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Complications in patients with severe COVID-19 infection who required admission to an intensive care unit in a fourth-level hospital in Bogotá, Colombia

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Abstract

Objective: To analyze the complications experienced by patients admitted to the ICU with severe COVID-19 at a fourth-level hospital in Bogotá, Colombia.
Materials and Methods: This retrospective, descriptive, cross-sectional study included 181 patients aged over 18 years with severe COVID-19 admitted to the ICU at Fundación Cardioinfantil from August 2020 to May 2021.
Results: Infections were the most prevalent complication, occurring in 72.9% of patients, with pulmonary superinfections and tracheitis being the most common. Neuropathy was observed in 18.7% of patients. Swallowing disorders were noted in 74% of patients, with 52.5% continuing to experience swallowing difficulties at discharge, leading to gastrostomy in 4.9%. Acute kidney injury was present in 26.5% of patients; 7.1% required de novo renal replacement therapy, and 2.8% needed renal replacement therapy at discharge. Myocardial injury was documented in 13.8% of patients.
Discussion: The study highlights the extensive range of complications affecting post-COVID-19 patients, particularly those with severe infections. Polyneuropathy and myopathy are reported in 25-45% of critically ill patients, whereas our study documented neuropathy in 18.7%. Swallowing disorders, occurring in 74% of patients, led to a gastrostomy rate of 4.9%, slightly above the literature range of 1.9%-4.8%. Tracheostomy, used as an alternative to reduce sedation and mechanical ventilation time, was performed in 21.5% of patients, resulting in reduced ICU and ward stays.
Conclusions: The most frequent ICU complications were healthcare-associated infections, underscoring the importance of early detection and preventive strategies. Neuromuscular sequelae, such as neuropathy, are significant factors affecting patient outcomes, highlighting the need for targeted rehabilitation methods.

Keywords: Post-Acute COVID-19 Syndrome, COVID Long-Haul, COVID-19 Syndrome, Post-Acute, Post Acute COVID 19 Syndrome, Post-Acute Sequelae of SARS-CoV-2 Infection, Post-COVID Condition, Post-COVID Conditions.

Complicaciones en pacientes con infección por COVID 19 severo en unidad de cuidados intensivo en un centro de cuarto nivel en Bogotá, Colombia

Resumen

Objetivo: Analizar las complicaciones experimentadas por pacientes admitidos en la UCI con COVID-19 severo en un hospital de cuarto nivel en Bogotá, Colombia.
Materiales y Métodos: Este estudio retrospectivo, descriptivo y transversal incluyó a 181 pacientes mayores de 18 años con COVID-19 severo admitidos en la UCI de la Fundación Cardioinfantil desde agosto de 2020 hasta mayo de 2021.
Resultados: Las infecciones fueron la complicación más prevalente, ocurriendo en el 72.9% de los pacientes, siendo las sobreinfecciones pulmonares y la traqueítis las más comunes. Se observó neuropatía en el 18.7% de los pacientes. Los trastornos de deglución se registraron en el 74% de los pacientes, con el 52.5% continuando con dificultades de deglución al alta, lo que llevó a una gastrostomía en el 4.9%. La lesión renal aguda estuvo presente en el 26.5% de los pacientes; el 7.1% requirió terapia de reemplazo renal de novo, y el 2.8% necesitó terapia de reemplazo renal al alta. La lesión miocárdica se documentó en el 13.8% de los pacientes.
Discusión: Este estudio resalta la amplia gama de complicaciones que afectan a los pacientes post-COVID-19, particularmente aquellos con infecciones severas. La polineuropatía y la miopatía se reportan en el 25-45% de los pacientes críticamente enfermos, mientras que nuestro estudio documentó neuropatía en el 18.7%. Los trastornos de deglución, presentes en el 74% de nustros pacientes, llevaron a una tasa de gastrostomía del 4.9%, ligeramente superior al rango de 1.9%-4.8% reportado en la literatura. La traqueostomía, utilizada como alternativa para reducir el tiempo de sedación y ventilación mecánica, se realizó en el 21.5% de los pacientes, resultando en una reducción de la estancia en la UCI y en la sala de hospitalización.
Conclusiones: Las complicaciones más frecuentes en la UCI fueron las infecciones asociadas con la atención sanitaria, subrayando la importancia de la detección temprana y las estrategias preventivas. Las secuelas neuromusculares, como la neuropatía, son factores significativos que afectan los resultados de los pacientes, destacando la necesidad de métodos de rehabilitación específicos.

