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**CASE PRESENTATION**

# Nursing care process in ventilator-associated pneumonia: a case report

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## ABSTRACT

**Introduction:** ventilator-associated pneumonia is a healthcare-associated infection that affects patients under hospital treatment, requiring appropriate care from nursing staff.
**Objective:** to describe the standardized nursing care process required for a patient with invasive ventilator-associated pneumonia.
**Case presentation:** a 40-year-old male patient experienced sudden deterioration of consciousness, bronchoaspiration, and respiratory compromise, requiring endotracheal intubation and mechanical ventilation. He developed ventilator-associated pneumonia during his stay in the Intensive Care Unit. The Nursing Care Process was applied using NANDA-NIC-NOC taxonomies, based on assessment by Marjory Gordon's domains. The predominant domain was elimination and exchange, focusing on respiratory function while considering other dysfunctional patterns. Standardized nursing interventions were implemented, achieving favorable patient evolution.
**Conclusion:** early approach, diagnosis, and management are fundamental in respiratory pathologies associated with mechanical ventilation. A structured care plan tailored to patient needs and based on scientific evidence is essential to improve clinical outcomes.

**Keywords:** Nursing Care; Outcome and Process Assessment, Health Care; Ventilator-Induced Lung Injury; Pneumonia, Ventilator-Associated; Respiration, Artificial.

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## INTRODUCTION

Ventilator-associated pneumonia (VAP) is defined as that which manifests at least 48 hours after endotracheal intubation and the start of mechanical ventilation (MV).[1] Within it, ventilator-related pneumonia (VRP) is part of what the World Health Organization (WHO) calls healthcare-associated infections (HAIs) or nosocomial infections, since it refers to infections that a patient contracts while receiving treatment in a hospital or other health center, and which he clearly did not suffer from at the time of his admission.

Eighty percent of nosocomial pneumonia cases occur in patients with artificial airway devices, making it the most common nosocomial infection and the leading cause of mortality. This epidemiological problem is especially relevant in Intensive Care Units (ICUs), where it affects approximately 10–30 % of patients receiving mechanical ventilation. Globally, mortality rates vary considerably, estimated between 17–30 %. In addition to factors related to morbidity and mortality, an increase in associated costs has been observed, ranging from $5,000 to $20,000 per diagnosis. In the Cuban context, mortality among patients admitted to critical care ranges from 18 % to 23 %.[2]

Endotracheal tube insertion is the primary risk factor for developing ventilator-associated pneumonia (VAP). This procedure creates a vulnerability in the airway's defenses, interferes with coughing, impairs the ability to clear mucus secretions, and facilitates the aspiration of bacteria present in secretions above the inflated cuff of the endotracheal tube. Furthermore, bacteria can form a protective film on and inside the endotracheal tube, making them resistant to both antibiotics and the patient's natural defenses. The greatest risk of developing VAP is concentrated in the first 10 days after intubation. It is estimated that between 9 % and 27 % of patients receiving mechanical ventilation develop this type of pneumonia.[3]

Nursing staff play a crucial role as the primary caregivers of critically ill patients, and due to their increased involvement in healthcare during ventilation, their contribution is fundamental to the prevention of these infections. The effectiveness of preventive measures is directly related to the level of knowledge and skill that nurses possess in this regard. In addition to its impact on reducing morbidity and mortality, the prevention of these infections is also linked to a decrease in the costs associated with the care of these patients, making it a quality indicator in critical care.[4]

Nursing seeks to establish a solid knowledge base that supports practice and raises the standard of care in diverse healthcare settings. The need to organize and classify this knowledge remains fundamental to the profession, as strengthening this knowledge base allows for a proper understanding of nursing diagnoses, which are then applied in clinical cases involving patients with ventilator-associated pneumonia according to the NANDA-I standards, expected patient outcomes (NOC), and nursing interventions (NIC).

In this context, NIC interventions are aimed at helping the patient progress towards achieving a desired outcome in the management of respiratory function associated with mechanical ventilation, together with the needs incorporated in the case.[5] For this reason, the objective of the present study is to describe the standardized nursing care process required by a patient with pneumonia associated with invasive mechanical ventilation.

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Rev Ciencias Médicas. 2025; 29(S1): e6952

## CLINICAL CASE REPORT

A 40-year-old male patient, born and residing in the city of Ambato, La Merced sector, mestizo, Catholic, with a complete secondary education, occupation: merchant, right-handed. The family reports that the patient has no allergies or pathological or surgical history, and that 30 minutes ago, apparently without cause, while resting, he suddenly began to scream and subsequently experienced a decrease in consciousness from which he did not recover. He vomited twice with food contents, after which he presented with distal cyanosis and tachypnea, which is why he was transferred to this health center.

