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ORIGINAL ARTICLE

Survey of Italian intensive care unit nurses' knowledge about endotracheal suctioning guidelines

Alessandra Negro[a,b,*], Roberta Ranzani[c,1], Mariagrazia Villa[a,2], Duilio Manara[b,c,3]

[a] General Intensive Care Unit, San Raffaele Hospital, Milan, Italy
[b] School of Nursing, Vita-Salute San Raffaele University, Milan, Italy
[c] San Raffaele Hospital, Milan, Italy

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Summary
Background: Endotracheal suctioning is a common procedure performed by intensive care nurses in order to establish and maintain gas exchange, adequate oxygenation and alveolar ventilation in critically ill patients under mechanical ventilation. As this procedure is associated with several complications and risks nurses should have an adequate knowledge on how to perform the procedure according to the evidence-based practice. Previously only a few studies have analysed nurses' knowledge of the guidelines on endotracheal suctioning.
Aim: To evaluate the knowledge of the American Association of Respiratory Care (AARC, 2010) evidence-based guidelines on the endotracheal suctioning technique by Italian intensive care nurses in different hospitals.
Materials and methods: An anonymous questionnaire based on previous studies was sent to a selected sample composed of the intensive care unit (ICU) nurses of 16 ICUs in 11 Italian hospitals.
Results: The questionnaire was sent to 379 nurses, with 65% of questionnaires returned completed. The total percentage of correct answers was 58%, and nobody completed the questionnaire without mistakes. Moreover, only 2.5% ($n = 6$) of the nurses gave 9/10 correct answers. Correct answers were more common amongst the more experienced ICU nurses.

* Corresponding author at: Via Panzeri 9/a, 20864 Agrate Brianza (MB), Italy. Tel.: +39 3473059883.
E-mail addresses: negro.alessandra1@gmail.com (A. Negro), robyranzani@hotmail.it (R. Ranzani), villa.mariagrazia@hsr.it (M. Villa), manara.duilio@hsr.it (D. Manara).
[1] Address: Via XXV aprile 11, 20060 Cassina de Pecchi (MI), Italy. Tel.: +39 3408896175.
[2] Address: Via Pontida 6/a, 20063 Cernusco sul Naviglio (MI), Italy. Tel.: +39 3388799014.
[3] Address: Via don Seghezzi, 2, 24021 Albino, Bergamo, Italy.

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Conclusion: Italian ICU nurses' knowledge of guidelines on endotracheal suctioning was not complete; however, experienced nurses demonstrated a better knowledge of the subject.

Implications for Clinical Practice

- Endotracheal suctioning is associated with risks and complications and it is considered one of the most painful experiences among ICU patients.
- The lack of updated knowledge about endotracheal suctioning among ICU nurses could be dangerous for mechanically ventilated ICU patients.
- A better training and education about the updated guidelines among nurses is warranted.

Introduction

Endotracheal suctioning is one of the most common procedures performed by intensive critical care nurses in order to establish and maintain gas exchange, adequate oxygenation and alveolar ventilation in critically ill mechanically ventilated patients (AARC, 2010; Pedersen et al., 2009). Physiologically, there are several mechanisms that allow removal of dangerous microorganisms from the respiratory system; the ciliate cells, the local immune system and the cough reflex. Nevertheless, in patients on mechanical ventilation the endotracheal tube inhibits these physiological processes, making suctioning unavoidable in order to remove endotracheal secretions and to prevent atelectasis and alveolar collapse. This procedure is associated with complications and risks: bleeding, lesions of the tracheal mucosa, infections, atelectasis, hypoxaemia, cardiovascular instability and elevated intracranial pressure (AARC, 2010; Pedersen et al., 2009). Moreover it is considered one of the most painful experiences among ICU patients (Patak et al., 2004). Several studies (Day et al., 2002a,b; Pedersen et al., 2009) and guidelines provide data on when and how to perform the procedure.

