Suctioning: a review of current research recommendations

Tina Day, Sarah Farnell and Jenifer Wilson-Barnett

Effective suctioning is an essential aspect of airway management in the critically ill. However, there are many associated risks and complications. These range from trauma and hypoxaemia to cardiac dysrhythmias and, in extreme cases, cardiac arrest and death. This paper identifies the current research recommendations for safer suctioning practices. The literature is reviewed in three parts: prior to suctioning; during suctioning; and post-suctioning. The recommendations prior to suctioning include patient assessment, patient preparation and hyperoxygenation. The recommendations during suctioning include appropriate catheter selection, depth of insertion, negative pressure, duration of procedure and number of suction passes. Measures for maintenance of asepsis, such as hand-washing, wearing gloves, goggles and aprons are other essential considerations, which must not be overlooked. The recommendations post-suctioning include reconnection of oxygen, patient reassurance and monitoring of the patient's oxygen saturation. In order to improve standards of care, it is imperative that nurses are aware of current research recommendations. This will enable nurses to make informed decisions about their own suctioning practices, based on the individual needs of the patient.

Introduction

Suctioning is described as the mechanical aspiration of pulmonary secretions from a patient with an artificial airway in position (AARC 1993). In a healthy patient, the action of ciliated cells in the airways, the local immune system, and the cough reflex are essential for the destruction and removal of micro-organisms as well as clearing debris from the lungs (Ashurst 1992). However, in the critically or acutely ill patient, these functions may be severely compromised, resulting in an excessive production of secretions, which may prove difficult to expectorate. Endotracheal and tracheostomy tubes form artificial airways, which bypass the normal physiological processes and inhibit the cough reflex. This leaves the respiratory tract vulnerable to opportunistic infections, with an increased production of mucus and reduced secretory pneumocytes and surfactant. An inability to expectorate this mucus, which is often thick and tenacious, is a common problem for the patient with a tracheostomy or endotracheal tube (Ashurst 1992). Periodic suctioning is required in order to clear these secretions and prevent atelectasis or alveolar collapse (Odell et al. 1993; Wainwright & Gould 1996). This paper reviews the literature relating to suctioning to identify current research recommendations for safer suctioning practice. Although there have been a number of publications relating to suctioning in recent years, few authors have examined what happens in actual practice. This paper identifies the potential pitfalls in practice...
and makes recommendations for future research into nurses' suctioning practices.

**Review of the literature**

The literature review has been divided into three main areas: prior to suctioning; during suctioning; and post-suctioning. The Cumulative Index of Nursing and Allied Health Literature (CINAHL) and MEDLINE data bases were searched from 1990 to 2001. The available literature on and surrounding suctioning was identified and studies were examined in depth. Selected studies published within the past 10 years and seminal papers were included in the final review. Key words used during the search included endotracheal and tracheal suctioning, assessment, patient preparation, hyperoxygenation, hyperinflation, normal saline instillation, suction catheters, suction pressure, and infection control.

Fifty-nine papers were included in the final review.

**Prior to suctioning**

**Assessment**

The purpose of suctioning is to remove secretions. However, it is widely accepted that this should be performed only as indicated, and not as a routine intervention (Dolan 1991; Pierce 1995; Glass & Grap 1995). Therefore, suctioning should be performed following a comprehensive assessment of the patient's respiratory status, which should include chest auscultation (Glass & Grap 1995; Griggs 1998). However, many nurses fail to perform chest auscultation prior to suctioning (Day et al. 2001).

**Patient preparation**

The importance of reducing stress in the critically or acutely ill patient cannot be overemphasised, and the nurse's role is paramount. Fiorenini (1992) argued that, in unrelaxed patients with acute pain, the suctioning procedure itself and the cough produced may result in physiological and behavioural changes.

