Custos do Cuidado Profissional para Pacientes com SRAG devido à COVID-19 em um Hospital Universitário Público do Distrito Federal: Uma Análise pelo Método Time-Driven Activity-Based Costing

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Professional Care Costs for Patients with SARI due to COVID-19 in a Public Teaching Hospital in Brazil's Federal District: A Time-Driven Activity-Based Costing Analysis

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Abstract

Objectives: This study analyzed the costs associated with healthcare professionals' care for patients with Severe Acute Respiratory Infections (SARI) due to COVID-19 at the Brasília University Hospital (HUB) during the Public Health Emergency (PHE). **Methods:** The Time-Driven Activity-Based Costing (TDABC) methodology was used to estimate costs based on the time and remuneration of shift-based and non-shift-based professionals, across wards and PHE phases. Sociodemographic and clinical data were extracted from electronic medical records, and a multivariate analysis was conducted to identify cost predictors. **Results:** The total cost of the 627 hospitalizations was R$10,391,881.31, with Phase 5 (July–December 2021) having the highest expenditures, accounting for over 50% of the total costs. The yellow ward (general ward) had the highest total costs (40.3%), followed by the red ward (intensive care unit with mechanical ventilation) and the orange ward (intensive care unit without mechanical ventilation). The median per-patient cost varied significantly between the wards. The red ward had the highest median cost (R$7,269.38; IQR R$2,849.77–15,310.70). Multivariate analysis identified age (0.6% cost increase per year), female (19% increase compared to males), patient origin (55.2% higher when referred from another hospital; 72.4% higher when transferred from another HUB sector), and length of stay (4.7–5.5% cost increase per additional day, depending on ward) as significant predictors of increased costs. **Conclusions:** This study reveals the complex and substantial costs associated with healthcare professionals' provision of hospital care for patients with COVID-19-related SARI during the PHE.
Keywords: COVID-19; economic analysis; hospital costs.

INTRODUCTION

The COVID-19 pandemic posed unprecedented challenges to health systems worldwide, revealing the need for rapid and well-organized responses to manage the health crisis (1). In Brazil, public health units within the Unified Health System (SUS) were primarily responsible for absorbing the increasing demand, particularly for severe cases requiring hospitalization and intensive care (1). In this context, tertiary SUS-affiliated teaching hospitals emerged as pivotal referral centers for managing patients with Severe Acute Respiratory Infections (SARI), playing a critical role in the pandemic response (2).

In Brazil's Federal District (DF), the COVID-19 public health emergency (PHE) pressured the private and public health systems. The public health network faced intense strain, serving both residents and patients coming from other states (3,4). The Brasília University Hospital (HUB) was one of the referral hospitals for severe COVID-19 cases (4). During the most critical periods, the HUB expanded its inpatient capacity, reorganized healthcare workflows, and mobilized teams to address the surge in SARI patients (3,4). These adaptations directly impacted operational costs, particularly those related to healthcare professionals essential for sustaining hospital care delivery.

Among the various components involved in hospital care, the cost associated with healthcare professionals' services emerged as one of the most significant. The workload, combined with the need for multidisciplinary teams working extended shifts, exacerbated the financial pressure on hospitals (5–7). In critical periods, especially during peak demand, healthcare services had to expand their teams and reallocate professionals, further escalating human resource costs (8–10). This scenario underscores the need to understand and quantify the costs related to the healthcare workforce as a central element of hospital management (11–13).

In addition to the direct increase in expenditures, the COVID-19 pandemic highlighted the complexity of accurately estimating the costs associated with the healthcare workforce. Different categories of professionals, such as physicians, nurses, physical therapists, nutritionists, and mid-level technical staff, played distinct and indispensable roles in COVID-19 healthcare, resulting in significant variations in per-patient costs, especially in intensive care units (ICUs). These differences stemmed from workload, professional specialization, institutional and regional policies, and fluctuating demand (14,15).

Although costing methods are widely used to support resource allocation decisions, challenges remain in capturing the full scope of costs related to healthcare professionals in crisis, such as the COVID-19 PHE (16–18). Micro-costing methods, particularly bottom-up approaches, permit the identification of costs at the individual level, detailing the specific components of each professional category and their contribution to total costs (19,20). This methodological approach enables a more accurate estimation of the resources employed and allows for analyzing cost–related factors, such as workload, care complexity, and interprofessional variability (19–21). Furthermore, micro-costing provides valuable information by disaggregating cost items to identify the most expensive components and can potentially suggest cost optimization opportunities (20–22). Conversely, macro-costing methodological approaches provide a broader overview of costs and are useful for aggregated comparisons. However, they may not be detailed enough to guide specific decisions (20,21).

In this context, the objective of this study was to estimate the costs associated with the healthcare professionals' services for patients with COVID-19-related SARI in a public teaching hospital during the COVID-19 PHE.

METHODS

Study Type

This study was nested within a clinical cohort at the Brasilia University Hospital (HUB) that investigated the effects of COVID-19-related SARI. The current study employed a bottom-up micro-costing analysis using the Time-Driven Activity-Based Costing (TDABC) methodology (23,24). TDABC measured human resources costs based on time spent at specific activities for non-shift-based healthcare workers, and on the working time of shift-based healthcare workers, while accounting for the hospital's operational capacity across the Public Health Emergency (PHE) phases.

Study Design

The study was conducted at a tertiary teaching hospital that is SUS-affiliated and located in the central area of the Federal District, Brazil. The hospital is specialized in medium- and high-complexity care, and serves as a referral center for obstetric emergencies, transplants, radiotherapy, high-risk pregnancies, and elderly healthcare, among other high-complex services (25).

During the COVID-19 PHE, the hospital operated under the Federal District Health Department regulation, offering up to 223 general beds, of which 40 beds (20 ICU and 20 wards) were allocated exclusively for COVID-19 patients during peak phases (25). Five distinct emergency phases were identified throughout 2020 and 2021, reflecting changes in care capacity and hospitalization flow: Phase 1 (March to September 2020), Phase 2 (October to December 2020), Phase 3 (January to February 2021), Phase 4 (March to June 2021), and Phase 5 (July to December 2021).

Study Population

The study included hospitalized adults with a laboratory-confirmed COVID-19 and a SARI diagnosis. Patients without confirmatory testing (RT-PCR or negative IgM serology test) or without laboratory confirmation were excluded.

The cohort was derived from the Hospital Epidemiological Surveillance database, which documents confirmed COVID-19 cases. Diagnostic confirmation was based on positive results of RT-PCR and/or IgM serology, as recorded in the electronic medical records. The presence of SARI was assessed by two hospital physicians, and members of the research team, who independently reviewed the medical records and validated them as a SARI case. Any discrepancies were resolved by consensus.

