

# Ventilator-associated pneumonia (VAP) in the pediatric ICU: an integrative review

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## Abstract

The present article seeks to accomplish an integrative literature review aiming to increase knowledge on the theme of the paper, so as to improve the nurse care provided to the pediatric patient in the intensive care unit, with ventilator-associated pneumonia (VAP) due to hospital causes. An integrative literature review was conducted by searches. Thus, the general objective of this study was to evaluate how the literature presents VAP in pediatric patients in the ICU, so as to verify if there are national protocols or guidelines in this context for assistance. Having that in mind, it is noteworthy that in the revision the authors verified there are few studies that mention pediatric patients, which demonstrates that more studies should be conducted to build more evidence and to contribute to the elaboration of protocols and guidelines targeted at the pediatric population, helping to reduce the high infection rates and infant mortality.

**Keywords:** pneumonia, artificial ventilation, mechanical ventilation.

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Nursing, through care practices and the production of scientific knowledge, has contributed to the process of building a nursing care increasingly directed towards the search for quality in a general scope and humanized patient care.

However, there is no way to effectively intervene in order to provide a humanized without seeking excellence in understanding the various features that make up the symptoms and therapies, inherent to the various pathologies that are part of daily nursing care, especially in relation to intensive care in pediatrics, which requires agility, as well as skilled and specific care. Although only 50-10% of hospitalized patients require intensive care, most hospital acquired infections occur in this unit<sup>1</sup> and the rate of hospital infection in intensive care unit (ICU) is 5-10% and up to double this number.<sup>2</sup>

The defense mechanisms of the respiratory system may show decreased efficiency during hospitalization. This reduction occurs as a result of conditions caused by the pathology itself or by an invasion of the body, crossing natural barriers and also by changes in drug therapy.<sup>3</sup>

Seriously ill patients requiring prolonged intensive care are most at risk of acquiring infections. Factors that contribute to the high infection rate and mortality in ICUs are possibly associated with the severity of the underlying disease, invasive procedures, the prolonged duration of hospitalization and use of antibiotics, especially those of broad spectrum, favoring the emergence of multidrug-resistant bacteria, which complicates therapy.<sup>4</sup>

In ICUs, pneumonia is the most frequent infection in Europe and the second most diagnosed infection in U.S. hospitals. The high mortality rates observed in hospital pneumonia largely reflect the factors related to the patient, the institution and regional characteristics. Because many patients with pneumonia also have other underlying pathologies, such as immunosuppression, altered level of consciousness and/or cardiopulmonary dysfunction, the rapid start of adequate antimicrobial therapy is crucial for therapeutic success.<sup>4</sup>

Pneumonia, together with surgical infections, sepsis and urinary tract infections, is the leading cause of death among hospital-acquired infections, accounting for approximately 10% of all hospital infections. Its prevalence in ICUs is 10-65% and its lethality is 13-55%.<sup>5</sup> As for the length of the stay of the patient, it increases on average nine days, considerably increasing hospital costs.<sup>6,7</sup> Pneumonia involves distal inflammation of the lung caused by infection by microorganisms and is histologically characterized by the accumulation of neutrophils in the distal bronchioles, alveoli and interstitium.<sup>8</sup>

Mechanical ventilation constitutes a great progress in intensive care, formulated as a method of artificially ventilating patients incapable of breathing spontaneously, reducing the work of breathing and preventing progressive circulatory failure secondary to increased production of CO<sub>2</sub>. Often considered a method of support that has saved the lives of critically ill patients, it is also associated with risks, side effects and complications. Many of these problems are

not directly related to the use of the ventilator itself, as is the case of nosocomial pneumonia, which results from a series of factors which include intubation. Patients submitted to invasive mechanical ventilation, which have the first lines of defense against infection altered, are patients who are at higher risk for nosocomial pneumonia.<sup>8</sup>

Ventilator-Associated Pneumonia (VAP) generally develops 48 hours after placement, being an inflammatory host response to the uncontrolled multiplication of microorganisms invading the distal airways. It is the most common nosocomial infection in intensive care units.<sup>(5, 9-10)</sup> The incidence of VAP is high, ranging between 6 and 52% depending on the population studied, type of ICU, and the type of diagnostic criteria used. This is because despite it being an extremely important infection, it is one of the most difficult to be diagnosed in a seriously ill patient.<sup>11</sup> Thus, promoting quality of life in an intensive care environment becomes a difficult issue, because at such a critical time the utmost concern is the fight against death, making use of all invasive procedures required. Endotracheal intubation is between the countless procedures used.<sup>9</sup>

