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Epidemiological profile of COVID-19 patients undergoing invasive mechanical ventilation in a Brazilian public hospital: a comparison between 2020 and 2021

Perfil epidemiológico de pacientes com COVID-19 submetidos à ventilação mecânica invasiva em um hospital público brasileiro: comparação entre os anos de 2020 e 2021

Perfil epidemiológico de pacientes con COVID-19 sometidos a ventilación mecánica invasiva en un hospital público brasileño: comparación entre los años 2020 y 2021

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ABSTRACT

Introduction: COVID-19 can lead to respiratory complications and require some patients to undergo invasive mechanical ventilation. As a recent disease, it is not clear which patient characteristics predispose to the need for the procedure. **Aim:** The aim of this study was to describe and compare the epidemiological profile of patients who required invasive mechanical ventilation between 2020 and 2021. **Outlining:** This is a descriptive and analytical study. Patient characteristics and outcomes were collected from medical records and divided into four groups (survivors - GS and non-survivors - GN of 2020 and 2021). **Results:** The sample consisted of 501 patients over 18 years of age. There was a difference ($p<0.005$) in Chronic Obstructive Pulmonary Disease, pneumothorax, age, prone position, and dialysis support in the GN, and tracheostomy, longer hospital stays, and longer stay in the Intensive Care Unit in the GS. The year 2020 had an older population with pneumothorax and neurological disease among non-survivors. **Implications:** The findings of the study will assist in the management of healthcare resources, implementation of measures to reduce the time of mechanical ventilation, and prioritization of vaccination for at-risk groups.

DESCRIPTORS

COVID-19; Epidemiological profile; Mechanical ventilation; Critical care.

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INTRODUCTION

COVID-19 is a disease caused by a virus from the coronavirus family, called SARS-CoV-2, which was discovered in December 2019. The first reports came from the city of Wuhan, China, and it was quickly declared a pandemic in March 2020 by the World Health Organization (WHO).[1-2]

Although SARS-CoV-2 can affect various organs and systems, respiratory system compromise is one of the most reported. Among the symptoms of COVID-19, the most common is dyspnea, which is usually accompanied by hypoxemia, and can quickly progress to a severe respiratory failure such as acute respiratory distress syndrome (ARDS).[1,3]

This severity leads to a series of patients with the disease needing hospitalization. According to WHO, 80% of patients present only mild symptoms, but 15% progress to hospitalization, with around 5% needing Intensive Care Unit (ICU) care. Among these, a portion progresses to Orotracheal Intubation (OTI) and consequently Invasive Mechanical Ventilation (IMV).[2] However, it is still unknown which patients require this procedure.

Furthermore, although scarce, current research shows that COVID-19 patients undergoing IMV present higher mortality rates when compared to those managed by other approaches.[4] Regardless of the COVID-19 diagnosis, there has always been a concern with patients requiring IMV. Studies show that clinical patients under IMV are more prone to complications such as infections, being an important factor for prognosis, with an association with mortality.[5] Additionally, older adults and the presence of comorbidities seem to be other factors to be considered for possible unfavorable clinical outcomes in patients under IMV.[6]

For planning, administration, and health actions, such as in pandemics, epidemiology plays a fundamental role since it studies the distribution and factors that cause diseases, as well as the events associated with them.[7] Given the appearance of COVID-19, a disease previously unknown, better understanding its evolution and outcome, especially in severe patients such as those undergoing IMV, is extremely relevant and can be an important key to future approaches. Additionally, it is necessary to verify if there has been a change in the profile of patients with COVID-19 between the first years of the pandemic, as vaccination campaigns only started in 2021 and were not carried out simultaneously in the population, with prioritization for the elderly.[8]

The study hypothesis was that elderly patients with comorbidities would characterize the largest portion of COVID-19 patients requiring IMV and would present higher mortality rates. Another hypothesis was that there would be a difference in the population profile affected by COVID-19 between the years 2020 and 2021.

The present study aimed to describe the epidemiological profile of COVID-19 patients requiring IMV in a Brazilian public hospital and compare the demographic and nosological profile of patients diagnosed with the disease and under IMV between the years 2020 and 2021. Additionally, the objective of this study was to investigate if there is an association between patients' clinical characteristics and the final outcome (survival or death).

METHOD

This is a descriptive and analytical retrospective epidemiological study approved by the Ethics and Research Committee (CEP) of the Piracicaba School of Dentistry Unicamp (opinion no. 4,821,606).

