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Telemetry-based insights: clinical indicators linked to unfavorable outcomes in heart failure

Perspectivas baseadas em telemetria: indicadores clínicos associados a desfechos desfavoráveis na insuficiência cardíaca

Información basada en telemetría: indicadores clínicos vinculados a resultados desfavorables en la insuficiencia cardíaca

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ABSTRACT

Objective: Evaluate the clinical profile of heart failure patients under telemetry and identify associations with unfavorable outcomes.

Methods: Cross-sectional study from 2019 to 2024 at a public university hospital. Coronary Care Unit nurses collected data from electronic medical records, which were analyzed using SPSS®. The project was approved by the Ethics Committee (Nº. 2019-0046).

Results: Out of 425 medical records, 43% showed events, primarily non-sustained ventricular tachycardia (14.8%). After arrhythmic events, 29.6% underwent urgent electrocardiogram, 30.1% had pharmacological adjustments, and 15.7% died after transfer to the Coronary Care

Unit. Significant associations included unfavorable outcomes in males (p=0.038), while diabetes mellitus was protective (p=0.004). Previous arrhythmias were also associated with adverse outcomes. Notably, event incidence was significant within the first 10 days of telemetry.
Conclusion: Pre-existing arrhythmias and male sex were associated with composite unfavorable outcomes in heart failure patients remotely monitored by telemetry.
Descriptors: Telemetry; Heart Failure; Cardiac Arrhythmias; Cross-sactional Studies; Patient Outcome Assessment.

RESUMO

Objetivo: Avaliar o perfil clínico de pacientes com insuficiência cardíaca sob telemetria e identificar associações com desfechos desfavoráveis.
Métodos: Estudo transversal realizado entre 2019 e 2024 em um hospital universitário público. Enfermeiros da Unidade de Cuidados Coronarianos recolheram dados de registos médicos electrónicos, que foram analisados utilizando o software SPSS®. O projeto foi aprovado pelo Comitê de Ética (Nº 2019-0046).
Resultados: De um total de 425 registos médicos, 43% apresentaram eventos, sendo o mais frequente a taquicardia ventricular não sustentada (14,8%). Após eventos arrítmicos, 29,6% dos pacientes realizaram eletrocardiograma de urgência, 30,1% tiveram ajuste farmacológico e 15,7% faleceram após transferência para a Unidade de Cuidados Coronarianos. Foram encontradas associações significativas entre desfechos desfavoráveis e o sexo masculino (p=0,038), enquanto a diabetes mellitus demonstrou um efeito protetor (p=0,004). Além disso, arritmias prévias também se associaram a desfechos adversos. Importa destacar que a incidência de eventos foi significativa nos primeiros 10 dias de telemetria.
Conclusão: Arritmias prévias e o sexo masculino foram associados a desfechos compostos desfavoráveis em pacientes com insuficiência cardíaca monitorizados remotamente por telemetria.
Descritores: Telemetria; Insuficiência Cardíaca; Arritmias Cardíacas; Estudo Transversal; Avaliação de Desfechos em Pacientes.

RESUMEN

Objetivo: Evaluar el perfil clínico de pacientes con insuficiencia cardiaca bajo telemetría e identificar asociaciones con resultados desfavorables.
Métodos: Estudio transversal realizado entre 2019 y 2024 en un hospital universitario público. Las enfermeras de la Unidad de Cuidados Cardiacos recopilaron datos de registros médicos electrónicos, que fueron analizados mediante el software SPSS®. El proyecto fue aprobado por el Comité de Ética (N° 2019-0046).
Resultados: De un total de 425 historias clínicas, el 43% presentó eventos, siendo el más frecuente la taquicardia ventricular no sostenida (14,8%). Luego de los eventos arrítmicos, al 29,6% de los pacientes se les realizó electrocardiograma de urgencia, al 30,1% se le realizó ajuste farmacológico y al 15,7% falleció tras el traslado a la Unidad de Cuidados Cardiacos. Se encontraron asociaciones significativas entre los resultados desfavorables y el sexo masculino (p=0,038), mientras que la diabetes mellitus demostró un efecto protector (p=0,004). Además, las arritmias previas también se asociaron con resultados adversos. Es importante resaltar que la incidencia de eventos fue significativa en los primeros 10 días de telemetría.

