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**Manuscript Title:**
Impact of a Prolonged COVID-19 Lockdown on Patterns of Admission, Mortality and Performance Indicators in a Cardiovascular Intensive Care Unit.

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Abstract

**Background:** The effects of an early and prolonged lockdown during the COVID-19 pandemic on cardiovascular intensive care units is not well established. This study analyses patterns of admission, mortality and performance indicators in a cardiovascular intensive care unit before and during the Argentine lockdown in the COVID-19 pandemic.

**Methods:** This is a retrospective observational cross-sectional study of all consecutive patients aged 18 years or more admitted to the Cardiac Intensive Care Unit at a high-volume reference hospital in Buenos Aires, Argentina comparing hospitalization rates, primary causes of admission, inpatient utilisation indicators, pharmacy supplies expenditures, and in-hospital mortality between March 5 and July 31, 2020 with two corresponding control periods in 2019 and 2018.

**Results:** We included 722 patients [mean age of 61.6 (SD 15.5) years; 237 (32.8%)] were females. Overall hospitalisations dropped 53.2% (95%CI: 45.3, 61.0%) from 295.5 patients/year over the periods 2018/2019 to 137 patients in 2020. Cardiovascular disease-related admissions dropped 59.9%, while admission for noncardiac causes doubled its prevalence from 9.6% over the periods 2018/2019 to 22.6% in the study period (P<0.001).

In the period 2020, the bed occupancy rate fell from 82.2% to 77.4%, and the bed turnover rate dropped 50% from 7.88 to 3.91 monthly discharges/bed. The average length of stay doubled from 3.26 to 6.75 days, and the turnover interval increased from 3.8 to 8.39 days in 2020.
Pharmacy supplies expenditures per discharge increased 134% along with a rise in antibiotics usage from 6.5 to 11.4 vials/ampoules per discharge ($P<0.02$). Overall mortality increased from 7% ($n=41$) to 13.9% ($n=19$) ($P=0.008$) at the expense of noncardiac related admissions (3.6% to 19.4%, $P=0.01$).

**Conclusions:** This study found a significant reduction in overall and cardiovascular disease-related causes of admission to the cardiac intensive care unit, worse performance indicators and increased in-hospital mortality along the first five months of the early and long-lasting COVID-19 lockdown in Argentina. These results highlight the need to foster public awareness concerning the risks of avoiding hospital attendance. Moreover, health systems should follow strict screening protocols to prevent potential biases in the admission of patients with critical conditions unrelated to the COVID-19 pandemic.

**Keywords:** Quality indicators, Patient outcomes, Public health, Equity in health care, Cardiovascular diseases, Intensive care
Impact of a Prolonged COVID-19 Lockdown on Patterns of Admission, Mortality and Performance Indicators in a Cardiovascular Intensive Care Unit

Introduction

During the Coronavirus Disease 2019 (COVID-19) pandemic, reports have suggested a decrease in the number of patients presenting to hospitals with emergency conditions such as acute myocardial infarction.¹ This drop is related not only to temporarily postponed elective procedures but also to a delay in seeking medical care for urgent and life-threatening cardiac conditions. The reasons for this phenomenon are unclear, but there have been concerns that fear of contracting COVID-19 may contribute.² On March 20 2020, Argentine authorities imposed a nationwide lockdown to prevent the spread of novel coronavirus disease and manage health care limited resources. Unlike other countries, in Argentina, the lockdown began early over the whole country, far before the exponential growth of new cases, and extended for more than 150 days in cities with high population density. This strategy may have increased the reluctance of patients with symptoms to contact emergency medical services and result in detrimental effects on medical care.

This study aims to analyse patterns of admission, mortality and performance indicators in a cardiovascular Intensive care unit before and during the lockdown in the COVID-19 pandemic.

We performed a single-centre cross-sectional study analysing the number of hospitalisations, causes of admission, in-hospital mortality and key performance indicators in a Cardiovascular Intensive Care Unit (CICU) in one of the four high
volume acute care reference state hospitals serving a catchment population of approximately three million people.

Methods

We retrospectively included all consecutive patients admitted to the CICU in the Division of Cardiology at the Hospital General de Agudos Dr. Cosme Argerich in Buenos Aires, Argentina. This reference centre, along with three others and thirty referral hospitals, is part of a net of thirty-four state hospitals distributed radially in the city.

