COVID-19 in ventilator-associated pneumonia in adults. Zone 1 General Hospital, Oaxaca Mexico, 2020-2022

https://doi.org/10.56238/sevened2023.006-063

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ABSTRACT

The magnitude of VAP before SARS-CoV-2 in Mexico was 39.7%, in our research we found that with COVID-19 this increased to 44.4%, higher than that reported by Lux et al. in whose research carried out in Chile with a sample of 112 ventilated adult patients, estimated an incidence of 42.8% of VAP. Murillo Yupanqui in his thesis developed in the Hospital of Peru analyzed 117 patients, reporting an incidence of 67.5%. In this sense, the study on bacterial infections in patients with COVID-19 in Cuba by Aguilera Calzadilla et al. agrees with the data obtained in this study (19,8,18).

We obtained a mean age of 59 years, similar to that found in the cohort study of coinfections in critical patients with COVID-19 by Baskaran et al. Sex was relevant in SARS-CoV-2 infection, globally the most affected were men, presenting the same behavior in the case of VAP, other studies have reported the same finding in patients with COVID-19 and non-COVID-19 where they have reported the sex differences and the immune response by sex to the development of this complication which is higher. Forel et al in their work in 2012 identified that being male was associated with a 2 times higher probability of developing VAPM (23,24,25,26,27).

The most frequent personal pathological history found in patients with COVID-19 was arterial hypertension, followed by diabetes mellitus, aspects similar to those referred to in the literature consulted. Garay et al. identified diabetes mellitus in 50.4%, systemic hypertension 46.4% and obesity 36.1%, and in his thesis Murillo identifies arterial hypertension 43.2% and obesity 33.9% as the first cause. The SARS-CoV-2 disease made us look again at chronic diseases and the association of complications with high mortality rates (23,8,27).

Keywords: COVID-19, Oaxaca Mexico, VAPVM, Adult, Pneumonia.

1 INTRODUCTION

Breathing is essential for life, some diseases or factors can interrupt it, the cessation of breathing is not always linked to the last breath of life. Concerned with preserving breathing, methods were discovered that helped to preserve it, beginning with Paracelsus and Versalius between the years 1530 and 1543 when they resuscitated a patient by placing a tube in his mouth and blowing air through a bellows, thus sitting on the bases of breathing. artificial respiration and mechanical ventilation. [1]

The deepening of this knowledge marked the beginnings of respiratory physiology in 1740. Applying this new concept, the *Académie des Sciences* de Paris taught that mouth-to-mouth inspiration was the most appropriate method for drowning people. [1.2]

Following this journey of research, in 1880 the first endotracheal tube was designed by Maecwen, years later, in 1895, Dr. Chevalier invented the laryngoscope and in the period of 1911 Drager created a positive pressure ventilation device, which became known as the pulmotor. [1]

Positive pressure mechanical ventilation was used in the polio epidemic that ravaged Denmark in 1953, playing a key role in the consequences of the disease. This technique and its results motivated the need to innovate artificial ventilation. First as a heavy tank with no control of respiratory flow, until it developed an oxygen control valve, to regulate what we now know as respiratory flow and inspiratory fraction of oxygen. The creation of intensive care was also necessary to be able to control the monitoring and management of ventilator parameters. [1]

History has also shown us that in every intervention carried out by man there is a reaction. In 1843 the American Oliver Wendell with his classic work " On the contagiousness of labor fever ", postulated that puerperal infections were transmitted to parturients by the same doctor. This first discovery alerted to the demand in hospitals for factors that conditioned nosocomial infections.

The onset of complications in invasive mechanical ventilation (IMV), which could lead to sequelae and death of patients, was conditioned by: ([1]

- how tracheal intubation is performed,
- contamination of the trachea with oropharyngeal flora by the tracheal tube or its translation by endotracheal tube pneumotamponation,
- bronchoaspiration,
- the duration of invasive mechanical ventilation,
- influence of the environment,
- the low efficacy of the prophylactic measures used,
- the state of the patients' anatomical and functional defenses
- the presence of complications in other organs.

