



Argentine Journal of Cardiology

Revista Argentina de Cardiología

JUNE 2026 - Vol 94 N° 3

www.sac.org.ar

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ISSN 2314-2278 ISSN electronic version 2314-2286 - Trademark registry N° 5198451

Indexed en SciELO, Scopus, Embase, LILACS, Latindex, Redalyc, Dialnet y DOAJ. Included in the U.S. National Library of Medicine (NLM)

VOL 94 N° 3 JUNE 2026

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Azcúenaga 980 - (1115) Buenos Aires - Argentina / Tel.: + 54 (11) 5031-5884 / e-mail: revista@sac.org.ar

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When the Problem Isn't the Valve: Delays in Care as Determinants of Access to Treatment in Severe Aortic Stenosis

Cuando el problema no es la válvula: las demoras asistenciales como determinantes de la atención en estenosis aórtica grave

CARLOS SZTEJFMAN¹

The recent history of severe aortic stenosis treatment has been characterized by remarkable technological advances. The widespread adoption of transcatheter aortic valve implantation (TAVI) has profoundly transformed the management of a disease that, for decades, was limited to conventional surgery and palliative care for patients deemed inoperable. The clinical outcomes across different surgical risk categories have established TAVI as an effective, safe, and increasingly accessible therapy option.

However, as the procedure has become increasingly optimized, a less visible yet equally significant question has emerged: what happens between the moment the treatment decision is made and the day the patient finally receives the valve?

This question rarely takes center stage at congresses or in scientific literature. Discussions typically focus on procedural success rates, vascular complications, pacemaker implantation and mortality whereas administrative processes, authorizations, institutional coordination, and logistical challenges remain largely overlooked. Nevertheless, for many patients, these factors may be just as decisive as the technical aspects of the procedure itself.

The study by Chiminela et al. (1) provides a particularly valuable perspective by addressing this largely overlooked aspect of cardiovascular care. Based on the multicenter experience of three Argentine institutions, the authors systematically describe the intervals between different stages of the diagnostic-therapeutic process and the actual TAVI. Their findings show that delays may extend over several months, from the initial specialist consultation to the day of valve implantation, reflecting the administrative and organizational complexity that characterizes many healthcare systems in our region. Importantly,

such delays may not be without clinical consequences.

Perhaps the most important finding of the study is not merely the magnitude of the observed delays, but the demonstration that they can be significantly reduced through relatively simple organizational interventions. The implementation of more structured care pathways—such as designating a fixed day of the week for procedures, establishing a stable and dedicated multidisciplinary team, appointing a single program coordinator, and providing individualized follow-up for each patient—was associated with a substantial reduction in waiting times.

This finding has major practical implications. In healthcare settings frequently constrained by budgetary limitations, it is tempting to assume that improvements in outcomes necessarily depend on the incorporation of new technologies or increased financial resources. However, the experience presented here demonstrates that process optimization can yield significant benefits even without substantial changes to the existing infrastructure.

This conclusion is strongly supported by international evidence. Hewitson et al. demonstrated that implementing a referral pathway with a comprehensive, on-site patient evaluation at a non-surgical center—rather than the traditional model centered on a tertiary care facility—reduced the mean time from referral to TAVI from 126 to 32 days ($p < 0.001$) and increased the acceptance rate for the procedure from 49.5% to 97.8%.⁽²⁾ The key to this transformation did not lie in new technologies, but in the reorganization of the care pathway: direct triage by specialized cardiologists, standardization of diagnostic testing at the local level, and close coordination with the team at the referral center. Although the context of the British National Health Service (NHS) differs substantially

REV ARGENT CARDIOL 2026;94:173-174. <https://doi.org/10.7775/rac.v94.i3.21020>

SEE RELATED ARTICLE: Rev Argent Cardiol 2026;94:181-186. <https://doi.org/10.7775/rac.v94.i3.21003>



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from the Argentine healthcare system, the organizational lesson remains fully transferable: the barriers that most delay access to TAVI are not technical but systemic, and addressing them is within the capacity of any institution willing to reorganize.

The issue becomes even more important when considering the natural history of severe symptomatic aortic stenosis. Several studies have shown that delays in therapeutic intervention can be associated with progressive clinical deterioration, recurrent hospitalizations, and even death prior to the procedure. The most compelling international data in this regard comes from the NHS: in 2019, 299 deaths were recorded among patients on the TAVI waiting list in the United Kingdom, which—when extrapolated to all centers—would amount to more than 500 potentially preventable deaths. (2) In this setting, waiting times cease to be a mere administrative variable and become a true indicator of the healthcare quality.

Another remarkable aspect of the study by Chiminela et al. is that it highlights a challenge shared by numerous Latin American centers. Difficulties related to authorizations, financing, device provision, and interinstitutional coordination represent daily challenges that are seldom quantified objectively. Generating local evidence is essential for understanding the magnitude of the problem and designing strategies tailored to the specific characteristics of each healthcare system.

Despite the methodological limitations inherent in its retrospective design, the limited number of participating centers, and the patient population predominantly covered by governmental funding, this study opens a new avenue for research in contemporary structural cardiology. Just as there are standardized indicators for evaluating the technical quality of procedures, the time has likely come to develop specific metrics to measure and compare the efficiency of the care pathways leading to TAVI. Their incorporation into national or regional registries could become a key health policy tool. It should be noted that, since this study was conducted, the time from authorization to valve provision has decreased considerably, representing a significant improvement in timely access to treatment.

The question that naturally arises is whether, given the impossibility of completely eliminating delays, it is at least possible to manage them more intelligently. In this regard, a recent study by Miranda et

al. addresses precisely this issue.(3) Drawing on a population-based cohort of more than 13 000 patients on the TAVI waiting list in Ontario, Canada, the authors developed and validated the Canadian TAVI Triage Tool (CAN3T), a risk stratification tool that estimates the individual's probability of death, hospitalization, or urgent TAVI during the waiting period and recommends a personalized maximum waiting time for each patient. In that cohort, more than 33% of patients on the waiting list experienced at least one hospitalization, and 4.5% died before undergoing the procedure. The CAN3T is not intended to replace the reorganization of care pathways, but rather to complement it: once waiting times have been reduced through organizational measures, tools such as this allow prioritization of those who can least afford to wait. It represents the logical next step based on the insights from the work of Chiminela et al.

Ultimately, the study by our colleagues—which sheds light on an important aspect of the Argentina healthcare reality—reminds us of a fundamental lesson: in modern cardiovascular medicine, excellence depends not only on available technology or the technical expertise of operators, but also on the capacity of healthcare systems to ensure that the right patient receives the right treatment at the right time.

Sometimes, the most difficult distance to bridge is not the one between the left ventricle and the aorta, but the one between a well-established clinical indication and the actual implantation of the valve in the patient who needs it.

Conflicts of interest

None declared

(See authors conflicts of interest forms on the website).

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Differences in Diastolic Function and Global Longitudinal Strain on Stress Echocardiography Between Elderly Diabetic and Non-Diabetic Patients

Diferencias entre el comportamiento de la función diastólica y el strain longitudinal global en el ecocardiograma de estrés de paciente ancianos diabéticos versus no diabéticos

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ABSTRACT

Background: Diabetes mellitus (DM) is a disease with increasing prevalence due to population aging. According to the Framingham study, DM is associated with an increased risk of heart failure in both women and men, regardless of the presence of concomitant coronary artery disease. In its early stages, diabetic cardiomyopathy is characterized by an almost always preserved left ventricular ejection fraction (LVEF), with reduced global longitudinal strain (GLS) and diastolic dysfunction.

Objective: The following study was conducted to describe alterations in diastolic function and GLS and their associations in a population of elderly diabetic patients.

Methods: This was an observational cohort study including consecutive patients undergoing a stress echocardiogram in our department, excluding those diagnosed with coronary artery disease. Diastolic function variables (E velocity, e' velocity and E/e' ratio) were measured, and patients were categorized as presenting normal diastolic function or mild (Grade 1), moderate (Grade 2), or severe (Grade 3) diastolic dysfunction. Speckle tracking was used to measure global longitudinal strain. 6 years Diabetic patients were compared with non-diabetic patients. Multivariate analysis was performed to identify the predictors of significant diastolic dysfunction (moderate or severe) and GLS. A p-value <0.05 was considered statistically significant.

Results: The study included 176 diabetic patients and 771 non-diabetic ones, with a mean age of 73 ± 6 years. Diabetic patients exhibited greater diastolic function parameter abnormalities at rest and during exercise compared with non-diabetic patients, as well as a significant reduction in GLS. The group with DM had a higher percentage of significant diastolic dysfunction both at rest (12.5% vs. 7.5%, $p < 0.001$) and during exercise (35% vs. 23%, $p < 0.001$). Left ventricular ejection fraction was normal and similar in both groups ($p = 0.417$). Global longitudinal strain was lower in patients with DM (-15.20% vs. -16.21% in patients without DM; $p < 0.001$). In logistic regression analysis, DM was an independent predictor of significant diastolic dysfunction and an independent predictor of GLS. Only one patient in the diabetic group presented with LVEF <50%.

Conclusion: In this population of elderly patients without ischemic heart disease, DM was independently associated with a higher prevalence of diastolic dysfunction, both at rest and during exercise, and with a reduction in stroke volume despite preserved left ventricular ejection fraction. These findings are consistent with the concept of a predominantly subclinical diastolic diabetic cardiomyopathy.

Key words: Diabetes mellitus - Heart failure - Ventricular dysfunction - Diastolic dysfunction.

RESUMEN

Introducción: La diabetes mellitus (DM) es una enfermedad cuya prevalencia va en aumento conforme el envejecimiento de la población. De acuerdo con el estudio Framingham, la DM implica un aumento del riesgo de insuficiencia cardíaca en mujeres y hombres más allá de la presencia de enfermedad coronaria concomitante. En estadios iniciales la miocardiopatía diabética se caracteriza por una fracción de eyección del ventrículo izquierdo (FEVI) casi siempre preservada, con disminución del strain longitudinal global (SLG) y disfunción diastólica.

Objetivo: El siguiente estudio se realizó con el objetivo de describir las alteraciones de la función diastólica y el SLG y sus asociaciones en una población de pacientes diabéticos añosos.

Material y métodos: Estudio de cohorte observacional en el cual se incluyeron pacientes consecutivos que acudieron a realizarse un ecocardiograma de estrés en nuestro servicio, excluyendo los pacientes con diagnóstico de enfermedad coronaria. Se midieron

REV ARGENT CARDIOL 2026;94:175-180. <https://doi.org/10.7775/rac.v94.i3.21004>

Received: 02/01/2026 – Accepted: 03/31/2026

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variables de función diastólica (Vel E, Vel e', relación E/e') y se categorizó a los pacientes como función diastólica normal y disfunción diastólica leve (Grado 1), moderada (Grado 2) o grave (grado 3). Se midió el SLG mediante speckle tracking. Se compararon los pacientes diabéticos versus no diabéticos. Se realizó análisis multivariado para establecer los determinantes de disfunción diastólica significativa (moderada o grave) y del SLG. Se consideró estadísticamente significativa una $p < 0,05$.

Resultados: Se incluyeron 176 pacientes diabéticos y 771 pacientes no diabéticos, con una edad media de 73 años. Los pacientes diabéticos presentaron mayor alteración de los parámetros de función diastólica en reposo y esfuerzo con respecto a los no diabéticos, y también una significativa disminución del SLG. El grupo con DM presentó mayor porcentaje de disfunción diastólica significativa tanto en reposo (12,5% vs 7,5%, $p < 0,001$) como en esfuerzo (35% vs 23%, $p < 0,001$). La FEVI fue normal y similar en ambos grupos ($p = 0,417$). El SLG fue menor en los pacientes con DM (-15,20% vs. -16,21% en pacientes sin DM; $p < 0,001$). En análisis de regresión logística la DM fue predictor independiente de disfunción diastólica significativa, y predictor independiente del SLG. Solo un paciente en el grupo de pacientes diabéticos presentó FEVI $< 50\%$

Conclusión: En esta población de pacientes añosos sin cardiopatía isquémica, la DM se asoció de manera independiente con una mayor prevalencia de disfunción diastólica, tanto en reposo como durante el esfuerzo, y con una reducción del SLG en presencia de FEVI preservada. Estos hallazgos son consistentes con el concepto de miocardiopatía diabética subclínica de predominio diastólico.

Palabras clave: Diabetes mellitus - Insuficiencia cardíaca - Disfunción ventricular - Disfunción diastólica

INTRODUCTION

The incidence and prevalence of diabetes mellitus (DM) is steadily increasing due to population aging, obesity, and physical inactivity (1) and is associated with the development of macro and microvascular coronary artery disease. (2) It has also been reported that type 2 DM may be associated with cardiomyopathy, particularly with heart failure regardless the presence of associated coronary artery disease, especially in women. (3,4) Heart failure is also related to a poorer prognosis in diabetic patients. (5) In this context, diastolic dysfunction often represents the first manifestation of structural and functional myocardial compromise and is considered more common than systolic dysfunction in diabetic patients without overt ischemic heart disease. (6,7) This pattern has led to the concept of diabetic cardiomyopathy, characterized in early stages by preserved left ventricular ejection fraction (LVEF) and early alterations in ventricular relaxation and distensibility. (8) In recent years, global longitudinal strain (GLS) assessed by echocardiography has emerged as a sensitive marker of subclinical systolic dysfunction, reflecting the involvement of longitudinal myocardial fibers. Several studies have shown that GLS may be reduced in diabetic patients even in the presence of preserved LVEF, suggesting early myocardial damage undetectable by conventional methods. (7,8)

OBJECTIVES

The objective of the present study was to assess differences in echocardiographic systolic and diastolic function and GLS parameters in elderly diabetic versus non-diabetic patients without evidence of ischemic heart disease. A secondary objective was to evaluate the prevalence of significant diastolic dysfunction and associated variables.

METHODS

An observational cohort study was conducted, including consecutive patients referred to the echocardiography service for resting and exercise stress echocardiography. Patients

with a history of known coronary artery disease, peripheral vascular disease, stroke, and those unable to exercise were excluded from the study, as were patients with significant (moderate or severe) valvular heart disease. Additionally, patients with a positive test for myocardial ischemia were excluded. The population was divided into two groups based on the clinical history of DM: patients with treated diabetes (DM) and patients without diabetes (No DM). A Vinno E 35 ultrasound system with a 2.4 MHz phased-array transducer was used to perform the study.

The following measurements were acquired at baseline and immediately post-exercise: in the mitral flow graph obtained with pulsed-wave Doppler at the tips of the mitral valves: peak E velocity (E velocity) at rest and immediately post-exercise; in the tissue Doppler recording at the level of the basal septum: e' velocity at rest and immediately post-exercise (e' velocity); E/e' ratio at rest and post-exercise (Figures 1–3); LVEF by the Simpson method in apical 4, and 2-chamber views, averaging both values at rest and immediately post-exercise; GLS (assessed by speckle tracking), averaging the apical 4-, 3-, and 2-chamber views at rest. Exercise testing was performed on a treadmill using the Bruce protocol. Measurements were acquired 1–2 minutes post-exercise when the A and E waves were no longer fused. Significant diastolic dysfunction was defined as moderate (grade 2) or severe (grade 3) diastolic dysfunction according to the definition of the American Society of Echocardiography (9) (Figures 1–3) or an E/e' ratio greater than 14.

Statistical analysis

For descriptive statistics, quantitative data are presented as mean \pm standard deviation (SD), and categorical data as frequency and percentage. Means in both groups were compared using Student's t-test, and proportions were compared using the chi-square test. A p-value < 0.05 was considered statistically significant. Univariate associations are expressed as odds ratios (OR) with their respective 95% confidence intervals (95% CI). A multiple logistic regression analysis was performed in which significant diastolic dysfunction (moderate or severe) was the dependent variable, and the following predefined variables were included in the model: advanced age (over 73 years), male sex, diabetes, hypertension, dyslipidemia, and smoking. A multiple regression analysis was also performed in which GLS was the dependent variable and diabetes, hypertension, male sex, age, dyslipidemia, and smoking were the independent variables.

Fig. 1. A. Mild diastolic dysfunction (grade 1). Pulse Doppler mitral filling. The mitral Flow pattern shows peak “E” velocity of 44.86 cm/s and peak “A” velocity of 58.74 cm/s. The corresponding E/A ratio is 0.76. This is the most frequent filling pattern in our study and is very prevalent in subjects over 60 years of age and in initial stage of heart diseases. **B.** Mild diastolic dysfunction (grade 1). Mitral annulus tissue Doppler. This image is related to Figure 1 and shows “e’” velocity of 5.52 cm/s , corresponding to an E/e’ ratio of 8.12. These values are associated with low pulmonary capillary pressure and absence of cardiac dyspnea.

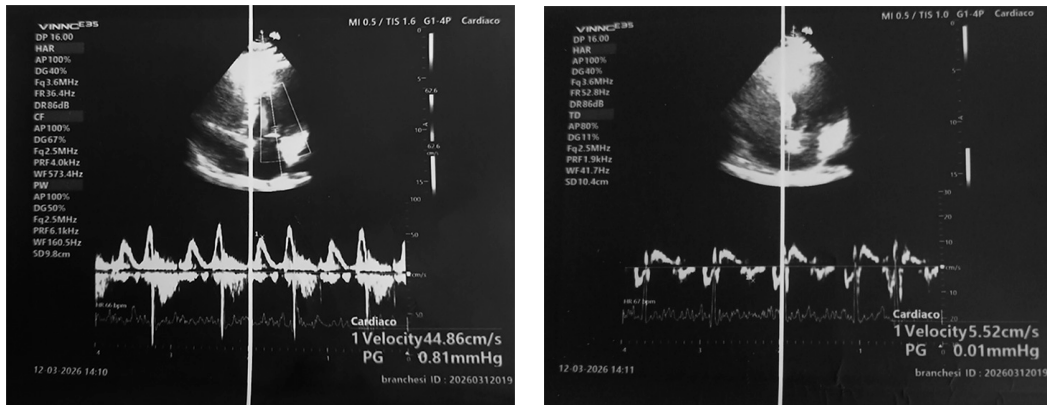


Fig. 2. A. Moderate cardiac dysfunction (grade 2). Pulsed Doppler mitral filling. The image shows peak E velocity of 78.21 cm/s and peak A velocity of 71.01 cm/s, with an E/A ratio of 1.10. This pattern is also called pseudonormal. **B.** Moderate diastolic dysfunction (grade 2). Mitral annulus tissue Doppler. This image is related to Figure 2. The E/e’ ratio is 11.90. These patients usually have a slightly raised capillary pressure and occasional symptoms of stress dyspnea.

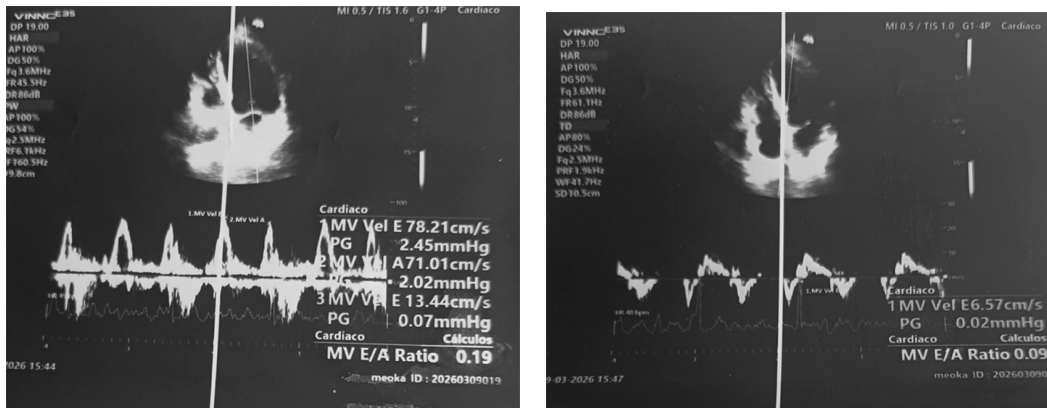
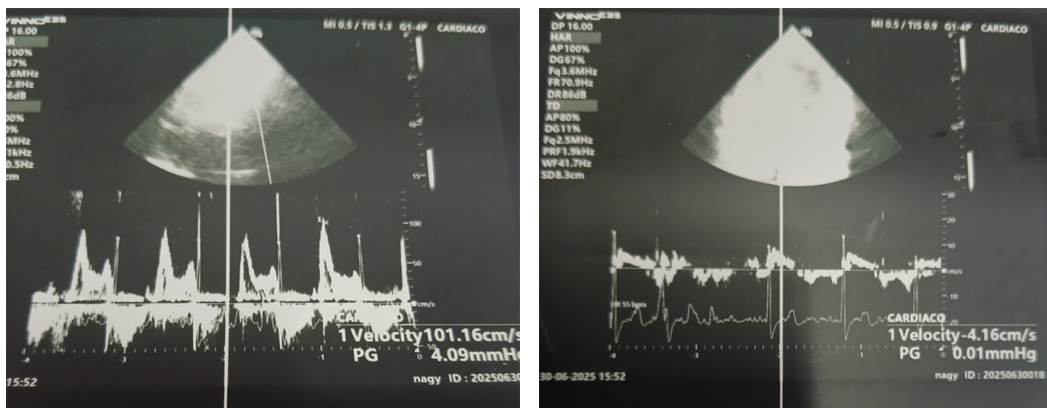


Fig. 3. A. Severe diastolic dysfunction (grade 3). Altered ventricular compliance. The mitral flow pattern shows peak “E” velocity of 101 cm/s and peak A velocity of 33 cm/s, with an E/A ratio of 3.06. This pattern is observed in advanced or decompensated heart diseases. **B.** Severe diastolic dysfunction (grade 3). Mitral annulus tissue Doppler. e’ velocity is 4.16 cm/s and the E/e’ ratio is 24 , indicating high pulmonary capillary pressure. This pattern is observed in frequently symptomatic patients.



RESULTS

A total of 1384 patients were evaluated in the stress echocardiography unit between March 2023 and December 2025; of these, 437 were excluded from the analysis due to coronary artery disease. A total of 947 patients with a mean age of 73 ± 6 years were included, 176 of which had diabetes (18.5%). The demographic characteristics and risk factors of patients with and without DM are presented in Table 1.

The group with DM consisted of a higher number of male patients and a greater incidence of hypertension, dyslipidemia, and smokers. The prevalence of moderate or severe diastolic dysfunction was significantly higher in the diabetic group, both at rest and immediately post-exercise. In addition, patients with DM had a significantly higher E/e' ratio both at rest and post-exercise due to a lower e'. There were no significant differences in LVEF at rest or immediately after exercise, and the GLS at rest was significantly lower in diabetic patients. (Table 2).

In a logistic regression model (in which diastolic dysfunction was the dependent variable and the independent variables were advanced age, male sex, diabetes, hypertension, dyslipidemia, and smoking), advanced age, diabetes, and male sex independently predicted moderate or severe diastolic dysfunction at rest. Advanced age, diabetes, and male sex also independently predicted moderate or severe diastolic dysfunction during exercise. (Tables 3 and 4)

Global longitudinal strain was significantly reduced in diabetic patients (Table 2), and in a multiple regression analysis, diabetes ($p=0.031$), hypertension ($p<0.001$), and male sex ($p=0.013$) were independent predictors of GLS, whereas age, dyslipidemia, and smoking were not.

DISCUSSION

Our case series includes a group of elderly patients with type 2 DM and without coronary artery disease. Although there were no inclusion or exclusion criteria

Table 1. Population characteristics

Variables	DM (n=176, 18.5%)	Non-DM (n=771, 81.5%)	p
Age, years, mean \pm SD	72 ± 7	73 ± 6 years	0.270
Male sex, n (%)	73 (41,5)	208 (27,0)	<0.001
Hypertension, n (%)	147 (83,5)	521 (67,6)	<0.001
DLP, n (%)	83 (47,2)	301 (39,0)	0.047
TS or ex-TS, n (%)	87 (49,4)	245 (31,8)	0.001

DLP: dyslipidemia; DM: diabetes; TS: tobacco smoker.

Table 2. Echocardiographic parameters of systolic function, diastolic function, and strain in diabetic and non-diabetic patients

Parameters	DM (n=176, 18.5%)	Non-DM (n=771, 81.5%)	p
Resting LVEF, %	59 ± 8	60 ± 7	0.255
Exercise LVEF, %	68 ± 9	69 ± 7	0.240
Resting peak E velocity, m/s	0.69 ± 0.20	0.67 ± 0.20	0.318
Resting peak e' velocity, m/s	0.061 ± 0.011	0.065 ± 0.012	<0.001
Resting E/e' ratio	12.4 ± 1.1	10.9 ± 5.5	<0.001
Exercise peak stress E velocity, m/s	0.88 ± 0.2	0.85 ± 0.2	0.018
Exercise peak stress e' velocity, m/s	0.071 ± 0.03	0.074 ± 0.02	0.640
Exercise E/e' ratio	13.9 ± 8	12.1 ± 5	< 0.001
Global longitudinal strain, %	-15.20	-16.21	< 0.001
Resting diastolic dysfunction, n (%)	22 (12.5)	55 (7.1)	< 0.001
Exercise-induced diastolic dysfunction, n (%)	62 (35)	177 (23)	< 0.001

LVEF: Left ventricular ejection fraction; DM: Diabetes mellitus

Table 3. Prediction of resting diastolic dysfunction. Univariate and multivariate analysis.

Independent variables	Univariate OR (95% CI)	p	Multivariate OR (95% CI)	p
Male	2.28 (1.6–3.2)	0.001	2.24 (1.54–3.26)	<0.001
Advanced age	1.48 (1.04–2.10)	0.025	1.44 (1.00–2.05)	0.045
Diabetes	1.90 (1.27–2.85)	<0.001	1.70 (1.11–2.59)	0.013
Hypertension	1.56 (1.04–2.33)	0.029	1.33 (0.87–2.01)	0.177
Dyslipidemia	1.05 (0.73–1.49)	0.658	1.11 (0.77–1.60)	0.562
Smoking	0.94 (0.65–1.36)	0.524	0.76 (0.52–1.13)	0.188

Table 4. Prediction of moderate-to-severe exercise-induced diastolic dysfunction. Univariate and multivariate analysis.

Independent variables	Univariate OR (95% CI)	p	Multivariate OR (95% CI)	p
Male	3.5 (1.75–7)	< 0.001	3.03 (1.45–6.32)	0.003
Advanced age	2.45 (1.18–5.07)	0.015	2.42 (1.15–5.10)	0.019
Diabetes	3.93 (1.97–7.84)	< 0.001	3.31 (1.60–6.85)	0.001
Hypertension	1.78 (0.77–4.14)	0.280	1.27 (0.53–3.04)	0.590
Dyslipidemia	1.16 (0.58–2.31)	0.781	1.23 (0.60–2.52)	0.555
Smoking	1.25 (0.62–2.50)	0.765	0.86 (0.41–1.82)	0.700

in the study that specifically addressed age, it is justified to consider the population as elderly given their mean age of 73 years and the fact that 95% of patients were over 60 years of age.

We found that these patients did not have significant abnormalities in left ventricular systolic function as assessed by LVEF at rest and during exercise, although in some studies the LVEF of diabetic patients is found to be slightly reduced. (10) On the other hand, several parameters of diastolic function were consistently significantly altered in this group of diabetic patients, and there was also a significant reduction in GLS, indicating an abnormal myocardial fiber function. (11)

The pathophysiological mechanisms implicated in diabetic cardiomyopathy (3–12) include impaired cardiac insulin signaling, mitochondrial dysfunction, increased oxidative stress, reduced nitric oxide availability, elevated advanced glycation end products, impaired myocardial calcium handling, inflammation, activation of the renin-angiotensin-aldosterone system, cardiac autonomic neuropathy, and microvascular dysfunction. (13,14)

Although there was a difference in the prevalence of other risk factors in the group of diabetic patients (more hypertension, dyslipidemia, and smoking), the multivariate analysis showed that DM is independently associated with diastolic function, as are advanced age and male sex, but not the other factors mentioned. Diabetes mellitus was also independently associated with GLS.

Moderate or severe diastolic dysfunction at rest

was found in 12.5% of diabetic patients, and moderate to severe diastolic dysfunction during exercise in 35%. It is known that exercise can reveal greater degrees of diastolic dysfunction, that is, a lower functional reserve of diastolic function.

