

Use of Diuretics in the Emergency Department Among Patients with Heart Failure: A Cohort Study

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Abstract

Introduction: Evidence suggests that patients with decompensated heart failure who receive loop diuretics earlier experience reduced morbidity and mortality rates.

Objectives: To determine the time from admission to administration of the first dose of diuretics in patients with heart failure and to evaluate the risk of readmission within 30 days after hospital discharge.

Methods: A prospective and retrospective cohort study of patients with decompensated heart failure treated in a cardiac emergency department between December 2018 and June 2020 was conducted. The risk of readmission was classified using the LACE score. The statistical analysis included the Shapiro–Wilk test for normality, the chi-square test for associations, and the Mann–Whitney test for comparisons, adopting a significance level of 5%.

Results: A total of 361 patients were included in the study, with a predominance of males (56%), an average age of 68 ± 12 years, reduced ejection fraction (57%), functional class III (73%), and hemodynamic profile B (81%). The average time from admission to diuretic infusion was 87 (60 to 128) minutes, with 26.3% of patients receiving the infusion within 60 minutes. A significant association was found between receiving diuretics within 60 minutes and a stay in the emergency department of less than 6 hours (early discharge) ($p < 0.05$). The LACE score indicated that 62% of patients were at moderate risk for readmission, with 21% readmitted within 30 days. Among patients at high risk for readmission (38%), abnormal lung sounds and jugular venous distention were each significantly associated with the high-risk classification ($p < 0.05$). For clinical follow-up, 274 patients were included; after 180 days, 15% had died, and 46% had been readmitted.

Conclusion: In this population, patients who received the medication early (within 60 minutes) had shorter stays in the emergency department.

Keywords: Heart Failure; Patient Readmission; Hospital Emergency Service.

Introduction

Heart failure is a complex syndrome that commonly affects elderly patients and is one of the leading causes of rehospitalization, as well as increased morbidity and mortality.^{1,2}

In the United States, heart failure affects approximately 6.2 million adults, with an estimated annual cost of \$30.7 billion to the healthcare system.³ Despite recent advances in treatment, national data indicate that this chronic disease remains the most frequent cardiovascular cause

of hospital readmission, with a rate of 21%.⁴ Although there is significant heterogeneity in clinical profiles, most patients with decompensated heart failure present signs and symptoms of pulmonary and systemic congestion. The literature shows that congestion is present in over 90% of patients admitted to the emergency department.^{5,6}

Moreover, achieving euvolemia early in patients with decompensated heart failure is linked to reduced mortality. A recent study showed that delays in diuretic administration are associated with an increased risk of all-cause mortality within one year. This highlights the importance of establishing metrics, such as the time from patient arrival in the emergency department to diuretic administration, referred to as “door-to-diuretic time,” to promote faster attainment of euvolemia.⁷ Similar findings were reported in a pioneering multicenter cohort study, which reinforced that early treatment with intravenous loop diuretics is associated with lower hospital mortality rates.⁸ Given its association with reduced mortality, door-to-diuretic time has been proposed as a new indicator of high-quality care in the emergency department. However,