Currently, the World Health Organization (WHO) defines Healthcare-Associated Infections (HAIs) as "infections contracted by a patient during treatment in a hospital or other health facility and that that patient did not have or were in incubation at the time of admission." HAIs can affect patients in any type of healthcare setting and can also occur after the patient is discharged. They translate not only into an increase in hospital days and care costs, but also in patients' quality of life (disability-adjusted life year DALYs). (3)

Therefore, it is important to monitor IMV, as it is an important source of complications in patients undergoing therapy. Of these, ventilator-associated pneumonia (VAP) stands out as one of the HAIs, which develops 48 to 72 hours after endotracheal intubation. (3.4)

The occurrence of VAP outbreaks is due, in most cases, to the contamination of respiratory therapy equipment, bronchoscopes and endoscopes, and to the colonization of microorganisms. The most frequently associated agents are non-fermenting Gram-negative bacilli such as Burkholderia cepacia , Pseudomona aeruginosa , Acinetobacter baumanni , fungi and opportunistic viruses. (4)

On December 31, 2019, coronavirus disease (COVID-19) was first reported in Wuhan (China). Since then, there has been a rapid spread at community, regional and international level, with an exponential increase in the number of cases and deaths. Moving on to the Americas region, first in the United States, then in Brazil, Latin America and the Caribbean. (5)

According to the first published research on the behavior of the disease, Wang et al, in their research highlighted complications that included acute respiratory distress syndrome (29%), acute cardiac injury (12%), and secondary infection with pneumonia or nosocomial bacteremia (10%). In addition, a considerable number of patients required ICU admission and placement of a high-flow nasal cannula or higher-level oxygen support measures to correct hypoxemia or, failing that, mechanical ventilation for approximately 5 to 10 days with a considerable number of deaths. (6.7)

According to several articles published since December 2019, the existence of a high prevalence of comorbidities and risk factors among patients with COVID-19 has been established, as well as a higher hospitalization rate. Bacterial co-infections in patients with this viral pneumonia pose a serious threat to their lives. Many of them come together to orchestrate serious complications, which cannot be ignored because they are potentially fatal and not always well identified. (7)

The bacterial microorganisms that most frequently cause respiratory infections in the hospital environment are: *Staphylococcus aureus* , *Enterococcus spp*, non-fermenting bacilli and enterobacteria. These pathogens are highly efficient in upregulating or acquiring antibiotic resistance mechanisms, a situation that further exacerbates the need for infection control measures, not only to control the spread of SARS-CoV-2, but also of multidrug-resistant bacteria. (8)

Although ventilator-associated infections by bacteria, viruses, and other pathogens are well-described phenomena in influenza, SARS, MERS, and other respiratory viral diseases, data on co-infections in COVID-19 pneumonia are limited, as are the factors that give rise to them. (8)

In Mexico, the first case of SARS-CoV-2 infection was confirmed on February 27, 2020. At this time there are more than 143,129 active cases and 325,716 deaths. The highest incidence was in Mexico City, with 148,000 cases, followed by the State of Mexico (595,000). [(7-10)]

Due to the frequency of HAI (11.2%) in hospital units, the Mexican Institute of Social Security (IMSS) developed and implemented the "Institutional Program for the Control and Prevention of Healthcare-Associated Infections 2019-2024", standardizing the prevention of these infections. The violation of this program, the decrease in its implementation, and the volume of cases arriving at hospitals during the course of the pandemic may likely have influenced the deaths of COVID-19 patients, although we have no evidence in this regard. [(eleven)]

In the state of Oaxaca, where we propose to carry out this work, as of July 3, 2023, there were 40 active cases of COVID-19, 8 municipalities affected, 2,799 deaths, and 5 hospitals dedicated to hospital care. At the beginning of July there was a slight increase with 600 active cases, 2,799 cumulative deaths and 6,334 hospitalized, with hospitalizations in internal medicine, intensive care rooms and intubation being a frequent procedure. [(12)]

To date, there are limited studies in the country that address the factors associated with the development of VAP in patients with COVID-19. This motivates us to carry out this work, in which it would be of great importance to identify the risks or conditions that could have contributed to the worsening and mortality of patients. COVID-19 will still remain a potentially fatal infection for some time to come, and therefore cases where intubation will be required are currently expected.

