Indonesian Journal of Global Health Research
Volume 8 Number 1, February 2026
e-ISSN 2715-1972; p-ISSN 2714-9749
http://jurnal.globalhealthsciencegroup.com/index.php/IJGHR

THE EFFECT OF COMBINED SUCTION TECHNIQUES ON PEEP AND OXYGEN SATURATION IN ICU PATIENTS : A SYSTEMATIC REVIEW

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ABSTRACT
Suction techniques in mechanically ventilated ICU patients affect important respiratory parameters, such as Positive End Expiratory Pressure (PEEP) and oxygen saturation. Open suction techniques can cause significant reductions in these parameters, necessitating a systematic evaluation of the effectiveness of combined suction techniques. The aim of this study is to provide evidence-based recommendations regarding the effects of combined suction techniques on PEEP and oxygen saturation in ICU patients. A systematic search was conducted in five databases of PubMed, ScienceDirect, EBSCO, and other databases was conducted for studies published between 2014 and 2024. The keyword using in English included "combined suction", "Ventilator", "ICU", "PEEP" and oxygen saturation. From the initial search, a total of 41 articles were identified. Ten full-text papers underwent a thorough evaluation after titles and abstracts were filtered according to the inclusion criteria (language, publication year, and open-access availability). Ten papers were chosen for final analysis after being critically evaluated and their applicability to the study's goals was evaluated. PRISMA guidelines were followed for study selection, and data extraction focused on PEEP and oxygen saturation results. A total of Based on 10 included literatures, it was shown that combined suction technique resulted in less decrease in PEEP and oxygen saturation compared to open suction technique. Pooled analysis showed that combined suction was superior in maintaining alveolar pressure and oxygenation during suctioning. The combined suction technique is more effective than the open suction technique in maintaining PEEP and oxygen saturation in mechanically ventilated ICU patients.

Keywords: combined suction; ICU; oxygen saturation; PEEP; ventilator

How to cite (in APA style)
Mubarok, A., Purnawan, I., & Ridar, I. (2026). The Effect of Combined Suction Techniques on Peep and Oxygen Saturation in ICU Patients: A Systematic Review. *Indonesian Journal of Global Health Research*, *8*(1), 949–956. https://doi.org/10.37287/ijghr.v8i1.1665.

INTRODUCTION

The ICU room is an intensive room that contains specialized staff and equipment used for observation, treatment, and therapy of patients suffering from life-threatening injuries and diseases. Patients admitted to the ICU room are critical patients who have impaired body functions (Ministry of Health, 2010). The use of a ventilator is required to improve oxygenation. One of the settings on the ventilator that can be used to develop alveoli is PEEP (Positive End Expiratory Pressure). PEEP is the positive pressure exerted at the end of expiration. PEEP is given to increase alveolar ventilation and help improve ventilatory perfusion. The opening of alveolar ventilation creates more gas exchange area (Carpio & Mora, 2023). PEEP also improves gas exchange, increases end-expiratory lung volume, improves lung homogeneity and reduces mortality (Ladha et al., 2015).

Oxygen saturation, also known as SpO2, is one of the important indicators for mechanically ventilated patients. Oxygen saturation causes an adjustment between fraction of inspired oxygen (FiO2) and arterial oxygen saturation. The safe limit for hypoxemia is 96-100% of the target oxygen saturation (Semler et al., 2022). In critical patients, hypoxemia can cause irreversible tissue damage (permanent neurological damage in less than 3 minutes), even death if treatment is not given (Cumpstey et al., 2022).

The patient was intubated before being mechanically ventilated. Intubation is the technique of inserting an endotracheal tube (ETT) using a laryngoscope. The use of an ETT increases mucus secretion in the patient. This increased secretion causes the cough reflex in patients with ETT to become thicker due to the warming and moisturizing effect of the upper respiratory tract where the ETT is placed. This leads to airway compromise. The action taken to provide an airway in an ETT is to perform suction or suctioning of mucus (Heriansyah et al., 2022).

