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Use and care of an endotracheal/ tracheostomy tube cuff — are intensive care unit staff adequately informed?

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Summary

Background. There is an apparent high incidence of tracheal stenosis in the Bloemfontein area. The aim of this study was to determine intensive care unit (ICU) staff knowledge of the use and care of endotracheal and tracheostomy tube cuffs.

Methods. One hundred and twelve qualified nurses, working in 11 different ICUs, were asked to complete an anonymous questionnaire regarding endotracheal/tracheostomy tube cuffs.

Results. The results highlight the following three areas of concern: (*i*) there was an overall misconception in 38% of the respondents that the function of the cuff was to secure the tube in position in the trachea to prevent self-extubation; (*ii*) accurate regulation of cuff pressure was not routine practice in any of the ICUs; and (*iii*) only half of the respondents felt their training regarding cuff care management was sufficient.

Conclusions. ICU staff had misconceptions regarding the function and care of endotracheal/tracheostomy tube cuffs. The concept of a higher cuff pressure for better stabilisation of the tube is probably an important factor that could have caused the increase in tracheal stenosis in the Bloemfontein area. Critical care nursing needs to emphasise the use of current techniques, discourage routine cuff deflation, and encourage collaboration with ICU physicians on standards of care. A protocol that could be used in the ICUs regarding the use and care of an endotracheal/tracheostomy tube cuff is proposed.

A tracheal stenosis can be caused by a direct traumatic injury to the trachea, severe tracheitis, or by factors related to intubation, i.e. cuff pressure, non-stabilised tube and poor hygiene.[1-4] Persistent high cuff pressure results in the destruction of the tracheal wall. The careful monitoring of cuff pressures, tube stability and hygiene of an endotracheal or tracheostomy (ET/TT) tube could play an important role in the prevention of tracheal stenosis.[3,4]

During the past few years an alarming number of patients have presented with acquired tracheal stenosis in the Bloemfontein area. Most patients were treated in intensive care units (ICUs) in the Free State. Therefore, the aim of this study was to establish whether ICU staff were adequately informed about the use and care of ET/TT tube cuffs.

Method

One hundred and twelve qualified nurses, working in 11 different ICU centres in the Bloemfontein area of the Free State, were asked to complete an anonymous questionnaire regarding the use and care of ET/TT tube cuffs. The nurses had to have been working for at least 6 months in their respective ICUs. The study took place over a 2-week period to ensure that the questions were answered impromptu, thus eliminating the chance of the nurses researching the topic. The ethics committee of the Faculty of Health Sciences, University of the Free State (UFS), approved the study.

Results were summarised using frequencies and percentages, or means or percentiles, as appropriate.

Results

The ICUs were not identified and were divided into government (group A) and private (group B) institutions. There were 66 respondents in group A and 46 in group B. The respondents' mean length of service in an ICU was 7 years (range 1 - 20 years) for group A, and 4 years (range 1 - 16 years) for group B.

There was no consensus regarding the length of time before an intubated patient, who was being ventilated, should undergo a tracheostomy. Answers ranged from 5 days to 6 weeks (mean 10 - 14 days) in both groups.

The answers received from the questionnaire are given in Table 1.

More than 90% of all respondents were unaware of the different types of cuffs available.

Most (83%) of the respondents (80% in group A and 89% in group B) felt that they were entirely responsible for their patients' cuff care management.

TABLE I. FUNCTION OF THE ET/TT CUFF

Answers given	Group A (*N* = 66)	Group B (*N* = 46)
Cuff's function:		
Secures tube in position (%)	**37**	**41**
Prevents self-extubation (%)	**46**	**26**
Prevents aspiration (%)	**74**	**86**
Seal for mechanical ventilation (%)	**48**	**71**
Do not know (%)	**14**	**10**

Most respondents in group A (84%) and more than half of respondents in group B (57%) indicated that they were unaware of any specific protocol regarding the care of tube cuffs in their respective units.

The answers regarding stability of the tube/cuff are represented in Table II.

TABLE II. TUBE STABILISATION METHODS

Answers given	Group A	Group B
Stabilisation of tube (methods)		
Fully inflate cuff to secure tube (%)	**32**	**4**
Correct techniques (strapping, etc.) (%)	**54**	**92**
Unaware of any method (%)	**14**	**4**

Regarding the care of an ET/TT tube and cuff, 50% of group A respondents were trained by a senior colleague, and 48% of group B respondents were trained at their college/university. Only half of all the respondents thought that the training they had received was adequate.

