RESEARCH

SURVIVAL ANALYSIS FOR PATIENTS WITH PNEUMONIA ASSOCIATED WITH INVASIVE MECHANICAL VENTILATION

ANÁLISE DE SOBREVIDA DE PACIENTES COM PNEUMONIA ASSOCIADA À VENTILAÇÃO MECÂNICA INVASIVA

ANÁLISIS DE SUPERVIVENCIA DE PACIENTES CON NEUMONÍA ASOCIADA A VENTILACIÓN MECÁNICA INVASIVA

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ABSTRACT

Objective: to analyze the survival of patients notified with pneumonia associated with invasive mechanical ventilation assisted in an intensive care unit. **Method:** an analytical, cross-sectional and retrospective study developed at the University Hospital of the Federal University of *Piauí, Teresina,* Brazil. Data collection took place through queries in the Hospital Infection Control Service spreadsheets, with a sample of 36 patients. The Kaplan-Meier method was used for survival analysis and the *log rank* test to compare the curves. **Results:** 23 (63.9%) participants were male; aged 60 years old or more - 20 (55.6%); and maintaining airway by means of an orotracheal tube - 21 (58.3%). The most common microorganism was *Acinetobacter baumanni* - 11 (30.6%) - and the most used antimicrobial class was that of antifungals - 51 (27.5%). Among the diagnoses, the most prevalent was malignant neoplasm - seven (19.5%). The Kaplan-Meier curve showed that the overall survival rate in the study was 63.9% up to 15 days of follow-up. There was better survival in female patients (69.2%), aged between 19 and 59 years old (68.8%), tracheostomized (73.3%), notified with *Pseudomonas aeruginosas* (71.4%) and using polymyxin (78.9%). **Conclusion:** the etiology of pneumonia can exert a direct influence on prognosis worsening and is related to increased mortality and survival rates. It is thus important to reinforce the effective use of protocols aimed at patient safety and at the training of health professionals for this reality.

Keywords: Pneumonia, Ventilator-Associated; Patient Safety; Cross Infection; Hospitals, University; Intensive Care Units; Critical Care.

RESUMO

Objetivo: analisar a sobrevida de pacientes notificados com pneumonia associada à ventilação mecânica invasiva assistidos em unidade de terapia intensiva. **Método:** estudo analítico, transversal e retrospectivo desenvolvido no Hospital Universitário da Universidade Federal do Piauí, Teresina, Brasil. A coleta de dados foi realizada por meio da consulta às planilhas do Serviço de Controle de Infecção Hospitalar, com amostra equivalente a 36 pacientes. O método Kaplan-Meier foi utilizado para a análise de sobrevida e o teste de log rank para a comparação das curvas. **Resultados:** 23 (63,9%) eram do sexo masculino, com faixa etária de 60 anos ou mais - 20 (55,6%); mantendo via aérea por tubo orotraqueal - 21 (58,3%). O microorganismo mais comum foi Acinetobacter baumanni - 11 (30,6%) - e a classe de antimicrobiano mais utilizada foi a de antifúngicos - 51 (27,5%). Entre os diagnósticos, o mais prevalente foi neoplasia maligna - sete (19,5%). A curva de Kaplan-Meier demonstrou que a taxa global de sobrevida no estudo foi de 63,9% até 15 dias de seguimento. Ocorreu maior sobrevida em pacientes do sexo feminino (69,2%), na faixa etária entre 19 e 59 anos (68,8%), traqueostomizados (73,3%), notificados com Pseudomonas aeruginosas (71,4%) e em uso de polimixina (78,9%). **Conclusão:** a etiologia da pneumonia pode influenciar diretamente no agravamento do prognóstico e apresenta relação com aumento da taxa de mortalidade e sobrevida. Assim, é importante reforçar a efetivação de uso de protocolos voltados para a segurança do paciente e da capacitação dos profissionais de saúde para essa realidade.

Palavras-chave: Pneumonia Associada à Ventilação Mecânica; Segurança do Paciente; Infecção Hospitalar; Hospitais Universitários; Unidades de Terapia Intensiva; Cuidados Críticos.

RESUMEN

Objetivo: analizar la supervivencia de pacientes notificados de neumonía asociada a ventilación mecánica invasiva asistida en una unidad de cuidados intensivos. **Método:** estudio analítico, transversal y retrospectivo desarrollado en el Hospital Universitario de la Universidad Federal de Piauí, Teresina, Brasil. La recogida de datos se realizó consultando las planillas del Servicio de Control de Infecciones Hospitalarias, con una muestra equivalente a 36 pacientes. Se utilizó el método de Kaplan-Meier para el análisis de supervivencia y la prueba de log Rank para comparar curvas. **Resultados:** 23 (63,9%) eran hombres, de 60 años o más - 20 (55,6%); mantener una vía aérea a través de un tubo orotraqueal - 21 (58,3%). El microorganismo más común fue Acinetobacter baumanni - 11 (30,6%) - y la clase de antimicrobianos más utilizada fue la de antifúngicos - 51 (27,5%). Entre los diagnósticos, el más prevalente fue el de malignidad: siete (19,5%). La curva de Kaplan-Meier demostró que la tasa de supervivencia global en el estudio fue del 63,9% hasta los 15 días de seguimiento. Se produjo una supervivencia más prolongada en