Thus, the research question is: What is the magnitude and factors associated with pneumonia due to mechanical ventilator use in adults with COVID-19 admitted to the General Hospital of Zone No1 in Oaxaca, Mexico, during the period 2020-2022?

In Mexico, in 2021, 361 hospital outbreaks of HAI were reported, which represented an increase of 115% compared to the previous year, COVID-19 ranked first with 33.5%, followed by ventilator-associated pneumonia with 25.4%. [(13)]

In relation to the most frequently identified microorganisms, through cultures with identified resistance, they found *E.* coli *with* 20%, *Pseudomona aeruginosa with 6.8% and* Klebsiella pneumoniae *with 4.6*%. The most lethal microorganism in 2021 was *Acinetobater baumannii.* [(13)]

2 STUDY DESIGN

Analytical cross-sectional observational epidemiological study. Performed at the General Hospital of Zone No1. Oaxaca, Mexico, during the years 2020-2022.

3 UNIVERSE AND SAMPLE

All adult patients with ventilator-associated pneumonia admitted to the General Hospital of Zone No. 1 (N=160). The sample consists of the total number of patients.

The preventive action schedule for ventilator-associated pneumonia was applied to only 24 adult patients with COVID-19 and non-COVID-19 from December 2021 to September 2022.

4 GETTING THE INFORMATION

The information was collected through sources implemented by the institution in the epidemiology sector.

- Two online registries: online epidemiological surveillance notification system (SINOLAVE), online system for hospital infections (INOSO)
- Form "Single Document for the Management of Action Packages for VAP Prevention" Of the total of 160 patients studied with ventilator-associated pneumonia, 44.4% had a diagnosis of COVID-19 and 53.8% were 55 years of age or older; The occurrence of VAP is higher as age increases, with values ranging from 6.3% to 31.3% for the age groups of 18 to 24 years and 65 years and over, respectively. According to the diagnosis of pneumonia in the COVID-19 group, the occurrence increases with age, which does not occur in the same way in non-COVID-19 groups, where the behavior is more stable between age groups, ($X^2 = 16.75$, $p = 0.005$). The mean age was 57 years for all VAPs, 59 and 53 years in the COVID-19 and non-COVID-19 groups, respectively.

Table 1.- Ventilator-associated pneumonia according to age group. Zone 1 General Hospital. Oaxaca. Mexico, 2020-2022.

Age group	Type of pneumonia				Total	
	COVID-19		It's not Covid-19			
	No.	%	No.	%	No.	%
18-24	0	0,0	10	11.2	10	6.3
25-34	5	7,0	14	15,7	19	11.9
35-44	12	16,9	8	9,0	twenty	12,5
45-54	10	14.1	fifteen	16,9	25	15.6
55-64	22	31,0	14	15,7	36	22,5
65 E+	22	31,0	28	31,5	fifty	31.3
Total	71	44,4	89	55,6	160	100,0

$X^2 = 16{,}75$, $p = 0{,}005$

70.0% of adult patients with VAP were men, with no statistical difference identified between the groups according to COVID-19 diagnosis ($X^2 = 0.34$, $p = 0.555$). Table 2

Table 2.- Ventilator-associated pneumonia according to gender. Zone 1 General Hospital. Oaxaca. Mexico, 2020-2022.

Sex	Type of pneumonia					
	COVID-19		It's not Covid-19		Total	
	No.	%	No.	%	No.	%
Female	23	32,4	25	28.1	49	30,0
Male	47	67,6	64	71,9	111	70,0

$X^2 = 0,34$, $p = 0,555$

The most common personal pathological history in all patients and in both groups is arterial hypertension, followed by diabetes mellitus. For all antecedents, their reports were higher in patients with COVID-19, although a significant difference was identified only between the types of pneumonia due to chronic kidney disease, which is more frequent in non-COVID-19 pneumonia than in patients with COVID-19 (9.0 vs 1.4 respectively and p = 0.04). Table 3

Table 3.- Ventilator-associated pneumonia according to personal pathological history. Zone 1 General Hospital. Oaxaca. Mexico, 2020-2022.