Data Collection and Analysis

The study adhered to the 8-steps TDABC framework proposed by Etges *et al.* (2019) (24), as outlined in Box 1.

Box 1 - Methodological approaches and study implementation steps

Study steps	Implementation details
A1. Define the research question and the technologies or interventions to be assessed	The objective was to estimate the costs for healthcare workers associated with hospitalizations for SARI related to COVD-19 at HUB.
A2. Map the processes: the care-delivery value chain.	Mapped patient care pathways from admission to discharge or death, identified PHE phases, and collected clinical and sociodemographic data.
A3. Identify the main resources used in each activity and department	The determination of the average time per service was achieved through the conduction of interviews with professionals and the meticulous analysis of administrative records.
A4. Estimate the total cost of each resource group and department	Healthcare workers' costs were calculated based on remuneration by professional category and workload.
A5. Estimate the capacity of each resource and calculate the capacity cost rate (CCR-$/h)	CCR was derived from the professional's hourly availability and the average time per activity.
A6. Analyze time estimates for each resource used in an activity	The assessment of the average time required for each service was conducted through interviews with professionals and estimates of shift hours.
A7. Calculate the total cost of patient care	The total cost per patient was calculated by summing the costs of service across wards and hospitalization phases.
A8. Perform cost data analysis	Analyses were conducted to explore cost variability according to the pandemic phase and other key variables. Subsequently, the results were compared with findings from studies previously published in the literature.

The patient care pathway within the HUB hospitalization was mapped (Box 1, Step A2), detailing the possible trajectories of patients from admission (26). Following the confirmation of a positive diagnosis for SARS-CoV-2, patients were then subjected to a triage process that determined their placement in one of three designated wards, namely the yellow ward (general ward), the orange ward (intensive care unit without mechanical ventilation), or the red ward (intensive care unit with mechanical ventilation). The allocation to a particular ward was determined by the clinical severity of the patient's condition. As the patients' clinical conditions evolved, they were transferred between wards, discharged, or referred to external healthcare services.

The definition of the study phases was based on an analysis of the HUB COVID-19 contingency plans, which included bed allocation policies (opening and closing of beds), according to the emergency response phase (Box 1, Step A2).

Clinical and sociodemographic data were collected from electronic medical records and the Hospital Epidemiological Surveillance database (Box 1, Step A2). For each patient, the total length of stay, the period of stay in each ward, and the number of services provided by healthcare professionals were identified.

To estimate costs, the TDABC method was applied to calculate the costs of activities performed by non-shift-based workers, who attended patients daily or as needed; and to calculate the activities of shift-based professionals working 24-hour shifts dedicated exclusively to COVID-19 patients.

Regarding the allocation of healthcare workforce time, the average daily number of shift-based professionals (physicians, nurses, and nursing technicians) per phase was obtained from the monthly schedules provided by the hospital. This approach enabled the identification of the number and category of professionals working each shift (Box 1, Step A3). These teams were dedicated exclusively to the care of patients with COVID-19, working 24-hour shifts.

Healthcare professionals who were not part of the shift-based team (physical therapists, nutritionists, social workers, psychologists, occupational therapists, speech therapists, dentists, and specialists such as pulmonologists, nephrologists, cardiologists, neurosurgeons, psychiatrists, and geriatricians) divided their working time between caring for patients with COVID-19 and other hospital duties. To define the time spent with COVID-19 patients, the sector heads were interviewed to estimate the average time spent per patient per ward (Box 1, Step A3). For these professionals, the cost per minute was derived from contracted working hours (Box 1, Step A4). Thus, the cost of each service was calculated by multiplying the remuneration proportional to the minutes worked by the average time spent per service by each professional (Box 1, Steps A5 and A6) and the number of visits per patient (Box 1, Step A2). The formula used was as follows:

$$\$_{service} = Re_{min} \times T\mu_{service} \times At_{P}$$

$\$_{service}$: Cost per Service

Re_{min}: Remuneration per minute (monthly salary ÷ monthly working minutes)

$T\mu_{service}$: Average time spent per service (minutes per professional)

At_P: Number of services per patient

The cost of the shift-based healthcare team working in the COVID-19-designated wards was calculated based on three components: (i) the daily remuneration of the professionals (derived from monthly income and total number of hours worked per month), (ii) the average number of professionals per shift (stratified by phase and ward), and (iii) the number of beds available per day during each emergency phase and ward (Box 1, Steps A5 and A6). The formula used to calculate the cost per bed-day was:

$$\$_{bed} = (Re_{day} \times QPP) / (Q_{beds})$$

$\$_{bed}$: Cost per Bed

Re_{day}: Remuneration per day

QPP: Average number of professionals per shift, considering the emergency phase and ward

Q_{beds}: Available beds per day, considering the emergency phase

The total cost per patient was calculated by multiplying the daily cost per bed by the patient's length of stay (number of hospitalization days). To operationalize this calculation, the daily remuneration was derived by dividing each professional's monthly salary divided by the number of monthly working hours. Then, this hourly rate was scaled to a 24-hour period to reflect the full duration of the shift, considering the team's availability and effort.

All data were meticulously organized into a non-identifying database, where each patient was identified by a unique code. In this database, the service counts, individual services costs, length of ward-specific stay, and costs, considering each emergency phase, were recorded (Box 1, Step A7). The activity mapping, cost breakdown, and formula applications were rigorously documented to ensure the methodological transparency and reproducibility of the study.

The data analysis was conducted using the software R (v. 4.4.1), Microsoft Excel 365, and the Statistical Package for the Social Sciences (SPSS® - v22.0). Descriptive statistics were utilized to calculate the mean, median, standard deviation, and interquartile range (IQR) of total costs, as well as costs stratified by patient, emergency phase, and ward. Data normality was assessed using the Shapiro-Wilk test. For non-normal distributions, the median and interquartile range (IQR) were used. A comparative analysis of costs between phases and wards was performed to identify significant variations. Total cost per patient, cost per phase, and cost per ward were identified individually. Additionally, a direct comparison was made between the TDABC-derived professional care costs (medical professional care costs estimated in this study) and the results obtained using a macro-costing approach, which was based on Hospital Admission Authorizations (HAA, per its acronym in Portuguese) reimbursements for the same cohort patients.

A multivariate analysis was conducted to assess the factors associated with total professional costs. A generalized linear model (GLM) with gamma distribution was employed to identify the association between predictor variables and the total professional cost, given the non-normal distribution of the dependent variable (total professional costs). Predictors included age, sex, patient origin (e.g., external referral, internal transfer), discharge reason (e.g., recovery, death), and ward-specific length of stay. The log link function was employed to estimate the model. The quality of the model fit was assessed using the Akaike Information Criterion (AIC). Collinearity among the variables was identified using correlation matrices. Only variables associated with total professional cost at $p < 0.10$ were retained in the final model, with statistical significance set at $p < 0.05$. The coefficients were presented in their exponential form (e^{β}) to facilitate interpretation. For categorical variables, e^{β} denotes the cost ratio between the category of interest and the reference. For continuous variables, e^{β} indicates the percentage cost change per unit increase in the variable analyzed (e.g., one additional day of hospitalization).

