







Cost management: microcosting by absorption in an emergency room during the COVID-19 pandemic

Gestão de custos: microcusteio por absorção em um pronto-socorro durante a pandemia de COVID-19

Gestión de costos: microcosteo por absorción en un servicio de urgencias durante la pandemia de COVID-19

Letícia Coutinho de Oliveira^I ; Danielly Negrão Guassú Nogueira^I ; Marli de Carvalho Jericó^{II} ;
Mara Cristina Nishikawa Yagi^I ; Alessandra Ladeira Boçois^I ; Cibele Cristina Tramontini^I 

^IUniversidade Estadual de Londrina. Londrina, Brazil; ^{II}Faculdade de Medicina de São José do Rio Preto, São José do Rio Preto, Brazil

ABSTRACT

Objective: to analyze the operating costs of an emergency room related to the care of COVID-19 patients in 2020 and 2021.

Method: cross-sectional, descriptive study with a quantitative approach. The measurement of costs was used from the perspective of the hospital manager, through absorption micro-costing. Direct, indirect and variable costs were evaluated from top to bottom (top-down). **Results:** the predominant profile was men, aged between 61 and 70 years, married, white and living in Londrina (Paraná, Brazil). The mean length of stay for critically ill patients was 12.20 days and for the others, 8.38 days. The main outcome was hospital discharge. Operating costs in 2020 were BRL 28,461,152.87, while in 2021 the values found were BRL 43,749,324.61. The average patient-day cost went from R\$2,614.45 in 2020 to R\$3,351.93 in 2021. **Conclusion:** costs increased in the study period. Be aware of the operational costs of emergency room, enablement or institutional financial planning, contributing to qualify management decision-making.

Descriptors: Coronavirus infections; COVID-19; Emergency Medical Services; Hospital Costs; Costs and Cost Analysis.

RESUMO

Objetivo: analisar os custos operacionais de um pronto-socorro relacionados ao atendimento de pacientes COVID-19 em 2020 e 2021. **Método:** estudo transversal, descritivo de abordagem quantitativa. A mensuração dos custos utilizou-se da perspectiva do gestor hospitalar, por meio de microcusteio por absorção. Custos diretos, indiretos e variáveis, foram avaliados de cima para baixo (top-down). **Resultados:** o perfil predominante foi de homens, com idades entre 61 e 70 anos, casados, brancos e moradores de Londrina (Paraná, Brasil). O tempo médio de internação para pacientes graves foi 12,20 dias e, para os demais, 8,38 dias. O desfecho principal foi a alta hospitalar. Os custos operacionais em 2020 foram de R\$28.461.152,87, já em 2021 os valores encontrados foram R\$43.749.324,61. O custo médio do paciente-dia foi de R\$2.614,45 em 2020 para R\$3.351,93 em 2021. **Conclusão:** verificou-se aumento dos custos no período estudado. Conhecer os custos operacionais do pronto-socorro, possibilita o planejamento financeiro institucional contribuindo para qualificar a tomada de decisões gerenciais.

Descritores: Infecções por Coronavírus; COVID-19; Serviços Médicos de Emergência; Custos Hospitalares; Custos e Análise de Custo.

RESUMEN

Objetivo: analizar los costos operativos de un servicio de urgencias relacionado con la atención de pacientes con COVID-19 en los años 2020 y 2021. **Método:** estudio descriptivo transversal con enfoque cuantitativo. Se utilizó la medición de costos desde la perspectiva del gestor del hospital, a través del microcosteo por absorción. Los costos directos, indirectos y variables se evaluaron de arriba hacia abajo (top-down). **Resultados:** el perfil predominante fue el de hombres, con edad entre 61 y 70 años, casados, blancos y residentes en Londrina (Paraná, Brasil). La estancia media de internación de los pacientes críticos fue de 12,20 días y, de los demás, de 8,38 días. El resultado principal fue el alta hospitalaria. Los costos operacionales en 2020 fueron de R\$ 28.461.152,87, mientras que en 2021 los valores encontrados fueron de R\$ 43.749.324,61. Los costos medios del paciente/día aumentaron de R\$2.614,45 en 2020 a R\$3.351,93 en 2021. **Conclusión:** se observó un aumento de los costos en el periodo estudiado. Conocer los costos operativos de un servicio de urgencias posibilita la planificación financiera institucional, contribuyendo a calificar la toma de decisiones gerenciales.

Descriptores: Infecciones por Coronavirus; COVID-19; Servicios Médicos de Urgencia; Costos de Hospital; Costos y Análisis de Costos.

INTRODUCTION

The *Severe Acute Respiratory Syndrome Coronavirus 2*, or SARS-CoV-2, is a highly transmissible virus that causes the respiratory disease called COVID-19, which gained pandemic status in March 2020, and can evolve into a severe clinical condition due to a chronic systemic inflammatory response, causing acute respiratory distress syndrome^{1,2}.