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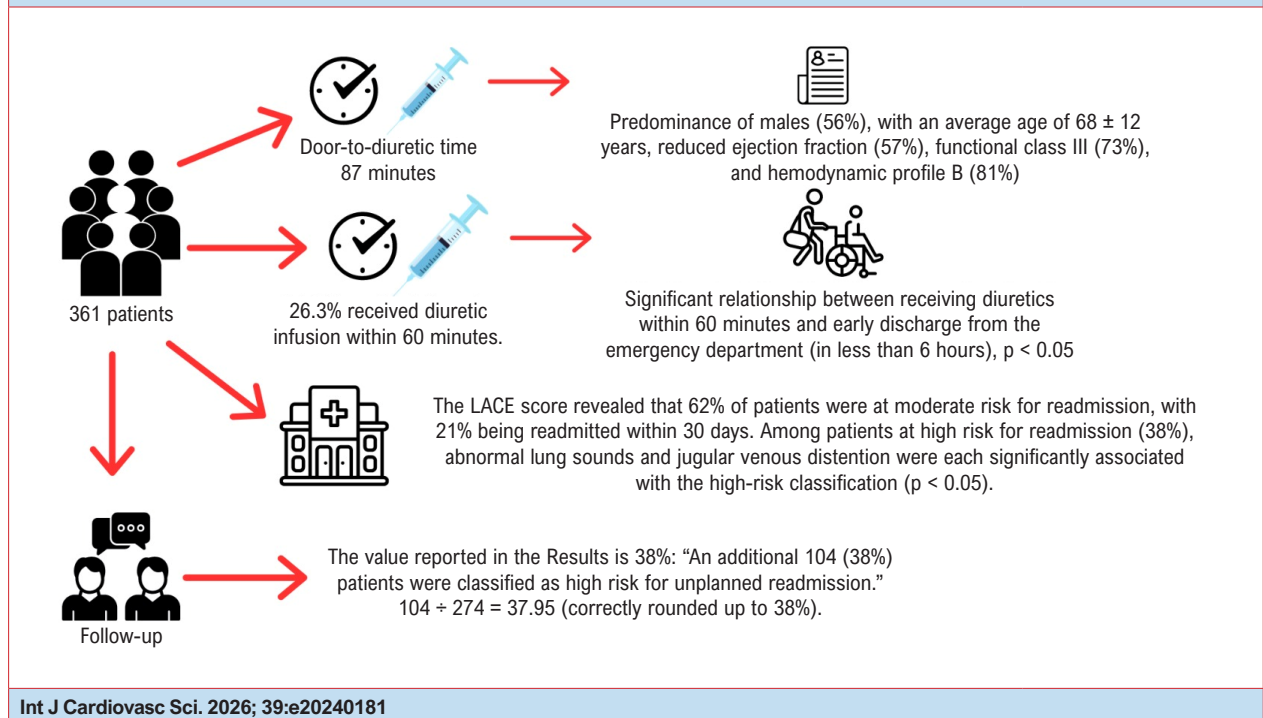
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Central Illustration: Use of Diuretics in the Emergency Department Among Patients with Heart Failure: A Cohort Study

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no current guidelines define the ideal time frame for diuretic administration.⁹

Additionally, measuring 30-day hospital readmission rates and identifying independent risk predictors are metrics used to evaluate the quality of care provided by hospitals. Electronic health record platforms have been necessary tools for identifying high-risk patients, allowing for early interventions to minimize future readmissions. Recent data have shown that hyponatremia, reduced ejection fraction, and acute coronary syndrome are significant causes of decompensation and strong predictors of hospital readmission within 30 days post-discharge.¹⁰

The management of heart failure has certainly improved over the decades, thanks to optimized pharmacological treatments, new devices, a better understanding of the syndrome's progression, and, importantly, the integration of a comprehensive therapeutic approach alongside non-pharmacological interventions across various care settings. Several tools available in the literature provide specific indicators to identify signs of congestion and aid in decision-making to achieve better outcomes. Among the validated instruments for predicting high-risk patients for readmission, the LACE score is widely used.¹¹

In clinical practice, a key aspect of keeping patients in their home environment is the early management of signs and symptoms of decompensation through the consistent use of medications and monitoring of weight, with careful control of diuresis, fluid retention, and hypervolemia. In

this context, this study aimed to assess the time between the admission of patients with decompensated heart failure and the administration of the first dose of diuretics, as well as to evaluate the risk of unplanned readmission within 30 days post-discharge using the LACE score.

Methods

Study design

This was a retrospective and prospective cohort study.

Population, setting, and time period

The study population comprised patients with heart failure who were consecutively treated in the emergency department of the Instituto de Cardiologia de Porto Alegre, Rio Grande do Sul, Brazil, from December 2018 to June 2020.

Eligibility criteria

Patients aged 18 years or older, of both sexes, with a medical diagnosis of decompensated heart failure confirmed by echocardiographic data and/or medical records, were included in the study. Medical records with incomplete data regarding diuretic therapy administration were excluded.