Palabras clave: síndrome post COVID agudo, secuelas post-agudas de la infección por SARS-CoV-2, condición post-COVID, condiciones post-COVID, COVID-19.

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Introduction

Patients with long stays in the intensive care unit (ICU) and multiple intrahospital complications may develop post-intensive care syndrome, which comprises a series of multisystem alterations, highlighting pulmonary, cardiovascular and renal involvement, with the need for prolonged hospitalizations and advanced support such as invasive mechanical ventilation, inotropic and vasopressor medications, and pronation cycles for the management of acute respiratory distress syndrome (ARDS). Additionally, post- COVID complications such as nosocomial infections, both by usual and resistant germs, neurological, metabolic, and psychiatric complications may occur. In the context of patients with physical deconditioning who may require ventilatory support due to tracheostomy and nutrition due to gastrostomy given the presence of swallowing disorders can lead not only to problems in the personal and family environment but also in public health, for example, in Colombia by December of 2020 de occupation of ICU beds increased from 54,85% to 61,22 in twelve days, it was declared red alert in Bogotá (less than 30% disponibility), and the quantity of ICU bed was increased in a 17%, some institutions reported occupation above 90%, and some of them announced drug shortage and health workers fatigue[1-3]. The aim of this study was to analyze the complications presented by patients who were admitted to the ICU due to COVID-19 in a fourth-level hospital in the city of Bogotá seeking to stablish the most common and important consequences for patients and challenges faced by heath workers in order to be prepare in case there is a new pandemic.

Materials and Methods

Study characteristics

This was a retrospective, descriptive, cross-sectional study that included patients with severe COVID-19 admitted to the ICU of Fundación Cardioinfantil-Instituto de Cardiología, a fourth-level hospital in Bogotá, Colombia.

Study population

Data were obtained from patients hospitalized at Fundación Cardioinfantil-Instituto de Cardiología who were older than 18 years with a diagnosis of COVID-19 (SARS-CoV-2 positive PCR) and severity criteria that required admission to the ICU in the period from August 2020 to May 2021. Patients were identified through an internal hospitalization census of the ICU, where patients were transferred due to a diagnosis of SARS- CoV-2 infection; this information was verified individually through institutional medical records.

Severe neumonia was determine using IDSA/ATS items, all patients had severe oxygenation desorder in blood arterial gases needing either orotracheal intubation or non invasive mechanical ventilation; also multilobar neumonia.

The criteria to define severe pneumonia was clinical assessed by the medical team of the institution, there were a combination of factors individualized for each patient. All patients had an arterial gas test assessment, and all of them had severe oxygenation disorder defined by parameters as Kirby ratio less than 250, respiratory acidosis and hyperlactatemia were also variables to determine severity, SOFA score was also used. Chest x-ray findings such as multilobar pneumonia, requirements of orotracheal intubation or non-invasive mechanical ventilation, and the need of vasopressor support were considered criteria for ICU admission due to severe pneumonia.

The following data were collected: demographic characteristics (age and sex), BMI (body 39 mass index), days of stay in the ICU and in the general ward, supplemental oxygen requirement, supplemental oxygen system, invasive mechanical ventilation requirement, additionally pathological history (cirrhosis, human immunodeficiency virus (HIV), arterial hypertension (AH), solid and hematological neoplasms, chronic kidney disease (CKD), hemodialysis, peritoneal dialysis, heart failure, coronary disease, chronic obstructive pulmonary disease (COPD), asthma, cerebrovascular disease (CVD), transplantation, immunosuppression, autoimmune disease and other comorbidities), use of angiotensin converting enzyme inhibitors (ACE inhibitors)/angiotensin 2 receptor agonists (ARB-II), clinical characteristics such as vasopressor use, septic shock, use of antibiotics divided into low spectrum (ampicillin sulbactam + clarithromycin, piperacillin tazobactam, or cefepime) and broad spectrum (carbapenems, ceftazidime avibactam, amikacin, vancomycin, and linezolid), use of antifungals (azoles and echinocandins), presence of bacterial or fungal superinfection (with focus specified, i.e., lung, abdomen, skin and soft tissues,associated with catheter, genitourinary, neurological or tracheitis complications), and use of neuromuscular blocking drugs (cisatracurium or rocuronium). Complications were neuropathy, Barthel discharge from the ICU and general ward, presence and severity of swallowing disorders (mild, moderate, or severe; admission compared with discharge), gastrostomy, tracheostomy, skin lesions, acute kidney injury, and de novo renal replacement therapy. Complication upon discharge were nosocomial infections, myocardial injury, antipsychotic dependence, discharge with medications (antipsychotics, benzodiazepines, opiates, and anticonvulsants), steroid-induced dysglycemia, intrahospital falls, gastrointestinal bleeding, deep venous thrombotic phenomenon (PTE or DVT), death upon discharge from the ICU (days until death after ICU stay) and readmission to the ICU.

