

RESEARCH ARTICLE**Demographics, Diagnoses, Care Patterns, and Outcomes of Patients Admitted to a Cardiac Intensive Care Unit in a High-Volume Reference Tertiary Center in South America****Authors**

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Abstract**Background**

Single and multi-center studies have described substantial changes in the landscape of health care in cardiac intensive care units (CICU). Few reports have quantitatively characterized current diagnoses in a contemporary CICU in Latin America.

This study aims to describe demographics, diagnoses, care patterns, and outcomes in patients admitted to a CICU in a high-volume center in South America.

Methods

A total of 1629 consecutive patients admitted to CICU from December 2017 to April 2020 were included in a prospective registry. The variables analyzed included demographic data, admission and final diagnoses, management, and outcomes.

Results

Among 1629 participants, 32.4% were women, and the median age was 62 years (53-71).

Admissions were due to primary cardiac causes in 1335 (81.9%), postsurgical care in 13.3%, and a combination of general and cardiac diagnoses in 4.8% of patients. The most frequent diagnosis on admission was acute coronary syndrome (ACS) (35.7%). Primary reasons for CICU admission were postprocedural observation (PPO) (31.8%), diagnosed or suspected ACS (31.7%), heart failure (10.1%), postsurgical management after cardiovascular surgery (8.9%), arrhythmia (5.8%), shock (4.5%) and cardiac arrest (CA) (1.2%). Advanced CICU therapy requirements were ventilatory assistance (19.3%) and vasoactive or inotropic drug use (19.6%). The overall mortality rate was 6.4%. Admission diagnoses associated with the highest mortality rates were CA (52.6%), noncardiogenic shock (39.5%), and cardiogenic shock (32.3%). Notably, patients admitted solely for PPO had a mortality rate of 0.8%.

Conclusions

In a contemporary CICU from a high-volume reference center in South America, the most frequent diagnosis was an ACS, although it represented only one-third of the admissions. One-fifth of admissions required advanced CICU therapies. CA and shock on admission carried a poor prognosis. We identified PPO as a substantially low-risk population.

1. Background

The creation of Coronary Care Units (CCUs) in the 1960s allowed to carry out surveillance and immediate treatment of life-threatening arrhythmias in acute myocardial infarction (AMI) with electrical cardioversion, one of the most significant innovations occurred in the realm of cardiology.¹ Since its creation, there have been prominent shifts in the demographic characteristics of patients admitted to CCUs, with a reduction in the incidence of AMI with ST-elevation (STEMI), an increased incidence of non-ST-elevation acute coronary syndrome (NSTEMI-ACS), and a higher proportion of patients with hemodynamic compromise associated with other cardiovascular conditions. All this combined with an increasingly older patient population with more comorbidities.^{2,3} For this reason, CCUs changed its name to Cardiac Intensive Care Units (CICU). Many changes have been observed in several US registries regarding diagnoses, severity, comorbidities, and need for non-cardiac therapies in the CICU.⁴⁻⁸ Other investigators have reported an increase in non-cardiac conditions, which reflects a higher proportion of patients with chronic cardiovascular disease presenting with an acute non-cardiac complication, e.g., sepsis.⁸ Accordingly, the Medical community needs to redesign them. Therefore, cardiologists need to adapt themselves to these changes in critical cardiac care and characterize the demographics, diagnoses, technologies, therapies, and outcomes objectively in the current CICUs to contribute to such redesigning.^{9,10} Since there is limited

information from South American CICUs, we carried out this study to further characterize demographics, diagnoses, care patterns, and outcomes of patients admitted in the contemporary setting of a CICU in South America.

2. Methods

This prospective study included all consecutive patients admitted from December 2017 to April 2020 to the CICU in the Division of Cardiology at the Hospital General de Agudos "Dr. Cosme Argerich" in Buenos Aires, Argentina. We analyzed risk factors, cardiovascular history, and comorbidities such as chronic obstructive pulmonary disease (COPD), chronic kidney disease (CKD), cancer, rheumatic disorders, and dementia.

We quantified the use of different treatment modalities, including inotropes and vasopressor drugs, mechanical ventilation (MV), noninvasive ventilation (NIV), hemodialysis, hemofiltration, intra-aortic balloon pump counter pulsation (IABP), and temporary pacing. We also analyzed the use of invasive hemodynamic monitoring with Swan Ganz (SG) or central venous catheters (CVC).