pacientes mujeres (69,2%), con edades comprendidas entre 19 y 59 años (68,8%), con traqueotomía (73,3%), notificadas con Pseudomonas aeruginosas (71,4%) y en uso de polimixina (78,9%). **Conclusión:** *la etiología de la neumonía puede influir directamente en el agravamiento del pronóstico y se relaciona con un aumento de las tasas de mortalidad y supervivencia. Por tanto, es importante reforzar el uso eficaz de protocolos orientados a la seguridad del paciente y la formación de los profesionales sanitarios para esta realidad.*

Palabras clave: *Neumonía Asociada al Ventilador; Seguridad del Paciente; Infección Hospitalaria; Hospitales Universitarios; Unidades de Cuidados Intensivos; Cuidados Críticos.*

INTRODUCTION

Healthcare-associated infections (HAIs) are a public health problem, considering that they increase the risk of morbidity and mortality of hospitalized patients, prolonging their hospitalization time, especially in those occupying Intensive Care Unit (ICU) beds.

By definition, any infection acquired within 48 to 72 hours and that is not in its incubation period is considered as a HAI, during the hospitalization of a patient or even after discharge.[1] In Brazil, according to the Ministry of Health, the mean rate of HAIs is nearly 15%, while in the United States and Europe it is 10%. However, the HAI rate varies considerably, as it is directly associated with the level of care and complexity of each health service.[2,3]

According to data extracted from a research study conducted in the University Hospital (*Hospital Universitário* - HU) of the *Universidade Federal do Piauí* (UFPI), this type of infection represents the fourth cause of death during hospitalization, and the ICU is considered as the place where the patients are more susceptible to acquiring it. In the HAI context, this same study highlights that the most frequently found is pneumonia, diagnosed in 144 (30.2%) patients, of which, in 50 (13.3%), the most common type was ventilator-associated pneumonia (VAP). In addition to that, the occurrence of deaths in patients diagnosed with HAIs was 20.7% and the cases notified in the ICU of this institution had a 2.3 times higher death occurrence in relation to patients from other hospitalization places.[3]

VAP is the leading cause of death among the HAIs, with 15% to 70% mortality, depending on the patient population. In addition to that, it is the main type of infection acquired by ICU patients, with a mean of five to 10 episodes per 1,000 admissions/year in hospitals in the United States.[1] These infections account for 15% of the healthcare-associated infections and for approximately 25% of all ICU-acquired infections.[4]

Prolonged use of invasive mechanical ventilation (IMV) is the main risk factor for VAP, increasing the patient's length of stay in the ICU by up to three times. But it is to be considered that the VAP rates can change according to the patient population and to the available diagnostic methods.[5]

In this sense, it is fundamental that actions to prevent VAP are a priority in the health institutions in order to promote safety for the patients who need invasive ventilatory assistance during their ICU stay, as this serious problem causes an increase in the morbidity and mortality rates, as well as in the health care costs.[6]

The relevance of the Nursing team in the prevention of VAP is highlighted because, as a component of the multidisciplinary team, it is based on the Brazilian MV Guidelines[7]. And, as per the patient safety protocols of the National Health Surveillance Agency (*Agência Nacional de Vigilância Sanitária* - ANVISA),[1] it actively participates in the care actions involving from invasive ventilatory support, planning and implementing interventions ranging from oral hygiene, oral and enteral feeding, positioning of the patient in bed and its decubitus change, to the cleaning and preservation of the circuits, filters and humidifiers.

This research is justified due to the considerable frequency of VAP in critically-ill patients, as well as to the possibility of indirectly identifying how Nursing care can be directed to increase patient survival and also because limitations are still found in the scientific literature with an approach to the survival analysis of patients with VAP.

In this meantime, the objective was to analyze the survival of patients notified with pneumonia associated with invasive mechanical ventilation assisted in an intensive care unit.

METHOD

A documentary and retrospective research study was carried out in the municipality of *Teresina*-PI, at the HU/UFPI, from December 2017 to December 2018. This institution offers medium- and high-complexity services, and the patient's gateway is the bed regulation system. It serves 33 medical and other health specialties, with capacity for 175 hospitalization beds, 15 ICU beds and 10 operating rooms.