Research ethics

The study protocol was approved by the Research Ethics Committee of the School of Medicine at the University of Brasília (approval number 4.112.214). A Free and Informed Consent Form (FICF) was obtained from all included participants, ensuring comprehension of the study’s objectives and the participation terms. Hospital” surveillance professionals selected the study sample, with safeguards to protect sensitive data. Measures were implemented at every stage of the study to prevent the exposure of study participants.

RESULTS

A total of 645 individuals hospitalized with COVID-19-related SARI were eligible for inclusion in the cohort, of which, 627 patients were included and had their medical record information collected for the present study. Most patients were male (59%), with a median age of 61 years (IQR 50–72). Patients aged 50-69 years constituted the largest age group (45.5% of males and 41.8% of females). Regarding the origin of hospitalization, most patients were referred from other hospitals (76.7%). The number of hospitalized patients varied across emergency phases and wards (Table 1). Overall, 56.6% (n = 355) of patients were admitted to the Yellow Ward (general care) at least once; however, when considering the phases independently, the Orange Ward (ICU without mechanical ventilation) recorded the highest number of hospitalized patients (n = 157) – in Phase 4. With respect to clinical outcomes, the in-hospital fatality rate at the HUB was notably elevated (28.7%), and a single unauthorized discharge was documented (Table 1).

Table 1 – Distribution of Hospitalized Patients with Severe Acute Respiratory Syndrome due to COVID-19 According to Sociodemographic, Hospital, and Outcome Characteristics. University Hospital of Brasília (HUB), Brazil, May 2020 to January 2022 $^{+}$

Characteristics	n	%	Median	IQR
GENDER AND AGE RANGE				
Male	371	59.17	61	51-73
0 to 19	-	-	-	-
20 to 29	10	2.70	-	-
30 to 39	30	8.09	-	-
40 to 49	46	12.40	-	-
50 to 59	82	22.10	-	-
60 to 69	87	23.45	-	-
70 to 79	66	17.79	-	-
80 and more	50	13.48	-	-
Female	256	40.99	60	48-72
0 to 19	1	0.39	-	-
20 to 29	13	5.08	-	-
30 to 39	14	5.47	-	-
40 to 49	39	15.23	-	-
50 to 59	55	21.48	-	-
60 to 69	52	20.31	-	-
70 to 79	55	21.48	-	-
80 and more	27	10.55	-	-
AGE	627	-	61	50-72

ORIGIN				
Other hospital (external referral)	481	76.71	-	-
Urgent Care Unit (UPA)	90	14.35	-	-
University Hospital of Brasília (internal transfer)	56	8.93	-	-
HOSPITALIZED PATIENTS BY EMERGENCY PHASE*				
Yellow Ward				
Phase 1	100	28.17	-	-
Phase 2	39	10.99	-	-
Phase 3	26	7.32	-	-
Phase 4	123	34.65	-	-
Phase 5	67	18.87	-	-
Orange Ward				
Phase 1	47	16.79	-	-
Phase 2	- **	-		
Phase 3	33	11.79	-	-
Phase 4	157	56.07	-	-
Phase 5	43	15.36	-	-
Red Ward				
Phase 1	95	41.48	-	-
Phase 2	15	6.55	-	-
Phase 3	13	5.68	-	-
Phase 4	64	27.95	-	-
Phase 5	42	18.34	-	-
OUTCOME				
Discharge	384	61.24	-	-
Death	180	28.71	-	-
Transfer	62	9.89	-	-
Unauthorized discharge	1	0.16	-	-

Yellow ward: general ward. Orange ward: intensive care unit (ICU), no mechanical ventilation. Red ward: ICU, with mechanical ventilation. Phase 1: March–September 2020; Phase 2: October–December 2020; Phase 3: January–February 2021; Phase 4: March–June 2021; Phase 5: July–December 2021.

+ One patient was hospitalized in 2021, with discharge on January 27, 2022.

* According to clinical evolution, patients were transferred between wards, and it was possible to pass through the same ward more than once.

** No admissions recorded in this ward and phase.

The total cost of the 9,192 hospitalization days was R$ 10,391,881.31, considering the aggregated value that integrates the three wards (Yellow, Orange, and Red) across all phases. The total cost of services provided by non-shift-based physicians (R$ 89,566.25) exceeded the cost of services provided by all other non-shift-based healthcare workers (R$ 60,412.96) (Table 2 and Appendix A).

The 355 patients hospitalized in the Yellow Ward accounted for 3,837 days of hospitalization at a total cost of R$ 4,189,673.76 - representing 40.3% of the overall costs. In this ward, the number of non-shift-based physician services (n = 1,403; cost of R$ 19,627.97) was slightly higher than the total number of services provided by all other non–shift-based healthcare workers (n = 918; cost of R$ 19,079.17). The total cost of shift-based professional services, considering all hospitalization days, amounted to R$ 4,150,966.62, with Phase 5 accounting for 47.8% (R$ 1,984,942.32) of this total (Table 2 and Appendix A).

With the smallest share of total costs (29.7% of the study's overall total), the Orange Ward admitted 280 patients, totaling 2,536 hospitalization days, at a cost of R$ 3,082,872.37; no admissions occurred during Phase 2. The Red Ward represented a similar proportion to the Orange Ward (30% of the overall total), with a cost of R$ 3,118,801.18, despite admitting fewer patients (n = 228), totaling 2,819 hospitalization days. The total cost of non–shift-based physician services in the Red Ward was R$ 49,638.60, and the cost of services provided by other non–shift-based healthcare workers was R$ 26,675.10 (Table 2 and Appendix A).

The median costs per patient exhibited variability across different wards and their respective emergency phases. The Red Ward showed the highest median cost (R$ 7,269.38; interquartile range [IQR]: R$ 2,849.77 to R$ 15,310.70), while the Orange Ward had the lowest (R$ 3,995.97; IQR: R$ 2,209.70 to R$ 8,013.12). Across emergency phases, Phase 5 of the Orange Ward recorded the highest median cost (R$ 30,570.58; IQR: R$ 18,250.44 to R$ 60,989.50), which is nine times higher than median cost of Phase 1 of the same ward (R$ 3,318.48; IQR: R$ 2,661.95 to R$ 7,352.71), which had the lowest median cost (Table 2).