Suctioning has been identified as a 'frightening and unpleasant experience' (Griggs 1998), and has been described as a feeling of choking or loss of breath (Berghorn-Engberg & Haljamae 1989). Sawyer (1997) gave a descriptive account of his experience as a patient in intensive care. He suggested that endotracheal suctioning was the closest he had come to 'hell on earth' (p. 28). Sawyer suggested that some nurses were better than others: 'In the hands of a skilled yet sensitive practitioner suctioning need not be more than a very necessary discomfort.' However, on occasions, Sawyer (1997) stated that it was 'horrid' and the 'coughing, gagging and choking spasms produced by the sink plunger technique were terrifying' (p. 29). This graphic description of suctioning highlights the importance of patient preparation. However, many nurses still fail to adequately prepare their patients prior to suctioning. In fact one study (Celik & Elbas 2000) identified that all nurses (n = 42) failed to explain the suctioning procedure to patients prior to suctioning. It is important to note that ethical approval was not obtained for this study as there was no research ethics committee or such body in the hospital at the time of the study. However, the authors acknowledged this limitation.

It is generally agreed that an appropriate explanation, along with adequate sedation and pain relief, can lead to a reduction in stress, anxiety and pain, and increase the effectiveness of the suctioning procedure (Peruzzi & Smith 1995; Wood 1998).

**Hyperoxygenation**

Suctioning may frequently lead to hypoxaemia, which can cause cardiac dysrhythmias (Stone et al. 1991b), hypotension (Goodnough 1985) and even cardiac arrest and death (Wood 1998). Strategies used to minimise these effects include hyperoxygenation or hyperinflation (Wainwright & Gould 1996).

Hyperoxygenation involves the administration of oxygen at a greater percentage or fraction of inspired oxygen (FiO2) than the patient has been currently receiving (Glass & Grap 1995; Wood 1998). This may be performed before (pre-oxygenation), during (insufflation)
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Several researchers have examined this issue. Harken (1975) studied the effectiveness of a 30-s period of pre-oxygenation, delivered by manual rebreath bag (MRB), on suctioning induced hypoxaemia in 11 post-cardiothoracic surgical patients. The author reported no significant rise in arterial oxygen tension ($PaO_2$) ($P > 0.05$). However, the study is limited by a small sample size and other methodological weaknesses are evident. For example, there were no reported measures of the patients' respiratory rate, $FiO_2$ or tidal volume of the MRB intervention, and no control group was used.

Adlkofer and Powaser (1978) investigated the effects of pre-oxygenation on hypoxaemia caused by endotracheal suctioning on 64 intensive care patients. Fifty-four patients received no pre-oxygenation and the remaining 10 were pre-oxygenated either by ventilator sigh mode (with no increase in oxygen percentage) or via an MRB (oxygen percentage not reported). The patients who received no pre-oxygenation demonstrated a significant fall in $PaO_2$ ($P < 0.001$). However, the group receiving either of the two interventions showed a non-significant change in $PaO_2$ following endotracheal suctioning ($P > 0.05$). The authors concluded that widespread variation exists in $PaO_2$ alterations and recommended that pre-oxygenation prior to endotracheal suctioning should be used for all patients.

Lucke (1982) carried out a study on 17 general ICU patients, and evaluated the effectiveness of two methods of pre-oxygenation: the use of 100% oxygen via the ventilator sigh mode or the MRB. The two methods were performed in random order before, during, and after succioning, and the succioning technique was identical for both groups. The results illustrated a significantly greater rise in $PaO_2$ and $SaO_2$ for those pre-oxygenated by the ventilatory sigh mode and the authors concluded that this method of pre-oxygenation was more effective than the MRB in controlling hypoxaemia in critically ill patients.