According to the World Health Organization, nearly 80% of the people infected with SARS-CoV-2 manifest COVID-19 in its mild or moderate form, while 15% develop a more severe form, which leads to the need for oxygen therapy, and 5% need treatment in Intensive Care Units (ICUs)³.

This unusual world scenario increased the need for care in health services and brought about a consequent and inevitable increase in the demand and consumption of human and material resources, such as medications, laboratory reagents and disposable Personal Protective Equipment (PPE) items. In addition to everything that was necessary to assist patients suspected and confirmed to be infected with this disease, resulting in countless changes in care flows and a significant increase in the number of hospital beds⁴.

In this way, urgency and emergency care sectors, such as the Emergency Room (ER), which act as gateways to hospital care, are the first to feel the repercussions such as overcrowding and transformation of a unit that had a profile of rapid care and screening into a hospitalization unit, staying with seriously-ill patients who had indications of ICU vacancies, but not available due to overcrowding in hospitals.

Waiting time for medical care and total care time are key performance indicators in urgency and emergency services. This is because the length of stay recommended for patients in this sector is 24 hours. In addition to contributing to overcrowding, excessive periods of time can also generate unfavorable treatment results and continuous cost increases⁵⁻⁷.

A survey carried out in 105 Brazilian hospitals, comparing costs for the first trimesters of 2019, 2020 and 2021, found that values increased by 89% in emergency room care. Hospital fees increased by 44% and exams by 51%. This increase occurred mainly in 2020 and 2021 and was related to the exponential increase in the costs of materials and medications, according to the Key Performance Indicators for Health (KPIH) system⁸.

It should be noted that severe COVID-19 cases generated significant concern with clinical management due to lack of scientific evidence and protocols. Thus, many of the research studies conducted on the topic point to the ICU care operating costs, but studies focused on costs in Emergency services are scarce in the current literature, causing a gap in knowledge, which this study aims at answering.

In a pandemic scenario, estimating the costs of hospital sectors involved in caring for patients who have a common diagnosis, in terms of exams, medications and human resources, among others, allows knowing the operating costs, generating subsidies for the development of management strategies and decision-making⁹.

Therefore, the objective of this study is to analyze the operating costs of an emergency service related to the care of COVID-19 patients in 2020 and 2021.

METHOD

This is a cross-sectional and descriptive study, with retrospective documentary research and a quantitative approach, having as a scenario the Emergency Room (ER) of a university hospital located in northern Paraná, which offers tertiary-level care, with exclusive assistance by the Unified Health System (*Sistema Único de Saúde*, SUS).

During the COVID-19 pandemic, this institution acted as a reference in the care of moderate and severe cases of the disease, the latter type representing 68% of all the care provided.

Regarding the service capacity of the ER in question, it had 69 beds installed. However, with daily overcrowding and rendering extra beds necessary to meet the demand, with a mean renewal rate of 247.7 calculated from the sum of discharges and deaths, divided by the number of days in the period and later multiplied by 100, given the extraordinary demand of the COVID-19 pandemic.

The main characteristic of health cost calculation methods is the way in which the components are identified and evaluated. With regard to identification, costs can be estimated through macro-costing or gross-costing or micro-costing methods. As for the evaluation of cost components, the methods can be carried out "top-down" or "bottom-up"¹¹.

The measurement of the cost involved in maintaining the sector was from the hospital manager's perspective, and the cost calculation method was micro-costing by absorption, which allows defining the operating cost of the sector. Direct, indirect and variable costs related to the production unit were included and the assessment was "top-down".

It should be noted that the costs of treating the disease were not investigated, but those of all the resources involved during hospitalization, only while the patient was in the sector.

To calculate the operating costs, a sum of direct, indirect and variable costs was performed. To calculate the mean patient-day cost, the value obtained from the operating costs was divided by the number of hospitalizations in the period.

Patients with a COVID-19 diagnosis confirmed by laboratory tests and aged at least 18 years old were included in the study, with a population of 3,565 patients, excluding pregnant women.

For the definition of a representative sample, the sample calculation was applied with a 95% confidence level and a 5% margin of error, obtaining an indication for a sample of 347 medical records, which had all the information collected electronically.

The sample obtained comprises patients with COVID-19, at different levels of disease complexity, including those who needed to be admitted to ICU beds, also known in this institution as Repressed Demand (RD).

The term RD refers to patients with indications for an ICU bed, with the need for continuous monitoring, including, among its criteria, severely-ill patients with progressive clinical deterioration and a need for high oxygen demand, which can be due to advanced airway or not, continuous use of vasoactive drugs for hemodynamic control and deterioration in laboratory tests, according to the used system.

