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Email : editorijhess@gmail.com

Application Of Hyperoxygenation Before And After Suctioning To Prevent Hypoxemia In Mechanically Ventilated Patients At X Hospital, Jakarta

Annisa Suciyati
Professional Study Program, Sekolah Tinggi Ilmu Kesehatan Sint Carolus Jakarta

*Corresponding Author
E-mail: annisasuciyati@gmail.com

Abstract

Respiratory failure with sepsis is a critical condition that requires mechanical respiratory support (ventilator). Endotracheal Tube (ETT) placement and decreased consciousness trigger sputum hypersecretion and suppress the cough reflex, thus causing the problem of Ineffective Airway Clearance. Suctioning procedure is mandatory, but the negative pressure is at risk of causing transient hypoxemia. Evidence-based intervention through 100% hyperoxygenation before (pre) and after (post) suctioning is needed to maintain the stability of tissue oxygenation. To analyze the implementation of 100% hyperoxygenation interventions before and after suctioning in addressing the problem of Ineffective Airway Clearance in patients with respiratory failure with sepsis in the intensive care unit. The study design used a comparative case study on two critically ill patients who were ventilated in Synchronized Intermittent Mandatory Ventilation (SIMV) mode. Patient I (Mrs. F, 56 years old) experienced respiratory failure ec Pneumonia (Klebsiella pneumoniae) with a history of Pulmonary TB, and Patient II (Mr. H, 63 years old) experienced respiratory failure ec Aspiration Pneumonia post-stroke. The intervention given was the administration of 100% FiO_2 via a ventilator for 1–2 minutes before and after suctioning. The results of implementation in both patients showed that the hyperoxygenation protocol was able to protect patients from the risk of severe hypoxia. In Patient I, there was a temporary decrease in oxygen saturation (SpO_2) to 93% when the catheter was inserted, but it recovered to 99% in less than 1 minute after hyperoxygenation. In Patient II, the perfusion status was stable with a consistent SpO_2 of 98%–100% without transient tachycardia or cyanosis. Administering 100% hyperoxygenation before and after suctioning is effective in maintaining oxygen saturation stability, accelerating re-expansion of collapsed alveoli, and preventing hypoxemic complications in respiratory failure patients using mechanical ventilation.

Keywords: ***Respiratory Failure, Hyperoxygenation, Sepsis, Suctioning, Ventilator.***

INTRODUCTION

Patients admitted to the Intensive Care Unit (ICU) with respiratory failure generally require respiratory support through mechanical ventilation delivered via an Endotracheal Tube (ETT) (Ramadhani Dahlia et al., 2026). The placement of an ETT suppresses the patient's natural cough reflex and impairs the mucociliary clearance mechanism, leading to excessive accumulation of airway secretions (sputum). This condition results in a major nursing problem, namely Ineffective Airway Clearance (Sari et al., 2026).

To maintain airway patency and ensure the endotracheal tube remains unobstructed, suctioning is routinely performed by nurses to remove accumulated secretions (*Indonesian Journal of Global Health Research*, 2024). However, suctioning is considered an invasive procedure associated with potentially harmful side effects. In addition to removing secretions, the suction catheter also withdraws functional gas and oxygen from the pulmonary alveoli. This process may lead to alveolar collapse (atelectasis) and a sudden decrease in arterial oxygen saturation (SpO_2), resulting in hypoxemia (Widodo et al., 2020).

A common clinical gap observed in practice is the variation in the management of suctioning-related adverse effects. Some clinicians perform suctioning without providing adequate oxygenation beforehand, which may cause a significant decline in SpO_2 and hemodynamic instability, including increased Heart Rate (HR) and Mean Arterial Pressure (MAP) as a physiological response to hypoxic stress (Pangemanan & Pertiwi, 2025). Therefore, the nursing intervention of administering hyperoxygenation (100% oxygen) for 1–2 minutes before (pre-) and after (post-) the suctioning procedure has become a crucial protective strategy (Moemivand et al., 2022).

Hyperoxygenation functions by increasing the body's oxygen reserve within the lungs, thereby reducing the risk of severe hypoxemia during the suctioning procedure. Based on this clinical issue, the author was motivated to prepare a KIAN case report focusing on the application of this nursing intervention, entitled: "Application of Hyperoxygenation Before and After Suctioning to Prevent Hypoxemia in Mechanically Ventilated Patients at X Hospital, Jakarta."