On physical examination, the patient presented with a heart rate (HR) of 136 bpm and blood pressure (BP) of 117/74 mmHg, with distal cyanosis. Respiratory examination revealed a respiratory rate (RR) of 32 breaths per minute, diffuse bilateral crackles, use of accessory muscles, decreased breath sounds, hypoventilation in both lung fields, and an oxygen saturation of 58 % on room air. The temperature was 36,4 °C. Neurological assessment showed a Glasgow Coma Scale score of 3/15 (eye opening 2, verbal response 1, motor response 3) and a Ramsay score of 6. No exsanguinating lesions were evident. The airway contained abundant food debris, with no breath suggestive of alcohol. The shock index was 1,16, and the pupils were isocoric, 3 mm, and unreactive to light.

### Laboratory tests

Arterial blood gas: pH 6.78, PCO2: 41.6, PO2: 190.7, HCO3: 6.1, BE: -29.7, Na: 142, K: 3.88, Cl: 105, glucose 156, lactate: 18.22.

### Imaging studies

Figure 1 shows a chest X-ray with bilateral parahilar infiltrates, that is, localized opacities around the hilar regions of both lungs. These findings usually suggest diffuse pulmonary involvement, consistent with infectious or inflammatory processes, and reflect impaired ventilation and gas exchange. The bilateral distribution indicates involvement of both lung fields, which may be associated with conditions such as pneumonia, pulmonary edema, or interstitial lung diseases.

**Fig. 1**Chest X-ray showing bilateral parahilar infiltrates.

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The patient presented with hypoventilation and poor respiratory mechanics, requiring oxygen via face mask at 10 liters per minute and corticosteroid administration. A permanent airway was established using sedation and analgesia with midazolam and fentanyl, and ventilation in volume-controlled assist mode (VA/C): FiO2: 70 %, tidal volume: 420 ml, respiratory rate: 16 breaths/min, inspiratory time: 1.25 seconds, and PEEP: 7 ml. Following airway management, the patient experienced hypotensive episodes, with mean arterial pressure (MAP) dropping below 55 mmHg. Norepinephrine was initiated at a dose appropriate to the patient's needs. A consultation with the on-call intensivist was requested, who decided to transfer the patient to the intensive care unit. Additional imaging and laboratory tests were also ordered. The patient has a poor short- and medium-term prognosis.

**Evolution in ICU:** During his stay in the ICU, the patient was on mechanical ventilation with unstable saturations, hypotension, and abundant mucopurulent secretions. A chest x-ray was performed with evidence of bilateral parahilar infiltrates in clinical correlation with pneumoaspiration, not space-occupying lesions.

**Diagnosis and treatment:** The medical diagnosis indicates ventilator-associated pneumonia, therefore antibiotic therapy is initiated with ampicillin/sulbactam 1,5 g IV stat every 6 hours and clarithromycin 500 mg IV stat every 12 hours. The previously mentioned sedation, analgesia, and vasopressor are continued. The patient is maintained with intravenous hydration using 0,9 % sodium chloride at 100 ml/h.

**Nursing care process (assessment)**
The patient was assessed using Marjory Gordon's functional health patterns, identifying the altered domains according to the NANDA-I taxonomy. Table 1 presents the systematic evaluation of the affected domains in the patient.

**Table 1.** Evaluation of Domains according to the NANDA methodology.

| DOMAIN | CLASS | CASE ANALYSIS |
|---|---|---|
| 1. Health Promotion | Class 1: Health Management | On physical examination, the patient presented with a heart rate of 136 bpm, respiratory rate of 32 rpm, temperature of 36.4 °C, saturation of 58% on room air, Glasgow: Eye Opening 2, Verbal 1, Motor 3 (6/15) |
| 2. Nutrition | Class: 1 Ingestion | Without alluding to this point |
| | Class: 2 Digestion | Without alluding to this point |
| | Class: 3 Absorption | Without alluding to this point |
| | Class: 4 Metabolism | Without alluding to this point |
| | Class: 5 Hydration | The patient is undergoing intravenous hydration with 0.9% sodium chloride. |
| 3. Elimination and exchange | Class 1: Urinary Function. | Requirement of a urinary catheter due to neurological status and coupling to invasive mechanical ventilation, and strict monitoring of fluid balance |
| | Class: 4 Respiratory Function | Patient requiring vasopressor support and under the effects of sedation and analgesia, intubated and coupled to invasive mechanical ventilation (IMV), mode (VA/C) fio2: 70%, tidal volume |