The study period encompasses the interval between the first confirmed case of COVID-19, March 5, and July 31 2020. We compared bed availability, hospitalisation rates, causes of admission, in-hospital mortality and performance indicators between the study period and two control periods corresponding to the same dates in 2019 and 2018.

Primary objectives included:

1. CICU overall admission and discharge rates;
2. primary causes of admission;
3. performance indicators analysis (inpatient utilisation indicators and pharmacy supplies expenditures); and
4. in-hospital mortality.

Inpatient utilisation indicators analysis included:

- bed occupancy rate (BOR): number of beds effectively occupied (bed-days)/number of beds \( \times 100 \);
- bed turnover rate (BTR): number of discharges (including deaths) in a given period/number of beds during that period;
• average length of stay (ALOS): total inpatient days of care/total discharges;
  
and

• Turnover interval (TOI): (available staffed bed days – occupied bed
days)/inpatient discharges.

Pharmacy supplies expenditures are expressed in rounded whole numbers in
local currency (ARS) using July 2020 purchase prices for both periods. To
simplify the analysis, we grouped supplies according to their primary therapeutic
effect in antibiotics, vasopressor drugs, inotropic agents, hypnotics and
analgesics, personal protective equipment, disposables supplies, or others. We
analysed efficiency by estimating pharmacy supplies expenditures per
discharge (ARS/discharge index).

For comparison, and given the heterogeneity of conditions admitted to the
CICU, we classified the primary cause of admission into the following groups:

• Post-Cath Lab. monitoring (PCL): all non-emergency Cath Lab central or
  peripheral diagnostic and therapeutic interventions monitored in the CICU
  after the procedure.

• Post-cardiovascular surgery monitoring (PCS): all elective or
  urgent/emergency cardiovascular surgical procedures with monitoring
  requirements in the CICU, including coronary, valvular, carotid, aortic or
  peripheral vascular surgeries.

• Electrophysiological interventions (EPI): supraventricular and ventricular
  arrhythmia ablations and pacemaker, defibrillator or cardiac
  resynchronisation therapy device implantations.

• Acute myocardial infarction (AMI): all acute coronary syndromes with ST-
  segment elevation or new left bundle branch block.
• Acute coronary syndrome (ACS): all acute syndromes other than AMI (unstable angina, non-Q infarction, vasospastic angina, or Tako-Tsubo syndrome).

• Arrhythmias: paroxysmal supraventricular and ventricular tachycardia, atrial fibrillation or flutter.

• Heart failure (HF): all cases of hemodynamic instability including left and right heart failure, pulmonary hypertension, pulmonary embolism, cardiac tamponade, or infective endocarditis.

• Non-cardiac conditions (NCC): stroke, pneumonia, acute renal failure, cardiorespiratory arrest unrelated to heart disease and other non-cardiovascular conditions admitted to the CICU.

Statistical Analysis

Categorical variables are described as absolute and relative frequencies and compared using the chi-square test. Quantitative variables are presented as mean and standard deviation (SD) or as the median and interquartile range [IQR 25-75] according to its distribution. Normality was checked using the Shapiro-Wilk test.

Means and 95% confidence intervals (95% CI) were determined for data obtained from 2018 and 2019 and compared with raw data from 2020.

Sample size

Based on the range of reduction of acute coronary syndromes and cardiovascular admissions observed in previous studies (25-60%) (3-9), we calculated a sample size of 124 patients in each group to achieve a power level
of 80% for a 25.2% relative risk reduction in the rate of cardiovascular admissions with a selected two-sided alpha level of 0.05 in a chi-squared test. Observed variations are expressed as percentages and 95% CI of reduction or increase from historical levels. A P-value<0.05 was considered significant. For data processing, we used Epi Info version 7.2.

**Ethics**

Under the Hospital General de Agudos “Cosme Argerich” ethics committee guidelines for clinical research, no approval requirement is necessary for this type of protocol; i.e., observational cross-sectional study without personal information disclosures. All participants signed an informed consent form. Diagnostic parameters and clinical assessments were performed according to the 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation (10) and the 2015 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation (11).

Data were collected fulfilling the ‘Epi-cardio’ database questionnaire (Epicrisis v. 3.0) at each CICU discharge (12).