Based on these findings, we conclude that our observations support the existence of cardiomyopathy with diastolic dysfunction in a small but statistically significant group of diabetic patients studied, and that diabetes is a determinant of this condition. This finding is consistent with several previously published series. (15)

In our study, this cardiomyopathy is characterized by preserved LVEF at rest and during exercise, and a mild but significant decrease in GLS, in addition to altered diastolic parameters on Doppler, consistent with several published series. (16)

In contrast, only one diabetic patient in our series presented with a low LVEF (systolic dysfunction), demonstrating a very low prevalence of diabetic-related systolic dysfunction in our series (it should be noted that patients with ischemic heart disease were excluded). The term “diabetic cardiomyopathy” was initially introduced based on postmortem findings in four diabetic adults with heart failure in the absence of coronary artery disease. (17) This condition —diabetic dilated cardiomyopathy in the absence of coronary artery disease— is described in case series, but its existence is more controversial. (18)

In summary, based on previous publications and the results of our study, we can conclude that diabetic cardiomyopathy with isolated diastolic dysfunction is

relatively common in asymptomatic elderly diabetics, but that the prevalence of diabetic dilated cardiomyopathy, whose existence is controversial, is very low, if it exists at all. This diastolic dysfunction in diabetic patients, beyond the presence of coronary artery disease, is associated with a higher incidence of heart failure in this population. Although the risk of heart failure is thought to be higher in diabetic women, in our study, male sex was associated with the presence of significant diastolic dysfunction. The significance of this finding is unclear, but it could be explained by the fact that diastolic dysfunction is not synonymous with diastolic heart failure.

Limitations

Our case series was limited to elderly patients with type 2 diabetes. Moreover, cardiomyopathy as a complication of type 1 diabetes is a condition of very low prevalence. (19)

The cross-sectional nature of our study does not allow us to draw conclusions regarding the development of heart failure during the course of this diastolic dysfunction, which is evident at rest and during exercise in a subgroup of diabetic patients. It has been described that more than one factor is involved in the development of heart failure in diabetics, some of which are extra myocardial, such as the phenomenon of hyperfiltration and increased blood volume in these patients. (20) Prospective follow-up of these patients would be necessary to clarify the prognostic significance of diastolic dysfunction in elderly diabetic patients.

Conflicts of interest

None declared.

(See authors' conflict of interests forms on the web).

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Analysis of Administrative and Financial Delays in the Process Leading to Transcatheter Aortic Valve Implantation: Real-World Experience in Argentina

Análisis de las demoras administrativas y financieras en el proceso hacia el implante valvular aórtico transcatóter: experiencia del mundo real en Argentina

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ABSTRACT

Background: Severe aortic stenosis (AS) is one of the most prevalent valvular heart diseases worldwide. Transcatheter aortic valve implantation (TAVI) has become an effective and safe therapeutic alternative across different surgical risk profiles. However, differences in access to the procedure and delays between the therapeutic decision and implantation vary substantially across healthcare systems.

Objective: The aim of this study was to analyze the procedural timelines between key stages of the diagnostic–therapeutic process and TAVI implantation in the real-world clinical practice of three Argentine centers, comparing two periods defined by institutional reorganization, in order to identify opportunities for organizational optimization.

Methods: A multicenter, observational, retrospective cohort study was conducted including 71 consecutive patients with symptomatic severe aortic stenosis (AS) who underwent TAVI between January 2022 and August 2025. Three procedural intervals were evaluated: first contact (FC) with an interventional cardiologist-implantation, computed tomography (CT)-implantation, and valve request–implantation. The intervals are presented as the median and interquartile range (IQR). Differences between periods were analyzed using the Mann–Whitney U test.

Results: The overall median intervals were 165 days (IQR 118–258) for FC–implantation, 145 days (IQR 98–216) for CT–implantation, and 67 days (IQR 45–112) for valve request–implantation. After institutional reorganization (November 2024), a significant reduction was observed in all three intervals ($p < 0.001$), with new medians of 138, 117, and 56 days, respectively.

Conclusions: Substantial delays were identified in the pre-TAVI process within the Argentine healthcare system, with a marked reduction following the implementation of organizational measures. Optimizing interinstitutional and administrative coordination emerges as a key strategy to improve procedural efficiency.

Key words: Aortic Valve Stenosis - Transcatheter Aortic Valve Replacement - Organizational Efficiency

RESUMEN

Introducción: La estenosis aórtica (EA) grave constituye una de las valvulopatías más prevalentes a nivel global. El implante valvular aórtico transcatóter (TAVI) se ha consolidado como una alternativa terapéutica eficaz y segura en distintos perfiles de riesgo quirúrgico. Sin embargo, las diferencias en el acceso al procedimiento y las demoras entre la decisión terapéutica y el implante varían sustancialmente según los sistemas de salud.

Objetivo: Analizar los tiempos asistenciales entre etapas clave del proceso diagnóstico-terapéutico y el TAVI en la práctica clínica real de tres centros médicos argentinos, comparando dos períodos definidos por una reorganización institucional de procesos médicos administrativos, con el fin de identificar oportunidades de optimización organizacional.

Material y métodos: Se realizó un estudio multicéntrico observacional de cohorte retrospectivo, que incluyó 71 pacientes consecutivos con EA grave sintomática sometidos a TAVI entre enero de 2022 y agosto de 2025. Se evaluaron tres intervalos asistenciales: primer contacto con el médico hemodinamista (PC)–implante, tomografía computarizada (TC)–implante y solicitud de válvula–implante. Los intervalos se presentan como mediana y rango intercuartílico (RIC). Las diferencias entre períodos se analizaron mediante la prueba U de Mann–Whitney.

REV ARGENT CARDIOL 2026;94:181-186. <https://doi.org/10.7775/rac.v94.i3.21003>

SEE RELATED ARTICLE: REV ARGENT CARDIOL 2026;94:173-174. <https://doi.org/10.7775/rac.v94.i3.21020>

Received: 10/25/2025 – Accepted: 02/01/2026

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Resultados: La mediana global de los intervalos fue de 165 días (RIC 118–258) para PC–implante, 145 días (RIC 98–216) para TC–implante y 67 días (RIC 45–112) para solicitud–implante. Tras la reorganización institucional (noviembre de 2024), se observó una reducción significativa en los tres intervalos analizados ($p < 0,001$), con medianas de 138, 117 y 56 días, respectivamente.

Conclusiones: Se observaron demoras sustanciales en el proceso pre-TAVI dentro del ámbito sanitario argentino, con una reducción sustancial tras la implementación de medidas organizacionales. La optimización de la coordinación interinstitucional y administrativa constituye una estrategia clave para mejorar la eficiencia asistencial.

Palabras clave: Estenosis aórtica - Implante valvular aórtico transcáteter - Eficiencia organizacional

INTRODUCTION

Aortic valve stenosis (AS) is one of the most prevalent valvular heart diseases worldwide, with an even higher prevalence among elderly patients, which is associated with a high burden of comorbidities and a poor clinical prognosis if timely and early treatment is not provided. (1,2) In recent decades, transcatheter aortic valve implantation (TAVI) has established itself as one of the primary therapeutic strategies for patients with severe symptomatic AS, encompassing various age groups and surgical risk subgroups. (3–5) Its adoption has expanded steadily, supported by robust evidence demonstrating its efficacy and safety compared with conventional surgical valve replacement.

However, despite its growing implementation, substantial differences have been documented across different regions and healthcare systems in terms of access to the procedure, financing challenges, and delays between the therapeutic decision and the actual performance of the implantation. (6,7) In this context, it is particularly relevant for our region to analyze in detail the duration of the different stages of the process leading to TAVI, with the aim of identifying optimization opportunities that can improve system efficiency and clinical outcomes for patients.

The purpose of this study was to analyze care intervals between key stages of the diagnostic-therapeutic process and TAVI in the real-world clinical practice of three centers in Argentina, comparing two time periods defined by a turning point, with the aim of identifying potential improvements in organizational efficiency and care delivery.

OBJECTIVE

We conducted this study with the aim of correlating by echocardiography the trigones and the CF with topographic anatomy to understand the anatomofunctional characteristics of cardiac mechanics.

METHODS

A retrospective, observational, multicenter cohort study was conducted, including the analysis consecutive patients with severe AS who underwent TAVI during the period from January 2022 to August 2025.

Demographic (age, gender), care-related (center, health insurance coverage), procedural (type of implanted prosthesis, need for prior coronary revascularization or valvuloplasty, use of a pacemaker, transesophageal echocardiography and in-procedure events), and clinical (periprocedural clinical complications and mortality during the 30-day follow-up period) variables were collected.

The clinical time points of interest were defined prospectively and analyzed as intervals in days between:

- First contact (FC) with the interventional cardiologist → implantation.
- Computed tomography (CT) → implantation.
- Valve request → implantation.

These metrics reflect the diagnostic and administrative sequence of the pre-TAVI process, in line with the characterization of “waiting times” used in international studies. (7)

Statistical analysis

Continuous variables were expressed as mean and standard deviation (SD) or median and interquartile range (IQR) according to their distribution characteristics. The normality of the variables was assessed by graphical inspection and the Shapiro–Wilk test. Categorical variables were presented as absolute frequencies and percentages. For the comparative analysis of care intervals, two periods were defined based on the cutoff date of November 1, 2024, corresponding to an institutional reorganization of the medical-administrative care pathways at the participating centers.

Differences between periods were assessed using Welch’s t-test for independent means, given the possible heterogeneity of variances between groups. In cases of non-normal distributions, the robustness of the results was verified using the nonparametric Mann–Whitney U test.

The data were analyzed using an exploratory approach with no corrections for multiple comparisons. All comparisons were two-sided, and a p-value < 0.05 was considered statistically significant. Statistical analysis was performed using standard statistical software for biomedical research (Stata®, version BE, StataCorp, College Station, TX, USA).

Ethical considerations

The study was conducted in accordance with the principles of the Declaration of Helsinki, (8) and was approved by the institutional ethics committees of the participating centers. The individual informed consent was waived given the retrospective nature of the study and the use of anonymized data.

RESULTS

Dissection and topographic anatomy of the cardiac fulcrum

A total of 71 patients who underwent TAVI between January 2022 and August 2025 were included in the analysis. Mean age of the study population was 80.9 ± 5.2 years, with female predominance. In terms of the procedure’s financiers, health coverage was provided primarily by the Comprehensive Medical Care Program (PAMI), while the Institute of Medical Assistance (IOMA) accounted for only a minority of cases, approximately 1%. (Table 1)

Regarding the technologies used for TAVI, the most commonly implanted valve prostheses were Evolut R/PRO (Medtronic Inc., Minneapolis, MN, USA),

followed by Sapien 3 (Edwards Lifesciences LLC, Irvine, CA, USA), ACURATE neo2 (Boston Scientific Corporation, Marlborough, MA, USA), and Myval (Meril Life Sciences Pvt. Ltd., Vapi, Gujarat, India), respectively. (Table 2)

No valve requests were rejected by the financiers, although in some cases, the amount of supporting documentation required for device provision was greater than for the rest of the patients.

Preoperative evaluation was complete in all patients, including electrocardiogram, transthoracic echocardiogram, coronary angiography, CT scan with TAVI protocol, and conventional surgical risk scores.

Procedures and adverse clinical events

Regarding the cardiovascular interventional procedures performed during pre-TAVI preparation, one-quarter of patients required percutaneous coronary intervention (PCI) prior to TAVI, while approximately 3% underwent balloon aortic valvuloplasty (BAV) as a bridge to the intended therapeutic procedure. Among the total number of patients included, only two had a history of permanent pacemaker implantation, while three required a permanent pacemaker post-implantation.

Intra-procedural adverse clinical events were recorded in only three patients: two required emergency

Table 2. Type of implanted valve prosthesis and periprocedural adverse clinical events

Variable *	n=71
Type of prosthesis implanted	
Evolut R/PRO	51 (71.8)
Sapien 3	17 (23.9)
ACURATE neo2	2 (2.8)
Myval	1 (1.4)
Pre-TAVI PCI	18 (25.3)
Aortic balloon valvuloplasty	3 (2.8)
Permanent pacemaker implantation	3 (4.2)
Intraprocedural adverse clinical events	3 (4.2)
Immediate post-implantation events (before discharge)	5 (7.0)
Mid-term post-discharge events	2 (2.8)
Overall 30-day mortality	3 (4.2)

* Data expressed as absolute values (percentage).
 PCI: percutaneous coronary intervention; TAVI: transcatheter aortic valve implantation

Table 1. Baseline characteristics of the study population

Variable *	n=71
Age, years	80.9 ± 5.2
Male gender	44 (62.4)
BMI, kg/m ²	26.8 ± 3.4
Hypertension	59 (83.3)
Dyslipidemia	37 (52.6)
Diabetes mellitus	23 (32.1)
Smoking	11 (15.9)
Chronic kidney disease	9 (13.3)
Peripheral vascular disease	8 (11.7)
Atrial fibrillation	16 (23.2)
Cancer	6 (8.1)
COPD	10 (14.7)
Previous pacemaker	2 (3.1)
LVEF, %	57 ± 9
Financier	
PAMI	70 (98.6)
IOMA	1 (1.4)
Other	0 (0)

* Data expressed as mean ± standard deviation or absolute value (percentage)
 BMI: body mass index; COPD: chronic obstructive pulmonary disease; IOMA: Institute of Medical Assistance; LVEF: left ventricular ejection fraction; PAMI: National Institute of Social Services for Retirees and Pensioners

pacemaker implantation, and one developed congestive heart failure. In the immediate post-implantation period, complications were observed in five patients: one emergency pacemaker, one vascular access complication, two deaths, and one case of acute cholecystitis unrelated to TAVI. In the mid term, two patients experienced clinical events (one case of congestive heart failure and one case of infectious endocarditis of a native valve with a fatal outcome). An overall mortality rate of 4.2% was observed during the 30-day follow-up period following the index procedure.

Analysis of care intervals

Analysis of delays in each of the care intervals showed that the median time between the FC with an interventional cardiologist and TAVI was 165 days (IQR 118–258); the median interval between CT and implantation was 145 days (IQR 98–216), and the median time from valve request to implantation was 67 days (IQR 45–112).

When comparing the periods defined by the cutoff date of November 1, 2024—corresponding to an institutional reorganization of medical and administrative workflows—a significant reduction was observed in all three intervals analyzed. Among the specific measures implemented as part of this reorganization, the following stand out: the designation of a fixed weekly day dedicated exclusively to TAVI ; the creation of a stable and dedicated team, always composed of the same physicians, technicians, and nurses from the hemodynamic department; the appointment of a single person responsible for the structural management of the program, avoiding the rotation of responsibilities among different professionals; the personalization of follow-up for each patient through direct communi-

cation via WhatsApp with the head of the structural pathology team; and, the systematic learning of the administrative processes of the financiers, in order to understand their internal logic and optimize the management of authorization requests.

Thus, prior to the pre-established turning point, the medians were 338 days (IQR 220–512) for the FC–implantation interval, 320 days (IQR 185–455) for CT scan–implantation, and 131 days (IQR 78–205) for request–implantation.

In contrast, in the subsequent period, these were reduced to 138 days (IQR 110–180), 117 days (IQR 88–165), and 56 days (IQR 39–82), respectively, showing a statistically significant difference in all cases ($p < 0.001$ for all three intervals). (Figure 1)

DISCUSSION

To the best of our knowledge, this study constitutes the first multicenter analysis conducted in Argentina that systematically evaluates care intervals in the diagnostic-therapeutic process prior to TAVI in the Argentine healthcare system. Our findings show that delays between the different stages of the care circuit are considerable and that, following the implementation of an institutional reorganization of administrative and clinical workflows, a significant and sustained reduction in times to the procedure was achieved.

These results are consistent with international reports indicating that prolonged waiting times between the therapeutic decision and implantation constitute a growing challenge in real-world TAVI practice, particularly in healthcare systems with coverage limitations or partial government funding. (7-9) Recent

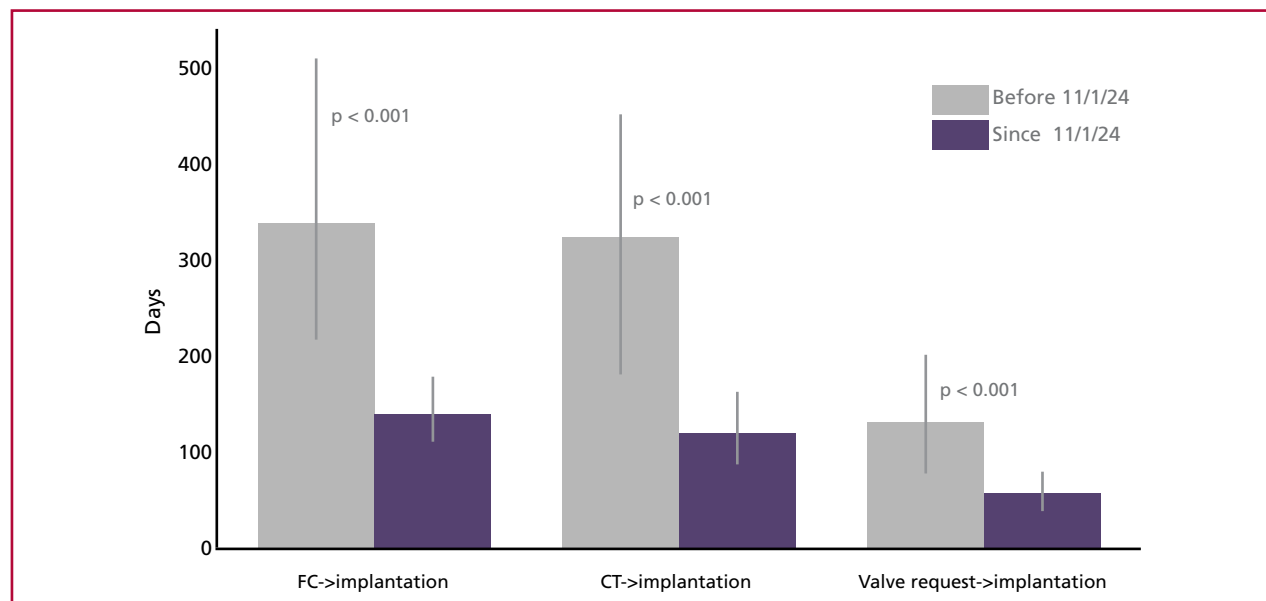
studies have shown that socioeconomic and structural factors within healthcare systems directly influence access to and timing of the procedure, leading to inequalities across regions and types of coverage. (10-13) In this regard, data from our cohort confirm that logistical and administrative barriers can be a major determinant of delays, even in settings with established experience in structural intervention.

The marked decrease observed in the FC–implantation, CT–implantation, and valve request–implantation intervals following institutional reorganization suggests that optimizing internal processes can have an immediate impact on the efficiency of care. In particular, closer coordination between clinical and administrative and financing teams (primarily PAMI and IOMA) allowed for a significant shortening of the authorization, provision, and scheduling stages of the procedure. This finding underscores the importance of integrated healthcare management strategies, which do not necessarily require additional technological investments, but rather an improvement in inter-institutional coordination and the definition of operational responsibilities. (14)

This set of low-cost, highly effective strategies demonstrates that institutional reorganization focused on people and processes can have the same or even greater impact than the incorporation of new technologies.

Furthermore, the study provides valuable information concerning the reality of access to TAVI in the Argentine healthcare area, where reliance on state coverage mechanisms and administrative bureaucracy often dictates the timing of therapeutic resolu-

Fig. 1. Analysis of prespecified time intervals prior to TAVI, and differences relative to the inflection point



FC: first contact with interventional cardiologist, CT: computed tomography
Data expressed as median (interquartile range)

tion. In this context, identifying the critical points in the process—from the initial indication to the actual availability of the valve prosthesis—can guide health policies aimed at accelerating equitable access to highly complex therapies.

The process from the therapeutic decision to the actual implantation involves multiple stages of high administrative complexity, which often results in prolonged delays. In this regard, it has been demonstrated that the presence of a coordinator to lead the TAVI program at the institutional level can be associated with greater organizational efficiency, a significant reduction in care times, and better patient satisfaction indicators, who would also potentially benefit from more structured follow-up during the post-procedural period. (15)

Although the present work did not aim to assess the clinical impact of delays in care at different stages of the process, several studies have suggested that prolonged waiting times may be associated with increased morbidity and mortality, both due to the progression of AS and to the decompensation of comorbidities during the pre-procedural period. (16) Within the analyzed cohort, five patients with severe AS who had initiated the evaluation process for TAVI experienced adverse events during the delay period: one suffered a disabling stroke, two died from cardiovascular causes, and two discontinued the administrative process before its completion. For this reason, the reduction in waiting times observed in our cohort could have favorable clinical implications, which deserve further exploration in future prospective studies. It is worth noting that in the analyzed cohort, the use of BAV as a bridging strategy to TAVI was recorded in a minority of cases. Its implementation in some of these patients was a direct consequence of prolonged administrative delays, which in itself constitutes a limitation of the system, considering that BAV entails known procedural risks and offers only a temporary clinical benefit; therefore, its use as a bridge forced by avoidable delays is inappropriate and should be described as a manifestation of the healthcare system dysfunction. Internationally, its indication is restricted to specific clinical situations and is not a standard practice in response to administrative delays. (17-20)

The causes that could explain these observed delays are multifactorial. These include referrals arriving with incomplete or insufficient diagnostic studies for therapeutic decision-making, delays in scheduling outpatient appointments and obtaining administrative authorizations, frail patients' dependence on caregivers, as well as socioeconomic and logistical barriers related to transportation and geographic distances. Moreover, holdups within the facility—common in units not exclusively dedicated to TAVI—are exacerbated by limited resource availability, such as a single angiography machine, and by the need to coordinate the simultaneous presence of anesthesiology

and vascular surgery teams to perform the procedure.

Finally, the findings presented here reinforce the need to develop specific quality indicators for the pre-TAVI process, to allow for continuous monitoring of access times and facilitate comparisons between institutions. The incorporation of these indicators into national or regional TAVI registries could serve as a key tool for promoting efficiency, equity, and transparency in access to this treatment within the Argentine and Latin American healthcare systems.

Limitations

This study has a number of limitations, which must be taken into account when interpreting the results. First, this is a retrospective cohort analysis based on a relatively small sample limited to three healthcare centers in the Buenos Aires Metropolitan Area, which might limit the extrapolation of the findings to other institutional settings or regions of the country with different healthcare infrastructure.

Second, all patients included were from public and social medicine healthcare centers, with coverage primarily provided by PAMI (National Institute of Social Services for Retirees and Pensioners) and IOMA (Institute of Medical Assistance). The population characteristic constitutes a significant limitation for generalizing the findings: the care timelines described reflect the specific dynamics of these financing institutions, whose administrative bureaucracy and documentation requirements for authorizing and providing the device differ substantially from those of private or prepaid health insurance. In Argentina, it is likely that in centers with predominantly private coverage, the intervals between the therapeutic decision and the implantation are significantly shorter, given that approval processes tend to be more streamlined and less document-intensive. On the other hand, while the predominance of PAMI in the cohort accurately reflects the epidemiological reality of severe AS in Argentina—a disease prevalent among older adults with state-funded coverage—it would be desirable to compare these results with data from centers with a greater diversity of coverage schemes, in order to more precisely determine the relative weight of administrative factors dependent on the financier versus institutional factors specific to each center.

Finally, the study was not designed to evaluate the direct clinical impact of care delays on post-TAVI outcomes, so the findings should be interpreted primarily as an organizational and efficiency assessment of the system rather than as an analysis of adverse clinical outcomes.

Despite these limitations, the present study provides novel and representative information on real-world clinical practice in the Argentine healthcare system, identifying concrete opportunities for improvement in the management of the pre-procedural process.

CONCLUSION

This observational study of patients from our region demonstrated that pre-TAVI care times exhibit notable variability, with significant delays between the different stages of the process. The implementation of an institutional reorganization of care pathways, established in November 2024, was associated with a substantial and statistically significant reduction in the three intervals analyzed, suggesting a progressive improvement in the operational and administrative efficiency of the participating centers.

Conflicts of interest

None declared.

(See authors' conflict of interests forms on the web).

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Impact of a Specialized Heart Failure Unit on Patients Hospitalized for Acute Heart Failure: A 10-Year Experience

Impacto de una unidad especializada en insuficiencia cardíaca en pacientes hospitalizados por insuficiencia cardíaca aguda: análisis de una década de experiencia

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ABSTRACT

Background: Acute heart failure (HF) remains one of the leading causes of hospitalization, morbidity, and mortality worldwide. The implementation of specialized HF units has been shown to improve the quality of care and clinical outcomes; however, there is limited evidence about their sustained impact in Latin America.

Objective: The aim of this study is to evaluate the impact of a specialized HF unit on quality-of-care measures in patients hospitalized for acute heart failure.

Methods: We conducted a retrospective cohort study that included consecutive patients admitted with a primary diagnosis of acute HF between January 2014 and December 2024. The HF program included a critical path method, structured discharge checklist, full-time physicians, specialized nurses, dedicated administrative staff, discharge education with written instructions, structured post-discharge follow-up, priority consultations, periodic presentation of indicators, grand rounds for advanced management decisions, lung ultrasound-guided decongestion, telemonitoring, and a day hospital. Over the last two years, patients selected as low-risk and treated exclusively in the day hospital were excluded. The endpoints analyzed included annual in-hospital mortality, 30-day hospital readmission, and length of hospital stay. Two periods were analyzed: the initial phase (2014–2019) and the consolidation phase (2020–2024).

Results: A total of 3368 hospitalizations for acute HF were analyzed. The annual volume of hospitalizations increased from 260 in 2014 to 463 in 2024 ($p = 0.002$). In-hospital mortality exhibited a slight, non-significant falling trend (from 5.0% to 3.9%). The 30-day hospital readmission rate remained stable, with less variability in the most recent years. Mean length of hospital stay decreased significantly from 9.3 days to 2.8 days ($p < 0.001$) and was significantly shorter during the consolidation phase (median 3.6 vs. 6.8 days; $p = 0.004$).

Conclusion: The implementation and consolidation of a specialized HF unit was associated with an increase in patient volume and sustained improvements in hospital efficiency, reflected in a significant reduction in length of hospital stay. The greater stability in mortality and hospital readmission rates during the consolidation phase suggests a sustained improvement in the quality of care, supporting the development of structured care models in Latin American health systems.

Key words: Acute heart failure - Decompensated heart failure - Heart failure units - Quality of health care

RESUMEN

Introducción: La insuficiencia cardíaca (IC) aguda continúa siendo una de las principales causas de hospitalización y morbimortalidad a nivel mundial. La implementación de unidades especializadas en IC ha demostrado mejorar la calidad asistencial y los resultados clínicos; sin embargo, la evidencia sobre su impacto sostenido en América Latina es limitada.

Objetivo: Evaluar el impacto de una unidad especializada en IC sobre métricas de calidad asistencial en pacientes hospitalizados por IC aguda.

Material y métodos: Se realizó un análisis retrospectivo de una cohorte consecutiva de pacientes hospitalizados con diagnóstico principal de IC aguda entre enero de 2014 y diciembre de 2024. El programa de IC incluyó manejo basado en caminos críticos, checklist estructurado al alta, médicos con dedicación exclusiva, enfermeros especializados, personal administrativo dedicado, educación al alta con indicaciones escritas, seguimiento posalta estructurado, consultas prioritarias, presentación periódica de indicadores, ateneos para decisiones de manejo avanzado, descongestión guiada por ultrasonido, telemonitoreo y hospital de día. En los últimos dos años, pacientes seleccionados de bajo riesgo tratados exclusivamente en hospital de día no fueron incluidos. Los puntos finales

REV ARGENT CARDIOL 2026;94:187-194. <https://doi.org/10.7775/rac.v94.i3.21008>

Received: 01/08/2026 – Accepted: 03/04/2026

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analizados anualmente fueron mortalidad intrahospitalaria, rehospitalización por IC a 30 días y duración de la estadía hospitalaria. Se compararon dos períodos: etapa inicial (2014–2019) y etapa de consolidación (2020–2024).

Resultados: Se analizaron 3368 hospitalizaciones por IC aguda. El volumen anual de internaciones aumentó de 260 en 2014 a 463 en 2024, con una tendencia creciente significativa ($p=0,002$). La mortalidad intrahospitalaria mostró una leve tendencia descendente (5,0% a 3,9%), sin significación estadística. La rehospitalización a 30 días se mantuvo estable, con menor variabilidad en los años más recientes. La duración de la estadía hospitalaria se redujo progresivamente de 9,3 a 2,8 días ($p<0,001$), siendo significativamente menor en la etapa de consolidación (mediana 3,6 vs. 6,8 días; $p=0,004$).

Conclusión: La implementación y consolidación de una unidad especializada en IC se asoció con un aumento del volumen asistencial y mejoras sostenidas en la eficiencia hospitalaria, reflejadas en una reducción significativa de la duración de la estadía. La mayor estabilidad de la mortalidad y la rehospitalización durante la etapa de consolidación sugiere una mejora sostenida en la calidad de la atención, apoyando el desarrollo de modelos estructurados de atención en sistemas de salud de Latinoamérica.

Palabras clave: Insuficiencia cardíaca aguda - Insuficiencia cardíaca descompensada - Unidades de insuficiencia cardíaca - Calidad de atención médica

INTRODUCTION

Heart failure (HF) is one of the leading causes of morbidity and mortality worldwide and represents a significant public health problem. This disease has a dynamic risk profile: risk is particularly high at the time of diagnosis, tends to decrease with the implementation of guideline-directed medical therapy, and increases significantly again with each episode of decompensation. (1)

Approximately one out of six patients with HF with reduced ejection fraction (HFrEF) develops worsening HF within the first 18 months of follow-up, resulting in the need for hospitalization or treatment with intravenous diuretics. These patients also present high hospital readmission rate as early as the first month following the index event, reflecting the recurrent and complex nature of the disease. (2)

In recent decades, HF has evolved into a global epidemic, with a lifetime risk estimated at up to 25% (3,4) and a cumulative mortality rate reaching 30–50% at 3 years and up to 75% at 5 years. (5) This impact is magnified in Latin America, where the burden of disease and structural constraints underscore the need for structured care strategies tailored to the local context.

