

Keywords:

closed suction system, open suction system,
endotracheal suction, ICU, nurses, suction capacity, guidelines

autore responsabile della corrispondenza:

Valeria Massida - mariavaleriamass@gmail.com

Letizia Pau¹, Cesar Ivan Aviles Gonzalez^{1,2,3}, Simone Paba^{1,2}, Maria Rita Pinna^{1,2}
Roberta Rosmarino^{1,2}, Valeria Massida^{1,2}

ANALYSIS OF THE USE OF THE CLOSED TRACHEAL SUCTION SYSTEM BY NURSES IN ICU

ABSTRACT

BACKGROUND

Tracheal suctioning is one of the most common procedures performed in intensive care units (ICU) that ensures airway patency and a good ventilator pattern in patients with OT tube or tracheostomy. This procedure can be carried out by two different devices: an open tracheal suction system (OTSS) and a closed tracheal suction system (CTSS), each with its own peculiarities.

After an analysis of the scientific literature, which supports the use of the CTSS, it was decided to conduct research in the intensive care units of Brotzu's and Duilio Casula's hospitals of the city of Cagliari, to analyse the actual use of the device by nurses, highlighting difficulties and doubts. The CTSS has always been the subject of discussion among nurses in ICU.

MATERIALS AND METHODS

The research study was carried out by performing random face-to-face interviews of nurses during data collection.

The interview consisted of eleven questions. At the same time, random observations of the CTSS's use were made, using the Duilio Casula Hospital ICU's protocol as a guide.

RESULTS

It was clear that the CTSS is used extensively, even daily. 62,5% of nurses believed that the CTSS was more effective, and 62,5% of the interviewed nurses reported using the device in all intubated and tracheostomy patients. However, 41,3% of nurses reported not using the device because it was believed to have a lower suction capacity.

The observation's results highlighted mistakes such as poor hand hygiene (89,5% of the observations), a failure to disconnect the probe from the suction system (63,15%), and repeated insertion of the probe (31,6%), and poor manual skills using the device (15,8%).

CONCLUSIONS

The analysis of the results highlighted how nurses had a good theoretical knowledge of the CTSS, but have been observed a lot of mistakes in the use of the device.

This suggests to consider the organization of practical re training courses in the intensive care units.

INTRODUCTION

Tracheal suctioning is a common procedure performed in ICU that ensures airway patency and a good ventilator pattern in patient with OT tube or tracheostomy. It can be carried out with two different devices with their own peculiarities: the open suction system (OTSS) and the closed suction system (CTSS). The correct use of those devices has a great clinical importance and it was considered by the World Health Organization (WHO) and by the Centre for Disease Control (CDC) as a high risk procedure, like the intubation procedure or the position of a tracheostomy⁽¹⁾. So, it is very important to know the characteristics of each device in order to be able to use it better with the patients.

The OTSS, but not the CTSS seems to be able to determine an increase in airway resistance and peak inspiratory pressure. So elevated airway resistance before the endotracheal suction may justify the use of a CTSS despite the OTSS that can be also contraindicated⁽²⁾.

However Naiara I. et al. highlight that hemodynamic and respiratory changes turned to physiological parameters one hour after the endotracheal suction using both of the devices⁽³⁾.

Moreover the pain score was significantly higher in the pain using OTSS during the endotracheal suction and after ten minutes⁽⁴⁾. Similar results were also obtained by Abbasali Ebrahimian et al. who analysed pain in patients during the endotracheal suction with both devices with CPOT scale⁽⁵⁾.

About the possible use of the CTSS as a method to prevent VAP, it seems that the type of endotracheal suction system, CTSS and OTSS, had no effect on occurrence of VAP^{(6) (7) (8)}.

Moreover the CTSS allow the removal of tracheobronchial secretions without disconnecting patient's ventilatory circuit.

So it helps to prevent alveolar decruitment, hypoxia⁽¹⁾ and aerosol generation, particularly in airway management in patients with COVID-19^{(1) (9)}. The use of CTSS exposes the risk to incomplete probe retraction that ensures airway patency and causes a Tidal volume reduction^{(10) (11)}.

This study was carried out to investigate the real use of the CTSS by nurses in intensive care units. In some empirical observations have emerged some doubt about the CTSS and its efficiency.

MATERIAL AND METHODS

Design: This is a quantitative descriptive observational study with the purpose of investigating the use of the closed suction system by nurses in the Intensive Care Units and to highlight the main doubts and mistakes in the use of the CTSS.

This can help to have a better use of the device. Data collection was conducted in July and August of 2022.