Suctioning techniques are generally categorized into open suction and closed suction. Open suction involves removing the ventilator, inserting a suction catheter directly into the ETT, and removing the secretions. Closed suction, on the other hand, uses a one-way valve system, which allows suction without removing the ventilator (Pagotto, 2008). Each technique has different advantages and disadvantages. Closed suction is associated with better oxygenation, maintenance of PEEP, reduced risk of environmental contamination, and minimized lung volume loss compared to open suction. However, closed suction is more expensive, with one device costing around IDR 300,000, compared to IDR 20,000 for an open suction device (Elmansoury & Said, 2017; Heriansyah et al., 2022).

Although both techniques have been extensively studied, there is limited evidence regarding the effectiveness of combining these suction techniques to optimize PEEP and oxygen saturation. A combined approach has the potential to overcome the limitations of both techniques, thereby providing better outcomes for mechanically ventilated patients in the ICU. This study aims to systematically review the literature to evaluate the impact of combined suction techniques in maintaining PEEP and oxygen saturation in ventilated ICU patients. By addressing this gap, this study seeks to provide evidence-based recommendations to optimize suctioning practices in critically ill patients.

METHOD

The design of this article is a literature review with reference to the Preferred Reporting Items for Literature Review and Meta-Analyses (PRISMA). The author formulates PICO to direct in the clinical search of the article. Article search sources use electronic databases such as EBSCO, Google Scholar, IJSR, Pubmed, and Science Direct. The article search is adjusted to the inclusion and exclusion criteria that have been determined by the framework and keywords used so that the desired article is obtained. The keywords in the search for evidance based research in this literature review are "Combined Suction", "ICU", "ventilator", "PEEP" and "Oxygen Saturation". The data synthesized were open and closed suction interventions on PEEP and oxygen saturation of ICU patients in the form of randomized control trials (RCTs).

RESULT

The results of the selection of articles generated from the five databases are 482 articles. The results showed that 10 selected journal articles discussed about suction techniques to optimize PEEP and oxygen saturation in mechanical ventilation patient. The following is the selection of articles by following the PRISMA chart as part of a strategy in collecting articles that re considered relevant and support the search for related journals.