**Results**

This cross-sectional study included 722 patients, 237 (32.8%) female, with a mean age of 61.6 (SD 15.5) years. There were no differences in age [64.5 (SD 15.2) vs 62.1 (SD 16.4)]; P=0.66) or female gender distribution (33.7% vs 29.2%; P=0.31) between the periods 2018/2019 and the period 2020. The bed availability was similar in both periods. Total admissions dropped from 585 in 2018/2019 (mean 292.5 patients per year) to 137 in 2020 (53.2%, 95%CI: 45.3,
61.0). This reduction occurred as a consequence of a substantial drop in cardiovascular disease-related admissions (59.9%) partially counterbalanced by a 10.7% increase in admissions for non-cardiac reasons, that doubled its prevalence from 56/585 patients (9.6%) over the periods 2018/2019 to 31/137 patients (22.6%) in the study period (\(P<0.001\)).

The decrease in cardiovascular disease-related admissions was primarily associated with PCL, PCS, AMI and other types of ACS.

Table 1 shows the reduction in CICU hospitalisation rates according to the primary cause of admission.

Regarding inpatient utilisation indicators, we observed a slight reduction in the BOR from 82.2% over the combined period 2018/2019 to 77.4% in the period 2020. The BTR along the study period was 3.91 monthly discharges per bed, representing a 50% drop compared to the average BTR (7.88) in the periods 2018/2019. Moreover, there was a twofold increase in ALOS from 3.26 days in 2018/2019 to 6.75 days in 2020. Similarly, TOI rose from 3.8 days in 2018/2019 to 8.39 days in 2020.

Monthly comparisons of inpatient utilisation indicators showed considerable variations during the period 2020 (Figure 1). The BOR dropped in June to 52.9% along with an increase in TOI to the highest level (11.3 days). Likewise, BTR achieved in June the lowest level (2.71 discharges per bed). On the other hand, July was the month with the highest BOR (100%) and ALOS (8.4 days).

Contrary to expectations, pharmacy supplies expenditures remained relatively stable, with a slight increase from ARS 5.8 million over 2018/2019 to ARS 6.2 million in 2020. However, after indexing pharmacy supplies expenditures per discharge, we found a 134% increase from about ARS 20,100 over 2018/2019
to ARS 47,100 in 2020. We also observed a decrease in antibiotics expenditure in 2020 from ARS 781,000 to ARS 748,500. On the other hand, there was an increase in personal protective equipment (51%), hypnotics, analgesics (50%) and vasoactive drugs (21%) expenditures. Other pharmacy supplies expenditures remained nearly constant over both periods. Despite the abovementioned reduction in antibiotics spending, the analysis of the number of vials used per discharge showed an increase from 6.5 units over the periods 2018/2019 to 11.4 in 2020 ($P<0.02$) (Table 2).

In-hospital mortality increased from 7% (41/585 patients) in 2018/2019 to 13.9% along the study period (19/137 patients, $P=0.008$). After stratifying mortality by cardiovascular and non-cardiac causes of admission, only the later increased the mortality rate (3.6% in 2018/2019 vs 19.4% in 2020, $P=0.01$) (Table 3).

Discussion

**Principal findings:**
We found a decrease in overall (53.2%) and cardiovascular (59.9%) CICU admissions with a 10.7% increase in hospitalisations for non-cardiac reasons (doubling its prevalence), worse performance indicators such as a 50% drop in bed turnover and almost a two-fold increase in mortality.

**Strengths and limitations:**
To our knowledge, this is the first report analysing causes of admission, in-hospital mortality and key-performance indicators in a CICU at a high-volume
acute care reference hospital during an early and long-lasting lockdown in the COVID-19 pandemic.

Some limitations should be noted. First, the study was carried out in a single-centre. Second, since up to 50% of urgent percutaneous coronary interventions are ordinarily referred from other centres, a lower number of referrals in the current context of the COVID-19 pandemic may have contributed to the reduction in admissions for AMI and other types of ACS. Third, there is no accurate information on the emergency department triage regarding screening criteria for hospital admissions to CICU.