Setting: The research was carried out in the intensive care units of the two hospitals of the city of Cagliari, Brotzu Hospital and Duilio Casula Hospital. There, almost all of the patients have OT tube or a tracheostomy. The ICU analysed are equipped with eleven beds.

Study population: Have been admitted to the study all the nurses working during the data collection in the hospitals considered, totally 40 nurses.

Nurses who have not given availability, or who were involved in the research, were excluded from the study.

Data collection: The data collection tools included interviews and observations.

Interviews were carried out using an half-structured interview (annex N°1) composed by eleven questions with open and closed answers.

The first part of the interview consisted on the collection of the characteristics of the population (age, experience in ICU, the knowledge about a protocol of the use of CTSS), instead the second part was about the use and the possible difficulties using CTSS.

Observations were carried out in a random way on nurses using CTSS. ICU's protocol of one of the hospitals was used to assess the use of CTSS (annex N°2).

RESULTS

A total of forty interviews were conducted. The nurses participating in the study were between 25 and 58 years old with an average age of 38,4 years old.

About the school education of the research population:

- 25% of the nurses had a certificate or similar
- 65% of the nurses had a three-year degree
- 10% of the nurses a master's degree

Considering other titles:

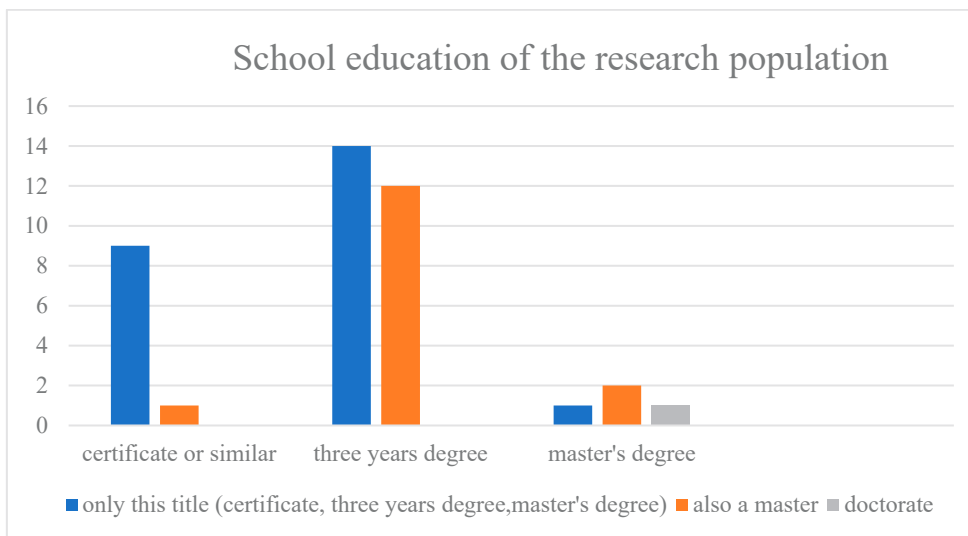
- 9 nurses had only a certificate or similar
- 1 nurse had a certificate and a master
- 14 nurse had only a three-year degree
- 12 nurses had a three-year degree and a master
- 4 nurses had master's degrees, and two of them also one or more master, and one of them also a doctorate

or aerosolization or with the necessity of frequent endotracheal aspiration.

Have been reported the reasons why nurses didn't use the CTSS:

- Ineffective suction (41,3%)
- Unavailable device (19,56%)
- Using CTSS in the routine (13,04%)
- Patient was close to extubation (10,5%)
- Lack of continuity between nurses (2,17%)
- Others (2,17%)

87% of nurses reported to change the device in the correct way. 85% of the research population reported an early change of the device mainly because of a damage and because of an ineffective suction and the necessity to use the OTSS. 99% of nurses washed the probe correctly, according to the manufacturer's indications. About the choice of the probe diameter, 52,5% of nurses reported to choose it on the basis of the OT tube or of the tracheostomy diameter, the 27,5% of nurses used this element and also the secretion density, 15% of nurses did not possess any



12,5% of nurses were working in ICU for less than a year, 42,5% for one to five years, 15% for five to ten years, 30% for more than ten years.

Everybody reported using the system, 67,5% every day at work. About the existence of a CTSS protocol in ICU, 50% of the nurses answered correctly, 30% answered wrong, 20% didn't know the answer.

62,5% of the nurses reported to use CTSS in every patient with OT tube or tracheostomy, 5% used CTSS just if the patient already have it, 32,5% only in some type of patients (patients with OT tube or tracheostomy with diseases transmissible by droplets

criteria, 5% reported other answers.