The sample consisted of data from patients who were admitted to the Piracicaba Regional Hospital with a COVID-19 diagnosis during the periods of March to August 2020 and 2021 and who underwent the procedure of IMV. Data were collected through information contained in medical records.

Inclusion criteria were patients with laboratory-confirmed COVID-19 diagnosis admitted to the hospital between March to August 2020 and 2021, requiring IMV, of both sexes, aged over 18 years.

Exclusion criteria were patients with a COVID-19 diagnosis who did not require IMV, patients with less than 24 hours of IMV, and patients still hospitalized during the data collection period.

The research phases consisted of data collection from medical records to characterize the sample, which was manually allocated to an electronic spreadsheet and then analyzed and treated to identify the profile of patients undergoing IMV with COVID-19 and compare them among four groups: 2020 survivors (GS 2020); 2021 survivors (GS 2021); 2020 non-survivors (GN 2020); and 2021 non-survivors (GN 2021).

The obtained data were: age (years and months), sex, type and quantity of comorbidities, IMV time (counted in days), ICU hospitalization time, and hospitalization time (both counted in days), presence of pneumothorax, pneumomediastinum and/or subcutaneous emphysema, extubation success (considered by staying off IMV for a period longer than 48 hours)[9], reintubation rate after 48 hours of ventilatory support absence, TQT, need for prone position, need for renal dialysis support, and outcome (survival or death).

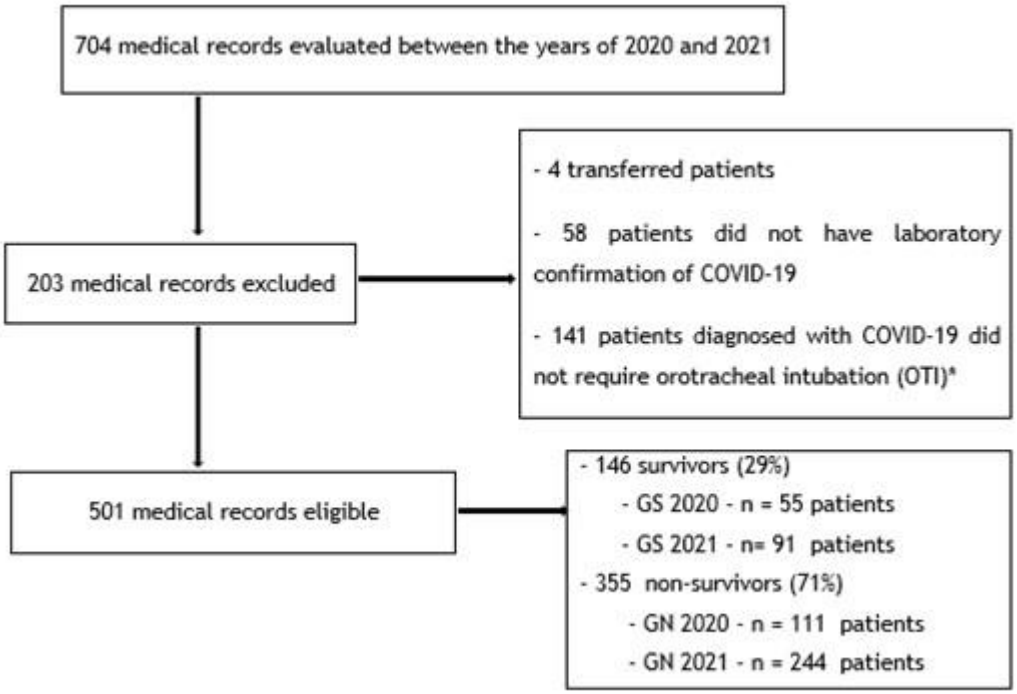
The normality of data was verified using the Kolmogorov-Smirnov test. The one-way ANOVA statistical test was used to compare continuous variable groups (age, number of comorbidities, IMV time, ICU and hospitalization time). The chi-square test was used to compare categorical variable groups (sex, obesity, Systemic Arterial Hypertension (SAH), Chronic Obstructive Pulmonary Disease (COPD), asthma, Diabetes Mellitus (DM), alcoholism, heart disease, history of Venous Thromboembolism (VTE), neurological disease, renal disease, cancer, pneumothorax, TQT, prone position, and renal dialysis support). Finally, the Kruskal-Wallis non-parametric test was used for categorical variables with more than two distribution types (success in first extubation and reintubation after a period longer than 48 hours). Multiple linear regression was performed to verify the association of the analyzed variables with survival or death outcomes.