Table 2 – Median Costs in Brazilian Reais by Hospital Ward and Emergency Response Phase University Hospital of Brasília, Brazil, May 2020 to January 2022+

	Non–On-Call Team		On-Call Team				
Ward and Phases	**Cost of services by physicians (R$) [A]**	**Cost of services by other professionals (R$) [B]**	**Cost of services by physicians (R$) [C]**	**Cost of services by other professionals (R$) [D]**	**Total Cost (R$) [A+B+C+D]**	**Median (R$)**	**IQR (R$)**
Yellow Ward							
Phase 1	5,442.11	8,086.78	581,189.34	165,363.90	760,082.13	5,560.53	2,601 - 9,444.38
Phase 2	1,846.68	1,060.29	272,511.99	74,840.49	350,259.45	7,435.68	4,285.79 - 11,740.60
Phase 3	1,343.04	1,331.78	369,467.46	91,448.10	463,590.38	15,929.20	10,557.81 - 19,814.90
Phase 4	7,778.44	5,681.27	468,615.72	142,587.30	624,662.73	3,535.52	1,897.01 - 5,859.63
Phase 5	3,217.70	2,919.05	1,513,617.60	471,324.72	1,991,079.07	21,270.69	9,122.12 - 42,554.55
Total Yellow Ward	**19,627.97**	**19,079.17**	**3,205,402.11**	**945,564.51**	**4,189,673.76**	**6,084.15**	**3,023.80 - 12,769.98**
Orange Ward							
Phase 1	5,274.72	4,631.19	186,757.50	53,137.50	249,800.91	3,318.48	2,661.95 - 7,352.71
Phase 2*							
Phase 3	1,738.26	1,216.85	228,200.49	56,482.65	287,638.25	7,574.96	4,518.78 - 10,563.80
Phase 4	9,330.66	6,017.66	452,351.40	138,172,48	605,872.22	2,781.48	1,358.50 - 4,510.49
Phase 5	3,956.04	2,792.99	1,474,272.80	459,073.16	1,940,094.99	30,570.58	18,250.44 - 60,989.50
Total Orange Ward	**20,299.68**	**14,658.69**	**2,341,582.19**	**706,331.81**	**3,083,406.37**	**3,995.97**	**2,209.70 - 8,013.12**

Red Ward							
Phase 1	22,996.82	15,342.92	629,995.30	179,962.16	848,297.20	7,623.49	2,813.31 - 12,546.77
Phase 2	2,421.98	1,749.68	166,674.00	45,774.00	216,619.66	8,765.15	4,260.95 - 20,524.03
Phase 3	1,822.48	1,452.26	144,889.20	35,862.00	184,025.94	15,383.90	3,076.32 - 18,481.46
Phase 4	12,589.50	5,137.96	249,047.40	75,778.50	342,553.36	3,708.93	1,239.60 - 7,602.09
Phase 5	9,807.82	2,992.28	1,154,885.60	359,619.32	1,527,305.02	21,487.08	6,888.89 - 42,110.57
Total Red Ward	**49,638.60**	**26,675.10**	**2,345,491.50**	**696,995.98**	**3,118,801.18**	**7,269.38**	**2,849.77 - 15,310.70**
TOTAL	**89,566.25**	**60,412.96**	**7,892,475.80**	**2,348,180.64**	**10,391,881.31**	**8,091.95**	**3,977.46 - 18,210.48**

Yellow ward: general ward. Orange ward: Intensive care unit (ICU), no mechanical ventilation. Red ward: ICU, with mechanical ventilation. Phase 1: March–September 2020; Phase 2: October–December 2020; Phase 3: January–February 2021; Phase 4: March–June 2021; Phase 5: July–December 2021.

+ One patient was hospitalized in 2021, with discharge on January 27, 2022.

* No admissions recorded in this ward and phase.

A direct comparison was feasible between the results of macro-costing published by Pereira et al. (26) and those of TDABC micro-costing (this study) for 95.2% of the patients (n = 597 of the 627 included in this study). The macro-costing approach, based on Hospital Admission Authorizations (HAA), yielded a total professional care cost by physicians of R$ 364,518.85 (median R$ 319.01; IQR: R$ 304.01–R$ 444.03) (26). In contrast, the TDABC micro-costing analysis, which accounted for both shift-based and non-shift-based professionals, estimated total cost at R$ 2,336,980.09 (median R$ 1,866.18; IQR: R$ 881.54–R$ 4,156.18), for the same 597 patients. The findings reveal that the costs ascertained through micro-costing were 6.4 times higher than those identified through macro-costing.

The multivariate analysis revealed numerous statistically significant factors associated with increased total professional costs. Age demonstrated a positive correlation, with each additional year of patient age associated with a 0.6% increase in total cost ($e^{\beta} = 1.006$; 95% CI: 1.002–1.009; $p = 0.004$). Female patients incurred 19.0% higher costs compared to male patients ($e^{\beta} = 1.190$; 95% CI: 1.053–1.345; $p = 0.005$). As for the patient's origin, referrals from external hospitals were associated with a 55.2% increase in costs ($e^{\beta} = 1.552$; 95% CI: 1.310–1.839; $p < 0.001$), while transfers from other HUB departments showed a 72.4% increase ($e^{\beta} = 1.724$; 95% CI: 1.338–2.223; $p < 0.001$), compared to patients admitted from urgent care units (UPAs).

The discharge reason was also a relevant factor. Transfers were associated with a 35.2% increase in costs ($e^{\beta} = 1.352$; 95% CI: 1.095–1.670; $p = 0.005$) compared to recoveries, while mortality showed no statistically significant difference in costs ($e^{\beta} = 1.111$; 95% CI: 0.950–1.298; $p = 0.188$). The length of stay was another pivotal factor in increasing costs: each additional hospitalization day increased costs by 4.7% in the Red Ward ($e^{\beta} = 1.047$; 95% CI: 1.038–1.057; $p < 0.001$), 4.7% in the Orange Ward ($e^{\beta} = 1.047$; 95% CI: 1.036–1.058; $p < 0.001$), and 5.5% in the Yellow Ward ($e^{\beta} = 1.055$; 95% CI: 1.046–1.065; $p < 0.001$) (Table 3).

Table 3: Multivariate Analysis* of Total Costs, Based on Predictors: Age, Origin, Discharge Reason, and Length of Stay in Yellow, Orange, and Red Wards.