The ICU beds of the institution are subdivided as follows: one sector with 10 beds for clinical hospitalizations in general; and another sector with five beds for

the care of patients with heart diseases. It is to be noted that admission to these sectors can be for patients of the institution itself (intraunits) or for those transferred from other hospitals in the state by the regulation system (interunits).

The population consisted of 36 patients admitted to the general and coronary ICU, who were notified with VAP by the Hospital Infection Control Service (*Serviço de Controle de Infecção Hospitalar* - SCIH) according to criteria recommended by the Ministry of Health,[1] in the years 2016, 2017 and until May 2018, without recording sample losses. This period was selected because there were complete data that contemplate the research objective from 2016, while in the preceding years this the information pertinent to the study was incomplete.

The inclusion criteria were the following: having been notified with VAP, having the notification form data filled out correctly and completely and having death as outcome, so that it was possible to analyze survival between the infection acquisition date and death. The patients who presented more than one infection site were excluded from the study, as well as those who were discharged due to cure or transfer to another intermediate care unit.

Data collection took place by means of queries in the SCIH spreadsheets referring to the HAI indicators, by the notification forms, as well as by consulting the electronic medical records through the management application for university hospitals.

For this, a form prepared by the researchers containing the following variables was used: age, gender, isolated microorganisms, infection notification date, antimicrobials used for VAP treatment, outcome (death) date, clinical diagnosis, invasive area of the device used (orotracheal tube or tracheostomy).

The data were organized and tabulated using *Microsoft Excel* for *Windows*, version 2010, and the statistical analyses were performed in IBM - *Statistics* (SPSS) for *Windows*, version 23.0. Subsequently, they were presented by means of simple and absolute frequencies for the qualitative variables; and as median, mean and 25 and 75 percentiles for the quantitative variables.

For the survival analysis, deaths up to 15 days of follow-up were considered as failure. As the sample consisted only of patients who had death as their outcome, in order to analyze the survival rate there was a need to consider a cutoff point for the statistical analysis, so 15 days were used,[8,9] justified for being the estimated time for the highest mortality rate due to VAP. Thus, patients who survived more than 15 days were considered as the survivors in the research.

The Kaplan-Meier method was used for survival analysis and the *log rank* test to compare the curves. *Cox* regression analysis evaluated the significant variables by means of the *Kaplan-Meier* method to determine the independent value of each one in relation to survival based on gross and adjusted risk ratios. A 5% significance level was considered in all the analyses performed.

This research was approved by the Research Ethics Committee (*Comitê de Ética em Pesquisa* - CEP) of the HU/UFPI and the precepts of privacy and confidentiality of the data used were protected. During the research there was no direct contact with the participants, reason why waiver of the Free and Informed Consent Form was required to the CEP, and a Data Use Commitment Form was submitted, which was signed by the institute's trustee so that the researchers could access the SCIH spreadsheets and the electronic medical record.

RESULTS

The results presented refer to the analysis of the variables obtained through the research conducted with 36 patients from an ICU, notified with VAP and who had death as outcome. According to the data presented in Table 1, most of the participants were male - 23 (63.9%) - with the most prevalent age group being 60 years old or more - 20 (55.6%).

Regarding the device used to provide support in MV, there was predominance of the orotracheal tube in the cases notified - 21 (58.3%).

The microbiological specification by tracheal aspirate culture revealed that the most common microorganism was *Acinetobacter baumanni* - 1 (30.6%), followed by *Klebsiella spp* - eight (22.2%). The most used antimicrobials for treating the infection were antifungals and carbapenems, with 51 (27.5%) and 33 (18.0%), respectively.

The prescribed antimicrobials were indicated to treat patients with VAP who had base clinical diagnoses in the following specialties: malignant neoplasm - seven (19.5%); gastrointestinal - six (16.7%); cardiovascular - five (13.9%); neurological - five (13.9%); respiratory - four (11.0%); infectious - four (11.0%); traumas - three (8.3%); and renal - two (5.5%).

The Kaplan-Meier curve shows that the overall survival rate in the study was 63.9% up to 15 days of follow-up and that the mean estimate was 90 days (Figure 1).

Table 1 - Sociodemographic and clinical profile of the patients hospitalized in an intensive care unit. *Teresina*, PI, Brazil, 2018 (n=36)

Variables	n	%	Median (P25; P75)
Gender			
Male	23	63.9	
Female	13	36.1	
Age group			
19-59 years old	16	44.4	
60+ years old	20	55.6	
Device			21.0 (10.5; 33.0)
Orotracheal tube	21	58.3	
Tracheostomy	15	41.7	
Isolated microorganisms			
Acinetobacter baumanni	11	30.6	
Klebsiella spp	08	22.2	
Others	05	16.8	
Candida albicans	02	5.6	
Protheus spp	02	5.6	
Antimicrobials used*			
Antifungals	51	27.5	
Carbapenem	33	18.0	
Vancomycin	25	13.5	
Penicillins	24	13.0	
Cephalosporins	14	7.6	
Aminoglycosides	9	4.8	
Fluoroquinolones	8	4.3	
Lincomycins	6	3.3	
Sulphonamides	6	3.3	
Oxazolidinones	4	2.1	
Macrolidia	3	1.6	
Glicycline	2	1.0	

*It refers to the number of times the medication was prescribed/indicated for the patient's treatment (n=185). In this case, it must be taken into account that the same patient can be using more than one antimicrobial concomitantly.