The analyses were performed using the SPSS (Statistical Package for the Social Sciences) version 20.0 computational statistical package, and a significance level of 5% was adopted for all analyses.

RESULTS

A total of 704 medical records of patients admitted to the ICU during the years 2020 and 2021 were evaluated, and then 203 were excluded from the sample according to pre-established exclusion criteria. In the end, the patients were allocated into four groups for analysis, named GS 2020, GS 2021, GN 2020, and GN 2021 (Figure 1).

Figure 1 - Flow diagram of the sample selection process.



Legend: *OTI, orotracheal intubation.
Source: Direct search.

The sample characteristics are presented in Table 1. They are shown as absolute frequency and percentage for categorical variables and mean ± standard deviation for continuous variables. There was a difference between GS 2021 and GN in both 2020 and 2021 for COPD, with a higher prevalence among non-survivors. There was also a difference in the presence of neurological disease between GN 2021 and GN 2020, with the former showing a higher frequency.

The analysis showed that GN 2020 had a higher pneumothorax rate compared to GS 2021. However, GN 2020 had a higher rate of this complication compared to GN 2021. When comparing GS 2021 with GN in both years, a higher frequency of performing tracheal intubation was observed in GS. GN in both years had a higher frequency of requiring dialytic renal support compared to both GS 2020 and 2021. GN in both 2020 and 2021 also had a higher need for prone positioning. A higher prevalence of obesity and DM was also observed among non-survivors, but without significant differences, as well as for other characteristics (HBP, asthma, alcoholism, heart disease, history of TEV, renal disease, and cancer). Regarding the number of comorbidities, there was only a difference between GS 2021 and GN 2020, with fewer comorbidities present among survivors.

When comparing continuous variables between survivors and non-survivors, there was a higher frequency of elderly patients among non-survivors. The mean age of patients (in both GS and GN) was also higher in 2020 compared to 2021. In both years, patients who survived had a significantly longer ICU and hospitalization time compared to GN. There was no difference in the variable of VMI time between the groups.

Table 1 – Epidemiological profile of COVID-19 patients who required invasive mechanical ventilation (n=501). Piracicaba, 2020 - 2021. São Paulo, Brazil.

Variables n (%)	GS 2020 (55)	GS 2021 (91)	GN 2020 (111)	GN 2021 (244)	*p-value*
Gender					
Female	24 (43.6)	47 (51.6)	43 (38.7)	123 (50.4)	0.158
Male	31 (56.3)	44 (48.3)	68 (61.2)	121 (49.5)	
Age years)	59.23 ± 14.83 [ab]	51.73 ± 11.91 [bc]	68.55 ± 11.54 [c]	57.42 ± 12.36	< 0.001
Obesity	17 (31)	30 (33)	22 (19.8)	80 (32.7)	0.079
SAH	31 (56.3)	42 (46.1)	62 (55.8)	130 (53.2)	0.507
COPD	12 (7.2)	7 (2.2) [bc]	32 (9.9)	42 (5.7)	< 0.001
Asthma	5 (9)	1 (1)	2 (1.8)	12 (4.9)	0.054
DM	21 (38.1)	25 (27.4)	50 (45)	93 (38.1)	0.085
Alcoholism	2 (3.6)	2 (2.2)	5 (4.5)	5 (2.0)	0.581
Heart disease	6 (10.9)	6 (6.6)	17 (15.3)	21 (8.6)	0.155
VTE history	2 (3.6)	2 (2.2)	2 (1.8)	4 (1.6)	0.812
Neurological disease	2 (3.6)	1 (1.1)	10 (9) [c]	4 (1.6)	0.002
Kidney disease	2 (3.6)	2 (2.2)	7 (6.3)	11 (4.5)	0.553
Cancer	2 (3.6)	0 (0)	4 (3.6)	5 (2)	0.305
pneumothorax	3 (5.4)	1 (1) [b]	20 (18) [c]	15 (6.1)	< 0.001
Tracheostomy	9 (16.3)	20 (21.9) [bc]	9 (8.1)	19 (7.7)	< 0.001
Pronation	26 (47.2) [c]	62 (68.1) [bc]	45 (40.5) [c]	204 (83.6)	< 0.001
Dialysis support	1 (1.8) [bc]	6 (6.6) [bc]	22 (19.8)	55 (22.5)	< 0.001
Comorbidities (n)	1.84 ± 1.34	1.30 ± 1.15 [b]	1.92 ± 1.14	1.68 ± 1.21	< 0.05
VMI time (days)	14.06 ± 13.74	17.59 ± 11.03	14.79 ± 11.50	14.38 ± 10.51	0.111
ICU time (days)	24.20 ± 22.97 [bc]	21.60 ± 12.52 [bc]	14.81 ± 11.06	13.23 ± 11.57	< 0.001
Hospitalization time (days)	30.27 ± 23.71 [bc]	27.07 ± 14.96 [bc]	15.40 ± 11.07	13.60 ± 11.68	< 0.001