In 2010 the American Association of Respiratory Care (AARC) published the AARC Clinical Practice Guidelines on endotracheal suctioning of mechanically ventilated patients with artificial airway, based on 10 recommendations. Nevertheless, only a few studies analysed if the guidelines for endotracheal suctioning are known and correctly followed by ICU nurses. Day and collaborators in the UK conducted the most important research on the topic (Day et al., 2001, 2002a,b, 2009). They showed that nurses are often not aware of the existence of guidelines and studies on this issue; moreover they found that there is a considerable discrepancy between guidelines and nurses' practice. Endotracheal suctioning guidelines are widely available in Italy through websites and scientific literature, though not in the Italian language. No study evaluated the knowledge of Italian ICU nurses about endotracheal suctioning guidelines.

Aim

To evaluate the knowledge of the evidence-based American Association of Respiratory Care (AARC, 2010) guidelines on the endotracheal suctioning technique by Intensive care nurses in different Italian hospitals.

Materials and methods

Design

Cross-sectional survey (Lo Biondo-Wood and Haber, 2001).

Research questions

What is the knowledge of Italian ICU nurses about best practices regarding endotracheal suctioning? Does knowledge vary among experienced vs. inexperienced ICU nurses?

Setting

Eleven hospitals situated in five Regions in the North-centre of Italy (Liguria, Lombardy, Piedmont, Umbria and Tuscany) were recruited to participate by convenience sampling. At the time of the survey there were 413,616 nurses in Italy, while the number of Italian ICUs was approximately 333; there is no official national register. The number of ICUs in the regions investigated was 85.

Instrument development

A panel of experts in the field of critical care nursing techniques developed a multiple-choice questionnaire, lacking a validated model from the literature, with only one correct answer. The questionnaire was subjected to a brief test phase, conducted with a small subset of respondents. In every question the ''I do not know'' choice was offered. The questionnaire was anonymous and it requested some supplementary information about the respondents, to investigate how long they had been working as nurses and how long they had worked in an ICU. The questionnaire included 10 questions, each describing a clinical case to facilitate the interpretation of the questions and the context of the procedures. The questions were based on the 10 recommendations of the American Association of Respiratory Care guidelines (AARC, 2010) and the review by Pedersen et al. (2009).

Table 1 AARC recommendations (2010).

16.1 It is recommended that endotracheal suctioning should be performed only when secretions are present, and not routinely. (1C)
16.2 It is suggested that pre-oxygenation be considered if the patient has a clinically important reduction in oxygen saturation with suctioning. (2B)
16.3 Performing suctioning without disconnecting the patient from the ventilator is suggested. (2B)
16.4 Use of shallow suction is suggested instead of deep suction, based on evidence from infant and paediatric studies. (2B)
16.5 It is suggested that routine use of normal saline instillation prior to endotracheal suction should *not* be performed. (2C)
16.6 The use of closed suction is suggested for adults with high FIO2, or PEEP, or at risk for lung derecruitment (2B) and for neonates. (2C)
16.7 Endotracheal suctioning without disconnection (closed system) is suggested in neonates. (2B)
16.8 Avoidance of disconnection and use of lung — recruitment manoeuvres are suggested if suctioning — induced lung derecruitment occurs in patients with *acute lung injury*. (2B)
16.9 It is suggested that a suction catheter is used that occludes less than 50% of the lumen of the ETT in children and adults, and less than 70% in infants. (2C)
16.10 It is suggested that the duration of the suctioning event be limited to less than 15 seconds. (2C)

The order of the questions followed the sequential phases of the endotracheal suctioning, from the preparation of the materials to the execution of the procedure. The questionnaire is presented in Appendix A (Table 1).

Procedures

After obtaining the required authorisation for the distribution of the questionnaire from the nursing and health departments of the various hospitals, we proceeded to contact by telephone the nursing coordinators of the operating units, in order to agree on how and when to forward the research material. Different modes of delivery and collection of the questionnaires were adopted, according to the needs and preferences of the various operating units. Primarily they were distributed and collected, in paper form, either manually or by correspondence. In cases where the questionnaires were sent by e-mail, the nurses were obliged to personally send answers by e-mail. The questionnaire was accompanied by a presentation letter, instructions for the correct compilation of the document and information regarding data protection.

Data analysis

Collected data were analysed statistically using the GraphPad Prism 5 program, performing a Fisher's Exact Test two-tailed, for the analysis groups small in number ($n < 300$), and a Chi-square test to examine all the answers together, given the great abundance of data.

Table 2 Description of the sample and distribution of returned questionnaires.

