Incidência e fatores associados a microrganismos multirresistentes entre adultos internados por covid-19: coorte retrospectiva*

Incidence and factors associated with multi-resistant microorganisms among adults hospitalized for covid-19: retrospective cohort*

Incidencia y factores asociados a microorganismos multirresistentes en adultos hospitalizados por covid-19: cohorte retrospectiva*

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RESUMO
Objetivo: identificar a incidência e os fatores de risco para o Microrganismo Multirresistente (MDR) e comparar os cuidados de Enfermagem entre os pacientes com e sem MDR. Método: coorte retrospectivo de adultos com a COVID-19. Os dados foram fornecidos a partir de uma base de dados e coletados por meio do formulário do Google Forms. As variáveis demográficas e clínicas foram comparadas por meio de análise univariada. Os fatores associados à ocorrência de MDR foram verificados por Regressão de Cox. O estudo foi aprovado pelo Comitê de Ética e Pesquisa da instituição (CAAE: 57234822.5.0000.5327). Resultados: a média de idade dos 371 pacientes foi de 57,06 ± 14,3 anos, 51,2% eram homens. A incidência de MDR foi de 10,5%. Os fatores de risco para MDR foram a internação e Unidade de Terapia Intensiva (HR: 14,0; IC95%: 1,8-18,6) e o uso de ventilação mecânica (HR: 2,4; IC95%: 1,5-39,9). Apesar de 93,3% dos pacientes terem cuidados de Enfermagem prescritos, houve uma menor prescrição de medidas de precaução entre os pacientes com MDR. Conclusão: a incidência de MDR entre os pacientes com a COVID-19 ocorreu em cerca de um décimo dos pacientes e foi associada a uma maior gravidade clínica durante a hospitalização. Suscita-se uma maior adesão à prescrição dos cuidados de Enfermagem como modo de prevenir a ocorrência de MDR nessa amostra de pacientes.

Descritores: Cuidados de Enfermagem; Resistência Microbiana a Medicamentos; Infecção Hospitalar; COVID-19.

ABSTRACT
Objective: to identify the incidence and risk factors for multidrug-resistant microorganisms (MDR) and compare nursing care between patients with and without MDR. Method: Retrospective cohort of adults with COVID-19. Data were provided from a database and collected through Google Forms. Demographic and clinical variables were compared using univariate analysis. Factors associated with the occurrence of MDR were verified by Cox regression. The study was approved by the Ethics and Research Committee of the institution (CAEE: 57234822.5.0000.5327). Results: The mean age of the 371 patients was 57.06 ± 14.3 years, 51.2% were men. The incidence of MDR was 10.5%. Risk factors for MDR were admission to the intensive care unit (HR: 14.0; 95%CI: 1.8-18.6) and use of mechanical ventilation (HR: 2.4; 95%CI: 1.5-39.9). Although 93.3% of patients had been prescribed nursing care, there was fewer prescription of precautionary measures among patients with MDR. Conclusion: The incidence of MDR among patients with COVID-19 occurred in about one-tenth of patients and was associated with greater clinical severity during hospitalization. Greater adherence to the prescription of nursing care is suggested as a way to prevent the occurrence of MDR in this sample of patients.

Descriptors: Nursing Care; Drug Resistance, Microbial; Cross Infection; COVID-19.
RESUMEN

Objetivo: identificar la incidencia y los factores de riesgo para el Microorganismo Multirresistente (MDR), y comparar los cuidados de enfermería entre pacientes con y sin MDR.

Método: cohorte retrospectiva de adultos con COVID-19. Los datos se proporcionaron desde una base de datos y se recopilaron a través del formulario de Google Forms. Las variables demográficas y clínicas se compararon mediante análisis univariado. Los factores asociados con la ocurrencia de MDR fueron verificados por regresión de Cox. El estudio fue aprobado por el Comité de Ética e Investigación de la institución (CAEE: 57234822.5.0000.5327).