Variable	e^{β}	95% CI	β	95% CI	p
Age	1.006	(1.002 - 1.009)	0.006	(0.002 - 0.009)	0.004
Sex					
Male	1	-	0	.	.
Female	1.190	(1.053 – 1.345)	0.174	(0.052-0.296)	0.005
Origen					
Urgent Care Unit (UPA)	1	-	0	-	-
Other hospital (external referral)	1.552	(1.310 - 1.839)	0.439	(0.270 - 0.609)	<0.001
University Hospital of Brasília (internal transfer)	1.724	(1.338 - 2.223)	0.545	(0.291 - 0.799)	<0.001
OUTCOME					
Discharge	1		0		
Transfer	1.352	(1.095 - 1.670)	0.302	(0.091 - 0.513)	0.005
Death	1.111	(0.950 - 1.298)	0.105	(-0.051 - 0.261)	0.188
Length of stay – red ward	1.047	(1.038 - 1.057)	0.046	(0.038 - 0.055)	<0.001
Length of stay – orange ward	1.047	(1.036 - 1.058)	0.046	(0.035 - 0.057)	<0.001
Length of stay – yellow ward	1.055	(1.046 - 1.065)	0.054	(0.045 - 0.063)	<0.001

*β, regression coefficient; e^{β}, exponential of the regression coefficient (multiplicative effect relative to the reference category)

Yellow ward: general ward. Orange ward: intensive care unit (ICU), no mechanical ventilation. Red ward: ICU, with mechanical ventilation.

DISCUSSION

The results highlight the complexity of the costs associated with healthcare workers' care during COVID-19-related SARI hospitalizations at HUB, emphasizing the influence of patient demographic characteristics (age, biological sex), clinical pathways (referral origin, length of stay), and care settings (ward type, pandemic phase). Our analysis identified pronounced cost variations according to the pandemic phase and the ward of hospitalization.

The aggregated care costs across all three wards totaled R$10,391,881.31, encompassing 863 hospitalizations and 9,192 hospitalization days. Phase 5 of the emergency was the costliest period, accounting for 52.6% of total costs, or R$5,458,479.08. The Yellow Ward (general care) had the highest cumulative costs (R$4,189,673.76), primarily due to its large number of patients (355 hospitalizations), especially in Phase 5, which had the highest costs (R$1,991,079.07) due to the peak daily cost of the shift-based team (R$3,035.08 per day). The total cost in the Orange Ward (ICU without mechanical ventilation) reached R$ 3,083,406.37, with the highest cost in Phase 5 (R$ 1,940,094.99). The Red Ward (ICU with mechanical ventilation), dedicated to the most critically ill patients, totaled R$ 3,118,801.18, of wish Phase 5 representing R$ 1,527,305.02.

The predominance of male hospitalized patients (59.17%) in our cohort aligns with global evidence from previous studies indicating the greater susceptibility of men and older adults to severe forms of the disease (27,28). However, this contrasts with the gender distribution of the general population of the Brazilian Federal District(52.3% women and 47.7% men), suggesting sex-specific vulnerabilities (29). Potentially related factors include biological differences, such as hormonal and genetic influences on the immune response, and behavioral patterns, which include greater occupational exposure risks and lower preventive healthcare engagement among men) (27,30). Additionally, the observed fatality rate (28.71%) was aligned with the Federal District's average (29.0%) and lower than the national average (32.1%), indicating the HUB's capacity to maintain fatality rates within expected levels during the pandemic(31).

During the surge of the Delta variant (phases 3 and 4), shortages of resources such as mechanical ventilation equipment and medicines were extensively documented as a challenge in pandemic studies, especially in settings with limited resources, such, as middle- and low-income countries (1). Although HUB avoided critical shortages, other hospitals within the referral hospital network were affected, which overburdened the system and indirectly impacted HUB through patient transfers and resource redistribution. This likely increased the healthcare workload and complexity of care, as well as prolonged hospital stays, all of which contributed to elevated costs. Phase 4 recorded the highest number of admissions in the Orange Ward (non-mechanically ventilated ICU) (56.07%), reflecting high demand for intermediate critical care and high ICU bed occupancy (Red Ward). However, the highest professional-related costs per patient were observed in the Red Ward (median cost per patient of R$7,269.38), due to the high complexity of care and the greater amount of time professionals required for such cases.

The multivariate analysis identified key factors associated with an increase in professional costs, including age, biological sex, patient origin, and length of stay. For each additional year of age, costs increased by 0.6%, which may be explained by greater clinical complexity and the need for prolonged care among older adults (32). Female patients incurred 19% higher costs than males, a disparity that may be tied to sex-based differences in comorbidities or care intensity for respiratory illnesses (27,30). Patient origin also influenced costs, with increases of 55.2% for those referred from other hospitals and 72.4% for those coming from other HUB departments compared to those referred from UPAs. This suggests that referred cases demand more time and complex care from healthcare and probably reflect the logistical and coordination challenges for transferred patients(33).

Length of stay emerged as one of the primary cost drivers, with each additional day of hospitalization increasing professional costs by 4.7% to 5.5%, depending on ward-specific care. This finding is consistent with studies that have identified prolonged stays as a key factor in the economic burden of managing patients with COVID-19 (34). Phase 5, corresponding to the period from July to December 2021, had the highest costs, particularly in the Orange Ward (median of R$ 30,570.58). This reflects the heightened care complexity and professional time required during the Delta variant surge. This period was marked by high demand for hospitalizations and operational challenges within the hospital system (35).

Phase 5 accounted for the highest total cost (R$ 5,458,479.08, with 152 hospitalizations), followed by Phase 1 (R$ 1,858,180.24, with 241 hospitalizations) and Phase 4 (R$ 1,573,088.31, with 344 hospitalizations). The elevated cost in Phase 5 can be attributed to the reduction in bed availability, which raised the proportional cost per patient – with professional remuneration and an average number of healthcare workers remaining constant, fixed personnel expenses were distributed across fewer patients, raising the proportional costs. In contrast, Phase 1 (the initial phase of the pandemic) and Phase 4 (the Delta variant surge) faced significant system overload, with many patients and fewer professionals per patient. This challenging scenario, characterized by insufficient staff-per-patient ratios, resource scarcity, ad-hoc operational adjustments and pressure on healthcare teams, heightened costs due to the intense demand, and the need for emergency resource allocation, which increased both the complexity and intensity of care (3,18).

The TDABC method allowed for the accurate quantification of the costs associated with healthcare professionals' time and remuneration. The results showed that the costs of medical services (R$89,566.25) exceeded the costs of services provided by other professionals (R$60,412.96). This disparity is consistent with prior studies showing that physicians' costs represent a significant portion of hospital expenditures during the pandemic (36).

The comparison between micro-costing and macro-costing (26) approaches revealed that the cost estimated by micro-costing was 6.4 times higher than that obtained through macro-costing, suggesting the greater accuracy of detailed methods in capturing the real-world healthcare workforce services expenditures. In the macro-costing study, costs were calculated based on the values of procedures recorded in the Hospital Admission Authorization (HAA). However, this method omits important variables such as the actual time dedicated by professionals and the care variations in care intensity required by each patient (26).