Acute HF remains one of the leading causes of hospitalization and mortality, particularly in subjects older than 65 years. Not only does it have a profound individual impact, but it also poses a significant burden on health care systems, given the vast resources required for its management. Despite the advances achieved in the armamentarium and prevention strategies, the rate of mid-term adverse events remains alarmingly high in patients hospitalized for acute HF. The probability of hospital readmissions within six months reaches approximately 50%, with annual mortality ranging between 12% and 20% according to various international registries. (6-8) These figures, consistent across different regions and settings, demonstrate that hospitalization for HF remains an adverse risk marker.

Reducing readmissions for HF is a strategic goal, as it can simultaneously lower healthcare costs and improve the quality of care provided. However, achieving this goal poses a complex challenge for healthcare systems, particularly in countries with structural and

budgetary constraints. In this context, the increasing complexity of HF and the expansion of therapeutic options have given rise to new care requirements, including specialized units, multidisciplinary teams, trained personnel, adequate infrastructure, and integrated care networks across different levels and centers. (9-11)

In this scenario, specialized heart failure units have emerged as an innovative organizational model of care, integrating trained multidisciplinary teams, standardized protocols, educational strategies, and structured monitoring. In developed countries, various programs of this type have been shown to reduce hospital readmissions, improve adherence to guideline-directed medical therapy, and optimize the quality of healthcare quality measures, with a favorable impact on mortality and long-term costs. (12-16)

However, there is still limited and fragmented evidence regarding the implementation, sustainability, and adaptation of these models in the Latin American context, particularly in Argentina. In low- and middle-income countries, the limitations in access to timely diagnosis, prognosis-modifying therapies, and organized models of care create a significant gap between guideline recommendations and real-world practice, resulting in high rates of rehospitalization and mortality. (17-20)

OBJECTIVE

Within this framework, the primary objective of this study is to evaluate the impact of a specialized heart failure unit on quality-of-care measures in patients hospitalized for acute heart failure at a high-complexity center in Latin America. To this end, the program's development was examined in two stages: the initial phase (2014–2019) and the consolidation phase (2020–2024). The indicators analyzed included in-hospital mortality, 30-day hospital readmission, and length of hospital stay, with the aim of assessing the program's development over a 10-year period.

METHODS

Study design

We conducted a retrospective observational cohort study that included consecutive patients admitted with a primary

diagnosis of acute HF between January 2014 and December 2024. The study was conducted at a leading cardiology center in Argentina, which implemented a structured program for the management of HF.

Inclusion and exclusion criteria

Patients diagnosed with primary acute HF were included in the study.

Those patients with HF secondary to infective endocarditis, severe organic valvular heart disease requiring intervention, myocarditis, acute myocardial infarction, or pulmonary thromboembolism were excluded, as well as those undergoing invasive procedures during hospitalization, such as cardiovascular surgery, percutaneous coronary intervention, pacemaker implantation, or heart transplantation.

Patient identification and data collection

Heart failure patients were identified based on the diagnoses recorded using the International Classification of Diseases (ICD) coding system. The discharge diagnosis was recoded and verified by a trained nurse. In cases of inconsistencies, the final decision was made by consensus between two heart failure specialists.

The variables analyzed included in-hospital mortality, length of hospital stay, 30-day hospital readmission for HF, documented education at discharge, prescription of beta-blockers and renin-angiotensin system inhibitors or angiotensin receptor-neprilysin inhibitors (ARNIs) in recent years, and assignment of a follow-up appointment at discharge.

In 2023, the Institute for Clinical Effectiveness and Health Policy (IECS) conducted an external audit to assess the methods used for analyzing the indicators.

The collected data was updated monthly, with the cutoff date set at the end of each month. Based on this data, graphs and reports were prepared and presented at the institutional regular review meetings. The Annual Indicators Report served as the systematic synthesis of all the information.

Specialized HF management program

The specialized HF management program implemented in the unit consisted of a multidisciplinary and comprehensive approach, with the following key characteristics (Figure 1):

Critical path method: Standardized protocols for the management of acute HF, including decongestion strategies, titration of prognostic-modifying medication, early mobilization, identification of barriers to discharge, and structured discharge planning.

Structured hospital discharge checklist: Assessment of the implementation of pharmacological treatment, scheduled post-discharge follow-up appointment, need for devices, patient education, and prognosis-modifying strategies (vaccination, smoking cessation counseling).

Dedicated heart failure physicians: A dedicated team of HF-specialist cardiologists leading patient care with full-time commitment and involvement in the training of future HF specialists.

Specialized HF nurses: Advanced practice nurses specialized in HF management who performed periodic clinical assessments, follow-up, and continuous monitoring of treatment response.

Dedicated administrative staff: Efficient coordination of hospital discharges, outpatient follow-up tracking, and post-discharge clinic scheduling.

Discharge education with written instructions: Provision of comprehensive patient education materials detailing HF

management, medication adherence strategies, and warning signs via educational booklets, a dedicated website, and pre-discharge nurse counseling.

Written patient instructions: Grid with drug names, specific dosages, and timing/administration schedules.

Structured post-discharge follow-up: Active follow-up through in-person and virtual consultations, with an initial post-discharge follow-up scheduled within 14 days of discharge. High-risk patients were scheduled for appointments at the day hospital.

Priority consultations: Provision of urgent, rapid-access consultations at the day hospital for complex and high-risk patients.

Grand rounds for advanced management: Periodic multidisciplinary case discussions for complex clinical decision-making, including advanced HF, cardiogenic shock, pulmonary hypertension, cardiomyopathies, and cardiac transplantation.

Ultrasound-guided lung decongestion: Use of ultrasound to assess response to diuretics and optimize congestion management.

Urinary sodium measurement: to systematically adjust the diuretic algorithm in the day hospital and in selected cases during hospitalization.

Telemonitoring: Progressive implementation over the past three years of technology for remote monitoring of vital signs and clinical parameters following hospital discharge.

Day hospital: Outpatient management of selected patients with low-risk acute heart failure and intensive follow-up of higher-risk patients, thereby avoiding unnecessary hospitalizations.

Regular presentation of quality indicators: Analysis and regular presentation of care measures as part of an institutional program for continuous quality improvement.

Invasive testing: In patients with heart failure, pulmonary hypertension, and post-heart transplantation

Definition of variables

The following endpoints were defined:

In-hospital mortality: Percentage of patients who died during the index hospitalization.

30-day hospital readmission: Percentage of patients who were readmitted within 30 days following discharge due to acute heart failure.

Length of hospital stay: Total number of days of hospitalization per patient.

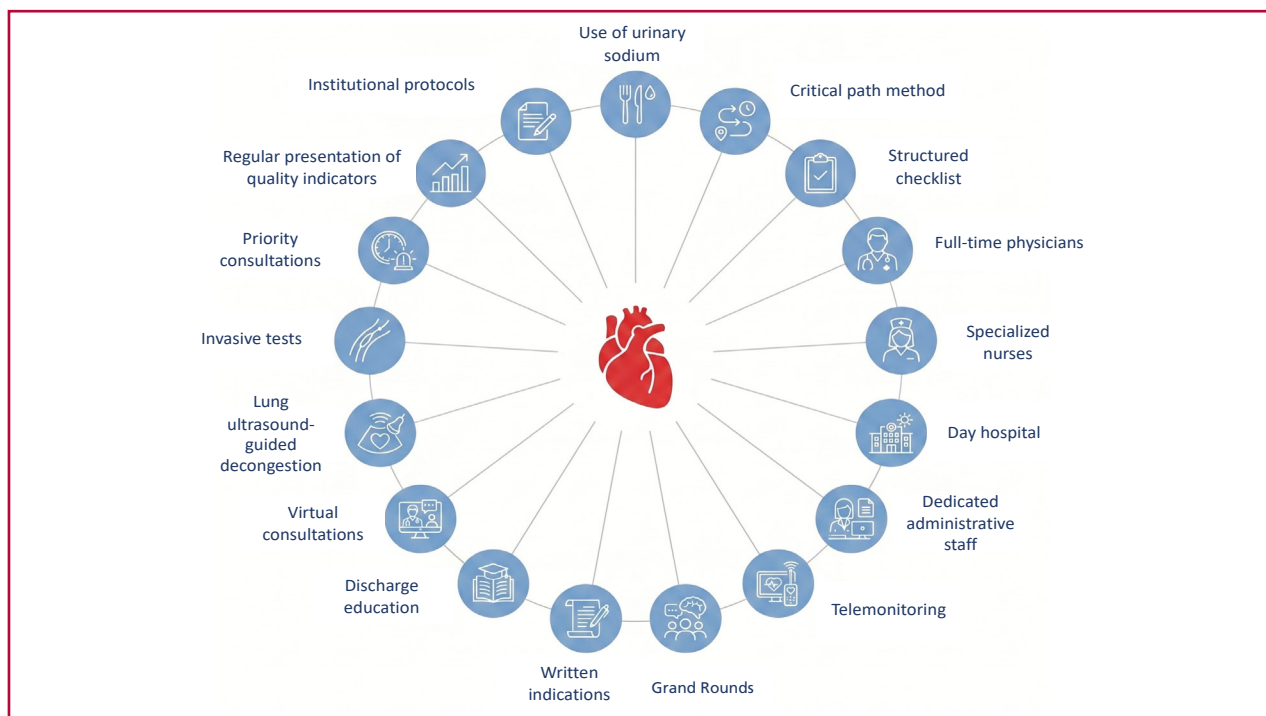
Statistical analysis

Descriptive statistics were used to characterize the study population and the results of the quality measures. Qualitative variables are presented as frequency and percentage, and quantitative variables are expressed as mean and standard deviation (SD) or median and interquartile range (IQR) according to their distribution. Linear regression analysis was performed to evaluate temporal trends in mortality, hospital readmission, and length of hospital stay. Results were compared between the two periods using the Student's *t*-test for continuous variables and the chi-square test for categorical variables. Additionally, the coefficient of variation (CV) was calculated for in-hospital mortality and 30-day hospital readmission in each period, as a measure of the stability and consistency of care performance over time. A *p*-value < 0.05 was considered statistically significant.

Ethical considerations

The study was approved by the institutional review board

Fig. 1. Components of the comprehensive heart failure care program



and registered on the PRIISA.BA platform of the Ministry of Health of the City of Buenos Aires. All the patients signed an informed consent form authorizing the transfer of their personal data for scientific purposes. The study was conducted following national and international ethical standards for research on human subjects, as the Declaration of Helsinki, (21) National Ministry of Health resolution 1480/20011, Act 3301 of the city of Buenos Aires, and ANMAT regulation 6677/10 with amendments 4008 and 4009.

RESULTS

Demographic and clinical characteristics

A total of 3368 hospitalizations for acute HF between 2014 and 2024 were analyzed. Mean age was 72 ± 10 years and 60% were men.

Hospitalization volume and trends

The annual volume of hospitalizations for acute HF increased significantly over the years, rising from 260 in 2014 to 463 in 2024 ($p = 0.002$) (Figure 2).

In-hospital mortality

In-hospital mortality exhibited a slight decrease across the study period, falling from 5.0% in 2014 to 3.9% in 2024, although this reduction was not statistically significant ($p = 0.648$). However, there was a trend toward lower in-hospital mortality and greater stability with a lower coefficient of variation (Figure 3).

Length of hospital stay

The length of hospital stay showed a progressive and sustained reduction over the analyzed period (2014–

2024), with a significantly downward trend over time ($p < 0.001$).

Mean length of hospital stay decreased significantly from 9.3 days in 2014 to 2.8 days in 2024 ($p < 0.001$). Median length of stay was significantly shorter during the program consolidation phase compared to the initial period: 3.6 (IQR 0.7) vs. 6.7 (IQR 1.9); $p = 0.004$ (Figure 4).

30-day hospital readmission

30-day hospital readmission rate for HF did not show statistically significant differences between the program initial period (2014–2019) and the consolidation phase (2020–2024). However, there was a significant shift in the temporal pattern of the indicator. During the initial phase, annual hospital readmission rates showed marked inter-annual variability, with values ranging approximately from 6% to 21%. In contrast, during the consolidation phase, 30-day hospital readmission rate remained within a narrower range, with values consistently around 13–14%. This finding was reflected in a substantial reduction in the CV of this indicator during the consolidation phase compared to the initial period, suggesting more stable and consistent care performance over time (Figure 5).

DISCUSSION

The results suggest that the implementation of a specialized heart failure unit was associated with a positive impact on multiple healthcare quality measures, particularly in terms of hospital efficiency. The sus-

tained reduction in length of hospital stay observed over the decade analyzed constitutes the most robust finding of the study and reflects more effective clinical management. This is likely related to optimized lung decongestion, earlier initiation of prognosis-modifying therapies, and the structured organization of the discharge and post-discharge follow-up processes. These findings are consistent with international experiences that have demonstrated that specialized heart failure units improve efficiency and clinical outcomes, especially in middle-income health systems. (10)

In-hospital mortality presented an absolute reduction, from 5.0% in the initial phase to 3.9% in the consolidation phase; yet this difference was not statistically significant. International registries such as ADHERE (22) and ESC-HF Pilot (23) have reported similar rates, while national and regional studies have

described higher in-hospital mortality rates, ranging from 7% to 11%. (17,20,24) The lack of statistical significance in our analysis may be attributed to the clinical heterogeneity of the patients and the inherent complexity of acute HF, a condition that remains associated with high mortality, even under optimal management. However, the observed reduction in absolute terms, along with greater inter-annual stability of the indicator, suggests a possible beneficial effect of the implemented care model.

The 30-day hospital readmission rates for HF were not significantly different between the two periods. However, during the consolidation phase, there was a marked reduction in the inter-annual variability of the indicator, as reflected in a lower CV. This finding suggests more consistent and predictable care performance, which may be linked to the implementation

Fig. 2. Trend in the annual number of acute heart failure hospitalizations during the implementation of the program and consolidation phase

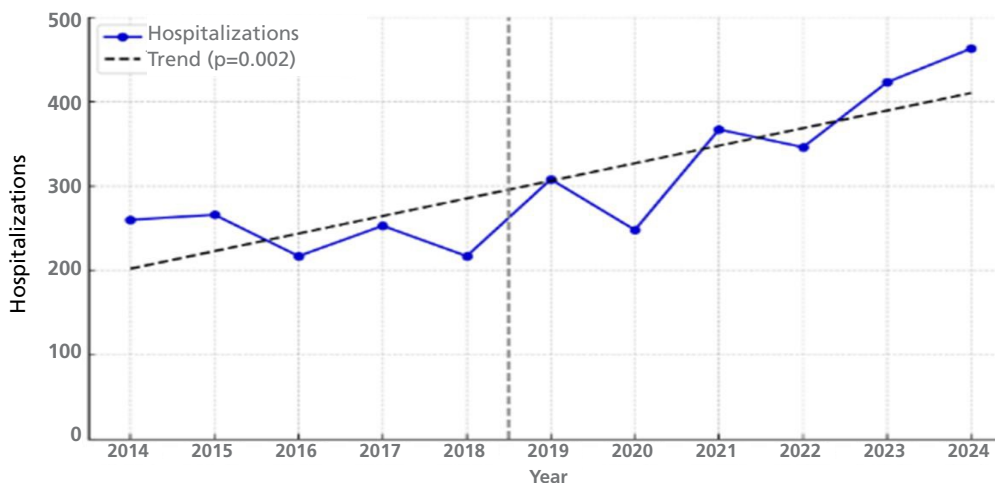
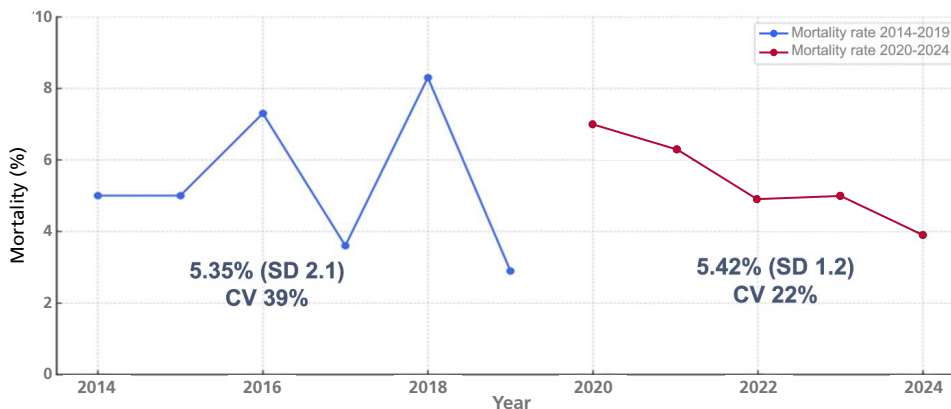
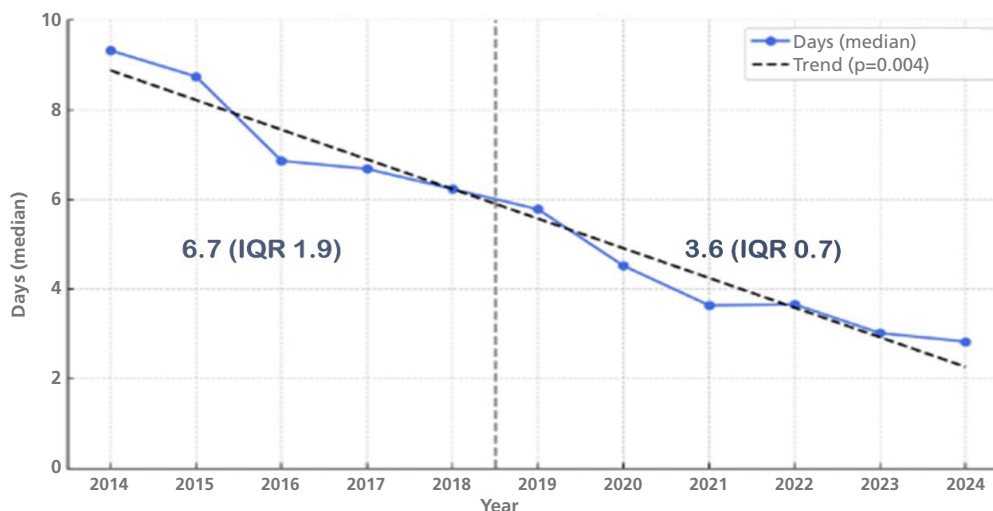


Fig. 3. In-hospital mortality in patients hospitalized for acute heart failure by program phase



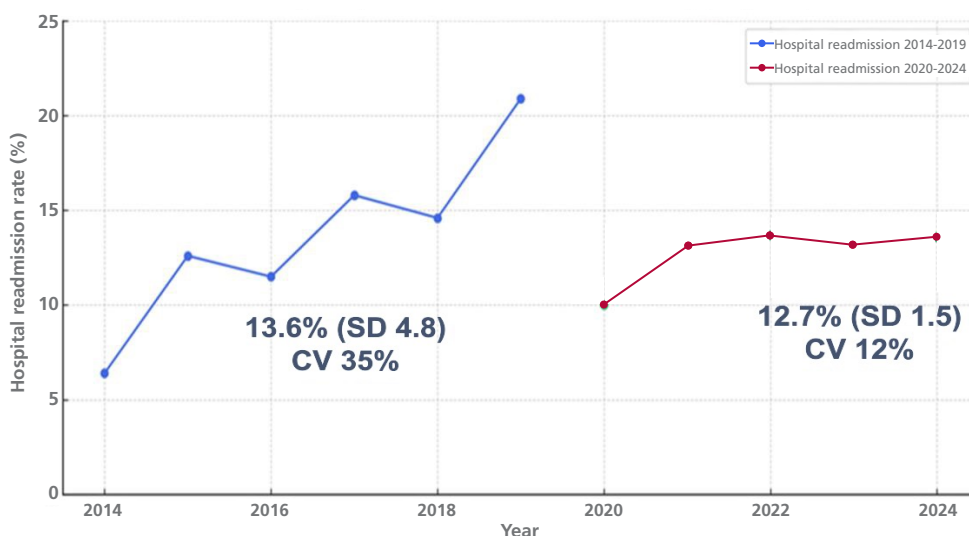
CV: coefficient of variation; SD: standard deviation

Fig. 4. Length of hospital stay for acute heart failure by program phase



IQR: Interquartile range

Fig. 5. Hospital readmission for heart failure at 30 days by program phase



CV: coefficient of variation; SD: standard deviation

of standardized processes, structured follow-up, discharge education, and the use of a day hospital for selected high-risk patients.

From the perspective of continuous quality improvement, stability of results constitutes a relevant indicator of care performance. (25) In this regard, even in the absence of significant reductions in hard events, the lower variability observed in mortality and hospital readmission during the consolidation phase can be interpreted as a sign of the program’s maturity and greater consistency in the care provided.

The literature has reported that a multidisciplinary approach in HF clinics reduces hospitalizations,

improves adherence, and optimizes the use of guideline-directed medical therapy, with an impact on clinical outcomes and costs, particularly in high-income countries. (10,17-20,26)

The prevalence of heart failure and its associated burden continue to rise, driven by population aging and increased survival among patients with cardiovascular disease. (27) In this context, there are still significant challenges related to structural limitations, heterogeneity in the quality of care, and restricted access to specialized care models, particularly in low- and middle-income countries, which is associated with worse clinical outcomes and inefficient use of health-

care resources. (18,28) Our results show that, even in this scenario, the implementation of a structured, specialized care program is feasible and can generate sustained improvements in key care quality measures.

It is important to note that, although the impact on in-hospital mortality and 30-day hospital readmissions did not show statistically significant differences between the two periods analyzed, the progressive and sustained reduction in length of hospital stay constitutes a relevant indicator of improvement in the efficiency and quality of care. Length of hospital stay has been recognized as a measure sensitive to the organization of care and the coordination of care processes. Its reduction, when achieved without an increase in adverse events, reflects more efficient and patient-centered care. (29) In this regard, integrating strategies such as structured discharge education, telemonitoring, and day hospital for selected patients could have contributed to the observed results. (30)

This study provides local evidence on the feasibility and impact of a specialized heart failure unit in a Latin American setting, facilitating comparison of these results with those from national multicenter registries. The ARGEN-IC registry, which included patients from 18 Argentine provinces, reported longer length of hospital stay, high in-hospital mortality, and limited access to early outpatient follow-up. (20) In comparison, our experience shows shorter length of hospital stay rates and greater stability in clinical outcomes over time, suggesting the positive impact of a structured and sustained care model.

The study has several limitations that should be considered. First, it is a single-center, retrospective study, with the biases inherent in this type of design. No analysis was performed adjusted for clinical severity, comorbidities, or other relevant prognostic predictors, which limits the causal interpretation of the results. Furthermore, in recent years, the hospital has established itself as a high-complexity referral center for advanced diseases and as a heart transplant center, which likely increased the proportion of more critically ill patients during the consolidation phase. This might have attenuated the observed impact on some outcomes. Finally, the absence of an external control group limits the possibility of making direct comparisons with other care models, and it was not possible to ensure full adherence to the program's various interventions by all patients.

CONCLUSION

The implementation and consolidation of a specialized HF unit at our institution was associated with significant improvements in hospital efficiency, reflected primarily in a progressive and sustained reduction in length of hospital stay over a decade of experience.

It is important to note that, although the impact on in-hospital mortality and 30-day hospital readmissions did not show statistically significant differences between the two periods analyzed, the greater stabil-

ity and lower variability of these indicators during the consolidation phase suggest a sustained improvement in the quality of care provided.

These findings provide evidence about the feasibility and impact of structured specialized care programs with standardized processes for heart failure patients in Latin America. The observed success in reducing the length of hospital stay and the lower variability in clinical outcomes suggest that this type of model could be replicated in other regional settings, contributing to more effective, predictable, and sustainable care for this vulnerable population.

Conflicts of interest

None declared.

(See authors' conflict of interests forms on the web).

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Cardiac Fulcrum: Its Relationship with Two-dimensional Echocardiography

Fulcro cardíaco: su relación con la ecocardiografía bidimensional

“What the eye does not see and the mind does not know does not exist,” even if it does!

D.H. Lawrence

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ABSTRACT

Background: Torrent Guasp's theory of cardiac function is based on the grouping of muscle fibers constituting the continuous helical myocardium, which folds unto itself to form the ventricular chambers. Anterior and inferior to the right trigone lies the cardiac fulcrum, a structure with osseous, chondroid, or tendinous histology depending on the specimen analyzed, where the basal loop (right segment) originates and the ascending fibers of the apical loop end to generate ventricular torsion and detorsion.

Objectives: The aim of this study was to correlate the trigone and fulcrum with topographic anatomy using echocardiography to understand the anatomic-functional characteristics of cardiac mechanics.

Methods: Thirty bovine hearts were dissected to standardize the dissection technique required to reach the cardiac fulcrum. The cardiac structures were then identified in the specimens and correlated with echocardiographic projections.

Results: Biauricular enucleation, identification, and palpation of the cardiac fulcrum at the base of the septal leaflet of the tricuspid valve and immediately below the right coronary and non-coronary leaflets of the aortic valve in bovine and human specimens is effective for anatomically locating the cardiac fulcrum. In the echocardiographic projections used, the topographic anatomy of the trigones, the cardiac fulcrum, and the ends of the continuous helical myocardium can be identified.

Conclusions: The echocardiographic views described for visualizing the fibrous skeleton, the cardiac fulcrum, and the ends of the continuous helical myocardium are useful for understanding the anatomic-functional unit. The key structures to locate the fulcrum are the tricuspid septal valve; the right coronary and non-coronary leaflets of the aortic valve; and the anterior basal interventricular septum. However, further studies are needed to develop applications of this knowledge in echocardiographic assessment.

Key words: Helical myocardium - Echocardiography - Ventricular torsion - Fulcrum

RESUMEN

Introducción: La teoría del funcionamiento del corazón de Torrent Guasp se basa en el agrupamiento de fibras musculares que constituyen el miocardio helicoidal continuo que se pliega sobre sí mismo para conformar las cavidades ventriculares. En posición anteroinferior al trigono derecho, se halla el fulcro cardíaco, una estructura con histología ósea, condroide o tendinosa según el espécimen analizado, sitio en donde se origina la lazada basal (segmento derecho) y finalizan las fibras ascendentes de la lazada apical para generar la torsión y detorsión ventricular.

Objetivos: Correlacionar mediante ecocardiografía al trigono y al fulcro con la anatomía topográfica para comprender las características anatomofuncionales de la mecánica cardíaca.

Material y métodos: Se disecaron 30 corazones bovinos para estandarizar la técnica de disección necesaria para llegar al fulcro cardíaco. Luego se identificaron las estructuras cardíacas en los especímenes y se relacionaron con las proyecciones ecocardiográficas.

Resultados: La enucleación biauricular, el reconocimiento y la palpación del fulcro cardíaco a nivel de la base de la valva septal de la tricúspide e inmediatamente por debajo de las valvas coronaria derecha y no coronaria de la válvula aórtica en los especímenes bovinos y humanos resulta eficiente para ubicar anatómicamente al fulcro cardíaco. En las proyecciones ecocardiográficas empleadas se puede reconocer la anatomía topográfica de los trigonos, del fulcro cardíaco y los extremos del miocardio helicoidal continuo.

Conclusiones: Las proyecciones ecocardiográficas comentadas para visualizar al esqueleto fibroso, fulcro cardíaco y a los extremos del miocardio helicoidal continuo son útiles para comprender la unidad anatomofuncional. Las estructuras clave a identificar para

REV ARGENT CARDIOL 2026;94:195-202. <https://doi.org/10.7775/rac.v94.i3.21002>

Received: 11/06/2025 – Accepted: 02/27/2026

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ubicar al fulcro son: la valva septal tricúspidea; las valvas coronaria derecha y no coronaria de la válvula aórtica, y el septum interventricular basal anterior. Sin embargo, se necesitan nuevos estudios para desarrollar aplicaciones de este conocimiento en la evaluación ecocardiográfica.

Palabras clave: Miocardio helicoidal - Ecocardiografía - Torsión ventricular - Fulcro

INTRODUCTION

Torrent Guasp's theory of cardiac function is based on the grouping of muscle fibers constituting the continuous myocardium, which folds to form the helical heart and thus shape the ventricular chambers. (1)

Anterior and inferior to the right trigone (RT) lies the cardiac fulcrum (CF), a structure with osseous, chondroid, or tendinous histology depending on the specimen analyzed. This is the site where the fibers of the right segment (RS) and the ascending segment (AS), the juxtaposed origin and end of the continuous helical myocardium, attach.