Resultados: la edad media de los 371 pacientes fue de 57,06 ± 14,3 años, el 51,2% eran hombres. La incidencia de MDR fue del 10,5%. Los factores de riesgo para MDR fueron la admisión a la Unidad de Cuidados Intensivos (HR: 14,0; 95% IC: 1,8-18,6) y el uso de ventilación mecánica (HR: 2,4; 95% IC: 1,5-39,9). Aunque el 93,3% de los pacientes tenían prescritos cuidados de enfermería, hubo menos prescripción de medidas cautelares entre los pacientes con MDR. Conclusión: la incidencia de MDR entre pacientes con COVID-19 ocurrió en aproximadamente una décima parte de los pacientes y se asoció con una mayor gravedad clínica durante la hospitalización. Se sugiere una mayor adherencia a la prescripción de los cuidados de enfermería como forma de prevenir la ocurrencia de MDR en esta muestra de pacientes.

Descriptores: Atención de Enfermería; Farmacorresistencia Microbiana; Infección Hospitalaria; COVID-19.

INTRODUCCIÓN

Coronavirus disease (COVID-19), an acute respiratory infection, is potentially serious, highly transmissible, and globally distributed. The epidemic began in the city of Wuhan, China, in December 2019, and quickly spread worldwide.1 Among the theories formulated, the most accepted thesis mentions that the virus was transmitted from the bat to an intermediate mammal, and from it to humans.2

Because it is a new and easily contagious disease, health professionals have sought to understand the effects caused by the COVID-19 pandemic on patients’ bodies, especially the possible medium- and long-term sequelae.3 One study, conducted in the United States of America, points to evidence that in addition to respiratory impacts, COVID-19 can even affect the central nervous system.4 Because of the high rate of COVID-19 transmission, it is recommended that professionals should adopt preventive measures to preserve their own health by using PPE (Personal Protective Equipment).5

PPE is also indicated to prevent cross-transmission of multidrug-resistant microorganisms (MDR) among hospitalized patients.6 The occurrence of MDR is considered one of the significant public health problems worldwide. It is estimated that between 5 and 15% of hospitalized patients acquire some type of MDR during their hospital stay.6 However, in view...
of the recent COVID-19 pandemic, its severe manifestation requires hospitalization and often invasive procedures, such as the insertion of intravenous devices, and airway tubes, among others. Prolonged periods of hospitalization associated with intensive care unit (ICU) stay are frequent scenarios that favor microbial resistance. MDRs show resistance to most antibiotics and are more frequently found in hospitals, especially in ICUs and surgical centers. This multidrug resistance happens mainly due to the inappropriate use of antibiotics, either by interrupting the treatment recommended by the physician or using them when not indicated. MDR infections involve costs with more expensive antibiotics, increased hospital stay, management of the consequences of the septic condition, as well as the institution of isolation protocols, often leading the patient to death. Therefore, it is essential to prevent the transmission of microorganisms by adopting effective strategies such as protocols, hand hygiene, and other preventive measures.

Nursing, due to its competence and responsibility towards uninterrupted patient care, develops a series of invasive and potentially contaminated procedures, which have a direct relationship with prophylactic actions to control hospital infections. Facing this problem of Health Care-Related Infections (HAIs), it is necessary that nurses, when managing the service and health care, are constantly updated to support their assistance with scientific evidence and in a critical and ethical posture.

The precautionary measures for prevention and control of COVID-19 and MDR, although already known and implemented in hospitals, the knowledge about how much the first increases the risk of the second (or the association between both conditions) is still incipient. Therefore, the importance of studies that focus on the discussion of the subject is fundamental. The technical and scientific mastery of Nursing is necessary to assist patients with COVID-19 and identify the profile of higher or lower risk for the development of MDR. The relevance of this study is in assessing the frequency of MDR among patients admitted with COVID-19 and filling the existing gap in the literature on Nursing care and identification of predisposing factors associated with MDR colonization. The results of this study will be useful in the implementation of preventive actions during the care performed by professionals so that the development of MDR is not a complication resulting from the hospitalization of patients with COVID-19.