The association of the clinical and sociodemographic variables with survival can be seen in Table 2, where better survival was found in female patients (69.2%) and in the age group from 19 to 59 years old (68.8%). In relation to the devices used, the patients who used tracheostomy (73.3%) presented better survival.

Mortality due to microorganisms was higher in the cases that were notified with *Klebsiella spp* and better survival was found among those who acquired *Pseudomonas aeruginosa* (71.4%).

Considering the antimicrobials used, there was a significant statistical association among the patients who made use of polymyxin B, whose death rate was 21% with a survival rate of 78.9%. In addition, there was a 70% reduction in the risk of death when compared to those who did not use this medication.

By performing a multivariate analysis using Cox regression adjusted for gender and age, it was observed that the patients who took the polymyxin B antimicrobial had longer survival curves than those who did not use it; the risk of death was 72% (adjHR=0.28 and 95%CI: 0.08-0.94), and the association was statistically significant by the Wald test (p=0.039) (Figure 2).
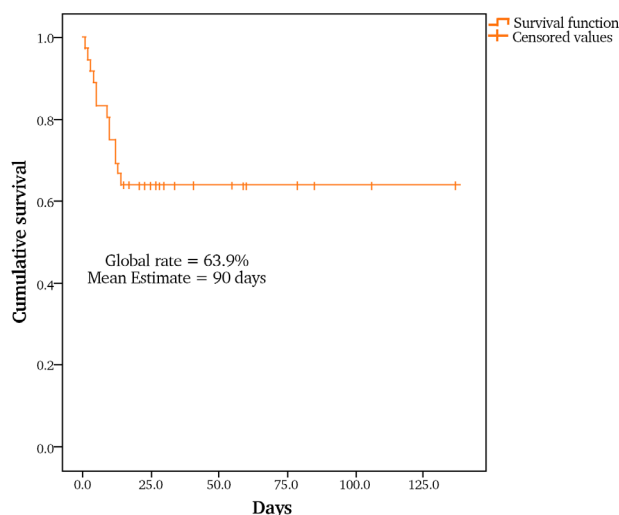
Figure 1 - Kaplan-Meier curve for the overall survival rate in 15 days of the patients hospitalized in an intensive care unit. *Teresina*, PI, Brazil, 2018

Table 2 - Analysis of deaths, survival and risk ratio in patients hospitalized in an intensive care unit. *Teresina*, PI, Brazil, 2018 (n=13)

|	Deaths		Survival 15 days (%)	HR* (95%CI)	*Log Rank* Test (p)
Gender	n	%			0.627
Female	4	30.8	69.2	1.0	
Male	9	39.1	60.9	1.33 (0.41-4.34)	
Age group					0.681
19-59 years old	5	31.3	68.8	1.0	
60+ years old	8	40.0	60.0	1.26 (0.41-3.86)	
Device used					0.374
Tracheostomy	4	26.7	73.3	1.0	
Orotracheal tube	9	42.9	57.1	1.69 (0.52-5.49)	
Isolated microorganisms					
Acinetobacter baumanni	4	36.4	63.6	0.96 (0.30-3.17)	0.966
Klebsiella spp	3	37.5	62.5	1.08 (0.30-3.94)	0.903
Pseudomonas aeruginosa	2	28.6	71.4	0.74 (0.16-3.34)	0.691
Others	5	33.3	66.7	0.94 (0.31-2.89)	0.920
Antimicrobials used*					
Cefepime	3	37.5	62.5	1.14 (0.31-4.16)	0.903
Piperacillin + tazobactam	9	40.9	59.1	1.71 (0.53-5.57)	0.362
Metronidazole	2	16.7	83.3	0.33 (0.07-1.50)	0.127
Ceftriaxone	2	22.2	77.8	0.48 (0.11-2.18)	0.331
Vancomycin	9	36.0	64.0	0.94 (0.29-3.03)	0.910
Meropenem	9	33.3	66.7	0.68 (0.21-2.22)	0.518
Clindamycin	2	33.3	66.7	0.04 (0.00-11.9)	0.787
Imipenem + cylastatin	2	33.3	66.7	0.79 (0.18-3.58)	0.762
Fluconazole	5	41.7	58.3	1.20 (0.39-3.68)	0.743
Polymyxin B	4	21.1	78.9	0.30 (0.09-0.97)	0.032
Sulfamethoxazole + trimetropine	1	16.7	83.3	0.36 (0.04-2.74)	0.296
Ciprofloxacin	1	16.7	83.3	0.37 (0.04-2.60)	0.268
Anidulafugine	3	50.0	50.0	2.05 (0.56-7.46)	0.264
Others	4	23.5	76.5	0.43 (0.13-1.39)	0.141