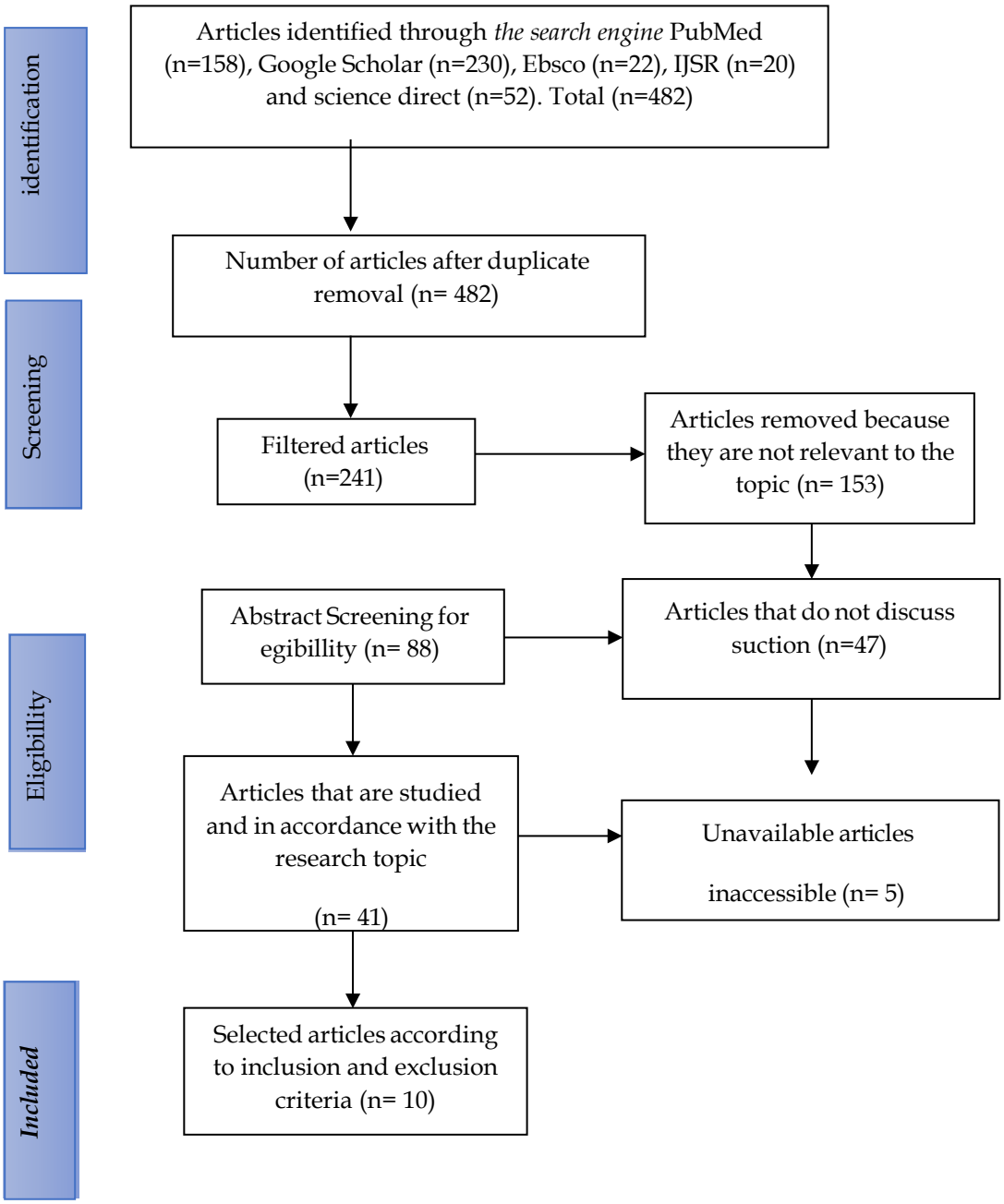

Figure 1. Prism Chart (strategy in article journal screening

Table 1
The Articles Reviewed

Article Title	Researcher & Year of Publication	Research Method/ Design	Intervention	Sample & Sampling Technique	Measured Externals	Result
Effects of combined tracheal suctioning and expiratory pause	Luciane de fraga martines,Wagner da silva naue Amanda soares skueresky (Martins et al., 2019)	Randomized crossover clinical trial study	Compare between combined tracheal suctioning and expiratory pause with closed suction	The sample comprised 31 patients who were divided into 2 control and inter vention groups	Effects Haemodynamics (heart rate, respiratory rate, mean arterial pressure, oxygen saturation) and weight of suctioned secretion	Combined suction increased the amount of secretion compared to closed suction. Combined suction increases the volume of suctioned

Article Title	Researcher & Year of Publication	Research Method/ Design	Intervention	Sample & Sampling Technique	Measured Externals	Result
						without altering hemodynamic parameters.
Comparison between the effect of open and closed tracheal suction systems physiological parameters of critically II patients	Hanan elashry,Mohamed Marwa More (Mohamed et al., 2023)	quasi exsperiment study	Compare effect of open and closed tracheal suction	A total of 94 samples were divided into 2 groups using the close and open suction techniques	Effect of open and closed suction on changes in physiological parameters (respiratory rate, oxygen saturation, blood pressure, mean arterial pressure)	No statistically difference between open and closed suction system in physiological parameters.
Effect of open versusclosed Suction on cardiorespiratory parameters and suction durati on among critically III mechanically ventilated patiens: quasi exsperiment	Zahra ahmed sayed (Ahmed Sayed, 2019)	quasi experiment study	Compare effect of open and closed tracheal suction	The study was conducted on 60 research samples divided into 2 groups (Open suction group and closed suction group)	Effect of section action in patients with endotracheal tube attachment	Close suction has a higher effect on cardiorespiratory parameters compared to open suction
Evaluating the influence of close suction on oxygen saturation hart rate and blood pressure in patien with mechanical	Erida Daulay,Mula tarigan,Farida linda sari tarigan (Daulay et al., 2024)	The researcher used a quantitative quasi-experimental design	Four-Level Modificati on Triage Five Level Emergenc y Severity Index (ESI) Triage	Sample purposiv collection technique , the number of samples is 199	The objective was to find out the effect of close suction action on oxygen saturation, heat rate and blood pressure	The application of closed suction system in the ICU showed promising results in maintaining the hemodynamic status of patients with mechanical ventilation
Comparison of the effects of open and close aspiration on end exspiratori lung in acut respiratory distress syndrome	Suleyman Yildirim, Saba Mukaddes Saygili, Onur Sunecli, Cenk Kirakli (Yildirim et al., 2024)	Randomized Crossover study	Compare effect of open and closed suction	Sample of this study is 20 patients who receiving invasive mechanical ventilation with ARDS	Effect of closed and open suction on loss of End-Expiratory Lung Volume (EELV)	Loss of EELV from endotracheal aspiration may cause alveolar collapse. In patients with ARDS, closed suction should be preferred over open suction since it is linked to