The data collected were based on the accounting records of the actual cost of maintaining the cost center of the evaluated sector, using the *Consolidated Health Economic Evaluation Reporting Standards 2022 Statement* (CHEERS) to prepare the study. Subsequently, they were transcribed into a Microsoft Excel® spreadsheet and validated through double typing.

The descriptive analysis was performed using costs calculated in reais (R\$) and in dollars (US\$) as dependent variable, the latter being calculated according to the quotation on October 10th, 2022, with a value of R\$5.19. As independent variables, gender, age group, skin color, marital status, city of origin, treatment outcome and stay in days were considered.

RESULTS

In an attempt to trace the predominant profile of services in the emergency room under study during 2021, the gender, skin color, marital status, age group, city of origin and hospitalization outcome variables of 347 patients who were admitted with a COVID-19 diagnosis were investigated.

It was possible to observe higher prevalence of male patients (56.20%), aged between 61 and 70 years old (27.95%), white-skinned (81.84%), married (46.69%) and residents of Londrina, Paraná, Brazil (61.96%).

Through the evaluation of the mean length of stay, the result obtained was that patients who were not waiting for an ICU bed remained hospitalized in this sector from one to 11 days, with a mean of 1.92 days, and that their mean length of stay total stay in the institution was nearly 8.38 days. However, those who presented clinical deterioration due to COVID-19 involvement and were waiting for an ICU vacancy remained in the ER from one to 12 days, with a mean of 2.80 days and a mean hospitalization time of 12.20 days.

In relation to the outcome presented, this can be classified as discharged and cured (5.48%) when the patient, after being discharged from the hospital, does not need any outpatient return visit to monitor their recovery, according to institutional protocol. There is also discharge with improvements, characterized by patients who require outpatient monitoring after their hospital discharge. Discharge due to evasion (0.86%), when the patient leaves the health service without medical consent. Death, represented by life end and transfer (14.70%), when the patient was referred to continue their treatment at another health institution.

The outcome of the condition presented at the end of the treatment in this sample showed important rates of hospital discharge due to clinical improvement (57.35%); however, it is important to highlight the high rates of deaths caused by COVID-19 (21.61%) during the same period.

Based on the evaluation of the profile of the patients treated at the unit, length of stay and treatment outcome, indices that offer an overview of the reality experienced by the sector in the midst of a pandemic, it is believed that these independent variables exert a direct influence on the final operating cost end of the sector. Therefore, it is possible to observe variations in the direct, indirect and variable costs in the ER during 2020 and 2021 (Figure 1).