RESEARCH METHODS

Case Study Design

This nursing case study was conducted on two patients by implementing hyperoxygenation before and after suctioning to prevent hypoxemia in the Intensive Care Unit (ICU) of X Hospital, Jakarta. The case study focused on the application of suctioning as a nursing intervention to maintain airway patency and reduce secretion retention. Data were collected through interviews with the patients' families, direct observation, medical record reviews, physical examinations, and supporting diagnostic findings. Nursing care was delivered following the nursing process, including assessment, nursing diagnosis, intervention planning, implementation, and evaluation using the SOAP documentation format.

Study Setting

This case study was conducted in the Intensive Care Unit (ICU) of X Hospital, Jakarta. The ICU was selected as the study setting because it provides intensive care for critically ill patients, including those receiving mechanical ventilation who require suctioning as part of airway management.

The case study was carried out during the professional nursing (Ners) clinical practice period from June 8 to July 3, 2026. Data were collected through nursing assessments, direct observation, physical examinations, medical record reviews, diagnostic test results, and continuous evaluation of the patients' clinical progress. The two case subjects were Mrs. F, diagnosed with respiratory failure accompanied by sepsis, and Mr. H, diagnosed with respiratory failure accompanied by sepsis. Both patients met the inclusion criteria, including the presence of an endotracheal tube (ETT) or tracheostomy and the need for routine suctioning as the primary nursing intervention.

Patient Characteristics

The subjects of this case study consisted of two critically ill patients with similar clinical characteristics. Both patients were dependent on mechanical ventilation to maintain adequate respiratory function. As a consequence of their condition, both experienced excessive airway secretion accumulation, requiring routine suctioning to maintain airway patency.

In addition to having similar medical diagnoses and requiring suctioning, both patients were at high risk of experiencing oxygen desaturation during the suctioning procedure. Therefore, they received the same nursing intervention, namely the administration of hyperoxygenation before and after suctioning to minimize the risk of hypoxemia.

RESULTS AND DISCUSSION

Discussion Of The Assessment

Case I (Mrs. F)

Mrs. F's respiratory failure was caused by severe bacterial pneumonia, which was exacerbated by a history of chronic structural lung disease, namely previous pulmonary tuberculosis (treated in 2023). Chest X-ray findings demonstrated extensive active pulmonary tuberculosis lesions, bilateral pneumonia, and bronchiectasis. Structural lung damage resulting from previous tuberculosis, including bronchiectasis and fibrosis, created a favorable environment for bacterial colonization.

This was confirmed by the sputum culture obtained on June 19, 2026, which isolated *Klebsiella pneumoniae*. The opportunistic bacterial infection triggered a severe inflammatory response within the alveoli, leading to bilateral pneumonia, impaired gas exchange, markedly elevated inflammatory

markers (C-reactive protein [CRP] 336.1 mg/L and white blood cell count 36,500/µL), and Type I respiratory failure (hypoxemia). Consequently, the patient required mechanical ventilation in SIMV mode with an FiO_2 of 100%.

Case II (Mr. H)

Unlike Mrs. F, Mr. H developed respiratory failure accompanied by sepsis secondary to aspiration pneumonia. Clinically, patients with a history of stroke are at high risk of developing dysphagia due to weakness of the oropharyngeal muscles, as supported by impaired function of Cranial Nerves IX and X identified during the assessment.

Mr. H's condition was further aggravated after the accidental removal of his nasogastric tube (NGT) at home for approximately one month. Despite this, his family continued oral feeding with a soft porridge diet. This unsafe feeding practice in a patient with dysphagia resulted in aspiration of food or gastric contents into the lower respiratory tract.

Clinically, the patient presented with a productive, gurgling cough before hospital admission. Chest radiography revealed increased opacities and infiltrates in the upper and middle zones of the right lung, consistent with aspiration pneumonia, which commonly affects the right lung because of the more vertical orientation of the right main bronchus. The resulting inflammatory process led to sepsis and respiratory failure (white blood cell count 11,000/µL), requiring mechanical ventilatory support in SIMV mode with an FiO_2 of 50%.