**OBJECTIVE**

To estimate the incidence, and factors associated with the presence of MDR and compare care related to the Nursing diagnosis ‘Risk of infection’ between adult patients with and without MDR hospitalized for COVID-19.

**METHOD**
This is a retrospective cohort conducted at a large, tertiary-level, university hospital that has been a reference for the care of patients with COVID-19 since the beginning of the pandemic.

The institution, located in southern Brazil, in the municipality of Porto Alegre (RS), has 836 beds and structures for the diagnosis and treatment of various pathologies in 60 specialties, with 6,719 employees. The data refer to patients admitted by COVID-19 between 03/21/2020 and 09/21/2020 and were collected and reviewed between May and August 2022.

Data were collected from adults (age >18 years) admitted between 3/21/2020 and 9/21/2020 for COVID-19, with the exception of those who had been hospitalized for more than 48 hours at another healthcare facility and were transferred to the study facility, or who had a diagnosis of MDR on admission, or who required precautionary measures for colonization prior to the current admission.

In 2022, the authors requested a query (report) from the institution's Information Technology Management Coordinator (CGTIC), who provided the data in spreadsheet format, according to the following search filters: reason, admission, COVID-19, patient chart number, MDR notification, Nursing Diagnosis (ND) Risk of infection, nursing care prescribed, admission date between 03/21/2020 and 09/21/2020.

Subsequently, each patient's medical record was reviewed. Respecting the eligibility criteria, the subject was included and, subsequently, the information collected from his or her electronic medical record through the Hospital Management Application (AGHUse).

Patient information was collected using a form completed directly on Google Forms, containing demographic variables (gender and age), clinical variables [Charlson Comorbidity Index, calculates the risk of death from clinical history, consisting of 19 comorbidity categories, each with a weight from one to six points (ranking in four categories: zero no comorbidity; 1-2 mild comorbidity; 3-4 moderate comorbidity; ≥5 severe comorbidity), obesity, hypertension, Diabetes Mellitus, length of stay, length of ICU stay, use and length of invasive mechanical ventilation], MDR-related variables (identified germ and site), type of isolation, and the Nursing care prescribed.

The Nursing care, collected through the query, that was of interest to the study are those prescribed according to the risk factor 'Increased environmental exposure to pathogens', of the ED 'Risk of Infection', of the subgroup 'Physical safety/Environment'. It was considered appropriate for each patient to be prescribed the aforementioned care during the entire period of hospitalization, from admission to discharge.

A sample size of 313 subjects was calculated to estimate the proportion of the outcome occurrence (MDR incidence), with a 20% confidence interval (CI) range (with the addition of 10% for possible losses and for refusals this number should be 323). The calculation (using Wald's method) considered the 95% confidence level and 13% expected percentage for MDR incidence (referred to by Marcolino et al., 2021)\(^2\). This calculation was performed using the online version of the PSS Health tool (PSS Health).

Data normality was assessed using the Shapiro-Wilk test. Continuous variables were described as mean and standard deviation, when normal distribution, or median and interquartile range for asymmetric distribution. Categorical variables were expressed as absolute numbers and percentages. According to data distribution, continuous variables...
(presented as mean and standard deviation, or median and interquartile range) were compared using Student's t-test or Mann-Whitney test, and categorical variables (presented as absolute number and percentages) were compared using Pearson's chi-square or Fischer's exact test. A p-value of less than 0.05 was considered statistically significant.

For multivariate analysis, Cox Regression with robust variance was employed, considering 95% CI (95% CI) and 5% significance level (p≤0.05). Incidence was described as a proportion obtained from the formula: number of new MDR cases / total number of patients without MDR x 100 during the study period.

The study was approved as to its ethical and methodological aspects by the Ethics and Research Committee (CEP) of the institution (opinion CAEE no. 57234822.5.0000.5327).

RESULTS

The database for the selected period resulted in a total of 411 patients. A number of 28 were excluded because they were transferred from other hospitals with more than 48 hours of hospitalization and 12 because they did not have a confirmatory test for COVID-19. Therefore, 371 patients were included in this analysis (Figure 1).