Article Title	Researcher & Year of Publication	Research Method/ Design	Intervention	Sample & Sampling Technique	Measured Externals	Result
						decreased volume loss at end-expiration without compromising ventilatory parameters.
Techniques Closed Suction Influence on Oxygen Saturation in Patients using Mechanical Ventilation in Intensive Care Unit Room	Widodo, Sri Daya Armiyati, Yunie Mustofa Machmudah (Widodo et al., 2020)	Pre-experimental study	Closed suction	Sample of this study is 14 patients in ICU with mechanical ventilation.	Effect of closed suction on oxygen saturation and AaDO2	Closed suction can decrease oxygen saturation. Up to 1200 milliliters of air may be lost from the lungs as a result of closed suction. Since hyperoxygenation can lower the incidence of hypoxemia by 49%, it must be performed prior to closed suction. Hyperoxygenation is advised prior to shutting the suction.
Effect of Open and Closed Tracheal Suctioning on Pain in Mechanically Ventilated Patients	Khayer, Fatemeh Ghafari, Somayeh Saghael, Mahmoud (Khayer et al., 2020)	Randomized Controlled Trial	Compare effect of open and closed tracheal suction	Sample of this study is 70 mechanically ventilated patients with tracheostomy	Effect of open and closed suction on pain	Pain score was significantly higher in the open suctioning group.
Comparing the effect of open and closed endotracheal suctioning on pain and oxygenation in post CABG patients under mechanical ventilation	Mohammadpour, Ali Amini, Shahram Shakeri, Mohammad Mirzaei, Sahereh (Mohammadpour et al., 2015)	Single blind parallel clinical trial	Compare effect of open and closed endotracheal suctioning	Sample of this study is 130 adult patients with CABG under mechanical ventilation	Effect of open and closed endotracheal suction on painand oxygen saturation	Open suction affects oxygen saturatio more than closed suction. Open and closed suction not have impact on pain during suctioning.
Open and closed endotracheal suction systems divergently affect pulmonary function in mechanically ventilated subjects: A quasi randomized clinical trial	Raimundo, Rodrigo Sato, Monica (Raimundo et al., 2021)	Quasi randomized controlled trial	Compare effect of open and closed suctioning	Sample of this study is 66 patients with under mechanical ventilation	Effect of open and closed endotracheal suction systems on pulmonary function	Open suction caused significantly increases airway resistance and peak inspiratory pressure.

Article Title	Researcher & Year of Publication	Research Method/ Design	Intervention	Sample & Sampling Technique	Measured Externals	Result
Effect of zero peep and <1,0 FiO2 on SpO2 and PETCO2 during Open Endotracheal Suctioning	Vianna, Jacqueline (Vianna et al., 2020)	Prospective, randomized, single blind	Effect of open suction	Sample of this study is 48 patients with mechanical ventilation	Effect of to analyze the behavior of SpO2 and end-tidal CO2 pressure (PETCO2) in open endotracheal suctioning	Following open endotracheal suctioning, neither SpO2 nor FIO2 significantly increased in the intragroup comparison with 0 PEEP baseline.

DISCUSSION

Based on the research findings presented above, it is evident that many methods have been used to techniques suctioning in patients with endotracheal intubation mechanical ventilation in the intensive care unit (ICU). Nonetheless, endotracheal intubation is one of the most significant risk factors linked to the buildup of mucus discharges in the airways, which is frequently seen in critically ill patients (Li Bassi et al., 2012). Through a two-phase gas–liquid flow mechanism, inspiratory and expiratory fluxes can also affect mucus transport. The three main variables that affect mucus transportation through the air flow are mucus viscosity, inspiratory/expiratory air velocity, and mucus layer thickness. Due to sedation and the endotracheal tube itself, people on mechanical ventilation are unable to cough effectively (Martins et al., 2019). The method used to remove mucus and free the airway is suction. There are three methods of suction. These methods are open suction, closed suction and combined suction. Each method has its own advantages and disadvantages.