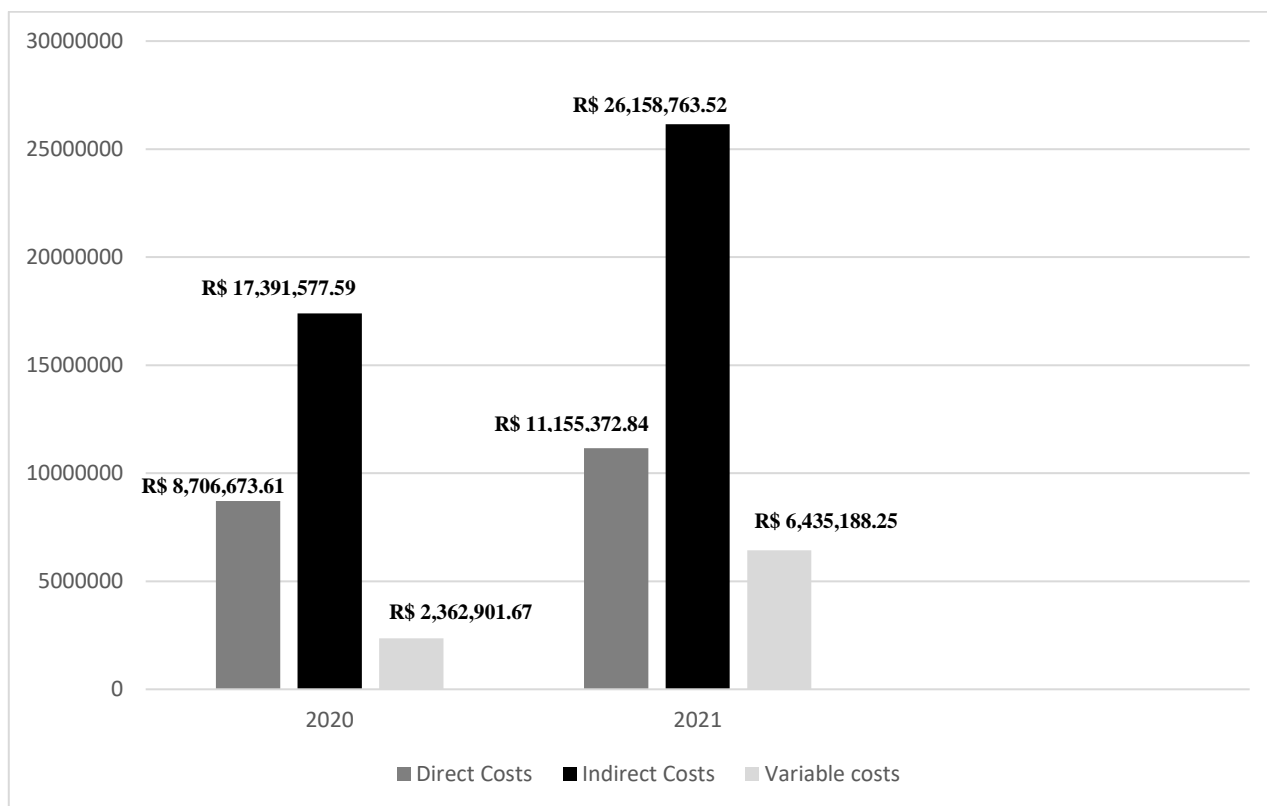


FIGURE 1: Variation of the calculations corresponding to direct, indirect and variable costs (in reais - R\$) in the Emergency Room. Londrina, PR, Brazil, 2021.

Direct costs can be stratified by human resources represented by R\$ 5,217,542.85 (US\$ 1,005,306.90) in 2020 and R\$ 5,147,182.27 (US\$ 991,749.95) in 2021, third-party services represented by R\$ 2,460,638.26 (US\$ 474,111.41) in 2020 and R\$ 4,328,803.05 (US\$ 834,066.09) in 2021, materials and medications represented by R\$ 964,480.72 (US\$ 185,834.43) in 2020 and R\$ 1,601,267.94 (US\$ 308,529.46) in 2021 and, also, general costs, represented by R\$ 64,011.78 (US\$ 12,333.67) in 2020 and R\$ 78,119.58 (US\$ 15,051.94) in 2021 (Figure 1).

In addition to the fixed costs related to maintaining service, it is important to consider the variable costs of R\$ 2,362,901.67 (US\$ 455,279.70) in 2020 and R\$ 6,435,188.25 (US\$ 1,239,920.66) in 2021, which fluctuate according to the increase or decrease in productivity of the sector (Figure 1).

It was verified that in 2020 the operating costs involved in carrying out the activities and running the emergency room were R\$28,461,152.87 (US\$5,483,844.48). However, in 2021 these costs reached R\$43,749,324.61 (US\$8,429,542.31), showing an increase of 34.95% and may be a reflection of the increase in the number of consultations and complexity of patients, as well as a longer stay in the ER in view of the pandemic scenario (Figure 1).

From a more detailed look at indirect costs, it was possible to evidence the predominance of rising values in several areas, as well as a drop in others. However, it is necessary to highlight the variables that are in line with the pandemic scenario experienced at the moment under study, such as the significant increase in costs related to gas therapy, whose value tripled in this one-year interval (Table 1).

TABLE 1: Stratification of the Emergency Room indirect costs. Londrina, PR, Brazil, 2021.

Indirect Costs	2020		2021	
	(R\$)	%	(R\$)	%
Warehouse	240,657.21	1.38	175,804.08	0.67
Archives and statistics	448,866.42	2.58	557,115.84	2.13
Surgical Center	4,580,277.45	26.34	6,627,531.24	25.34
Image exams	2,353,920.20	13.53	3,279,023.40	12.54
Laboratory tests	3,321,937.22	19.10	3,422,291.16	13.08
Gas therapy	33,907.45	0.19	116,230.32	0.44
Hemodynamics	524,855.80	3.02	22,473.60	0.09
Hospital hygiene	351,760.74	2.03	416,971.80	1.59
Laundry	527,350.78	3.03	676,702.92	2.59
Nutrition	1,030,059.80	5.93	1,168,846.56	4.47
Administrative sectors	1,563,967.83	8.99	1,760,533.08	6.73
Support sectors	2,414,016.69	13.88	7,935,239.52	30.33
Total	17,391,577.59	100	26,158,763.52	100,00

Another important data points to a significant 95.72% reduction in the hemodynamics values which, in 2020, represented 3.02% of the indirect costs and, in 2021, dropped to only 0.09% (Table 1).

The support sectors comprise the Hospital Infection Control Commission (*Comissão de Controle de Infecção Hospitalar*, CCIH), sewing, blood center, maintenance, telephony, janitorial, concierge, hemodialysis, Central Sterile Supply Department (CSSD), Information Technology (IT), social service, copies, pharmacy, dairy and psychology.