Legend: SAH: systemic arterial hypertension; COPD: chronic obstructive pulmonary disease; DM: diabetes mellitus; VTE: venous thromboembolism; IMV: invasive mechanical ventilation; ICU: intensive care unit. a $p < 0.05$, significantly different from survivors 2021. b $p < 0.05$, significantly different from non-survivors 2020. c $p < 0.05$, significantly different from non-survivors 2021.
Source: Prepared by the authors.

The categorical variables for extubation success and need for reintubation after 48 hours are presented in Table 2. The GS of both years had a higher rate of success in extubation compared to GN. Despite the success in the first extubation, some patients needed a new OTI procedure during hospitalization, which was higher in 2020, but still in the survivors group. Some patients did not fit into the mentioned variables due to factors such as TQT procedure or death without a previous attempt at extubation.

Table 2 – Comparison of success variables in extubation and reintubation after a period longer than 48 hours. (n=501). Piracicaba, 2020 - 2021. São Paulo, Brazil.

	GS 2020	GS 2021	GN 2020	GN 2021	*p* -value < 0.001
Success in extubation n (%)					
Yes	41 (74.5) [ab]	62 (68.1) [ab]	4 (3.6)	6 (2.4)	
No	2 (3.6)	3 (3.2)	6 (5.4)	8 (3.2)	
Not applicable	12 (21.9)	26 (28.7)	101 (91)	230 (94.4)	
Reintubation after time > 48 hr (%)					< 0.001
Yes	4 (7.2) [ab]	1 (1,1) [ab]	2 (1.8)	4 (1.6)	
No	33 (60)	61 (67)	2 (1.8)	2 (0.8)	
Not applicable	18 (32.7)	28 (30.7)	107 (96.3)	234 (95.9)	

Legend: DPD = a p<0.05, significantly different from non-survivors in 2020. b p<0.05, significantly different from non-survivors in 2021.
Source: Elaborated by the authors.

The final model, performed through multiple linear regression (Table 3), indicated that the variables of hospitalization time, ICU time, success in the 1st extubation, TQT procedure, age, and presence of pneumothorax would explain 67% of the variability regarding the patient outcome (survival or death). In situations of stability of the other variables, hospitalization time could predict 93% of the patient outcome variability. For ICU time, there could be 75%, followed by extubation success, predicting 71% of the variability. The variables of TQT procedure, age, and presence of pneumothorax could predict 12%, 11%, and 5% of this variability, respectively.

Table 3 – Prediction of patient outcome variability. Piracicaba, 2020 to 2021. São Paulo, Brazil.

	B	SE B	β	*P*	R^2	Adjusted R^2
Final model					0.671	0.666
Constant	0.797	0.181		< 0.001		
Presence of pneumothorax	-0.093	0.044	-0.055	0.036		
TQT	0.172	0.051	0.12	< 0.001		
Age	0.000	0.000	0.112	< 0.001		
ICU time	0.025	0.003	0.751	< 0.001		
Length of stay	-0.027	0.003	-0.930	< 0.001		
Extubation success	0.389	0.031	0.717	< 0.001		

Legend: ICU: Intensive Care Unit; TQT: Tracheostomy.
Source: Elaborated by the authors.