Open suction method requires disconnecting the patient from the ventilator and inserting A single-use disposable suction catheter (Raimundo et al., 2021). Research indicated that in order to prevent lung infections, the open suction system has to be operated aseptically. Although open suctioning is important, it can result in hypoxemia, which is a common disadvantages of this suctioning technique (Tavangar et al., 2016). Other disadvantages of open suction is hypoxemia because when the suction is applied, removing the oxygen source from the patient's airway may cause hypoxemia (Tavangar et al., 2016). Closed suction method catheter is suction with enclosed in a transparent plastic sheath and allow the patient to remain on the ventilator during suctioning without disconnecting patient from mechanical ventilation. Closed suction should be used particularly for patients who need high level of Positive End Expiratory Pressure (PEEP) and Friction Inspired Oxygen (FiO2) (Mohamed et al., 2023).

The drop in lung capacity typically associated with tracheal suctioning is limited by the use of closed-system suction, showing that the development of alveolar collapse due to endotracheal suction is linked to the loss of positive airway pressure brought on by ventilator disconnection. This implies that CES can assist avoid alveolar collapse and the ensuing development of athelectasis in mechanically ventilated patients with high PEEP levels who are more susceptible to lung volume decrease related air depressurization (Martins et al., 2019). The disadvantages of using close suction are expensive, frequent blockages at the end of the canul, the advantage is a minimal drop in air volume and a low incidence of infection.The comparation between open and closed suction is closed suction ability to reduce the risk of desaturation than open suction. Closed suction also maintain levels of PEEP to reduce the risk of alveolar collapse (Yildirim et al., 2024).

Combined suction is closed suction with expiratory pause manuver performed directly on the mechanical ventilation. Combined suction stabilized during the expiratory pause, increasing the efficiency of negative pressure during tracheal aspiration (Martins et al., 2019). Combined suction

is a combination technique of open suction and close suction where the nurse performs a prasat with a regular canul which is cheap through a connector that has a hole that can open and close to insert the canul without breaking the connection between the ventilator and the endotracheal tube.

CONCLUSION

The conclusions of this study is the results were obtained that the use of open suctions and closed suctions still has advantages and disadvantages. There was another alternative between open and closed suction is combined suction.

REFERENCES

Ahmed Sayed, Z. (2019). Effect of Open versus Closed Suction System on Cardiorespiratory Parameters and Suction Duration among Critically Ill Mechanically Ventilated Patients. Egyptian Journal of Health Care, 10(2), 409–418. https://doi.org/10.21608/ejhc.2019.196307

Carpio, A., & Mora, J. (2023). Positive End-Expiratory Pressure.

Cumpstey, A., Oldman, A., Martin, D., Smith, A., & Grocott, M. (2022). Oxygen Targets During Mechanical Ventilation in the ICU: A Systematic Review and Meta-Analysis. Critical Care Explorations, 4, e0652. https://doi.org/10.1097/cce.0000000000000652

Daulay, E., Tarigan, M., & Siregar, F. L. S. (2024). Evaluating the influence of closed suction system on oxygen saturation, heart rate, and blood pressure in patients with mechanical ventilation. Rawal Medical Journal, 49(3), 511–514. https://doi.org/10.5455/rmj.20240524063904

Elmansoury, A., & Said, H. (2017). Closed suction system versus open suction. Egyptian Journal of Chest Diseases and Tuberculosis, 66(3), 509–515. https://doi.org/10.1016/j.ejcdt.2016.08.001

Heriansyah, H., Yakub, A. S., Harmiady, R., Junaidi, J., & M, Y. (2022). Tindakan Suction Terhadap Saturasi Oksigen Pada Pasien Terpasang Ventilator Dengan Ett. Media Keperawatan: Politeknik Kesehatan Makassar, 13(2), 146. https://doi.org/10.32382/jmk.v13i2.3077

Kemenkes Republik Indonesia. (2010). Keputusan Menteri Kesehatan Republik Indonesia Nomor 1778/MENKES/SK/XII/2010.