The risk factors for the development of VAP can be classified as modifiable and non-modifiable. Non-modifiable risk factors are: age, severity score upon admission to the ICU and the presence of comorbidities (heart failure, chronic obstructive pulmonary disease, diabetes, neurological diseases, cancer, trauma and post-operative recovery). Modifiable factors relate to the environment (microbial flora) in the ICU. Thus, recognition of the most frequent germs in the unit is crucial.<sup>12</sup>

In this context, studies seeking to establish care guidelines in order to systematize and streamline service tend to contribute to the quality of care.<sup>13</sup>

Many of the considerations when selecting the most appropriate empirical treatment for serious infections in adults and children are very similar and include: presence and type of infection focus, severity, the patient's immune status, age, community or hospital-acquired.<sup>14:16</sup>

The diagnosis and management of infections in hospitalized patients in the ICU is a challenge because one third of patients who are admitted present fever without focus at some time during hospital stay. This situation often results in prolonged hospitalization, requests for multiple laboratory tests and, on occasions, inappropriate use of antibiotics. Moreover, approximately 20-30% of patients with sepsis do not show clear clinical focus. This is compounded because the possibility of documenting infections in a pediatric intensive care unit (PICU) is a complex task, since only about 30% have positive blood cultures when the focus is not endovascular (bacteremia associated with central venous catheters). The late start of antibiotic treatment is related to increased mortality associated with these infections, which is why early and appropriate treatment is essential.<sup>15</sup> It is estimated that the incidence of VAP in adults exceeds 10%. The incidence in children, estimated by the National Nosocomial Infections Surveillance System (NNIS) is 20%.<sup>16:30</sup>

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Based on these considerations, this study aims at an integrative literature review and to increase knowledge on the subject of research to improve nursing care to pediatric patients in the ICU with VAP due to nosocomial causes.

Thus, the general aim of this study was to evaluate how the literature presents VAP in pediatric patients in the ICU, checking if there are national care protocols or guidelines in this area.

The issue sparked interest, and the aim was to observe how this pathology is managed when it occurs in a pediatric patient with VAP, and to promote prevention of this nosocomial disease.

## METHODOLOGY

To achieve the general goal, we used the method of integrative literature review. This method makes it possible to summarize research already completed, and to draw conclusions from a topic of interest. A well conducted integrative review requires the same standards of strictness, clarity and replication used in primary studies.<sup>17</sup>

An integrative literature review, as well as providing a synthesis of the knowledge produced about a certain topic, also allows one to see of gaps in evidence in professional practice and provides context in a particular topic.<sup>18</sup>

A study from 2007 mentions, based on Broome, that "the integrative review is defined as a review of previous studies that are summarized by means of an extraction of the findings of many studies".<sup>19:36</sup>

For the development of this integrative review, the following steps were followed: establishment of the issues for review, determination of inclusion and exclusion criteria for articles (sample selection), definition of information to be extracted from selected articles, analysis of results, presentation of results and discussion.

The following databases were used to select the articles: Biblioteca Virtual de Saúde (BVS-BIREME), favoring the databases LILACS, SCIELO and BDENF (Base de Dados da Enfermagem). The choice of three different databases aimed to minimize, in extent possible, biases that may arise in this type of research.

Inclusion criteria for articles were: articles in electronic media, with abstracts available in the selected databases and with available information about goals, methods, results and conclusions of the study.

The period considered was 1999-2007. Articles that describe procedures, interventions or nursing guidelines for VAP were included. The proposed descriptors for the study were: VAP, ventilator-associated pneumonia, nosocomial pneumonia, Pediatric ICU. To filter through the BVS, the following descriptors were associated: pediatric ICU nosocomial pneumonia, infection pediatric ICU, pediatric ICU VAP.

The search was conducted by online access. For the analysis and subsequent synthesis of the articles that met

the inclusion criteria, a summary table built especially for this purpose was used, with the following aspects considered relevant: the name of research, authors' names; recommendations/conclusions.