![Figure 1. Study flowchart. Porto Alegre, RS, Brazil, 2022.](image)

The mean age of the patients was 57.06 ± 14.3 years, and males represented 51.2% of the sample. Other demographic and clinical characteristics of all patients included are described in Table 1.

The incidence of MDR was 10.5%. The mean time to outcome (MDR) was 19.1± 2.9 days. Among the 39 patients who had MDR, 35 (89.7%) patients became infected during their ICU stay. The remaining cases occurred in the clinical inpatient unit after discharge from the ICU.

MDR patients had more comorbidities (p=0.008) and were classified as high comorbidity (p=0.045) according to the Charlson severity score. Also, patients with MDR stayed longer in
the hospital [27 days (IQ: 21-48) vs 8 days (IQ: 4-16); p<0.001]. All MDR patients had ICU admissions and stayed longer under intensive care (median: 25 vs nine days; [p<0.001]). The proportion of patients requiring invasive mechanical ventilation (p<0.001) and the time under mechanical ventilation (p=0.003) was also higher among MDR patients. The in-hospital mortality of patients with MDR was higher than that of patients who did not have MDR (59% versus 15.4%; p<0.001) [Table 1].

Table 1 - Demographic and clinical profile of the total of patients and comparison between the group of patients with and without MDR. Porto Alegre, RS, Brazil, 2022.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total (n=371)</th>
<th>With MDR (n=39)</th>
<th>Without MDR (n=332)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male sex§</td>
<td>190 (51.2)</td>
<td>19 (48.7)</td>
<td>171 (51.5)</td>
<td>0.74#</td>
</tr>
<tr>
<td>Age£ (anos)</td>
<td>57.06 ± 14.3</td>
<td>56.9 ± 13.6</td>
<td>57.08 ± 14.4</td>
<td>0.94##</td>
</tr>
<tr>
<td>Charlson scoreπ</td>
<td>0 (0 -1)</td>
<td>1 (0 -2)</td>
<td>0 (0 – 1)</td>
<td>0.008*</td>
</tr>
<tr>
<td>Charlson Classification</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No comorbidity§</td>
<td>300 (80.9)</td>
<td>29 (74.4)</td>
<td>271 (81.6)</td>
<td></td>
</tr>
<tr>
<td>Slight comorbidity§</td>
<td>27 (7.3)</td>
<td>1 (2.6)</td>
<td>26 (7.8)</td>
<td></td>
</tr>
<tr>
<td>Moderate comorbidity§</td>
<td>20 (5.4)</td>
<td>2 (5.1)</td>
<td>23 (7.0)</td>
<td></td>
</tr>
<tr>
<td>Severe comorbidity§</td>
<td>24 (6.4)</td>
<td>7 (17.9)</td>
<td>12 (3.6)</td>
<td></td>
</tr>
<tr>
<td>Obesity§</td>
<td>79 (21.3)</td>
<td>13 (33.3)</td>
<td>66 (19.9)</td>
<td>0.052*</td>
</tr>
<tr>
<td>Systemic arterial hypertension§</td>
<td>170 (45.8)</td>
<td>21 (53.8)</td>
<td>149 (44.9)</td>
<td>0.28#</td>
</tr>
<tr>
<td>Diabetes Mellitus§</td>
<td>201 (54.2)</td>
<td>17 (43.6)</td>
<td>157 (47.3)</td>
<td>0.31#</td>
</tr>
<tr>
<td>Length of hospital stayπ (days)</td>
<td>9 (5-20)</td>
<td>27 (21-48)</td>
<td>8 (4-16)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Length of stay in ICUπ (days)</td>
<td>172 (46.4)</td>
<td>39 (100)</td>
<td>133 (40.1)</td>
<td>&lt;0.001#</td>
</tr>
<tr>
<td>Length of stay in ICUπ (days)</td>
<td>13 (6 – 25)</td>
<td>25 (14-38)</td>
<td>9 (5-21)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Use of mechanical ventilation§</td>
<td>136 (36.7)</td>
<td>38 (97.4)</td>
<td>98 (29.5)</td>
<td>&lt;0.001#</td>
</tr>
<tr>
<td>Time on mechanical ventilationπ (days)</td>
<td>14 (8-25)</td>
<td>24 (13-35.8)</td>
<td>12,5 (6-21.3)</td>
<td>0.003*</td>
</tr>
<tr>
<td>Death§</td>
<td>74 (19.9)</td>
<td>23 (59)</td>
<td>51 (15.4)</td>
<td>&lt;0.001#</td>
</tr>
</tbody>
</table>

