

# Oral hygiene in reducing the incidence of pneumonia associated with mechanical ventilation in pediatric intensive care patients

Martina de Jesús Aguilar Pesántez<sup>1</sup>, Carmen Cecilia Ordoñez Montero<sup>2</sup>, Lorena Elizabeth Padilla Romero<sup>3</sup>, Dolores Amparito Rodríguez Sánchez<sup>4</sup>, Jorge Gayol Samutlón<sup>5</sup>

<sup>1</sup>Universidad de Cuenca, Ecuador, Email: martina.aguilar@ucuenca.edu.ec

<sup>2</sup>Universidad de Cuenca, Ecuador, Email: carmenc.ordonezm@ucuenca.edu.ec

<sup>3</sup>Universidad de Cuenca, Ecuador, Email: lorena.encalada@ucuenca.edu.ec

<sup>4</sup>Universidad de Cuenca, Ecuador, Email: dolores.rodriguez@ucuenca.edu.ec

<sup>5</sup>Universidad Internacional de Valencia, España, Email: jorge.gayol.s@professor.universidadviu.com

---

Received: 16.09.2024

Revised: 19.10.2024

Accepted: 24.11.2024

---

## ABSTRACT

**Introduction:** A large number of critically ill pediatric patients who are hospitalized in an intensive care unit (ICU) require mechanical ventilation (MV). MV being the predisposing risk factor that causes Nosocomial Pneumonia (NN).

**Objective:** To analyze the effectiveness of respiratory care practices such as Oral Hygiene in reducing the incidence of Pneumonia associated with Mechanical Ventilation in pediatric Intensive Care patients.

**Methodology:** This research uses a qualitative, descriptive design through a systematic review of documents related to the topic based on the literature search under the Prisma method. Results: Applying the inclusion and exclusion criteria, 616 results were obtained through the Pubmed, Medline, and Web of Science databases. After a complete review of the texts, 20 articles were selected to carry out this review using the Mendely manager.

**Discussion:** the infection is considered acquired in the Intensive Care Unit (ICU) when it is diagnosed after 48 hours of stay; 1 in 4 patients in the ICU acquire infection during their course in the hospital. One of the most feared complications in the PICU are HAIs; these are generally associated with the use of mechanical ventilation, whether invasive or non-invasive.

**Conclusions:** The prevalence of ventilator-associated pneumonia in pediatric intensive care patients demonstrates the importance of this complication in medical care.

**Keywords:** Oral Hygiene, Ventilator Associated Pneumonia, Pediatric Intensive Care Units, Disease Prevention

## 1. INTRODUCTION

### Theoretical Framework

A large number of critically ill patients who are hospitalized in an intensive care unit (ICU) require mechanical ventilation (MV). This is a transition process that the patient must go through for a certain period of time. This procedure consists of totally or partially replacing spontaneous ventilation, indicated mainly in acute or chronic respiratory tract conditions (Costa et al., 2018).

On a global scale, pneumonia is considered the main cause of infant mortality, it is estimated that every year 1.2 million infants under 5 years of age die from this condition, pneumonia is considered a clinical condition that can be caused by various pathogens such as bacteria, viruses, fungi or other pathogens, It can also be acquired by inhaling chemicals or liquids. (García Borges et al., 2021)

It is determined that the prevalence of hospital-acquired lower respiratory tract infections in the Intensive Care Unit is between 50% and 65% of all nosocomial infections acquired. Mechanical ventilation (MV) is the predisposing risk factor that causes Nosocomial Pneumonia (NN). (García Borges et al., 2021)

In this case, as mentioned by Borges G, the risk of contracting pneumonia potentially increases depending on the time that mechanical ventilation lasts. The individual can have a risk of up to 50% mortality if they are located in the intensive care unit (ICU), likewise direct pneumonia can also cause 50% mortality. And the increase in the incidence of users acquiring a lung infection in the ICU is approximately 6 to 20 times higher than patients hospitalized in other areas (García Borges et al., 2021)

In the same way, as Sánchez mentions, routine procedures are used in the ICU, such as the use of antibiotic therapy, the mobilization and manipulation of biomedical and health equipment, as well as enteral feeding, all these actions provide for pathogens that penetrate the respiratory tract. (Sánchez Peña, 2021)

According to Pinheiro, saliva and oral biofilm are the most common reservoirs, adding to this the susceptibility of patients, since they are subjected to frequent aspiration of secretions from the upper respiratory tract, being another of the main causes of acquired pneumonia. ( Pinheiro et al., 2021) .