When the costs of these sectors are individually observed, it is noted that the three that have the greatest representation in costs when comparing 2020 and 2021 are as follows, respectively: blood center, with R\$ 169,627.17 (US\$ 32,683.46) in 2020 with a 96.67% increase in 2021 (R\$ 5,090,866.80/US\$ 980,899.19); pharmacy, which in 2020 represented R\$ 741,927.97 (US\$ 142,953.36) with a 23.49% increase in 2021 (R\$ 969,618.24/US\$ 186,824.32); and hemodialysis, with R\$ 309,350.23 (US\$ 59,605.05) which presented a 17.13% increase in 2021 (R\$ 373,255.44/US\$ 71,918.19) (Table 1).

When comparing the number of hospitalized patients and the operating cost of the sector, represented month by month in 2020 and 2021, a general increase is observed; however, with emphasis on the month of June which, in 2021, had the highest cost (R\$ 4,275,145.09/US\$ 823,727.37) (Table 2).

By evaluating the mean operating costs for 2020 and 2021 stratified monthly, it was possible to propose the mean daily cost for patient care (Table 2).

TABLE 2: Distributions of the monthly and annual mean patient-day costs in the Emergency Room. Londrina, PR, Brazil, 2021.

Months	Mean patient-day cost (R\$) in the ER	
	2020	2021
January	2,415.22	2,858.67
February	2,276.78	2,960.03
March	2,710.92	3,485.98
April	3,227.77	3,480.33
May	2,978.37	3,244.17
June	3,048.67	4,296.62
July	2,926.97	3,272.79
August	2,082.86	3,194.11
September	1,975.35	3,599.46
October	2,469.38	3,516.05
November	2,270.66	3,189.69
December	2,990.45	3,125.27
Annual mean	2,614.45	3,351.93

The mean daily cost per hospitalized patient for COVID-19 treatments was calculated based on the assessment of the total operating cost, which was then divided by the number of patients hospitalized during the period. Thus, there was an increase in patient-day costs in 2021, with an annual mean of R\$ 3,351.93 (US\$ 645.84), whereas the mean patient-day cost for 2020 was R\$ 2,614.45 (US\$ 503.74), with a 22.01% increase.

DISCUSSION

The profile of the first COVID-19 case documented in Brazil corresponds to a 61-year-old man who traveled to Italy, arriving in Brazil on February 21st, 2020, presentingodynophagia, runny nose, cough and fever¹¹. What the results found in this study indicate is that the profile of the patients surveyed is in line with the one presented at the beginning.

A studie indicates that 51% of the hospitalizations correspond to male patients¹². The age group most affected is between 61 and 70 years old. An Italian study evidenced that most of the cases at the beginning of the pandemic corresponded to male patients over 60 years old¹³.

The findings also show that, during the pandemic, the self-care deficit of aged men was intensified, rendering them more vulnerable to health problems¹⁴.

Advanced age is an important characteristic in relation to moderate and severe cases of the disease, as recommendation No. 39 of the National Health Council (*Conselho Nacional de Saúde, CNS*) of May 2020 reports that people over the age of 60 fit into the risk groups^{12,15}.

There was predominance of white-skinned individuals, married and living in Londrina, Paraná, Brazil, projections that were also reasserted by a study carried out in the Brazilian South region at a reference hospital for COVID-19 that analyzed 86 adult patients and showed the major frequency of white-skinned patients (72.1%), married (41.9%) and residents of the municipality where the hospital is located (64%)¹⁶.

Thus, when the treatment outcomes were evaluated, the discharge percentage was improved, followed by deaths. A study developed in Rio de Janeiro with 176 patients pointed out hospital discharge as the predominant outcome with 64.8%, followed by 35.2% of deaths¹⁷.

In relation to length of stay, the mean hospitalization time was 8.38 days for non-severe patients and 12.20 days for severely-ill patients. As described in the current literature, the mean hospitalization time can vary from 7.6 days for patients admitted to wards to 9.5 days for those in need of ICU beds^{9,16}.

From determination of the costs, it was observed that the direct costs increased by 21.96% in 2020. This impact is mainly due to third-party services and to materials and medications.

According to the institution protocol, third-party services are interpreted as outsourced labor to meet staffing needs. In the midst of the pandemic period, there was emergency hiring of service providers, which justifies the 10.54% increase.

Materials and medications presented a 3.28% increase, which can be explained by the rise in the total number of consultations, as well as the increase in the prices of inputs such as syringes, medications, gloves, masks and disposable aprons^{18,19}.

It becomes important to note that, when discussing materials and medications, the institution under study has, in addition to providing inputs at workstations, an integrated system for dispensing some inputs through the patient's care record and that variable costs are observed through these values.