Although the HAA represents the federal government's disbursement for the cost of hospitalizations in the SUS, it does not fully reflect the real conditions of the health system - which also relies on state and municipal funding (37, 38). For this reason, the direct comparison between the amounts calculated by micro-costing and those obtained by macro-costing based on the HAA has limitations, possibly intensified in this study due to the high demand and the significant increase in costs during the COVID-19 crisis (38). Even so, this comparison offers valuable insights, especially in the debate on the underfunding of the SUS and the low values of HAAs. As Peixoto et al. point out, it is essential to develop and standardize micro-costing methodologies that estimate hospital costs more accurately, to support discussions on the need to update the values of HAA(37).

Despite the relevance of the findings, this study presents some limitations that should be considered. Its single-center design (HUB) inherently restricts the generalizability of results to other settings and realities, given that available resources, care dynamics, and public health conditions may vary significantly. Additionally, data collection may have been impacted by the conditions imposed by the pandemic, such as the high workload and the need to adapt to an emerging and rapidly evolving disease. It is possible that medical records did not fully capture all services provided by non–shift-based professionals due to the healthcare teams' overload and the pressure to meet emergent demands. These limitations underscore the need for a cautious interpretation of the results and reinforce the importance of conducting additional studies in diverse settings to validate the findings and strengthen their generalizability.

CONCLUSIONS

The findings underscore the multifactorial nature of hospital care costs during the public health emergency caused by SARS-CoV-2, emphasizing the influence of factors such as biological sex, age, patient origin, length of stay, and temporal cost fluctuations according to the pandemic phase. The findings of this study are constrained by the distinct operational context of HUB, a tertiary hospital affiliated with the SUS, which restricts the generalizability of the results.

Nevertheless, they offer valuable insights into the economic burden of hospital care during health emergencies and provide a practical framework to guide strategic decisions on resource allocation and the planning of more effective responses in future crises.

Further studies in diverse epidemiological and operational settings - including multicenter analyses - are needed to refine cost benchmarks, deepen understanding of these findings, and enhance their applicability in shaping strategies for the SUS and comparable healthcare systems worldwide.

REFERENCES

1. Ranzani OT, Bastos LSL, Gelli JGM, Marchesi JF, Baião F, Hamacher S, et al. Characterisation of the first 250,000 hospital admissions for COVID-19 in Brazil: a retrospective analysis of nationwide data. Lancet Respir Med [Internet]. 2021 Apr 1 [cited 2025 Feb 19];9(4):407–18. Available from: https://pubmed.ncbi.nlm.nih.gov/33460571/

2. Grasselli G, Zanella A, Carlesso E, Florio G, Canakoglu A, Bellani G, et al. Association of COVID-19 Vaccinations With Intensive Care Unit Admissions and Outcome of Critically Ill Patients With COVID-19 Pneumonia in Lombardy, Italy. JAMA Netw Open [Internet]. 2022 Oct 27 [cited 2025 Feb 19];5(10):E2238871. Available from: https://pubmed.ncbi.nlm.nih.gov/36301541/
3. HUB-UnB - Hospital Universitário de Brasília — Empresa Brasileira de Serviços Hospitalares [Internet]. [cited 2025 Feb 20]. Available from: https://www.gov.br/ebserh/pt-br/hospitais-universitarios/regiao-centro-oeste/hub-unb
4. Azevedo MMM de, Nascimento JC do, Cruz MS, Lima AD dos R, Poças KC. Modelo lógico para o plano de enfrentamento à covid-19: contribuições para a avaliação. Physis: Revista de Saúde Coletiva [Internet]. 2024 Aug 16 [cited 2025 Feb 20];34:e34049. Available from: http://dx.doi.org/10.1590/S0103-7331202434049pt
5. Shrestha N, Shad MY, Ulvi O, Khan MH, Karamehic-Muratovic A, Nguyen USDT, et al. The impact of COVID-19 on globalization. One Health. 2020 Dec 20;11:100180.
6. Castro MC, Massuda A, Almeida G, Menezes-Filho NA, Andrade MV, de Souza Noronha KVM, et al. Brazil's unified health system: the first 30 years and prospects for the future. Lancet [Internet]. 2019 Jul 27 [cited 2025 Feb 19];394(10195):345–56. Available from: https://pubmed.ncbi.nlm.nih.gov/31303318/
7. De Albuquerque MV, Leandro Ribeiro LH. Desigualdade, situação geográfica e sentidos da ação na pandemia da COVID-19 no Brasil. Cad Saude Publica. 2021 Jan 11;36(12):e00208720.
8. Kim JN, Oh IH. Optimizing Hospital Bed Capacity and Resource Allocation Using Inflow and Outflow Indices for Effective Healthcare Management. Inquiry [Internet]. 2024 Jan 1 [cited 2025 Feb 19];61. Available from: https://pubmed.ncbi.nlm.nih.gov/39614715/
9. Castagna F, Xue X, Saeed O, Kataria R, Puius YA, Patel SR, et al. Hospital bed occupancy rate is an independent risk factor for COVID-19 inpatient mortality: a pandemic epicentre cohort study. BMJ Open [Internet]. 2022 Feb 15 [cited 2025 Feb 19];12(2). Available from: https://pubmed.ncbi.nlm.nih.gov/35168984/
10. Mateen BA, Wilde H, Dennis JM, Duncan A, Thomas N, McGovern A, et al. Hospital bed capacity and usage across secondary healthcare providers in England during the first wave of the COVID-19 pandemic: A descriptive analysis. BMJ Open. 2021 Jan 26;11(1).
11. Hitch D, Angeles MR, Lau E, Nicola-Richmond K, Bennett C, Said CM, et al. Hospital costs of COVID-19, post-COVID-19 condition and other viral pneumonias: a cost comparison analysis. Med J Aust [Internet]. 2024 Nov 4 [cited 2025 Feb 19];221 Suppl 9(S9):S23–30. Available from: http://www.ncbi.nlm.nih.gov/pubmed/39489521
12. AlManie SA, AlHazami MS, Ebrahim A, Attique MS. Assessment of Direct Medical Cost of Hospitalized COVID-19 Adult Patients in Kuwait During the First Wave of the Pandemic. Clinicoecon Outcomes Res [Internet]. 2024 [cited 2025 Feb 19];16:509–22. Available from: http://www.ncbi.nlm.nih.gov/pubmed/39069972
13. Bartsch SM, Ferguson MC, McKinnell JA, O'shea KJ, Wedlock PT, Siegmund SS, et al. The Potential Health Care Costs And Resource Use Associated With COVID-19 In The United States. Health Aff (Millwood) [Internet]. 2020 Jun 1 [cited 2025 Feb 19];39(6):927–35. Available from: https://pubmed.ncbi.nlm.nih.gov/32324428/
14. Emanuel EJ, Persad G, Kern A, Buchanan A, Fabre C, Halliday D, et al. An ethical framework for global vaccine allocation. Science (1979) [Internet]. 2020 Sep 1 [cited 2025 Feb 19];369(6509):1309–12. Available from: https://www.science.org/doi/10.1126/science.abe2803