The myocardium relies on the CF to generate ventricular torsion and detorsion. This structure in the human heart, its anatomy and function, was first described by Trainini et al. in 2019. (2,3)

OBJECTIVE

We conducted this study with the aim of correlating by echocardiography the trigones and the CF with topographic anatomy to understand the anatomofunctional characteristics of cardiac mechanics.

METHODS

We used a conventional scale, dissection kit, LED lamp, surgical loupes, a professional camera, and a Mindray M7 ultrasound machine. Thirty bovine hearts were dissected to standardize the dissection technique required to reach the CF. The anatomical location of the structures was compared between human and bovine species. The CF in humans and cattle has been extensively studied in previous studies and shows 100% concordance in location between the two species. (2,3) The difference lies in the fact that the CF in the bovine heart is macroscopically visible.

The fresh hearts were dissected, and the location of the trigones and the CF was identified. All adipose tissue adhering to the sulci was removed. An incision was made in the right and left atrioventricular grooves to enucleate both atria. The tricuspid septal leaflet (TSL), the right coronary (RCL) and non-coronary (nCL) leaflets of the aortic valve, and the basal interventricular septum (IVS) were identified. Subsequently, the TSL was resected in the apical-basal direction and pulled toward the right ventricular (RV) chamber so that the CF was exposed underneath. Color coding of the trigones and the CF was performed using photo editing software. The color-coded bovine hearts were sectioned to replicate the conventional section planes and axes used in conventional echocardiography, and all findings were correlated with echocardiographic projections from studies in our database.

Ultrasound Settings

Using a Mindray M7 ultrasound machine and a 2.5 MHz transducer, two-dimensional long and short parasternal views, apical views, and subxiphoid views were obtained. High-quality images that allowed us to evaluate the heart's

fibrous skeleton were acquired. When configuring the equipment, it is important to consider the following aspects: 1) gain should be adjusted to optimize the signal-to-noise ratio and avoid signal saturation; 2) depth should be adjusted to visualize the structure of interest; 3) the transducer frequency should be selected according to the depth of the area of interest being studied.

RESULTS

Dissection and topographic anatomy of the cardiac fulcrum

The CF is located in the IVS below the aortic root, in relation to the left and right aortic leaflets, behind the TSL, and in front of the pulmonary artery (PA).

When enucleating the right atrium (RA) and preserving the interatrial septum (IAS), the CF is located by palpating the IAS above the insertion site of the TSL, in a whitish, protruding region with a hard, stony consistency in the bovine specimen (Figures 1 and 2). By dissecting the TSL from its ventricular surface and pulling it toward the ventricular chamber, the CF is exposed. (3)

Echocardiographic Correlates

We identified the CF, the trigones, the segments of the continuous helical myocardium, and the related anatomical structures. The findings were compared with echocardiographic projections obtained from healthy patients. (Figure 3) (4,5)

Echocardiographic views

Parasternal views

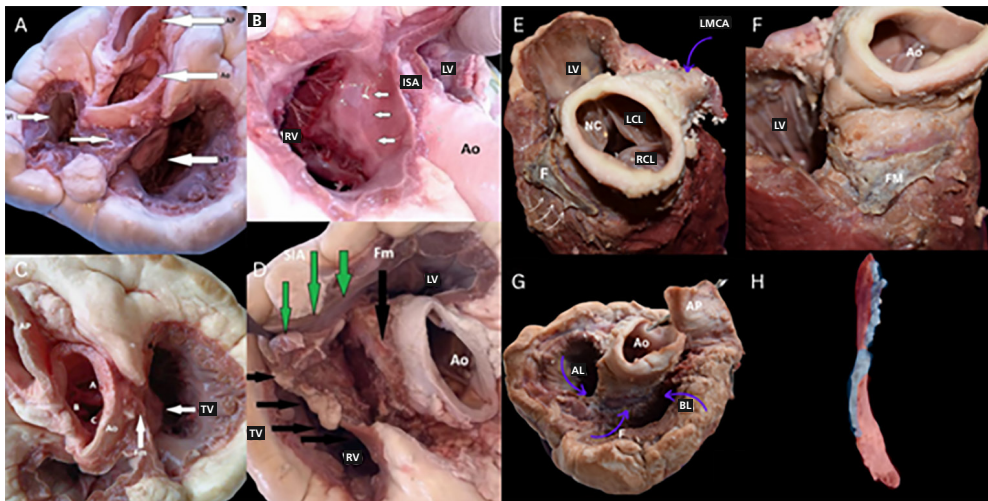
Long axis view. The free wall of the right ventricle (RV) is visible, consisting of the right segment of the basal loop (BL); below it, the interventricular septum (IVS) is formed by the two segments of the apical loop (AL). At the ventricular base, the four segments of the helical myocardium are visible, while the descending (DS) and ascending (AS) segments are located in the medial and apical portions. The posterior papillary muscle marks the origin of the AS.

In the parasternal long axis view, the IVS is divided into two sectors by an echogenic line separating the AS and DS. It is an area of high friction with high hyaluronic acid content. (6) The AS inserts beneath the RCL and nCL into a hyperechoic structure: the CF is located below and anterior to the RT (Figure 4).

Modified long axis: a long axis of the RV is achieved as shown in Figure 4. Above the TSL, on the lower IAS, the tip of the AS is seen inserting into an echogenic structure: the RT and the CF.

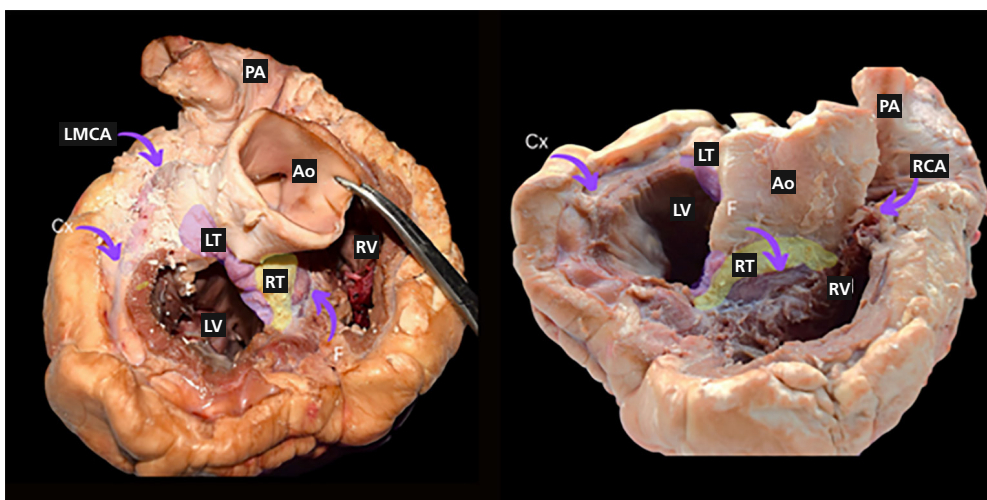
Short axis over the great vessels: the base of the TSL continues within the IVS with a hyperechoic structure, the fibrous skeleton of the heart. The re-

Fig. 1. Anatomical location of the cardiac fulcrum (CF). **A:** Whole bovine heart, viewed from the base. With the atria removed, the two ventricles, great vessels, and atrial surface of the tricuspid valve leaflets are exposed. **B:** Bovine heart with the right atrium removed, showing the TSL. Above its insertion, the CF is located in a region characterized by a distinct protuberance of hard, stony consistency (white arrows). **C and D:** bovine heart: structures related to the CF. Note the insertion of the TSL below the CF and the RCL (C) and nCL (A) above it. In D, the TSL has been resected and pulled toward the RV chamber (TV and black arrows), exposing the CF (large black arrow). The IAS has also been resected and displaced (green arrows). **E:** bovine heart. The atria and the free wall of the RV have been enucleated to expose the CF. The CF is located in close proximity with the insertion base of the TSL and below the aortic hemi annulus relative to the RCL and nCL of the aortic valve. The left main coronary artery (LMCA) is positioned at 180° from the cardiac fulcrum. **F:** CF viewed from the RV. **G:** Apical and basal loops. **H:** Resected bovine osseous CF. Note the helical imprint of the structure.



Ao: aorta; AL: apical loop; BL: basal loop; F and Fm: fulcrum; ISA: interatrial septum; LCL: left coronary leaflet of the aortic valve; LMCA: left main coronary artery; LV: left ventricle; nCL: non-coronary leaflet of the aortic valve; PA: pulmonary artery; RA: right atrium; RCL: right coronary leaflet of the aortic valve; RV: right ventricle; TSL: tricuspid septal leaflet. Authors' own images.

Fig. 2. Bovine heart. Color coding of the trigones, coronary filaments, and cardiac fulcrum.



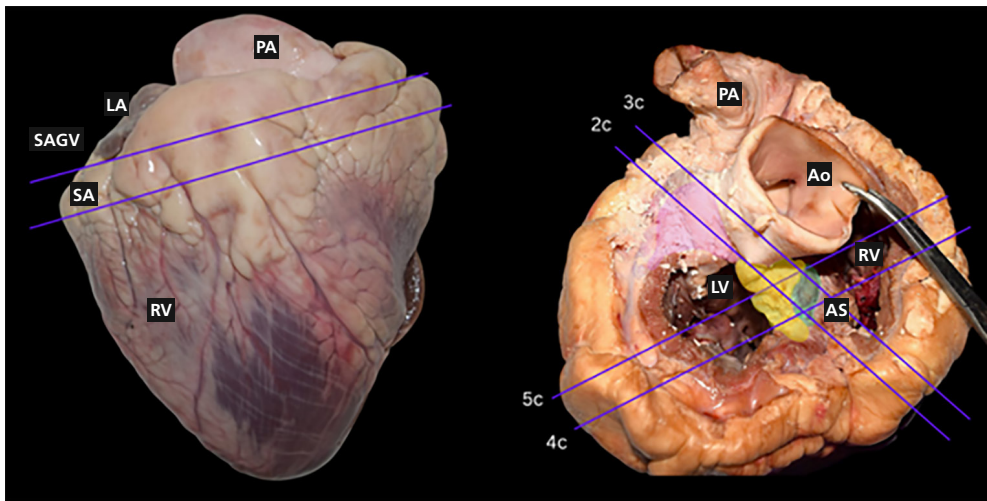
Ao: Aorta; Cx: Circumflex artery; F: Fulcrum; LT: Left trigone; LMCA: Left main coronary artery; LV: Left ventricle; PA: Pulmonary artery; RCA: Right coronary artery; RT: Right trigone (yellow); RV: Right ventricle. Authors' own images.

flected echo generates an image that stands out from the surrounding tissue due to its striking brightness and blurred edges: the RT and the CF. In this view, it is important to identify the RCL and nCL as well as the base of the TSL. These structures are what mark the

location of the CF with reasonable accuracy. (Figure 4).

Basal short axis: On the short-axis LV view between the great vessels and the mitral valve (MV), a bright area adjacent to the TSL is visible. This corresponds to the RT and the CF.

Fig. 3. Bovine heart. Left: section at the level of the short axes in parasternal views. SA: conventional short axis; SAGV: short axis of the great vessels. Right: section level of the apical views.



2c: two chambers, 3c: three chambers, 4c: four chambers, 5c: five chambers. Green: cardiac fulcrum. Ao: aorta; Ap: pulmonary artery; AS: ascending segment; LA: left atrium; LV: left ventricle; RV: right ventricle. Lilac-colored region: left trigone; yellow-colored region: right trigone. Authors own images.

In this view, the RS forms the free wall of the RV; the AS corresponds to the right ventricular endocardium entering the CF, while the left segment (LS) correlates with the posterolateral region of the LV (Figure 4).

Apical views

Four chambers: the atria and ventricles are visible. Additionally, the MV and TV. At the apex of the heart, adjacent to the insertion, the echogenic transition separating two media of different tissue density is documented: one of the media is the RT of the heart, and the CF is immersed beneath it. The AS enters the CF with muscular pigmentation. (Figures 5 and 6).

Five chambers: atria, RV, LV, left ventricular outflow tract (LVOT), and aorta (Ao). Additionally, the MV and TV. Adjacent to the insertion base of the TSL, there is an echogenic transition: one of the media is the RT, and the CF is immersed beneath it. The other structure with lower tissue density are the terminal fibers of the AS. (Figure 5).

Two chambers: LA, LV, papillary muscle, part of the RT adjacent to the CF, the mitral and tricuspid valves. Below the CS, adjacent to the posterior mitral valve leaflet, an echogenic transition is documented that separates two media of different tissue density: one of the media is the RT, and below it is the CF. In this case, the ultrasound beam travels along the major axis of the structure, providing a large reflective surface. The AS enters the fulcrum through its inferior border. (Figure 5).

Three chambers: LA, LV, part of the RV, LVOT, Ao, and MV. The RT is located below the insertion of the RCL and nCL; the CF is embedded below and

anterior to it. The septal segment extending toward this area corresponds to the terminal fibers of the AS (Figure 5).

Subxiphoid views: In the 4-chamber view, a hyperechoic area is visualized in the inferior IAS: the RT. It is possible to obtain a non-conventional 5-chamber subxiphoid view and visualize the root with its leaflets. Adjacent to the RCL, a bright structure is identified that continues with the distal end of the AS. This region correlates with the location of the CF. In a section at the level of the great vessels, below the RCL and nCL and immediately adjacent to the insertion base of the TSL, the CF is located. In a section at the level of the TV, at the insertion base of its septal leaflet and within the brightest area, the RT is located, and the CF is located anterior to it. The basal IVS, at that level, corresponds with the AS end of the helical myocardium. (Figure 7)

DISCUSSION

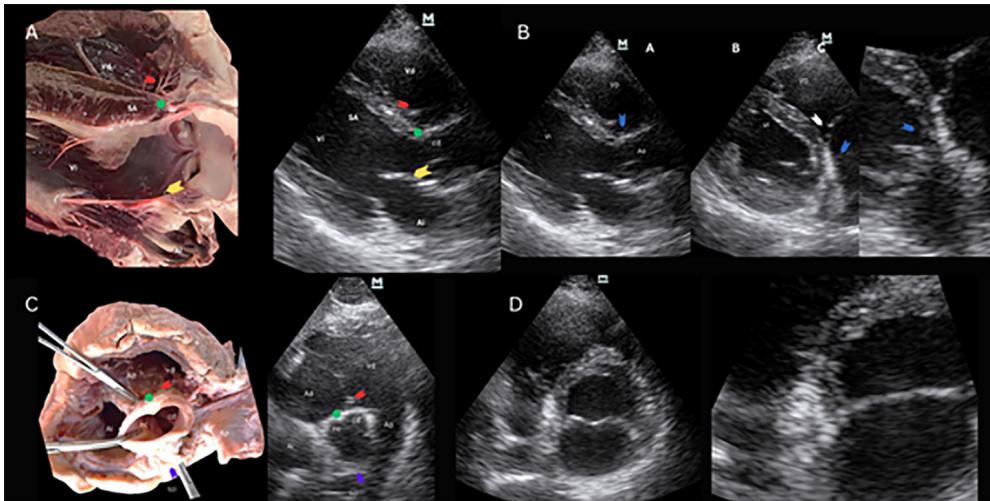
Anatomical structure of the heart based on the continuous helical myocardium

According to Francisco Torrent Guasp (7), the helical myocardium folds unto itself to form the ventricular chambers. The myocardium assumes a helical arrangement, forming the two ventricular chambers.

In the CF are inserted muscle fibers originating from the AS of the apical loop and the DS of the basal loop, aortic root tissue, accessory tissue of the TSL, and filaments from the Aschoff-Tawara AV node. (8)

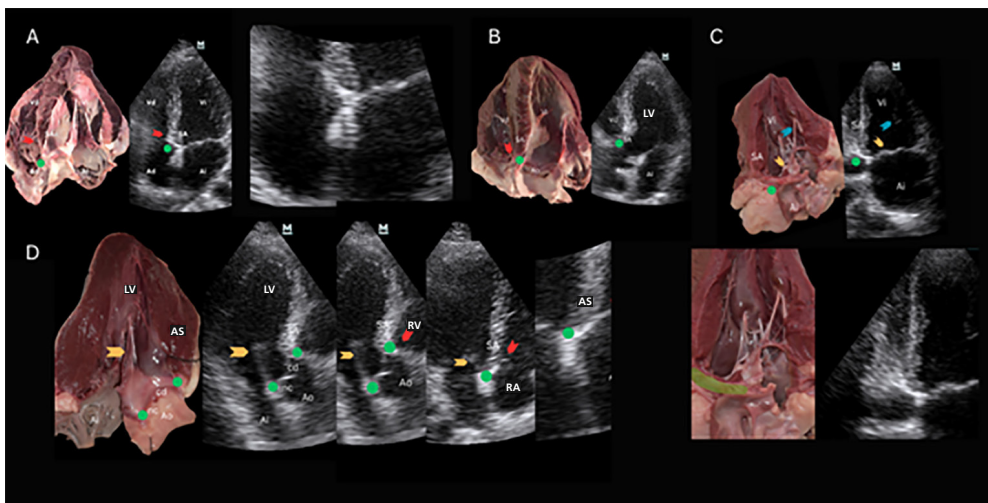
In the mammalian heart, there are fibrous structures known as fibrous trigones which consist of dense connective tissue and surround the atrioventricular openings.

Fig. 4. Parasternal views. **A.** Bovine heart and on the right its echocardiographic counterpart in humans. Parasternal long axis. **B.** Zoomed in with focus on the TSL. Blue arrows: AS entering the CF (RT). White arrow: TSL. Note the brightness of the structures that make up the heart's fibrous skeleton. **C.** Bovine heart sectioned at the level of the great vessels and, on the right, its human echocardiographic counterpart: parasternal short-axis view at the level of the great vessels' outflow. Below the RCL and nCL and in close proximity to the TSL insertion site (red arrow) lies the CF (green circle). The origin of the TSL is located 180° relative to the CF (on the opposite side of the image). **D.** Short-axis view at the level of the MV and TV. The base of the TSL (red arrow) continues with the CF (green circle) within the IVS (bright structure).



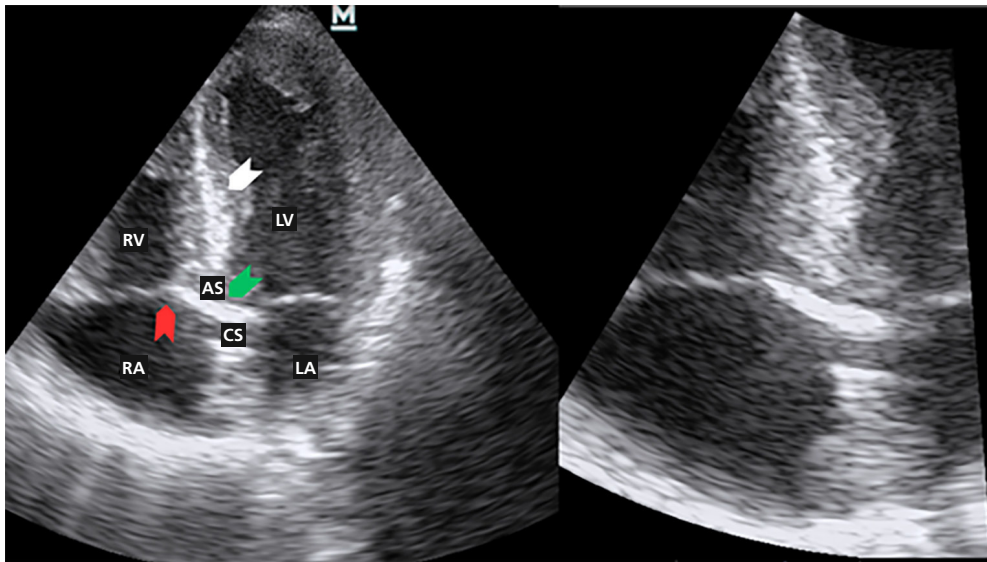
Ao: aorta; AS: ascending segment; CF: cardiac fulcrum; LA: left atrium; LMCA: left main coronary artery; LV: left ventricle; nCL: non-coronary leaflet; PA: pulmonary artery; RA: right atrium; RCL: right coronary leaflet; RT: right trigone; RV: right ventricle; TSL: tricuspid septal leaflet. Red arrow: TSL, yellow arrow: anterior leaflet of the mitral valve. Authors' own images.

Fig. 5. Apical views. **A.** Sectioned bovine heart and on the right its human echocardiographic counterpart. Four-chamber view: at the cross, on the interatrial-ventricular septum is an image that stands out for its brightness, the fibrous skeleton of the heart. Within it lies a structure where the helical myocardium begins and ends: the CF. The AS enters the hyperechoic zone. **B.** Sectioned bovine heart and on the right its human echocardiographic counterpart. Five-chamber view: left atrium. The AS enters the CF through its inferior border. **C.** Sectioned bovine heart and on the right its human echocardiographic counterpart. Apical 2-chamber view: the AS from the apical loop enters the CF through its inferior border (green circles). The CF is shown in a longitudinal section. **D.** Sectioned bovine heart and on the right its human echocardiographic counterpart. Three-chamber view: the AS enters the CF through its inferior margin (green circles). Red arrow: TSL, yellow arrow: anterior leaflet of the mitral valve. Anterior mitral valve (yellow arrow).



Ao: aorta; AS: ascending segment; CF: cardiac fulcrum; LA: left atrium; LMCA: left main coronary artery; LV: left ventricle; nC: non-coronary aortic leaflet; RA: right atrium; RT: right trigone; RV: right ventricle. TSL: tricuspid septal leaflet. Authors' own images.

Fig. 6. Apical four-chamber view. The AS is seen entering the RT and the CF at its lower margin (green arrow). The structures that stand out most clearly are the CF, RT, and right coronary filum. The latter surrounds the tricuspid annulus and is adjacent to the CS. Right: close-up view of the same structures.



AS: ascending segment, CS: coronary sinus, LA: left atrium, LV: left ventricle, RA: right atrium, RV: right ventricle. Green arrow: right trigone, right coronary filum, and cardiac fulcrum. White arrow: overlapping segments of the continuous helical myocardium (ascending and descending segments of the apical loop). Area with a large friction surface separated by high hyaluronic acid content. Authors' own images.

There are two trigones. The left trigone (LT) is located between the mitral orifice and the aorta. The right trigone (RT), a central fibrous structure, is the most prominent and is located between the tricuspid orifice (right), the aorta (posterior), and the pulmonary-tricuspid cord (anterior). The trigones connect with the coronary filum, fibrous structures that surround the valve rings. The LT connects with the left coronary filum, and the RT with the right coronary filum.

Surrounding these trigones and coronary filum is connective tissue that was described by Lower as the "fibrous rings of the heart." (9)

Cardiopulmonary and cardio-aortic continuity is marked by the musculofibrous cone, which exhibits thickening at the ends of each semilunar valve. (10)

Adjacent to the RT, in an anteroinferior position, lies the CF, a structure with osseous, chondroid, or tendinous histology depending on the species analyzed. (2)

The CF is the electromechanical unit of the heart where the torque produced by the contraction of both bands interacts to produce ventricular torsion and detorsion. (11,12) In heart failure and other conditions such as amyloidosis, detorsion is among the first mechanisms to be affected. (13, 14)

In hypertensive patients, ventricular suction is prolonged at the expense of an extension of the pro-diastolic contraction phase of the left ventricle compared with healthy individuals. (15)

The fiber arrangement determines shape and function. This structural analysis can be demonstrated through automated tractography reconstructions of diffusion tensor magnetic resonance imaging data. (16,17)

There are three twists that occur in the continuous myocardium. This arrangement, the sequential activation of the helical myocardial segments, and the anisotropic properties of their fibers determine that the electrical impulse, as it passes between these segments, produces a helical motion with opposite forces, leading to myocardial torsion-detorsion and creating the mechanical conditions necessary for mitral valve opening by suction and ventricular filling. (18,19)

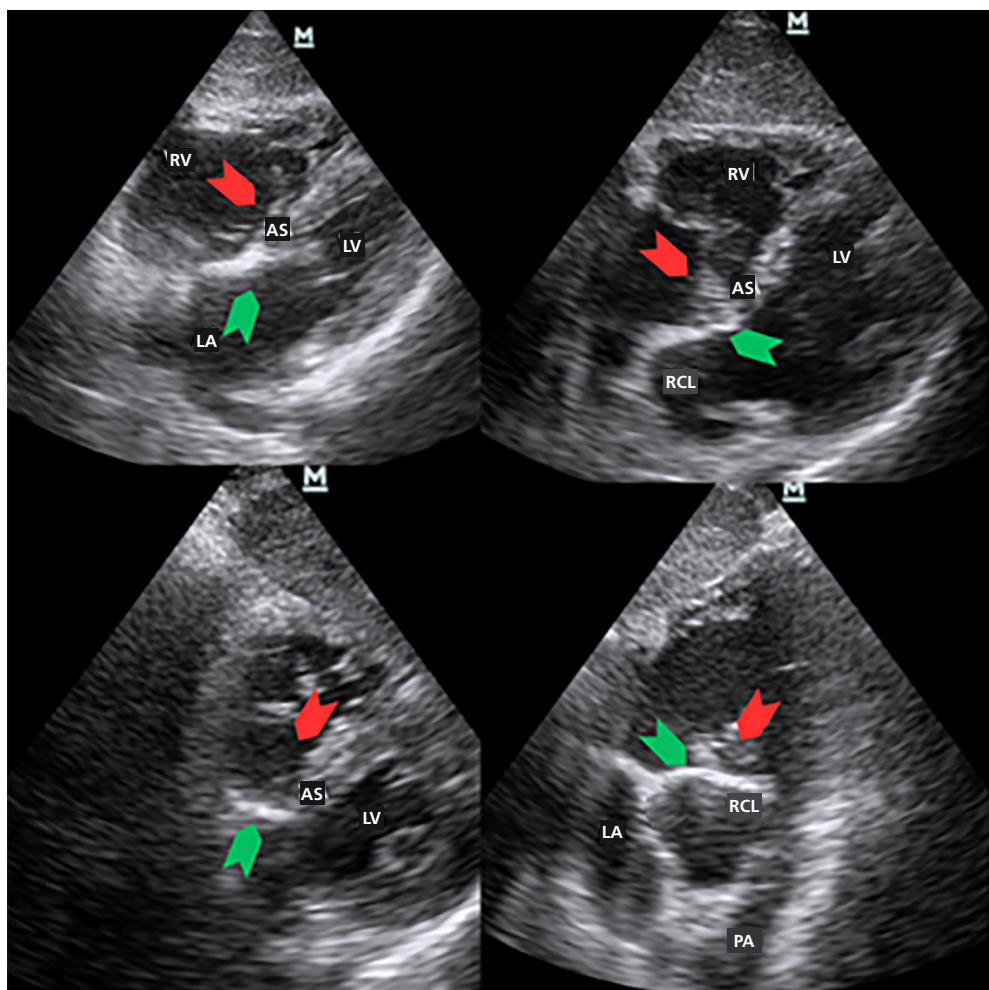
Restoring both systolic and diastolic ventricular synchrony (restoration of ventricular suction) through resynchronization could be a valuable option for recovering cardiac efficiency. (20)

Acoustic impedance of the trigones, the fulcrum, and the helical myocardium

Visualization of the trigones is possible due to the high density of collagen and other proteins that make up this matrix, which appear as a bright area.

The ultrasound reflective surface is the plane separating two media with different acoustic impedances. This property is related to the density of the medium through which the ultrasound wave propagates. When the ultrasound wave strikes a surface with higher acoustic impedance than the medium through which

Fig. 7. Subxiphoid views. Top left: 4-chamber view; top right: 5-chamber view. Bottom left: axial section through the tricuspid valve; bottom right: section at the level of the great vessels.



Ao: aorta; LA: left atrium; LV: left ventricle; Nc: non-coronary leaflet; PA: pulmonary artery; RCL: right coronary leaflet; RV: right ventricle. Green arrow: ascending segment (SA) of the apical loop entering the fulcrum. Red arrow: tricuspid septal leaflet. Authors' own images.

it propagates, an echo is reflected with an intensity directly proportional to the difference in density between the media forming the reflective interface. In turn, the intensity of the sound penetrating or propagating through the medium is inversely proportional to that difference in density.

When the ultrasound strikes the trigones, coronary filum, the CF, and the muscle tissue spatially associated with the trigones, reflected echoes are produced that make up the final echocardiographic image. The trigones, coronary filum and CF produce a very intense and bright reflected echo due to the reflective interface located between the aforementioned structures.

The CF and the trigones cannot be differentiated by two-dimensional echocardiography because, in humans, the difference in acoustic impedance between the structures is negligible. However, it is

possible to identify the fulcrum through its anatomic-topographic relationships due to its constant and unique relationship with nearby structures: the insertion base of the TSL, the RCL and nCL, and the distal end of the AS.

Limitations

We must acknowledge, on the one hand, the classic limitations of echocardiography: a) the spatial resolution of the method, which limits observation; b) acoustic impedance is similar between the trigones and the fulcrum; c) ultrasound probe settings (depth, gain, etc.). And on the other hand, those inherent to the location of the structures and their visualization: some of the echocardiographic views that best locate this complex of structures are unconventional views and axes.