All of the earlier studies reviewed have involved the administration of 100% oxygen as a means of pre-oxygenating patients. Rogge et al. (1989) was the first to compare hyperoxygenation with 100% to hyperoxygenation with 20% above the patient's baseline $FiO_2$ in 11 patients with chronic obstructive pulmonary disease (COPD). Four hyperinflations were delivered at 1.5 times the calculated tidal volume with either 100 or 20% above the baseline via a MRB. This was followed by 10's of continuous endotracheal suctioning, and the sequence was repeated three times. No significant differences were found in $SaO_2$ levels between the two protocols ($P > 0.05$). The authors concluded that hyperoxygenation at 20% above the baseline $FiO_2$ should be sufficient to prevent hypoxaemia, but strongly recommended replication before clinical implementation.

Despite the increasing body of literature supporting the use of pre-oxygenation/hyperoxygenation, this does not always occur in practice. In their study, Celik and Elbas (2000) found that 97.6% ($n = 41$) of nurses observed did not pre-oxygenate their patients prior to succioning. Similar findings were also identified in Day et al.'s (2001) study. Of the 16 nurses observed 12 failed to pre-oxygenate their patients.

Hyperinflation

Hyperinflation involves inflating a patient's lung with tidal volumes greater than those delivered by the ventilator (Wood 1998). This is achieved by means of a MRB or an increased ventilator tidal volume (Mancinelli-Van Atta & Beck 1992; Robson 1998; Wood 1998). Hyperinflation is known to increase residual capacity and reduce the incidence of atelectasis and shunting (Fiorentini 1992; Carroll 1994). However, the degree of hyperinflation above baseline tidal volume required to prevent a fall in arterial oxygenation remains unclear. Glass and Grap (1995) and Grap et al. (1994) suggest that hyperinflation should be 150% above the baseline tidal volume. However, this is difficult to achieve by MRB technique alone (Glass et al. 1993; Clapham et al. 1995) and may also be a cause of discomfort to the patient. Moreover, large tidal volumes have been associated with barotrauma (Lookinland & Appel 1991), changes in mean arterial pressure and intrathoracic pressure (Ashurst 1992; Carroll...
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1994), and reduced venous return, resulting in hypotension (Odell et al. 1993; Glass & Grap 1995; Wainwright & Gould 1996).

Stone et al. (1991a) examined the effects of hyperinflation, delivered by a ventilator, on oxygenation and haemodynamic variables of 34 cardiac surgical patients. The subjects were assigned at random to receive three hyperinflation breaths selected from one of five possible tidal volumes. Significant changes in mean arterial pressure, pulmonary artery pressure and cardiac output were seen in all groups. A similar study by Stone et al. (1991b) showed an increase in mean arterial pressure with each hyperinflation sequence. The authors attributed this finding to an increased left ventricular preload and cardiac output, or a reduced left ventricular afterload. However, Wainwright and Gould (1996) argue that this increase could be due to any rise in heart rate, caused by vagal stimulation during suctioning. Unfortunately, these data was not presented with the findings. Stone et al. (1991b) recommend that hyperinflation should not be used as a matter of routine practice. However, the study is limited by a small sample size and does not acknowledge that endotracheal suctioning alone can be the cause of such haemodynamic changes. Several authors recommend using the ventilator sigh mode as a means of providing hyperinflation prior to suctioning (Carroll 1994), although some patients may poorly tolerate this.

Denehy (1999) made several recommendations regarding manual hyperinflation including: education of therapists, to improve reliability and potential effectiveness of the technique; inclusion of a manometer in the circuit; establishing an optimal treatment regimen and clarifying the types of patient conditions which respond best to manual hyperinflation. Denehy (1999) suggests that, although the role of manual hyperinflation in airway clearance remains unclear, it is commonly employed in the management of intubated patients by physiotherapists who perceive the technique to be effective in mobilising secretions and improving atelectasis. More research is necessary to establish the reliability, safety and efficacy of the technique, especially compared with other treatment modalities such as positioning, exercise and mobilisation (Denehy 1999). The outcome of manual hyperinflation depends upon the skill of the practitioner and type of equipment used (Denehy 1999). Therefore, hyperinflation should only be performed by those competent to do so.