Therefore, when analyzing the variable costs generated in 2020 and 2021, the 63.29% increase reflects even more clearly the intensification in the consumption of inputs for the care of COVID-19 patients. Thus, studying the variable costs becomes indispensable in the process of observing the economic impacts generated by the pandemic²⁰.

Absorption micro-costing also includes the assessment of indirect costs, with the apportionment criterion being the most commonly used in the hospital environment²¹. During the evaluation of indirect costs, there are increases closely related to the care of COVID-19 cases, as is the case of gas therapy, which increased by 70.83%.

The increase in the values of medicinal gases during the pandemic is associated with the large number of patients in need of oxygen therapy, as well as the increase in the price of 1 m³ of oxygen, given the high demand and shortage of the product¹⁸.

With regard to the hemodynamics sector, a study indicates that, during the COVID-19 pandemic, the volume of interventions aimed at the treatment of structural heart diseases decreased by more than 90%. A scenario that can be justified by the redistribution of medical resources with the contingency of professionals for COVID-19 care, as well as the concern about patients with contagion by the virus, which on several occasions made the search for the health service be late²².

It should be noted that the hospital under study had its activities focused on the COVID-19 care, causing other tertiary-level hospitals from the municipality to supply most of the demands for care to patients not contaminated by the virus.

When detailing the support sectors, a significant increase in the blood center, pharmacy and hemodialysis costs was identified. During the COVID-19 pandemic, there was a growing need for transfusion of blood components, making it necessary for blood centers to develop campaigns to attract donors in the midst of a pandemic scenario, where several restrictive measures were imposed, thus increasing the work demand of this sector²³.

In relation to the pharmacy sector, a study carried out in Rio Grande do Sul points out that the prices of medications during the pandemic significantly burdened health costs due to the use demand exceeding production in this scenario²⁴.

Regarding the hemodialysis service, there was a high number of patients who developed acute kidney injury during the COVID-19 pandemic. A study carried out in 2020 showed that nearly 32% of the patients with the disease have kidney damage requiring hemodialysis treatment²⁵.

Through a detailed month-by-month look at the years analyzed in this study, in association with the daily newsletters released by the municipal government, it is noticed that the month of June has high rates of confirmed COVID-19 cases, high numbers of deaths throughout the national territory and a consequent increase in costs in the sector.

Brazil started to occupy the second place globally in numbers of COVID-19 cases and of deaths between May and June 2021²⁶. It is believed that there is a direct relationship between these numbers and seasons of the year, when autumn and winter are conducive to the development of respiratory diseases, as well as to the spread of viruses responsible for them²⁷.

For the purpose of calculating patient-day costs, the annual mean found increased by 22.01% between the years studied. Studies on costs during the same period indicate that the daily cost of a COVID-19 patient is between R\$ 2,500.00 and R\$ 3,000.00²⁸.

The increase in the patient-day cost values when comparing the years is due to the unhealthiness of the sectors that care for these cases, with the increase in the amount of inputs and individual protection equipment items used by the work team with the purpose of preventing contagion among the professionals¹⁹.

Therefore, the financial impacts generated by the pandemic not only concern the increase in the number of consultations reflected in hospital expenses, but also reflect macroeconomic and social issues. This new scenario made the emergency room assume a central and strategic role during the pandemic.

Study Limitations

The cost structure developed by the researched institution, where some types of costs commonly identified as direct are calculated through apportionment criteria proportionally to each sector, thus becoming part of the indirect cost calculations, presented itself as a study limitation.

CONCLUSION

It is concluded that there was an increase in costs during the period under study. Comprehensive knowledge of costs by managers of health institutions allows supervising the metrics of each unit, promoting monitoring of the results. During the COVID-19 pandemic, the care units for infected patients underwent severe changes with regard to materials and human resources, legacies left by the pandemic where an understanding of the new reality is currently being sought. Therefore, it is up to managers to approach data that exert a direct impact on the budget, such as material values, payroll, patient waiting time and equipment idle time.

REFERENCES

1. Zhu N, Zhang D, Wang W, Xingwang L, Yang B, Jingdong S, et al. A novel coronavirus from patients with pneumonia in China, 2019. *N Engl J Med*. 2020 [cited 2022 Jul 15]; 382(8):727-33. DOI: <https://doi.org/10.1056/nejmoa2001017>.