Personal pathological history	Ventilator-associated pneumonia						X^2 (p)
	COVID-19		It's not Covid-19		Total		
	No.	%	No.	%	No.	%	
Hypertension	22	31,0	22	24,7	44	27,5	0,8 (0,378)
Diabetes mellitus	19	26,8	19	21.4	38	23,8	0,6 (0,424)
Chronic kidney disease	1	1.4	8	9,0	9	5.6	4,3 (0,04)
Obesity	5	7,0	1	1.1	6	3.8	3,8 (0,05)
Cardiovascular disease	2	2.8	1	1.1	3	1,9	0,6 (0,433)
COPD	2	2.8	0	0,0	2	1.3	2,5 (0,195)
Other	5	7,0	6	6.7	our	6,9	0,01 (0,941)
None	31	43,7	52	58,4	83	51,9	3,4 (0,06)

In 9 out of 10 patients, the hospital stay was at least 11 days. Although it did not represent statistical significance, in patients with COVID-19 the prevalence of hospitalization was higher than in non-COVID-19 patients (85.9% vs 80.9%).

Table 4.- Ventilator-associated pneumonia according to length of hospital stay and duration of mechanical ventilation (days). Zone 1 General Hospital. Oaxaca. Mexico, 2020-2022.

Length of hospital stay	Ventilator-associated pneumonia				Total	
	COVID-19		It's not Covid-19			
	No.	%	No.	%	No	%
<1	0	0,0	1	1.1	1	0,6
1 a 4	1	1.4	3	3.4	4	2,5
5 a 7	3	4.2	5	5.6	8	5,0
8 a 10	6	8,5	8	9,0	14	8.8
>= 11	61	85,9	72	80,9	133	83,1

$X^2 = 1{,}69$, $p = 0{,}004$

Mechanical ventilation was used more frequently for 8 or more days (73.1%). In 9 out of 10 COVID-19 patients, assisted ventilation time was 8 or more days, significantly longer than in non-COVID-19 patients (84.5% vs 64.0%, respectively).

Table 5.- Ventilator-associated pneumonia according to duration of mechanical ventilation (days). Zone 1 General Hospital. Oaxaca. Mexico, 2020-2022.

Fan Days	Ventilator-associated pneumonia				Total	
	COVID-19		Covid-19 No			
	No.	%	No.	%	No.	%
1 a 3	0	0,0	8	9,0	8	5,0
4 a 7	our	15,5	24	27,0	35	21.9
>=8	60	84,5	57	64,0	117	73,1

$X^2 = 11{,}0$, $p = 0{,}004$

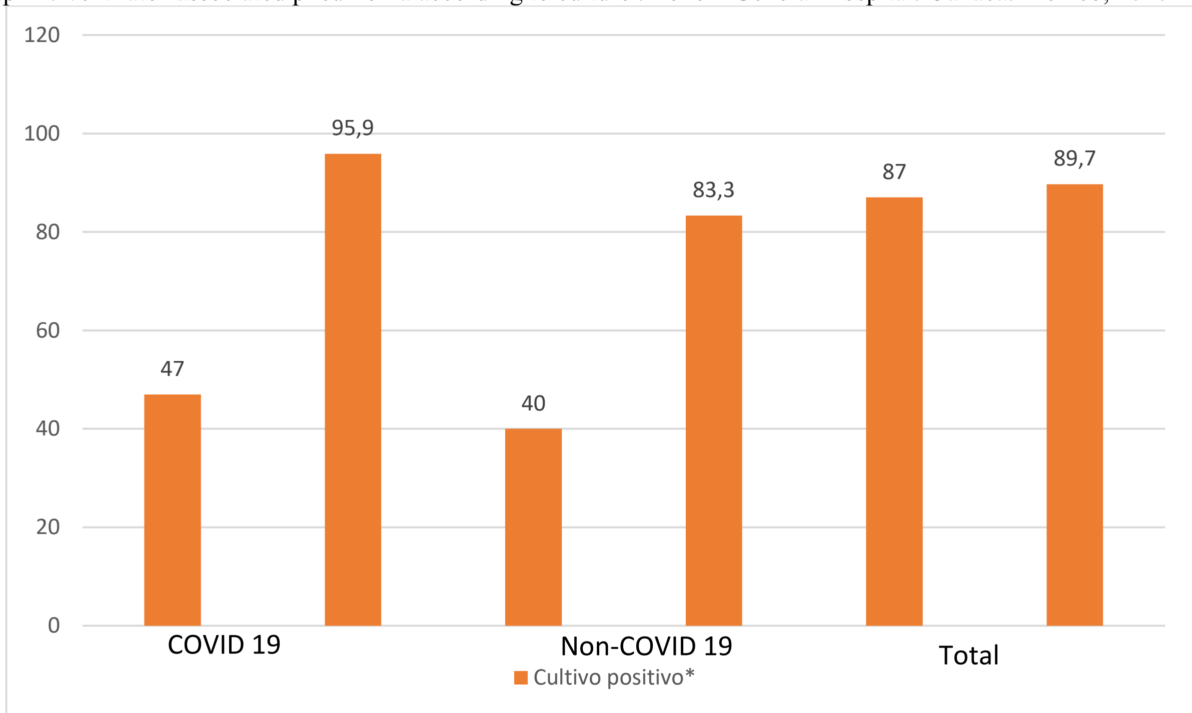
The health service where most patients with VAP were admitted was internal medicine (60.6%). There were no significant differences between COVID-19 and non-COVID-19 patients regarding this variable. Table 6