Study logistics, variables, and outcomes

Data collection was conducted using emergency department records, along with electronic and physical medical records of patients treated for decompensated heart failure. The study was preceded by a pilot study to identify any necessary adjustments to data collection instruments, potential methodological changes, and to minimize bias. Sociodemographic and clinical variables were gathered, including signs and symptoms of decompensation, ejection fraction, New York Heart Association (NYHA) functional class, hemodynamic profile, and variables related to emergency department admission, such as consultation time and the timing and dose of diuretics. A data collection tool was developed by the researchers to systematically record these variables.

Clinical follow-up was conducted via telephone, focusing on variables such as hospital readmission within 30 days, cardiovascular events, the impact of the disease on daily activities, and details regarding medications used, including acquisition methods, assistance with administration, and organization. Patients with decompensated heart failure were defined as those documented in medical records or those who received intravenous diuretic therapy along with clinical descriptions of signs and symptoms consistent with the condition. The primary outcome was rehospitalization, whereas the secondary outcome included a combination of emergency department visits. The variable under investigation was the time from admission to the emergency department to administration of the first dose of diuretics.

To minimize potential bias, data collection was carried out entirely by a single researcher who had undergone prior training (calibration). Participants were included sequentially, meaning that all patients admitted to the emergency department with decompensated heart failure were enrolled in the study (selection), provided there was a record of intravenous diuretic administration in their medical records. Patients' previous use of medications was not considered; instead, the focus was on congestion status and the need for diuretics (confounding). Loss to follow-up (tracking) was defined as 20 unsuccessful attempts to contact the patient by telephone on different days and shifts.

Instruments: Adapted Manchester Triage System and LACE score

In this emergency department's clinical practice, patient triage upon arrival is conducted by a nurse using the Manchester Triage System¹² and the guidelines of the Risk Classification Protocol of the National Humaniza SUS Program.¹³ The risk classification is divided into five color-coded categories, each representing a different severity level and a maximum waiting time for medical attention. The colors red and orange indicate high priority, whereas yellow, green, and blue are considered lower priority. The use of risk classification tools in emergency departments helps to standardize professional actions, allowing for a thorough assessment of each patient's needs and vulnerabilities, which facilitates effective prioritization.¹⁴

To assess the risk of unplanned readmission or death within 30 days after hospital discharge in patients with decompensated heart failure, the LACE score was used. This tool, previously validated in Brazil, evaluates factors such as hospital length of stay, acute exacerbations during hospitalization, comorbidities, and emergency department visits. The LACE score is calculated based on these components, with the final score predicting the risk of readmission. The risk is categorized as low (0 to 4), moderate (5 to 9), or high (above 9).¹⁵

Ethical considerations

The project adhered to the guidelines established by National Health Council Resolution No. 466/2012 and was submitted to the Research Ethics Committee of IC-FUC under CAAE number 3.237.714. The Term of Commitment for Data Utilization from Medical Records was employed to ensure complete confidentiality of information and patient anonymity, along with the Telephone Follow-Up Consent Form.

Statistical analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 25.0. For the sample size calculation, a 95% confidence level was considered, with 37.3% of patients receiving diuretics within 60 minutes, based on the multicenter Registry Focus and Very Early Presentation and Treatment in Emergency Department of Acute Heart Failure (REALITY AHF),⁸ which examines the relationship between the timing of furosemide initiation and clinical outcomes. A margin of error of $\pm 5\%$ was applied, resulting in a total sample size of 360 individuals.

Continuous variables were described as mean and standard deviation for those with a normal distribution, or as median and interquartile range (25th to 75th percentiles) for those with a non-normal distribution. The normality of the data was assessed using the Shapiro–Wilk test. Categorical variables were presented as absolute numbers and relative percentages. The chi-square test was used to assess associations between categorical variables, while the non-parametric Mann–Whitney test was employed to compare the length of stay in the emergency department, time to administration of the first dose of diuretics, and the LACE score in evaluating the risk of unplanned readmission. A significance level of 5% was adopted.