From another perspective, Vliegenthart mentions that despite all the advances that are currently observed, traditional methods such as non-invasive life support, orotracheal intubation and invasive mechanical ventilation continue to be the first-line treatments in the Intensive Care Unit. These treatment methods, despite the advantages they provide, can cause certain injuries or complications that worsen the patient's condition, among the most common are ventilation-related pneumonia (VAP), other injuries at the level of the trachea and neurological damage ( Vliegenthart et al., 2019)

In this sense, Cabrita X, perceive that patients when subjected to invasive procedures such as intubation, variations in the elimination of orotracheal secretions are evident, this is due to the presence of pathogens such as Gram-positive or Gram-negative streptococci in their microflora, these pathogens are responsible for causing pneumonias associated with mechanical ventilation (Cabrita Xavier et al., 2023)

Regarding the means of prevention of ventilator-associated pneumonia in pediatric patients. , in their research they assure that this is based on the execution and monitoring of the following measures: maintaining a raised head of 30 to 45 degrees, compliance with the oral hygiene protocol using chlorhexidine gluconate, performing daily assessment in order to reduce sedo analgesia and being able to access early extubation, use protective measures for the patient's gastric mucosa, These results ensured a decrease of up to 44.5% in the rates of pneumonia associated with mechanical ventilation. ( Irani et al., 2020)

For this reason, priority should be given to the oral care and hygiene of hospitalized pediatric patients, in such a way that the care provided by health personnel is of vital importance based on knowledge on this subject, since they pay less attention to these precautionary measures and assume more importance in other less relevant ones.( Irani et al., 2020)

## 2. Justification

One of the most serious complications in patients who are in the Intensive Care Unit under mechanical ventilation is pneumonia, which is life-threatening and mainly affects pediatric patients. Despite all the new advances that have been observed throughout history in medical care, this continues to be a potential concern due to the impact caused on morbidity and mortality, added to this the hospital costs that it represents due to the increase in hospital stay.

One of the key pillars in the prevention of these complications is oral hygiene, since if the patient inhales these oral bacteria, infectious lung processes can be triggered. However, it has been shown that the application of oral hygiene measures carried out correctly in pediatric patients under mechanical ventilation has had a great influx in its improvement, which is why it is a subject of greater attention and understanding.

In this context, it is essential to carry out this research since it addresses a clinical need that has not been resolved and that presents standards of improvement for the care of pediatric patients in the ICU. By analyzing and exploring the relationship between oral hygiene and the incidence of ventilator-associated pneumonia in this age group, we can effectively identify prevention strategies and improve clinical care protocols.

In addition, this research contributes to the optimization of resources used to treat complications and significantly reduce the economic burden associated with pneumonia. Ultimately, this research aims to potentially improve clinical outcomes and quality of life for pediatric patients in intensive care.

## 3. Objectives

### Specific objective

To analyse the effectiveness of respiratory care practices such as oral hygiene in reducing the incidence of ventilator-associated pneumonia in paediatric intensive care patients.

### Specific objectives

- To determine the prevalence of ventilator-associated pneumonia in pediatric intensive care patients
- To describe the relationship between oral hygiene and the incidence of pneumonia in mechanically ventilated pediatric patients

## 4. MATERIAL AND METHOD

### Study design

The present research uses a qualitative, descriptive design through a systematic review of documents related to the subject based on the search of literature under the prism method, through the exploration of the various databases such as: Pubmed, Medline, Web of Science. Likewise, the research question is established in PICO format.

**PICO Question**

What is the impact of oral hygiene interventions in reducing the incidence of ventilator-associated pneumonia in paediatric intensive care patients, compared to standard oral care or no intervention?

Q: Pediatric patients in intensive care under mechanical ventilation

I: Respiratory care practices, such as oral hygiene.

C: comparison of these interventions with standard oral care or no intervention

O: Reduced incidence of ventilator-associated pneumonia

**Search strategies**

An exhaustive search is carried out in medical databases specific to pediatrics. To carry out the same, the keywords referring to the topic of the research question were identified, DeCS and MeSH descriptors were used, as well as the search for scientific articles, presented in Spanish, English, Portuguese, Boolean operators were used: OR, AND, NOT.

**Board 1.** Terms used

Term used	Keywords/natural language	Descriptors/documentary language
Oral Hygiene	hygiene	Oral Hygiene
Ventilator-Associated Pneumonia	Pneumonia	Ventilator Associated Pneumonia
Pediatric Intensive Care Units	Pre-hospital	Pediatric Intensive Care Units
Disease Prevention	Prevention measures	Disease Prevention

**Source:** Authors' elaboration based on MeSH/MeSH

**Search results according to different databases****Board 2.** PubMed database search

Search	Results
(Patients pediatric in intensive care) AND (Nursing care)	120
(Patients pediatric in intensive care) AND (Pneumonia) OR (Mechanical ventilation)	300
(Patients pediatric in intensive care) AND (Oral hygiene)	28
(Patients pediatric in intensive care) AND (early mechanical ventilation weaning)	28

**Source:** own elaboration

**Board 3.** Medline database search

Search	Results
(Pediatric patients in intensive care) Y (Nursing Care)	16
(Pediatric patients in intensive care) and (pneumonia) or (mechanical ventilation)	30
(Pediatric patients in intensive care) Y (Oral Hygiene)	10
(Pediatric patients in intensive care) Y (early weaning from ventilation)	10