Table 6.- Ventilator-associated pneumonia according to care service. Zone 1 General Hospital. Oaxaca. Mexico, 2020-2022.

Customer Service	Ventilator-associated pneumonia				Total	
	COVID-19		Covid-19 No			
	No.	%	No.	%	No.	%
Internal Medicine	43	60,6	53	59,6	96	60,0
Intensive Care Unit	28	39,4	28	31,5	56	35,0
General Surgery	0	0	6	6.7	6	3.8
Gynaecology	0	0	1	0,6	1	0,6
Emergencies	0	0	1	1.1	1	0,6

Of the total number of patients, cultures were performed in 60.6% of them. Positive culture was highly significant in COVID-19 patients than in non-COVID-19 patients (95.9% vs 83.3%). Figure 1

Graph 1. Ventilator-associated pneumonia according to culture . Zone 1 General Hospital. Oaxaca. Mexico, 2020-2022.



Source. Online registration of the nosocomial epidemiological surveillance system.

The main microorganisms isolated were: *Candida albicans (13.4%),* Acinetobacter baumannii (12.4%) and Escherichia coli (11.3%). Statistically it was not significant, but both *Klebsiella pneumoniae* and *Pseudomona aeruginosa* occurred more frequently in patients with COVID-19 compared to patients without COVID-19. Table 7

Table 7.- Ventilator-associated pneumonia according to antimicrobial isolation. Zone 1 General Hospital. Oaxaca. Mexico, 2020-2022.

Agents identified	Ventilator-associated pneumonia				Total	
	COVID-19		It's not Covid-19			
	No	%	No	%	No.	%
Candida albicans	5	10.2	8	16,7	13	13.4
Acinetobacter Baumanii	6	12.2	6	12,5	12	12.4
Escherichia coli	5	10.2	6	12,5	11	11.3
Klebsiella pneumoniae	8	16.3	1	2.1	9	9.3
Pseudomona aeruginosa	5	10.2	4	8.3	9	9.3
Staphylococcus aureus	4	8.2	4	8.3	8	8.2
Other	14	28,6	our	22,9	25	25,8

62% of the isolated cultures were sensitive according to the results of the antibiograms performed. Table 8.

In the most isolated agents, *Candida albicans* was sensitive to all antifungals of the Vitek2 automated system, *Acinetobacter baumannii was not sensitive to any antibiotic and* E. coli *was more sensitive to ampicillin and carbapenems.*

Table 8.- Biological agent according to antimicrobial susceptibility. Zone 1 General Hospital. Oaxaca. Mexico, 2020-2022.