Results

Initially, 1,100 medical records of patients treated for decompensated heart failure in the emergency department were reviewed. Of these, 361 were eligible and included in the study. During the study, 55 patients passed away, and 32 were lost to follow-up, resulting in a total of 274 patients with a 180-day follow-up (Figure 1).

Among all the medical records analyzed, patients treated for decompensated heart failure were predominantly in NYHA functional class III, with adequate perfusion but signs of congestion (profile B). The majority were male,

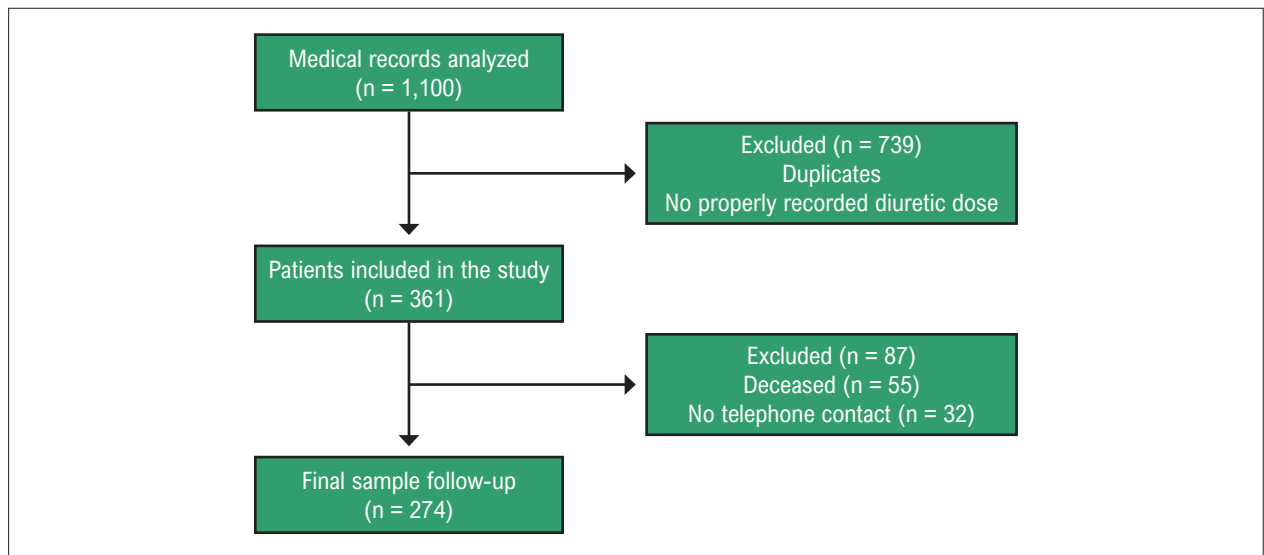


Figure 1 – Study flowchart.

with a mean age of 68.5 ± 12.2 years. These and other characteristics of the study population are detailed in Table 1.

Risk classification and signs of decompensation

Overall, 12% of patients were classified as high priority for care, whereas 87% were categorized as non-high priority. The most common signs and symptoms of heart failure decompensation, as documented in physical examinations, included dyspnea (97%), orthopnea (92%), abnormal lung sounds (78%), edema (71%), and jugular venous distention (15%).

Admission time and diuretic infusion

Following initial treatment, 60% of patients were stabilized and discharged home, and 39% required hospitalization, with an average length of stay of 6 (4 to 12) days.

Patients received diuretic doses of 40 mg (72%) or 20 mg (14.7%). The time from arrival at the emergency department to administration of the first dose of diuretic was 87 (60 to 128) minutes. Overall, 72 patients received the medication within 60 minutes, whereas 202 patients received it after 60 minutes. Patients with heart failure with preserved ejection fraction who received the medication within the recommended timeframe had better clinical outcomes and were discharged earlier ($p < 0.05$).

Among the entire population analyzed, 48% stayed in the emergency department for less than 6 hours. Comparing the groups based on whether they received the first dose of diuretic before or after 60 minutes, there was a significant association between early diuretic administration and a shorter stay in the emergency department ($p < 0.003$) (Figure 2).