Combining hyperinflation with oxygenation has been shown to be effective in preventing suctioning-induced hypoxaemia (Lookinland & Apel 1991; Wainwright & Gould 1996). However, there are major limitations to the use of hyperinflation via the MRB, which may lead to respiratory damage due to variable tidal volumes and airway pressures (Dam et al. 1994), barotrauma (Stone et al. 1991b), and alterations in mean arterial pressure and cardiac output (Stone et al. 1991b; Singer et al. 1994).

Putting hyperinflation is rarely achieved in clinical practice (Glass et al. 1993; Robson 1998). In their study of 100 nurses, Glass et al. (1993) found that only 30% were able to achieve the patient's current tidal volume, with an overall mean delivery of 17% lower than current tidal volumes. Robson (1998) argued that the question of 'to bag or not to bag' has no clear answer, yet the technique continues to be widely used by physiotherapists who cite anecdotal evidence of its effectiveness (King & Morrell 1992). However, it is recommended by some authors that hyperinflation should be delivered by ventilator mode only (Glass et al. 1993; Grap et al. 1994; McKelvie 1998). Robson (1998) nevertheless suggested that until there is a definitive validation of the effectiveness of hyperinflation by MRB, it may be a useful technique for treating atelectasis, mobilising secretions and improving oxygenation. Robson (1998) recommended adequate training and the use of in-circuit monitoring of tidal volumes, airway pressures and a positive end expiratory pressure (PEEP) valve, if appropriate.

Instillation of normal saline

The instillation of normal saline prior to suctioning has become common practice in some areas (Ackerman 1993; Ackerman et al. 1996). However, as Blackwood (1999) argued, this is an example of a widely practised
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In fact, there is considerable research evidence against its use (Blackwood 1999). Respiratory secretions and saline apparently do not mix in vitro, and there is no evidence to indicate that they might mix in vivo (Hanley et al. 1978).

Hanley et al. (1978) instilled isotope-tagged 0.9% saline prior to suctioning and found that only 18.7% of the saline was removed. The remaining saline was shown by X-ray to remain in the trachea and bronchi, with none reaching the lung peripheries. In light of the empirical findings, questions are raised about the effectiveness of normal saline instillation. One theory is that it elicits a cough reflex (Gibbs et al. 1997). However, Gray et al. (1990) observed that a comparable cough could be stimulated by the suctioning procedure alone. Although some authors have continued to support the use of saline (Burton & Hodgkin 1984), this is not based on controlled research studies.

Gray et al. (1990) compared the physiological effects of suctioning with and without normal saline instillation. The study indicated that there were no differences in respiratory mechanics, airway pressures or gas exchange. However, other researchers have shown conflicting results. In their study of 26 critically ill patients, Ackerman and Gugerty (1990) studied the effects of normal saline instillation on oxygen saturation (SpO2). SpO2 levels fell significantly after suctioning, and those who had received a bolus of normal saline beforehand suffered a much greater fall in SpO2.

Similarly, Kinloch and Rock (1999) investigated the effect of normal saline instillation on SvO2. In this observational study, 35 critically ill adult patients, all of whom had undergone coronary bypass grafting, were assigned to one of two groups. One group of patients had 5 ml of normal saline instilled at the start of suctioning; the other group had the same procedure without the use of saline. The results demonstrated that the time required for mixed venous oxygen saturation to return to baseline values after suctioning was an average of 3.78 min longer when saline was used. The authors concluded that the use of saline had an adverse effect on oxygenation. Kinloch and Rock (1999) suggested that this contributes to the growing body of evidence indicating that suctioning using saline may have an adverse effect on oxygenation.

The effects of normal saline instillation on the amount of sputum aspirated have also been investigated. Bostick and Wendelgass (1987) measured sputum weight with and without normal saline, and found the group receiving the normal saline bolus had the greatest weight of sputum. Similarly, Ackerman and Gugerty (1990) showed an increase in weight of sputum when normal saline was used. However, both authors state that the weight increases were small, and of neither statistical nor clinical significance. It is also important to note that assessing the weight of sputum can be unreliable, either with or without saline, as there are many factors that could influence how much sputum is aspirated on a single occasion.