**Source:** own elaboration

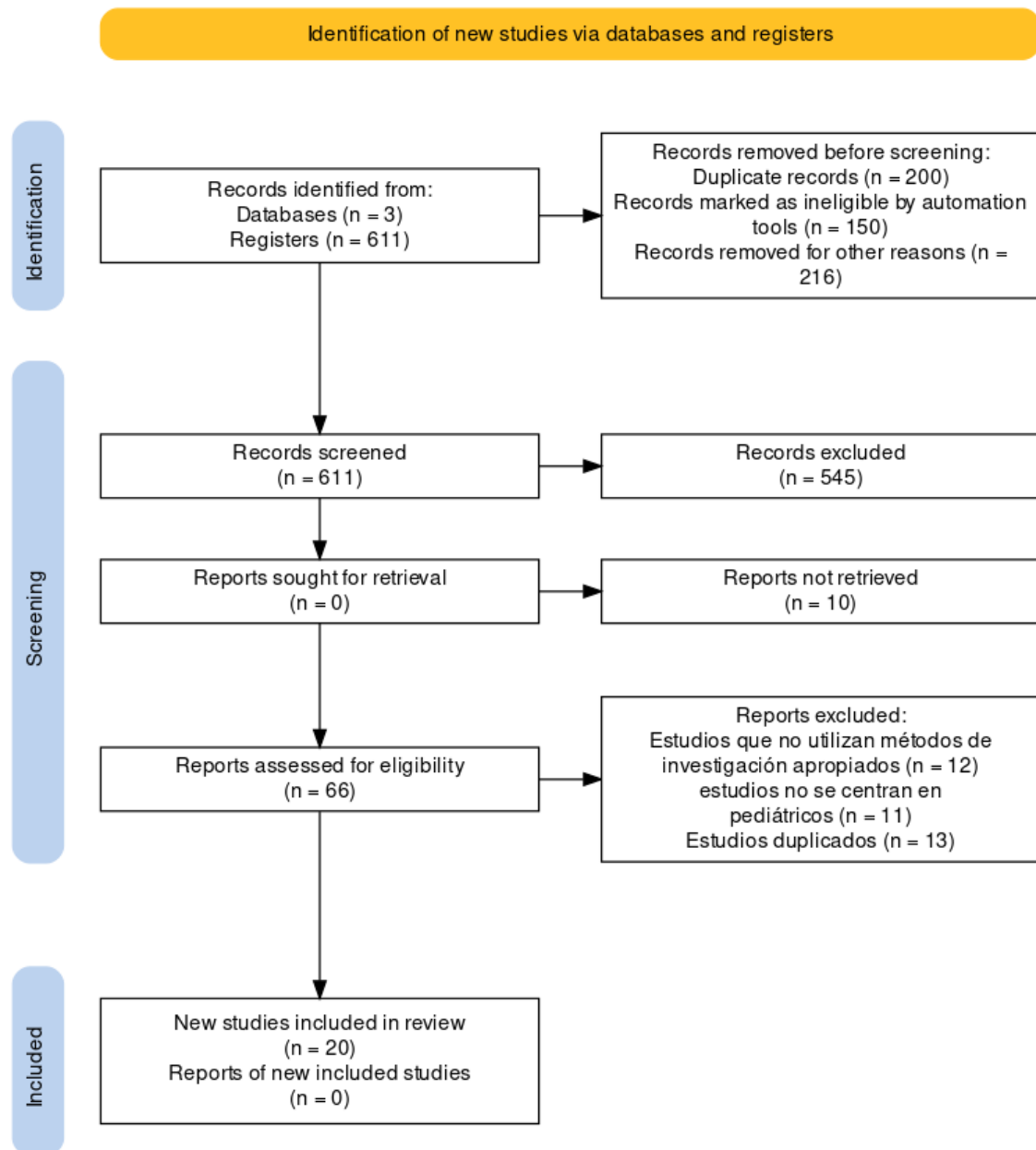
**Board 4.** Web of Science Database Search

Search	Results
(Pediatric patients in intensive care) Y (Nursing Care)	20
(Pediatric patients in intensive care) and (pneumonia) or (mechanical ventilation)	25
(Pediatric patients in intensive care) Y (Oral Hygiene)	14
(Pediatric patients in intensive care) Y (early weaning from ventilation)	10

**Source:** own elaboration

**5. Flowchart Prism**

In order to comply with the methodological standards that a systematic review entails, the search for data and the extraction of bibliographic sources related to the subject were carried out, using databases such as PUBMED, MEDLINE, Web of Science.