Another question investigated the main difficulties using CTSS:

- 26,15% of nurses had the feeling of not sucking properly, in particular with high density secretions
- 21,5% of nurses reported that the CTSS didn't have an effective suction capacity
- 15,4% of nurses reported an ineffective suction capacity of the CTSS with a diameter probe of less than 16 Ch
- 12,3% had an important difficult with the manual skills

- 9,23% didn't reported any difficulties
- 15,4% reported other difficulties like a difficult insertion of the catheter into the tracheostomy because of the inner cannula, or like a reduced aspiration capacity but resolvable by aerosol therapy or reducing PEEP

About the main complications nurses reported: no complications (50% of nurses), hypoxia because of a lower aspiration capacity (35% of nurses), an abnormal ventilation because of an lower suction capacity (35%), decreased patient comfort because of a frequent use of the CTSS because of a lower suction capacity (20%), discomfort from incorrect and incomplete probe retraction (2,5%).

About the lower suction capacity of the CTSS, have been analysed two different probes of the OTSS with different diameter of 14 and 16 Ch, both of them with a length of 50 cm, and two different CTSS probes of with a diameter of 14 and 16 Ch with a length of 54 and 58 cm. Considered a OT tube with a diameter of 7,5mm, connected with one of the probe, the probe will be introduced for a length of about 10 cm.

In fact, according to the guidelines the probe must be introduced for the same length of the OT tube or the tracheostomy tube. (1)

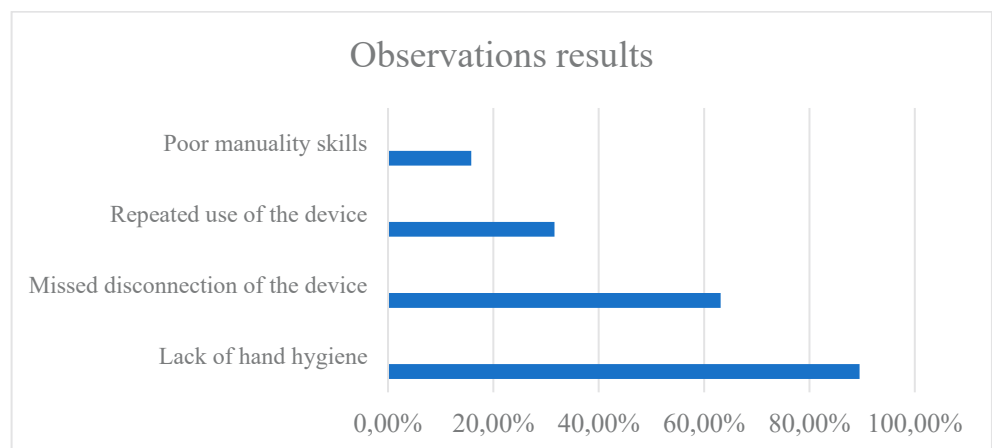
So the different length of the OTSS and CTSS probe couldn't change the different lower suction, but it could be given by a different movement during the removal of the probe during the aspiration (using the OTSS is a circular movement whereas in the CTSS is a linear movement).

At the end of the interview the nurses were asked which system they preferred and 62,5% of the nurses reported to choose CTSS, 32,5% chose OTSS, while 27,5% of nurses reported that the devices were the same.

Observations highlighted some nurses mistakes using CTSS, compared to the ICU's protocol based on guidelines. A total of 25 observations were made, taking into account that tracheal suction is a procedure carried out as needed in accordance with

the guidelines. Six of them couldn't be considered because CTSS has been removed and OTSS has been used after this operation. It's important to highlight that CTSS has been linked after the OTSS use, a very dangerous behaviour for the patient safety. A total of 19 observations have been analysed:

- 89,5% of procedures did not perform hand hygiene before the use of the CTSS, of the most important indications for the prevention of infection
- 63,15% of procedures did not perform disconnection of the CTSS from the suction system which could expose the patient to an increased risk of accidental extubation
- 31,6% of observations highlighted a repeated use of the probe without any pauses, instead of the guidelines which admit to repeat the procedure up to a maximum of three times with a break of 30-60 seconds between one aspiration and another
- 15,8% of observations was reported a poor manual skill using the CTSS, in particular inserting and removing the probe into the sleeve



CONCLUSIONS

The use of the closed suction system is still subject of discussion by nurses. There is an important use of the device and the research shows sufficient theoretical knowledge.