2. Siordia JA. Epidemiology and clinical features of COVID-19: a review of current literature. *J Clin Virol.* 2022 [cited 2022 Jul 15]; 127:104357. DOI: <https://doi.org/10.1016/j.jcv.2020.104357>.
3. World Health Organization. Oxygen sources and distribution for COVID-19 treatment centres: interim guidance. Geneva: WHO; 2020 [cited 2022 Jul 15]. Available from: <https://www.who.int/publications/i/item/oxygen-sources-and-distribution-for-covid-19-treatment-centres>.
4. Nogueira DNG, Aligleri A, Sampaio CP. Medical Waste: implications for the new coronavirus pandemic scenario. *Adv Nurs Health.* 2020 [cited 2022 Jul 12]; 2:11-5. Available from: <https://ojs.uel.br/revistas/uel/index.php/anh/article/view/39760>.
5. Oliveira IS. Gerenciamento de leitos no setor de urgência e emergência [dissertação de mestrado]. Vitória: Universidade Federal do Espírito Santo; 2019.
6. Brito MP. Aplicação de técnicas de gestão avançada Lean Healthcare para otimizar o fluxo de pacientes do pronto-socorro de um hospital universitário público de Belo Horizonte [dissertação de mestrado]. Belo Horizonte: Universidade Federal de Minas Gerais; 2018 [cited 2022 Jul 12]. Available from: <https://repositorio.ufmg.br/handle/1843/BUOS-BCDPTM>.
7. Borges F, Bernardino E, Stegani MM, Tonini NS. Performance of nurses in the bed management service of a teaching hospital. *Rev Bras Enferm.* 2020 [cited 2022 Jul 12]; 73(4): e20190349. DOI: <http://dx.doi.org/10.1590/0034-7167-2019-0349>.
8. Pizetta L, Reis AC, Mexas MP. Indicadores chave de desempenho para gestão hospitalar: percepções de gestores públicos de saúde. *RAHIS.* 2022 [cited 2022 Jul 12]; 19(4). DOI: <https://doi.org/10.21450/rahis.v19i4.8026>.
9. Santos HLP, Maciel FBM, Santos Junior GM, Martins PC, Prado NMB. Gastos públicos com internações hospitalares para o tratamento da COVID-19 no Brasil em 2020. *Rev Saude Publica.* 2021 [cited 2022 Jul 12]; 55:52. DOI: <https://doi.org/10.11606/s1518-8787.2021055003666>.
10. Brasil. Ministério da Saúde. Diretriz metodológica: estudos de microcusteio aplicados a avaliações econômicas em saúde. Secretaria de Ciência, Tecnologia e Insumos Estratégicos; 2019 [cited 2019 Aug 20]. Available from: https://rebrats.saude.gov.br/images/Documentos/Diretriz_Metodologica_Estudos_de_Microcusteio_Aplicados_a_Avaliacoes_Economicas_em_Saude.pdf.
11. Rodriguez-Morales AJ, Gallego V, Escalera-Antezana JP, Méndez CA, Zambrano LI, Franco-Paredes C, et al. COVID-19 in Latin America: the implications of the first confirmed case in Brazil. *Travel Med Infect Dis.* 2020 [cited 2022 Jul 12]; 35:101613. DOI: <https://doi.org/10.1016/j.tmaid.2020.101613>.
12. Rosso LH, Carvalho SM, Maurer TC, et al. Perfil e desfechos clínicos de pacientes internados por COVID-19 em um hospital d. o sul do Brasil. *Rev Baiana Enferm.* 2022 [cited 2022 Out 05]; 36:1-11. DOI: <https://doi.org/10.18471/rbe.v36.45838>.
13. Lagi F, Piccica M, Graziani L, Vellere I, Botta A, Tilli M, et al. Early experience of an infectious and tropical diseases unit during the coronavirus disease (COVID-19) pandemic, Florence, Italy, February to March 2020. *Euro Surveill.* 2020 [cited 2022 Aug 7]; 25(17). DOI: <https://doi.org/10.2807/1560-7917.ES.2020.25.17.2000556>.
14. Muniz VO, Braga LCA, Araujo PO. Self-care deficit among older men in the COVID-19 pandemic: implications for nursing. *Rev Bras Enferm.* 2022 [cited 2022 Aug 7]; 75(4):e20210933. DOI: <https://doi.org/10.1590/0034-7167-2021-0933pt>.
15. Girão MMF, Coelho NP, Barroso BS, Gadelha MSV. Perfil epidemiológico dos pacientes de SARS-COV-2 no Brasil. *Id on Line Rev. Mult. Psic.* 2020 [cited 2022 Aug 7]; 14(51):646-58. DOI: <https://doi.org/10.14295/online.v14i51.2605>.
16. Pontes L, Danski MTR, Piubello SMN, Pereira JFG, Jantsch LB, Costa LB, et al. Clinical profile and factors associated with the death of COVID-19 patients in the first months of the pandemic. *Esc Anna Nery.* 2022 [cited 2022 Aug 7]; 26:e20210203. DOI: <https://doi.org/10.1590/2177-9465-EAN-2021-0203>.
17. Alves RP, Carvalho JVB, Santos LASL. Perfil dos pacientes adultos com COVID-19 internados em uma unidade de terapia intensiva. *Res. Soc. Dev.* 2022 [cited 2022 Aug 7]; 11(5):e43411528481. DOI: <http://dx.doi.org/10.33448/rsd-v11i5.28481>.
18. Rios JR. Análise de custos em uma unidade de terapia intensiva nos anos de 2018 a 2020: estudo em um hospital universitário do Triângulo Mineiro [monografia]. Uberlândia: Universidade Federal de Uberlândia; 2021 [cited 2022 Aug 7]. Available from: <https://repositorio.ufu.br/handle/123456789/33038>.
19. Brollo NP, Guth SC. Os impactos decorrentes da pandemia ocasionados pela COVID-19 nos custos hospitalares de unidade de terapia intensiva (UTI). *Repositório Institucional da UCS;* 2021 [cited 2022 Jul 12]. Available from: <https://repositorio.ucs.br/xmlui/bitstream/handle/11338/9615/Artigo%20Natieli%20Panisson%20Brollo.pdf?sequence=1&isAllowed=y>.
20. Vieira DHDC, Teodósio ASS, Fraga M S. Aplicação do custeio variável: a eclosão da epidemia da Covid-19 e o gerenciamento econômico de microempresa. In: *Anais do XXVIII Congresso Brasileiro de Custos;* 2021 nov 17-19; Brasil, Associação Brasileira de Custos; 2021 [cited 2022 Aug 7]; p. 1-16.
21. Leite G, Soraggi G, Bcheche H, Grossi L. Métodos de custeio: conceitos, análises e aplicações. Belo Horizonte: PJ Consultorias; 2020 [cited 2022 Aug 7]. Available from: <https://pjuufmg.com.br/wp-content/uploads/2020/05/E-book-de-controle-de-custos-1.pdf>.
22. Sharma A, Razuk V, Nicolas J, Beerkens F, Dangas GD. Dois anos de pandemia da COVID-19: implicações para as salas de hemodinâmica e suas práticas atuais. *J. Transcatheter Interv.* 2022 [cited 2022 Aug 7]; 30:eA20220003. DOI: <https://doi.org/10.31160/JOTCI202230A202203>.
23. Chaves AN, Menezes TMO, Silva VA, Trajano RA, Freitas RA, Batista VM. Doação de sangue na pandemia da COVID-19: campanha incentivadora em um hemocentro. *REAS.* 2022 [cited 2022 Aug 7]; 15(9):e10903. DOI: <https://doi.org/10.25248/reas.e10903.2022>.
24. Lanza K. Custos de medicamentos durante a pandemia de COVID-19: uma análise situacional [dissertação de mestrado]. Santa Maria: Universidade Federal de Santa Maria; 2022 [cited 2022 Aug 7]. Available from: <https://repositorio.ufsm.br/handle/1/25673>.