**Source:** Authors' elaboration based on (Haddaway et al., 2022)

### Selection procedure

#### Inclusion criteria

- Controlled Clinical Trials and Randomized Clinical Trials
- Studies involving paediatric patients (0-18 years)
- Oral hygiene interventions

#### Exclusion Criteria

- Studies that do not focus on pediatric patients in intensive care
- Studies that do not use appropriate research methods
- Duplicate studies

## 6. RESULTS

Applying the criteria of language, year, full texts, free and eliminating duplicate articles. A total of 616 results were obtained using the Pubmed, Medline, Web of Science databases. Once the titles were read for eligibility, 66 articles remained, of which, after a complete review of the texts, 20 articles were selected for review. It was decided to use Mendely as a bibliographic manager and to manage all the articles.

Author/s	Year	Title	Type of study	Objective	Variables studied
Haniyeh Irani, Gholamhosee, Alireza Rahat Dahmardeh, Zahra Pishkar Mofrad	2020	The Effect of Oral Care with Miswak Versus Chlorhexidine on the Incidence of Ventilator-Associated Pneumonia: A Clinical Trial Study	This randomized, single-blind clinical trial	To compare the effect of oral care with miswak and chlorhexidine mouthwash on the incidence of VAP in ICU patients.	endotracheal tube insertion, score of 10 or less according to the Beck Oral Assessment Scale (BOAS)
Walfrido García Borges, Marnolvis Samón Nuñez, Joel Vigó González, Yindris Mercedes Martínez Torres, Marleannis Fernández Coba	2021	Ventilation-Associated Pneumonia in a Pediatric Intensive Care Unit	retrospective, descriptive and longitudinal study,	To describe the incidence of ventilation-associated pneumonia in a paediatric intensive care unit.	Pneumonia, cause of infant mortality
Anton H. van Kaam, Cornelië SH Aarnouds Moens, Aleid G van Wassenae, Wes Tierra	2019	Duration of mechanical ventilation and neurodevelopment in preterm infants	Retrospective cohort study.	To investigate the association between the duration of invasive mechanical ventilation (IMV) and long-term neurodevelopmental outcomes in preterm infants in an era of restricted IMV.	duration of invasive mechanical ventilation (IMV)
Tânia Filipa Cabrita-Xavier <sup>1</sup> , Filipe Correia-de Melo <sup>1</sup> , Maria do Céu Mendes-Pinto-Marques	2023	Oral hygiene care for orotracheal intubated patients: influencing factors. Systematic review of the literature	Systematic Review of the Literature Study	To identify primary scientific evidence on the main factors that interfere in the provision of oral hygiene care, developed by nurses, to orotracheally intubated users in intensive care units.	Oral hygiene care provided to users in orotracheal intubation
Andrada, F., Wasinger, E., Ponce, G., Vargas, M., Romano, F., Bello, C., Cesario, H., Telayna, S., Titolo, A., Darritchon, A., Driussi, F., & Vargas, M.	2021	Characteristics and follow-up of subjects on mechanical ventilation in a pediatric intensive care unit in the province of Buenos Aires.	Descriptive, cross-cutting	Determine nursing staff knowledge with respect to measures to prevent pneumonia associated with mechanical ventilation and management of enteral feeding in patients admitted to the ICU of a public hospital.	comprehensive understanding of the characteristics of pediatric patients under mechanical ventilation in a pediatric intensive care unit in the province of Buenos Aires,

Barrera-Robledo, M. E., & Uribe-Caputi, J. C.	2022	Prevalence and factors associated with nosocomial pneumonia in the intensive care unit.	Observational cross-sectional study with an analytical component.	The objective of this study is to describe the prevalence and associated factors such as hospital stay in the ICU, concomitant diseases and situations in patients under 18 years of age with nosocomial pneumonia with a stay in the intensive care unit in a tertiary care clinic in the city of Cali, in the period January 2015 and January 2016.	Prevalence of factors associated with ICU stay
Branco, A., Lourenço, E. M. S., Monteiro, A. B., Fonseca, J. P., Blatt, C. R., & Caregnato, R. C. A.	2020	Education to prevent ventilator associated pneumonia in intensive care unit.	quasi-experimental, retrospective study	to assess nursing adherence to the Ventilator-Associated Pneumonia Prevention Package and incidence rate, before and after continuing education.	patients connected to mechanical ventilators admitted to the Intensive Care Unit
Camejo Serrano, Y. de los Á., Elias González, J. A., Morales Torres, G., Rivera Morell, M., & Licea Castellano, L.	2019	Risk factors for acquired infections in the Pediatric Intensive Care Unit of Bayamo	Analytical study of cases and controls in patients treated in the Unit Pediatric Intensive Care Unit (ICU)	identify risk factors for the onset of this disease	healthcare-associated infections (SAIs) are a health problem
Durán Rodríguez, R., Mercedes, A., Méndez, R., Cobas Sánchez, A., Paján, R., & Castillo Pérez, and	2017	Behavior of mechanic ventilator-associated pneumonia in adult intensive care.	Cross-sectional descriptive study	To assess the behavior of ventilator-associated pneumonia (VAP) in the Adult Intensive Care Unit of the "Octavio de la Concepción y de la Pedraja" General Teaching Hospital in Baracoa between January and December 2015	Review of medical records of patients, admission book and sepsis control record of the service.