Conclusión: Las arritmias previas y el sexo masculino se asociaron con resultados compuestos desfavorables en pacientes con insuficiencia cardiaca monitoreados remotamente por telemetría.
Descriptores: Telemetría; Insuficiencia cardiaca; Arritmias cardíacas; Estudios transversal; Evaluación de resultados en pacientes.

INTRODUCTION

Heart failure (HF) is a syndrome that remains challenging to understand, with many associated etiologies in which the heart is unable to pump blood effectively and performs this function in a disordered manner, increasing the likelihood of arrhythmias, particularly atrial fibrillation, which raises the risk of thromboembolic events, which can cause death[1]. HF affects about 56.2 million people worldwide (between 1% and 3% of the adult population) and has a reduced survival rate, where less than 50% the patients survive within five years of diagnosis, presenting median survival time of 3.1 years and 3 out 5 patients dying due to HF in 5 years, with these outcomes associated with advanced age, pre-existing risk factors, and chronic comorbidities[2-4].

In Brazil, the primary results of the Brazilian Registry of Acute Heart Failure (*BREATHE)* study identified high mortality associated with a cardiac condition within 12 months of the hospital discharge (20.4% of the studied population)[5]. The readmission for decompensation of HF happened in 31.7% of the sample after the same period[5]. According to a study conducted in 2025, which analyzed data provided by the Department of Information and Informatics of the Unified Health System *(DataSUS),* a Brazilian health information system that shares data related to health indicators and care in the country, it was found that the total expenditure on hospitalizations for HF in 2024 reached a daily value of R$ 2.395, potentially reaching up to 6 billion reais per year in hospitalizations[6].

A recent study performed in the United States in 2022 indicated that HF contributed to 425.147 deaths, representing 45% of the total deaths related to cardiovascular causes, moreover, 6.7 millions of adults over 20 years old live with HF and 1 in 4 people live with the risk of developing HF during life[7-9]. Furthermore, the prevalence of HF in American adults between 65 and 70 years can reach 8.5%[7].

In the hospital setting, where patients are admitted due to acute episodes or decompensation of HF-related risk factors, intense monitoring of any complications is essential[10]. The rapid progression to clinical decompensation in these patients leads to extended hospital stays due to the necessary therapies, including intravenous diuretics and

vasoactive drugs, which are used for rapid hemodynamic stabilization and to alleviate congestion. These treatments can increase the risk of arrhythmias, necessitating continuous monitoring to prevent unfavorable events such as arrhythmias, cardiopulmonary arrest, or death[5,11].

It is essential to use all available technological resources to prevent harm to hospitalized HF patients, aiming to safeguard their health through an individualized assessment of each case[12,13]. In this context, remote cardiac telemetry stands out as a portable technology that transmits patients electrocardiographic signals in real time via radiofrequency through a Bluetooth wireless network to a monitor located in an intensive care unit. This technology is recommended for hospitalized patients who require 24-hour monitoring due to the risk of developing cardiac arrhythmias and hemodynamic instability[10,14]. Recent studies indicate that the use of non-invasive remote monitoring appears to reduce hospitalizations and mortality associated with HF, where the detection of the clinical deterioration in a hasty way may be differential when utilized this kind of technology[14].

The nurse responsible for telemetry monitoring plays a critical role in overseeing remote monitoring systems, identifying technical failures, and detecting electrocardiographic changes to ensure timely and effective care. A structured monitoring protocol should guide care for this patient population by promoting mobility and comfort during hospitalization, ensuring safe and appropriate monitoring, and enabling the early identification of clinical changes that require immediate intervention[15].