The use of high-frequency transducers, other echo-

cardiographic techniques, and the operator's experience and skill can be crucial for obtaining high-quality images and overcoming the limitations of this method.

CONCLUSION

The dissection technique described to reach the cardiac fulcrum is applicable in bovine and human hearts. The echocardiographic projections used to visualize the fibrous skeleton, CF, and the ends of the continuous helical myocardium are useful for understanding the anatomic-functional unit where ventricular torsion and detorsion occur. It is possible to identify the fulcrum through its anatomic-topographic relationships due to its association with nearby structures.

The views that best identify the CF are modified 3-chamber, and apical 4-chamber views. The intermediate apical 2-chamber view (between 4-chamber and pure 2-chamber views) allows for longitudinal imaging of the fulcrum. Apical views generally allow for observation of the ascending segment entering the RT and the CF.

Conflicts of interest

None declared.

(See authors' conflict of interests forms on the web).

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Screening for Obstructive Sleep Apnea in Patients with Arterial Hypertension: Development and Internal Validation of an Exploratory Model Based on Clinical and Echocardiographic Variables

Cribado de apnea obstructiva del sueño en pacientes con hipertensión arterial: desarrollo y validación interna de un modelo exploratorio basado en variables clínicas y ecocardiográficas

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ABSTRACT

Background: Obstructive sleep apnea (OSA) is a recognized cause of secondary hypertension and a factor contributing to the progression of cardiovascular damage. Although its prevalence in hypertensive patients is high, it is often underdiagnosed.

Objective: To develop and validate a clinical predictive model based on routine variables to estimate the risk of OSA in patients with hypertension (HTN).

Methods: A retrospective cohort of patients with hypertension treated in an outpatient cardiology clinic was analyzed. Patients with complete data and diagnostic polysomnography were included. Polysomnography was indicated based on clinical criteria, according to the suspicion of OSA. Clinical and echocardiographic variables were evaluated, with age categorized into clinically relevant ranges. Predictors were selected using two methods: LASSO and AIC stepwise. Predictor robustness was assessed using bootstrap validation (n=1000). Model performance was evaluated using the area under the ROC curve (AUC), performance metrics, and calibration with the Hosmer-Lemeshow test.

Results: A total of 1795 patients were included, 88 of whom (4.9%) had OSA. The independent predictors were diastolic dysfunction (OR 2.39; 95% CI 1.54-3.74), male sex (OR 2.12; 95% CI 1.35-3.38), age between 45 and 65 years (OR 1.71; 95% CI 1.10-2.66), and body mass index (OR per 1 kg/m² 1.08; 95% CI: 1.05-1.11). The model showed an AUC of 0.70 (95% CI 0.59-0.81), 71% sensitivity, 55% specificity, 98% negative predictive value, and 56% overall accuracy, with good calibration.

Conclusions: The clinical model developed, based on simple variables that are easily obtained in outpatient practice, showed moderate discriminatory power and a high negative predictive value, which suggests its utility as a screening tool to rule out OSA in hypertensive patients. Its implementation could help optimize the indication for polysomnography, although it requires external validation in different settings before widespread clinical adoption.

Key words: Obstructive sleep apnea – Arterial hypertension – Predictive models – Screening – Echocardiography

RESUMEN

Introducción: La insuficiencia cardíaca (IC) aguda continúa siendo una de las principales causas de hospitalización y morbimortalidad a nivel mundial. La implementación de unidades especializadas en IC ha demostrado mejorar la calidad asistencial y los resultados clínicos; sin embargo, la evidencia sobre su impacto sostenido en América Latina es limitada.

Objetivo: Evaluar el impacto de una unidad especializada en IC sobre métricas de calidad asistencial en pacientes hospitalizados por IC aguda.

Material y métodos: Se realizó un análisis retrospectivo de una cohorte consecutiva de pacientes hospitalizados con diagnóstico principal de IC aguda entre enero de 2014 y diciembre de 2024. El programa de IC incluyó manejo basado en caminos críticos, checklist estructurado al alta, médicos con dedicación exclusiva, enfermeros especializados, personal administrativo dedicado, educación al alta con indicaciones escritas, seguimiento posalta estructurado, consultas prioritarias, presentación periódica de indicadores, ateneos para decisiones de manejo avanzado, descongestión guiada por ultrasonido, telemonitoreo y hospital de día. En los últimos dos años, pacientes seleccionados de bajo riesgo tratados exclusivamente en hospital de día no fueron incluidos. Los puntos finales analizados anualmente fueron mortalidad intrahospitalaria, rehospitalización por IC a 30 días y duración de la estadía hospitalaria.

REV ARGENT CARDIOL 2026;94:203-210. <https://doi.org/10.7775/rac.v94.i3.21005>

Received: 01/08/2026 – Accepted: 03/04/2026

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Se compararon dos períodos: etapa inicial (2014–2019) y etapa de consolidación (2020–2024).

Resultados: Se analizaron 3368 hospitalizaciones por IC aguda. El volumen anual de internaciones aumentó de 260 en 2014 a 463 en 2024, con una tendencia creciente significativa ($p=0,002$). La mortalidad intrahospitalaria mostró una leve tendencia descendente (5,0% a 3,9%), sin significación estadística. La rehospitalización a 30 días se mantuvo estable, con menor variabilidad en los años más recientes. La duración de la estadía hospitalaria se redujo progresivamente de 9,3 a 2,8 días ($p<0,001$), siendo significativamente menor en la etapa de consolidación (mediana 3,6 vs. 6,8 días; $p=0,004$).

Conclusión: La implementación y consolidación de una unidad especializada en IC se asoció con un aumento del volumen asistencial y mejoras sostenidas en la eficiencia hospitalaria, reflejadas en una reducción significativa de la duración de la estadía. La mayor estabilidad de la mortalidad y la rehospitalización durante la etapa de consolidación sugiere una mejora sostenida en la calidad de la atención, apoyando el desarrollo de modelos estructurados de atención en sistemas de salud de Latinoamérica.

Palabras clave: Insuficiencia cardíaca aguda - Insuficiencia cardíaca descompensada - Unidades de insuficiencia cardíaca - Calidad de atención médica

INTRODUCTION

Obstructive sleep apnea (OSA) is a respiratory disorder characterized by recurrent episodes of partial or complete obstruction of the upper airway during sleep, leading to intermittent hypoxemia, sleep fragmentation, and sustained sympathetic activation. (1,2) Its prevalence ranges from 9% to 38% in the general adult population, (3) with a higher incidence in men and in overweight or obese individuals. (4)

In the context of hypertension (HTN), OSA has gained particular relevance as it is a recognized cause of secondary hypertension and is associated with poorer blood pressure control, increased arterial stiffness, cardiac remodeling, and a higher risk of cardiovascular events. (5,6) Previous studies have shown that up to 30–50% of patients with HTN may have OSA, and this proportion is even higher in the subgroup with resistant hypertension. (7,8)

Despite its high prevalence, OSA remains an underdiagnosed condition, especially in the outpatient setting, where polysomnography, considered the gold standard for its diagnosis, is not always feasible due to limitations in availability, cost, or accessibility. (9) This highlights the need for specific screening tools for this population, capable of optimizing the selection of candidates for confirmatory studies and rationalizing the use of diagnostic resources.

In addition to polysomnography, ambulatory respiratory polygraphy has established itself as a valid diagnostic alternative in patients with high clinical suspicion, particularly in the outpatient setting. However, its performance may be limited in patients with cardiovascular comorbidities, such as hypertension, in whom clinical complexity may require more comprehensive studies.

Although validated screening scales exist for the general population, such as STOP-BANG or NoSAS, (6,7) their performance may vary in hypertensive patients, where the incorporation of echocardiographic parameters, such as diastolic dysfunction or cardiac morphological characteristics, could provide additional predictive value.

On this basis, the objective of this study was to develop and internally validate a clinical predictive screening model for OSA in patients with hyperten-

sion, using routine clinical and echocardiographic variables to generate a tool applicable in outpatient practice and adapted to this high-risk population.

OBJECTIVE

To develop and validate a clinical predictive model based on routine clinical and echocardiographic variables to estimate the risk of OSA in patients with hypertension.

METHODS

Study design and population

A retrospective observational study was conducted in a cohort of patients diagnosed with hypertension (HTN) treated in the outpatient Cardiology Department of a private institution in the Autonomous City of Buenos Aires, Argentina from 2017 to 2022. Adult patients over 18 years of age with a diagnosis of HTN who underwent a complete clinical evaluation and echocardiographic study were consecutively included. In the context of routine clinical practice, a subgroup of patients was evaluated for obstructive sleep apnea (OSA) using polysomnography based on clinical criteria and availability. Patients with incomplete data on the variables of interest were excluded, as were those with inconclusive or technically inadequate sleep studies. Additionally, patients with severe chronic respiratory diseases, advanced heart failure, or conditions that could interfere with the correct interpretation of sleep studies were excluded.

Definitions

Hypertension was defined according to current guidelines (10,11) and based on ambulatory blood pressure monitoring (ABPM) values: nighttime blood pressure (resting period) $\geq 120/70$ mmHg, daytime blood pressure (active period) $\geq 135/85$ mmHg, and mean 24-h blood pressure $\geq 130/80$ mmHg. A non-dipper pattern was considered present when the nocturnal reduction in systolic blood pressure was $<10\%$ compared to daytime values. Ambulatory blood pressure was measured with a validated oscillometric device (MED-ITECH® ABPM-04 model, Easy ABPM software version 1.1.2.3) (12). The cuff size was selected according to the patient's brachial circumference and the cuff was placed on the non-dominant arm. The active period was defined as the time between 8:00 a.m. and 10:00 p.m. in which measurements were taken every 20 minutes, and the passive period, as the time between 10:00 p.m. and 8:00 a.m. in which measurements were taken every 30 minutes. This information was supplemented with the patient's personal diary to corroborate the periods of activity and rest.

OSA, previously known as obstructive sleep apnea-hypopnea syndrome (OSAHS), was defined according to the current guidelines of the American Academy of Sleep Medicine (AASM) at the time of patient enrollment. (13) OSA was defined as the presence of repeated episodes of complete or partial upper airway obstruction during sleep detected by polysomnography and quantified by the apnea-hypopnea index (AHI). In the analyzed cohort, the diagnosis of OSA was exclusively determined by polysomnography, considered the gold standard for diagnostic confirmation. OSA was diagnosed with an AHI ≥ 5 events/hour, and its severity was classified as mild (5-14), moderate (15-29), or severe (≥ 30). Hypopnea was defined as a $\geq 30\%$ airflow reduction for at least 10 seconds, associated with $\geq 3\%$ oxygen desaturation and/or an arousal defined as a transient microarousal detected by polysomnography, which briefly interrupts the continuity of sleep.

Left ventricular (LV) diastolic dysfunction was defined according to current guidelines, (14,15) by applying the algorithm of the American Society of Echocardiography (ASE) and the European Association of Cardiovascular Imaging (EACVI), which integrates echocardiographic parameters to establish diastolic dysfunction and estimate LV filling pressure. In patients with sinus rhythm, diastolic dysfunction was considered when at least two of the following criteria were met: mean E/e' ratio >14 , septal e' <7 cm/s or lateral e' <10 cm/s, left atrial volume index >34 ml/m², or tricuspid regurgitation velocity >2.8 m/s. Severity was categorized according to this algorithm as grade I (impaired relaxation with normal filling pressure), grade II (pseudonormal pattern with elevated filling pressure), or grade III (restrictive pattern with elevated filling pressure). For the predictive model, diastolic dysfunction was considered a dichotomous variable (presence/absence), regardless of the grade of severity, to facilitate its use as a rapid screening tool.

Outcome of interest

Our outcome of interest was the presence of OSA.

Statistical analysis Cohort description

Continuous variables were expressed as mean and standard deviation or median and interquartile range, depending on their distribution, and categorical variables as percentages. Comparisons between groups were performed using Student's t-test or the Mann-Whitney U test for continuous variables and the chi-square test for categorical variables. Quantitative variables were categorized according to clinically relevant cutoff points or explored using generalized additive models and visual analyses to determine potential clinically significant inflection points, which were then used for categorization. Body mass index (BMI) was calculated as weight in kilograms divided by height in square meters. Age was analyzed as both a continuous and a categorical variable (stratified into <45 , 45–65, and >65 years).

Selection of OSA predictors

Clinical and echocardiographic variables selected a priori based on their pathophysiological relevance and prior evidence were considered. Clinical variables included demographic characteristics, traditional cardiovascular risk factors (such as hypertension, diabetes, dyslipidemia, and smoking), and anthropometric parameters. Echocardiographic variables included structural and functional measures of the left ventricle, including assessment of diastolic and systolic function. To identify predictors, two comple-

mentary selection methods were used: the LASSO (Least Absolute Shrinkage and Selection Operator) penalized regression and the stepwise selection guided by the Akaike Information Criterion (AIC), which prioritized a parsimonious and clinically interpretable approach. Each method was run within a bootstrap resampling scheme with replacement (1000 iterations, with the frequency of variable inclusion recorded in each one, with the selection proportion and its 95% binomial confidence interval). Since both methods were applied with the same number of iterations, they were assigned equal weighting (1/2 each) in the calculation of a combined stability score. Predefined cutoff points ($\geq 75\%$ selection in each method) were established to define consensus, and those variables that simultaneously exceeded these thresholds in both methods were considered robust. This combined approach was adopted to improve robustness in predictor selection and reduce the risk of overfitting.

Multivariate analysis

The variables with the highest consistency (high frequency and/or agreement across methods) and those considered clinically relevant were included in multivariate logistic regression models to estimate the risk of OSA. Given the low number of events, a parsimonious approach was prioritized to avoid overfitting. Likewise, the inclusion of highly correlated or redundant variables was avoided to reduce model instability and improve its generalizability. The number of events per variable remained close to the recommended limits; therefore, the results should be interpreted with caution regarding the model's stability. The results were expressed as odds ratios (OR) with their 95% confidence intervals (95% CI). The model's performance and discriminatory power were assessed with the area under the ROC curve (AUC), and standard diagnostic metrics such as sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy were calculated over 1000 bootstrap iterations to estimate their stability.

Model calibration was verified using the Hosmer-Lemeshow test and calibration curves. All analyses were performed using RStudio software (v4.4.0), and a p-value <0.05 was considered statistically significant.

Ethical considerations

The study was conducted in accordance with the principles of the Declaration of Helsinki. (16) Given the retrospective nature of the analysis and the use of anonymized data, individual informed consent was not required.

RESULTS

General description of the population

A total of 1795 patients diagnosed with hypertension and complete complementary studies were included, of whom 88 (4.9%) had a confirmed diagnosis of OSA via polysomnography. The mean age of the cohort was 59.3 ± 14.2 years, with a predominance of females (53%). In the OSA group, a higher proportion of males was observed (63.6% vs. 46.2%; $p=0.002$) and the mean age did not show statistically significant differences (56.9 ± 11.9 vs. 59.4 ± 14.3 years; $p=0.115$). Regarding cardiovascular risk factors, in the OSA group, the percentage of patients with diabetes mellitus was similar (15.9% vs. 17.0%; $p=0.902$) but the body mass index was higher (32.9 ± 6.5 vs. 29.3 ± 5.5 kg/m²; $p<0.001$). Likewise, the prevalence of diastolic

dysfunction was significantly higher in the OSA group (51.1% vs. 34.7%; $p=0.002$). Regarding cardiovascular events during follow-up, no statistically significant differences were observed between the two groups; the remaining baseline characteristics are presented in Table 1.

Variable selection using machine learning algorithms

In the variable selection analyses, both methods, the stepwise and LASSO, demonstrated high stability in identifying predictors of OSA. The selection frequency was plotted graphically, showing that variables such as age, sex, BMI, diastolic dysfunction, and cardiovascular history remained among the most consistently selected. The comparative map between the two methods revealed a group of variables that simultaneously exceeded the consensus thresholds ($\geq 75\%$ selection in both stepwise and LASSO methods), thus reinforcing their robustness as predictors. In this graph, the shaded area represents strict consensus between methods, while the size of each point reflects the weighted score (a 50/50 average of the proportions in both algorithms), allowing us to appreciate not only the consensus between methods but also the degree of stability of each variable. In contrast, other variables appeared more sporadically or were method-dependent, suggesting lower stability. These findings are summarized in Figure 1, which shows a Selection Concordance Map (LASSO - stepwise). In the comparative analysis, a small subset of variables showed a high frequency of simultaneous selection in both methods (consensus zone), which are the most stable predictors. The remaining exhibited low frequencies or were dependent on a single approach, which reflects lower consistency. In line with these findings and to prioritize model parsimony, diabetes mellitus was not included in the final model. Although it showed an association in the bivariate analysis, this could be explained by its multicollinearity with BMI and other cardiometabolic factors. Additionally, the limited number of events in the cohort constrained the number of variables that could be included in the multivariate model; therefore, its exclusion should be interpreted as a methodological decision aimed at preserving the model's stability rather than as a lack of clinical relevance.

Multivariate analysis: predictors of OSA

The presence of diastolic dysfunction, gender, age between 45 and 65 years, and BMI were associated with the presence of OSA. Other variables, such as a history of diabetes, coronary artery disease, or biochemical parameters, did not show a statistically significant association (Table 1). In the multivariable analysis, the independent predictors of OSA were diastolic dysfunction (OR 2.39; 95% CI 1.54-3.74; $p<0.001$), male gender (OR 2.12; 95% CI 1.35-3.38; $p=0.001$), age between 45-65 years (OR 1.71; 95% CI 1.10-2.66; $p=0.017$), BMI (OR per 1 kg/m² 1.08; 95% CI 1.05-1.11; $p<0.001$).

Final prediction model

The final model showed an AUC of 0.70 (95% CI 0.59-0.81), 71% sensitivity, 55% specificity, 8% PPV and 98% NPV. Calibration—assessed using the Hosmer-Lemeshow test—showed no significant differences ($p>0.05$), which indicated a good fit. The diagnostic performance of the model is presented in Figure 2.

DISCUSSION

Our findings can be summarized in three main points. First, we observed a low prevalence of OSA in our cohort of hypertensive patients, which likely reflects a selection bias, given that polysomnography was not performed systematically. Second, we identified that routine clinical and echocardiographic variables, easily obtainable in daily practice—such as gender, middle age (45–65 years), BMI, and diastolic dysfunction—were independently associated with OSA. Finally, we developed and internally validated an exploratory clinical model for OSA. The model demonstrated moderate discriminatory power consistent with tools based on simple clinical variables and acceptable sensitivity along with high negative predictive value, which suggests potential utility as a complementary tool to guide indication for polysomnography in outpatient practice.

Regarding prevalence, our results contrast with those reported in the literature. Globally, it is estimated that more than 936 million adults have OSA at any degree, and approximately 425 million cases are moderate-to-severe. (3) In hypertensive patients, the reported prevalence ranges from 30% to 50%, and in the subgroup with resistant hypertension it ranges approximately from 70% to 80%. (1,2,17,18) These differences reinforce the idea that in our cohort, the prevalence is likely underestimated, consistent with observations in other clinical settings where the indication for sleep studies depends on clinical suspicion. (19, 20)

Regarding associated variables, left ventricular diastolic dysfunction was the most consistent echocardiographic finding in our model. The intermittent hypoxia and nocturnal pressure overload characteristic of OSA promote myocardial and atrial remodeling, which is associated with an increased risk of atrial fibrillation and disease progression (5,15,21,22). Likewise, male sex, middle age (45-65 years), and elevated BMI are widely validated predictors in screening scales such as STOP-Bang and NoSAS. (6,7)

Although tools such as STOP-Bang and NoSAS have demonstrated good performance in the general population, their applicability in hypertensive patients may be limited as they do not consider cardiac structural variables. In this regard, our model incorporates diastolic dysfunction as a marker of cardiovascular remodeling, which could add a potentially relevant pathophysiological dimension in this specific population. This approach could represent an advantage over tools based exclusively on clinical and an-

Table 1. Baseline characteristics

Variable	Overall	No OSA	OSA	p
n	1795	1707	88	
Female, n (%)	951 (53.0)	919 (53.8)	32 (36.4)	0.002
Age (years), mean (SD)	59.25 (14.2)	59.37 (14.3)	56.86 (11.9)	0.107
BMI, kg/m ² , mean (SD)	29.50 (6.0)	29.32 (5.9)	32.90 (6.5)	<0.001
Daytime SBP, mmHg, mean (SD)	139.52 (15.6)	139.36 (15.6)	142.47 (16.1)	0.069
Nighttime SBP, mmHg, mean (SD)	126.27 (18.2)	126.05 (18.1)	130.56 (20.6)	0.024
LA area, cm ² , mean (SD)	24.06 (8.8)	24.12 (8.9)	22.83 (7.6)	0.179
IVS, mm, mean (SD)	11.18 (1.7)	11.17 (1.7)	11.37 (1.6)	0.278
Total cholesterol, mg/dL, mean (SD)	181.11 (41.0)	181.10 (40.7)	181.38 (47.5)	0.951
LDL, mg/dL, mean (SD)	105.76 (36.1)	105.86 (36.1)	103.67 (37.7)	0.579
HDL, mg/dL, mean (SD)	49.89 (16.8)	50.14 (16.9)	45.07 (13.3)	0.006
CICr, mL/min, mean (SD)	110.34 (49.9)	109.72 (49.5)	122.38 (55.9)	0.020
Diabetes mellitus, n (%)	304 (16.9)	290 (17.0)	14 (15.9)	0.906
Dyslipidemia, n (%)	559 (31.1)	518 (30.3)	41 (46.6)	0.002
Statins, n (%)	520 (29.0)	486 (28.5)	34 (38.6)	0.054
Diastolic dysfunction, n (%)	637 (35.5)	592 (34.7)	45 (51.1)	0.002
LVH, n (%)	333 (18.5)	312 (18.3)	21 (23.9)	0.240
Treatment, n (%)	1,401 (78.6)	1,329 (78.4)	72 (83.7)	0.295
Treatment with 3 or more drugs, n (%)	252 (14.0)	237 (13.9)	15 (17.0)	0.500
Age 45-60 years, n (%)	612 (34.1)	570 (33.4)	42 (47.7)	0.008
CrCl <50 ml/min, n (%)	111 (6.2)	109 (6.4)	2 (2.3)	0.182
Albuminuria >20 mg/day, n (%)	508 (28.3)	486 (28.5)	22 (25.0)	0.560
HTN stratum, n (%)				0.397
Controlled HTN	653 (36.4)	624 (36.6)	29 (33.0)	
Isolated systolic HTN	469 (26.1)	450 (26.4)	19 (21.6)	
Isolated diastolic HTN	105 (5.8)	100 (5.9)	5 (5.7)	
Systolic and diastolic HTN	568 (31.6)	533 (31.2)	35 (39.8)	
Follow-up, months, mean (SD)	43.16 (24.1)	42.98 (24.1)	46.62 (24.8)	0.167
MACE, n (%)	162 (9.0)	158 (9.3)	4 (4.5)	0.189
Death, n (%)	53 (3.7)	51 (3.8)	2 (2.3)	0.684
Treatment, n (%)	1,401 (78.6)	1329 (78.4)	72 (83.7)	0.295

BMI, body mass index; CrCl, creatinine clearance; HDL, high-density lipoproteins; HTN, hypertension; IVS, interventricular septum; LA, left atrium; LDL, low-density lipoproteins; LVH, left ventricular hypertrophy; MACE, major adverse cardiovascular events; OSA, obstructive sleep apnea; SBP, systolic blood pressure; SD, standard deviation.

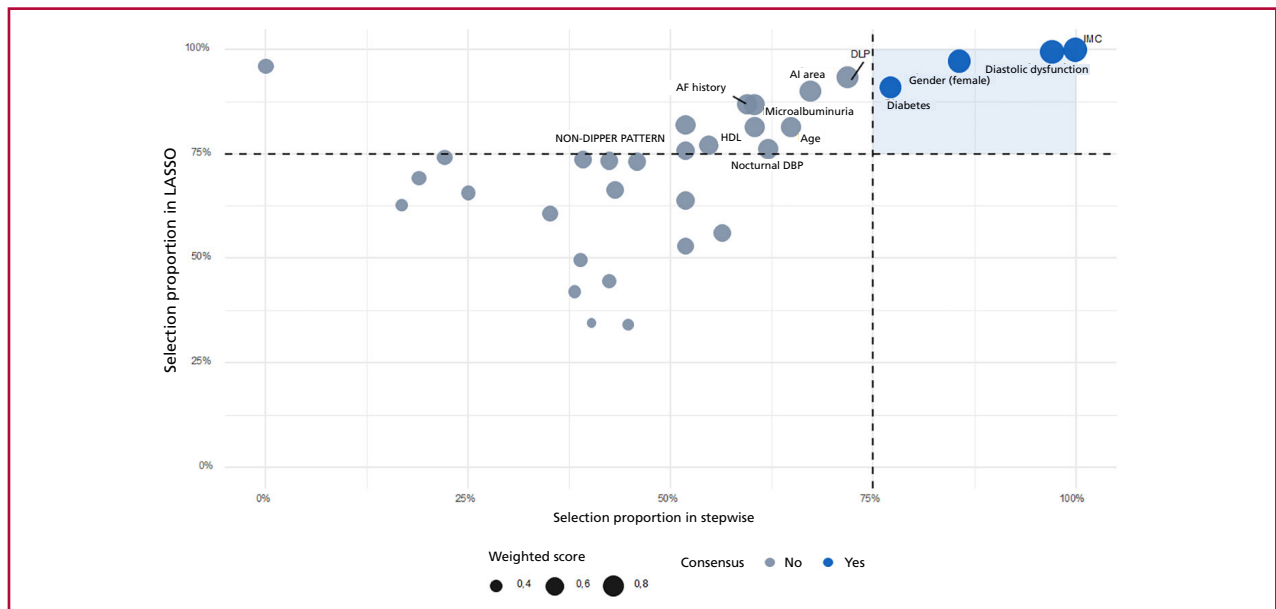
thropometric variables, particularly in populations with high cardiovascular risk, such as hypertensive patients. However, the absence of a direct comparison with these scores in our cohort constitutes a limitation; therefore, future studies should further evaluate the relative performance and incremental utility of this model compared to widely validated screening tools.

Although diabetes showed an association in the bivariate analysis, it did not remain a predictor in the final model, which could be explained by its multicollinearity with other cardiometabolic variables,

particularly BMI. Additionally, the limited number of events in the cohort constrained the number of variables that could be included in the multivariate model; therefore, its exclusion should be interpreted as a methodological decision aimed at preserving the stability of the model rather than as a lack of clinical relevance. (23,24)

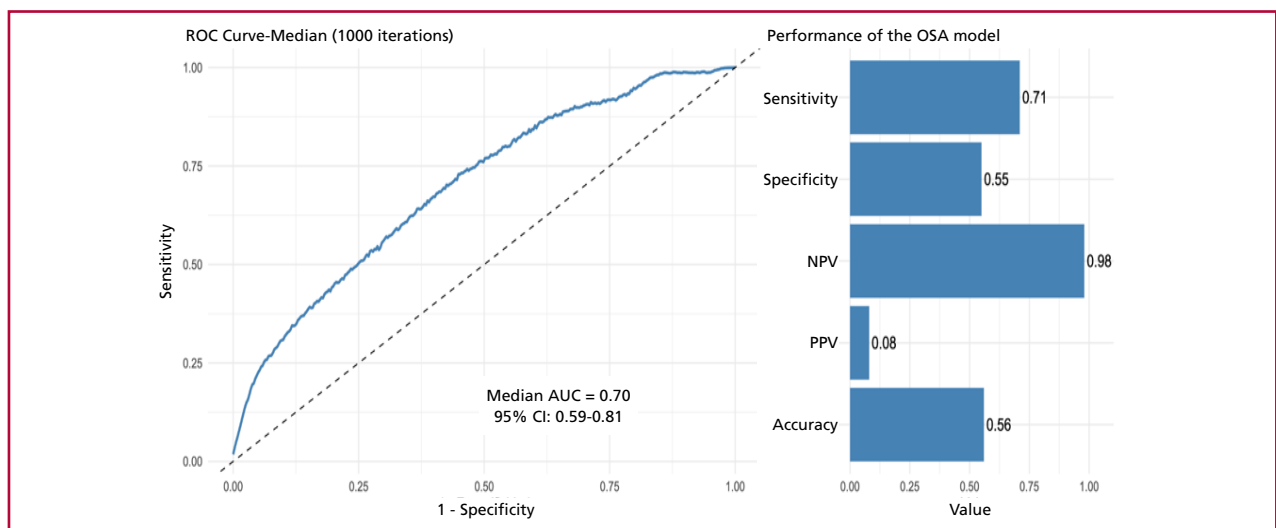
From a methodological standpoint, the combined use of two variable selection strategies (LASSO and AIC stepwise) within an internal validation framework using bootstrapping made it possible to identify clinically relevant predictors with good stability in or-

Fig. 1. Stability map: LASSO vs. stepwise



Size = weighted score (50% LASSO / 50% STEP). Shaded region = consensus (75% / 75% thresholds). AF: atrial fibrillation; BMI: body mass index; DBP: diastolic blood pressure; DLP; dyslipidemia; HDL: high-density lipoprotein; LA: left atrium; MACE: major adverse cardiovascular events.