Espinoza Torres, C. L., Cabrera Álvarez, N. E., Clavero Duarte, J. J., Solís Quintana, E. Y., & Rodríguez Valiente, L.	2023	Nursing Knowledge on Prevention Measures in Ventilator-Associated Pneumonia	Descriptive, cross-sectional study	To determine the knowledge of nursing staff regarding measures for the prevention of pneumonia associated with mechanical ventilation and management of enteral feeding in patients admitted to the ICU of a public hospital	Knowledge of standard precautionary measures
Vaca Moreano, A. P., Quinteros Portilla, R. E., Paredes Garcés, M. G., & Acosta Nuñez, J. M.	2023	Prevention of pneumonias associated with invasive mechanical ventilation in an intensive care unit.	Systematic review	Analyzing Ventilator-Associated Pneumonia: Risks, Problems, and New Concepts	pneumonia associated with intubation and mechanical ventilation
Wagh, A., & Sinha, A.	2018	Prevention of healthcare-associated infections in paediatric intensive care unit. Child's Nervous System	Literature review	Healthcare-Associated Infection Prevention Analysis in the Pediatric Intensive Care Unit	Healthcare-associated infections
Keykha, A., Ramezani, M., Amini, S., & Moonaghi, H. K.	2022	Oropharyngeal Decontamination for Prevention of VAP in Patients Admitted to Intensive Care Units: A Systematic Review.	Review of randomised clinical trials (RCTs) published in databases	To evaluate recent OHC strategies to decrease VAP.	Pathogenic organisms contribute to the development of ventilator-associated pneumonia (VAP) in intensive care units (ICUs)
Caroline Louise Sampaio Pinheiro <sup>1</sup> Fernanda Pereira Lima <sup>1</sup> Fernanda Conceição Machado <sup>1</sup> Sara de Souza Santos <sup>2</sup> Allan Roberto Xavier Malheiro <sup>2</sup> Ledilce Almeida Atafde <sup>2</sup> Andreia Cristina Leal Figueiredo <sup>1</sup>	2020	Oral and tracheal microbiota of pediatric and adolescent patients in an intensive care unit	This is an exploratory study carried out in elderly patients 5 months to 13 years admitted to the PICU of a referral hospital	To characterize the oral and tracheal microbiota of hospitalized patients. to a pediatric intensive care unit (PICU)	Two microbiological samples were collected with a swab in the posterior region of the tongue from patients receiving spontaneous and mechanical ventilation within the first 24 and 48 hours after admission to the PICU

Neal R. Haddaway, Matthew J. Page, Chris Pritchard, Lucas A. McGuinness	2022	PRISMA 2020: An R package and Shiny app to produce PRISMA 2020-compliant flowcharts, with interactivity for optimized digital transparency and open synthesis.	Systematic reviews	They aim to ensure that the methods and findings of the review are described in sufficient detail.	We developed a free-to-use, open-source R package and a web-based Shiny application to allow users to design PRISMA flowcharts for their own systematic reviews.
MsC. Heriberto Arencibia Sosa, I Dr. Naurah Esther Mathador, II MsC. José Luis Lobaina Lafita I and Dr. Jorge Sánchez Guillaume	2021	Clinical characteristics of ventilator-associated pneumonia in pediatric intensive care	Descriptive and cross-sectional study	determine the main variables associated with the development of ventilator-acquired pneumonia in children admitted to the Intensive Care Unit of the Children's Hospital "Dr. Juan de La Cruz Martínez Maceira" of Santiago de Cuba, since January 2007 to December 2011.	development of ventilator-acquired pneumonia in children admitted to the Care Unit
F. S. Ludovichetti, A. Zuccon, P. Positello, N. Zerman*, A. Gracco, E. Stellini, S. Mazzoleni	2022	Preventive oral hygiene and ventilator-associated pneumonia in paediatric intensive care unit. European Journal of Paediatric Dentistry	Systematic review of literature	The aim of this literature review is to investigate whether Improving oral hygiene could affect the appearance of nosocomial diseases.	Importance of good oral care packages. mitigate the growth of bacteria in the bloodstream, and Prevent the development of ventilator-associated pneumonia.
Miguel Ángel Pezo Galdea Menoscal Tómalá Karina Lorena Ángela García Barreto	2018	Ventilator-Associated Pneumonia in Patients Admitted to ICU: Etiology and Risk Factors	Systematic review	To delve into ventilator-associated pneumonia (VAP) in patients admitted to the intensive care unit (ICU),	ventilator-associated pneumonia (VAP)
Melissa Katherine Sánchez-Peña, Luz Angélica Orozco-Restrepo, Óscar Felipe Suárez-Brochero	2020	Association between oral health, pneumonia, and mortality in intensive care patients	Cross-sectional study	To identify the association between oral health status, ventilator-associated pneumonia, and mortality in	mechanical ventilation are at risk of pneumonia