Risk of unplanned readmission at 30 and 180 days

In total, 21% of the patients in the sample required readmission within 30 days. The LACE score indicated

that 170 (62%) patients were at moderate risk for early readmission, with 192 (70%) of these being readmitted within thirty days. An additional 104 (38%) patients were classified as high risk for unplanned readmission, of whom 82 (30%) were readmitted. Abnormal lung sounds ($p < 0.05$) and jugular venous distention ($p < 0.05$) were significantly associated with classification as high risk.

Among all patients, 38.5% sought care in the emergency department, and 23.8% were readmitted in the 12 months following hospital discharge. The average number of emergency department visits per year was 2.34 ± 2.07 , and the average number of hospitalizations was 1.79 ± 1.48 .

During telephone follow-up, 61% of patients reported experiencing some degree of heart failure decompensation within the first 6 months. The majority of patients required hospital readmission within 180 days. On average, these patients sought care 5.3 ± 3.5 times over 6 months. Cardiovascular events were recorded in 127 patients (Table 2).

According to the telephone follow-up, 70% of patients were using beta-blockers, 51% were on diuretics, 21% were taking angiotensin-converting enzyme inhibitors, and 15% were on antiplatelet agents. However, 60% of patients reported not adhering to all prescribed medications within the first 6 months of treatment, and 65% obtained their medications through the public health system. Among the studied population, 41% reported managing and taking their regular medications independently, while 31% received assistance from family members for daily medication intake.

When asked how their health condition affected their daily routine, 29% of patients reported that their condition interfered with activities requiring minimal effort, 24% with activities requiring moderate effort, 13% with basic activities, and 8% felt it did not interfere with their routine at all.

Table 1 – Sociodemographic and clinical characterization of the population (n = 361)

Variables	n (%)
Age, years	68.5 ± 12.2
Male sex	202 (56)
Origin: Porto Alegre	170 (47.6)
Ejection fraction	46.2 ± 17.9
HFrEF	186 (57)
HFpEF	140 (43)
NYHA functional class	
I	12 (3.8)
II	40 (12.8)
III	230 (73.5)
IV	31 (9.9)
Hemodynamic profile	
A	44 (14.5)
B	246 (81.2)
C	13 (4.3)
Etiology	
Ischemia	155 (56.8)
Valvular	62 (22.7)
Idiopathic dilated	29 (10.6)
Previous comorbidities	
Hypertension	268 (74.2)
Coronary artery disease	228 (63.2)
Diabetes mellitus	132 (36.6)
Atrial fibrillation	114 (31.6)
Dyslipidemia	77 (21.3)
Diuretic doses	
40 mg	260 (72)
20 mg	53 (14.7)

Variables are expressed as absolute numbers (n) and percentages (%) or mean ± standard deviation. HFpEF: heart failure with preserved ejection fraction; HFrEF: heart failure with reduced ejection fraction.

Discussion

In this cohort, the time between the patient's arrival at the emergency service and the administration of the first dose of diuretics was 87 (60 to 128) minutes, with only 26.3% receiving the infusion within 60 minutes. Data from the literature suggest that early intravenous administration of loop diuretics improves the prognosis during the acute phase, reduces the likelihood of readmissions, and decreases in-hospital mortality among patients with decompensated heart failure,^{16,17} as shown in the Central Illustration. However,

more recent studies have reported conflicting findings, suggesting no significant difference in clinical stability, hospitalization rates, or morbidity and mortality between early infusion and continuous intravenous use of diuretics in the hospital setting.^{18,19} A meta-analysis conducted on a similar population indicated that early diuretic administration in patients with decompensated heart failure is associated with improved oxygenation ($p = 0.004$), but not with reduced hospital mortality ($p = 0.225$).²⁰

The lack of guidelines, protocols, and standardized procedures leads to significant variability in practices among healthcare professionals working on the frontlines in the emergency service, from risk classification to the clinical management of this high-risk population. As a result, suboptimal therapeutic interventions are often encountered in cases of decompensation. Patients with this complex syndrome, often accompanied by multiple comorbidities, frequently exhibit hemodynamic instability, requiring substantial skill and clinical experience for effective management.