However it's important to highlight the nurses feeling of a lower suction capacity using CTSS, which however, cannot be justified with certainty by any scientific evidence.

However the observations highlights a lot of mistakes in the use of the CTSS.

This suggests the importance of organising re-training session with a practical approach, to improve the critical patients assistance.

In particular patients with important hypoxia during the endotracheal suction and to reduce aerosol generation.

REFERENCES

1. Imbriaco, G., & Monesi, A. (2021). Closed tracheal suctioning systems in the era of COVID-19: is it time to consider them as a gold standard? *In Journal of Infection Prevention* (Vol. 22, Issue 1, pp. 44–45). SAGE Publications Ltd. <https://doi.org/10.1177/1757177420963775>.
2. Raimundo, R. D., Sato, M. A., da Silva, T. D., de Abreu, L. C., Valenti, V. E., Riggs, D. W., & Carll, A. P. (2021). Open and closed endotracheal suction systems divergently affect pulmonary function in mechanically ventilated subjects. *Respiratory Care*, 66(5), 785–792. <https://doi.org/10.4187/RESPCARE.08511>.
3. Naiara Matilde, I., Rakel Ferreira, R., Vedovato, A., Maria Freire Vieira Lima, N., Castilho de Figueiredo, L., Dragosava, D., Marques Tonella, R., & Isabela Morsch Passos, A. (2017). Comparação dos Efeitos Hemodinâmicos e Respiratórios no Uso dos Sistemas de Aspiração Traqueal Aberto e Fechado Comparison of Hemodynamic and Respiratory Effects in the Use of Open and Closed Tracheal Suctioning Systems. *In J Health Sci* (Vol. 19, Issue 2).
4. Khayer, F., Ghafari, S., Saghaei, M., Yazdannik, A., & Atashi, V. (2020). Effects of open and closed tracheal suctioning on pain in mechanically ventilated patients. *Iranian Journal of Nursing and Midwifery Research*, 25(5), 426. https://doi.org/10.4103/ijnmr.ijnmr_135_18.
5. Ebrahimian, A., Tourdeh, M., Paknazar, F., & Davari, H. (2020). The effect of the open and closed system suction on pain severity and physiological indicators in mechanically ventilated patients with traumatic brain injury: A randomised controlled trial. *Turkish Journal of Anaesthesiology and Reanimation*, 48(3), 202–207. <https://doi.org/10.5152/TJAR.2019.03342>.
6. Coppadoro, A., Bellani, G., & Foti, G. (2019). Non-pharmacological interventions to prevent ventilator-associated pneumonia: A literature review. *In Respiratory Care* (Vol. 64, Issue 12, pp. 1586–1595). American Association for Respiratory Care. <https://doi.org/10.4187/RESPCARE.07127>.
7. Ardehali, S. H., Fatemi, A., Fariba Rezaei, S., Forouzanfar, M. M., & Zolghadr, Z. (2020). The Effects of Open and Closed Suction Methods on Occurrence of Ventilator Associated Pneumonia; a Comparative Study. *In Archives of Academic Emergency Medicine* (Vol. 8, Issue 1). <http://journals.sbmu.ac.ir/aaem>.
8. Hlinková, E., Nemcová, J., & Bielená, K. (2014). CLOSED VERSUS OPEN SUCTION SYSTEM OF THE AIRWAYS IN THE PREVENTION OF INFECTION IN VENTILATED PATIENTS. *Cent Eur J Nurs Midw*, 5(2), 63–710.
9. de Seta, D., Carta, F., & Puxeddu, R. (2020). Management of tracheostomy during COVID-19 outbreak: Heat and moisture exchanger filter and closed suctioning system. *In Oral Oncology* (Vol. 106). Elsevier Ltd. <https://doi.org/10.1016/j.oraloncology.2020.104777>.
10. Kumar, N., Singh, K., Kumar, A., & Kumar, A. (2021). Unusual cause of hypoxia due to incomplete removal of the closed suction catheter system during COVID-19 ventilation. *In Journal of Clinical Monitoring and Computing* (Vol. 35, Issue 6, pp. 1529–1530). Springer Science and Business Media B.V. <https://doi.org/10.1007/s10877-021-00695-z>.
11. Ruan, S. Y., Lin, F. C., Huang, C. T., Ku, S. C., & Wu, H. D. (2015). Effect of incomplete withdrawal of a closed-suction catheter on airway resistance. *In Intensive Care Medicine* (Vol. 41, Issue 8, pp. 1496–1497). Springer Verlag. <https://doi.org/10.1007/s00134-015-3886-y>.