**ISSN:** 1561-3194 **RNPS:** 1877
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| | | |
|---|---|---|
| | | 420 ml, respiratory rate: 16, inspiratory time 1.25, PEEP: 5 |
| | Gastrointestinal function | Without alluding to this point |
| | Integumentary function | The patient remains in a supine position for the duration of their hospital stay, which puts them at risk of developing skin lesions such as pressure points, which can lead to skin ulcerations. |
| | Sleep / Rest | Patient under sedation and analgesia. Ramsay 6/6 |
| 4. Activity / Rest | Activity/ Exercises | Norton scale 7 points (high risk). Patient with impaired physical mobility due to sedation; position changes are performed every 2 hours to prevent pressure ulcers. |
| | Cardiovascular/pulmonary responses | MAP below 55 mmHg, therefore requiring vasoactive medication. Associated with mechanical ventilation, there is a decrease in PEEP, with unstable saturations, tachypnea, and tachycardia. |
| | Self-care | Patient sedated and ventilated, which is why there is a deficit in self-care. |
| 5. Perception/Cognition | Verbal impairment | patient under the effects of sedation-analgesia and mechanical ventilation |
| 6. Self-perception | Self-concept | Without alluding to this point |
| 7. Role/Relationships | Caregiver role | The patient is under the care of healthcare personnel. |
| | Role performance | Without alluding to this point |
| | Family relationships | Without alluding to this point |
| 8. Sexuality | | Without alluding to this point |
| 9. Coping and stress tolerance | | Without alluding to this point |
| 10. Vital Principles | | Without alluding to this point |
| 11. Safety/Protection | Infection | Patient on mechanical ventilation |
| | Physical injury | The patient remains in a supine position throughout their hospital stay, which puts them at risk of developing skin lesions such as bedsores. |
| | Violence | Without alluding to this point |
| | Environmental hazards | Without alluding to this point |
| 12. Comfort | Physical comfort | Without alluding to this point |
| | Comfort of the environment | Without alluding to this point |
| 13. Growth and development | | Without alluding to this point |

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The analysis of the presented clinical case is based on the NANDA categorization, to establish the nursing diagnoses related to the patient's needs manifested in the case, as a guide for planning the NOC objectives.

## DISCUSSION

The deterioration of the patient's defense mechanisms and colonization of the oropharynx by pathogenic microorganisms predispose critically ill patients to the development of ventilator-associated pneumonia (VAP). Other factors to consider for the development of VAP include: continuous aspiration, orotracheal reintubation, prolonged intubation, bacteremia, and immobility in intubated and sedated patients.[6]

Ventilator-associated pneumonia is considered the leading cause of death from nosocomial infections in the ICU. Therefore, another essential factor is that nursing professionals have the theoretical knowledge and put it into practice, in order to provide quality care for the improvement of critically ill patients.[7]

Baca Sánchez,[8] in her article mentions that knowledge in nursing professionals is a cornerstone for improving healthcare and perfecting its processes. Throughout history, knowledge has generated changes in the evolution of humanity, in technology, in science, and in health. For this reason, it is considered extremely important that ICU nursing professionals have the necessary knowledge about the prevention of ventilator-associated pneumonia, in order to contribute responsibly to reducing this infection, which is deteriorating the health of critically ill patients.

According to the literature, there is a predominance of hospital-acquired lower respiratory tract infections, especially in ICUs, where they account for 50-65 % of all nosocomial infections. In this case, the cumulative risk of developing pneumonia increases proportionally with the duration of mechanical ventilation. Pneumonia is a pulmonary complication that develops 48 to 72 hours after endotracheal intubation in patients undergoing mechanical ventilation. It is the most frequent infectious complication in patients admitted to ICUs and affects 27 % of all critically ill patients.[7]

Maintaining strict aseptic technique, good oral hygiene, and avoiding injury by ensuring proper fixation of both the feeding tube and the endotracheal tube significantly reduces the risk of ventilator-associated pneumonia (VAP). Díaz et al.,[9] in their article, mention that prevention is primarily based on reducing oropharyngeal colonization, the inoculum, or both. This prevention can be structured into two groups of measures: general and specific. Specific measures include reducing oropharyngeal colonization or the inoculum that reaches the lower respiratory tract through oral irrigation with chlorhexidine and intestinal decontamination.