Despite the increasing use of remote cardiac telemetry in hospitalized patients with HF, evidence on clinical indicators associated with unfavorable outcomes remains limited, particularly in real-world settings. Most studies emphasize technological performance or medical decision-making, with little focus on nursing-led monitoring and its impact on patient safety and outcomes[16]. Consequently, the nursing role in continuous telemetry surveillance, early arrhythmia detection, and timely intervention is underexplored. This study addresses this gap by evaluating the clinical profile of patients with HF monitored by remote cardiac telemetry and identifying factors associated with unfavorable outcomes, thereby supporting evidence-based nursing practice and the development of monitoring protocols.

METHOD

Study Type

This is an observational, analytical, cross-sectional study based on secondary data extracted from electronic medical records of patients with HF monitored by remote cardiac

telemetry during hospitalization. The data collection period spanned from January 2019 to December 2024.

Participants

All HF patients who received early discharge to a general hospital ward with an indication for remote cardiac telemetry monitoring during the study period were included. Participants were selected through the authorization form for use of the technology made available by the cardiovascular care unit (CCU) responsible for patient monitoring. Early discharge is granted to hemodynamically stable patients who still have a risk of arrhythmia, requiring continuous remote monitoring in a hospital ward. Patients with incomplete records (missing full name and/or medical record number) that prevented accurate data collection were excluded from the study. A sample size calculation was not performed, as the study included all retrospective patients who used remote monitoring within the established period.

Study Variables and Data Collection

Data were collected using a structured instrument that comprised the following groups of variables: (1) sociodemographic variables (age, sex, and race); (2) clinical variables, including cardiovascular risk factors, comorbidities, prior cardiovascular history, HF etiology, and left ventricular ejection fraction; (3) variables related to the current hospitalization, such as reason for admission, length of stay, inpatient unit, medications used, and cardiological interventions; (4) history of arrhythmic events prior to the current hospitalization and during hospitalization before the initiation of telemetry; (5) variables related to telemetry indication and use, including clinical indications and duration of monitoring; and (6) clinical outcomes during telemetry monitoring, including arrhythmic events, cardiopulmonary arrest, death, and subsequent clinical management. Unfavorable outcomes were defined as the occurrence of any arrhythmia, cardiopulmonary arrest, or death during the monitoring period.

Data were obtained using a structured instrument specifically developed for this study, based on information extracted from electronic medical records and the cardiovascular care unit database. The researcher responsible for data collection received training from cardiology nursing professionals to ensure accuracy, consistency, and reliability of the extracted data. Data was stored in the Research Electronic Data Capture platform (REDCap®). The data collection period spanned from January 2019 to December 2024.

Data Analysis

Categorical variables were described using absolute and relative frequencies, whereas continuous variables were expressed as mean and standard deviation or median and interquartile range, according to data distribution. Normality was assessed using the Shapiro–Wilk test. Associations between categorical variables and unfavorable outcomes were evaluated using Pearson's chi-square test, given the categorical nature of the variables and the study's objective to assess associations rather than causality. Spearman's correlation was applied when appropriate for non-normally distributed variables.

Time-to-event data were analyzed descriptively using Kaplan–Meier curves to estimate the probability of remaining free from unfavorable outcomes over the monitoring period, without comparisons between exposure groups.

A two-tailed $p<0.05$ was considered statistically significant. Data were analyzed using the Statistical Package for Social Sciences (SPSS), version 22.0 (IBM Corp, NY, United States).

Ethical Aspects

This study adhered to ethical standards and followed the guidelines and norms for research involving human subjects as set forth in Resolution 466/2012. The study was approved by the Research Ethics Committee of the institution (approval number 2019-0046).

RESULTS

Data from 425 medical records of HF patients discharged with remote cardiac telemetry were analyzed. The average age was 62.8±14.5 years, with a predominance of males (64.9%). Among the etiologies of HF, ischemic causes were the most prevalent (39.5%), followed by cardiomyopathy (14.6%). The ejection fraction was 32.6±15.5%. Additional data are presented in the table below (Table 1).