*Interpretation within the context of the wider literature:*

Unlike other countries, COVID-19 mandatory lockdown began early in Argentina, with a low number of confirmed cases and even with a long doubling time. The lockdown remained for 150 days in high-density population cities and the metropolitan area of Buenos Aires. This particular policy resulted in a long doubling time during the first 60 days. The next step was to allow several activities, which in turn contributed to the faster spread of the disease that reached a peak in July. In this scenario, we observed a 50% reduction in CICU admissions compared with equal periods in the past two years. This decline occurred at the expense of a significant drop in hospitalisations for cardiovascular reasons. The increase observed in non-cardiac causes of admission did not compensate for the sharp fall in overall hospitalisations. Bhatt et al. has reported in a multicentric study a 40% reduction in Massachusetts State admissions to the CICU in March 2020.³

The monthly-trend analysis revealed a consistent reduction in admissions throughout the study period. Other countries as Germany, UK and several USA
states have reported a sharp fall in admissions for only 30 days at the onset of coronavirus pandemic with a rapid recovery in the following month.\textsuperscript{4,5}

Several facts may account for the decrease in admissions to the CICU in Argentina. First, during the pandemic onset, patients' reluctance to seek medical care for fear of contracting the infection in hospital facilities and traffic restrictions imposed during the first phase may have contributed to a lower patient volume. Second, the overburden of the emergency department with suspect cases of COVID-19 may have reduced the admission for patients with other conditions. Subsequently, the full occupancy of intensive care unit beds with COVID 19 patients resulted in more critical non-cardiac patients admitted to CICU to the detriment of bed availability for those presenting with cardiac conditions.

Although the fall in admission rates was evident in every group, it markedly affected patients with AMI as a consequence of a 65% decrease in primary percutaneous interventions at the Cath Lab and a similar reduction (60%) in ACS without ST-elevation admissions. It was due to imposed protocols delaying invasive intervention to prioritise human resources in the health care system.

Other countries have applied similar protocols; for example, the UK, Austria, Italy and the USA reduced ACS admissions by 39.4%, 26.5%, 40% and 38%, respectively.\textsuperscript{4,6-8} Likewise, Northern Italy cut down non-urgent percutaneous procedures above 50%.\textsuperscript{9}

The increase observed in ALOS differs from other series in which a reduction was detected.\textsuperscript{3} Two factors may explain this rise and the drop in BTR. Although there was a marked decrease in admissions usually associated with a short length of stay, e.g., PCL monitoring, AMI and other types of ACS, the increase
in the prevalence of patients admitted with non-cardiac diseases requiring complex and long-lasting therapies, i.e., a prolonged stay, altered both inpatient utilisation indicators.

The increase in ALOS and TOI with a stable BOR seems to be inconsistent. The analysis of Figure 1 may explain this paradox. Of note, none of the inpatient utilisation indicators rates showed a homogeneous performance over the whole study period. The BOR dropped to 52.9% in June and rose sharply up to 100% in July whereas TOI reached the peak in June when BTR was at the lowest level. The performance of these indicators may be explained by how the COVID-19 outbreak evolved along the study period. New cases edged up over March and April, doubled every two weeks in June and reached almost a weekly doubling time in July. We hypothesize that the decline in visits to the emergency department in June may have resulted in a consequent drop in CICU admissions increasing the TOI indicator. The public’s fear of getting infected in hospital, the adoption of restrictive measures and a firm stay-at-home recommendation may account for this finding. Later in July, the overburden of the intensive care units with COVID-19 cases resulted in the admission of critical non-cardiac patients to the CICU, which in turn determined the highest BOR and ALS for the study period.

The severity of non-cardiac patients explains by itself the high death rate observed throughout the period 2020 as has been already observed when a health care system focuses on COVID-19 delaying the medical response to less severe patients.\(^7\)

Despite the lower rate of admissions, CICU costs remained high. Other authors have reported similar findings.\(^{13}\) Pharmacy supplies expenditures per discharge
far doubled the two previous years’ amounts. The requirement of antibiotics, analgesics, vasoactive and hypnotic drugs, and personal protective equipment is responsible for this increment.

The increase in the prevalence of admissions for non-cardiac reasons explains the antibiotics, analgesic, and hypnotic drugs overspending. COVID-19 pandemic is responsible for the personal protective equipment increment.

*Implications for policy, practice and research:* These results highlight the need to foster public awareness concerning the risks of avoiding hospital attendance, particularly in most vulnerable groups. Moreover, health systems should follow strict screening protocols to prevent potential biases in the admission of patients with critical conditions unrelated to the COVID-19 pandemic.