To develop the analysis articles on conceptual aspects, diagnosis and pediatric VAP management were selected, in order to review and quantify those articles that contain features that meet the objectives proposed for the study.

Results and discussion of the data obtained are descriptively presented, allowing the reader to evaluate the applicability of the integrative review prepared, and also to achieve the goal of this method, i.e. positively impact the quality of nurse practice, providing support for nurses to act and contribute to the optimization of care for pediatric patients affected by VAP, also having in mind further studies to create care protocols.

The representation of this quantification is presented in the next chapter, Results.

## RESULTS

Of the initial sample of 34 references in Lilacs, 4 in Scielo, 1 in BDENF and 208 in "google scholar", totaling 247 literatures, filtering was conducted according to the inclusion criteria listed in the method, thus obtaining, after excluding repeated articles (39), a total of 12 items (abstracts and full texts), of which 8 corresponded to the goals.

It is noteworthy that during the analysis of selected texts, two additional cited literatures were found in the articles reviewed, to which electronic access was obtained, and they were added to the research. With this, a total of 10 articles met the objectives proposed.

The proposed objective for the present study was resumed, which was to "evaluate how the literature presents VAP in pediatric patients in the ICU, so as to verify if there are national protocols or guidelines in this context for assistance". It was found that the literature, according to the adopted approach can be categorized as follows: risk factors, incidence / prevalence, mortality, diagnosis approach and treatment. As for whether or not care protocols or guidelines are in place, the authors found only one article addressing the guidelines subject. The tables below present the distribution of literature according to the categories proposed.

### Risk Factors

For risk factors, one article was found, as presented in Table 1.

As shown in table 1, five studies discuss the risk factors for infections in pediatric ICU and the need for invasive procedures, especially mechanical ventilation, is a factor cited in all selected studies as a predisposing factor for the occurrence of infection. Another factor cited as important is the severity of the patient's condition. Age below 24 months or up to two years is another important factor cited in two studies.<sup>23,24</sup> Previous antibiotic therapy is cited as a risk factor in the study

**Table 1.** Risk factors for VAP

AUTHOR / YEAR	TITLE	Abstract
Sociedade Brasileira de Pneumologia e Tisiologia - 2007 (2007) <sup>22</sup>	Diretrizes brasileiras para tratamento das pneumonias adquiridas no hospital e das associadas à ventilação mecânica - 2007. (Brazilian guidelines for treatment of hospital acquired and ventilator-associated pneumonia - 2007.)	This study presents a picture that shows the independent risk factors for VAP. As major risk factors cited are: trauma, burns, neurological disease, duration of mechanical ventilation over 10 days, witnessed bronchoaspiration, colonization of the respiratory tract 7.5 by Gram-negative, no antibiotic therapy, use of PEEP * ( $\geq$ cmH <sub>2</sub> O).
Banderó Filho, Rechke e Hömer (2006) <sup>20,267</sup>	Perfil epidemiológico das infecções hospitalares na Unidade de terapia intensiva infantil do Hospital de Caridade e Beneficência de Cachoeira do Sul, RS, Brasil. (Epidemiological profile of nosocomial infections in pediatric intensive care unit at the Hospital de Caridade e Beneficência de Cachoeira do Sul, Brazil.)	As risk factors that may be related to hospital infections in newborns, this literature suggests: low weight, immaturity of the immune system, the frequent need for invasive procedures of mechanical ventilation, and factors related to the environment and health professionals.
Casellas JM (2006) <sup>14</sup>	Infecções graves na unidade de terapia intensiva pediátrica (Serious infections in pediatric intensive care unit)	This study describes as the major risk factors in PICUs for infection rate: less than 24 months of age, serious preexisting disease, prolonged exposure to invasive procedures, prior antibiotic therapy, previous ICU stay and immunosuppression.
De Cicco et al (2005) 21:	Implementación de un sistema de vigilancia activa de infecciones intrahospitalarias em una unidad de cuidados intensivos pediátrica.	Pediatric ICU patients are more susceptible to infection due to the severity of the condition and also due to the higher frequency of invasive procedures.
Abramczyk et al (2003) <sup>23</sup>	Nosocomial infection in a pediatric intensive care unit in a developing country.	Age up to two years, serious illness, invasive procedures, long hospitalization, high population density in the ICU and parenteral nutrition.