Table 1 - Characteristics of patients with heart failure using remote cardiac telemetry (N=425). Porto Alegre, RS, Brazil, 2025

Variable	**Total (n = 425)**
Age, years*	62.8 ± 14.5
Gender, male†	276 (64.9)
Race, white†	362 (85.2)
Risk Factors/Comorbidities†	
Systemic Arterial Hypertension	246 (57.9)

Overweight/Obesity	203 (47.8)
Smoking	200 (47.1)
Diabetes Mellitus	146 (34.4)
Etilism	87 (20.5)
Family history of heart disease	60 (14.1)
Dyslipidemia	37 (8.7)
Etiology of Heart Failure†	
Ischemic	168 (39.5)
Cardiomyopathy	62 (14.6)
Valvular	44 (10.4)
Hypertensive	32 (7.5)
Tachycardiomyopathy	13 (3.1)
Cardiotoxicity	8 (1.9)
Alcoholic	7 (1.6)
Chagasic	7 (1.6)
Peripartum	6 (1.4)
Congenital	4 (0.9)
Myocarditis	3 (0.7)
Extracardiac disease (endocrine, autoimmune, renal)	1 (0.2)
Left Ventricular Ejection Fraction (%)*	32.6 ± 15.5

Source: Elaborated by the authors, 2025.
* Data expressed as mean; ± standard deviation; † absolute number and relative frequency.

The technology was indicated for patients with arrhythmias identified during the current hospitalization (43.3%), followed by patients using inotropic or antiarrhythmic drugs (26.8%), post-cardiopulmonary arrest or cardioversion (8.5%), post-primary angioplasty (8.0%), syncope (5.6%), post-ablation or device implantation (pacemaker or cardioverter-defibrillator) (2.6%), electrical storm (1.9%), stroke (1.2%), postoperative period of coronary artery bypass graft surgery (0.7%), digitalis toxicity (0.7%), and post-transcatheter aortic valve implantation (0.7%). The median duration of remote cardiac telemetry use was 9 days (range: 1–93 days). Telemetry was discontinued upon hospital discharge or per medical team's guidance, when no longer deemed necessary.

Table 2 presents results regarding patients who had arrhythmia prior to hospitalization and those who experienced arrhythmias during the current hospitalization before the use of remote cardiac monitoring.

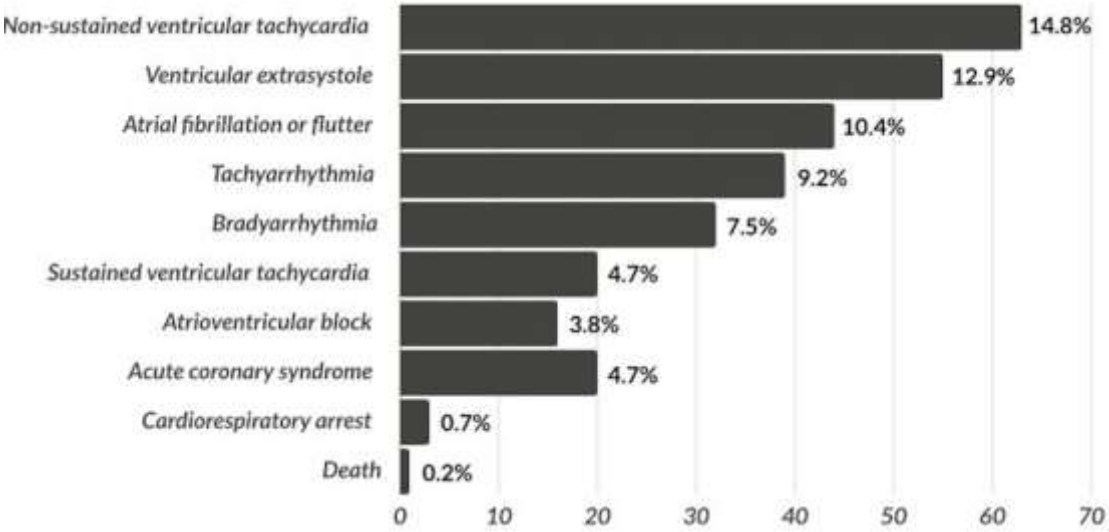
Table 2 - Patients with prior arrhythmia before hospitalization and those who presented arrhythmia during the current hospitalization (N=425). Porto Alegre, RS, Brazil, 2025