Other detrimental effects of normal saline instillation include infection control issues and bacterial contamination. Rutala et al. (1984) observed 24 nurses opening 92 normal saline vials, using an ungloved hand to twist or snap the top off the vial. The nurses were then asked to squirt 5 ml of the saline into a culture tube. The vials were examined at 24 and 48 h, and the nurses were asked to simulate hand-washing in a sterile bag for 15 s with a culture medium. The result showed that 23% of the vials were contaminated (the most prevalent bacterium being Staphylococcus epidermidis) and that 46% of the nurses had contaminated at least one of the vials during the study. Many authors now argue that, if the premise of saline is to moisten thick secretions, attention should be diverted towards the humidification of inspired gases and systemic hydration of the patient (Ackerman 1993; Schwenker et al. 1998; Blackwood 1999).

Maintenance of asepsis

Suctioning is an invasive procedure and, therefore, is associated with an increased risk of infection (Pierce 1995). Tracheal or endotracheal intubation prevents an effective cough as the glottis remains open, which limits the clearance of secretions and promotes pooling at or near the end of the tube (Judson & Sahn 1994; Chatila et al. 1995). The tube itself acts as an
irritant, leading to inflammation and impaired mucociliary function. All of these factors may lead to an increased risk of infection in a debilitated and immunocompromised patient (Judson & Sahn 1994; Wood 1998). There is little argument that aseptic suctioning should be mandatory in all patients (Luce et al. 1993; Odell et al. 1993; Dean 1997). However, there is considerable variation in how this is implemented in practice, ranging from the use of non-sterile gloves (using a non-touch suctioning technique) to sterile gloves (Parker 1999a). The closed method of suctioning has been shown to reduce the incidence of nosocomial pneumonia by avoiding opening the airway to contamination (Ashurst 1992). Closed systems also limit exposure of the surrounding area to contamination and protect nearby personnel from exhaled secretions.

Parker (1999b) argued that the importance of hand hygiene and the use of protective gloves cannot be overemphasised. Universal precautions should be implemented, which includes the use of gloves, aprons and goggles during open suctioning in order to minimise the infection risks to the practitioner (Wood 1998; Pratt et al. 2001). Brooks et al. (1999) investigated the suctioning practices of practitioners during suctioning and discovered that glove practices varied from not using gloves, to using two sterile gloves. Surprisingly, 2.8% (n = 7) of subjects reported not wearing gloves. May (2000) argued that infection control is an issue that affects everybody and it should underpin clinical practice across the entire spectrum of healthcare. However, it requires role models for good practice and appropriate training of all professional and ancillary staff.

Gloves do not replace the need for hand-washing as hands should be washed before and after a procedure (Parker 1999a). Furthermore, Parker (1999b) argued that hand-washing occurs approximately half as often as it should, and for a shorter duration than recommended. A change in attitudes and behaviour is desperately needed by healthcare workers towards hand-washing procedures (Parker 1999b). In one study, none of the nurses were seen to wash their hands before suctioning (Celik & Elbas 2000). This is of concern, as good infection control is central to nursing practice (Parker 1999a).

**During suctioning**

**Catheter selection**

It is widely accepted that the external diameter of the suction catheter should not exceed one-half of the internal diameter of the endotracheal tube (Odell et al. 1993; Glass & Grap 1995; Wood 1998). This allows air to enter the lungs whilst oxygen is being removed during suctioning, which guards against excessive negative pressures and potential atelectasis. Larger size catheters have been shown to increase the risk of trauma due to greater mucosal contact (Young 1984). In fact, one study identified that all nurses (n = 16) used a larger than recommended size suction catheter (Day et al. 2001). Adult size endotracheal or tracheostomy tubes range from 30 to 38 French Gauge (FG), or 7 to 9 mm, whereas suction catheters range from 8 to 16 FG, or 2 to 2.5 mm (Odell et al. 1993). In order to calculate the maximum size suction catheter to use, Odell et al. (1993) recommended the following formula: size of endotracheal/tracheal tube minus 2 times 2.