Statistical analysis

Continuous variables are presented as medians, with respective ranges or means and standard deviations. Categorical variables are presented as n (%); the percentage of missing data is indicated, if applicable.

Results

Data were collected for patients who required admission to the ICU at Fundación Cardioinfantil-Instituto de Cardiología due to COVID-19 and who were subsequently discharged to the regular ward at the same institution; 181 patients who met these criteria were identified. The demographic and clinical characteristics of these patients are summarized in Table 1. In the study population, 70.2% were men, and 29.8% were women, between 20-100 years of age (median, 61 years). Patient BMI ranged from 18.1 to 74.1 (average, 27.7).

Table 1. Patients characteristics **(N=181)**

Age	**61.0 [20.0, 101]**	
20-39	25 (13.81%)	
40-59	62 (34.25%)	
60-79	85 (46.96%)	
> 80	8 (4.42%)	
Missing	1 (0.55%)	
Sex		
Female	29.83%	
Male	70.17%	
BMI	**27.7 [18.1, 74.1]**	
Normal	50 (27.62%)	
Overweight	72 (39.78%)	
Obese I	39 (21.55%)	
Obese II	15 (8.29%)	
Obese III	5 (2.76%)	
Days of stay in ICU	**10.0 [1.00, 51.0]**	
Days of stay in ward	**8.00 [1.00, 51.0]**	
	No	**Yes**
Cirrhosis	97.79%	2.21%
HIV	98.90%	1.10%
HT	55.80%	44.20%
ACEI or ARA II	61.88%	38.12%
Neoplasia	94.48%	5.52%
Chronic kidney disease	93.37%	6.63%
Kidney replacement therapy hemodialysis	98.90%	1.10%
Renal replacement therapy peritoneal dialysis	98.90%	1.10%
Diabetes mellitus	80.66%	18.78%
Heart failure	95.58%	4.42%
COPD	95.58%	4.42%
Asthma	98.34%	1.66%
Stroke	97.79%	2.21%
Transplant	97.79%	2.21%
Immunosuppression	93.92%	6.08%
Autoimmune disease	95.03%	4.97%

The average stay in the ICU was 10 days, and the subsequent stay in the ward was 8.0 days.

Among the 181 patients only 28% (51 patients) did not have comorbidities, the remaining 72% had at least one comorbidity (8.2%), but more frequently they presented more than one (63.8%). The most common reported comorbidities (overlapping some of them) were hypertension (44.2%), diabetes mellitus (19.4%), chronic kidney disease (6.6%), immunosuppression (6.1%), neoplasia (5.5%), autoimmune disease (5%), heart failure (4.4%), coronary artery disease (4.4%), COPD (4.4%), CVA (2.2), transplantation (2.2%), and asthma (1.6%).

Table 2 lists the support measures the patients received (oxygen, invasive ventilation, septic shock support, antibiotics, antifungals, and relaxants). In this cohort, 64.6% of the 84 patients received invasive mechanical ventilation, 47.3% required vasopressor support, and 34.1% of the patients had septic shock.

A total of 89.1% of the patients received a low-spectrum antibiotic (defined as ampicillin sulbactam + clarithromycin, piperacillin tazobactam or cefepime). In contrast, 30.9% needed a broad spectrum antibiotic (defined as carbapenem, ceftazidime, avibactam, amikacin, vancomycin or linezolid) as second line treatment after low-spectrum antibiotic therapy.

Only 7.7% received antifungal treatment, with 3.9 % receiving azoles. Among the patients, 52.2% were administered relaxants, primarily cisatracurium

Infections were the most frequent complication (Table 3) and occurred in 72.9% of patients; pulmonary superinfections and tracheitis were the most common, followed by genitourinary infections (14.9%) and infections associated with catheters (6.1%).

Neuropathy occurred in 18.7% of the patients, with 100% of the diagnoses made by a physiatry specialist.