We categorized reasons for admission as cardiac, cardiac complications in otherwise non-cardiac patients, non-cardiac complications in patients with heart disease, post-cardiac surgery (PCS), or post non-cardiac surgery (PNCS). We analyzed the clinical picture of patients admitted with heart disease. We further classified causes of admission to CICU as arrhythmia, heart failure (HF), cardiogenic shock, non-cardiogenic shock, post-cardiac arrest (post-

CA), respiratory failure, vasodilators, or sedation requirement, post-procedure control, suspected or diagnosed ACS or other. Patients admitted with pulmonary hypertension, myocarditis, pulmonary embolism, or severe valvular heart disease were included within the HF group.

3. Statistical Analysis

Quantitative variables are presented as mean and standard deviation (SD) or as a

median and interquartile range [IQR 25-75] according to its distribution. Normality was checked using the Shapiro-Wilk test. Categorical data are reported as absolute or percent values. A p-value <0.05 was considered significant. For data processing, we used Epi Info version 7.2, Statistix, and Medcalc software.

Table 1 *Baseline Characteristics*

Demographics	n: 1629
Age, years median (IQR)	62 (53-71)
	n (%)
Female	528 (32.4)
With health insurance	712 (43.7)
Risk Factors	
Hypertension	947 (58.1)
Current smoker	384 (23.6)
Ex-smoker	453 (27.8)
Dyslipidemia	423 (25.9)
Diabetes	395 (24.3)
Cardiovascular history	
Coronary artery disease	640 (39.3)
Heart failure	172 (10.6)
Cerebrovascular disease	94 (5.8)
Peripheral arterial disease	95 (5.8)
Congenital heart disease	49 (3.0)
Pulmonary hypertension	21 (1.3)
Chronic diseases	
Chronic obstructive pulmonary disease	79 (4.9)
Chronic kidney disease	52 (3.2)
Cancer	46 (2.8)
Rheumatic disease	39 (1.9)
Dementia	7 (0.43)

4. Results

Among 1629 patients, 528 (32.4%) were female, and the median age was 62 years (IQR 53-71). Patients older than 80 years accounted for 10% of the population.

Table 1 summarizes the baseline characteristics of the study population. Hypertension was the most prevalent

cardiovascular risk factor (58.1%), and nearly 40% of patients had a history of coronary heart disease.

The primary admission diagnosis was heart disease in 81.9% of patients, with ACS (35.7%) and HF (10.3%) as the most prevalent. Non-cardiac causes accounted for 10.4% of admissions (Table 2).

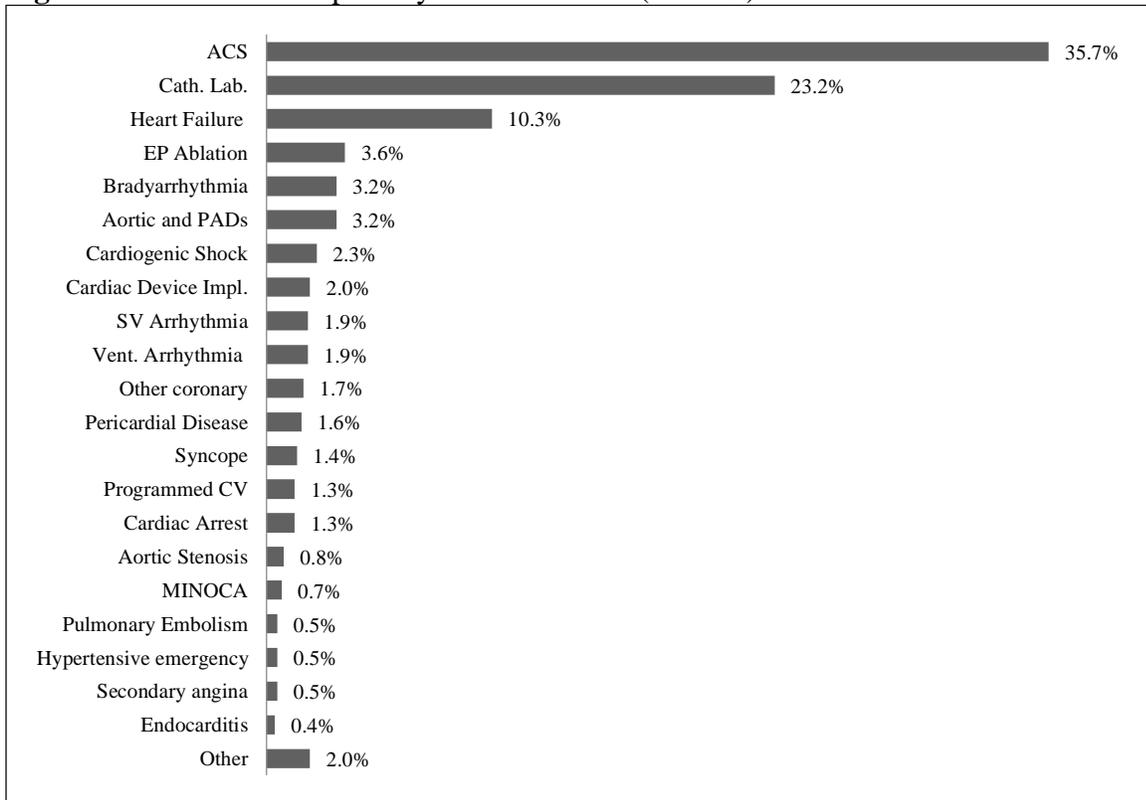
Table 2 Categories of Primary Reason for Admission to the Cardiac Intensive Care Unit (CICU) in the Overall Cohort (n=1629)