				mechanically ventilated patients in a tertiary care hospital in Pereira, Colombia.	
Claudenice Rodrigues dos Santos <sup>1</sup> , Brunna Hellen Saraiva Costa <sup>2</sup> , Thainá Karoline Costa Dias <sup>3</sup> , Haline Costa dos Santos Guedes <sup>4</sup> , Maria Sandra Sousa da Paz <sup>5</sup> , Thaís Costa de Oliveira <sup>6</sup> , José Nildo de Barros Silva Júnior <sup>7</sup> , Hanna Louise Macedo Marinho	2018	Risk Factors That Favor Pneumonia Associated With Mechanical Ventilation	This is a bibliographic study, an integrative review.	Analyze the main risk factors that favor pneumonia associated with mechanical ventilation	Risk factors, mechanical ventilation.

## 7. DISCUSSION

According to the information analyzed, as indicated by the European Centre for Disease Prevention and Control Protocols for Healthcare-Associated Infections in Intensive Care Units of 2017, they define that the infection is considered as acquired in the Intensive Care Unit (ICU) when it is diagnosed after 48 hours of the patient's stay in the unit and was not present or in the period of incubation at the time of admission (Camejo Serrano et al., 2019) (Ludovichetti et al., 2022).

In this sense, according to statistics issued by the World Health Organization (WHO), approximately 247 people die every day in the United States of America as a result of HAI, and 1 in 4 patients who are in ICU acquire infection during their course in the hospital instance, it is known that in underdeveloped countries complication rates can double (Camejo Serrano et al., 2019).

From the same perspective (Andrada et al., 2021). It defines mechanical ventilatory assistance as a life-sustaining therapy whose epidemiology in pediatric patients fluctuates between 30% and 64%. Which, according to (Arencibia Sosa et al., 2021) it, can trigger prolongation of this and in turn associate with complications and adverse effects, which is why it is recommended that it be discontinued as soon as possible as the patient acquires the ability to ventilate spontaneously achieving an adequate gas exchange.

One of the most feared complications in PICU is HAI, which is usually associated with the use of mechanical ventilation, either invasively or non-invasively. Among the most frequent group of infections are bloodstream infections and pneumonia associated with mechanical ventilation; the latter refers to those patients who have been ventilated for more than 48 hours and develop nosocomial pneumonia. According to the National Institute of Clinical Oncology, it is considered that up to 30% of ventilated patients develop ventilator-associated pneumonia. The consequences of these complications can lead to an increase in both mortality and morbidity, which in turn affects a longer length of hospitalization stay in the intensive care unit and in hospitalization in general, as well as the use of the prolonged mechanical ventilator. Wagh & Sinha, 2018

For the World Health Organization (WHO), pneumonia is a type of acute respiratory infection that affects the lower respiratory tract, which are made up of bronchi, bronchioles and alveoli when the latter is mainly affected, it is when there are major complications, since it is here where gas exchange takes place.

Likewise, in a study carried out in 2013-2014 in different Latin American countries such as: Colombia, Peru, Venezuela, Bolivia, Ecuador and Mexico, in patients who were hospitalized in the intensive care unit, suffering from infections associated with mechanical ventilation, it is shown that 63% of these patients contracted pneumonia and 35% who underwent tracheostomy contracted bronchitis (Barrera-Robledo & Uribe- Caputi, 2022).

According to Cornejo's study, it shows us that in patients under 5 years of age, there is an increase of up to 7 times more probability of infection compared to patients who are older than this age. The existing risk was up to 10 times higher in patients with malnutrition disorders, while those who suffered from an underlying pathology or comorbidity quintuple the risk of the disease appearing, on the other hand, the risk of getting sick due to mechanical ventilation increased up to 10 times (Camejo Serrano et al., 2019).

In addition, according to Bronco and Durán, they mention that according to their research, prevention strategies and measures should be implemented against these cases, one of the methods used is the VAP (ventilator associated pneumonia) prevention package, which consists of prevention measures such as: maintaining oral hygiene using products such as 0.12% chlorhexidine, In turn, this is accompanied by a good brushing of the teeth, keeping the bedside elevated between 30 to 45°, the position of the mechanical ventilator filter and the pressure in the endotracheal tube must be monitored (Branco et al., 2020) and . (Durán Rodríguez et al., 2017)

In the same way, Keykha shows in his study that the use of antiseptic such as chlorhexidine is effective in oropharyngeal disinfection and therefore reduces the prevalence of VAP. However, despite this, this medium had a reaction on gram-negative bacteria that are resistant. In addition, it was visualized that the combination of two antiseptics such as colistin and chlorhexidine was more effective in preventing VAP than using a single one. The results regarding the use of brushes are not clear since chlorhexidine was used at the same time. However, in all types of patients it is established that the use of brushes is one of the best methods of oral hygiene. With respect to the use of povidone-iodine, Nanosil and non-absorbable topical antibiotics also demonstrated efficacy in reducing the incidence of VAP, while Iseganan did not show a significant effect. ( Keykha et al., 2022) In fact, according to Torres, they explain in their study that oral care is a key element in reducing the prevalence of nosocomial pneumonias associated with mechanical ventilation. However, it usually goes unnoticed in the care applied to pediatric patients, causing significant complications in this age group during their stay in the intensive care unit (Espinoza Torres et al., 2023) .