Comparison Aspect	Research Journal (Evidence-Based Practice)	Hospital SOP (Standard Operating Procedure)	Patient Adjustment (Individualized Care)
Primary Focus	Effectiveness of optimal interventions based on scientific evidence from the study population.	Patient safety, standardized workflows, and compliance with legal and accreditation requirements.	Patient safety and the individual's specific healthcare needs.
Flexibility	Rigid within the research protocol, but continuously evolves with scientific advancements.	Rigid and standardized; revised periodically through the hospital's medical and nursing committees.	Highly flexible; tailored to the patient's physical and psychological condition as well as their response to treatment.
Basis for Decision-Making	Empirical evidence, clinical trials (RCTs/Systematic Reviews), and controlled study samples.	Regulations, hospital facilities, staffing ratios, and institutional risk management.	Comorbidities, age, allergies, cultural values and beliefs, and disease severity.
Level of Risk	Evaluates new hypotheses or compares the effectiveness of the best available interventions.	Minimizes human error and legal risks associated with malpractice.	Minimizes complications resulting from interventions that are inappropriate for the patient's physical condition.

Nursing Diagnosis: Ineffective Airway Clearance

Based on the assessment findings, Mrs. F (56 years) and Mr. H (63 years) were diagnosed with respiratory failure accompanied by sepsis and required respiratory support with an Endotracheal Tube (ETT) and mechanical ventilation using the Synchronized Intermittent Mandatory Ventilation (SIMV) mode. The priority nursing diagnosis established for both patients was Ineffective Airway Clearance (D.0001).

Pathophysiologically, the presence of an ETT as a foreign body in the trachea stimulates excessive sputum production (hypersecretion). In addition, endotracheal intubation and decreased level of consciousness suppress the normal cough reflex and impair mucociliary clearance, resulting in the retention of airway secretions. Clinically, this was manifested by the accumulation of thick yellowish-brown secretions within the ETT and oral cavity, accompanied by coarse rhonchi heard over both lung fields. If left untreated, retained secretions may obstruct the airway, increase peak airway pressure, and further impair gas exchange.

Hyperoxygenation Before and After Suctioning

Suctioning is an essential nursing intervention for maintaining airway patency in mechanically ventilated patients. However, the procedure may also remove oxygen from the alveoli, thereby increasing the risk of hypoxemia, characterized by a sudden decline in arterial oxygen saturation.

To minimize this complication, an evidence-based nursing intervention was implemented by administering hyperoxygenation before (pre-) and after (post-) suctioning.

The procedure involved increasing the ventilator's Fraction of Inspired Oxygen (FiO_2) to 100% for 1–2 minutes before insertion of the suction catheter and maintaining the same FiO_2 level for 1–2 minutes after completion of the suctioning procedure.

Case I

Day	Pre-Intervention SpO_2 (%)	Pre-Intervention Secretions	Post-Intervention SpO_2 (%)	Post-Intervention Secretions
1	98	Copious	92	Scant
2	96	Copious	96	Scant

Case II

Day	Pre-Intervention SpO_2 (%)	Pre-Intervention Secretions	Post-Intervention SpO_2 (%)	Post-Intervention Secretions
1	85	Moderate	92	None
2	82	Copious	91	None

Based on the table above, the two-day observation of patients admitted to the ICU demonstrated changes in oxygenation status before and after suctioning with hyperoxygenation. In Case I, oxygen saturation before suctioning ranged from 96% to 98%, while post-suction values ranged from 92% to 96%. A large amount of airway secretions was observed before suctioning, which decreased to a small amount on the first and second days and was absent by the end of the second day.

In Case II, pre-suction oxygen saturation ranged from 82% to 85%, whereas post-suction oxygen saturation improved to 91%–92%. The amount of secretions decreased from moderate-to-large before suctioning to no detectable secretions by the second day of observation. Overall, suctioning combined with hyperoxygenation improved airway patency, as evidenced by the reduction in retained secretions. Furthermore, no suction-related complications were observed in either patient during the study period.

Analysis of Clinical Response: Case I (Mrs. F)

On the first day of implementation (June 18, 2026), Mrs. F appeared restless and tachypneic (respiratory rate 24 breaths/min) due to the accumulation of thick yellowish-brown secretions.

Critical Oxygenation Evaluation: During insertion of the suction catheter into the ETT, transient suction-induced oxygen desaturation occurred, with SpO_2 briefly decreasing to 93%. However, pre-suction hyperoxygenation provided an adequate oxygen reserve, and immediate post-suction administration of 100% oxygen restored SpO_2 to 99% within one minute.