**Depth of insertion**

Stimulation of the vagus nerve may result in alterations in heart rate (such as bradycardias) and blood pressure. Prolonged paroxysmal coughing will result in increased intrathoracic pressure, decreased venous return and transient hypotension (Wood 1998). Griggs (1998) suggested that, a few days after tracheostomy formation, most patients are able to cough secretions to the end of the tracheostomy tube and the suction catheter need only be inserted to just beyond the end of the tube (approximately 15 cm), thus reducing pain and trauma (Ashurst 1992). This method, although rather subjective, can also be applied to those patients with endotracheal tubes as long as they are able to cough. However, Pierce (1995), Dean (1997), and Wood (1998) all recommended inserting the catheter fully to the carina, which is either felt by resistance or on stimulation of a cough, then withdrawing the catheter 1 cm prior to the application of suction.
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Negative pressure
Application of negative pressure during suctioning may cause trauma to the mucosa as it becomes invaginated through the eyes of the suction catheter. Significant tracheal damage, ulceration and necrosis were found in an animal study where the effects of continuous and intermittent suctioning in two experimental groups were compared with a control group (Czarnik et al. 1991). However, the excessive suction pressures of 200 mmHg may have contributed to these findings. Using high negative pressures does not mean that more secretions will be aspirated, therefore limiting pressures to between 80 and 150 mmHg is recommended (Boggs 1993; Luce et al. 1993). To prevent the suction catheter from adhering to the tracheal mucosa, negative pressure should only be applied during withdrawal (Glass & Grap 1995).

Glass and Grap (1995) also advocated the use of continuous suctioning on catheter removal as there is no evidence to suggest that intermittent suctioning reduces trauma, and at least one study that has identified it as ineffective (Luce et al. 1993; Thelan et al. 1994). Similarly, rotation of the catheter during withdrawal has not been associated with significant increases in sputum removal, and may in fact contribute to further trauma (Glass & Grap 1995). Despite this evidence, practitioners continue to use excessively high suctioning pressures. Celik and Elbas (2000) reported that the patients in their study were being suctioned using a suction machine that delivered a ‘minimum’ negative pressure of 300 mmHg. This is twice the recommended negative pressure. This study also found that 82.6% of suction passes (n = 90) performed by nurses involved suction being applied during insertion of the suction catheter, which is also not recommended practice. Suction catheters should have a built-in valve to prevent suction being applied on insertion (Odell et al. 1993).

Donald et al. (2000) tried to establish whether having a manometer visible in a suction circuit would affect the level of negative pressure used during suctioning. The findings suggest that the negative pressure was significantly higher (mean applied pressure of 359.5 mmHg) than recommended as safe in the literature. Therefore, suggesting that the inclusion of a visible manometer did not prove to be an adequate method of ensuring that safe pressures were used during suctioning. However, it is important to note that this study was simulated in a physiotherapy department and did not involve patients.

Duration of procedure
The majority of researchers recommend that suctioning should take between 10 and 15 s to perform, as longer durations are associated with an increased risk of mucosal damage and hypoxaemia (Boggs 1993; Odell et al. 1993; Smith 1993). In Day et al.’s (2001) study all nurses (n = 16) failed to suction within this recommended duration. However, it is also important to adequately remove secretions.

Number of passes
Wood (1998) argued that the number of suction passes in one suctioning event, perhaps due to copious amounts of secretions, may also lead to complications. Some authors recommend allowing the SpO2 to return to pre-suctioning parameters before another suction pass is attempted (Smith 1993), which Pierce (1995) argued should be no less than 30 s. However, the majority of researchers advocate that no more than three suction passes should be made per episode and that the number of passes should be kept to a minimum (Fiorentini 1992; Glass & Grap 1995).