Variables	Arrhythmia identified prior to this hospitalization*	Prior arrhythmia detected by telemetry during current hospitalization*
Atrial fibrillation or flutter	156 (36.7)	149 (35.1)
Atrioventricular block	61 (14.4)	109 (25.6)
Bradyarrhythmia or tachyarrhythmia	53 (12.5)	124 (29.2)
Ventricular tachycardia (sustained/non-sustained)	44 (10.4)	168 (39.5)
Ventricular fibrillation or tachycardia, asystole, pulseless electrical activity	34 (8.0)	30 (7.1)
Ventricular extrasystole	32 (7.5)	148 (34.8)

Source: Elaborated by the authors, 2025.
*Absolute number and relative frequency.

In the analyzed sample, at least one complication was identified in 43% of the medical records during remote cardiac telemetry use. The most prevalent observed arrhythmia was non-sustained ventricular tachycardia (14.8%), followed by ventricular extrasystole (12.9%) and atrial fibrillation or flutter (10.4%). There were episodes of acute coronary syndrome in 4.7% of cases, 0.7% cardiopulmonary arrests, and 1 (0.2%) death during the monitoring period (Figure 1).

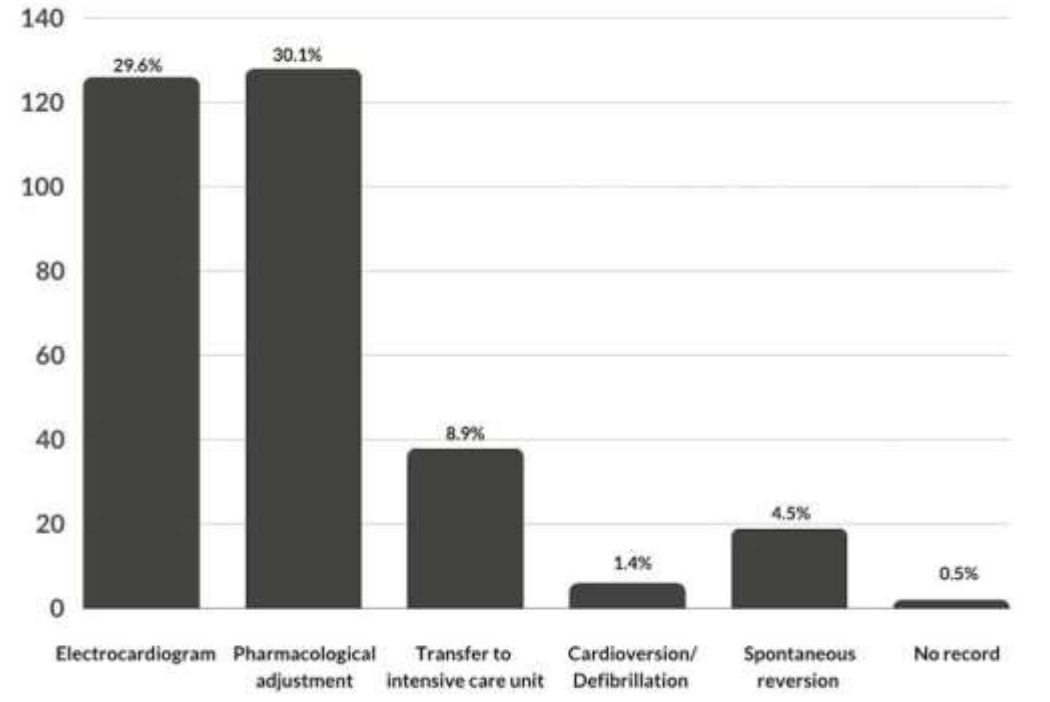
Figure 1 - Intercurrences identified during the use of remote cardiac telemetry (n=425). Porto Alegre, RS, Brazil, 2025



Source: Elaborated by the authors, 2025.

Following event identification, 29.6% underwent an urgent electrocardiogram, 30.1% received pharmacological adjustments, and 8.9% were transferred to intensive care units (Figure 2). Of the patients transferred to the ICU, 15.7% subsequently died.