\* PEEP: positive end expiratory pressure  
Source: Research data, 2008.

of the Sociedade Brasileira de Pneumologia e Tisiologia<sup>22</sup> however, in the study by Casellas,<sup>23</sup> previous antibiotic therapy is highlighted as a risk factor, thus showing a controversial point that indicates the need for further studies.

### Incidence and prevalence

Reference to the incidence and prevalence was found in 7 articles as presented in Table 2.

The incidence and prevalence of significant ventilator-associated pneumonia is reported in most studies found in this review. The study by De Cicco et al<sup>21</sup> reports that pneumonia associated with ventilation was above the 75th percentile. The study by Carvalho et al<sup>16</sup>, reports prevalence of 37.5% of VAP.

Bacteria in discussed in three studies<sup>20, 24, 25</sup> as prevalent were *Pseudomonas* spp and *Kebsiella pneumoniae*, and there are also references to *S. aureus*.<sup>16</sup> According to Casellas et al,<sup>14</sup> nosocomial infections are somewhat more frequent in children than in adults, and in PICUs, infection rates range from 3-25% (average 11%).

### Mortality

Two articles that studied mortality, as shown in Table 3.

The two studies above were conducted in the pediatric ICU and showed a significant mortality rate, ranging from 8

to 11.3% thus indicating the need for specific studies in this population due to its frailty, in order to identify patterns for the development of specific guidelines.

### Diagnostic approach

Oropharynx and tracheobronchial contamination by microorganisms is frequent in patients on mechanical ventilation<sup>26:30</sup>. However, the relationship between colonization and lung infection is not yet clear.

In this study, we found four articles that deal with the diagnostic approach, as shown in Table 4.

The national guideline of the Sociedade Brasileira de Pneumologia e Tisiologia proposes the use of the Clinical Pulmonary Infection Score (CPIS) proposed and researched by Pugin et al,<sup>29</sup> which generates a total score of 12 points maximum (0 -12). This guideline clarifies that CPIS greater than six was associated with a high likelihood of occurrence of VAP, with sensitivity and specificity of 93 and 100% respectively. The study of Luna et al<sup>28</sup> indicates that CPIS resulted in early diagnosis of VAP, before the appearance of the classic signs of the disease.

This score, in principle considers the general population, however, it is apparent through this review that the study by Carvalho et al<sup>16</sup> discusses the difficulties of proper diagnosis

**Table 2.** Incidence and prevalence of VAP

AUTHOR / YEAR	TITLE	Abstract
Banderó Filho, Rechke e Hömer (2006) <sup>20</sup>	Perfil epidemiológico das infecções hospitalares na Unidade de terapia intensiva infantil do Hospital de Caridade e Beneficência de Cachoeira do Sul, RS, Brasil. (Epidemiological profile of nosocomial infections in pediatric intensive care unit at the Hospital de Caridade e Beneficência de Cachoeira do Sul, Brazil).	After SCN and S.aureus (bacteremia due to intravascular catheter), two other most prevalent etiologic agents: Pseudomonas sp. and Klebsiella pneumoniae, bacteria that have been identified as colonizing in children undergoing mechanical ventilation in ICU often isolated in cultures of tracheal aspirates of patients with ventilator-associated pneumonia.
Casellas JM (2006) <sup>14</sup>	Infecções graves na unidade de terapia intensiva pediátrica (Serious infections in the pediatric intensive care unit)	Hospital infections are slightly more frequent in children than adults, when viral infections are included. In PICUs, infection rates range from 3-25% (average 11%). In this cohort study conducted at the Hospital de Niños de San Isidro, the observed incidence of ventilator-associated pneumonia (VAP) was 9% (21/211 ventilated in 12 months of observation).
Carvalho et al (2005) <sup>16</sup>	Monitoramento microbiológico seqüencial da secreção traqueal em pacientes intubados internados em unidade de terapia intensiva pediátrica (Sequential microbiological monitoring of tracheal aspirates in intubated patients admitted to pediatric intensive care unit)	In this study, the incidence of VAP was 23% (16 of 68 patients). One of the agents isolated in tracheal secretions of patients with VAP was S. aureus in six of 16 cases (37.5%); of those, four strains were resistant to oxacillin.
De Cicco et al (2005) <sup>21</sup> :	Implementación de un sistema de vigilancia activa de infecciones intrahospitalarias em una unidad de cuidados intensivos pediátrica.	In this study, ventilator-associated pneumonia were above the 75th percentile.
Abramczyk et al (2003) <sup>23</sup>	Nosocomial infection in a pediatric intensive care unit in a developing country.	One of the most common types of nosocomial infections identified in the pediatric ICU was pneumonia. Ventilator associated pneumonia was present in 5.7 of 1000 days of ventilation.
Elward, Warren e Fraser (2002) <sup>24</sup>	Ventilator-associated pneumonia in pediatric intensive care unit patients: Risk factors and outcomes.	Among pediatric patients, the highest incidence occurs between 2 months and 1 year of age, and the bacterium most commonly implicated in VAP is Pseudomonas aeruginosa. The rate of ventilator associated pneumonia was 11.6/1000 days of ventilation.
Avila-Figueroa C et al (1999) <sup>25</sup> .	Prevalencia de infecciones nosocomiales en niños: encuesta de 21 hospitales en México	In this study, catheter-related sepsis and nosocomial pneumonia (25%) related to ventilation were identified as the main clinical forms of nosocomial infection, and K. pneumoniae was found as the main organism causing infections in hospitalized children.