Most (76%) of group B respondents, but only 7.5% of group A respondents, were aware of an accurate way to measure cuff pressure. The availability of cuff pressure meters in private institutions could account for the difference in answers given by the two groups.

The respondents mentioned numerous complications arising from incorrect cuff pressure. Table III highlights these answers more specifically.

TABLE III. COMPLICATIONS OF INCORRECT CUFF PRESSURES

Answers given	Group A	Group B
Complications of incorrect pressure		
Tracheal necrosis (%)	**40**	**54**
Tracheal stenosis (%)	**16**	**21**
Miscellaneous (aspiration, dilatation, etc.) (%)	**20**	**16**
Not aware of any (%)	**24**	**9**

Discussion

These results highlight the following three areas of concern: (*i*) there was an overall misconception among 38% of the respondents that the function of the ET/TT tube cuff was to secure the tube in position in the trachea to prevent self-extubation; (*ii*) accurate regulation of cuff pressures was not routine practice in any of the ICUs; and (*iii*) only half of the respondents felt that their training regarding cuff care management was sufficient.

The most frequent cause of tracheal stenosis is iatrogenic (usually from intubation for ventilatory support).[1] This form of stenosis occurs with equal frequency in ET and TT tubes, but has become less common with new cuff technology.[5] The area of the trachea that is affected is usually 2 cm in length, and involves the anterior and lateral walls. The posterior wall is relatively protected from stenosis because of its ability to distend into the oesophagus. However, with a firm nasogastric tube in place, the posterior wall can also be involved.[5,6]

A tracheal stenosis may present directly, or hours and even months after extubation. Exertional dyspnoea is the most common presenting symptom. For adult males, the trachea is D-shaped with a transverse diameter of 23 mm (± 5 mm) and an anteriorposterior (AP) diameter of 18 mm (± 3 mm).[7] For adult females the transverse diameter is 20 mm with an AP diameter of 15 mm.[8] Exertional dyspnoea is usually evident when the tracheal lumen has been halved to ± 10 mm. Dyspnoea and stridor at rest only appear when the tracheal lumen is narrowed to 5 mm or less.[8] Some authors advocate routine tracheal assessment 6 weeks after extubation for every patient who underwent an event that may have caused a laryngo-tracheal injury. The events include long duration of intubation, excessive cuff pressures, infected tracheal secretions, and severity of hypoxic incidents.

Superficial damage to the tracheal mucosa by the inflated cuff can occur within 15 minutes at a lateral wall pressure of 20 mmHg, but is not progressive.[9] At a pressure of 50 mmHg, lasting for 15 minutes, damage to the tracheal mucosa is more extensive and can include partial denudation of the basement membrane. At a pressure of 100 mmHg, lasting for 15 minutes, the basement membrane disintegrates and the mucosal stroma is exposed. Within 4 hours at 100 mmHg, the damage can penetrate to the cartilage causing necrosis, which is then usually accompanied by bacterial invasion.[9] The trachea can resist long periods of cuffed intubation as long as the lateral wall pressure exerted by the cuff is kept below 25 mmHg, because venous capillary pressure is impeded at around 30 mmHg.[9,10]

There is no documented consensus regarding cuff care management and research results with recommendations for cuff care are inconsistent and conflicting.[11] The responsibility for cuff care management has shifted to the nursing staff. With this increasing responsibility, nursing practice should focus on cuff care management skills and include these in their training curriculum of ICU personnel.[11]

The following three areas of cuff care management are of utmost importance in preventing complications:

1. Stabilisation of the ET/TT tube

Stabilisation of the tube (and cuff) is crucial in tracheal mucosa protection. Pressure necrosis at the site of tracheostomy stoma can be reduced by the use of swivel connectors and ventilator tubing supports that will prevent undue traction on the tracheostomy tube.[8,12] The tracheal mucosa is sensitive to the motion at the tip of the tube against the tracheal wall, which can be reduced by correct positioning and securing of the tube.[8]

2. Local infection control

Careful wound care can help prevent local infection that may lead to further destruction of the exposed tracheal stroma or cartilage.[8] Although routine cuff deflation is not indicated, it can be used in the following selective situations: to clear the upper airway of secretions, to allow patients to vocalise, and to check for a cuff leak.[11]