15. Norheim OF, Abi-Rached JM, Bright LK, Bærøe K, Ferraz OLM, Gloppen S, et al. Difficult trade-offs in response to COVID-19: the case for open and inclusive decision making. Nature Medicine 2020 27:1 [Internet]. 2020 Dec 18 [cited 2025 Feb 19];27(1):10–3. Available from: https://www.nature.com/articles/s41591-020-01204-6
16. Bourgeault IL, Maier CB, Dieleman M, Ball J, MacKenzie A, Nancarrow S, et al. The COVID-19 pandemic presents an opportunity to develop more sustainable health workforces. Hum Resour Health. 2020 Dec 1;18(1).
17. Denis JL, Côté N, Fleury C, Currie G, Spyridonidis D. Global health and innovation: A panoramic view on health human resources in the COVID-19 pandemic context. International Journal of Health Planning and Management. 2021 May 1;36:58–70.
18. Lopes LT, Barros FPC de. Gestão de recursos humanos do SUS na pandemia: fragilidades nas iniciativas do Ministério da Saúde. Saúde em Debate [Internet]. 2022 Jun 17 [cited 2025 Feb 20];46(133):277–89. Available from: https://www.scielo.br/j/sdeb/a/zhKNYFY6jskFBdMdYyLdH6t/
19. Silva EN da, Silva MT, Pereira MG. Identificação, mensuração e valoração de custos em saúde. Epidemiologia e Serviços de Saúde [Internet]. 2016 Apr 1 [cited 2025 Feb 20];25(2):437–9. Available from: https://www.scielo.br/j/ress/a/NgDGnzBGKmQqnz9QtrnHb6n/
20. Drummond ME, Sculpher MJ, Torrance GW, O'Brien BJ, Stoddart GL. Methods for the Economic Evaluation of Health Care Programmes. Methods for the Economic Evaluation of Health Care Programmes [Internet]. 2005 Jun 2 [cited 2025 Feb 19]; Available from: https://academic.oup.com/book/54294
21. Tan SS, Van Ineveld BM, Redekop WK, Roijen LH Van. Comparing Methodologies for the Allocation of Overhead and Capital Costs to Hospital Services. Value in Health. 2009 Jun 1;12(4):530–5.
22. García-Mochón L, Špacírová Z, Espín J. Costing methodologies in European economic evaluation guidelines: commonalities and divergences. Eur J Health Econ [Internet]. 2022 Aug 1 [cited 2025 Feb 19];23(6):979–91. Available from: https://pubmed.ncbi.nlm.nih.gov/34825296/
23. Etges APB da S, Polanczyk CA, Urman RD. A standardized framework to evaluate the quality of studies using TDABC in healthcare: the TDABC in Healthcare Consortium Consensus Statement. BMC Health Serv Res [Internet]. 2020 Dec 1 [cited 2025 Feb 20];20(1). Available from: https://pubmed.ncbi.nlm.nih.gov/33256733/
24. da Silva Etges APB, Cruz LN, Notti RK, Neyeloff JL, Schlatter RP, Astigarraga CC, et al. An 8-step framework for implementing time-driven activity-based costing in healthcare studies. Eur J Health Econ [Internet]. 2019 Nov 1 [cited 2025 Feb 20];20(8):1133–45. Available from: https://pubmed.ncbi.nlm.nih.gov/31286291/
25. Brasil. Cadastro Nacional de Estabelecimentos de Saúde [Internet]. 2023 [cited 2023 Apr 10]. Available from: https://cnes.datasus.gov.br/
26. Pereira ACE da S, Gallo LG, Oliveira AF de M, de Oliveira MRF, Peixoto HM. Costs of hospital admissions due to COVID-19 in the federal capital of Brazil: a study based on hospital admission authorizations. Braz J Infect Dis [Internet]. 2024 Mar 1 [cited 2025 Feb 20];28(2). Available from: https://pubmed.ncbi.nlm.nih.gov/38670167/
27. Hippisley-Cox J, Coupland CAC, Mehta N, Keogh RH, Diaz-Ordaz K, Khunti K, et al. Risk prediction of covid-19 related death and hospital admission in adults after covid-19 vaccination: national prospective cohort study. BMJ [Internet]. 2021 Sep 17 [cited 2025 Feb 21];374. Available from: https://pubmed.ncbi.nlm.nih.gov/34535466/

28. Williamson EJ, Walker AJ, Bhaskaran K, Bacon S, Bates C, Morton CE, et al. Factors associated with COVID-19-related death using OpenSAFELY. Nature [Internet]. 2020 Aug 20 [cited 2025 Feb 21];584(7821):430–6. Available from: https://pubmed.ncbi.nlm.nih.gov/32640463/
29. Censo 2022 | IBGE [Internet]. [cited 2025 Feb 21]. Available from: https://www.ibge.gov.br/estatisticas/sociais/populacao/22827-censo-demografico-2022.html?=&t=acesso-ao-produto
30. Jin JM, Bai P, He W, Wu F, Liu XF, Han DM, et al. Gender Differences in Patients With COVID-19: Focus on Severity and Mortality. Front Public Health [Internet]. 2020 Apr 29 [cited 2025 Feb 21];8. Available from: https://pubmed.ncbi.nlm.nih.gov/32411652/
31. Portela MC, Martins M, Lima SML, de Andrade CLT, de Aguiar Pereira CC. COVID-19 inpatient mortality in Brazil from 2020 to 2022: a cross-sectional overview study based on secondary data. Int J Equity Health [Internet]. 2023 Dec 1 [cited 2025 Feb 21];22(1):1–18. Available from: https://equityhealthj.biomedcentral.com/articles/10.1186/s12939-023-02037-8
32. Richardson S, Hirsch JS, Narasimhan M, Crawford JM, McGinn T, Davidson KW, et al. Presenting Characteristics, Comorbidities, and Outcomes Among 5700 Patients Hospitalized With COVID-19 in the New York City Area. JAMA [Internet]. 2020 May 26 [cited 2025 Feb 21];323(20):2052–9. Available from: https://pubmed.ncbi.nlm.nih.gov/32320003/
33. Miethke-Morais A, Cassenote A, Piva H, Tokunaga E, Cobello V, Rodrigues Gonçalves FA, et al. COVID-19-related hospital cost-outcome analysis: The impact of clinical and demographic factors. The Brazilian Journal of Infectious Diseases. 2021 Jul 1;25(4):101609.
34. Bartsch SM, Ferguson MC, McKinnell JA, O'Shea KJ, Wedlock PT, Siegmund SS, et al. The Potential Health Care Costs And Resource Use Associated With COVID-19 In The United States. Health Aff (Millwood). 2020 Jun;39(6):927–35.
35. OPAS. Atualização epidemiológica: Incremento de variante Delta e seu potencial impacto na região das Américas - 8 de agosto de 2021 - OPAS/OMS | Organização Pan-Americana da Saúde [Internet]. 2021 [cited 2025 Feb 21]. Available from: https://www.paho.org/pt/documentos/atualizacao-epidemiologica-incremento-variante-delta-e-seu-potencial-impacto-na-regiao
36. Shrestha N, Shad MY, Ulvi O, Khan MH, Karamehic-Muratovic A, Nguyen USDT, et al. The impact of COVID-19 on globalization. One Health. 2020 Dec 20;11:100180.
37. Peixoto HM, Brito MAM, Romero GAS, Monteiro WM, Lacerda MVG de, Oliveira MRF de. Deficiência de glicose-6-fosfato desidrogenase e uso de primaquina: estimativa de custos de profissionais por macrocusteio e microcusteio. Rev Saude Publica [Internet]. 2017 Oct 11 [cited 2025 May 25];51(51):90. Available from: https://www.revistas.usp.br/rsp/article/view/139630