Swallowing disorder (Table 4) occurred in 74% of patients (mild, 41.44%; moderate,

27.6%; and severe, 4.97%), and swallowing disorder at hospital discharge occurred in 52.5% of patients (mild, 32%; moderate, 13.8%; and severe, 6.6%; no data, 3.3%). This led to a gastrostomy in 4.9% of the patients.

A total of 21.5% of patients required tracheostomy, and skin lesions were present in 31.5% of the patients (mild, 22%; and severe, 9.4%).

Acute kidney injury occurred in 26.5% of patients, 7.1% required de novo renal replacement therapy, and 2.8% required renal replacement therapy at discharge. Myocardial injury was documented in 13.8% of patients.

Table 2. Support measures (N=181)

	No	Yes	No data
Oxygen Support	2.76%	96.69%	0.55%
Nasal cannula	95.03%	4.42%	0.55%
Venturi	98.90%	0.55%	0.55%
No rebreathing mask	76.80%	22.65%	0.55%
High flow mask	95.03%	4.42%	0.55%
Invasive ventilation	34.81%	64.64%	0.55%
Vasopressor Support	52.49%	47.51%	-
Septic shock	65.75%	34.25%	-
Low spectrum antibiotic	10.50%	89.50%	-
Ampicillin sulbactam + clarithromycin	33.15%	66.85%	-
Piperacillin tazobactam	82.32%	17.68%	-
Cefepime	61.33%	38.67%	-
Broad spectrum antibiotic	67.96%	30.94%	1.10%
Carbapenemic	65.75%	33.70%	0.55%
Ceftazidime avibactam	91.71%	7.18%	1.10%
Amikacin	89.50%	9.39%	1.10%
Vancomycin	79.01%	19.89%	1.10%
Linezolid	90.61%	8.29%	1.10%
Antifungal	92.27%	7.73%	-
Azoles	96.13%	3.87%	-
Echinocandins	97.24%	2.76%	-
Amphotericin B	98.90%	1.10%	-
Relaxants	47.51%	52.49%	-
Cisatracurium	61.88%	38.12%	-

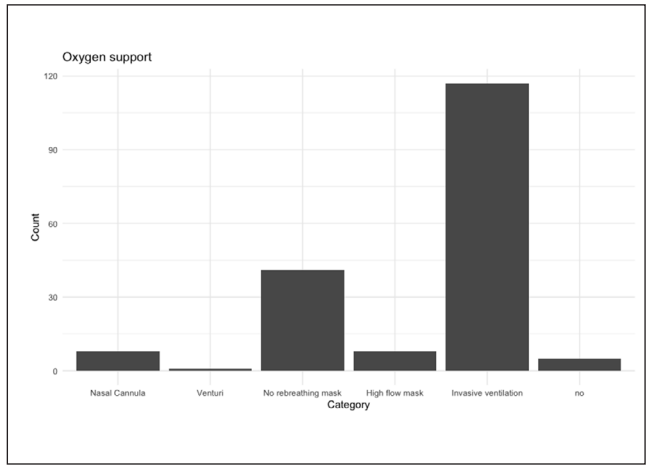

Figura 1.

A total of 13.8% of the patients developed dependence on antipsychotics, 12.2% had a need for antipsychotics at discharge, 7.7% had a need for benzodiazepines at discharge, 7.7% had a need for opiates at discharge, and 5.5% had a need for anticonvulsants at discharge. Among the patients, 14.9% had steroid-induced dysglycemia. Of the patients included, 0.6% had intrahospital falls; however, no data were found for 19.3% of patients. A total of 6.6% of the patients presented digestive bleeding, and a venous thrombotic phenomenon was documented in 37.6% (18.2% with pulmonary thromboembolism and 20.4% with deep vein thrombosis).

Death after discharge from the ICU occurred in 5.0% of the patients, with a median of 20 days after admission to the ICU, and 7.7% of the patients were readmitted to the ICU.