*HR: Gross Hazard Ratio, 95CI.
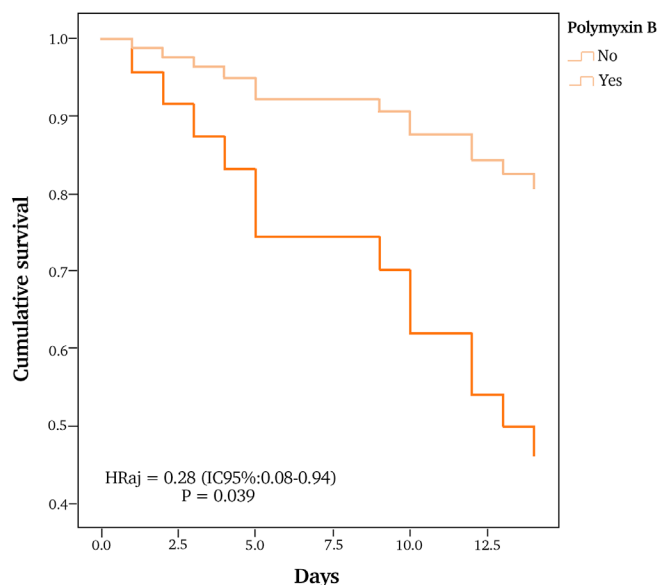
Figure 2 - Survival curve and adjusted Hazard Ratio (gender and age) by means of Cox regression for the effect of polymyxin B in patients hospitalized in an intensive care unit. Teresina, PI, Brazil, 2018

DISCUSSION

After presentation of the results, it was possible to characterize the research participants, who were mostly male - 23 (63.9%). When compared to a study conducted in an intensive care unit for adults of a hospital in *Santa Catarina*, similar data were found: in a sample of 120 individuals under study, 69 (57.5%) were male.[10]

There was predominance of aged patients in the sample. The literature justifies this result by the fact that a multifactorial process occurs during aging, resulting in functional declines, causing physiological changes and leading to an increase in the number of infections.[11]

Evaluating the predominance of the orotracheal tube in use in the study patients, when referring to situations of severe respiratory dysfunction, orotracheal intubation is the fastest option used in the health units. However, this device is referred to in the literature as a risk factor for VAP, as it impairs the host's nonspecific defenses and allows the inhaled particles to have direct access to the lower airways. In addition to that, it reduces the effectiveness of the coughing process, thus facilitating the accumulation of secretions and the formation of biofilm, acting as a reservoir for microorganisms.[12,13]

The results of the cultures were similar to those of a study conducted in a public teaching hospital located in *Fortaleza* - CE, where there was also predominance of Gram-negative bacteria, such as *Acinetobacter baumannii* - two (12.5%); *Pseudomonas aeruginosa* - five

(31.25%) and *Klebsiella pneumoniae* - three (18.75%).[14] In contrast, Ferreira *et al.* (2017) found that the most prevalent microorganisms were *Klebsiella pneumoniae* (15.4%) and *Staphylo-coccus aureus* (23.1%).[15]

A study observed that the main antibiotics used as monotherapy options for respiratory tract infections (RTIs) in the study ICU were penicillins associated with betalactamase, cephalosporin, quinoline and carbapenem inhibitors. Ceftriaxone stood out, which is a cephalosporin used in hospital pneumonia, since it presents good activity against Gram-positive cocci, except for oxacillin-resistant *Staphylococcus aureus* and *Enterococcus sp*, as well as good activity against some Gram-negatives, such as *Klebsiella sp* and *Proteus sp*.[16]

Among the medical diagnoses of the patients notified with VAP, the most prevalent was malignant neoplasm, with seven (16.7%). In comparison with another research study, the main causes of hospitalization were poisoning (28.5%), neurological diseases (16.5%), respiratory diseases (12%) and infectious diseases (9.5%).[10]

Data from the literature point out that the clinical conditions and comorbidities, such as chronic diseases, immunosuppression and neoplasms at admission, represent important risk factors for death in patients with HAIs. The ICU stay depends on several factors, such as the nature of the underlying disease and the therapeutic conditions resulting from complications that require

complex treatments. With this, there is a large percentage of patients who are already admitted with a quite deteriorated health status, often with complications of their underlying disease.[3]