Antibiotic	Biological agent				
	C white N (%)	*E. coli N (%)*	*K Tire N (%)*	*P air N (%)*	Other N (%)
Ampicilin	0 (0,0)	11 (91,7)	11 (84,6)	4 (44,4)	4 (16,0)
Cefepime	0 (0,0)	1 (8,3)	3 (23,1)	4 (44,4)	2 (8,0)
Ceftacidin	0 (0,0)	1 (8,3)	1 (7,7)	2 (22,2)	1 (4.0)
Ceftriaxone	0 (0.0)	1 (8.3)	3 (23.1)	0 (0.0)	1 (4.0)
Ciprofloxacino	0 (0.0)	0 (0.0)	4 (30.8)	3 (33.3)	6 (24.0)
Early	0 (0.0)	7 (58.3)	7 (53.8)	0 (0.0)	1 (4.0)
Gentamicin	0 (0.0)	6 (50.0)	7 (53.8)	4 (44.4)	8 (32.0)
Meropenem	0 (0.0)	8 (66.7)	9 (69.2)	3 (33.3)	2 (8.0)
Norfloxacin	0 (0.0)	0 (0.0)	3 (23.1)	1 (11.1)	3 (12.0)
TMPSMX	0 (0.0)	4 (33.3)	1 (7.7)	0 (0.0)	4 (16.0)
Levofloxacino	0 (0.0)	0 (0.0)	0 (0.0)	1 (11.1)	3 (12.0)
Tigecycline	0 (0.0)	1 (8.3)	2 (15.4)	0 (0.0)	6 (24.0)
Vancomycin	0 (0.0)	0 (0.0)	1 (7,7)	0 (0,0)	8 (32,0)
Imipenem	0 (0,0)	4 (33,3)	2 (15,4)	1 (11.1)	0 (0,0)
Amphotericin	5 (45,5)	0 (0,0)	0 (0,0)	0 (0,0)	1 (4,0)
Caspofungin	5 (45,5)	0 (0,0)	0 (0,0)	0 (0,0)	0 (0,0)
Fluconazol	5 (45,5)	0 (0,0)	0 (0,0)	0 (0,0)	0 (0,0)
Voriconazole	4 (36,4)	0 (0,0)	0 (0,0)	0 (0,0)	1 (4,0)
Cefoxitina	0 (0,0)	2 (16,7)	2 (15,4)	1 (11.1)	0 (0,0)

Calb = Candida albicans ; _ E coli = Escherichia coli coli ; K pn = Klebsiela pneumoniae ; P Aer = Pseudomona aeruginosa

62% of the isolated cultures were resistant according to the results of the antibiograms performed. Table 9.

The most isolated agents according to their resistance, *Candida albicans* showed no antimicrobial resistance, *Acinetobacter baumannii* was resistant to all antibiotics of the Vitek2 automated system, and *E. coli* was more resistant to ampicillin, ciprofloxacin, ceftriaxone, and cefepime.

Table 9.- Biological agent according to antimicrobial resistance. Zone 1 General Hospital. Oaxaca. Mexico, 2020-2022.

Antibiotic	Biological agent				
	E. coli	And b	K pn	P air	Other
Cefotaxima	7 (58.3)	1 (11.1)	3 (23.1)	4 (44.4)	1 (4.0)
Ceftriaxone	9 (75.0)	1 (11.1)	6 (46.2)	3 (33.3)	3 (12.0)
Ciprofloxacino	10 (83.3)	7 (77.8)	8 (61.5)	2 (22.2)	9 (36.0)
Levofloxacino	2 (16.7)	5 (55.6)	1 (7.7)	2 (22.2)	3 (12.0)
TMPSMX	4 (33,3)	4 (44,4)	6 (46,2)	1 (11.1)	4 (16,0)
Cefepime	9 (75,0)	7 (77,8)	8 (61,5)	3 (33,3)	3 (12,0)
Cefoxitina	7 (58,3)	0 (0,0)	2 (15,4)	1 (11.1)	1 (4,0)
Ampicilin	11 (91,7)	3 (33,3)	11 (84,6)	0 (0,0)	5 (20,0)
Ceftacidin	5 (41,7)	3 (33,3)	4 (30,8)	0 (0,0)	1 (4,0)
Gentamicin	3 (25,0)	7 (77,8)	2 (15,4)	2 (22,2)	6 (24,0)
Ampicilina sulbactam	6 (50,0)	4 (44,4)	5 (38,5)	0 (0,0)	1 (4,0)
Norfloxacina	4 (33,3)	0 (0,0)	3 (23,1)	0 (0,0)	0 (0,0)
Meropenem	1 (8,3)	8 (88,9)	1 (7,7)	3 (33,3)	2 (8,0)
Early	0 (0,0)	0(0,0)	3 (23,1)	0 (0,0)	1 (4,0)
Linezolid	0 (0,0)	0 (0,0)	0 (0,0)	0 (0,0)	2 (8,0)
Piperacilina Tazobactam	1 (8,3)	5 (55,6)	2 (15,4)	0 (0,0)	0 (0,0)
Imipenem	0 (0,0)	6 (66,7)	0 (0,0)	1 (11.1)	0 (0,0)
Amycin	0 (0,0)	6 (66,7)	0 (0,0)	1 (11.1)	0 (0,0)