	n	%
Primary Cardiac Cause	1335	81.9
ACS	477	35.7
STEMI	259	19.4
NSTE-ACS	218	16.3
Post-procedure in cardiac catheterization lab	310	23.2
Heart Failure	137	10.3
Cardiogenic Shock	31	2.3
Arrhythmia		
Electrophysiological ablation	48	3.6
Bradyarrhythmia	42	3.2
Supraventricular Arrhythmia	25	1.9
Ventricular Arrhythmia	25	1.9
Non-Primary Cardiac Causes	294	18.1
Acute CV complication in patients without cardiac disease	18	1.1
A general medical condition in patients with cardiac disease	59	3.6
Post Cardiac Surgery	106	6.5
Post-Non-Cardiac Surgery	111	6.8

ACS, acute coronary syndrome; **STEMI**, ST-elevation myocardial infarction; **NSTE-ACS**, non-ST-elevation acute coronary syndrome.

Among ACS, 54.3% (n=259) were STEMI and 45.7% (n=218) NSTE-ACS. Patients admitted after a scheduled procedure in the catheterization laboratory were 23.2% (n=310). Cardiogenic shock was a smaller group: 2.3% (n=31) (Figure 1).

The main reasons for admission to CICU were: post-procedure control in 31.8% patients (n=517), suspected or diagnosed ACS in 31.7% (n=515), HF in 10.1% (n=164), PCS in 8.9% (n=146), and any type of shock in 4.5% (n=74) (Figure 2-A).

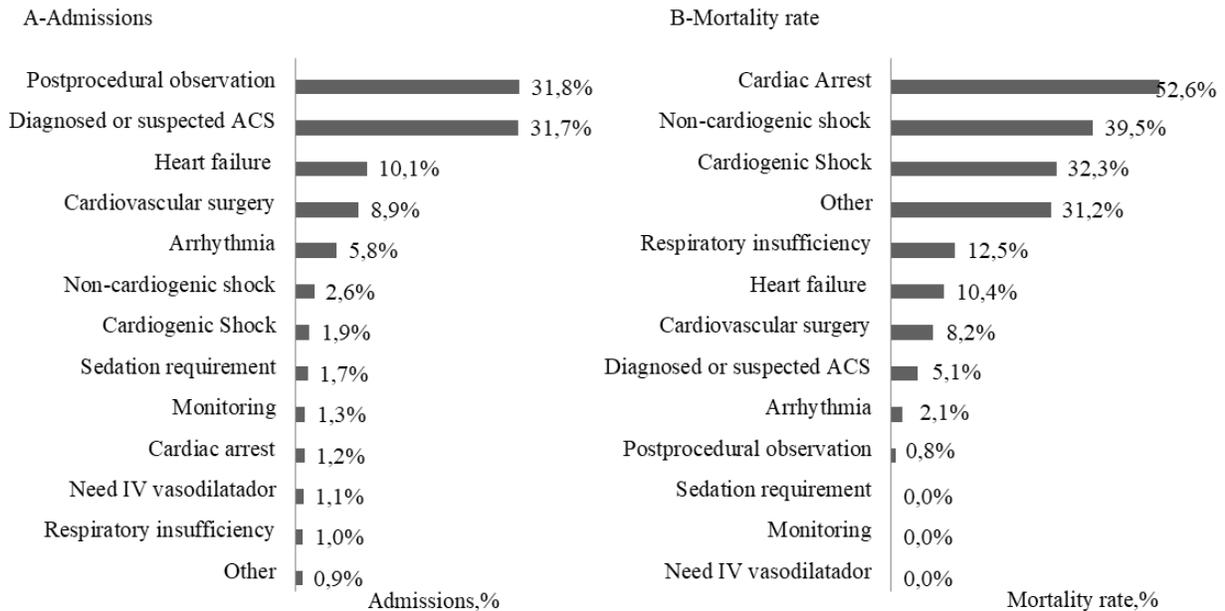
Figure 1 Admissions for primary cardiac causes. (n=1335)