Monitoring the patient’s heart rate and rhythm, arterial blood pressure and SpO2 during the suctioning procedure is also recommended. Suctioning should cease and hyperoxygenation be initiated immediately if any untoward complications are observed (Glass & Grap 1995; Wood 1998).

Post-suctioning
There is little reference to post-suctioning priorities within the literature. However, reconnection of the patient to oxygen therapy following suctioning should take place within a maximum period of 10 s (Adam & Osbourne 1997; Day 2000). Monitoring the patient’s heart
### Table 1 Summary of recommended practice

<table>
<thead>
<tr>
<th>Action</th>
<th>Recommended practice</th>
</tr>
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<tbody>
<tr>
<td><strong>Prior to suctioning</strong></td>
<td>Suctioning should be performed following a comprehensive assessment of the patient’s respiratory status, which should include chest auscultation (Glass &amp; Grap 1995; Griggs 1998)</td>
</tr>
<tr>
<td>Assessment</td>
<td>Suctioning has been identified as a ‘frightening and unpleasant experience’ for patients (Griggs 1998) leading to anxiety, which has been shown to increase pain and discomfort (FIORENTINI 1992). Therefore, an appropriate explanation, along with adequate sedation and pain relief, can lead to a reduction in stress, anxiety and pain, and increase the effectiveness of the suctioning procedure (Peruzzi &amp; Smith 1995; Peruzzi &amp; Smith 1995)</td>
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<tr>
<td>Patient preparation</td>
<td>Suctioning may frequently lead to hypoxaemia (Adkikofer &amp; Powaser 1978), which can cause cardiac dysrythmias (Stone et al. 1991b), hypotension (Goodnough 1985) and even cardiac arrest and death (Wood 1998). In order to minimise these risks, pre-oxygenation of patient prior to suctioning is recommended (Wainwright &amp; Gould 1994)</td>
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<tr>
<td>Pre-oxygenation</td>
<td>Suctioning is an invasive procedure associated with an increased risk of infection (Pierce 1995). It is recommended that hands should be washed before and after suctioning and that aprons, gloves and goggles should be worn during suctioning (Wood 1998; Parker 1999a;b; Pratt et al. 2001)</td>
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<tr>
<td>Infection control</td>
<td></td>
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<tr>
<td>Suctioning</td>
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<tr>
<td>Catheter selection</td>
<td>Larger suction catheters have been shown to cause trauma, due to greater mucosal contact (Young 1984), whereas smaller catheters may be ineffective at removing secretions. The recommended formula to calculate the maximum size suction catheter to use is: series Size of endotracheal/tracheostomy tube – 2.2 (Odböck et al. 1993)</td>
</tr>
<tr>
<td>Depth of catheter insertion</td>
<td>It is recommended that suction catheters are fully inserted to the carina and then withdrawn 1 cm before suction is applied (Dean 1997; Wood 1998). However, for those patients able to cough, this may not be necessary (Griggs 1998)</td>
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<tr>
<td>Negative pressure</td>
<td>Applied negative pressure should be between 80 and 150 mmHg or 10.6–20 kPa (Luce et al. 1993, Boggs 1993). Higher pressures have been shown to cause trauma, hypoxaemia and atelectasis (Czarnik et al. 1991). To prevent the suction catheter from adhering to the tracheal mucosa, negative pressure should only be applied during withdrawal (Glass &amp; Grap 1995). Suction pressure should be applied continuously as opposed to intermittent (Glass &amp; Grap 1995)</td>
</tr>
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<td>Duration of suction</td>
<td>Suctioning should take between 10 and 15 s to perform, as longer durations are associated with an increased risk of hypoxaemia and trauma (Boggs 1993). However, it is also important to adequately remove secretions</td>
</tr>
<tr>
<td>Number of suction passes</td>
<td>The number of suction passes may contribute to the occurrence of complications (Wood 1998). It is therefore recommended that no more than three suction passes be made during any one suction episode (Glass &amp; Grap 1995)</td>
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<tr>
<td>Post-suctioning</td>
<td></td>
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<tr>
<td>Reconnection to oxygen therapy</td>
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<tr>
<td>Assessment</td>
<td>In order to minimise the risk of hypoxaemia, it is important to reconnect the patient to oxygen within 10 s post-suctioning (Day 2000; Adam &amp; Osbourne 1997)</td>
</tr>
<tr>
<td>Rate, rhythm, SpO₂, colour and perfusion assessment</td>
<td>To determine the effectiveness of the suctioning procedure, a thorough assessment of the patient should be made post-suctioning. This should include chest auscultation (Glass &amp; Grap 1995; Day 2000)</td>
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<tr>
<td>Reduction of stress and anxiety</td>
<td></td>
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<tr>
<td>To prevent oxygen toxicity, it is important to reduce the level of inspired oxygen to pre-suctioning parameters (Pierce 1995)</td>
<td></td>
</tr>
<tr>
<td>Hand-washing</td>
<td>The importance of hand-washing to prevent cross-infection cannot be overemphasised (Parker 1999b)</td>
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</table>