MDR=Multidrug-Resistant Organism; ICU=Intensive Care Unit.
§Values expressed as absolute numbers and percentages.
£Values expressed as mean±standard deviation. πValues expressed as median and interquartile range.
#Pearson's chi-square test, ##Student's t-test, &Fischer's exact test, *Mann-Whitney test.

Multivariate analysis, adjusted for age and comorbidities on the Charlson Score, showed that ICU admission and MV use were independent risk factors for MDR (Table 2).
Table 2 - Multivariate analysis for factors associated with the occurrence of multidrug-resistant microorganisms. Porto Alegre, RS, Brazil, 2022.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Gross HR</th>
<th>Adjusted HR</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of invasive mechanical ventilation</td>
<td>9.78 (2.3-41.5)</td>
<td>2.4 (1.5-39.9)</td>
<td>0.002*</td>
</tr>
<tr>
<td>ICU admission</td>
<td>12.1 (1.6-19.5)</td>
<td>14.0 (1.8-18.6)</td>
<td>0.015*</td>
</tr>
</tbody>
</table>

HR=Hazard Ratio. * Cox Regression

As for the types of MDR, 48.7% of patients were infected by carbapenem-resistant *Acinetobacter baumannii*, followed by *Klebsiella pneumoniae* (15.4%), coagulase-negative *Staphylococcus* (15.4%), *Pseudomonas aeruginosa* (7.6%), among others (Figure 2). The main means of obtaining samples for MDR culture was sputum (n=26; 66.7%), followed by blood culture (n=9; 24.2%), anal swab (n=2; 5.1%), and urine (n=2; 5.1%).

![Figure 2](image)

Figure 2 - Types of multidrug-resistant microorganisms. Porto Alegre, RS, Brazil, 2022.

Of the total patients evaluated, 93.3% (n=346) had Nursing care prescribed, at any time of hospitalization, related to the ND Risk of infection. Among patients with MDR, 15.4% (n=6) had no care prescribed and among patients without MDR, 5.7% (n=19) had no care related to risk of infection (p<0.001). Nursing care ‘implement contact precaution measures’, implement aerosol and droplet precautions measures, were prescribed in higher proportion to patients without MDR (p<0.001). While the care ‘observe signs of infection’ was more prescribed to patients with MDR (12%) versus patients without MDR (1.9%) (p=0.002) [Table 3].

Table 3 - Nursing care prescribed and comparison between the group of patients with and without multidrug-resistant microorganisms. Porto Alegre, RS, Brazil, 2022.

<table>
<thead>
<tr>
<th>Nursing Care</th>
<th>Total (n=346)</th>
<th>With MDR (n=33)</th>
<th>Without MDR (n=313)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apply standard disinfectant to equipment and surfaces</td>
<td>208 (60.1)</td>
<td>21 (63.6)</td>
<td>187 (59.7)</td>
<td>0.76*</td>
</tr>
<tr>
<td>Implement contact precaution measures</td>
<td>167 (48.2)</td>
<td>8 (24.2)</td>
<td>159 (50.8)</td>
<td>0.001*</td>
</tr>
<tr>
<td>Implement aerosol precautions</td>
<td>136 (39.3)</td>
<td>4 (12.1)</td>
<td>132 (42.1)</td>
<td>&lt;0.001*</td>
</tr>
</tbody>
</table>
Implement precautions for droplets\textsuperscript{a}  
<table>
<thead>
<tr>
<th></th>
<th>131 (37.8)</th>
<th>4 (12.1)</th>
<th>127 (40.6)</th>
<th>0.001$^{#}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restrict visits\textsuperscript{b}</td>
<td>41 (11.8)</td>
<td>1 (3.0)</td>
<td>40 (12.8)</td>
<td>0.07$^{#}$</td>
</tr>
</tbody>
</table>