DISCUSSION

Studies have shown that patients who require mechanical ventilation and ICU hospitalization have high mortality rates (80% and 60% respectively).[10] A similar result was found in the present study, as out of 704 medical records evaluated, only 141 COVID-19 patients did not require mechanical ventilation. Of those who did require it, 71% died. However, contrary to some research, which shows that prolonged hospitalization is associated with a higher death rate, the present study found a longer ICU and hospital stay among survivors.[11]

There was no significant difference in the duration of mechanical ventilation between survivors and non-survivors. Therefore, the justification for survivors having stayed longer in the ICU may lie in the structural differences between hospitals in the country, such as the availability of human resources and materials outside the ICU, as well as the profile of the patient in question. Data showed a need for

prone positioning in 60% of survivors, a procedure that requires the use of sedatives and neuromuscular blockers, which can bring complications such as ICU-acquired weakness and the consequent need for rehabilitation.[12] In the hospital structure of the study, a rehabilitation team composed of physiotherapists was designated for only 24 hours in the ICU, justifying a greater need for patient stay in that sector, consequently increasing the overall hospitalization time.

There was a higher success rate in extubation among patients who survived. Although the need for a new intubation for various reasons was observed during hospitalization, this happened in only a small portion of patients and did not interfere with the patient's outcome, making it possible to remove them from ventilatory support again. This data supports other existing research that shows successful weaning is associated with better outcomes.[5]

A portion of the study patients underwent tracheostomy, probably due to the prolonged mechanical ventilation time of some patients (more than 14 days), and these patients were among the survivors. Some severely ill patients may not have the necessary clinical conditions for the procedure, which may explain a lower incidence of tracheostomy in patients who died. Performing tracheostomy early or late has not shown a significant change in COVID-19 patient mortality.[13] However, a 2020 study showed that when the procedure is necessary, 55% of tracheostomized patients successfully weaned from mechanical ventilation, contributing to a reduction in mortality.[14]

Among the non-survivors, a significantly higher prevalence of COPD was observed compared to the survivors for both years, consistent with other studies demonstrating that patients with COPD are more likely to present with a severe form of COVID-19 and higher mortality rates.[15] Although research has shown a high incidence of cerebrovascular disease, which is associated with increased mortality rates, this finding was only observed in the present study for the year 2020.[16] Regarding other comorbidities such as diabetes and obesity, studies suggest that these may lead to worse outcomes for COVID-19 patients. In the present study, there was no significant difference for patients with these comorbidities, but there was a higher trend of this population among non-survivors.[17]

In both years, a portion of the sample had pneumothorax among non-survivors, but this finding was more prominent in 2020. Pneumothorax can be caused by factors such as improper management of mechanical ventilation (especially in patients with altered pulmonary mechanics) or by the disease's own pathophysiology. This was also observed in a 2021 study,[18] which found a high mortality rate among COVID-19 patients who presented with this complication. Although research does not provide sufficient data to relate the presence of pneumothorax with mortality, it is a variable that must be prevented and properly managed in the ICU.

In previous findings, the need for dialytic renal support was an independent intra-hospital mortality factor in COVID-19 patients, which corroborates the present study, in which these patients also had a higher mortality rate.[11] In other words, COVID-19 patients' mortality seems to stem from respiratory system decline, as well as complications in other systems, such as the renal system.

An interesting finding was significantly higher mortality among patients who underwent prone positioning, in both years. Although the technique is frequently used due to improvement in ventilation-perfusion ratio and consequently in oxygenation, in the present study, it was not sufficient to alter patient outcomes. This was also observed in a 2022 study, in which COVID-19 patients who underwent prone positioning showed improvement in oxygenation after the technique was performed, but still had a mortality rate of 69.3%, demonstrating the severity with which the disease can present.[19]

Age has already been demonstrated as an important prognostic factor. The same was observed in this study, where advanced age was found among non-survivors, which could be justified by a more deficient immune response in this population.20 Interestingly, this finding was more prominent in 2020. At the time this study was being conducted, there were no Brazilian literature studies comparing patient profiles in 2020 (the year the pandemic was reported) and 2021 (the pandemic still existed). However, an ongoing study has shown that vaccination may have influenced the profile of hospitalized patients in Brazil due to the definition of priority groups, including the elderly.[8]

The present study has some limitations, such as the fact that the time on mechanical ventilation was not observed separately after the endotracheal intubation procedure. Additionally, data was not collected on whether the endotracheal intubation was performed early or late, or whether the decannulation procedure was performed later. The incidence of neuromuscular blockade use and the diagnosis of FMAUTI were also not collected, which could help explain prolonged hospitalization. Nonetheless, this is the first Brazilian study, found to date, that compared the years 2020 and 2021, and the limitations do not affect the importance of the data that help us better understand the profile of COVID-19 patients. This information can help healthcare services identify patients at greater risk of mortality, as well as allocate and manage resources, human and material, more accurately. In addition to helping with better healthcare system management, this study can also contribute to the development of measures that reduce the time spent on mechanical ventilation, as well as risk stratification, which facilitates determining priority groups in vaccination campaigns.