Discussion

There are a large number of complications that affect post-COVID-19 patients, especially those who present severe infection and who require treatment in an ICU. Post-intensive care syndrome includes symptoms such as dyspnea, pain, sexual dysfunction, compromised lung function and decreased exercise tolerance; however, the most frequently encountered complications are neuromuscular, resulting in poor mobility, frequent falls and quadriparesis. Polyneuropathy and myopathy have been documented in 25 to 45% of critically ill patients during and after their stay in the ICU with mechanical ventilation, showing more severe neurodegenerative complications, including symmetrical flaccid paralysis, respiratory and limb weakness, systemic inflammatory response syndrome and multiorgan dysfunction [1], which generate significant disabilities due to muscle weak-ness, delay physical rehabilitation and are related to subsequent complications such as prostration, pressure ulcers, nosocomial infections, etc. In our study, neuropathy was documented in 18.7% of the patients; this diagnosis was made in all cases though collaboration with the physical medicine and rehabilitation department. As one of the consequences of prolonged hospitalization and physical deconditioning that goes hand in hand with disease severity and the need for admission to an ICU, patients may present swallowing disorders or dysphagia, which sometimes involves the need for gastrostomy to meet the nutritional needs of patients and to avoid or treat malnutrition. The need for gastrostomy use varied from 1.9% to 4.8% at Massachusetts General Hospital between March and April 2020 [2]. In our study, swallowing disorder (Table 4) occurred in 74% of patients, being mild in 41.44%, moderate in 27.6% and severe in 4.97%, with swallowing disorder at hospital discharge also being reported (mild, 32%; moderate, 13.8%; and severe, 6.6%; no data, 3.3%); 4.9 % of the patients required gastrostomy, a figure that is slightly higher than that reported in the literature.

Patients with severe COVID-19 share many risk factors with ICU patients due to other pathologies, such as multiorgan failure, hyperglycemia related to the use of corticosteroids and metabolic alterations, prolonged use of muscle relaxants and parenteral nutrition, which are risk factors for

myopathy and neuropathy. An excess of cytokines leads to metabolic and electrical microvascular alterations, the production of oxygen free radicals, which lead to tissue hypoxia, and increased vascular permeability, explaining myopathy and neuropathy[3].

The chronic use of steroids both in the acute episode and later for the management of pulmonary fibrotic complications and pneumonia is notable; corticosteroids are related to osteonecrosis, osteoporosis and myopathy. All of the above hinder the rehabilitation of ICU patients and therefore foster greater dependence on a ventilator and the need to continue invasive support measures such as tracheostomies.

Table 3. Superinfection (N=181)

	No	Yes
Total	27.07%	72.93%
Lung	54.70%	45.30%
Abdomen	96.69%	3.31%
Bacteriemia	82.32%	17.68%
Skin and soft tissues	95.58%	4.42%
Associated with catheter	93.9%	6.1%
	No	**Yes**
Total	27.07%	72.93%
Lung	54.70%	45.30%
Abdomen	96.69%	3.31%
Bacteriemia	82.32%	17.68%
Genitourinary	85.08%	14.92%
Neurological	99.45%	0.55%
Tracheitis	69.06%	30.94%

Table 4. Swallowing disorder (N=181)

	No	Yes	No data
Swallowing disorder	24.86%	74.03%	1.10%
Mild	57.46%	41.44%	1.10%
Moderate	71.27%	27.62%	1.10%
Severe	93.93%	4.97%	1.10%
Swallowing disorder at discharge	44.20%	52.49%	3.31%
Mild	64.64%	32.04%	3.32%
Moderate	82.87%	13.81%	3.31%
Severe	90.06%	6.63%	3.31%
Gastrostomy	94.48%	4.97%	0.55%

Patients undergoing prolonged hospitalization and invasive ventilatory support (orotracheal intubation) in the ICU are at higher risk of developing complications. As such, tracheostomy has been suggested for these patients as an alternative to reduce the need for sedation time and mechanical ventilation[4]. The evidence for and against this approach is extensive. An estimated 4.2-52% of patients hospitalized in the ICU who require mechanical ventilation due to COVID-19 received tracheostomies[4]. A study conducted in Italy found that early tracheostomy was associated with an increased risk of death in critically ill patients with COVID-19. That study recommended postponing tracheostomy in critically ill patients with SOFA scores > 6 and D-dimer levels > 4, with tracheostomy considered after 2 weeks[3]. A meta-analysis conducted with fourteen studies that included 2371 tracheostomy patients found that early tracheostomy was associated with significant reductions in the duration of invasive mechanical ventilation and the length of stay in the ICU. Mortality was reported for 2343 patients and was comparable between the groups (OR 1.09, 95% CI 0.79–1.51, p = 0.59). The results of that meta-analysis suggest that early tracheostomy in critically ill COVID-19 patients is associated with better outcomes, except mortality[4]. In our study, 21.5% of the patients underwent a tracheostomy, and in the majority of these patients, the length of stay in the ICU and in the general ward was reduced. Mortality among patients with tracheostomy was 13.7%.