Perform infection prevention care as directed by ICCH\textsuperscript{c}  
<table>
<thead>
<tr>
<th></th>
<th>18 (5.2)</th>
<th>2 (6.0)</th>
<th>16 (5.1)</th>
<th>0.93$^{#}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observe for signs of infection\textsuperscript{d}</td>
<td>10 (2.9)</td>
<td>4 (12.1)</td>
<td>6 (1.9)</td>
<td>0.002$^{#}$</td>
</tr>
<tr>
<td>No care prescribed\textsuperscript{e}</td>
<td>25 (7.2)</td>
<td>6 (15.4)</td>
<td>19 (5.7)</td>
<td>0.001$^{#}$</td>
</tr>
</tbody>
</table>

\textsuperscript{a}Values expressed as absolute number and percentage.  
\textsuperscript{b}Pearson's chi-square test.  
\textsuperscript{c}Committee for Hospital Infection Control.  
\textsuperscript{d}This study identified a 10.5% incidence of MDR among the selected sample of patients with COVID-19. As described by Andrade et al. (2006), in a retrospective study of critically ill patients, the prevalence of resistant bacteria was 12.98%, similar to this one, but in a period before the pandemic.\textsuperscript{13} The recent study by Marcolino et al. (2021), although it evaluated patients with COVID-19, had different objectives than this research. This was a prospective cohort that evaluated hospital infection as one of the secondary outcomes among 2,054 patients hospitalized for COVID-19 from 25 Brazilian hospitals. Thus, the hospital infection rate observed was 13.1%.\textsuperscript{12}  

Patients in this study who developed MDR had more comorbidities according to the Charlson score, 24% of patients had severe comorbidity, of which 33% were obese and more than 50% hypertensive. In the study by Andrade et al. (2006), obesity was not reported and chronic diseases, hypertension, and diabetes mellitus were identified in a lower percentage, 16.6%, and 9.5%, respectively.\textsuperscript{13}  

It is observed that patients with MDR had a longer length of stay (27 vs eight days) and longer ICU stay (25 vs nine days) than patients without MDR. There are no recent studies with similar findings, the most similar to this one, was a prevalence study conducted in Germany among patients without COVID-19. These authors identified that the factors associated with the occurrence of MDR, among 1,718 people from 629 hospitals, were: male gender, antibiotic use, and tumor.\textsuperscript{14}  

The \textit{Acinetobacter baumannii} Complex bacteria stood out as it was the most frequent among the patients evaluated in the study period. According to Martín et al. (2018), this bacterium is one of the most prevalent causes of hospital infections. The increasing resistance of \textit{Acinetobacter baumannii} to primary antimicrobial therapies has created a deadly combination of pathogenicity and antimicrobial resistance that harms hospitals.\textsuperscript{15} \textit{Acinetobacter baumannii} is a frequent cause of so-called HAIs. During the COVID-19 pandemic, caused by the SARS-CoV-2 virus, co-infections and increased bacterial resistance to antibiotics were observed.\textsuperscript{16}  

During the period of this research, among the 39 patients who underwent bacteriological tests, the main collection site was the airway with sputum samples. In a study conducted in the ICU, among the 98 patients included with MDR, the main collection site was blood culture and tracheal aspirate, however, it was not detected in any clinical sample the genus of the bacterial species \textit{Acinetobacter}.\textsuperscript{13}
It is noteworthy that the main form of transmission of microorganisms, including *Acinetobacter sp.*, is by the hands of health professionals who are colonized by direct contact with patients or contaminated material. The contamination of environmental surfaces is an important reservoir of carbapenem-resistant *Acinetobacter sp.* Thus, the implementation of Standard Precautions (SP) is the first strategy for the prevention of cross-infection. Among the measures for SP it stands out in this study that the care of articles, clothes, equipment, and surfaces, was the measure most frequently prescribed by nurses since the total sample was of patients with COVID-19. This measure is in accordance with the guidelines for the transmission prevention of aerosol-borne infections.