ACS, acute coronary syndrome; **Cath. Lab.**, post-procedure in cardiac catheterization lab; **Cardiac Device Impl.**, Cardiac Device Implantation; **EP ablation**, electrophysiological ablation; **MINOCA**, Acute Myocardial Infarction with Non-Obstructive Coronary Arteries; **CV**, cardioversion; **PAD**, Peripheral arterial disease; **SV Arrhythmia**, Supraventricular Arrhythmia; **Vent. Arrhythmia**, Ventricular Arrhythmia.

Twenty-three percent of patients required a CVC (n=376), and only 4.4% underwent SG catheterization (n=72). Moreover, 19.3% required ventilatory assistance: MV in 15.2% (n=247) and NIV in 4.1% (n=67). Vasodilators were the titratable drugs more commonly used in the CICU, 13.8% (n=255), followed by vasopressors, 10.9% (n=177), and inotropes, 8.7% (n=141). Temporary pacemakers were placed in 2.03% of patients (n=33), and IABP in 0.92% (n=15). Only 2.64% (n=43) of patients required hemodialysis or ultrafiltration.

Overall mortality reached 6.45% (n=105). We observed the highest mortality in patients admitted with any of the following situations: post-CA (52.6%), non-cardiogenic shock (39.5%), and cardiogenic shock (32.3%). HF was associated with a 10.4% mortality, followed by post-cardiovascular surgery care (8.2%). Patients admitted with suspected or confirmed ACS had a mortality rate of 5.1%, whereas admissions for post-procedure control had a mortality rate of just 0.8%. There were no deaths among patients admitted for monitoring (Figure 2-B).

Figure 2 Reasons for Admission to Cardiac Intensive Care Unit (CICU) and Related Mortality. (n=1629)



^A Frequency of admissions according to the cardiac intensive care unit (CICU) admission cause.

^B It represents the mortality rate at CICU associated with the relevant admission cause. ACS, acute coronary syndrome; IV, intravenous.

5. Discussion

After collecting data on the total number of consecutive patients admitted to the CICU at a tertiary academic hospital in South America along two-years, we observed that the reasons for admission include a heterogeneous group of diseases. Most patients present with heart disease of diverse etiology. ACS and HF are less frequent than in previous decades at the expense of an increase in formerly less prevalent acute cardiovascular diseases.¹¹ We also observed there is a group of patients admitted for non-cardiac conditions, and more than a third of admissions are only for post-procedure control or monitoring requirements.

5.1. Population Characteristics

In this cohort, males are more prevalent, and the mean age is lower than the

reported in European and North American registries but similar to that described in other South American studies¹² in countries of comparable epidemiology. Likewise, the proportion of octogenarians in our research is around 10%, versus 20% in North America and Europe. The prevalence of risk factors, chronic diseases, and cardiovascular history is lower than in other registries¹³; the younger population may account for this finding.