In consideration of this premise , Galdea also identified that there are significant shortcomings in terms of the correct application and the importance that health professionals give to these activities (Pezo Galdea et al., 2018) .

In the same way, Costa identified that there is a need to apply specific care for the treatment of this hospital complication in order to improve the health status of the pediatric patient. Stating that the lack of care of nurses related to the lack of interest and the incorrect application of care related to the patient's hygiene is considered a risk factor in the ICU, triggering consequences in recovery and evolution (Costa et al., 2018) .

In short, as Vaca mentions, standard oral care measures and their impact as a means of prevention are extremely important, giving key results in the quality of life of the pediatric patient, reducing their incidence of complications and therefore the reduction of hospital stay and associated expenses.(Vaca Moreano et al., 2023)

## 8. CONCLUSIONS

We can conclude that the prevalence of ventilator-associated pneumonia in pediatric intensive care patients demonstrates the importance of this complication in medical care. Data collected through comprehensive literature review and epidemiological studies provide a detailed picture of the burden of disease in this vulnerable population. Prevalence rates vary, highlighting the importance of ongoing surveillance and effective prevention plans. These results highlight the need to proactively address ventilator-associated pneumonia as a major challenge in pediatric healthcare to improve clinical outcomes and reduce associated morbidity and mortality in mechanically ventilated patients in pediatric intensive care units.

Likewise, the analysis of the effect of respiratory care measures, particularly oral hygiene, on reducing the incidence of pneumonia with mechanical ventilation in pediatric intensive care patients suggests a significant association between these measures and the prevention of this complication. The reviewed studies and evidence synthesis consistently show that the use of oral hygiene measures, such as regular brushing and antimicrobial mouthwashes, can effectively reduce the risk of ventilator-associated pneumonia in this vulnerable population.

## 9. Limitations and future lines

### Among the main limitations we can find:

**Selection bias:** some of the studies included in the systematic review may have been conducted in specific clinical settings that do not fully reflect the diversity of children in intensive care units. This can lead to selection bias.

**Quality of evidence:** The primary studies included in the review may be of low quality, which may affect the reliability of the findings. It is important to consider the diversity of research designs and the robustness of the methods used.

### Future lines

**Cost-benefit analysis:** To assess the economic impact of implementing oral hygiene measures in pediatric intensive care units, a detailed cost-benefit analysis is required that considers both the associated costs and the benefits in terms of health and quality of life.

**Education and training:** Education and training programs should be established to better understand and adhere to oral hygiene practices as a preventive measure against ventilator-associated pneumonia by health care professionals, caregivers, and pediatric patients.