Most preventive practices are aimed at reducing the volume of oropharyngeal secretions that reach the lower respiratory tract. This practice involves the participation of a nursing team responsible for providing quality care, positioning the professional as responsible for the application of the theoretical basis based on updated literature, application of theories and models, as well as the management of resources in favor of improving the health status of the seriously ill person. Therefore, the mission of the nursing professional is and will be the management and execution of care by and for the person.[10] Likewise, controlling the conditions that indicate the need for ventilatory support and administering appropriate sedation and analgesia considerably improve the hemodynamic status of the patient.

**ISSN:** 1561-3194 **RNPS:** 1877
Rev Ciencias Médicas. 2025; 29(S1): e6952

One of the most relevant nursing activities focuses on preserving sleep, considering changes and effects of medication on the patient's sleep pattern, and other external factors that may disrupt the patient's rest. Therefore, it is crucial not to neglect the patient's comfort, as stated by Álvarez Guerrero et al.,[11] who also mention the existence of multiple environmental stressors and compromised general health. This necessitates standardized and specific nursing care to ensure safe care and prevent potential underlying complications during this period, particularly regarding the sleep stage and duration of the ventilated patient.

Placing the patient on a suitable therapeutic mattress/bed, monitoring oxygenation status before and after position changes, positioning the patient to facilitate ventilation/perfusion, and turning immobilized patients at least every two hours are some of the nursing activities focused on skin care and improving comfort to avoid hindering the individual's future independent activities, as stated by Silva Faria et al.,[12] who also argue that the nurse's role is extremely important in meeting needs, enhancing and readapting abilities, and guaranteeing the patient's dignity. Comfort is a relevant area of nursing care, characterized by a feeling of physical tranquility and bodily well-being. Comfort can be described as relief, tranquility, or transcendence. It is a holistic experience of the person after receiving comfort measures, even with ventilatory support.

Regarding medication administration and monitoring of its efficacy, the reduction of sedation and analgesia, and the progress of the patient on mechanical ventilation, these should always be documented. This allows for tracking the patient's stage of illness and any hemodynamic changes, thus correlating nursing activities. Therefore, the antimicrobial regimen should focus on the specific microbial pathology. Álvarez A,[13] states in his article that the antimicrobial regimen should cover the most prevalent microorganisms in the unit. Coverage for anaerobic microorganisms is not necessary and should only be considered in the presence of abscesses, necrotizing pneumonia, or obvious aspiration observed by the medical team.

One of the main complications of a critically ill patient's stay in intensive care is skin disease, which has become a significant health problem affecting critically ill patients in intensive care. This can lead to other complications, worsening the patient's condition and reducing their life expectancy. Furthermore, it increases the length of hospital stay, the workload of healthcare professionals, and healthcare costs. In general, this delays the objective of the intensive care unit, which is the patient's recovery and healing.[14] Therefore, our nursing activities focus on: observing for redness, extreme heat, edema, or drainage of the skin and mucous membranes; monitoring skin color and temperature; and observing for excessive dryness or moisture. For this reason, it is also necessary to instruct family members or caregivers about the signs of skin integrity loss, as appropriate.[15]

Training critical care nurses in the prevention of ventilator-associated pneumonia decreases ICU length of stay and mortality. The Safety-Zero Tolerance Projects Advisory Council of the Ministry of Health proposes promoting such training, and simulation-based teaching methodology emerges as optimal for training the necessary skills and knowledge, focused on all areas.[16] According to Conley,[17] VAP increases the length of hospital stay and the number of days of ventilation, representing additional costs of $14,000-$57,000 per hospitalization, and therefore, their care should be emphasized in all their needs.

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In this regard, a study by Lorente,[18] found that ventilator-associated pneumonia (VAP) leads to increased morbidity, mortality, and healthcare costs. Therefore, various measures have been proposed to try to prevent it. The Zero Pneumonia (NZ) project, implemented in 2011, reviewed 35 measures to prevent VAP and proposed a package of measures consisting of seven mandatory measures and three highly recommended but non-mandatory measures, which yielded significant results in improving patient stays in the ICU.

## CONCLUSIONS

Early assessment, diagnosis, and management are fundamental in respiratory illnesses, reducing complications and hospital stay. Empirical management, appropriate ventilation, and timely antibiotic use improve clinical outcomes. Selecting the ventilation mode based on the underlying pathology decreases morbidity and mortality and facilitates weaning. Managing acidosis and volume also positively impacts survival. In a clinical case of ventilator-associated pneumonia, an evidence-based care plan was implemented, highlighting the role of nursing staff in triage, ventilation, and follow-up, as well as the importance of family support.

**Conflict of Interest**
The authors declare no conflict of interest in relation to the publication of this clinical case.

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