E. coli = Escherichia coli; Ac b = Acinetobacter Baumanii ; K pn = Klebsiela pneumoniae ; PAer = Pseudomona aeruginosa ; S Aur = Estafilococo áureo

After analyzing each element that makes up the guide, we evaluate compliance with the schedule of preventive actions for ventilator-associated pneumonia (Appendix 3). It was possible to evaluate the fulfillment of these actions in only 24 patients and the inadequate category predominated (61.5%), the adequate category was empty. Table 10.

Table 10.- Ventilator-associated pneumonia according to the compliance package of the VAP preventive package. Zone 1 General Hospital. Oaxaca. Mexico, 2020-2022.

Compliance	Ventilator-associated pneumonia					
	COVID-19 (N = 5)		It's not Covid-19 (N = 19)		Total (N = 24)	
	No	%	No	%	No.	%
Appropriate	0	0,0	0	0,0	0	0
Moderately adequate	3	60,0	5	26.3	8	33,3
Inappropriate	2	40,0	14	73,7	16	66,7

Age was identified as a factor associated with ventilator-associated pneumonia due to COVID-19, with significance for all groups and prevalence ratios between 1.35 (1.12-1.64) and 2.25 (1.34-3.77) times higher probability of occurrence compared to the 18-24 years old group. In the case of ventilation time, a 3.62-fold (1.71-7.66) increase in COVID-19 ventilator-associated pneumonia is identified from the fourth day of assisted ventilation compared to 1 to 3 days. Table 11.

Table 11. Factors associated with ventilator-associated pneumonia. Zone 1 General Hospital. Oaxaca. Mexico, 2020-2022.

Variables	**Ventilator-associated pneumonia**		**Total No (%)**	**RP (IC 95%)**	**p**
	Covid-19 No (%)	**No Covid-19 No (%)**			
Total	71 (44,4)	89 (55,6)	160 (100,0)	-	-
			Age		
18-24	0 (0,0)	10 (100,0)	10 (6,3)	1	-
25-34	5 (26,3)	14 (73,7)	19 (11,9)	1,71 (1,22-2,40)	0,008
35-44	12 (60,0)	8 (40,0)	20 (12,5)	2,25 (1,34-3,77)	0,002
45-54	10 (40,0)	15 (60,0)	25 (15,6)	1,67 (1,21-2,30)	0,020
55-64	22 (61,1)	14 (38,9)	36 (22,5)	1,71 (1,22-2,40)	0,000
65 years+	22 (44,0)	28 (56,0)	50 (31,3)	1,35 (1,12-1,64)	0,009
			Ventilation time (days)*		
1 a 3	0 (0,0)	8 (100,0)	8 (5,0)	1	-
4 a 7	11 (31,4)	24 (68,6)	35 (21,9)	3,62 (1,71-7,66)	0,000
>= 8	60 (51,3)	57 (48,7)	117 (73,1)		

5 DISCUSSION

Healthcare-associated infections are a public health problem and a major economic cost in hospitals. Ventilator-associated pneumonia is one of the most frequent HAIs. The increase in severe COVID-19 pneumonia has led to a greater demand for the use of mechanical ventilation, exposing patients to a risk factor for developing ventilator-associated pneumonia. The identification of these factors associated with VAP in patients with COVID-19 will allow us to know to which age group to direct preventive actions.