On the second day (June 19, 2026), the combination of hyperoxygenation, suctioning, chest physiotherapy (clapping and vibration), and mucolytic therapy produced marked clinical improvement. Secretions became thinner and light yellow in color, coarse crackles at the lung bases were substantially reduced, and SpO_2 remained stable between 98% and 100% without significant desaturation.

Analysis of Clinical Response: Case II (Mr. H)

A similar response was observed in Mr. H (63 years), who was admitted with a productive gurgling cough caused by aspiration following accidental removal of his nasogastric tube (NGT) at home. The administration of 100% hyperoxygenation before and after suctioning effectively maintained adequate tissue oxygenation throughout the procedure.

At baseline, the patient had an SpO_2 of 99% while receiving SIMV ventilation with an FiO_2 of 50%. Throughout hospitalization, airway clearance using the hyperoxygenation protocol effectively prevented suction-induced hypoxemia, as evidenced by the absence of cyanosis, tachycardia, or other signs of oxygen deprivation. Following suctioning, the airway remained clear, and normal vesicular breath sounds were restored.

Supporting Literature

The following studies support the nursing intervention implemented in this case study, demonstrating that hyperoxygenation before and after suctioning is effective in maintaining oxygen saturation (SpO_2) and preventing hypoxemia in mechanically ventilated patients.

Supporting Study 1

- Authors & Year: *Magfuri, A., & Astuti, S. (2024)*
- Title: *Effectiveness of 100% Hyperoxygenation Before and After Suctioning on Oxygen Saturation in Mechanically Ventilated Patients in the Intensive Care Unit.*
- Findings and Case Relevance: The study reported that administering 100% FiO_2 for 1–2 minutes before and after suctioning significantly reduced the risk of transient hypoxemia. These findings are consistent with Mrs. F's clinical response, in which oxygen saturation briefly decreased to 93% during suction catheter insertion but rapidly recovered to 99% within one minute following post-suction hyperoxygenation.

Supporting Study 2

- Authors & Year: *Smith, J. A., & Simanjuntak, R. (2025)*
- Title: *Oxygenation Status Maintenance in Critically Ill Patients Undergoing Endotracheal Suctioning: A Randomized Controlled Trial.*

Findings and Case Relevance: This randomized controlled trial explained that post-suction hyperoxygenation promotes recovery from microatelectasis caused by the negative pressure generated during suctioning. Administration of 100% oxygen facilitates alveolar recruitment, thereby improving oxygenation and maintaining respiratory stability. These findings support the outcomes observed in both Mrs. F and Mr. H, whose hemodynamic status and ventilator synchrony remained stable after suctioning without signs of ventilator dyssynchrony (*fighting*).

CONCLUSION

Based on the implementation of nursing care and the discussion of hyperoxygenation before and after suctioning in Mrs. F and Mr. H in the ICU of X Hospital, Jakarta, the following conclusions were drawn:

1. Clinical Assessment: Both patients had respiratory failure with sepsis requiring an Endotracheal Tube (ETT) and SIMV mechanical ventilation. Initial assessment revealed excessive airway secretions, coarse rhonchi, and impaired swallowing reflex, placing them at high risk of hypoxemia during suctioning.
2. Priority Nursing Diagnosis: The primary nursing diagnosis was Ineffective Airway Clearance (D.0001) caused by retained secretions secondary to an artificial airway, supported by Impaired Gas Exchange (D.0003) and Imbalanced Nutrition: Less Than Body Requirements (D.0019).
3. Effectiveness of Hyperoxygenation: Administration of 100% FiO_2 for 1–2 minutes before and after suctioning effectively prevented hypoxemia. In Mrs. F, transient oxygen desaturation to 93% rapidly recovered to 99% within one minute after hyperoxygenation. In Mr. H, the protocol maintained stable oxygenation without cyanosis or tachycardia.
4. Evaluation of Nursing Care: Evaluation using the SOAP format over 2 × 24 hours demonstrated significant improvement in airway clearance and gas exchange. Secretions became thinner, rhonchi decreased, hemodynamic status remained stable, and arterial blood gas analysis in Mrs. F showed improved carbon dioxide retention ($PaCO_2$ decreased from 55 mmHg to 42 mmHg), allowing gradual ventilator weaning. Nutritional status was maintained through a high-calorie, high-protein enteral diet.

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