Fig. 2. Performance of the OSA predictive model



ROC curve obtained with 1,000 bootstrap iterations. Median AUC: 0.70 (95% CI: 0.59-0.81). On the right, model performance with 71% sensitivity, 55% specificity, 98% negative predictive value (NPV), 8% positive predictive value (PPV), and 56% overall accuracy. OSA: obstructive sleep apnea

der to reduce the overfitting risk. (9,25) Unlike other scores developed in the general population, this model was derived from a cohort of hypertensive patients, a high-risk group with a high prevalence of OSA (1-3, 22,23,26), which could enhance its applicability in outpatient clinical practice. The clinical implications of detecting OSA in hypertensive patients are significant. Untreated OSA contributes to the progression of hypertension and is associated with an increased risk of cardiovascular events. (15,27) In this regard, the

American Heart Association has emphasized the importance of considering screening strategies in high-risk subgroups, such as those with resistant hypertension. (24) Similarly, interventions such as continuous positive airway pressure (CPAP) have demonstrated a reduction in blood pressure, especially in patients with resistant hypertension or an altered nocturnal blood pressure profile. (23,28)

Finally, among the limitations of our study, its retrospective and single-center design should be noted,

which could restrict the generalizability of the results. The low prevalence of OSA in the cohort, along with the small number of events, may have limited statistical power and affected the stability of the model, with a potential risk of overfitting in the selection of predictors. However, the implementation of variable selection techniques and internal validation using bootstrapping sought to mitigate this effect. Likewise, the low prevalence of OSA may have affected the diagnostic metrics, particularly the positive predictive value. The high negative predictive value observed should be interpreted in this context, given that prevalence directly impacts its magnitude. In this scenario, the model may prove more useful for ruling out the disease than for confirming it, although its performance should be evaluated in populations with higher prevalence.

Since the indication for polysomnography was not systematic but rather guided by clinical suspicion, the analyzed cohort represents a selected subgroup of patients, which introduces potential selection and verification bias. Consequently, the results should be interpreted in the context of a population with an increased pretest probability of OSA. Future studies should validate this model in larger multicenter cohorts, compare it with existing screening tools, and explore the incorporation of biomarkers and parameters derived from nocturnal blood pressure and left atrial strain, in order to optimize its performance. (14,15) Taken together, these findings provide preliminary evidence regarding the value of a clinical screening model in this population, which needs further confirmation in prospective studies and other cohorts.

CONCLUSION

The developed clinical model, based on simple variables that are easily obtained in outpatient practice, demonstrated moderate discriminatory power and high negative predictive value, which suggests its utility as a screening tool to rule out OSA in hypertensive patients. Its implementation could optimize screening, rationalize the indication for polysomnography, and promote early detection of a highly prevalent and frequently underdiagnosed condition. However, external validation in different settings and populations is required before widespread clinical adoption.

Conflicts of interest

None declared.

(See authors' conflict of interests forms on the web).

Funding

No external funding.

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Use of Automated External Defibrillators in the Buenos Aires Subway System: Experience from a Public Cardioprotection Program

Activación de desfibriladores externos automáticos en el subterráneo de la Ciudad de Buenos Aires: experiencia de un programa de cardioprotección pública

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ABSTRACT

Background: Out-of-hospital sudden cardiac death is one of the leading causes of cardiovascular mortality worldwide. Early defibrillation is the most important determinant of survival in patients with shockable rhythms, particularly ventricular fibrillation. For this reason, numerous international guidelines recommend the implementation of public defibrillation programs in high-traffic areas.

Objective: The aim of this study was to report the response system activations and use of automated external defibrillators (AEDs) in the Buenos Aires City subway system following the implementation of a cardioprotection program.

Methods: A descriptive observational study was conducted based on the program's operational registries between 2018 and 2024. All instances in which system personnel responded to retrieve an AED in response to events potentially consistent with cardiac arrest were analyzed.

Results: During the study period, 27 system activations were recorded. In 15 cases, the AED was applied to the patient analyzing the heart rhythm. Among the cases analyzed, 14 shockable rhythms and 1 non-shockable rhythm were identified. In 12 cases, the process was interrupted due to the patient regaining consciousness or the identification of events not consistent with cardiac arrest. Survival was confirmed in 7 patients.

Conclusions: These results suggest that the program enabled an adequate response to this extreme situation.

Key words: Out-of-hospital cardiac arrest - Automatic external defibrillator - Public defibrillation - Cardiopulmonary resuscitation - Public transportation

RESUMEN

Introducción: La muerte súbita cardíaca extrahospitalaria es una de las principales causas de mortalidad cardiovascular a nivel mundial. La desfibrilación precoz es el determinante más importante de supervivencia en pacientes con ritmos desfibrilables, particularmente fibrilación ventricular. Por ello, múltiples guías internacionales recomiendan implementar programas de desfibrilación pública en espacios con alta circulación de personas.

Objetivo: Reportar las activaciones del sistema de respuesta y la utilización de desfibriladores externos automáticos (DEAs) en el sistema de subterráneos de la Ciudad de Buenos Aires tras la implementación de un programa de cardioprotección.

Material y métodos: Se realizó un estudio observacional descriptivo basado en registros operativos del programa entre 2018 y 2024. Se analizaron todas las ocasiones en que personal del sistema acudió a buscar un DEA ante eventos potencialmente compatibles con paro cardíaco.

Resultados: Durante el período analizado se registraron 27 activaciones del sistema. En 15 casos el DEA fue colocado en el paciente y analizó el ritmo cardíaco. Entre los casos analizados se identificaron 14 ritmos desfibrilables y 1 no desfibrilable. En 12 casos el proceso se interrumpió por recuperación de la conciencia o identificación de eventos no compatibles con paro cardíaco. Se confirmó supervivencia en 7 pacientes.

Conclusiones: Estos resultados sugieren que el programa permitió una respuesta adecuada ante esta situación extrema.

Palabras clave: Paro cardíaco extrahospitalario - Desfibrilador externo automático - Desfibrilación pública - Reanimación cardiopulmonar - Transporte público

REV ARGENT CARDIOL 2026;94:211-215. <https://doi.org/10.7775/rac.v94.i3.21009>

Received: 03/12/2026 – Accepted: 04/17/2026



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INTRODUCTION

Argentina estimates approximately 45 000 sudden deaths annually, most of which occur in out-of-hospital settings.

Out-of-hospital cardiac arrest is one of the leading causes of cardiovascular death worldwide. Survival depends largely on early recognition of the event and prompt defibrillation when the initial rhythm is shockable. (1)

Ventricular fibrillation is one of the most common rhythms in witnessed cardiac arrests and can be reversed through early defibrillation. Various international guidelines recommend the implementation of public defibrillation programs in high-traffic areas, such as airports, transport stations, and shopping centers.

The Autonomous City of Buenos Aires subway system is one of the country's main modes of urban transportation and, under normal operating conditions, handles between 300 and 400 million trips per year, making it a particularly important setting for the implementation of cardioprotection and public defibrillation strategies.

The availability of automated external defibrillators (AEDs) in these settings allows non-medical personnel to initiate treatment before emergency services arrive.

In 2017, our group published a study on sudden death in rugby clubs, demonstrating the benefits of early intervention for victims of sudden death through the implementation of cardiopulmonary resuscitation (CPR) programs and the use of AEDs. (2) Continuing along these lines, the Buenos Aires subway system implemented a cardiac protection program that included the installation of AEDs and staff training on their use.

In this context of high passenger traffic, the implementation of cardioprotection programs takes on special relevance.

The objective of this study was to describe the activations of the response system and the effective use of AEDs in this context.

METHODS

A descriptive observational study was conducted based on operational registries from the cardiac protection program implemented in the Buenos Aires subway system.

All events recorded between 2018 and 2024 in which system personnel responded to retrieve an AED in response to a clinical situation potentially consistent with cardiac arrest were included.

System activation was defined as any situation in which an AED was requested or retrieved.

For each activation, the following data were recorded:

- whether or not the device was used
- rhythm detected by the AED
- availability of information on subsequent outcomes, whenever possible.

No additional interventions were performed, nor was the patients' usual clinical management altered.

The cardiac protection program also included training of

subway system and railway workshop operating personnel in basic CPR and the use of AEDs. Overall, approximately 600 employees received specific training in recognizing a cardiac arrest, activating the emergency system, initiating CPR, and using the AED.

The statistical analysis was limited to descriptive statistics.

Ethical Considerations

No experiments were conducted on humans or animals. Personal data was anonymized in accordance with current regulations and informed consent was waived as the data consisted of non-identifiable retrospective information.

RESULTS

A total of 27 system activations were recorded, with 15 episodes of shockable rhythms treated (Table 1).

Of these activations:

- 15 cases (55.5%) required the use of the AED with electrode placement and rhythm analysis.
- 12 cases (44.5%) were resolved before the device was used, generally because the patient regained consciousness, exhibited spontaneous movements, or the event was due to syncope, a fall, or other situations not consistent with cardiac arrest.

Among the 15 patients evaluated using an AED, the rhythms detected were:

- 14 shockable rhythms (ventricular tachycardia (VT), or ventricular fibrillation (VF))
- 1 non-shockable rhythm.

Mean patient age was 53.3 ± 15.4 years, and 80% were male. Thirteen patients had ischemic heart disease. In all cases of ventricular fibrillation, the device indicated and delivered defibrillation following the device's automatic algorithm.

Regarding subsequent outcomes, survival was confirmed in 7 patients. In 7 additional cases, it was not possible to obtain hospital information after transfer, so the final outcome could not be determined. (Figure 1)

The time recorded until the first shock was less than 4 minutes in all cases and less than 2 minutes in 40%. (Figure 2) Subsequent hospital diagnoses primarily included ischemic heart disease and channelopathies. All initial interventions were performed by trained non-medical personnel.

DISCUSSION

This study describes the experience of a cardioprotection program implemented in the Buenos Aires subway system, based on the availability of AEDs and staff training on their use.

More than half of the system's activations resulted in the effective use of the AEDs suggesting that trained personnel was able to recognize situations potentially consistent with cardiac arrest and activate the corresponding protocol. All events were managed by non-medical personnel trained through brief but systematic training programs. This had a direct impact on patient survival. (3)

Another notable finding was the high incidence of

Table 1. Patients treated with AED in the CABA subway system. Source: SAME intervention reports

Patient	Gender	Age (years)	Type of arrhythmia recorded	Number of shocks	Hospital diagnosis
1	Female	31	Ventricular fibrillation	1	Brugada syndrome
2	Male	58	Ventricular fibrillation	2	Ischemic heart disease
3	Male	66	Ventricular tachycardia and ventricular fibrillation	1	Ischemic heart disease
4	Male	24	Ventricular tachycardia and ventricular fibrillation	1	Long QT syndrome
5	Male	71	Ventricular fibrillation	3	Ischemic heart disease
6	Male	58	Ventricular tachycardia and ventricular fibrillation	2	Heart failure Ischemic heart disease
7	Female	63	Ventricular fibrillation	2	Ischemic heart disease
8	Male	44	Ventricular fibrillation	2	Ischemic heart disease
9	Male	80	Ventricular fibrillation	2	Ischemic heart disease with pacemaker
10	Male	47	Ventricular fibrillation	1	Ischemic heart disease and drug abuse
11	Female	47	Ventricular fibrillation	1	Multivessel ischemic heart disease
12	Male	39	Ventricular fibrillation	2	Ischemic heart disease and drug abuse
13	Male	57	Ventricular fibrillation	2	Multivessel ischemic heart disease with new PCR and pacemaker implantation
14	Male	46	Ventricular tachycardia	3	Ischemic heart disease
15	Male	68	Ventricular fibrillation	1	Ischemic heart disease

Fig. 1. Results of the cardiac protection program in the Buenos Aires subway system between 2018 and 2024

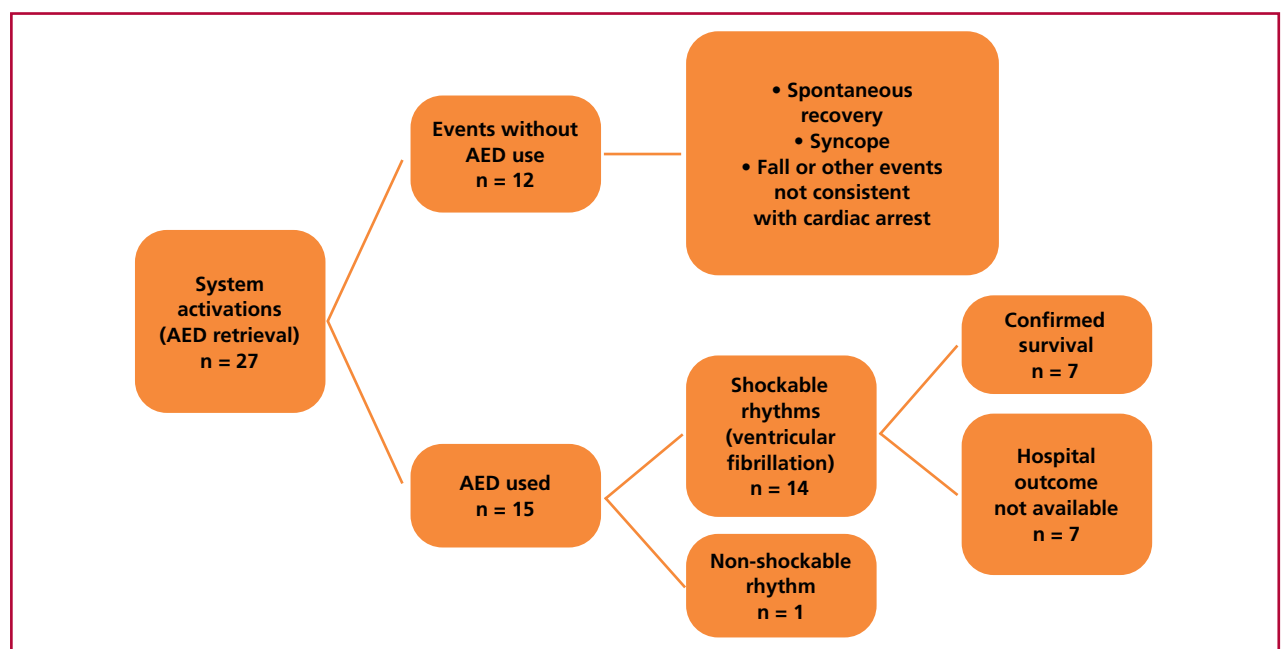
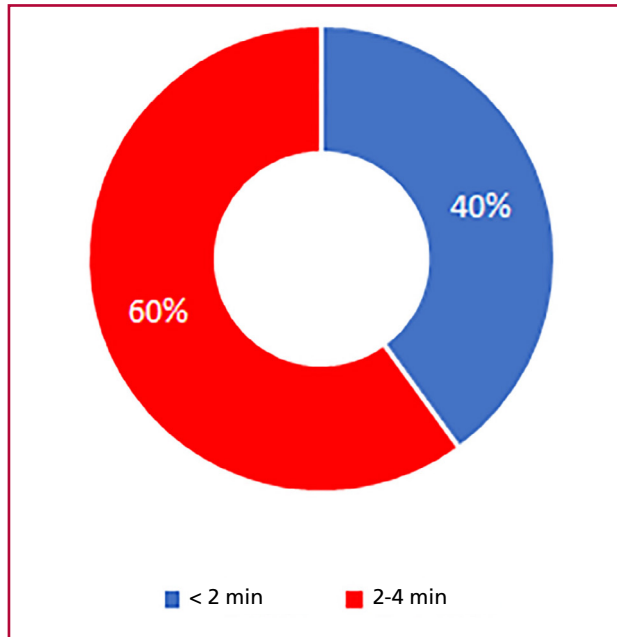


Fig. 2. Time interval from the onset of a sudden death event to the first shock delivered by the AED



Source: SAME intervention reports. Period: 2018–2024

Public defibrillation programs have shown favorable results in various high-traffic settings. (Table 2). At Chicago’s O’Hare Airport, one of the first structured public access defibrillator programs, a 56% survival rate was reported among patients treated with an AED following witnessed cardiac arrest. (6)

Similarly, the Public Access Defibrillation Trial demonstrated that the availability of defibrillators in public spaces significantly increases survival rates compared with programs based solely on cardiopulmonary resuscitation. (7)

Furthermore, the Japanese experience in train stations has shown that survival rates can reach nearly 50% when the time to intervention is reduced to less than 3 minutes. In our case, the time recorded until the first shock was less than 4 minutes in all cases, and less than 2 minutes in 40% of cases. (9,10)

The experience observed in the Buenos Aires subway system aligns with this approach of public defibrillation strategies implemented in urban settings with high foot traffic.

Limitations

This study has several limitations.

The sample size is relatively small, and the analy-

Table 2. Comparison between international public defibrillation programs and the experience of the cardiac protection program implemented in the Buenos Aires subway system

Study	Setting	Cases analyzed	Shockable rhythms	Reported survival
Caffrey SL et al., NEJM 2002 (6)	O’Hare Airport, Chicago	21	Predominance of ventricular fibrillation	56%
Hallstrom AP et al., NEJM 2004 (Public Access Defibrillation Trial) (7)	Public spaces in the U.S.	235	Prevalence of ventricular fibrillation	Higher survival rate than CPR alone
Weisfeldt ML et al., Circulation 2011 (8)	U.S. OHCA Registry	>10 000	Variable	Better in shockable rhythms
Present study	Buenos Aires Subway	27 shocks	14 cases of ventricular fibrillation	Partial hospital follow-up

CPR: cardiopulmonary resuscitation

sudden cardiac death in men under 60 years of age. This pattern is consistent with regional data describing a higher prevalence of premature ischemic heart disease in Latin America, likely linked to a higher burden of poorly controlled classical risk factors. (4)

Moreover, a significant proportion of activations ultimately did not require the use of the device. This is consistent with international registries of public defibrillation programs, where situations such as syncope or transient loss of consciousness can initially mimic a cardiac arrest. (5)

sis is limited to describing activations and device use.

In addition, complete hospital follow-up is not available for all patients, which prevents an accurate assessment of post-event clinical outcomes.

It was not possible to analyze neurological outcomes following cardiac arrest.

Finally, the period analyzed included the time corresponding to the COVID-19 pandemic, during which the use of public transportation experienced a marked reduction. During 2020, the number of subway passengers decreased significantly due to traffic restric-

tions and limited use of the system by essential workers, with a gradual recovery during 2021.

CONCLUSION

The implementation of a cardiac protection program in the Buenos Aires City subway system enabled registering multiple activations of the response system and the effective use of AEDs in a high-traffic public transportation setting.

These findings reinforce the importance of AED availability and staff training in public spaces as part of early response strategies for out-of-hospital cardiac arrest.

Such programs could be replicated in other urban transit systems in Latin America.

Conflicts of interest

None declared.

(See authors' conflict of interests forms on the web).

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Spontaneous Coronary Artery Dissection: What Have We Learned and Where Are We Headed?

Diseción coronaria espontánea: ¿qué hemos aprendido y hacia dónde vamos?

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ABSTRACT

Spontaneous coronary artery dissection (SCAD) is a trigger for acute myocardial infarction (AMI), mainly in young or perimenopausal women with minimal or no cardiovascular risk factors. Diagnosis is complex. In 2022, the first multicenter registry of SCAD with long-term follow-up was published, but there are no documents or consensus statements based on real-world data in Latin America. Therefore, there is an urgent need to conduct an in-depth review of the literature to begin generating findings that can explain the behavior of the disease. This review addresses these objectives.

Key words: Spontaneous coronary dissection - Acute myocardial infarction in young adults - Fibromuscular dysplasia - Epidemiology.

RESUMEN

La diseción coronaria espontánea (DCE) es un desencadenante de infarto agudo de miocardio (IAM) principalmente en mujeres jóvenes o perimenopáusicas con mínimos o nulos factores de riesgo cardiovascular. El diagnóstico es complejo. En 2022 se publicó el primer registro multicéntrico de DCE con seguimiento a largo plazo. No existe ningún documento ni consenso basado en datos reales en Latinoamérica, por lo que la necesidad de realizar una revisión profunda de la literatura para empezar a generar resultados que permitan explicar el comportamiento de la enfermedad es preteroria. A estos objetivos responde la presente revisión.

Palabras clave: Diseción coronaria espontánea - Infarto agudo de miocardio en jóvenes - Displasia fibromuscular - Epidemiología.

INTRODUCTION

Spontaneous coronary artery dissection (SCAD) is a trigger for acute myocardial infarction (AMI), mainly in young or perimenopausal women with few or no risk factors for cardiovascular disease, and it accounts for up to one-third of AMIs in this population. (1,2)

SCAD is caused by bleeding from the vasa vasorum or a tear in the intima, which creates a false lumen that occludes the true lumen, compromising distal blood flow. Diagnosis is complex, requires experience and a high clinical index of suspicion, and is key to guiding definitive management. (3–6)

The information available up to 2022 was based on case reports, retrospective series, and position state-

ments from developed countries; however, on that year the first multicenter SCAD registry with long-term follow-up was published, enabling the characterization of many poorly understood aspects of the disease. (4,7)

Objectives

There is no document or consensus statement based on real-world data from Latin America regarding the incidence and course of SCAD. This highlights the need to address the issue, conduct an in-depth review of the literature, and generate findings that can explain the behavior of the disease, which has never been characterized in our region. This is the aim of the present review.

REV ARGENT CARDIOL 2025;93:216-223. <https://doi.org/10.7775/rac.v94.i3.21015>

Received: 08/07/2025 – Accepted: 11/14/2025

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METHODS

A systematic review of the literature was conducted by selecting the most important studies related to this condition. The search was performed in PubMed, SciELO, and Google Scholar using the keywords “Spontaneous coronary artery dissection,” “SCAD,” “Diseccción coronaria espontánea,” and “Diseccción coronaria espontánea y displasia fibromuscular.”

Given the complexity of the disease and the scarcity of large-scale studies, we selected the largest registries, reviews, and the most comprehensive case reports in English and Spanish published over the past 20 years.

RESULTS

Definition, history, and epidemiology of the disease

SCAD is defined as the acute separation of the epicardial coronary arteries' layers, unrelated to trauma, iatrogenic causes, or atherosclerotic disease. (1,2)

The first description was provided by Pretty in 1931 during the autopsy of a 42-year-old woman who had died of sudden death. A link was therefore established between SCAD, ischemic heart disease, and sudden death in young women. (3)

SCAD has emerged as an increasingly common cause of acute coronary syndrome (ACS) and sudden death, including cases related to ventricular arrhythmias in young or middle-aged patients without a high burden of atherosclerotic disease. (1–3)

It has been nearly a century since the first description of findings related to the disease. However, it is in the last decade that more knowledge has been generated, due to a greater number of publications and position statements from various scientific societies aimed at developing better clinical and therapeutic approaches. (4–6) In 2022, Saw et al. published the first multicenter SCAD registry in Canada, involving 750 adult patients followed over a 4-year period, characterizing poorly understood aspects of the disease, such as those related with treatment, recurrence, and mortality. (4)

SCAD affects both sexes throughout their lives; it is more common in Caucasian individuals and women, with a peak incidence between 45 and 53 years of age. (1,3,6) It accounts for 0.07% to 0.2% of all coronary angiographies performed for any reason and 2% to 4% in the context of an ACS. (7,8) Its prevalence is 1.7% to 4% of all ACS cases. When considering gender and age, Canadian, French, Spanish, and New Zealand registries show that SCAD accounts for 24% to 36% of ACS cases in perimenopausal women. (4,8,9,10)

Regarding AMI during pregnancy, it is known to occur on average in 1 out of every 16 000 pregnancies, and SCAD accounts for up to 50% of these events, particularly in the postpartum period. (11)

There is no established monogenic cause, so there are no recommendations for conducting family genetic screening following a SCAD episode. However, due to the direct link with fibromuscular dysplasia (FMD),

it is considered good practice to screen for SCAD first-degree relatives with FMD. (3)

The prevalence in men is very low, and it appears that the disease has no emotional trigger and is not related to FMD, but rather to physical stress, as the few reports are based on extreme sports and young soldiers. (3,12)

One-year mortality is 2%, and at 3 years it is estimated to be close to 1%, with a 3-year recurrence rate of AMI of approximately 18%. (1,13)

Pathophysiology and etiopathogenesis

There are two pathophysiological theories that converge on a similar point: the formation of a hematoma that compresses the true lumen and causes myocardial ischemia. The first is the spontaneous appearance of an intimal dissection flap (“outside-in” theory), and the second is hemorrhage within the media or the vasa vasorum (“inside-out” theory), in which there is no endothelial rupture. The latter theory has received greater clinical validation and support from optical coherence tomography (OCT). (14)

Pathological findings reveal periadventitial inflammatory infiltration, in contrast to what occurs in collagen diseases, where the adventitia is spared and there is necrosis of the arterial media. (3)

The etiology of the disease is multifactorial. Genetic, hormonal, hereditary, and acquired factors, as well as systemic diseases are involved, which in the presence of precipitating factors appear to promote SCAD development.

Some possible associations are discussed below. (3,14)

a) **Fibromuscular dysplasia (FMD):** This is an arterial disease strongly associated with SCAD. Some reports associate them in 11–86% of all cases, depending on the diagnostic method used. In the French DISCO registry—the largest European multicenter cohort to date—373 patients were enrolled, and the coexistence of SCAD and FMD was documented in 45% of all included patients. Furthermore, the association between SCAD and non-coronary arterial involvement due to FMD is commonly reported in the literature, renal and carotid arteries being the most frequently affected. (9)

FMD causes involvement of the arterial walls through a non-atherosclerotic and non-inflammatory mechanism similar to SCAD, primarily affecting women in their fifties with few cardiovascular risk factors. (3,6)

The main characteristic of the affected vessels is concentric or tubular narrowing. The disease can be unifocal or multifocal, and unilateral or bilateral. The most common and severe form of presentation is the multifocal type, which is characterized by areas of stenosis and dilation or a beaded pattern. Complications range between stenosis, dissection and arterial aneurysms affecting the cervical, renal, and visceral arteries. (3,6)

b) **Female gender, pregnancy, and menopause:** The prevalence of the disease in women, between the end of the fourth decade of life and the beginning of the fifth, supports the hormonal hypothesis. (3)

Canadian studies report a prevalence of pregnancy-associated SCAD of approximately 1.81 cases per 100 000 people. Peripartum involvement accounts for 10% to 15% of all SCAD cases with an apparent poorer prognosis, since it presents as ST-segment elevation ACS with greater involvement of the left main coronary artery or proximal multivessel disease, which is associated with more extensive infarcts and a greater degree of ventricular dysfunction. (4,11) Pregnant women with SCAD are typically multiparous and older at the time of delivery; however, there are some case reports of SCAD occurring years after delivery. (3,14)

It is hypothesized that hormonal changes in coronary estrogen and progesterone receptors alter vascular architecture and induce conformational changes that predispose to SCAD. (13)

Among the triggering factors, the first pregnancy appears to be a trigger for the development of the disease in subsequent pregnancies. Other factors reported with a weaker association include preeclampsia, advanced maternal age, Black race, hypertension, dyslipidemia, depression, the Valsalva maneuver, nausea, and migraine. (11,13)

c) **Inflammatory conditions:** There are few associations with specific inflammatory diseases due to vasculitis per se. (13)

d) **Inheritance and genetics:** A mutation in the genes encoding the formation of the extracellular matrix of fibrillar collagen predisposes individuals to weakness of the arterial walls. (15,16) SCAD has been linked to more than 7 genes. Some related syndromes include Ehlers-Danlos (COL3A1 mutation), Marfan (FBN1 mutation), and Loeys-Dietz (TGFBR1, TGFBR2, and TGFBR3 transforming growth factor mutations). The DISCO registry found a direct association with the locus for DFM, known as PHACTR 1. (9)

Diagnosis

The characteristic presentation of SCAD is AMI in a woman with few or no cardiovascular risk factors. Chest pain is the initial symptom (85–96% of cases), with typical radiation and accompanied by dyspnea, diaphoresis, elevated biomarkers, and even abnormalities in left ventricular motility and ejection fraction. At first glance, therefore, the clinical picture is indistinguishable from that of an atherosclerotic event, stress cardiomyopathy, or a myocardial infarction without epicardial obstructive lesions. (3,6,7)

Among the most common electrocardiographic findings, ST-segment elevation typically occurs in 20% to 50% of cases, and ventricular arrhythmias are present in 3–7% of cases. (1,3)

Clinical suspicion is based on the patient's characteristics (age, sex and absence of cardiovascular risk

factors). Coronary angiography is the first-line diagnostic test due to its availability. Its major limitation is that it allows for only two-dimensional evaluation, precluding a complete characterization of the arterial walls. Therefore, in light of current evidence, the use of methods that better characterize the arterial walls, the true and false lumen, hematoma, and vessel tear is recommended, including intravascular ultrasound (IVUS) and OCT. (3,4,6)

The complexity of the modern methods described above lies in their availability, high cost, the risk of intimal tear, and lack of trained operators, which leads to a risk of complications affecting up to 8% of patients diagnosed or treated using these methods.