Figure 2 - Management after intercurrence (n=425). Porto Alegre, RS, Brazil, 2025



Source: Elaborated by the authors, 2025.

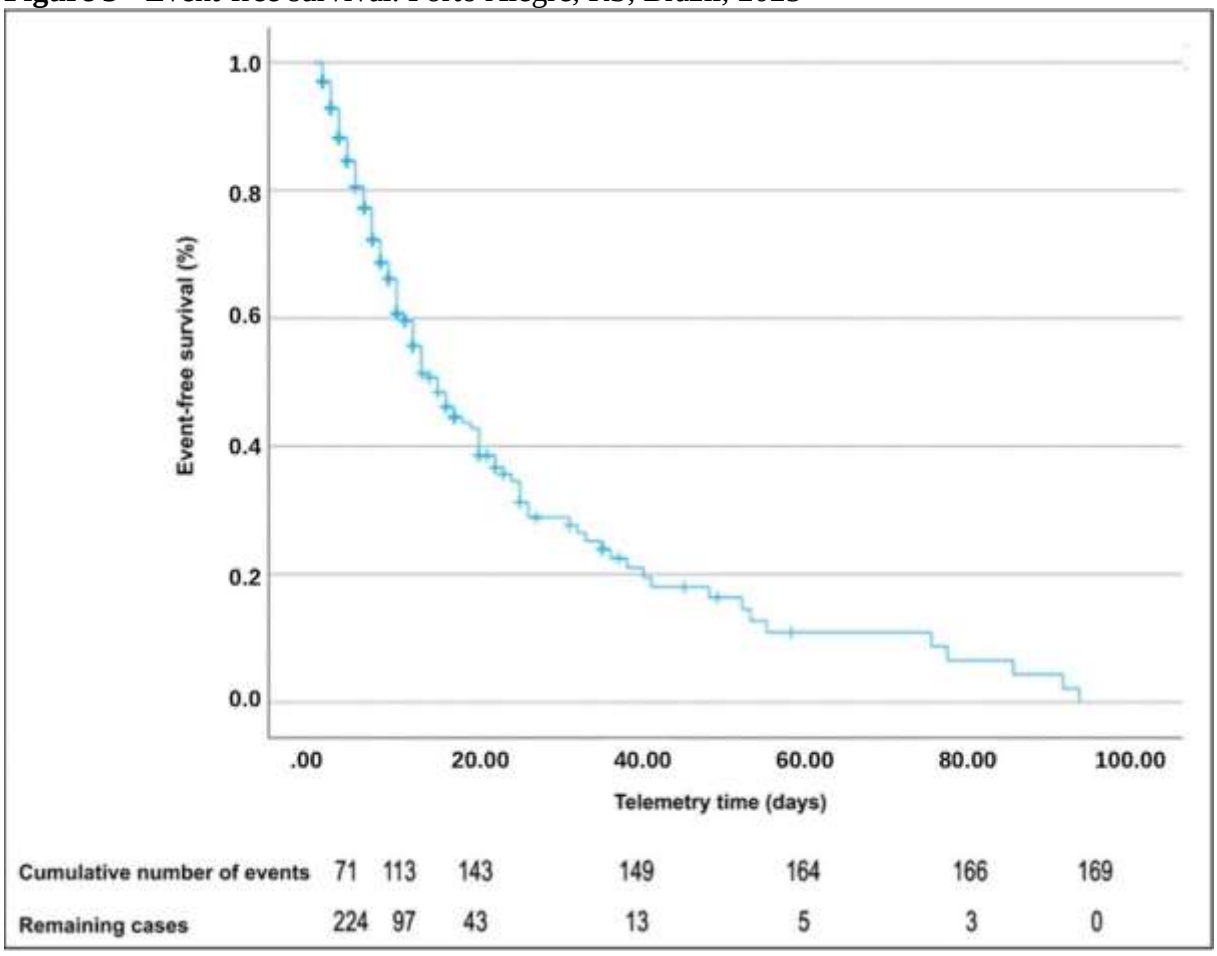
Unfavorable outcomes (arrhythmia, cardiopulmonary arrest, or death) were identified in 169 patients (39.8%). Of these, 20.5% had only one event, 14.8% had two events, 3.8% had three events, and 0.7% had four events.