In the pre-hospital setting, the observational FAST-FURO study found that early intravenous administration of furosemide during pre-hospital care for patients with heart failure was not associated with a reduced hospital length of stay or short-term mortality. Given the varying findings in clinical practice and the literature, uncertainty remains about the ideal door-to-diuretic time in acute heart failure and whether rapid clinical decongestion can improve prognosis beyond symptom relief.²¹

Of all the patients treated, 12% were classified by the triage team as high priority and 87% as low priority for care. The primary complaints of decompensation reported by the sample analyzed were dyspnea and edema. Few patients showed signs of poor perfusion, with congestion being the predominant symptom in heart failure, underscoring the use of diuretics as a central strategy for managing signs and symptoms of fluid overload. The clinical presentation of individuals with acute heart failure in emergency departments is highly predictive of mortality at 7 and 30 days. However, the use of validated algorithms for individualized risk stratification could enhance care efficiency for lower-risk patients and reduce the likelihood of early discharge for higher-risk individuals.¹⁸

This study found that most patients were classified as having a moderate risk for unplanned readmission within 30 days of discharge. Sixty percent of patients experienced decompensation within 180 days post-discharge, with 46% and 23% requiring readmission at 6 and 12 months, respectively. It is important to note that this patient sample consisted of individuals with associated chronic conditions, classified as NYHA functional class III, and hemodynamic profile B, characterized by adequate perfusion but with signs of congestion.

An important aspect highlighted by this research is that the average number of emergency department visits and hospital readmissions per patient was lower than data published from other healthcare services in the literature. These findings suggest that such clinical outcomes may

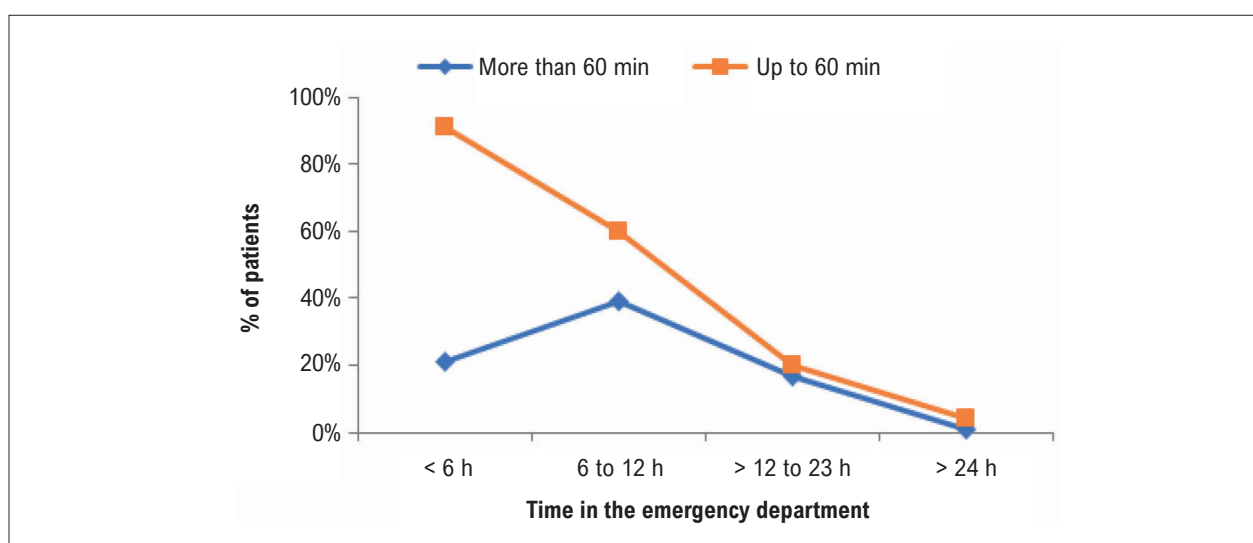


Figure 2 – Time of diuretic administration and length of stay in the emergency department.