*Conclusions*  
This cross-sectional study found a significant reduction in CICU admissions, a shift in admission diagnoses, worse performance indicators and increased in-hospital mortality in a high-volume acute care reference centre during the first five months of the enduring Argentine COVID-19 lockdown.
Contributorship: Dr JLS (corresponding author) had full access to all data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

- Concept and design: Authors # 1 and 3 in the list
- Acquisition of data: Authors # 8, 9, and 10 in the list
- Analysis and interpretation of data: Authors # 1, 7, and 11 in the list
- Drafting of the manuscript: Authors # 2, 4, 5, and 6 in the list
- Statistical analysis: Authors # 11 in the list

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Conflict of interests: There is no conflict of interests.

Data Availability: The data that supports the findings of this study cannot be shared publicly for the privacy of individuals that participated in the study. The data will be shared on reasonable request to the corresponding author.
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### Tables and Figures

**Table 1.** Reduction in CICU cardiovascular hospitalisation rates according to the primary cause of admission.

|                  | 2018 | 2019 | Mean | 2020 | % reduction | 95%CI      |
|------------------|------|------|------|------|-------------|------------|
| Arrhythmias      | 26   | 31   | 28.5 | 13   | 54.4        | 29.59, 79.18 |
| AMI              | 37   | 40   | 38.5 | 13   | 66.2        | 47.88, 84.59 |
| ACS              | 35   | 39   | 37   | 15   | 59.5        | 38.94, 79.98 |
| HF               | 46   | 60   | 53   | 30   | 43.4        | 23.14, 63.65 |
| PCL              | 61   | 65   | 63   | 22   | 65.1        | 50-49, 79.67 |
| PCS              | 25   | 42   | 33.5 | 8    | 76.1        | 59.57, 92.67 |
| EPI              | 14   | 8    | 11   | 5    | 54.5        | 14.70, 94.39 |

PCL: post Cath. Lab. monitoring, PCS: post-cardiovascular surgery monitoring, AMI: acute myocardial infarction, HF: heart failure, EPI: electrophysiological interventions, ACS: acute coronary syndrome.
Table 2. Pharmacy supplies expenditures in 2018/2019 and 2020.

|                                  | Mean 2018/2019 (ARS) | 2020 (ARS) |
|----------------------------------|----------------------|------------|
| Antibiotics                      | 781,000              | 748,500    |
| Personal protective equipment    | 230,000              | 384,400    |
| Analgesics/Hypnotic drugs        | 536,500              | 821,000    |
| Inotropic drugs                  | 455,600              | 465,000    |
| Vasoactive drugs                 | 100,100              | 121,100    |
| Heparins                         | 393,100              | 421,000    |
| Disposable supplies              | 2,0 million          | 1,9 million|
| Other drugs and supplies         | 1,3 million          | 1,4 million|
| Total                            | 5,8 million          | 6,2 million|

Table 3. In-hospital mortality in 2018/2019 and 2020.

|                                  | 2018/19     | 2020    | P=  |
|----------------------------------|-------------|---------|-----|
|                                 | n   | %     | n   | %   |     |
| In-hospital Mortality           | 41/585 | 7.0   | 19/137 | 13.9 | 0.008 |
| Cardiovascular                   | 39/529 | 7.4   | 13/106 | 12.3 | 0.09  |
| Non-cardiovascular               | 2/56   | 3.6   | 6/31   | 19.4 | 0.01  |
**Figure 1.** Monthly variation of inpatient utilisation indicators in 2018/2019 and 2020.

### A. Bed Occupancy Rate

| Month | 2018-2019 | 2020 |
|-------|-----------|-------|
| MAR   | 68.8      | 69.0  |
| APR   | 71.8      | 81.6  |
| MAY   | 85.6      | 80.7  |
| JUN   | 97.0      | 52.9  |
| JUL   | 90.4      | 100   |

### B. Bed Turnover Rate

| Month | 2018-2019 | 2020 |
|-------|-----------|------|
| MAR   | 8.02      | 8.42 |
| APR   | 6.14      | 4.77 |
| MAY   | 7.98      | 2.92 |
| JUN   | 7.43      | 2.15 |
| JUL   | 7.57      | 3.57 |
The monthly variation of inpatient utilisation indicators over 2018/2019 remained stable. In 2020, the bed occupancy rate dropped almost 50% in June and rose sharply up to 100% in July while the turnover interval reached the peak in June when the bed turnover rate was at the lowest level.