Male sex showed a statistically significant association with unfavorable outcomes (95% CI 60.4–69.5, p=0.038). A diagnosis of diabetes mellitus was found to be protective against unfavorable events (95% CI 29.8–38.9, p=0.004), while other risk factors did not show statistically significant associations.

The presence of arrhythmias prior to hospitalization was also associated with unfavorable outcomes, with statistical significance for ventricular extrasystole (95% CI 30.3–39.4, p=0.024), atrial fibrillation or flutter (95% CI 30.5–39.6, p=0.018), ventricular tachycardia (sustained/non-sustained) (95% CI 4.6–9.5, p=0.016), and bradyarrhythmia or tachyarrhythmia (95% CI 24.9–33.5, p<0.001). The test used to assess the association between categorical variables was Pearson's chi-square test.

The Kaplan curve (Figure 3) shows that most unfavorable events were identified within the first 10 days of monitoring (113 events).

Figure 3 - Event-free survival. Porto Alegre, RS, Brazil, 2025



Source: Elaborated by the authors, 2025.

DISCUSSION

This study presents, for the first time in the literature, clinical data related to the monitoring of HF patients using remote cardiac telemetry. Guidelines on ventricular arrhythmia and sudden death prevention indicate that an HF diagnosis and the occurrence of arrhythmic events worsen the clinical condition due to disease decompensation in elderly populations and in cases with reduced ejection fraction (<40%)[12]. The occurrence of arrhythmias in this population may also be linked to the therapeutic use of arrhythmogenic drugs—medications used to alleviate congestion in HF may increase the number of arrhythmic events, such as vasoactive drugs[12,17].

Male individuals had a higher prevalence of remote cardiac telemetry use compared to females, with a significant association with unfavorable events (p=0.038). This finding aligns with studies that associate higher cardiovascular risk in this population, as well as the higher prevalence of risk factors and comorbidities in men and the increased occurrence of arrhythmias leading to death in this group[18]. This population more frequently presents HF with ischemic origin and reduced ejection fraction, which are associated with higher incidence of ventricular arrhythmias, which may explain the disparity in arrhythmia incidence during the remote monitoring. These data suggest that protocols should prioritize continuous monitoring for male patients with additional risk markers or as an isolated determinant[19].

While diabetes mellitus was shown to be a significant cardioprotective factor in the study population (p=0.004), this finding may reflect a potential bias, as secondary data collection may mean that some unfavorable events were not recorded in the medical records. This result reflects a limitation of the study, since the data collection was made from medical records, and there is a possibility of data loss. According to data from the Global Burden of Disease Study (2023), cardiovascular deaths attributed to diabetes and metabolic risks have increased across all age groups, totaling more than 19.2 million deaths in that year[20]. The literature indicates that diabetes is an independent risk factor but may also be associated with atrial fibrillation, as changes in cardiac structure due to increased fibrosis related to diabetes can result in diastolic dysfunction, which is already present in HF, further increasing the risk of events[21]. Diabetes mellitus moreover promotes a structural remodeling (fibrosis), causing autonomic dysfunction, microvascular disease and metabolic disturbance, that increase susceptibility to both atrial and ventricular arrhythmias. These findings support that diabetes may amplify short-term arrhythmia risk detectable during monitoring, especially when

associated with other arrhythmia-promoting conditions such as hypertension, coronary disease and HF[22].