The contamination of environmental surfaces is an important reservoir of carbapenem-resistant *Acinetobacter sp.* Thus, the implementation of Standard Precautions (SP) is the first strategy for the prevention of cross-infection. Among the measures for SP it stands out in this study that the care of articles, clothes, equipment, and surfaces, was the measure most frequently prescribed by nurses since the total sample was of patients with COVID-19. This measure is in accordance with the guidelines for the transmission prevention of aerosol-borne infections.

The care 'apply standard disinfectant on equipment and surfaces' related to the ND 'Risk of Infection' reflects the Nursing team's concern in preventing IRAS. The implementation of the care bundle, described by Yazici and Bulut (2018) was shown to be effective in reducing infections associated with invasive devices. A study conducted in an ICU in Bahia analyzed how equipment contamination occurs before and after the cleaning/disinfection routine. The microorganisms found in the equipment, after the use of cleaning/disinfection procedures, are presented in smaller quantities with the identification of the place of its installation and the professionals who handled it.

A study also carried out in an ICU, emphasized the importance of contact precaution measures to be taken by health professionals, as fundamental in order to avoid cross-infection in hospitalized patients. Despite the importance, Cunha et al. (2020), found that health professionals partially use contact precaution measures. In this study, the implementation of contact precaution measures also seems to have been partially adopted, since this care was prescribed for less than half of the patients. Therefore, basic measures, such as correct hand hygiene, and the use of gloves and aprons, are not always applied.

The other means of germ transmission is the dissemination of particles by aerosols, capable of remaining suspended in the air, traveling several meters and remaining for hours, being eliminated during breathing, speaking, coughing, or sneezing. Thus, the contamination of COVID-19 occurs through the transmission of these particles through the airways, and depending on the host and environmental factors can result in serious infections. For prevention, the measures associated with standard precautions, the use of an apron, goggles, N-95 mask, and a private room are necessary.

In this sense, the low frequency observed in this study of the nursing care prescription to implement the precautionary measures for aerosols and droplets - is noteworthy, since all patients had COVID-19. An integrative review study mentioned that nurses' actions are important for preventing the transmission of multidrug-resistant microbial infections and encourage professionals' adherence to standard precautionary measures, droplet and aerosol precautions. The authors reinforce the importance of evaluating the action taken and providing opportunities for reflection, and critical discussions on the subject in this context.

The limitation of this study is that it did not consider the population of ICU patients without the MDR outcome, making it impossible to make comparisons of factors existing in the intensive care setting; however, it is pondered that we performed multivariate analysis to minimize this bias. Furthermore, there are no studies in the literature that have compared patients with COVID-19 for the MDR outcome. Another weakness that can be mentioned was the fact that
we did not collect the proportion of new nursing professionals hired in the institution during the pandemic period due to the increase in ICU beds contracted at the time. Even with the limitations pointed out above, this is the first study that assessed the occurrence of MDR in a sample of patients with COVID-19.

The knowledge produced in this study for the Nursing field may contribute to the strengthening of the importance of implementing infection prevention and control measures in the hospital environment. In line with what is recommended by the WHO in order to prevent IRAS and ensure patient safety.

**CONCLUSION**

Analysis of patients with COVID-19 identified that about one-tenth (10.5%) of patients developed MDR, i.e. there was an important incidence rate of MDR during the first six months of the pandemic in 2020. The associated factors for MDR were: greater clinical severity, need for intensive care, and greater susceptibility to invasive procedures such as mechanical ventilation. The profile of patients with MDR during the pandemic, as well as the frequency of the different Nursing care prescribed, raise tools for the continuous improvement of Nursing care in the hospital setting.

**CONTRIBUTIONS**

The authors contributed equally to the research design, data collection, analysis, and discussion, as well as to the writing and critical review of the content, with intellectual input, and approval of the final version of the study.

**CONFLICTING INTERESTS**

The authors declare that they have no conflict of interest related to the article.

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