25. Gallota C, Viana TG, Augusto F, Genovese RE, Balda CA, Carneiro IA. Impacto da pandemia pela COVID-19 no perfil de pacientes críticos atendidos por um serviço de hemodiálise. SciELO Preprints. 2022;2022 [cited 2022 Aug 7]; 1(3429). DOI: <https://doi.org/10.1590/SciELOPreprints.3429>.
26. Fiocruz. Observatório COVID-19. Boletim observatório COVID-19 após seis meses de pandemia no Brasil. Rio de Janeiro: Fiocruz; 2020.
27. Pires D, Furlan Junior O, Ribeiro Filho AA. A influência do clima sobre infecções respiratórias agudas em crianças de zero a cinco anos: estudo de caso no município de Rio Rufino no planalto catarinense. Centro Universitário Unifacvest; 2019 [cited 2022 Jul 15]. Available from: <https://www.unifacvest.edu.br/assets/uploads/files/arquivos/8a503-a-influencia-do-clima,-pires-2019-2.pdf>.
28. Carlos ACS, Porto F. Custos das diárias de unidade de terapia intensiva no Sistema Único de Saúde na COVID-19. J Manag Prim Health Care. 2020;2022 [cited 2022 Aug 7]; 12e:003. DOI: <https://doi.org/10.14295/jmphc.v12.1099>.

Author's contributions:

Conceptualization: L.C.O. and D.N.G.N.; methodology, M.C.J. and M.C.N.Y.; data curation, L.C.O.; investigation, L.C.O. and D.N.G.N.; formal analysis, L.C.O. and D.N.G.N.; manuscript writing, L.C.O. and D.N.G.N.; writing—review and editing, L.C.O. and A.L.B.; visualization, M.C.N.Y., C.C.T., M.C.J. and D.N.G.N.; supervision, M.C.N.Y., C.C.T., M.C.J. and D.N.G.N. All authors have read and agreed to the published version of the manuscript.