Appendix. Table A - Detailed Costs by Ward, Emergency Phase, Professional Category, and Service Type, University Hospital of Brasília, Brazil, May 2020 to January 2022+

			Non–On-Call Team				On-Call Team (24h)				
	Patients	Hospitalization Days	Number of Services by Physicians	Cost of Services by Physicians (R$)	Number of Services by Other Professional	Cost of Services by Other Professionals (R$)	Daily Cost of Services by Physicians (R$)	Cost of Services by Physicians (R$)	Daily Cost of Services by Other Professionals (R$)	Cost of Services by Other Professionals (R$)	Total Cost (R$)
Yellow Ward											
Phase 1	100	1167	389	5,442.11	349	8,086.78	141.70	165,363.90	498.02	581,189.34	**760,082.13**
Phase 2	39	327	132	1,846.68	55	1,060.29	228.87	74,840.49	833.37	272,511.99	**350,259.45**
Phase 3	26	306	96	1,343.04	70	1,331.78	298.85	91,448.10	1,207.41	369,467.46	**463,590.38**
Phase 4	123	1,383	556	7,778.44	298	5,681.27	103.10	142,587.30	338.84	468,615.72	**624,662.73**
Phase 5	67	654	230	3,217.70	146	2,919.05	720.68	471,324.72	2,314.40	1,513,617.60	**1,991,079.0**
Total Yellow Ward	35	3837	1,403	19,627.97	918	19,079.17		945,564.51		3,205,402.11	**4,189,673.7**
Orange Ward											
Phase 1	47	375	264	5,274.72	198	4,631.19	141.70	53,137.50	498.02	186,757.50	249,800.91
Phase 2*	-	-	-	-	-	-	-	-	-	-	-
Phase 3	33	189	87	1,738.26	61	1,216.85	298.85	56,482.65	1,207.41	228,200.49	287,638.25
Phase 4	157	1,335	467	9,330.66	309	6,017.66	103.10	137,638.50	338.84	452,351.40	605,338.22
Phase 5	43	637	198	3,956.04	119	2,792.99	720.68	459,073.16	2,314.40	1,474,272.80	1,940,094.99

Total Orange Ward	280	2536	1,016	20,299.68	687	14,658.69		706,331.81		2,341,582.19	**3,083,406.37**
Red Ward											
Phase 1	94	1,265	959	22,996.82	839	15,342.92	141.70	179,962.16	498.02	629,995.30	847,585.54
Phase 2	15	200	101	2,421.98	87	1,749.68	228.87	45,774.00	833.37	166,674.00	216,619.66
Phase 3	13	120	76	1,822.48	84	1,452.26	298.85	35,862.00	1,207.41	144,889.20	184,025.94
Phase 4	64	735	525	12,589.50	243	5,137.96	103.10	75,778.50	338.84	249,047.40	342,553.36
Phase 5	42	499	409	9,807.82	143	2,992.28	720.68	359,619.32	2,314.40	1,154,885.60	1,527,305.02
Total Red Ward	228	2819	2070	49,638.60	1396	26,675.10		696,995.98		2,345,491.50	**3,118,801.18**
Overall Total (All Wards)											
Phase 1	241	2,807	1,612	33,713.65	1,386	28,060.89	141.70	398,463.56	498.02	1,397,942.14	1,858,180.24
Phase 2	54	527	233	4,268.66	142	2,809.97	228.87	120,614.49	833.37	439,185.99	566,879.11
Phase 3	72	615	259	4,903.78	215	4,000.89	298.85	183,792.75	1,207.41	742,557.15	935,254.57
Phase 4	344	3,453	1,548	29,698.60	850	16,836.89	103.10	356,538.28	338.84	1,170,014.52	1,573,088.31
Phase 5	152	1,790	837	16,981.56	408	8,704.32	720.68	1,290,017.20	2,314.40	4,142,776.00	5,458,479.08
TOTAL	**86**	**9,192**	**4,489**	**89,566.25**	**3,001**	**60,412.96**		2,348,180.64		7,892,475.80	**10,391,881.31**

Yellow ward: general ward. Orange ward: intensive care unit (ICU), no mechanical ventilation. Red ward: ICU, with mechanical ventilation. Phase 1: March–September 2020; Phase 2: October–December 2020; Phase 3: January–February 2021; Phase 4: March–June 2021; Phase 5: July–December 2021.

$^{+}$ One patient was hospitalized in 2021, with discharge on January 27, 2022.

* No admissions recorded in this ward and phase.

DECLARAÇÃO DE CONTRIBUIÇÃO DOS AUTORES (Credit authorship contribution statement)

Ana Carolina Esteves da Silva Pereira: Conceptualization, Methodology, Formal analysis, Data Curation, Investigation, Writing - Original Draft; **Luciana G. Gallo:** Conceptualization, Methodology, Investigation, Writing - Original Draft; **Ana Flávia de M. Oliveira:** Conceptualization, Methodology, Investigation, Writing - Review & Editing; **Maria Regina F. de Oliveira:** Conceptualization, Methodology, Writing - Review & Editing, Project administration; **Henry M. Peixoto:** Conceptualization, Methodology, Formal analysis, Writing - Review & Editing, Project administration.

DECLARAÇÃO DE CONFLITO DE INTERESSE (Conflicts of interest)
All authors declare that they have no conflict of interest.

DECLARAÇÃO DE DISPONIBILIDADE DE DADOS DE PESQUISA (Availability of data and material)
The datasets generated and/or analyzed during the current study are not publicly available due to confidentiality restrictions but are available from the corresponding author on reasonable request.

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ETHICAL APPROVAL
The study protocol was approved by the Research Ethics Committee of the School of Medicine at the University of Brasília (approval number 4.112.214).