IVUS has been available for more than 20 years. It has a spatial resolution of 150 μm and allows for the characterization of intimal tears, false lumen, and intraluminal thrombi. OCT has revolutionized the diagnosis of SCAD since 2008. It has a spatial resolution of 10 to 20 μm , is superior to IVUS in delineating the lumen-intima interface, and is suitable for visualizing intimal tears, stenosis, intramural hematomas, and false lumen. (1,3,6)

Angiographically, SCAD presents with moderate lesions in the middle or distal third with TIMI 3 distal flow. (14) The most commonly affected vessel is the anterior descending artery (32–46% of cases), followed by the circumflex artery (15–45%) and the right coronary artery (10–39%). Multivessel involvement has been reported in 9% to 23% of the remaining cases. (3) In an analysis of 132 patients with left main coronary artery dissection published by Morosato et al., 95% of cases presented as an ACS, and 36% occurred during pregnancy; in turn, 22% of cases progressed to cardiogenic shock and 8% with ventricular arrhythmias. (17)

Other characteristics that, in the absence of dissection, could increase diagnostic yield include coronary tortuosity, the presence of FMD, and scarring in the affected vessel. (6)

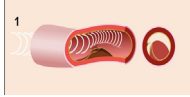

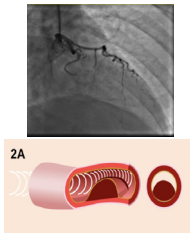
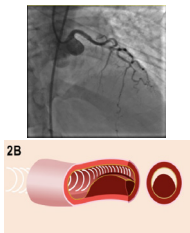
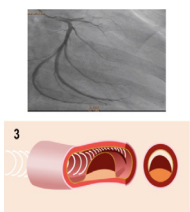
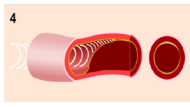
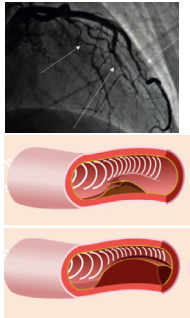
Angiographic Classification

The angiographic description of SCAD was developed by Saw et al. in 2014 and initially comprises three types. Since up to 25% of patients may present with dissections at more than one site, we suggest expanding the classification to include a fourth and fifth type, which complement the diagnosis of the disease and are currently undergoing validation. (5,18,19) (Figure 1)

Type 1: It is characterized by a typical dissection sheet, evidenced by multiple radiolucent spaces (due to intimal tear) with contrast retention or delayed passage. (6,18)

Type 2: It occurs in 60% to 75% of cases and is characterized by the absence of intimal tear. Diffuse narrowing is observed due to the intramural hematoma, which causes variable obstruction, with an acute change in vessel caliber, which may or may not return

Fig. 1. Angiographic classification

Saw's SCAD angiographic classification		
Type	Image	Finding
Type 1		Typical dissection sheet, with multiple radiolucent spaces due to intimal tear, with delayed contrast flow through the tear. (1,3,7)
Type 2		Absence of intimal tear. Diffuse narrowing due to an intramural hematoma causing variable obstruction, with an acute change in vessel caliber that may or may not return to its initial shape. Lesions measure an average of 20 millimeters. This type is subdivided into 2 subtypes. (2,3,7,8)
Type 2A		Long lesion, larger than 20 mm, that narrows at the point of dissection but returns to its original diameter at the end. (7)
Type 2B		Long lesion, larger than 20 mm, that narrows at the site of dissection but does not return to its original diameter at the end. (4,7)
Type 3		This is the least common lesion and the most difficult to diagnose. It is suggestive of atherosclerotic disease due to a ruptured, long (11 to 20 mm) plaque in a single vessel, while the other vessels are characterized by tortuosity. It requires IVUS or OCT to confirm the presence of an intramural hematoma. (3,7)
Type 4		Total vessel occlusion, with an image resembling a flute's peak. Difficult to characterize due to preserved vessel architecture before and after the lesion, with no atherothrombotic findings. (1,3,5,7)
Type 5		Multiple coronary territories dissected in parallel, with or without coexisting SCAD types. (5)

to its initial form. The lesions are typically long and measure an average of 20 millimeters. They are subdivided into two types, and the intramural hematoma can be characterized using OCT. (6,17)

Type 2a: A long lesion, larger than 20 mm, that narrows at the site of dissection but returns to its original diameter at the end. (6,18)

Type 2b: A long lesion, larger than 20 mm, that narrows at the site of dissection but does not return to its original diameter at the end. (6,18)

Type 3: This is the least common and most difficult to diagnose of all SCAD types. The image is suggestive of atherosclerotic disease in a single vessel and is characterized by tortuous vessels elsewhere. Lesions are typically extensive (11 to 20 mm). It cannot be distinguished from a ruptured plaque, except through intravascular imaging that characterizes the compressive intramural hematoma. (6,18)

Type 4: It presents with total vessel occlusion, with a “flute peak” appearance. It is difficult to characterize because the vessel architecture is preserved both before and after the lesion, with no atherothrombotic findings. The definitive treatment is percutaneous. (5)

Type 5: Multiple coronary territories are dissected in parallel, with or without coexisting types of SCAD. Definitive treatment must be interventional. (5)

Treatment

Based on the only prospective, multicenter study available to date, the recommendation is to analyze each case individually, aiming to choose conservative treatment over interventional treatment. (4) However, given the high risk of recurrence, some authors suggest invasive management from the outset. (17, 20) (Table 1 and management algorithm in Figure 2).

Conservative Treatment

The primary objectives are angina management, prevention of chronic pain and recurrence, and extracardiac vascular anomalies' screening. Patients with impaired left ventricular systolic function should receive standardized treatment for this condition. Some observational data from angiography suggest that the majority (73–97%) of patients show improvement in scar formation at the site of the dissections after weeks or months. (7,13,14,21)

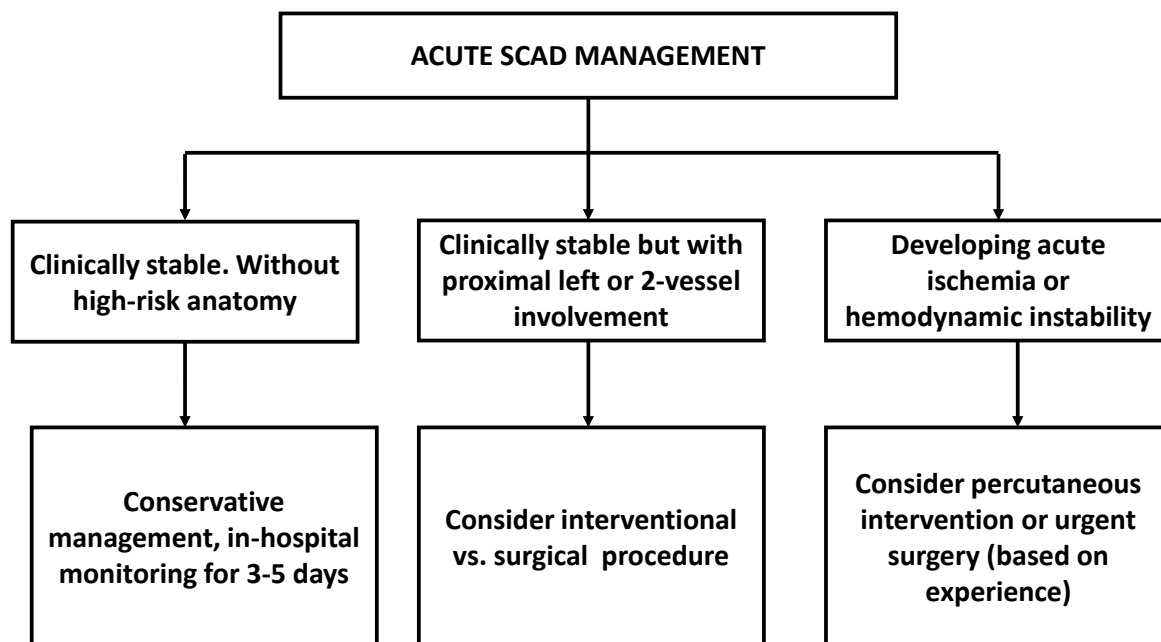
In high-risk cases—characterized by persistent pain, extensive and proximal dissection of a vessel, multivessel involvement, poor distal flow, shock, or ventricular arrhythmias—revascularization via percutaneous intervention or coronary artery bypass grafting is recommended, depending on the experience of each center. Due to the pathophysiology of the disease, fibrinolysis is contraindicated. (3,13,14)

Table 1. Recommended Treatment for Spontaneous Coronary Dissection

Treatment	Recommended treatment for SCAD	
	Recommendation	Indication
Beta-blockers	+	Independent of LVEF. They reduce up to 64% the risk of recurrence. Their use is contraindicated during pregnancy. (1,9)
ACEI	-	Recommended in conjunction with a decrease in LVEF. Anti-remodeling effect. (1,7)
ARA II	-	Recommended in cases of ACEI intolerance and in conjunction with a decrease in LVEF: anti-remodeling effect. (1,7)
Aspirin	+/-	In cases of PCI: 3 months to 1 year of DAPT. (1,7)
P2Y12	+/-	In cases of PCI: 3 months to 1 year of DAPT o (P2Y12 inhibitors?). (1,7)
Anticoagulation	-	Initial treatment for ACS. Once SCAD is confirmed, anticoagulation should be discontinued due to the pathophysiological mechanism and the potential spread of the hematoma. (1,7)
Statins	-	Not recommended. (1,7)
Antianginal agents	+	Their use should be recommended: 20% of patients experience persistent pain. (1,7)
Fibrinolysis	-	Contraindicated: increases the risk of dissection.
PCI	+/-	Complex or refractory cases. Indicated for active ischemia and type 4–5 dissection. Risk of enlarging the dissection and stent migration.
CABG	+/-	Multivessel disease or left main coronary artery disease. Failed PCI or medical therapy.

ACEI: Angiotensin-converting enzyme inhibitors; ACS: Acute coronary syndrome; ARA II: Angiotensin II receptor antagonist; CABG: Coronary artery bypass grafting; DAPT: Dual antiplatelet therapy; LVEF: Left ventricular ejection fraction; PCI: Percutaneous coronary intervention.

Fig. 2. SCAD management algorithm



Source: Adapted and modified from: Hayes S, et al. Spontaneous coronary artery dissection: Current state of the science: A scientific statement from the American Heart Association. *Circulation*. 2018; 137:e523-e557

Pregnancy and lactation are periods associated with an increased risk of toxicity transmission; therefore, the risk of mother-to-fetus transmission must be considered in any treatment.

Expert opinions suggest:

Beta-blockers: They reduce wall stress and SCAD recurrence. This conclusion is based on an observational study of 327 patients, in which 64% of cases who used beta-blockers had a lower incidence of recurrence. (21) A meta-analysis on recurrence published in 2022 by Chi et al. confirmed the reduced risk of recurrence with beta-blockers (RR 0.51; 95% CI 0.33–0.77; $p < 0.001$). Their use is limited in pregnant women due to fetal bradycardia and intrauterine growth restriction. (22)

Antiplatelet therapy: Most patients are discharged on at least one antiplatelet agent. Regarding dual antiplatelet therapy, its continuation is recommended for a period ranging from one month to one year following a percutaneous coronary intervention. Beyond that, there is lack of scientific support. The evidence regarding the use of clopidogrel in pregnant women is unclear. (3,6)

Antianginal therapy: Pain following a dissection is common and accounts for approximately 20% of hospital admissions within 30 days after SCAD; it may even become chronic, so the use of antianginal therapy may be considered. (1)

Invasive treatment

Percutaneous coronary intervention (PCI) poses a significant challenge due to the risk of invading the false lumen and enlarging the dissection. The success rate varies among different cohort studies, ranging from 47% to 72%. With regard to the anatomical characteristics or the affected territory at the time of intervention, proximal dissections of one or multiple vessels are taken into account, particularly those of the anterior descending artery or the left main coronary artery. If adequate TIMI 2–3 flow is maintained, even in the presence of significant occlusion, medical management is recommended due to the risk of hematoma resorption and subsequent stent migration. (1,6,14)

Coronary artery bypass grafting (CABG) is successful in the short term in most cases. It is rarely performed (1% of cases) and is reserved for cases of treatment failure with medical and percutaneous therapies. (6,14,20)

In the aforementioned report by Morosato et al., when treatment options were discussed, it was clarified that CABG was performed in 21% of cases, which reduced mortality compared with medical treatment alone; this allowed for the hypothesis that the intervention (PCI-CABG) in this group of patients is associated with a lower incidence of adverse events. (17)

The incidence of recurrent in-hospital myocardial infarction is 5% to 10%, and the risk of extension of

the same dissection is 17% during the first 2 weeks; half of these cases occur within 48 hours after discharge, so a minimum hospital stay of 5 days is recommended. (3,13)

Rehabilitation and Physical Activity

Available data show low adherence to cardiovascular rehabilitation. The evidence clearly demonstrates the benefits of rehabilitation and the safety of the process. It is recommended to follow the Vancouver General Hospital program for SCAD, based on exercise testing with blood pressure targets not exceeding 130/80 mmHg and a heart rate between 50% and 70% of the age-adjusted maximum. (3)

Special Considerations

Pregnancy-associated SCAD: Most events occur during the first 4 to 5 weeks postpartum. However, the disease can manifest at any stage of pregnancy, with reports even during the lactation period. (11,23) Most events present as ST-segment elevation ACS involving the left anterior descending artery, with higher morbidity and mortality than in the non-pregnant group. Recommendations regarding invasive diagnosis and treatment are similar to those for the non-pregnant group. (3,11,14,24)

Psychosocial considerations: Patients with SCAD present higher scores on distress, anxiety, and depression assessments, reduced physical capacity and greater emotional dependence. (3)

Assessment and management of chest pain following SCAD: Experience indicates that chest pain following SCAD is common and may occur in up to 50% of registered patients, becoming a problem in the emergency department. (3,6,14) The general approach is the same as for the first SCAD episode and indistinguishable from that for an atherosclerotic event. It is recommended that patients with persistent symptoms that are refractory to optimal medical treatment undergo further evaluation. (3)

Prognosis and Recurrence

The prognosis for this disease is favorable. Two forms of recurrence have been described: the first involves extension of the dissection due to acute expansion of the intramural hematoma; the second involves a new dissection in an artery other than the one previously affected, occurring more than 30 days after the initial event. The latter is the most widely accepted. Recurrence rates vary depending on study design, population scope, the definition of recurrence, and the final treatment provided. They range from approximately 5% at 22 months, 15% at 27 months, and 30% at 10 years. (25)

A meta-analysis that included 14 studies with 4206 SCAD patients analyzed risk factors associated with recurrence. The findings most strongly associated with recurrence were vascular anomalies, such

as FMD (RR 2.02; 95% CI 1.03–3.94; $p = 0.04$) and hypertension (RR 1.49; 95% CI 1.05–2.12; $p = 0.02$). (26) Another notable characteristic of recurrence is that it appears to occur most often within the first week following the primary event, and it is more frequent in groups that received medical treatment than in those who underwent intervention. (26) There is no strong evidence to suggest that pregnancy is a clear predisposing factor for recurrence, as the limited available evidence comes from a small case series. (11)

Gaps in the Approach to the Disease

Many aspects of the disease remain unclear, ranging from predisposing factors to genetic and microvascular associations related to arterial collagen formation, as seen in FMD; moreover, the hormonal effects on the arterial wall and the spontaneous formation of intramural hematomas have not been fully elucidated. There is a significant gap in knowledge on the role of noninvasive diagnosis using coronary angiography and regarding treatment, the duration of beta-blocker use, single- or dual antiplatelet therapy as well as the management of psychosocial conditions that perpetuate the risk of disease recurrence remain undefined. (27) All of these factors provide sufficient reason to continue the search for new information based on local data, in order to gain a full understanding of the disease behavior and offer better treatment.

CONCLUSION

SCAD is a major cause of ACS in young people, particularly in perimenopausal women with few cardiovascular comorbidities. To date, no large randomized trials are available to evaluate all aspects related to the disease. However, large cohorts from industrialized countries provide insights into the possible etiology and pathogenesis, as well as diagnostic and therapeutic approaches. Clinical suspicion continues to play a fundamental role in ensuring an appropriate initial approach, with the aim of providing timely diagnosis and treatment.

Conflicts of interest

None declared.

(See authors' conflict of interests forms on the web/Additional material).

Funding

None.

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Discordant Test Findings: False Positives or a New Paradigm in Ischemic Heart Disease?

Estudios discordantes, ¿falso positivo o nuevo paradigma de la cardiopatía isquémica?

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The discrepancy between the results of a treadmill exercise test (TET) and those of myocardial perfusion imaging poses a complex scenario. Although a “normal” SPECT (single-photon emission computed tomography) result suggests the absence of obstructive coronary artery disease, it does not necessarily ensure normal coronary circulation. Various macrovascular and/or microvascular conditions limit the increase in myocardial blood flow during exercise, without evidence of localized perfusion defects.

Treadmill exercise test is highly available, low-cost, noninvasive and commonly used for the early detection of coronary artery disease in asymptomatic patients (with a sensitivity of 68% and specificity of 76%) or to assess functional capacity and/or chronotropic response in various clinical settings. A TET is considered positive in the presence of a horizontal or downsloping ST-segment depression of at least 1 mm and/or the presence of angina or angina-like symptoms.

Rest-stress SPECT myocardial perfusion imaging (MPI) enhances the standard TET by providing tomographic images. It provides not only information on the presence or absence of perfusion abnormalities in arterial territories but also allows assessment of left ventricular ejection fraction (LVEF) and volumes during both phases of the test. The combination of both tests significantly increases the likelihood of detecting ischemic heart disease, with a sensitivity of 82% and a specificity of 77%.

Homogeneous MPI with normal ventricular volumes and LVEF has high negative predictive value—a low probability of presenting cardiovascular events. However, when the results of both methods are discordant (positive TET with “normal” MPI), the prognostic implications are unknown, and the therapeutic strategy is not clearly defined. (1)

We present two clinical cases with discordant findings.

CASE 1

A 56-year-old male patient underwent a TET as part of the workup for a health certificate. The patient was an athlete with a history of hypertension under medical treatment and was currently asymptomatic. The TET was positive for ST-segment depression. Myocardial perfusion imaging with rest/stress SPECT was performed. The TET (Figure 1A) was positive, demonstrating a 4-mm horizontal ST-segment depression in leads V2 through V6 at 750 kgm/min (5.1 METs), with a tension-time index (TTI) of 20 002. The patient remained asymptomatic. There were no perfusion defects (Figure 1B). However, transient LV dilation and a 17% decrease in LVEF during peak exercise were identified as high-risk criteria (Figure 1C). Coronary angiography (CA) was performed, revealing three-vessel disease with severe stenosis in the mid left anterior descending coronary artery, mid left circumflex artery and lateral marginal artery, as well as chronic total occlusion in the mid right coronary artery with heterocoronary collateral circulation (Figure 1D-F).

CASE 2

A 57-year-old male patient presented with atypical chest pain with variable functional class. He had a history of dyslipidemia that was currently being treated. During a routine cardiovascular checkup, he underwent a TET that was positive for chest pain associated with a horizontal ST-segment depression during peak exercise at 1200 kgm/min (9.6 METs) with an ITT of 35,775 (Fig. 2A). Myocardial perfusion was normal (Fig. 2B). A coronary angiography was performed, which revealed no significant coronary artery lesions (Fig. 2D and E). Therefore, noninvasive assessment

REV ARGENT CARDIOL 2026;94:224-226. <https://doi.org/10.7775/rac.v94.i3.21010>

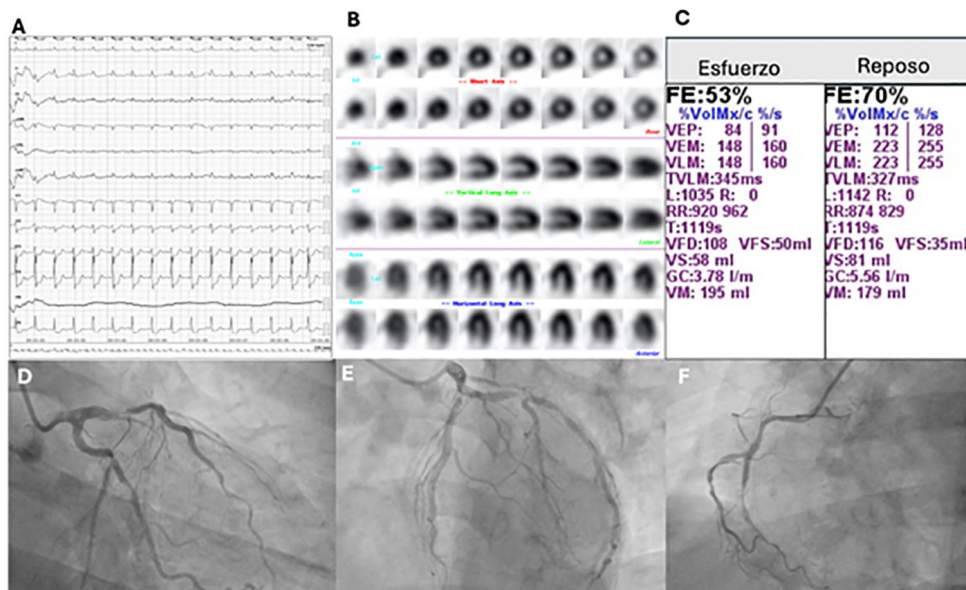
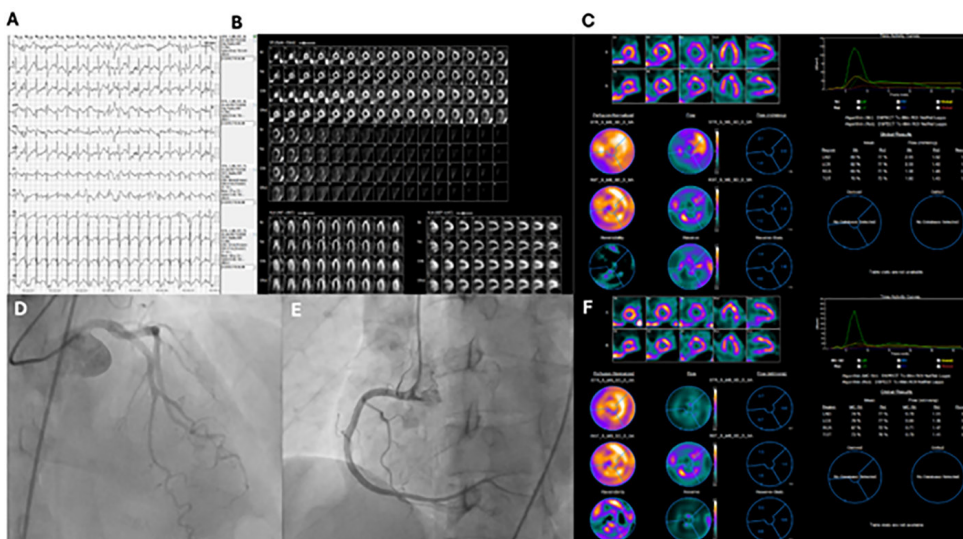
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Fig. 1. Discordant myocardial perfusion imaging in a patient with significant epicardial coronary artery disease**Fig. 2.** Discordant myocardial perfusion imaging in a patient with microvascular disease

of myocardial flow reserve (MFR) using dipyridamole and cold test was requested, resulting in MFR of 1.3 (normal value >2.0) and 0.5 (normal value >1.5), respectively (Fig. 2C and F). This result was consistent with smooth muscle-dependent and endothelium-dependent microvascular dysfunction.

All patients gave their informed consent before undergoing these tests.

Discordant tests account for 4 to 24% of perfusion imaging tests. Previously, a positive TET result in the absence of significant coronary artery disease was considered a false positive. Today, the paradigm shift

in our understanding of coronary artery disease has made us realize that epicardial circulation accounts for only 5% of the entire coronary artery tree, while the remaining 95% corresponds to microcirculation. (2)

We present two clinical cases with discordant findings, resulting from two distinctly different clinical scenarios:

In case 1, the TET was positive while the SPECT scan showed homogeneous perfusion with high-risk signs in the presence of severe multivessel obstructive coronary artery disease. In this scenario, homogeneous MPI results from balanced ischemia due to

reduced blood flow across the various coronary artery territories; thus, regional hypoperfusion cannot be observed. (3)

On the other hand, the TET was positive in case 2 with homogeneous MPI and no high-risk signs in the absence of significant obstructive coronary artery disease. In this case, an imbalance between myocardial blood flow supply and demand is due to inadequate microcirculation vasodilation; this may or may not manifest as a perfusion defect, but it can be detected by quantifying MFR. (4)

Microvascular disease occurs when smooth muscle relaxation is impaired or when there is abnormal nitric oxide release due to endothelial dysfunction. (5) In both situations the reduction in MFR is associated with higher mortality and worse prognosis, with or without obstructive coronary artery disease. (6)

Based on the discussion so far, it is clear that a discordant result does not necessarily mean a false-positive EST result (absence of myocardial ischemia). Conversely, it should raise suspicion of one of these two clinical scenarios, which must be evaluated in the context of a history of coronary artery disease, the presence or absence of symptoms, and their relationship to coronary artery anatomy. In the absence of significant stenosis, assessment of MFR should be considered.

An interpretation of MPI that incorporates the systematic assessment of each clinical and electrocardiographic finding will facilitate risk stratification and help to determine which patients should be selected for invasive tests or medical treatment.

Conflicts of interest

None declared.

(See conflicts of interest forms on the website).

Ethical considerations

Not applicable.

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Hypertrophic Cardiomyopathy: A Significant Risk Factor? A Case of Infective Endocarditis

Miocardopatía hipertrófica, ¿factor de riesgo significativo? Un caso de endocarditis infecciosa

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Infective endocarditis (IE) is a systemic disease resulting from an infection, usually bacterial, of the endocardial surface of the heart. Although it may occur in apparently healthy valves, most cases occur in patients with preexisting valvular disease, in those with prosthetic heart valves, or in patients with certain heart conditions, in whom trauma resulting from turbulent or high-pressure blood flow (associated with valvular or cardiac structural defects) together with inflammatory or hypercoagulable states, leads to the formation of fibrin-platelet thrombi, to which microorganisms may attach during episodes of bacteremia.

The microorganisms most frequently associated with IE vary depending on whether the valves are native or prosthetic and whether the patient is an intravenous drug user. In endocarditis involving native valves, Viridans group streptococci are the most common, followed by *Staphylococcus aureus* and coagulase-negative staphylococci, especially *S. epidermidis* and *S. lugdunensis*, while *Enterococcus* spp., HACEK group bacteria, and fungi, among others, are found in smaller proportions. (1)

Hypertrophic cardiomyopathy (HCM) is a structural heart disease that can cause predisposing hemodynamic abnormalities. However, it is not included among the formal indications for antibiotic prophylaxis in dental procedures according to current guidelines. Evidence regarding its true risk of IE is limited and, in some studies, contradictory. In this context, the occurrence of endocarditis caused by unusual pathogens in patients with HCM offers an opportunity to further explore the association between HCM and IE.

We present a 66-year-old female patient with multiple cardiovascular risk factors, a history of myocardial infarction treated with percutaneous coronary intervention, and HCM diagnosed in 2022. She had systolic anterior motion of the anterior mitral leaflet

and severe mitral regurgitation, for which alcohol septal ablation was performed with a limited clinical response. Other relevant medical history includes multiple urinary tract infections and dental infections.

The patient presented to the Emergency Department with intermittent precordial pain of varying intensity, peaking at 10/10, oppressive in nature, without radiation and lasting for several minutes, in a setting of fever of up to 38.5°C.

On physical examination, blood pressure was 96/69 mmHg, heart rate 90 bpm, body temperature 37.8°C, and respiratory rate 20 breaths/min. Heart sounds were normal, with a 3/6-intensity holosystolic murmur that was audible over four areas of the precordium. No other significant findings. The admission ECG showed sinus rhythm, 90 bpm, axis +60°, asymmetric T waves, and a flat ST segment.

Admission to the Coronary Care Unit was decided. Transthoracic echocardiography revealed severe septal hypertrophy, with myocardial texture abnormalities consistent with hypertrophic cardiomyopathy, inferobasal and medial hypokinesis, marked mitral annular calcification with significant left atrial dilation, and a very high dynamic gradient across the left ventricular outflow tract.

Troponin levels were positive in two measurements, so coronary cineangiography was performed, which showed patent stents with no new angiographically significant lesions.

Given the context of persistent fever, a transesophageal echocardiogram was indicated. It revealed a 2.5 x 2.8 cm mass at the free edge of the anterior mitral valve which protruded into the left ventricle during diastole and caused severe mitral regurgitation. Blood cultures were obtained and were positive for *Staphylococcus saprophyticus*. Based on these findings, the patient was diagnosed with IE according to the modified Duke criteria, and cefazolin therapy was initiated.

