂, PaCO₂ and SaO₂ levels
- Cardiovascular, neurological, haemodynamic or pulmonary changes associated with suctioning
- Assessment tools utilised during suctioning
- Prevalence of mucosal trauma or mucosal dysfunction
- Volume of secretion removal, frequency of suctioning
- Prevalence of atelectasis, tracheitis, or pneumonia
- Changes in patient comfort associated with suctioning

Effects of Suctioning

A number of studies indicated that suctioning is a potentially harmful procedure.

- Tracheal trauma, suctioning-induced hypoxaemia, hypertension, cardiac arrhythmias and raised intracranial pressure have all been associated with suctioning.
- Patients have reported that suctioning can be a painful and anxiety provoking procedure.
- Most studies reviewed highlighted the necessity for individual patient assessment prior to initiating tracheal suctioning to determine the need for the procedure rather than as a routine.

- Several studies also noted the need for psychological support for the patient.
- Suctioning should only be done when clinically necessary.
- The evidence on haemodynamic, cardiovascular and neurological adverse effects associated with suctioning, supports the practice of individualised assessment prior to, and close observation during and following the procedure.

- The evidence on the harmful effects of suctioning supports nurses encouraging patients to cough up the secretions themselves, if they are able.

Suctioning Techniques

A number of adverse effects of suctioning have been associated with the technique used. The studies reviewed indicated the following:

Instillation of Sodium Chloride 0.9%

- There is no conclusive evidence to indicate that instilling 0.9% sodium chloride prior to suctioning adults with an artificial airway increases the removal of resident respiratory secretions.

Clinical Indicators for Suctioning

coarse breath sounds,
noisy breathing,
increased or decreased pulse,
increased or decreased respiration,
increased or decreased blood pressure,
prolonged expiratory breath sounds.

- Ensuring patients are adequately hydrated is one way nurses can facilitate the removal of respiratory secretions.

Minimising the Introduction of Infection

- There is the potential for multiple bacteria to enter the lower airway during repeated suctioning procedures which contributes to lower airway colonisation and nosocomial pneumonia particularly if 0.9% sodium chloride instillation is routinely used as part of the procedure.
- Aseptic technique should be considered an essential component of the suctioning procedure despite the lack of rigorous research in this specific area.

Size of Suction Catheter

- The ratio of the diameter of the endotracheal tube may be directly related to the negative pressure within the lungs.
- The size of the suction catheter should occlude no more than half of the internal diameter of the artificial airway to avoid greater negative pressures in the airway and to potentially minimise falls in PaO₂.

Duration of Suctioning

- Doubling the duration of the suction period could also double the decrease in PaO₂ levels.
- The incidence of tracheal lesions found was directly related to several factors, including the length of time the vacuum was applied during suctioning.
- Expert opinion suggests suction duration times of <10-15 seconds decreases the risk of trauma, hypoxia and other side effects.

Oxygenation

Hyperoxygenation refers to an increase in the fraction of inspired oxygen (FIO₂), **hyperinflation** refers to lung inflations (usually 1-3) with an increased volume of gas, and **hyperventilation** refers to the technique of increasing alveolar minute ventilation. **Pre-oxygenation** refers to the provision of oxygen (either at or above baseline O₂ levels) prior to the commencement of suctioning, and **post-oxygenation** refers to oxygen provision (either at or above baseline O₂ levels) following completion of suctioning.

Suctioning-Induced Trauma

- Although the majority of studies that focused on suctioning trauma were conducted on animals, researchers have suggested that patients who are subjected to frequent suctioning episodes are also at risk of tracheal mucosal damage.
- The effectiveness of any pre-oxygenation technique can be influenced by individual patient conditions, duration of suctioning, negative suction pressure, suction flow and size ratio between the suction catheter diameter and the diameter of airway lumen.
- Hyperoxygenation prior to suctioning may potentially minimise suctioning-induced hypoxaemia.
- Combining hyperoxygenation and hyperinflation has been identified by some researchers as a technique for potentially minimising suctioning-induced hypoxaemia. Some form of hyperoxygenation prior to suctioning can minimise the potential of post suctioning hypoxaemia in adult hospitalised patients.
- The majority of research protocols described used 100% oxygen when hyperoxygenating prior to suctioning. The research is inconclusive regarding the

optimum levels of hyperoxygenation for reversal of hypoxaemia in different patient groups, particularly in patients with Chronic Obstructive Pulmonary Disease - some of whom may not tolerate increased levels of oxygen.