Our research found that age with significance of 1.35 (1.12-1.64) and 2.25 (1.34-1.377) in the 18-24 age group was identified as associated factors, an increase of 3.62 (1.71-7.66) from the fourth day of ventilation was identified. Similar to previous studies regarding the duration of mechanical ventilation use. [22.23]

The magnitude of VAP before SARS-CoV-2 in Mexico was 39.7%, in our research we found that with COVID-19 this increase to 44.4%, higher than that declared by Lux et al., in whose research carried out in Chile with a sample of 112 ventilated adult patients, estimates an incidence of 42.8% of VAP. Murillo Yupanqui, in his thesis developed at the Hospital of Peru, analyzed 117 patients, reporting an incidence of 67.5 %.In this sense, the study on bacterial infections in patients with COVID-19 in Cuba carried out by Aguilera Calzadilla et al agrees with the data obtained in this research. [19,8,18]

Age is another important factor. The older you are, the more likely VAP is to occur. We obtained a mean age of 59 years, similar to that found in the cohort study of co-infections in critically ill COVID-

19 patients by Baskaran et al. Gender was relevant in SARS-CoV-2 infection, globally the most affected were men, presenting the same behavior in the case of VAP, other studies reported the same finding in patients with COVID-19 and not with COVID-19 where sex differences and the immune response of sex to the development of this complication was reported, which is the greatest. Forel et al, in their 2012 study, identified that being male was associated with a two-fold greater likelihood of developing VAP. [23,24,25,26,27]

The personal pathological history found in patients with COVID-19 most frequently was arterial hypertension, followed by diabetes mellitus, aspects similar to those reported in the literature consulted. Garay et al identified diabetes mellitus in 50.4%, systemic hypertension in 46.4% and obesity in 36.1%, and in their thesis Murillo identified arterial hypertension in 43.2% and obesity in 33.9%. The SARS-CoV-2 disease has reminded us of chronic diseases and the association of complications with high mortality rates. [23,8,27]

The hospital stay was 20 days and the use of a mechanical ventilator was 13 days for the development of pneumonia, findings higher than those of Lux et al [19] , 9.5 days with prolonged use of ventilation. the intensive care unit. This is different from those found by Murillo, who reported a hospital stay of 8.5±6 days. The ICU was the service that presented the greatest care of patients with ventilatory support, and our hospital differed because the concentration of critical patients was in the internal medicine service.

In the meta-analysis carried out by Alhumaid, it was shown that bacteria, fungi, and viruses were among the most frequent co-infections in patients with SARS-CoV-2 infection. Coinciding with the results of this study in the isolated microorganisms, Estrada et al, in their study of 252 cultures, identified isolation of some microorganism in 35.3%, in which the main isolated microorganisms were: *Klebsiella pneumoniae (22.5%),* Acinetobacter baumannii *(20.2%),* Pseudomona aeruginosa *(13.5%) and* Staphylococcus aureus *(11.2%).*

The sensitivity and resistance reported by Estraday et al(24) was for ceftriaxone, cefepime, piperacillin-tazobactam, amikacin and ciprofloxacin, mainly for Acinetobacter baumannii *and* Klebsiella pneumoniae*, in the investigation the highest resistance was presented for ampicillin*, Acinetobacter baumannii *have multidrug resistance, similar to previous publications* (23).

Due to the impact that COVID-19 has had on the world and the development of VAP, it was noted that from the beginning due to the use of protective equipment, some preventive actions were not carried out, marked by the recommendations of Vásquez, it can be noted that in this investigation the preventive actions were inadequate in 42.3%.

6 LIMITATIONS AND STRENGTHS

The main limitation is related to the study design, which only allows the identification of associations and not risk factors. The second is related to the limited application of the schedule of preventive actions in a small number of patients with mechanical ventilation and COVID-19 disease, which may mean interfering with the result obtained. However, the data obtained for analysis is a valuable result.

7 CONCLUSIONS

Ventilator-associated pneumonia remains a public health problem, which has increased during COVID-19, with a higher incidence of cases in patients with SARS-CoV-2, due to increased days of mechanical ventilation use, days of hospital stay, and high hospital costs.

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