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

Ladha, K., Vidal Melo, M. F., McLean, D. J., Wanderer, J. P., Grabitz, S. D., Kurth, T., & Eikermann, M. (2015). Intraoperative protective mechanical ventilation and risk of postoperative respiratory complications: hospital based registry study. BMJ (Clinical Research Ed.), 351, h3646. https://doi.org/10.1136/bmj.h3646

Li Bassi, G., Saucedo, L., Marti, J.-D., Rigol, M., Esperatti, M., Luque, N., Ferrer, M., Gabarrus, A., Fernandez, L., Kolobow, T., & Torres, A. (2012). Effects of duty cycle and positive end-expiratory pressure on mucus clearance during mechanical ventilation*. Critical Care Medicine, 40(3), 895–902. https://doi.org/10.1097/CCM.0b013e318236efb5

Martins, L. de F. G., Naue, W. da S., Skueresky, A. S., Bianchi, T., Dias, A. S., & Junior, L. A. F. (2019). Effects of combined tracheal suctioning and expiratory pause: A crossover randomized clinical trial. Indian Journal of Critical Care Medicine, 23(10), 454–457. https://doi.org/10.5005/jp-journals-10071-23263

Mohamed, H. E., Mehrez Mahmoud, M., El, T., Gouda, S., & Kandeel, N. A. (2023). Comparison Between the Effect of Open and Closed Tracheal Suction Systems on Physiological Parameters of Critically Ill Patients. Mansoura Nursing Journal (MNJ), 10(1), 271–282.

Mohammadpour, A., Amini, S., Shakeri, M. T., & Mirzaei, S. (2015). Comparing the effect of open and closed endotracheal suctioning on pain and oxygenation in post CABG patients under mechanical ventilation. Iranian Journal of Nursing and Midwifery Research, 20(2), 195–199.

Pagotto, L. (2008). Comparison between open and closed suction systems: a systematic review. Brazilia Intensiva, 4, 20.

Raimundo, R. D., Sato, M. A., da Silva, T. D., de Abreu, L. C., Valenti, V. E., Riggs, D. W., & Perrow Carll, A. (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

Semler, M. W., Casey, J. D., Lloyd, B. D., Hastings, P. G., Hays, M. A., Stollings, J. L., Buell, K. G., Brems, J. H., Qian, E. T., Seitz, K. P., Wang, L., Lindsell, C. J., Freundlich, R. E., Wanderer, J. P., Han, J. H., Bernard, G. R., Self, W. H., & Rice, T. W. (2022). Oxygen-Saturation Targets for Critically Ill Adults Receiving Mechanical Ventilation. New England Journal of Medicine, 387(19), 1759–1769. https://doi.org/10.1056/nejmoa2208415

Tavangar, H., Javadi, M., Sobhanian, S., & Jahromi, F. F. (2016). The Effect of the Duration of Pre-Oxygenation before Endotracheal Suction on Hemodynamic Symptoms. Global Journal of Health Science, 9(2), 127. https://doi.org/10.5539/gjhs.v9n2p127

Vianna, J. R. de F., Di Lorenzo, V. A. P., da S Simões, M. M. L., Guerra, J. L., & Jamami, M. (2020). Effects of zero PEEP and < 1.0 FiO2 on SpO2 and PETCO2 during open endotracheal suctioning. Respiratory Care, 65(12), 1805–1814. https://doi.org/10.4187/respcare.07435

Widodo, S., Daya, D., Armiyati, Y., Mustofa, A., Machmudah, M., & Poddar, S. (2020). Techniques closed suction influence on oxygen saturation in patients using mechanical ventilation in intensive care unit room. Malaysian Journal of Medicine and Health Sciences, 16(2014), 102–105.

Yildirim, S., Saygili, S. M., Süneçli, O., & Kirakli, C. (2024). Comparison of the effects of open and closed aspiration on end-expiratory lung volume in acute respiratory distress syndrome. Korean Journal of Anesthesiology, 77(1), 115–121. https://doi.org/10.4097/kja.23194