As previously mentioned, long hospital stays related to physical and neurological sequelae have another series of implications, such as nosocomial infections, including cathe-ter-associated infections and ventilator-associated pneumonia[5]. It is essential, especially in ICU patients, to carry out an exhaustive search for the microorganisms that cause infectious processes and to use diagnostic tools to quickly withdraw antibiotic treatments when not necessary and thus reduce the rates of in-hospital resistance. Infections in our patients were the most frequent complications (72.9%), with pulmonary infections and tracheitis being the most common, followed by genitourinary infections (14.9%) and infections associated with intravenous catheters (6.1%). Nevertheless, it is crucial to emphasize that, despite the high prevalence of infections among patients, mortality remained low due to the early initiation of antimicrobials and the narrowing of the spectrum based on culture results.

Intrahospital falls are a complication associated with patients with delirium and physical deconditioning, and they are associated with significant disability, decreased independ-ence, reduced quality of life, prolonged hospitalization and a significant increase in mor-tality, especially when fractures occur. In a study carried out in Madrid, in-hospital falls in patients hospitalized in the ICU for COVID-19 varied from 0.07% to 0.15%, with an inci-dence of falls per thousand days of stay

Table 5. Tracheostomy, skin injuries, acute kidney injury, myocardial injury

	No	Yes	No data
Tracheostomy	78.45%	21.55%	-
Skin Injuries	68.51%	31.49% (Grade 1)	-
Mild	77.90%	22.10%	-
Severe	90.61%	9.39%	-
Acute kidney injury	72.38%	26.52%	1.1%
De novo kidney replacement therapy	92.27%	7.18%	0.55%
Renal replacement therapy at discharge	96.13%	2.76%	1.10%
Myocardial injury	86.19%	13.81%	-

of up to 1.59%. There are factors that are significantly related to falls: the place of occurrence (patient room, 53.2%) and period studied ($p < 0.001$)[6]. In another study in which 3.5% of patients hospitalized for COVID-19 fell, more arrhythmias were documented in patients who fell than in patients who did not fall (28.6% vs. 1.7%, $p < 0.001$)[7]. In our study, 0.6% of patients had in-hospital falls; this result may be associated with a self-report culture in our institution by both the nursing staff and the medical staff.

The role of renal involvement as a marker of poorer prognosis in patients infected with SARS-CoV-2 has been widely documented[8–12]. The incidence of renal involvement during the hospital stay of patients with SARS CoV2 infection is approximately 11% (7.4-15.1%) and even higher in critically ill patients (23%); 6.8% (1.0-17.0) require renal re-placement therapy (RRT)[13]. The difference in incidence is related mainly to the presence of other factors such as patient characteristics, infection severity, and the difference in the definitions and management of this type of complication.

Nonspecific mechanisms for renal involvement have been detailed, mainly related to direct damage to the virus mediated by angiotensin-converting enzyme 2 receptors, an im-balance in the renin-angiotensin-aldosterone axis, proinflammatory cytokines, and microvascular thrombosis[14].

In our cohort of patients, the incidence of renal involvement was 26.5%, slightly higher than that presented by critically ill patients. The rate of patients requiring RRT was also very similar to the overall incidence. However, there are not abundant data that allow a comparison of how many of these patients continued to require RRT at discharge, which in this study was 2.8%; almost 10% presented the initial complication in the ICU. The disagreement between the incidences is possibly related, as already mentioned, to differences between the baseline comorbidities of patients as well as the degree of infection and the use of diverse protocols for the management of renal involvement[13].

Myocardial injury is defined as elevated levels of ultrasensitive troponins, and these elevated levels are also associated with a greater risk of severity and/or mortality [15]. The in-cidence of myocardial injury among patients with SARS-CoV-2 infection has been report-ed to be 16.3% [11.8-21.3], occurring more in older patients and those with baseline arterial hypertension[13]. The proposed mechanisms by which myocardial injury occurs are mainly based on direct cardiotoxicity due to the virus and systemic inflammation, with other additional mechanisms being an imbalance in myocardial supply-demand, plaque rupture and coronary thrombosis, pharmacological adverse effects and hydroelectrolytic disorders[16-18]. For our cohort, the incidence was higher than that reported globally, possibly because of the type of patients selected post ICU stay, in whom the mechanisms described as predisposing for this alteration could be more accentuated or aggregative in a greater proportion.