## REFERENCES

1. Andrada, F., Wasinger, E., Ponce, G., Vargas, M., Romano, F., Bello, C., Cesario, H., Telayna, S., Titolo, A., Darritchon, A., Driussi, F., & Vargas, M. (2021). Characteristics and follow-up of subjects on mechanical ventilation in a pediatric intensive care unit in the province of Buenos Aires. *Argentinian Journal of Respiratory & Physical Therapy*, 3(3). <https://doi.org/10.58172/ajrpt.v3i3.175>
2. Arencibia Sosa, H., Mathador, N. E., Lobaina Lafita, J. L., & Sánchez Guillaume, J. (2021). Clinical characteristics of ventilator-associated pneumonia in pediatric intensive care. In *MEDISAN* (Vol. 16, Issue 11).
3. Barrera-Robledo, M. E., & Uribe-Caputi, J. C. (2022). Prevalence and factors associated with nosocomial pneumonia in the intensive care unit. *MedUNAB*, 25(2), 227–236. <https://doi.org/10.29375/01237047.4099>
4. Branco, A., Lourençone, E. M. S., Monteiro, A. B., Fonseca, J. P., Blatt, C. R., & Caregnato, R. C. A. (2020). Education to prevent ventilator-associated pneumonia in intensive care unit. *Revista Brasileira de Enfermagem*, 73(6). <https://doi.org/10.1590/0034-7167-2019-0477>
5. Cabrita Xavier, T. F., Correia de Melo, F., & Mendes Pinto Marques, M. do C. (2023). Oral hygiene care for orotracheally intubated patients: Influencing factors. *Systematic review of literature. Global Nursing*, 22(2), 555–606. <https://doi.org/10.6018/eglobal.516121>
6. Camejo Serrano, Y. de los A., Elias González, J. A., Morales Torres, G., Rivera Morell, M., & Licea Castellano, L. (2019). Risk factors for acquired infections in the Pediatric Intensive Care Unit of Bayamo. 2018-2019. *Multimed. Medical Journal*, 24(2). <https://orcid.org/0000-0002-8463-411X>
7. Costa, B. H. S., Dias, T. D. K. C., Paz, M. S. S. da, Santos, C. R. dos, Oliveira, T. C. de, Marinho, H. L. M., Júnior, J. N. de B. S., & Guedes, H. C. dos S. (2018). Cliff factors that favor pneumonia associated with mechanical ventilation. *Revista de Enfermagem UFPE on Line*, 12(12), 3401. <https://doi.org/10.5205/1981-8963-v12i12a235025p3401-3415-2018>
8. Durán Rodríguez, R., Mercedes, A., Méndez, R., Cobas Sánchez, A., Paján, R., & Castillo Pérez, Y. (2017). ORIGINAL ARTICLE Behavior of mechanic ventilator-associated pneumonia in adult intensive care. *Rev Inf Cient*, 96(4), 615–625.
9. Espinoza Torres, C. L., Cabrera Álvarez, N. E., Clavero Duarte, J. J., Solís Quintana, E. Y., & Rodriguez Valiente, L. (2023). Nursing knowledge on prevention measures in Ventilator-Associated Pneumonia. *Nursing Notes*, 24(41), 60–66. <https://doi.org/10.59843/2618-3692.v24.n41.41442>
10. García Borges, W., Samón Nuñez, M., Vigó González, J., Mercedes Martínez Torres, Y., & Fernández Cobas, M. (2021). Ventilation-associated pneumonia in a pediatric intensive care unit. <https://orcid.org/0000-0002-2180-3203>
11. Haddaway, N. R., Page, M. J., Pritchard, C. C., & McGuinness, L. A. (2022). PRISMA2020: An R package and Shiny app for producing PRISMA 2020-compliant flow diagrams, with interactivity for optimised digital transparency and Open Synthesis. *Campbell Systematic Reviews*, 18(2). <https://doi.org/10.1002/cl2.1230>
12. Irani, H., Sargazi, G., Dahmardeh, A. R., & Mofrad, Z. P. (2020). The Effect of Oral Care with Miswak Versus Chlorhexidine on the Incidence of Ventilator-Associated Pneumonia: A Clinical Trial Study. *Medical - Surgical Nursing Journal*, 8(4). <https://doi.org/10.5812/msnj.100387>
13. Keykha, A., Ramezani, M., Amini, S., & Moonaghi, H. K. (2022). Oropharyngeal Decontamination for Prevention of VAP in Patients Admitted to Intensive Care Units: A Systematic Review. In *Journal of Caring Sciences* (Vol. 11, Issue 3, pp. 178–187). Tabriz University of Medical Sciences. <https://doi.org/10.34172/jcs.2021.029>
14. Ludovichetti, F. S., Zuccon, A., Positello, P., Zerman, N., Gracco, A., Stellini, E., & Mazzoleni, S. (2022). Preventive oral hygiene and ventilator-associated pneumonia in paediatric intensive care unit. *European Journal of Paediatric Dentistry*, 23(4), 298–302. <https://doi.org/10.23804/ejpd.2022.23.04.09>
15. Pezo Galdea, M. Á., Menoscal Tómalá, K. L., & García Barreto, Á. (2018). Ventilator-associated pneumonia in patients admitted to the ICU: Etiology and risk factors. *World of Research*, 2(3), 140–150.
16. Pinheiro, C. L. S., Lima, F. P., Machado, F. C., Santos, S. de S., Malheiro, A. R. X., Ataíde, L. A., & Figueiredo, A. C. L. (2021). Oral and tracheal microbiota of pediatric and adolescent patients in an intensive care unit. *Special Care in Dentistry*, 41(5), 599–606. <https://doi.org/10.1111/scd.12602>
17. Sánchez Peña, M. K. (2021). Association between oral health, pneumonia and mortality in intensive care patients. *Medical Journal of the Mexican Institute of Social Security*, 58(4). <https://doi.org/10.24875/RMIMSS.M20000072>
18. Vaca Moreano, A. P., Quinteros Portilla, R. E., Paredes Garcés, M. G., & Acosta Nuñez, J. M. (2023). Prevention of pneumonias associated with invasive mechanical ventilation in an intensive care unit. *Health, Science and Technology*, 3, 326. <https://doi.org/10.56294/saludcyt2023326>
19. Vliegenthart, R. J. S., van Kaam, A. H., Aarnoudse-Moens, C. S. H., van Wassenaer, A. G., & Onland, W. (2019). Duration of mechanical ventilation and neurodevelopment in preterm infants. *Archives of Disease*

in Childhood - Fetal and Neonatal Edition, 104(6), F631–F635. <https://doi.org/10.1136/archdischild-2018-315993>

20. Wagh, A., & Sinha, A. (2018). Prevention of healthcare-associated infections in paediatric intensive care unit. *Child's Nervous System*, 34(10), 1865–1870. <https://doi.org/10.1007/s00381-018-3909-4>