CONCLUSION

It was possible to conclude that surviving COVID-19 patients required prolonged ICU and hospitalization time in both 2020 and 2021. These two variables, along with successful extubation, the presence of endotracheal intubation, pneumothorax, and patient age, were associated with the patient's outcome. Among patients with higher death rates, the presence of COPD, complications during hospitalization such as pneumothorax and the need for renal dialysis support, as well as the need for prone position, were found. The differences found between the years were the presence of pneumothorax and neurological disease, as well as advanced age, which were more prevalent in 2020, particularly among non-survivors.

RESUMO

Introdução: A COVID-19 pode trazer complicações respiratórias e fazer com que alguns pacientes necessitem de Ventilação Mecânica Invasiva. Por ser uma doença recente, não está claro quais as características dos pacientes que predispõem à necessidade do procedimento. **Objetivo:** foi descrever e comparar o perfil epidemiológico de pacientes que necessitaram de Ventilação Mecânica Invasiva entre os anos de 2020 e 2021. **Delineamento**: Trata-se de um estudo de caráter descritivo e analítico. As características e o desfecho do paciente foram coletados em prontuário. Em seguida, foram divididos em quatro grupos (sobreviventes - GS e não sobreviventes - GN de 2020 e 2021). **Resultados**: A amostra foi composta por 501 pacientes, com idade acima de 18 anos. Houve diferença (p< 0,005) para Doença Pulmonar Obstrutiva Crônica, pneumotórax, idade, posição prona e suporte dialítico no GN, e traqueostomia, tempo maior de internação hospitalar e em Unidade de Terapia Intensiva em GS. O ano de 2020 apresentou uma população mais idosa, com pneumotórax e doença neurológica entre os não sobreviventes. **Implicações:** Os achados do estudo auxiliarão na gestão de recursos de saúde, implementação de medidas para redução do tempo de permanência em VMI e priorização da vacinação dos grupos de risco.

DESCRITORES

COVID-19; Perfil epidemiológico; Ventilação mecânica; Cuidados críticos.

RESUMEN

Introducción: El COVID-19 puede traer complicaciones respiratorias y hacer que algunos pacientes requieren Ventilación Mecánica Invasiva. Al tratarse de una enfermedad reciente, no está claro qué características de los pacientes predisponen a la necesidad del procedimiento. **Objetivo:** describir y comparar el perfil epidemiológico de los pacientes que requirieron Ventilación Mecánica Invasiva entre los años 2020 y 2021. **Delineación:** Se trata de un estudio descriptivo y analítico. Las

características del paciente y la evolución se recogieron de la historia clínica. Luego, se dividieron en cuatro grupos (sobrevivientes - GS y no sobrevivientes - GN de 2020 y 2021). **Resultados:** La muestra estuvo constituida por 501 pacientes, mayores de 18 años. Hubo diferencia (p< 0,005) para Enfermedad Pulmonar Obstructiva Crónica, neumotórax, edad, decúbito prono y soporte de diálisis en NG, y traqueotomía, mayor estancia hospitalaria y estancia en Unidad de Cuidados Intensivos en GS. El año 2020 presentó una población de mayor edad, con neumotórax y enfermedad neurológica entre los no sobrevivientes. **Implicaciones**: Los hallazgos del estudio ayudarán en la gestión de los recursos sanitarios, la implementación de medidas para reducir el tiempo dedicado a la VMI y la priorización de la vacunación de los grupos de riesgo.

DESCRIPTORES
COVID-19; Perfil epidemiológico; Ventilación mecánica; Cuidados críticos.

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COLLABORATIONS

KCSO: contributed to the conception, study design, data interpretation, and manuscript writing. VL, JESJ, APTO, and CA: contributions to data interpretation, manuscript writing, and critical article review. JBA: contributions to data treatment, analysis, interpretation, and critical article review. **All authors agree and are responsible for the content of this version of the manuscript to be published.**

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AVAILABILITY OF DATA

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CONFLICTS OF INTEREST

There are no conflicts of interest to declare.