Table 6. Characteristics upon discharge from the ICU

	No	Yes	No data
Antipsychotic dependence	82.32%	17.68%	-
Discharge with an antipsychotic	87.85%	12.15%	-
Discharge with a benzodiazepine	92.3%	7.7%	-
Discharge with an opiate	92.27%	7.73%	-
Discharge with an anticonvulsant	94.48%	5.52%	-
Steroid dysglycemia	85.08%	14.92%	-
Intrahospital falls	80.11%	0.55%	19.34%
Digestive bleeding	92.27%	6.63%	0.55%
Venous thrombotic phenomenon	62.43%	37.57%	-
Pulmonary thromboembolism	81.77%	18.23%	-
Deep venous thrombosis	79.56%	20.44%	-
Number of ICU readmissions	92.3%	7.7%	-
Post ICU death	87.29%	4.97%	7.73%
		Median	**No data**
Days until Death Post ICU		20 [2-65]	14 7.7%
		Median (SD)	
Number of ICU readmissions		0.95 (0.363)	

Other important post-COVID complications are neuropsychiatric manifestations, which can be explained not only by stress related to hospitalization and ICU stays but also by direct involvement of the virus in the central nervous system and by the cytokine storm that can lead to long-term cognitive changes[3,19]. Such complications, including cognitive deterioration and delirium, have been reported in patients after ICU stays, with incidence rates varying between 30-80%, with various levels of severity [1]. Neuropsychiatric manifestations have been associated with factors that perpetuate these alterations, such as social isolation, insomnia and prolonged immobilization, leading to the use of antipsychotic and hypnotic medications for long periods, which can have adverse effects and drug interactions because such patient are often polymedicated. In our study, 12.2% of the patients required continued treatment with antipsychotics after hospital discharge, and 7.7% of the patients received an opioid prescription, a proportion similar to that (7.8%) described in a series of 855 patients hospitalized for COVID-19 published by Delaney et al.[20]. Regarding the ambulatory indications for benzodiazepines, 7.7% of the patients were prescribed this class of drug at discharge, greater than the 2.6% documented in a similar series [20]. Medications used for the management of delirium and insomnia are very prevalent as post-COVID manifestations.

Regarding the use of anticonvulsant drugs, 5.5% of the patients analyzed received a pre-scription for at least one drug of this class at the time of discharge. This is related to the prevalence of seizures in cohorts of patients with COVID-19, in some reports reaching up to 26% [21]. Likewise, an increase in the prevalence of the use of these drugs has previously been documented in patients with COVID-19 compared with the general population (5.0% vs. 3.6%)[22].

Steroid-induced dysglycemia, defined as sustained elevation of ≥140 mg/dl during dexamethasone treatment, was identified in 14.9% of the study population, a complication re-ported at a lower rate than in other scenarios where it has been described between 53–70% in patients without previous diagnosis of diabetes[23]. Considering the recommendation for the use of dexamethasone based on the results of the RECOVERY trial, multiple series have been published in which an increase has been documented both in the average levels of glycemia and in the requirement for higher doses of intrahospital insulin in patients hospitalized for COVID-19 who receive steroids compared to those who do not[24].

Regarding venous thromboembolic events (VTEs), 38.6% of the patients had at least one episode, among whom 18.2% had a pulmonary thromboembolism and 20.4% had a deep vein thrombosis of the lower limbs identified by imaging methods (chest angiography, lower limb Doppler ultrasound and lung ventilation/perfusion scintigraphy). These findings are similar to those reported in a previous meta-analysis (total of 1083 patients), i.e., thrombotic events in 43% (95% CI 0.29–0.65) of COVID-19 patients admitted to the ICU and 22% (95% CI 0.08–0.40) of the general population diagnosed with COVID-19[25].

These data contrast with the evidence obtained at the national level and in Latin America, where prevalence of thrombotic events of less than 5% have been reported for patients hospitalized for COVID-19[26].

Skin involvement in SARS-CoV-2 infection is usually grouped into 5 groups:
morbilliform rash, urticarial lesions, vesicular lesions, pernio erythema and vasoocclusive lesions[27]. It has even been suggested that the presentation of mucocutaneous lesions in COVID-19 is associated with the need for mechanical ventilation[28]. Although these injuries appear as disease manifestations, in hospitalized patients, specifically those with critical illness who require ICU management, the most frequent injuries are pressure injuries resulting from intense pressure and/or prolonged pressure or pressure combined with shear stress[29]. The reported incidence of this type of injury in critically ill COVID-19 patients is approximately 14.4%[15]. For our cohort of patients, the incidence of these injuries was higher, i.e., 31.5%, more than double that reported, and these injuries were strictly mild. These differences are related to factors specific to each case, such as the length of stay in the ICU, disease severity, alterations in oxygenation and hemodynamics, the use of vasopressors, incontinence, immobility, and nutritional status[30].