The use of positive pressure when deflating cuffs to pre-

TABLE IV. PROTOCOL FOR ENDOTRACHEAL/TRACHEOSTOMY TUBE CUFF CARE

1. Measure cuff pressure 6-hourly and keep pressure below 25 mmHg
2.1 Endotracheal tube:
- **Secure endotracheal tube and ventilator piping adequately with ventilator support arm and adhesive techniques, always using strapping or equivalent to secure the tube to the patient's head**
- **Ensure that there is no traction on the endotracheal tube**
- **Ensure that the patient's head remains in the midline position**

2.2 Tracheostomy tube:
- **Use a ventilator support arm and sponge rest on the sternum with adhesive strapping to secure circuit pipes in place, also use adhesive strapping or equivalent to secure the tracheostomy tube to the patient's neck to ensure it remains stable (allow one finger space to prevent strangulation)**

3. No routine cuff deflation
4. Six-hourly gentle aseptic endotracheal/tracheostomy tube suctioning with proper oral care (no need to deflate cuff)
5. Ensure that when a humidification system is in use it is below the level of the patient to prevent aspiration of circuit fluids
6. Unless indicated, do not nurse the patient flat on his/her back, but rather position the patient with head elevated 30° - 45°
7. Use the smallest possible nasogastric tube to prevent posterior tracheal wall irritation

Situations that could jeopardise endotracheal/tracheostomy tube cuff care:
- **When patients are regularly turned to prevent pressure sores**
- **When changing dressings or dirty adhesive strapping**
- **While physiotherapy, especially chest physiotherapy, is being given**
- **During daily X-rays where patients are positioned for adequate X-ray films**

vent aspiration of upper airway secretions is a good technique that can help to prevent infection.[11]

3. Cuff pressure

Most physicians believe that a soft cuff on the ET/TT tube provides adequate protection of the tracheal mucosa. These soft cuffs can, however, produce suprisingly high mucosal pressures and tracheal wall necrosis if the cuff pressure is not controlled.[10] The literature recommends both the minimum leak technique (MLT) and the minimum occlusive volume (MOV) for cuff inflation and the monitoring of cuff pressure to prevent tracheal injury.[11] The MLT is the smallest volume of air needed in the ET/TT tube cuff, that still *allows* for a small air leak on inspiration.[11] The MOV is the smallest volume of air needed in the ET/TT tube cuff to *prevent* an air leak on inspiration.[11]

In patients receving mechanical ventilation with increasing airway pressures, the tracheal diameter widens on inspiration, and cuffs require higher cuff volumes and pressures to seal the dilated airway. The phenomenon known as 'chasing the trachea' can occur, which essentially is the scenario where more air volume is required in the cuff as the trachea is gradually 'stretched'. In this scenario, the cuff is inflated to a recommended safe range during inspiration, when the trachea is normally dilated, but during expiration, when the trachea narrows, the inflated cuff can cause stretching of the tracheal mucosa. Over time cuff pressure decreases and ventilation pressure also decreases because of air volume leaking around the cuff due to the loss of tracheal wall integrity.

Increasing amounts of air are then required in the cuff to seal the trachea and profound dilation of the trachea can occur.

To prevent tracheal injury the ultimate cuff is one that would be partially inflated on inspiration and partially deflated on exhalation.[11]

Any inflatable cuff, no matter how soft, is potentially harzardous when confined within the tracheal lumen with no safety mechanism for pressure control.[10] The volume of air necessary to raise the cuff pressure from the point of seal to an unsafe pressure (greater than 30 mmHg) is only 2 - 3 cc of air.[10] It is, however, unrealistic to expect that the inflation volume be monitored so closely in a busy ICU.[10]

In some modern ICUs there are continuous cuff pressure monitors relayed to the patient's digital display, enabling ICU staff to monitor cuff pressure accurately and continuously. The intra-cuff pressure is measured and this differs slightly from the tracheal mucosal wall pressure that is exposed to the cuff. This measurement is, however, sufficient in obtaining a reference value that can be monitored. In Third-World countries this technology is not readily available and a dynamic cuff system is sought that can safely control cuff pressure by continual measurement in an inexpensive way. The dynamic fluid-filled cuff system is being investigated as a possible option at the Faculty of Health Sciences, UFS, Bloemfontein.

This study has shown that ICU staff had misconceptions regarding the function and care of ET/TT tube cuffs. The concept of a higher cuff pressure for better stabilisation of the tube is probably an important factor that could have caused the increase in tracheal stenosis in the Bloemfontein area. Critical care nursing needs to emphasise use of current techniques (MLT, MOV),[11] discourage routine cuff deflation, and encourage collaboration with ICU physicians on standards of care. A protocol that could be used in the ICUs regarding the use and care of an ET/TT tube cuff is proposed in Table IV.

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