In a research study conducted at the university hospital in northern *Minas Gerais*, it was possible to verify that most of the patients who developed VAP evolved to death, reasserting this infection as a risk factor for ICU mortality. The clinical outcome was that the occurrence of deaths varied according to age, gender, device, antimicrobials used and isolated microorganism. According to the findings in the sample, the Kaplan-Meier curve showed that the overall survival rate was 63.9% and that the mean estimate was 90 days.[17]

From the results obtained, better survival was found in individuals aged between 19 and 59 years old (68.8%). This confirms that the deaths directly related to the respiratory disorder were more numerous in the aged patients. Short-term survival in patients over 65 years old is significantly lower than that observed in younger patients. Although the number of deaths is higher in older adults, the mortality rate has been decreasing, detailing that the possible cause is immunization by vaccination.[18]

Infection by *Klebsiella spp* presented the highest death rate among the microorganisms. This Gram-negative, facultative anaerobic bacillus can survive on inanimate objects or fomites; however, it is sensitive to most antibiotics. This is justified by the existence of strains producing extended spectrum betalactamase enzyme, which destroys large numbers of antibiotics.[19]

In addition to that, it is emphasized that the development of VAP is also associated with colonization by microorganisms such as *Staphylococcus aureus*, methicillin-resistant *Pseudomonas aeruginosa*, *Acinetobacter*, *Enterobacter spp*, *Proteus mirabilis* and *Streptococcus hemolyticus*, and that the highest mortality is caused by *Pseudomonas aeruginosa*, a finding that differs from this study.[20]

A significant association was identified between polymyxin and survival when compared to the other antibiotics. It shows effective and rapid bactericide activity for a variety of Gram-negative bacteria. In addition to that, it is effective in the treatment of meningitis, sepsis, UTI, skin infection and eye infection, among others.[21,22]

In this context, it may be noted that pneumonia presents a strong relationship with increased mortality, implying worsening in the unfavorable prognosis by the patients and higher costs for the institution. VAP prolongs MV use time as well as the length of stay in the ICU.[14]

It becomes relevant to highlight the importance of the role of Nursing in the prevention of VAP, as emphasized by the *Conselho Federal de Enfermagem* (COFEN) rule,[23] considering that this is the health care profession that has the most contact and performs most of the care actions for critically-ill patients. It is thus a study of great interest to this professional category, not excluding its relevance to other areas and the duty of other health professionals in the compliance with measures for the prevention of VAP.

The knowledge of these professionals on preventive measures stimulated by training in health, permanent education in health, use of protocols and training sessions, is an ally of a good and safe assistance practice and in the prevention of errors in the care provided. Educational strategies and technical standardization for best practices are a way to assist in risk management, promoting improvements in assistance and consequently reducing the HAI rates.[24]

The contribution of this study to the Nursing practice is that research studies like this also provide a warning on the survival time of these patients and, thus, reinforce the importance of the effective use of protocols aimed at the prevention VAP, so that there can be more appropriate planning of the Nursing team's actions and of those by other members of the ICU assistance team.

The strategies for adherence to the preventive measures must be constantly monitored by the sector's team, representing a challenge to be overcome on a daily basis, given the insufficient knowledge of the professionals; their main role regarding quality assistance and actions aimed at patient safety are determining factors for this movement. Teams with high rates of adherence to the prevention measures are those that present the most significant reduction in the incidence density rates of VAP and of other hospital infections.[25]

In this sense, the risks for the occurrence of this infection must be known by the health professionals, in order to be eligible for direct actions with an impact on prevention, on the indiscriminate use of antibiotics, on the MV exposure time, and on an effective control of VAP.

Despite being a widely discussed theme in the literature, there are still limitations in the search for studies that address survival analysis for patients with VAP, mainly research studies that portray the use of polymyxin as an important mortality reducer when compared to other antimicrobials used for the treatment. In addition

to that, this research does not reflect the national reality, as it evidences data from a specific geographic region.

CONCLUSION

The overall survival rate in the study was 63.9% up to 15 days of follow-up and the mean estimate was 90 days, and is related to the etiology of pneumonia and to the type of drug and ventilatory treatments selected. It is also concluded that the group in which better survival was observed has the following characteristics: women aged between 19 and 59 years old and using tracheostomy.

The etiology of pneumonia can exert a direct influence on prognosis worsening and is related to the increase in the mortality and survival rates. Thus, it is important to reinforce the effective use of protocols aimed at patient safety and the training of health professionals for this reality.