Source: Research data, 2008.

of VAP because of the difficult diagnostic standardization for pediatric patients.

Therefore, the authors understand that further studies using the CPIS specifically for pediatric patients may bring clearer evidence for studies of VAP in pediatric patients.

### Treatment

Two articles addressed treatment, as shown in Table 5.

A key point highlighted in the choice of treatment is to be aware of the presence of risk factors for multi-resistant germs, and then treat with VAP with appropriate antibiotic therapy since this is considered the "gold standard" treatment for this type of pathology.

The concept of adequate empirical antibiotic therapy is based on a microbiological criterion that, in most cases, will

only be available around the fourth or fifth day of treatment in approximately 40-70% of patients, depending on the series studied<sup>22:14</sup>.

Through literature, one sees that the identification of the causative agents of VAP is crucial, as only then will their sensitivity profiles be understood, creating an appropriate empirical antibiotic therapy. It is possible to say that each case requires specific treatment.

Now, to resume an adjacent approach of this study, the authors sought to check whether there are national care protocols or guidelines in this area.

The literature review identified a national guideline of the Sociedade Brasileira de Pneumologia e Tisiologia, published in 2007.<sup>22</sup> This guideline states that several studies presented evidence that initial treatment with an appropriate anti-

**Table 3.** Mortality in VAP

AUTHOR / YEAR	TITLE	Abstract
Avila-Figueroa C et al (1999) <sup>25</sup>	Prevalencia de infecciones nosocomiales en niños: encuesta de 21 hospitales en México	In this study among pediatric patients diagnosed with nosocomial pneumonia, the mortality observed was 8%.
Abramczyk et al (2003) <sup>23</sup>	Nosocomial infection in a pediatric intensive care unit in a developing country.	In this study mortality from ventilator associated pneumonia in pediatric patients was 11.3%.

Source: Research data, 2008.