Atrial fibrillation is considered the most frequent arrhythmia in populations with HF and was the second most identified arrhythmia in this study, following only extrasystoles. This type of arrhythmia leads to cardiac overload, damaging the heart walls and encouraging clot formation, which can result in stroke. A prior diagnosis of atrial fibrillation was statistically significant ($p=0.018$), supporting the need for continuous monitoring to enable appropriate management and intervention, reducing the risk of complications or worsening HF symptoms due to reduced cardiac output from impaired atrial systole. Identifying arrhythmic events prior to hospitalization with remote monitoring indicates that continued management of recurrent arrhythmias should be maintained in HF patients to prevent rehospitalization due to clinical worsening and reduce unfavorable events that could lead to death[23-25]. During the hospitalization period preceding telemetry use, bradycardia or tachyarrhythmia ($p<0.001$) were statistically significant in identifying events in remote telemetry, which may be related to structural changes in the heart, as seen in HF patients. Related symptoms may progress to pre-syncope or syncope, and their occurrence tends to be multifactorial, influenced by physiological factors, medication use, substance abuse, or established health problems, not necessarily cardiac-related[23,24]. This observation aligns with prior studies showing that past arrhythmic episodes are among the most powerful predictors of recurrence and of arrhythmia-related adverse outcomes; it therefore validates the clinical practice of targeted, intensified monitoring and proactive intervention for patients with prior arrhythmias[25,26].

Our results have direct implications for telemetry program design and for nursing roles in remote monitoring. Modern remote and in-hospital telemetry systems can detect clinically meaningful arrhythmias and may predict impending malignant events when integrated with continuous data analysis—thereby creating opportunities for earlier intervention. However, the effectiveness of monitoring depends critically on how data are triaged and acted upon[23]. The implications for nursing-led remote monitoring are central to successful remote monitoring, evolving the interpretation of clinical signals, and care coordination and specially the patient education post discharge of patients with HF, with a structured interview, orientation about symptom recognition, daily weights, health diet, medication adherence and when to escalate care, in order to reduce hospitalizations. It's important to keep the follow-up the coaching by video/phone contact, coordination with primary care and attendance to cardiologist[27].

Identifying unfavorable events, such as arrhythmias, allows for more appropriate management of complications, aiming to reduce the risk of prolonged hospital stays, which are already lengthy in this population due to necessary therapies. This approach contributes to personalized and targeted care, optimizing clinical outcomes in HF patients. Established care protocols should be evaluated based on the most current guidelines to ensure safe and effective healthcare quality. Additionally, training and education for the care team (nurses and physicians) responsible for identifying events on the remote cardiac telemetry monitor in the cardiac care unit should be prioritized.

LIMITATIONS

This study has some methodological limitations that should be acknowledged. Data collection was based on secondary information extracted from electronic medical records, and the identification of events depended on documentation performed by nurses and physicians in the cardiac care unit, which may have resulted in incomplete recording of some occurrences. To minimize information bias, data were extracted using a structured instrument, and the researcher responsible for data collection received specific training in cardiology nursing and telemetry-related variables to ensure consistency and accuracy.

Occasional telemetry monitoring failures and missed identification of arrhythmic events may also have influenced the results. Although standardized monitoring routines were in place at the institution, variability in clinical practice and documentation cannot be entirely excluded. To reduce the impact of confounding, the analysis focused on well-defined clinical variables consistently available in the medical records and employed appropriate statistical tests for association.

Additionally, the cross-sectional design limits causal inference, and the findings reflect a specific institutional context and period, which may restrict generalizability to other settings. A prior history of arrhythmias and cardiovascular conditions may also have contributed to the higher incidence of arrhythmic events observed. Nevertheless, by including all eligible patients monitored by telemetry during the study period and clearly defining outcomes and variables, this study provides a comprehensive real-world overview of telemetry use in hospitalized patients with HF.

CONCLUSION

In a sample of HF patients using remote telemetry, male sex and the presence of arrhythmias prior to hospitalization were associated with composite unfavorable outcomes.

Furthermore, the event incidence was significant within the first 10 days of telemetry. The early detection of these defects can be useful in making decisions and reducing complications, highlighting the importance of remote monitoring, especially in patients with early discharge from critical units, to guarantee patient safety. As remote monitoring becomes established as a common therapy, continuous training of the nursing staff is important, as they are normally responsible for evaluating monitoring alarms directly from the intensive care units, remotely, and acting in cases of identified emergencies, enabling the reduce of mortality by treating arrhythmias or more serious events such as cardiorespiratory arrest with early identification through bedside care in the inpatient unit.

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Availability of data and material

Access to the dataset may be granted upon request to the corresponding author.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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