5.2. Reasons for Admission to CICU

As we have already mentioned, most patients present with primary heart disease; ACS remains the primary cause of admission, but in contrast with three decades ago, it only represents a third of the total. These results agree with data from the American multicenter registry published by Bohula et

al.,¹³ in which the ratio of ACS was 32%, and less than a half corresponded to STEMI. In our population, this proportion reverses since we found a higher prevalence of STEMI. The latter may result from a higher volume of patients referred from other centers for emergency percutaneous coronary interventions.

Fifty percent of the admissions are due to a heterogeneous group of cardiovascular conditions that were historically less prevalent in former CCUs, including native or prosthetic valvular disease, pulmonary embolism, aortic disease, peripheral arterial disease, pulmonary hypertension, cardiac tamponade, and endocarditis. Moreover, in one out of ten patients, the reason for admission to CICU is an associated non-cardiac condition that may result in decompensation of underlying heart disease and prompt hospitalization. These findings are similar to the data from a registry of 7,000 patients published by Casella et al.¹⁴ In consequence, many medical associations insist on channeling cardiac critical care into a formal subspecialty within cardiology to address the training needs of cardiologists in critical care medicine.¹⁵

5.3. Type of Therapeutic Procedures

In this series, around 20% of patients needed some form of ventilatory assistance, inotropes or vasodilators, and more than 20% required CVC. Although these figures are lower than in other registries,¹³ they are notably high since shock and PCS barely exceeded 10% of total admissions.

There are two striking findings in this cohort. First, the use of IABP is low (less than

1%), which may be attributable to the low incidence of mechanical complications after AMI in the current era. Besides, there is no bridging to heart transplantation in the CICU. Second, there is a non-negligible number of patients undergoing pulmonary artery catheterization (4%), considering that this procedure has been set aside over time due to a lack of consensus on its utilization.⁴ In this series, near half of the pulmonary artery catheterizations were performed in the setting of mixed or refractory shock, ventricular dysfunction, respiratory disease, or renal failure, i.e., clinical settings for which hemodynamic management with the SG catheter is beneficial.¹⁶ In the registry of Bohula et al.,¹³ the variability among centers ranges from 0.5% up to 33%. In conclusion, the use of the SG catheter is still a matter of debate among cardiologists.

5.4. Reason for Admission to the CICU and Mortality

The primary reason for admission to the CICU is post-procedure control, representing one-third of patients. This ratio is similar to that in other registries,¹³ and likewise, carries a minimal death rate. Therefore, we consider that this subset of patients should be better stratified to address whether they require admission to the CICU.

On the other hand, patients presenting with shock or post-CA have the highest mortality rate. Regarding its etiology, cardiogenic is notably not the most common cause in this cohort. These results are consistent with Watson et al.⁷ report, in which shock or hypotension was one of the main reasons for admission to CICU, although, in

contrast with our series, two-thirds were of the cardiogenic type (either Killip class IV or progression of chronic HF).

The overall mortality rate tends to be lower than the reported in other series, which again calls attention to the variability in the risk profile of patients admitted to CICU.

In summary, we should admit that cardiac critical care involves not only the most common types of heart disease but also other complex cardiac and non-cardiac conditions. A rational approach is to promote professional skill training and interdisciplinary groups; and implement work protocols to optimize the quality of care and reduce morbidity and mortality, both of which remain elevated, particularly in the high-risk subgroup. Moreover, it is also necessary to identify low-risk groups whose low mortality rate casts doubt about the need for admission to CICU.

6. Limitations

Although this is a single-center study, we consider it provides relevant information since it arises from patients admitted to a high-volume reference center in a cardiac critical care unit. Economic restrictions could

limit the use of percutaneous mechanical circulatory support devices such as Impella and prevent further analysis. However, the study describes all the therapeutic modalities widely used in most CICUs in South America.

7. Conclusions

In a contemporary CICU of a single high-volume reference center in South America, the most frequent diagnosis was an ACS, although it represented only one-third of the admissions. One out of ten patients admitted for a non-cardiac cause. One-fifth of patients require advanced therapies. Cardiac arrest and shock are predictors of poor prognosis. We identified that patients admitted for post-procedure control or monitoring are a substantial subset of low risk.

Admissions to CICU are currently not limited to classic coronary syndromes. This scenario should direct our efforts towards skill training and the implementation of interdisciplinary groups. Another big challenge is to identify risk groups with a low rate of events.

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