**Table 4.** Diagnostic approach for VAP.

AUTHOR / YEAR	TITLE	Abstract
Sociedade Brasileira de Pneumologia e Tisiologia - 2007 (2007) <sup>22</sup>	Diretrizes brasileiras para tratamento das pneumonias adquiridas no hospital e das associadas à ventilação mecânica - 2007. (Brazilian guidelines for treatment of hospital acquired and ventilator-associated pneumonia - 2007.)	Considering that false-positive diagnoses cause a strong impact on the indiscriminate use of antibiotics, in selective pressure by favoring the development of more resistant pathogens, as well as increased costs of treatment and mortality rate, a group of authors created the Clinical Pulmonary Infection Score (CPIS) through which the findings, Gram and tracheal aspirate cultures at the time of diagnosis generate a total score of a maximum of 12 points (0 -12). A CPIS of more than six was associated with a high likelihood of occurrence of VAP, with sensitivity and specificity of 93 and 100% respectively.
Luna et al (2006) <sup>28</sup>	Appropriateness and delay to initiate therapy in ventilator-associated pneumonia.	The serial and prospective use of the simplified version of CPIS in patients undergoing MV, resulted in early diagnosis of VAP before the appearance of the classic signs of the disease.
Carvalho et al (2005) <sup>16</sup>	Monitoramento microbiológico seqüencial da secreção traqueal em pacientes intubados internados em unidade de terapia intensiva pediátrica (Sequential microbiological monitoring of tracheal aspirates in intubated patients admitted to pediatric intensive care unit)	There were difficulties in this study for the adequate diagnosis of VAP due to difficulties in standardizing the diagnosis, particularly in the case of pediatric patients.
Camargo et al (2004) <sup>27</sup>	Ventilator associated pneumonia: comparison between quantitative and qualitative cultures of tracheal aspirates.	This study compared the assessment of tracheal aspirates with qualitative and quantitative microbiological evaluation, and found that there was greater sensitivity in qualitative methods and greater specificity in quantitative methods.

Source: Research data, 2008.

crobial regimen results in lower mortality rates. The guideline emphasizes that its goal is to provide the basis and information that can assist in the preparation of empirical treatment regimens guided by the risk of potentially resistant pathogens as shown in Figure 1.

According to research conducted for this study, the determination of an appropriate empirical antibiotic regimen for VAP should consider the following key points:

- Development of appropriate empirical antimicrobial regimens reduces mortality. (Grade B).
- In patients with high pre-test probability of pneumonia, a delay to start treatment increases the risk of death. (Grade B).
- The impact on reducing mortality resulting from

changes in antimicrobial therapy after culture results is not clear. However, the etiological investigation should always be performed, since its results provides information on the patterns of bacterial resistance, help to reduce costs and provide data on the local epidemiology. (Grade B).<sup>22:14</sup>

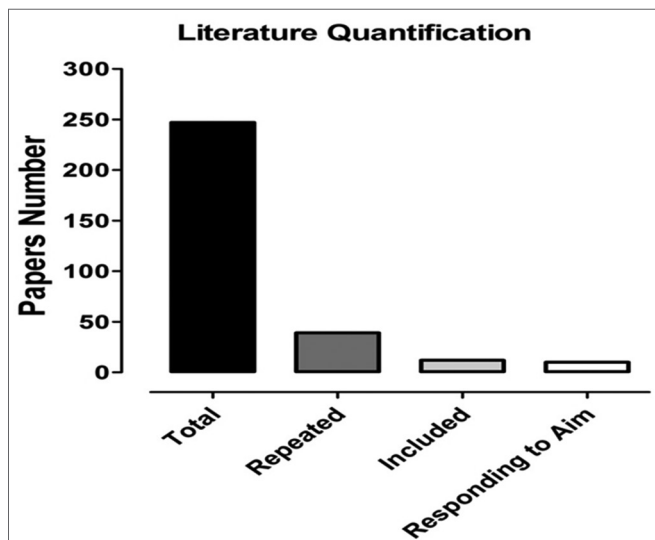
It should be clarified that these basic points mentioned in the study of the Sociedade Brasileira de Pneumologia e Tisiologia are based, as identified on the quote, in grade B evidence, which are cited as from a "limited database", being based on:

Intervention studies that include only a limited number of patients, post-hoc or subgroups ERCS analysis, or meta-analysis of ERCS. In general, the "B" category is appropriate when there are few randomized trials, when they are small in size, when they are conducted in a population that differs