	No. of ICU	No. of nurses	No. of questionnaire returned
General	9	214	142
Cardiosurgical	3	80	57
Neurosurgical	3	63	39
Coronary care unit	1	22	9

The sample

A purposeful sample was selected. The questionnaire was administered to the nurses of 16 ICUs. The sample was composed of 379 nurses from 16 ICUs of 11 Hospitals, forming a research network of experts.

Inclusion criteria: Italian ICU nurses, caring for adult patients.

Exclusion criteria: Paediatric and neonatal Italian ICU nurses.

The research was conducted from May to September 2011 (Table 2).

Ethical issues

The study was approved by the Internal Review Hospital Board of each participating hospital. Each participant was asked for their consent after the research project design and its purposes were explained in detail through the presentation of the whole protocol. Anonymity and confidentiality were assured as was the freedom to leave the study at any time. The participants gave their consent at the beginning of the study, after its presentation. All participants remained involved voluntarily in the study until its completion.

Results

The questionnaire was administered to 379 nurses; 247 (65%) questionnaires were compiled and returned. Among the 247 nurses who returned the questionnaire, 57% ($n = 142$) worked in a general ICU, 23% ($n = 57$) in a Cardiovascular ICU, 16% ($n = 38$) in a Neurosurgical ICU and 4% ($n = 9$) in a Coronary care unit (Tables 3 and 4).

Table 3 Distribution of years of work in ICU.

Years of work	Number of nurses	%
<1	5	2
1—5	72	29
6—10	59	24
>10	111	45

Table 4 Distribution of years of work of nurses.

Years of work in ICU	No. of nurses	%
<1	22	9
From 1 to 5	103	42
From 6 to 10	65	26
>10	57	23

The percentage of correct answers was 58% and nobody completed the whole questionnaire without mistakes. Moreover, only 2.5% ($n = 6$) of the nurses answered 9/10 questions correctly.

Nurses who had been working for less than five years had a lower percentage of correct answers than the others (correct answers: 383/770 vs. 1033/1699, $p \leq 0.0001$ Chi-square test) (Tables 5 and 6).

Nurses working for more than five years answered the questions about the diameter of the suction catheter, volume of saline to be injected, the depth of insertion of the suction catheter into the endotracheal tube and the negative pressure to be applied better than the less experienced colleagues.

Regarding the length of working experience in ICU, nurses working in an ICU for more than five years answered the questionnaire better than less experienced colleagues (correct answers: 735/1220 vs. 669/1250, $p = 0.0009$ Chi-square test). A statistically significant higher percentage of correct answers were observed from nurses working in an ICU for more than one year compared to nurses with less than one year experience. With the question about the correct duration of endotracheal suctioning (188/225 people vs. 13/22 people who work in a I.C.U. for less than one year, $p = 0.0093$ Fisher's Exact Test), on the negative pressure to be applied (correct answers 165/225 vs. 11/22, $p = 0.0235$ Fisher's Exact Test) and the disconnection of the patient from the ventilator during the procedure (correct answers: 212/225 vs. 16/22, $p = 0.0032$ Fisher's Exact Test). Moreover, nurses working in an ICU for more than five years had a statistically significant higher number of correct answers compared to their less experienced colleagues for the question about the diameter of the suction catheter (correct answers: 92/122 vs. 63/125, $p \leq 0.0001$ Fisher's Exact Test), about pre-oxygenation (correct answers 42/122 vs. 29/125, $p = 0.0672$ Fisher's Exact Test) and the volume of saline to be instilled (correct answers 80/122 vs. 60/125, $p = 0.0069$ Fisher's Exact Test).

Nurses from General ICU performed better than others (855/1420 correct answers vs. 311/570 correct answers for Cardiosurgical ICU, $p = 0.0235$, vs. 201/390 correct answers for the Neurosurgical ICU, $p = 0.0025$, vs. 42/90 correct answers for the Coronary care unit CCU, $p = 0.0145$ Fisher's Exact Test).

Table 5 Correct/incorrect answers and years of work.

Years of work	Correct answers	Wrong answers
<1	21	29
From 1 to 5	362	358
From 6 to 10	350	240
>10	683	426

Table 6 Correct/incorrect answers and years of work in ICU.