- A washout time of up to two minutes can be required when hyperoxygenation is being delivered via some ventilators, to allow time for the increased oxygen percentage to come through the ventilator tubing and reach the patient. Some newer ventilator models however, can now accommodate this dead space, reducing delays in the increased oxygen percentages reaching the patient.

Hyperinflation

- Adverse effects may occur in some patients when using hyperinflation and therefore thorough individual patient assessment is recommended.
- Hyperinflation may have clinical implications for patients who have raised ICP, are in the post-operative period following vascular/cardiac surgery, or for those who are haemodynamically unstable.
- Potential difficulties, specifically dyspnoea, have been associated with hyperinflation with larger volumes of gas. Patients have

reported feeling dyspnoeic during hyperinflation protocols when larger tidal volumes (900cc) were used.

- Using a ventilator for hyperinflation/hyperoxygenation results in less haemodynamic alterations than using a manual resuscitation bag. If possible the ventilator should be used to provide hyper-ventilation/hyper-

oxygenation prior to suctioning.

- Repeated hyperinflation/suction sequences can result in significant haemodynamic changes in mean arterial pressure, cardiac output and heart rate and therefore should be limited to only those necessary to maintain airway patency. These changes have been identified with three successive hyper-

inflation-suctioning sequences and some researchers recommend that hyperinflation-suction passes should be limited to two per session.

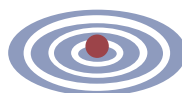
- Potential difficulties have been identified when hyperinflating with larger volumes of gas. Some researchers have suggested that using tidal volumes that are indexed to the size of the patient may assist in minimising potential difficulties.

Suctioning of Patients with a Head Injury

- Cumulative increases have been reported in mean intracranial pressure (MICP), mean arterial pressure (MAP) and cerebral perfusion pressure (CPP) in the acute head-injured patient associated with each consecutive suction sequence.
- Repeated suctioning procedures may increase MICP in the adult with acute severe head injury so that three suction passes are potentially less safe than two.
- Researchers have reported delays of up to 10 minutes for haemodynamic and neurological responses to return to baseline levels following suctioning. Therefore nurses need to consider modifying activities and delaying interventions that are known to increase MICP or MAP beyond a 10 minute interval. Nurses should plan care activities based on thorough assessment of patient needs and if required, consider paced rather than consolidated care activities.
- Research suggests that patients with severe closed head injury, particularly those who respond to suctioning with a spiking ICP pattern, are at risk of periods of cerebral hypertension during suctioning.
- Given the potential harmful effects of suctioning in a head-injured patient, nurses should not perform suctioning on a routine schedule. Instead the patient should be monitored continuously and suctioning should be performed only when indicated. Assessments should include both neurological and cardiovascular assessments to minimize potential complications.
- Researchers have reported that ICP levels responded less dramatically to suctioning when short-duration pre-suction hyperventilation was used to maintain systemic hypocapnia. However it continues to be unclear whether the resulting hypocapnia has a beneficial or harmful effect, particularly in ischaemic regions of the brain. There may be the potential for vasoconstriction to decrease cerebral blood flow to a level dangerous to cerebral integrity.