Another striking aspect that we found in the patients evaluated post-COVID was related to functional dependence, as measured using the Barthel index, with a greater compromise in functionality immediately after ICU stays, with severe dependence (average of 48 points). After the hospital stay, the patients presented moderate dependence (average Barthel score, 62 points). This has repercussions on the treatment and follow-up of patients because strict multidisciplinary follow-up is necessary as is a comprehensive rehabilitation plan that includes physical, occupational, respiratory, and speech therapy and physiatry, in addition to other clinical specialties to meet the needs of each patient. Comparisons with the literature are challenging because not all studies use the same Barthel scale; however, the neurological manifestations of post-COVID syndrome, including a substantial decrease in activities of daily living and an increase in neuromuscular issues due to weakness, among others, are well described[31]. In addition to myopathy and neuropathy, which are common in ICU patients, all of the above lead to moderate to severe decreases in functionality, which was found in this study.

In terms of mortality during 2021, the available data suggest a general fatality rate of 10% (95% CI: 8.0-11.0), with this for hospitalized patients slightly higher at 13% (95% CI: 9.0-17.0) and significantly higher for those patients who required

admission to ICUs, i.e., 37.0% (95% CI: 24.0-51.0)[32]. For our population and for our center, the mortality of hospitalized patients was 9.6%[33], which is slightly lower than the global trend. However, there are no extensive data on the mortality of patients discharged from the ICU who re-main hospitalized in the general ward.

In this study, the mortality rate was 5%, approximately half the reported mortality rate for hospitalized patients[33]. The median number of days to death was 20 days, and the mortality rates for the first 30 days (7.87%) and 90 days (7.62%) after hospital discharge[34] were lower than for patients who remained hospitalized; notably, these rates include patients with different degrees of severity, not only patients who required admission to the ICU.

In regards to limitations, this study includes both patients, before the administration of Dexamethasone and after its use established in the DISCOVERY study protocol. Patients who were referred to another hospital were not included in the study. During the pandemic, the hospital had 4 intensive care units with different medical groups, which could generate variability in management between each of them.

As conclusions, long hospital stays related to physical and neurological sequelae have serious health implications for patients and will subsequently determine the outcomes during their stay in the general ward. The pandemic caused by SARS-CoV-2 infection and its pulmonary involvement generated an expanded need for management and follow-up in the ICU, as well as longer ICU stays. As a consequence, there has been an increase in the risks associated with extended disease periods in infectious, organic and pharmacological terms; these factors are still being evaluated.

In this study, the most frequent complications of patients who required admission to the ICU were infections associated with health care, which occurred in 72.9% of patients, and of these, lung infections and tracheitis were the most common.

Neuromuscular sequelae such as neuropathy in critically ill patients, evidenced in 18.7% of our cohort, are factors that could be involved in the outcomes of these critically ill patients. This suggests the importance of rehabilitation methods focused on physical reconditioning.

Although in patients managed in this ICU the most frequent complications also tend to be infections, the rate on the COVID-19 patients is higher, possibly in relation to the longer stay as well as the neurological compromise described.

The aim of this article was to provide information on the characteristics of a fourth-level center in Bogotá, Colombia, and patients exposed to ICU management during the COVID-19 pandemic.

The findings of this study denote the importance of the early recognition of these infections during the surveillance of these patients. These also emphasizes the need to find and reinforce prevention strategies such as hand washing, the rational use of immunosuppressive drugs, antibiotics and support procedures (tracheostomy or gastrostomy), and the management of comorbidities that exacerbate immunosuppression states. Early rehabilitation, as soon as possible for the patient, could also be a factor of interest to avoid further neurological compromise and an even longer stay.

Ethical considerations

Protection of people and animals. Does not apply.

Protection of vulnerable population. Does not apply.

Confidentiality. The data were only accessible to the authors. The ethics committee from Fundacion Cardioinfantil approved the protocol DDI – 4576 – 2021 on 14 october 2021,

Privacy. Patient identifiable data were not used or disclosed in this study and were kept anonymous during the whole data analysis.

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Conflicts of Interest. The authors declare no conflict of interest

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