Table 2 – Readmissions and cardiovascular events (n = 274)

Variables	n(%)
Hospital readmissions	
30 days	58 (21)
180 days	127 (46)
Cardiovascular events	
Stroke	8 (3)
Acute myocardial infarction	30 (11)
Death	41 (15)

Variables expressed as percentages (%)

reflect the benefits of regular outpatient follow-up by a specialized multidisciplinary team. In this context, patients receive individualized guidance after hospital discharge, with an emphasis on recognizing early signs and symptoms of decompensation, which helps encourage self-care. Frequent readmissions are often caused by poor adherence to pharmacological and non-pharmacological treatments, worsening cardiac function, and, importantly, exposure to inadequate therapy, whether due to suboptimal treatment or delays in emergency care.²³

Several tools and scoring systems are available to predict the risk of readmissions. The LACE score is widely employed in Canada and the United States, including by the Canadian Institute for Health Information (CIHI). Recent meta-analyses suggest that a high-risk LACE score effectively predicts readmission risk and could also be used to predict 30-day readmissions for chronic conditions.²⁴

Furthermore, telemonitoring has emerged as an important tool in heart failure management, given that many patients present to the emergency department with signs

of congestion. During the COVID-19 pandemic, the use of telemedicine consultations for early monitoring increased rapidly. Patients with heart failure who received outpatient care through telemedicine or in-person visits had better outcomes compared to those who did not receive such monitoring, emphasizing the need for more individualized care to reduce hospital readmissions.²⁵

Healthcare institutions reported a 30% to 90% decrease in heart failure admissions during the early months of the COVID-19 pandemic. Patients with chronic diseases were encouraged to practice social distancing to minimize their risk, leading to a reduction in readmission rates to 8.8%, significantly lower than the historical trend, which ranged between 15.8% and 19.1%.²⁶

As a historical cohort, this study has several limitations, including incomplete or missing documentation by healthcare professionals, and potential underreporting in some cases. Another limitation is the lack of standardized laboratory tests, such as creatinine and albumin, for all patients, which restricted certain analyses. Despite these limitations, the research is valuable in fostering discussions among frontline healthcare teams in emergency departments to improve the management of patients with decompensated heart failure during the acute phase. It also supports the development of standardized institutional protocols to promote rapid stabilization of the syndrome and reduce unfavorable outcomes in this high-risk population.

Conclusion

The results of this study suggest that, in this cohort of patients with decompensated heart failure, classified as functional class III and hemodynamic profile B, the time from admission to administration of the first dose of diuretics was suboptimal compared to current literature recommendations. Most patients were at moderate risk for unplanned readmissions within 30 days. The variables age and male sex were independent

predictors of hospital readmission. The frequency of emergency department visits and hospital readmissions was lower than what has been reported in the literature.

Time to diuretic administration has been suggested as a quality-of-care indicator in the emergency department. In this population, patients who received the medication early (within 60 minutes) had a shorter stay in the emergency department. In this context, developing protocols to optimize diuretic administration for patients with decompensated heart failure and hypervolemia could facilitate earlier discharge and, consequently, reduce wait times. Moreover, tools such as the LACE score can help identify patients at higher risk of unplanned readmission, potentially preventing future readmissions. Finally, further studies are recommended to explore the timing of diuretic administration and its clinical implications.

Author Contributions

Conception and design of the research, acquisition of data: Rosa NC, Moraes MAP; Rosa NC, Moraes MAP; analysis and interpretation of the data, statistical analysis, writing of the manuscript and critical revision of the manuscript for intellectual content: Rosa NC, Alves CN, Moraes MAP.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

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Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of the Instituto de Cardiologia do RS / Fundação Universitária de Cardiologia under the protocol number 38787820.2.0000.5333. All the procedures in this study were in accordance with the 1975 Helsinki Declaration, updated in 2013. Informed consent was obtained from all participants included in the study.

Use of Artificial Intelligence

The authors did not use any artificial intelligence tools in the development of this work.

Availability of Research Data

The underlying content of the research text is contained within the manuscript.

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