**Table 5.** Treatment for VAP

AUTHOR / YEAR	TITLE	Abstract
Casellas JM (2006) <sup>14</sup>	Infecções graves na unidade de terapia intensiva pediátrica (Serious infections in pediatric intensive care unit)	The treatment of severe infections in PICUs should be directed to those patients in whom the clinical severity causes bacteremia to be a high probability. Microorganisms responsible for these infections are isolated in blood cultures, highlighting the importance of quantitative cultures of lower respiratory tract before start the initial empirical treatment (TEI). The TEI must have ≥ 90% activity against potential pathogens and a low probability of selecting resistance and last a maximum of 72 hours (reevaluate according to the clinical course and culture results). Subsequently, adjust the spectrum according to species, sensitivity, focus and available drugs (cost, toxicity, resistance induction). In selecting the TEI in PICUs, one should take into account the following factors: age, location and severity of infection, immune status, where the pathogen was acquired (standard susceptibility, predictability of etiology), safety, toxicity, efficacy, and prior and adequate collection of representative cultures. The goal should not be to systematically transform TEI in definitive treatment.
Sociedade Brasileira de Pneumologia e Tisiologia - 2007 (2007) <sup>22</sup>	Diretrizes brasileiras para tratamento das pneumonias adquiridas no hospital e das associadas à ventilação mecânica - 2007. (Brazilian guidelines for treatment of hospital acquired and ventilator-associated pneumonia - 2007.)	The decision to start antibiotics immediately after clinical diagnosis of pneumonia is of crucial importance, and proper choice requires knowledge of the prevalent agents and their sensitivity profiles and the unit in which the patient was admitted. This is quite important, since within the same hospital, regimens for empirical treatment of VAP may differ. Currently, the presence of risk factors for multiresistant germs serves as a basis for an adequate treatment regimen. It is vital to be clear that the concept of adequate empirical antibiotic therapy is based on a microbiological criterion that, in most cases, will only be available around the fourth or fifth day of treatment in approximately 40-70% of patients, depending on the series studied. Therefore, to ensure adequate treatment, it is imperative to know the prevalence of the most frequent bacterial agents in the unit and their sensitivity profiles.

Source: Research data, 2008.



**Figure 1.** Results of research

from the recommended target population, or when the results are somehow inconsistent.<sup>22:1</sup>

It is noted that:

It is not recommended that one of the options presented be simply chosen for treatment, it should serve as the basis for a broad discussion within each hospital, including pulmonologists, intensive care physicians, general physicians

and infection control professionals when developing their own empirical treatment protocols. Among the functions of the Hospital Infection Control, which are mandatory in Brazilian hospitals according to the Ministry of Health (Decree 2616, May 12, 1998), the most prevalent pathogens and their antimicrobial susceptibility profile must be known and systematically informed, and from there treatment protocols should be developed.<sup>22: 12</sup>

It is noteworthy, however, that this study did not find any specific reference to treatment in pediatric patients. On the other hand, according to data already shown in Table 4, which represents studies that reported data on diagnostic approach, according to a study by Carvalho et al<sup>16</sup>, diagnostic standardization for pediatric patients is difficult. Therefore, this evidence indicates that future more specific and better targeted studies, perhaps randomized controlled trials conducted with the pediatric ICU population affected by VAP, can bring more specific evidence for the development of protocols and guidelines aimed at such a fragile population.

Randomized controlled trials are recommended because, according to data from the Sociedade Brasileira de Pneumologia e Tisiologia, evidence based on this type of study are well delineated and “provide a consistent model of findings in the population for which the recommendation is made. Category A requires substantial numbers of studies involving an adequate number of participants”.<sup>22:1</sup>

## FINAL CONSIDERATIONS

One can consider that there are yet few studies addressing pediatric VAP. It is felt that invasive procedures, mainly MV, are risk factors for infection in pediatric ICU. As these factors usually cannot be changed because, aside from the VM, the patient's age and the use of antibiotic therapy are also considered, there is an increased incidence and significant prevalence of VAP, with children presenting hospital infection more often and significant mortality rate.

Microorganisms colonizing the bronchial tree and oropharynx are often responsible for contamination of patients undergoing MV. To start treatment, literature recommends that the bacterial agents be identified by creating an appropriate empirical antibiotic therapy. It should be taken into account that there are few studies mentioning pediatric patients, highlighting that further studies must be conducted to produce more evidence, which could contribute to the development of protocols and guidelines directed at the pediatric population, helping to reduce these high rates of infection and mortality in children.

It was observed that the literature discusses risk factors, incidence/prevalence, mortality, diagnostic approach and treatment, and that further studies using CPIS (Clinical Pulmonary Infection Score) specifically for pediatric patients may help to establish more clear evidence.

Regarding the existence of guidelines or care protocols, there is a national guideline of the Sociedade Brasileira de Pneumologia e Tisiologia, which does not include specific data for pediatric patients, once again highlighting the need for further studies with pediatric patients.

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