Years of work in ICU	Correct answers	Incorrect answers
<1	103	117
From 1 to 5	566	464
From 6 to 10	381	269
>10	354	216

Discussion

Several nurses in the study were unaware of recommended practices and a number demonstrated potentially unsafe practices. In agreement with previous research (Day et al., 2001), there is a lack of relevant knowledge regarding the tracheal suctioning procedure, although there can be no real comparison between the two studies, due to the differences in the research methodology. In Italy, this data could be explained by a lack of knowledge of guidelines, perhaps due to the understanding of the English language by many nurses. Even the basic and advanced training programmes available may partially explain this lack of knowledge of the guidelines. Intensive and Critical Care Nursing course programmes in our country do not reach this level of specialisation and are reserved for postgraduate courses that are frequented by a minority of nurses. Sole in an interesting multisite survey on suctioning techniques and airway management practice found many differences in nurses' clinical practice, stating that one reason for the finding may be that most staff members (83%) do not base their practice on published reports (Sole et al., 2003).

The question about the closed suction circuit obtained few correct answers: this could suggest that nurses are not up to date regarding the new guidelines. Otherwise, it may be a misunderstanding caused by the misinterpretation on the known indications, which indeed recommend closed circuit suction only for patients who need a high FiO2 and PEEP or at risk of lung depression and advise suction without disconnecting the patient from the ventilator (AARC, 2010).

The increase in the answers ''I do not know'' for question number 9 about the negative pressure, may be due to the fact that the pressure of the aspirator on the wall is usually preset at the same level; consequently the nurses do not pay attention to checking it prior to suction.

Nurses with more than five years of work experience and those with at least one year of ICU experience had a better knowledge of the procedure.

Nurses who worked less than one year in an Intensive Care Unit have little knowledge about the duration of the suction, the negative pressure and the disconnection of the patient from the ventilator. This result probably explains that the nurses do not have enough experience to know each feature of the procedure. These results suggest that work experience could improve the knowledge of the nurses in these wards.

It is also noticeable how the ward influences the knowledge of the nurses. For example the results show that the

nurses who work in General ICU have more knowledge about endotracheal suctioning compared to nurses of other wards. In particular General ICU nurses who have been working for more than five years have accurate information about the diameter of the suction catheter, the saline instillation and the pressure. This outcome might suggest that it is only with experience that nurses can understand and become confident with these technical and specific procedures.

Overall, beside the limited knowledge of the guidelines, there is probably an incorrect interpretation of them. The English language of the guidelines could be an obstacle that limits its understanding of them; it would be appropriate to provide a translation.

Moreover, we believe there is an unmet need for the training and education of tracheal suctioning, e.g. with the introduction of simulation techniques, which give the opportunity to practice without the risk of harming an actual patient (Jarzemsky and McGrath, 2005).

One limitation of this investigation is that it did not analyse how nurses perform the procedure during daily practice. Findings of Day et al. (2002a,b) indicate that there was no significant relationship between nurses' theoretical knowledge and observed practice, so it would be interesting to understand if there is a discrepancy between theory and practice and to understand the nurses' motivation for their actions.

Limitations

The questionnaire we used was not validated; however, it was developed by experts in the field of nursing in critical care, it underwent a brief test phase before the final version.

Years of experience were grouped and treated as a categorical variable; this stratification of a continuous variable may have introduced more bias.

The sample could not be representative of the Italian ICU nurses, due to the convenience sampling method used.

It would be important to know potential reasons for nurses' refusal to participate. There may be a selection bias, in that nurses with limited knowledge may have declined to participate in the study.

Although the aim of the survey was to evaluate the knowledge of evidence-based guidelines on the endotracheal suctioning technique, there could be some misunderstanding in the interpretation of these guidelines and results could partly be a reflection of procedures and daily practice.

Conclusion

Endotracheal suction is an invasive procedure that can cause significant problems; the lack of up to date knowledge revealed by our survey could increase the risk of complications. A better training and education programme about updated guidelines among nurses is warranted. A better basic training and continuing education on critical care procedures and guidelines among Italian nurses is also needed.

This study may be the beginning of action-research projects for the activation and implementation of methods to improvement in hospitals, in order to better clinical practices.