rate, rhythm, SpO₂, colour and perfusion is important both during and following the procedure (AARC 1993). It is also essential that a comprehensive respiratory assessment takes place following suctioning (Glass & Grap 1995), which should include chest auscultation to assess air entry and breath sounds (Day 2000). However, all of the nurses in Day et al.’s (2001) study (n = 16) failed to perform chest auscultation post-suctioning. It is also important to reduce the level of inspired oxygen to pre-suctioning parameters to
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Suctioning should be observed for colour and consistency, and the findings documented. In order to prevent oxygen toxicity (Pierce 1995). Sputum should be observed for colour and consistency, and the findings documented. In order to minimise stress and anxiety caused by the suctioning procedure, reassurance should always be given to the patient after suctioning. Finally, the importance of hand-washing post-suctioning to prevent cross-infection cannot be over emphasised (Parker 1999b). However, as Day et al. (2001) demonstrated, many still fail to wash their hands post-suctioning. A summary of recommended practice is presented in Table 1.

Implications for clinical practice

Despite the complications associated with suctioning few studies (Day et al. 2001; Celik & Elbas 2000; Donald et al. 2000) have investigated actual suctioning practices. Furthermore, all of these studies have identified that suctioning practices are potentially unsafe and not based on current research recommendations. In order to improve standards of care, it is imperative that nurses are aware of research evidence. This will enable nurses to make informed decisions about their own suctioning practices, based on the individual needs of the patient. All healthcare professionals are responsible for the quality of their clinical practice (Crimson 1999; DoH 1998; UKCC 1992a,b). Therefore, nurses need to ensure that their knowledge and clinical skills are up to date and evidence-based.

Conclusion

The literature reviewed has highlighted numerous factors that may increase the risk of suctioning—related complications for critically or acutely ill patients. The responsibility for this intervention rests with the nurse and any knowledge deficits may result in poor practice and dangerous suctioning techniques. In order to be accountable for performing this skill, nurses should be aware of current research recommendations and be able to implement safer suctioning practices in accordance with professional accountability, clinical governance and quality assurance requirements (DoH 1998; UKCC 1992a,b), thus ensuring that the highest possible standards of care are maintained. It is essential that nurses are taught correct suctioning techniques and that clinical guidelines are in place to ensure that practice is up to date. As this review has highlighted, few studies have investigated what occurs in actual practice. It is therefore recommended that further research is undertaken to explore the suctioning practices of healthcare professionals and to introduce educational strategies for ensuring that practice is evidence-based.

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