Recommendations

1. Suctioning should only be done when a thorough assessment of the patient establishes the need for such a procedure. Individualised assessment prior to, and close observation during and following the procedure is recommended. Patients should be encouraged to cough up secretions themselves if they are able to do so. (Level IV)
2. Because of the potential associated hazards, nurses require procedural skill and gentleness when suctioning. (Level IV)
3. Nurses should not instil 0.9% sodium chloride prior to suctioning adults with an artificial airway. Ensuring patients are adequately hydrated is one way nurses can facilitate the removal of respiratory secretions. (Level III.1)
4. Aseptic technique should be used while suctioning adult hospitalised patients with an artificial airway. (Level IV)
5. The size of the suction catheter should occlude no more than half of the internal diameter of the artificial airway to avoid greater negative pressures in the airway and to potentially minimise falls in PaO₂. (Level IV)
6. Expert opinion suggests suction duration times of <10-15 seconds. (Level IV)
7. Some form of hyperoxygenation prior to suctioning can minimise the potential of post suctioning hypoxaemia in adult hospitalised patients. (Level III.1)
Combining hyperoxygenation and hyperinflation can potentially minimise suctioning-induced hypoxaemia. (Level III.1)
8. Using tidal volumes that are indexed to the size of the patient may assist in minimising potential difficulties. (Level III.1)
9. When hyperoxygenating, allow time for the increased oxygen percentage to come through the ventilator tubing and reach the patient. (Level IV)
10. A ventilator should be used rather than a manual resuscitation bag to provide hyperventilation/hyperoxygenation prior to suctioning to reduce haemodynamic alterations. (Level III.2)
11. Use a maximum of two suction passes. (Level III.1)
12. Thorough individual patient assessment is required when planning suctioning interventions. Hyperinflation may have clinical implications for patients who have raised ICP, are post operative following vascular/cardiac surgery, or for those who are haemodynamically unstable. (Level II)
13. Modify activities and delay interventions that are known to increase MICP or MAP beyond a 10 minute interval. Plan care activities based on thorough assessment of patient needs and whenever possible consider paced rather than consolidated care activities. (Level III.1)



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Summary of Evidence

1. Tracheal trauma, suctioning-induced hypoxaemia, hypertension, cardiac arrhythmias and raised intracranial pressure have been associated with the suctioning procedure. (Level III.3)
2. Patients have reported that suctioning can be a painful and anxiety provoking procedure. (Level IV)
3. Administering a bolus of 0.9% sodium chloride (normal saline) to liquefy secretions is not substantiated in the literature. (Level III.1)
4. There is potential for multiple bacteria to enter the lower airway during repeated suctioning procedures, particularly if saline instillation is routinely used as part of the procedure. (Level IV)
5. The ratio of the diameter of the suction catheter to the inside diameter of the ET tube could be directly related to the negative pressure within the lungs. (Level IV) Falls in PaO₂ levels have been reported to be greater when larger suction catheters were used. (Level III.2)
6. Doubling the duration of the suction period may also double the decrease in PaO₂ levels. (Level III.2)
7. Hyperoxygenation prior to suctioning can potentially minimise suctioning-induced hypoxaemia. Combining hyperoxygenation and hyperinflation may minimise suctioning-induced hypoxaemia. (Level III.1)
8. Patients have reported feeling dyspnoeic during hyperinflation when larger tidal volumes (900cc) were used. (Level III.1)
9. A washout time of up to two minutes can be required when hyperoxygenation is being delivered via some older ventilators to allow time for the increased oxygen percentage to come through the ventilator tubing and reach the patient. (Level IV)
10. Using the ventilator for providing hyperinflation and hyperoxygenation may result in less haemodynamic alteration when compared with the manual resuscitation bag (MRB) as a technique. (Level III.2)
11. Increases in MICP, MAP and CPP levels in the acute head injured patient may be associated with suctioning and these changes may be cumulative with each consecutive suction sequence. (Level III.1)
12. Repeated hyperinflation- suction sequences can result in significant haemodynamic changes in MAP, Cardiac Output and Heart Rate. (Level II)
13. Patients with severe closed head injury, particularly those who respond with a spiking ICP pattern, are at risk for periods of cerebral hypertension during suctioning. (Level III.1)

¹ Thompson, L. Suctioning Adults with an Artificial Airway. The Joanna Briggs Institute for Evidence Based Nursing and Midwifery; 2000. Systematic Review No. 9

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