REFERENCES

1. Agência Nacional de Vigilância Sanitária – ANVISA (BR). Medidas de Prevenção de Infecção Relacionada à Assistência à Saúde/ Agência Nacional de Vigilância Sanitária. Brasília: Anvisa; 2017[cited 2019 Nov 13]. Available from: http://portal.anvisa.gov. br/documents/33852/3507912/Caderno+4+-+Medidas+de+Pr even%C3%A7%C3%A3o+de+Infec%C3%A7%C3%A3o+Relacion ada+%C3%A0+Assist%C3%AAncia+%C3%A0+Sa%C3%BAde/ a3f23dfb-2c54-4e64-881c-fccf9220c373

2. Sousa AFL, Oliveira LB, Moura MEB. Perfil epidemiológico das infecções hospitalares causadas por procedimentos invasivos em unidade de terapia intensiva. Rev Prev Infecç Saúde. 2016[cited 2020 Jan 14];2(1-2):11-7. Available from: https://doi.org/10.26694/repis.v2i1-2.6048

3. Soares SGC, Mascarenhas MDM, Moura LNB, Pereira AFM. Caracterização das infecções relacionadas à assistência à saúde em um hospital de ensino do Nordeste do Brasil. Rev Enferm UFPI. 2017[cited 2018 Jan 14];6(2):37-43. Available from: http://www.ojs.ufpi.br/index.php/ reufpi/article/view/5933/pdf

4. Perugini MRE, Perugini VH, Figueira FD, Fontana LMS, Diniz JJ, Santos DL, et al. Impacto de um bundle nas taxas de pneumonia associada à ventilação mecânica (PAV) em uma unidade de terapia intensiva pediátrica em Londrina-PR. Semina Cienc Biol Saúde. 2015[cited 2020 Feb 7];36(1):259-66. Available from: http://www.uel.br/revistas/uel/ index.php/seminabio/article/view/19396/17008

5. Santos LRL, Almeida Neto OP, Freitas EAM. Infecções relacionadas à assistência à saúde em unidades de terapia intensiva adulto de hospitais universitários: revisão integrativa. Rev Aten Saúde. 2016[cited 2020 Feb 15];14(49):66-71. Available from: https://www.researchgate. net/publication/312366369_Infeccoes_relacionadas_a_assistencia_a_ saude_em_unidades_de_terapia_intensiva_adulto_de_hospitais_ universitarios_revisao_integrativa

6. Silva SG, Nascimento ERP, Salles RK. Pneumonia associada à ventilação mecânica: discursos de profissionais acerca da prevenção. Esc Anna Nery Rev Enferm. 2014[cited 2020 Feb 20];18(2):290-5.

Available from: https://www.scielo.br/pdf/ean/v18n2/1414-8145-ean-18-02-0290.pdf

7. Associação de Medicina Intensiva Brasileira (BR). Diretrizes Brasileiras de Ventilação Mecânica. AMIB/SBPT; 2013[cited 2020 Dec 30]. Available from: https://www.amib.org.br/fileadmin/user_upload/amib/2018/junho/15/ Diretrizes_Brasileiras_de_Ventilacao_Mecanica_2013_AMIB_SBPT_ Arquivo_Eletronico_Oficial.pdf

8. Souza ES, Belei RA, Carrilho CMDM, Matsuo T, Yamada-Ogatta SF, Andrade G, et al. Mortalidade e riscos associados a infecção relacionada à assistência à saúde. Texto Contexto Enferm. 2015[cited 2020 May 05];24(1):220-8. Available from: http://dx.doi.org/10.1590/0104-07072015002940013

9. Silva TG, Souza GN, Souza SS, Bitencourt JVV, Madureira VF, Luzardo AR. Incidência de pneumonia associada à ventilação mecânica em uma Unidade de Terapia Intensiva. Rev Pesqui (Univ Fed Estado Rio J Online). 2017[cited 2020 May 05];9(4):1121-5. Available from: http://www.seer.unirio.br/index.php/cuidadofundamental/article/ view/5899/pdf

10. Kock KS, Rosa BC, Martignago N, Maurici R. Pneumonia associada à ventilação mecânica (PAVM): incidência e desfecho clínico em uma unidade de terapia intensiva no sul de Santa Catarina. ACM Arq Catarin Med. 2017[cited 2020 Feb 5];46(1):2-11. Available from: http://www.acm.org.br/acm/seer/index.php/arquivos/article/ view/248/135

11. Brown RT, Pierluissi E, Guzman D, Kessel ER, Goldman E, Sarkar U, et al. Functional disability in late-middle-aged and older adults admitted to a safety-net hospital. J Am Geriatr Soc. 2014[cited 2019 Dec 5];62:2056-63. Available from: http://dx.doi.org/10.1111/jgs.13103

12. Zanei SSV, Kawamura MM, Mori S, Cohrs CR, Whitaker IY. Valoração e registros sobre higiene oral de pacientes intubados nas unidades de terapia intensiva. REME - Rev Min Enferm. 2016[cited 2020 Feb 5];20:e965. Available from: http://dx.doi.org/10.5935/1415-2762.20160035

13. Caratto V, Ball L, Sanguineti E, Insorsi A, Firpo L, Alberti S, et al. Antibacterial activity of standard and N-doped titanium dioxide-coated endotracheal tubes: an in vitro study. Rev Bras Ter Intensiva. 2017[cited 2019 Dec 5];29(1):55-62. Available from: https:// www.scielo.br/pdf/rbti/v29n1/0103-507X-rbti-29-01-0055.pdf