Conflict of interest statement

The authors have no conflict of interest to declare.

Appendix A. Questionnaire

Personal information:

- **How long have you worked as a nurse?**
  /__/ < 1 year /__/ 1-5 years /__/ 6–10 years /__/ > 10 years
- **How long have you worked in your actual ward?**
  /__/ < 1 years /__/ 1 – 5 years /__/ 6-10 years /__/ > 10 years

1. **A patient from ER is coming to ICU with acute respiratory failure; he has already been intubated and is connected to mechanical ventilation. The ICU nurse prepares the devices to use, included a closed suction circuit.**
   - ❑ Correct, because it should be used for all intubated patients or with a tracheostomy, as recommended by guidelines.
   - ❑ Correct, because the patient probably needs high FiO2 and PEEP.
   - ❑ Not correct, because the closed circuit should only be used for newborns.
   - ❑ I do not know.
2. **The closed circuit prepared by the nurse has a suction catheter with a caliber of 14ch, and the patient is intubated with a n°8 endotracheal tube.**
   - ❑ Not correct, because it is necessary to choose the largest …suction catheter.
   - ❑ Correct, because the suction catheter should occlude less than one half of the tube lumen.
   - ❑ Not correct, because the suction catheter should occlude less than 2/3 of the tube lumen.
   - ❑ I do not know.
3. **The patient presents GCS 3, so the nurse decides to suction him once a shift, at least.**
   - ❑ Not correct, because the maneuver should be performed every two hours.
   - ❑ Correct, in order to maintain the airways open.
   - ❑ Not correct, because the maneuver should be performed only if necessary.
   - ❑ I do not know.
4. **The nurse decides to perform manual lung-recruitment before the suction:**
   - ❑ Not correct, because it should be performed only after a medical prescription.
   - ❑ Correct, because it should be performed before suctioning, as recommended by guidelines.
   - ❑ Not correct, because it should be performed only if occurred desaturation during the previous suctioning.
   - ❑ I do not know.
5. **During the first suction the patient switched from 97% to 74% of peripheral oxygen saturation. The nurse should:**
   - ❑ Preoxygenate the patient before suctioning, as recommended by guidelines.
   - ❑ Preoxygenate the patient, because of desaturation during the previous tracheal suctioning.
   - ❑ Perform suctioning normally, because preoxygenation should be performed only when a desaturation less than 60% occurs.
   - ❑ I do not know.
6. **The nurse decides to perform saline instillation, in order to facilitate the suction of dense secretions**
   - ❑ Correct, if you use close suction circuit.
   - ❑ Not correct, because the maneuver does not provide clear benefits.
   - ❑ Correct, because it facilitates the dissolution of secretions.
   - ❑ I do not know.
7. **The nurse decides to perform a long suction, in order to remove the major quantity of secretion.**
   - ❑ Correct, because the maneuver should last one minute at least.
   - ❑ Not correct because the maneuver should last less than one minute.
   - ❑ Not correct because the suction should last less than 15 seconds.
   - ❑ I do not know.
8. **The nurse inserts the suction catheter into the endotracheal tube until it meets resistance, and then he retracts the catheter 1cm, before to apply negative pressure.**
   - ❑ Correct, because it reduces the risk to cause suction injury on endotracheal mucosa.
   - ❑ Not correct because the suction catheter should be inserted into the artificial airways for the whole length of endotracheal tube.
   - ❑ Not correct because suction catheter should be inserted until 2/3 of the length of endotracheal tube.
   - ❑ I do not know.
9. **The nurse decides that endotracheal suctioning is needed with a negative pressure of 170mm/Hg, in order to remove the most secretions.**
   - ❑ Correct because the maneuver provides complete removal of secretions.
   - ❑ Not correct because the negative pressure should be below 150mm/Hg in adult.
   - ❑ Not correct because the negative pressure should be over 170 mm/Hg in adult;
   - ❑ I do not know.
10. **The nurse takes care not to disconnect the patient from the ventilator during the tracheal suction.**
    - ❑ Correct, because it facilitates the continuation of mechanical ventilation.
    - ❑ Not correct, because it does not permit suction of all secretions.
    - ❑ Correct because the nurse can suction all secretions.
    - ❑ I do not know.

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