14. Rodrigues NA, Fragoso LVC, Beserra FM, Ramos IC. Impactos e fatores determinantes no bundle de pneumonia associada à ventilação mecânica. Rev Bras Enferm. 2016[cited 2019 Dec 5];69(6):1108-14. Available from: https://doi.org/10.1590/0034-7167-2016-0253

15. Ferreira EG, Kimura A, Ramos F, Albuquerque PL, Antunes MD, Oliveira DV. Prevalência de pneumonia associada à ventilação mecânica por meio de análise das secreções traqueobrônquicas. Rev RENE. 2017[cited 2019 Dec 5];18(1):114-20. Available from: https://doi.org/10.15253/2175-6783.2017000100016

16. Tavares CA, Veras MCB, Silva ACR, Araújo SES, Lima MFS. Avaliação da prescrição de antimicrobianos para infecção relacionada à assistência à saúde em um hospital escola de Recife – PE. Rev Epidemiol Controle Infecç. 2015[cited 2019 Nov 7];5(3):123-30. Available from: https:// online.unisc.br/seer/index.php/epidemiologia/article/view/5496/4466

17. Mota EC, Oliveira SP, Silveira BRM, Silva PLN, Oliveira AC. Incidência da pneumonia associada à ventilação mecânica em unidade de terapia intensiva. Medicina. 2017[cited 2019 Nov 10];50(1):39-46. Available from: https://doi.org/10.11606/issn.2176-7262.v50i1p39-46

18. Harboe ZB, Dalby T, Weinberger DM, Benfield T, Molbak K, Slotved HC, *et al*. Impact of 13-valent pneumococcal conjugate vaccination in invasive pneumococcal disease incidence and mortality. Clin Infect Dis. 2014[cited 2019 Dec 15];59(8):1066-73. Available from: https://doi.org/10.1093/cid/ciu524

19. Lima MRS, Soares NS, Mascarenhas MDM, Amaral EJLS. Intervenção em surto de Klebsiella pneumoniae produtora de betalactamase de espectro expandido (ESBL) em unidade de terapia intensiva neonatal em Teresina, Piauí, 2010-2011. Epidemiol Serv Saúde. 2014[cited 2019 Dec 11];23(1):177-82. Available from: https://doi.org/10.5123/S1679-49742014000100017

20. Nepomuceno RM, Miranda CB, Nogueira CB, Nogueira C, Silva LCF, Silva LD. Fatores de risco modificáveis para pneumonia associada à ventilação mecânica em terapia intensiva. Rev Epidemiol Controle Infecç. 2014[cited 2019 Nov 11];4(1):23-7. Available from: https://online.unisc.br/seer/index.php/epidemiologia/article/view/3933/3381

21. Neiva LBM, Fonseca CD, Watanabe M, Vattimo MFF. Polimixina B: efeito dose e tempo dependente na nefrotoxicidade in vitro. Acta Paul Enferm. 2013[cited 2020 Feb 11];26(1):57-62. Available from: http://dx.doi.org/10.1590/S0103-21002013000100010

22. Neiva LBM, Borges FT, Watanabe M, Pessoa EA, Barbosa DA, Vattimo MFF. Nefrotoxicidade da polimixina B: estudo experimental em células e implicações para a prática de Enfermagem. Rev Esc Enferm USP. 2014[cited 2020 Mar 11];48(2):272-7. Available from: http://dx.doi.org/ 10.1590/S0080-62342014000002000011

23. Conselho Federal de Enfermagem (BR). Resolução COFEN nº 639/2020: dispõe sobre as competências do enfermeiro no cuidado aos pacientes em ventilação mecânica no ambiente extra e intra-hospitalar. COFEN; 2020[cited 2021 Mar 03]. Available from: http://www.cofen.gov.br/resolucao-cofen-no-639-2020_79633.html

24. Melo MM, Santiago LMM, Nogueira DL, Vasconcelos MFP. Pneumonia Associada à Ventilação Mecânica: conhecimento dos profissionais de saúde acerca da prevenção e medidas educativas. Rev Pesqui (Univ Fed Estado Rio J Online). 2019[cited 2020 Mar 11];11(n.esp):377-82. Available from: http://dx.doi.org/10.9789/2175-531.2019.v11i2.377-382

25. Lourençone EMS, Branco A, Monteiro AB, Fonseca JP, Caregnato RCA. Adesão às medidas preventivas versus incidência de pneumonia associada à ventilação mecânica. Rev Epidemiol Controle Infecç. 2019[cited 2020 Mar 15];9(2):1-7. Available from: https://online.unisc.br/seer/index.php/epidemiologia/article/view/12596/8029