REV ARGENT CARDIOL 2026;94:227-229. <https://doi.org/10.7775/rac.v94.i3.21011>

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The patient developed refractory acute pulmonary edema attributed to the progression of mitral regurgitation, so valve replacement surgery was indicated.

During the surgical procedure, the mitral valve was found to have multiple vegetations, exuberant tissue proliferation, and leaflet damage. The valve annulus was difficult to identify because it was invaded by an abscess in the anterior region; therefore, the mitral valve was replaced with a size 25 mechanical prosthesis (Figures 1 and 2).

During the first 48 hours after surgery, the patient presented alternating atrial fibrillation and complete atrioventricular block that did not resolve one week after surgery; therefore, a permanent DDDR pacemaker was implanted. She showed no other significant complications, so she was discharged after completing the 6-week antibiotic therapy with cefazolin 1 g IV every 8 hours, following the last negative blood culture.

During subsequent outpatient follow-up visits, the patient has shown a favorable clinical course.

S. saprophyticus is a common bacterium of the genitourinary tract. Rectal, vaginal, and urethral colonization is associated with urinary tract infection (UTI) caused by this organism, making it the second most common pathogen in uncomplicated UTI in women. This microorganism belongs to the group of coagulase-negative staphylococci, responsible for

Fig. 1. Excised mitral valve.



Fig. 2. Purulent material obtained from a valvular abscess.



5-8% of cases of bacterial endocarditis involving native valves. However, 85% of these cases are caused by *S. epidermidis*. The clinical course of this condition typically involves high rates of valve destruction, heart failure, and death, and more than half of cases require valve replacement. IE caused by *S. saprophyticus* has been rarely reported. A study conducted in 2020 reported that, as of that date, only four cases had been published. (2,3)

There are few reported cases of IE in patients with HCM in the literature. *Streptococcus* is the predominant pathogen. The mitral valve is the most commonly affected, and the majority of cases occur in patients with outflow tract obstruction, suggesting that the length of the mitral leaflets and turbulent blood flow in the left ventricular outflow tract are factors that may erode the endocardium, making these patients susceptible to IE. (4) Complications are common, and 43% of patients underwent surgical valve replace-

ment, according to a Spanish registry including 27 hospitals. Mortality is variable but remains extremely high (between 22% and 42%, depending on the series). (5)

Although patients with HCM have an 18- to 28-fold higher risk of IE than the general population, the American Heart Association guidelines have excluded HCM from the list of cardiac conditions requiring antibiotic prophylaxis for procedures since 2007. (6)

Bacterial endocarditis caused by *Staphylococcus saprophyticus* in a native valve is an extremely rare condition. Although the association between HCM and IE has been documented, the literature is scarce and limited to case reports and small case series due to the low incidence of this condition.

This case contributes additional evidence supporting HCM as a predisposing condition for IE and highlights the need to reassess the role of antibiotic prophylaxis in patients with HCM to minimize the risk of this potentially serious disease.

Conflicts of interest

None declared.

(See conflicts of interest forms on the website).

Ethical considerations

Not applicable.

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Renovascular Hypertension: Lessons Learned from Three Clinical Cases

Hipertensión renovascular: lecciones aprendidas a partir de tres casos clínicos

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Hypertension (HTN) is the leading risk factor for cardiovascular disease and death worldwide. (1) The prevalence of secondary HTN is 10–35%, reaching up to 50% in patients with resistant HTN. Renovascular hypertension (RVH) is defined as occlusion or stenosis of the renal arteries that reduces renal perfusion pressure, leading to renal dysfunction and eventual atrophy. This process activates the renin-angiotensin-aldosterone system (RAAS) and the sympathetic nervous system, resulting in elevated blood pressure. (2) Atherosclerotic renovascular disease is estimated to be present in 14% to 40% of adults with hypertension; however, only 0.1% to 5% of cases are considered hemodynamically significant to result in RVH. (1) The prevalence of RVH is notably higher in patients with severe or resistant HTN.

Renal artery stenosis is the most common cause of renovascular disease. Other causes of secondary HTN include fibromuscular dysplasia, renal artery arteritis, renal artery dissection, extrinsic compression, and extrarenal embolism.

We present three medical records of patients with secondary HTN due to renovascular disease.

CLINICAL CASE 1

A 64-year-old female patient with a medical history of obesity, heavy smoking, and ischemic heart disease was diagnosed with HTN 10 years ago, with typical blood pressure (BP) readings of 170/70 mmHg. The patient is currently being treated with six medications at the maximum tolerated doses and has good adherence to treatment. Transthoracic echocardiography (TTE): left ventricular (LV) mass 106 g/m², left ventricular ejection fraction (LVEF) 46%. Ambulatory blood pressure monitoring (ABPM): sustained daytime and nighttime systolic HTN, non-dipper pattern. Renal artery Doppler ultrasound: renal asymmetry due to left kidney atrophy, lobulated contours, and decreased parenchymal thickness. Peak systolic velocity up to 47 cm/s. Computed tomography angiography

(CTA) of the aorta: atheromatous plaque at the origin of the left renal artery. Patent right renal artery with atheromatous plaque at the origin. Stenosis of the left common iliac artery with a diameter of 4 mm and stenosis of the ipsilateral external iliac artery. Atrophic left kidney. A stent was placed in the left iliac artery, resulting in effective control of BP and kidney function. The patient is currently being treated with losartan, bisoprolol, hydrochlorothiazide, and amlodipine.

CLINICAL CASE 2

A 78-year-old female patient with a history of tobacco use and HTN diagnosed at the age of 40, with typical blood pressure readings of 150/80 mmHg, currently being treated with four medications at the maximum tolerated doses. TTE: moderate aortic stenosis. LV mass 141 g/m². LVEF 60%. Ambulatory blood pressure monitoring (ABPM): daytime and nighttime systolic and diastolic HTN. Renal artery Doppler ultrasound: indirect signs of proximal stenosis of both renal arteries. CTA of the abdomen: ostial occlusion of the left renal artery. Atrophic left kidney. Unsuccessful angioplasty and endovascular revascularization, with post-operative stroke and death.

CLINICAL CASE 3

A 43-year-old female patient with a history of HTN diagnosed at age 40 is currently being treated with two medications at the maximum tolerated doses. Maximum systolic BP readings of 210 mmHg. TTE: LV mass 148 g/m². LVEF 60%. ABPM: nighttime HTN, increased BP upon waking. Renal artery Doppler ultrasound: increased velocities of up to 320 cm/s in the proximal third of the right renal artery. CTA of the abdomen: stenosis of the right renal artery measuring 7 mm in length, immediately distal to the origin, with a minimum diameter of 3.8 mm and a 6 mm post-stenotic dilation. The patient is currently under clinical follow-up and evaluation by vascular surgeons.

Renal artery stenosis accounts for approximately

REV ARGENT CARDIOL 2026;94:230-232. <https://doi.org/10.7775/rac.v94.i3.21012>

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90% of cases of renovascular disease, with fibromuscular dysplasia accounting for about 9%. (2)

Renovascular hypertension is rare in the general population with HTN (<1%), although its prevalence increases significantly in patients with severe HTN and manifestations of atherosclerosis, reaching up to 35%. (2) It should be particularly suspected in patients > 50 years with cardiovascular risk factors or established vascular disease.

The American Heart Association (AHA) recommends screening for renovascular disease in patients with resistant HTN, HTN of abrupt onset or worsening or increasingly difficult to control, as well as early-onset HTN. (3) It also suggests considering assessment of renal artery stenosis in situations such as onset of severe HTN in adults > 55 years, worsening kidney function after initiating renin-angiotensin system inhibitors or antagonists, severe HTN in the context of diffuse atherosclerosis, significant kidney asymmetry or unexplained atrophic kidney, episodes of decompensated heart failure with kidney dysfunction, and presence of a murmur in the lateral abdominal wall. (1)

Moderate stenosis may be asymptomatic, and its progression is often associated with the development of HTN and target organ damage. The three cases presented corresponded to secondary HTN due to atherosclerotic renovascular disease.

In cases of clinical suspicion, the diagnosis must be confirmed by imaging tests. (4) Renal angiography is the gold standard, as it allows quantification of the gradient across the stenosis. In symptomatic patients, a gradient > 20 mmHg or a distal/proximal ratio < 0.9 suggests significant stenosis. However, Doppler ultrasound of the renal arteries is usually the initial test due to its availability and low cost, with sensitivity and specificity of 85% and 92%, respectively. (3) A luminal diameter reduction \geq 60% combined with a peak systolic velocity exceeding 200-300 cm/s strongly indicates hemodynamically significant stenosis. (3) The limitations of this method include operator dependence and technical difficulties.

The usefulness of captopril renal scan and plasma renin activity measurement is limited due to their lower sensitivity and specificity compared with other methods. Therefore, they are not recommended as screening tests. Computed tomography angiography has high sensitivity and specificity (90–100%) for assessing vascular anatomy, although it does not provide direct hemodynamic information. Magnetic resonance imaging with gadolinium-based contrast agent also enables an adequate diagnosis, although stenosis severity may be overestimated.

Endovascular revascularization, which was introduced in 1978, has become the primary interventional method. (5) However, multiple clinical trials comparing revascularization and optimal medical therapy did not demonstrate a significant benefit in patients with atherosclerotic stenosis for controlling blood pressure, kidney function, or the development of cardiovascu-

lar events. Nevertheless, certain subgroups—such as those with uncontrolled HTN, progressive kidney dysfunction, or acute pulmonary edema—may derive greater benefit.

Among the most relevant trials, the DRASTIC, ASTRAL, and STAR studies showed no differences in blood pressure control between balloon angioplasty and medical therapy. The CORAL trial concluded that stenting did not significantly reduce major cardiovascular events compared with medical therapy. More recently, a retrospective study conducted in 2022 evaluated stent placement in patients with resistant HTN, kidney injury, or acute cardiorenal syndrome. The intervention produced favorable results even for patients who had been excluded from previous studies, suggesting that appropriate patient selection is a key aspect.

Regarding the previously presented cases, clinical case 1 achieved an adequate clinical and blood pressure response following stent placement, with improved kidney function. In clinical case 2, the intervention was unsuccessful, and the patient developed a fatal postoperative cerebrovascular complication. Conversely, in clinical case 3, the decision was to optimize medical treatment with adequate BP control. These scenarios reflect the heterogeneous disease progression and the need to individualize therapeutic decisions.

In asymptomatic patients or in those with adequate BP control with medical therapy, invasive revascularization is not recommended; instead, strict control of cardiovascular risk factors should be prioritized. (3) Stenting is generally reserved for stenoses > 70%, with a clear clinical correlation and presence of resistant HTN. (3, 5)

While retrospective studies suggest that revascularization may reduce the medication burden in patients with resistant HTN, controlled clinical trials show differences compared to medical therapy alone. The intervention has been reported to reach success rates of 90%, although restenosis may occur in up to 15% of cases. (6) Therefore, the indication should be based on an individualized risk-benefit assessment and a multidisciplinary approach.

Renovascular hypertension represents a significant cause of secondary HTN, particularly in patients with resistant HTN and atherosclerotic disease. This case series illustrates the variability in clinical presentation, course, and response to treatment, underscoring the importance of appropriate workup and tailored therapeutic strategies. While revascularization may be beneficial in selected patients, optimal medical treatment remains the cornerstone of management, with interventional procedures reserved for situations with a clear clinical indication and potential benefit.

Conflicts of interest

None declared.

(See conflicts of interest forms on the website).

Ethical considerations

Not applicable.

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Dual Protection with LLAMACORN and Chimney Stenting in High-Risk Valve-in-Valve Transcatheter Aortic Valve Replacement for Small Bioprostheses

Doble protección con LLAMACORN e implante de stent en chimenea en el reemplazo valvular aórtico percutáneo con la técnica valve-in-valve de alto riesgo para bioprótesis pequeñas

SANTIAGO ORDOÑEZ¹, JORGE TELLO¹, FEDERICO LIBERMAN¹, FERNANDO CURA^{1, MTSAC}.

Valve-in-valve (ViV) transcatheter aortic valve replacement (TAVR) in small surgical bioprostheses presents a double challenge: the high risk of coronary obstruction and the potential for poor hemodynamic results. Coronary obstruction remains a critical threat during ViV-TAVR, with 30-day mortality rates of approximately 41%. (1) Small rings with high-profile struts require a strategy that ensures coronary patency while optimizing the effective orifice area (EOA). (2)

We present the case of a 72-year-old female with a failing 19-mm Biocor EPIC surgical bioprosthesis. Pre-procedural multi-slice computed tomography (MSCT) revealed extreme anatomical risk, which included 1.7-mm bilateral coronary heights and virtual narrow valve-to-coronary (VTC) distances: 2.2 mm (left) and 2.4 mm (right) (Figure 1). Furthermore, a narrow 22.5-mm mean diameter of sinotubular junction (STJ) indicated a high risk of sinus sequestration (Figure 2).

Given the ultra-high risk, a dual-protection strategy was planned. First, the LLAMACORN (Leaflet Laceration with Balloon-mediated Annihilation to Prevent Coronary Obstruction with Radiofrequency Needle) technique was performed on the left coronary cusp. This modification of electrosurgical techniques allows for controlled leaflet laceration, facilitating subsequent coronary access. (3) Simultaneously, bilateral chimney stents were positioned in the left main and right coronary arteries as a second safety net.

A 23-mm Evolut Pro+ self-expanding valve was successfully implanted. Self-expanding valves have shown superior hemodynamic performance in small

bioprostheses compared to balloon-expandable valves. (4) Following deployment, bioprosthetic ring fracture was performed using a high-pressure balloon to further optimize the EOA and minimize residual gradients. (5,6)

Final angiography confirmed coronary patency (TIMI 3 flow) without the need for chimney stent expansion on the right side, while the left chimney stent was optimized. Post-procedural echocardiography showed significant hemodynamic improvement, with a 9-mmHg final mean transvalvular gradient (Figure 3).

This case demonstrates that combining leaflet modification (LLAMACORN) with chimney stenting is a feasible and synergistic strategy for ultra-high-risk ViV-TAVR. While chimney stenting provides immediate protection, LLAMACORN ensures long-term coronary access, which is particularly vital when using supra-annular self-expanding valves in narrow aortic roots.

In conclusion, the "dual protection" workflow addresses both the immediate risk of coronary obstruction and the long-term need for coronary access. This approach appears to be safe and reproducible, offering a reliable strategy for procedural success and optimal hemodynamics in patients with failing small surgical bioprostheses and extreme anatomical risk.

Conflicts of interest

None declared.

(See conflicts of interest forms on the website).

Ethical considerations

Not applicable.

REV ARGENT CARDIOL 2026;94:233-235. <https://doi.org/10.7775/rac.v94.i3.21023>

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Fig. 1. Pre-procedural MSCT Assessment of Coronary Risk. **(A)** Annulus perimeter (60.9 mm) and area (293 mm²). **(B)** VTC distances: 2.2 mm (left) and 2.4 mm (right). **(C–D)** Bilateral 1.7-mm coronary artery height.

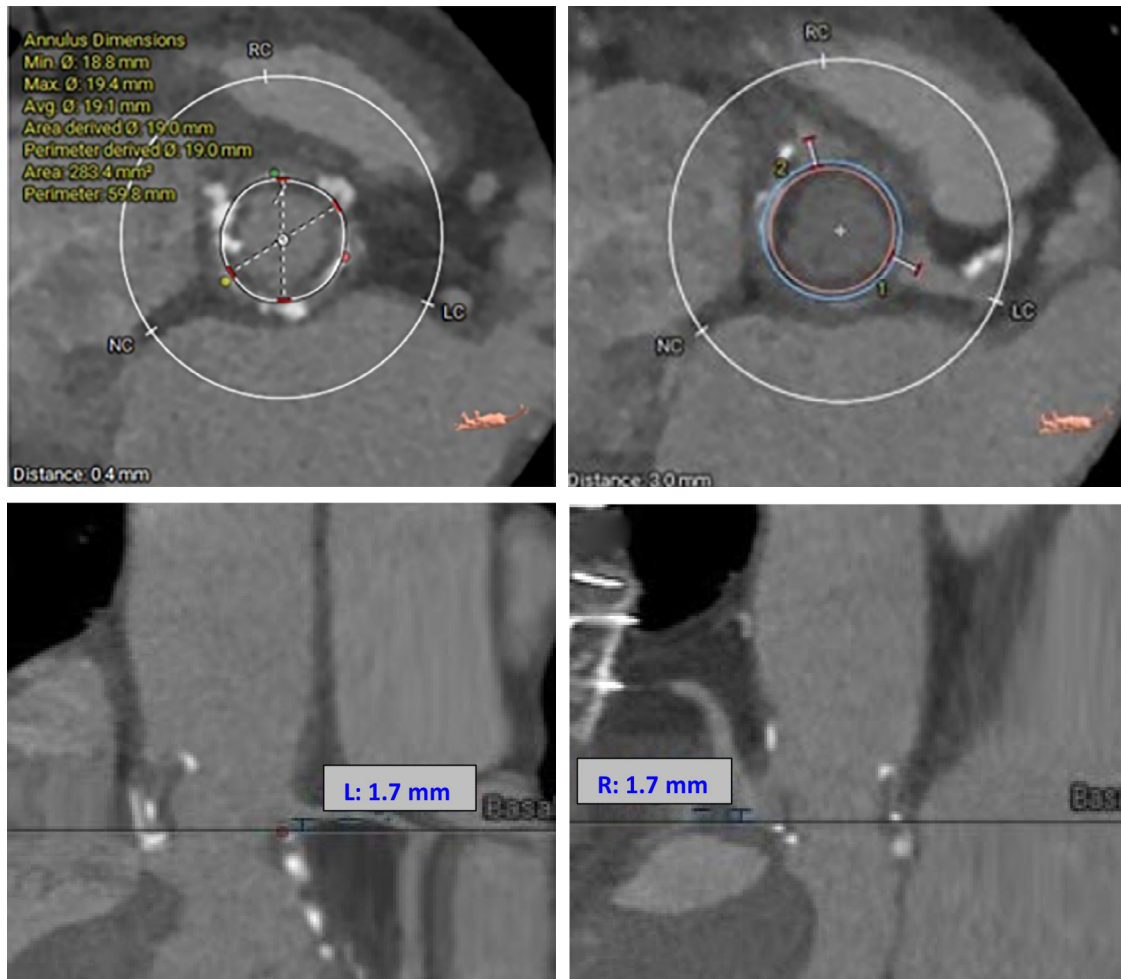


Fig. 2. MSCT Assessment of the aortic root architecture. **(A)** Measurement of the sinotubular junction (STJ) showing a narrow 22.5-mm mean diameter and a 9.2-mm height from the annulus plane. **(B)** Measurement of the ascending aorta: 23.7 mm. Note: The narrow STJ relative to the surgical ring highlights the high risk of sinus sequestration.

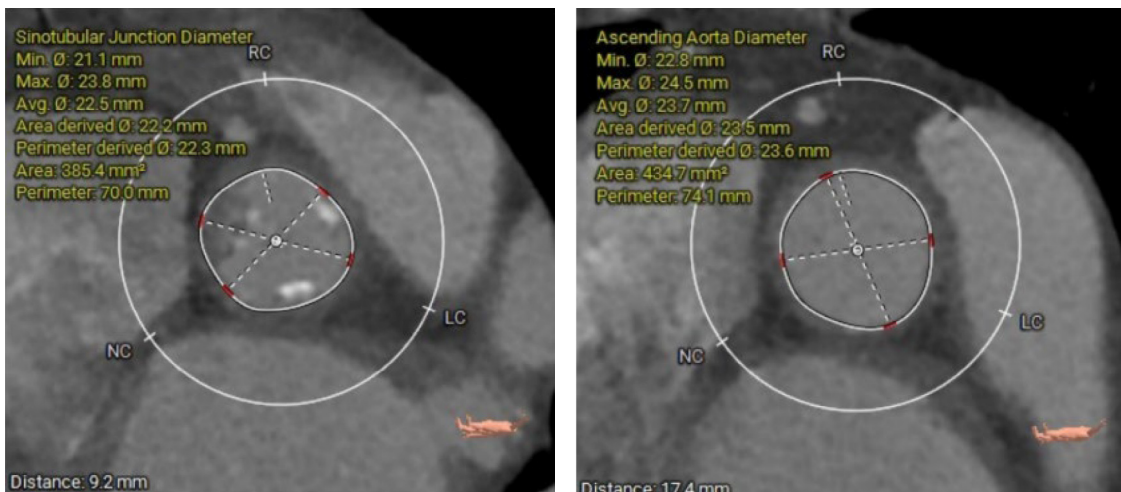
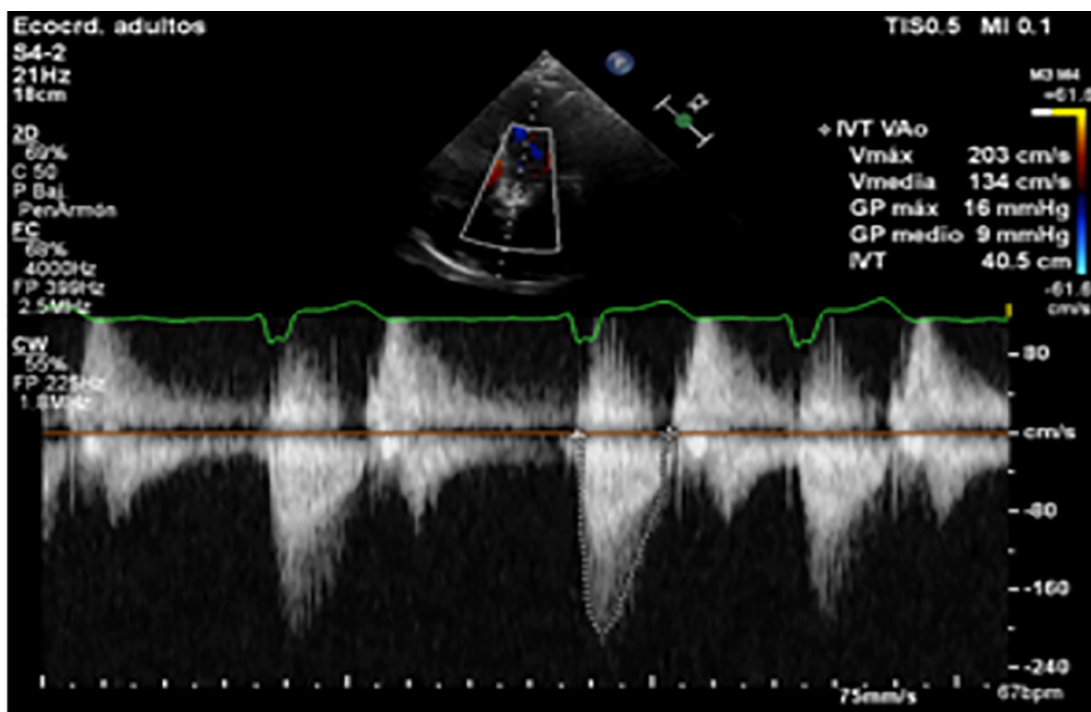


Fig. 3. Post-procedural Echocardiographic Assessment. Continuous-wave Doppler showing a 9-mmHg final mean transvalvular gradient, which confirms the excellent hemodynamic performance of the 23-mm Evolut Pro+ valve after bioprosthetic ring fracture.



Supplemental material

Video 1: Procedural fluoroscopy showing the LLAMACORN technique, chimney stent positioning, and final Evolut Pro+ deployment with confirmed coronary patency.

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Giant Intracranial Internal Carotid Artery Aneurysm Associated with Spontaneous Bilateral Extracranial Internal Carotid Artery and Vertebral Artery Dissection

Aneurisma gigante de arteria carótida interna intracraneana asociado a disección espontánea bilateral de arterias carótidas internas extracraneanas y arteria vertebral

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We present the case of a 54-year-old female patient with a history of tobacco use, depression, and sedentary lifestyle who had previously consulted with a neurologist for chronic migraine without aura. The patient was referred by a psychiatrist for cardiologic evaluation due to a panic disorder characterized by precordial pain and anxiety. She presented to consultation asymptomatic and alert. Blood pressure was normal, no murmurs were heard over the precordium or carotid arteries, and the neurological examination was normal.

Given the history of headaches, a computed tomography (CT) scan of the brain without contrast media was performed. A space-occupying lesion measuring 18 x 16 mm was observed, projecting above and to the left of the *sella turcica*. Peripheral calcifications were present, which could be indicative of a pituitary adenoma or a calcified aneurysm. For this reason, a multi-detector-row helical computed tomography angiography of the intracranial vessels was performed. At the level of the cervical region, the right internal carotid artery (ICA) presented a pronounced type-C kinking prior to its intrapetrous segment, along with a 7-mm neckless saccular aneurysm on its rostral aspect. On the internal surface of the supraclinoid segment of the left carotid artery, close to the origin of the ophthalmic artery, on its caudal aspect and extending posteriorly, there was an extensive giant saccular aneurysm measuring 18 x 13 mm. This aneurysm had a well-defined neck, isolated wall calcifications, and produced central displacement of the circle of Willis, predominantly affecting the A1 and M1 segments.

As the patient evolved with headache and decreased visual acuity a digital subtraction angiography was ordered. The right internal carotid artery (ICA)

presented a saccular aneurysm without a neck on the C4 segment, and a giant M1 segment aneurysm with a well-defined neck was identified in the intracerebral left ICA. Given these findings, a selective angiography of both carotid and vertebral arteries, cerebral angiography, and 3D angiography of the left ICA were performed. Images consistent with fibromuscular dysplasia (FMD) were observed, along with dissection of both ICAs and the right vertebral artery in its cervical segment. A fusiform C1 segment pseudoaneurysm of the right ICA was also present. A 20-mm dissecting aneurysm was observed in the posterior communicating segment of the left ICA, with posterior direction.

After evaluating the therapeutic options, endovascular treatment was decided. The occlusion test showed opening of the anterior communicating artery, with adequate parenchymography in the left middle cerebral artery territory. The giant left ICA aneurysm was occluded using six detachable coils in the giant left posterior-segment ICA aneurysm, while preserving the wide aneurysm neck.

The patient was discharged free of symptoms. On follow-up imaging, selective catheterization of the left ICA revealed partial exclusion of the giant aneurysm in the posterior segment. Microcatheterization of the artery distal to the aneurysm was challenging due to the segment's pronounced curvatures and severe aneurysmal dysplasia. A 3.5 x 30-mm flow diverter was placed in the M2 segment of the left middle cerebral artery. The device was well-positioned against the arterial wall, completely covering the neck while preserving the carotid termination. Final angiograms showed a crescent sign within the aneurysmal remnant, with preservation of all normal arterial branches and a normal parenchymal phase. Regarding the

REV ARGENT CARDIOL 2026;94:236-238. <https://doi.org/10.7775/rac.v94.i3.21018>

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right ICA pseudoaneurysm, surgery is indicated for symptomatic patients with high risk of morbidity and mortality. The possibility of placing a stent plus coils or a flow diverter was considered. However, given the presence of kinking and the challenges associated with passing the guidewire in an asymptomatic patient, medical treatment with aspirin and clopidogrel was chosen.

Internal carotid artery aneurysms, defined as a 50% or greater increase in the normal diameter of the vessel, are rare, accounting for 0.1% to 2% of all carotid procedures. When the traditional triad of neck pain, ipsilateral oculosympathetic paresis, and hemispheric ischemic symptoms is absent, the condition is underdiagnosed. Internal carotid artery aneurysms can be classified by pathophysiology or etiology. The pathophysiological classification divides these aneurysms into true aneurysms—which may be symptomatic or asymptomatic—and false aneurysms or pseudoaneurysms. According to their etiology, they may be post-

traumatic (the most common etiology), associated with an underlying primary arteriopathy or connective tissue disorders (as Ehlers-Danlos syndrome type IV, Marfan syndrome, cystic medial degeneration, fibromuscular dysplasia), or atherosclerotic.

Cervical artery dissection (CeAD) is a frequent stroke etiology in young patients and accounts for 20% of strokes in patients < 45 years of age. Of all carotid artery diseases, extracranial ICA dissections account for 70–80%, while extracranial vertebral artery dissections constitute 15% of cases. Doppler ultrasound, magnetic resonance angiography, and computed tomography angiography are useful noninvasive diagnostic tests. The prognosis for extracranial carotid artery disease is better than that for intracranial disease. (1)

In a multicenter study of internal carotid and vertebral artery dissections, Bassi et al. reported that 63.2% were spontaneous dissections; in the remaining patients, trauma was the most common etiology. An-

Fig. 1. A. Multidetector-row helical computed tomography angiography of the intracranial vessels. Giant saccular aneurysm measuring 18 x 13 mm with a well-defined neck, on the internal surface of the supraclinoid segment of the left internal carotid artery (ICA), caudal aspect, in a posterior direction and close to the origin of the ophthalmic artery. **B.** Pseudoaneurysm of the right ICA. **C.** Dissection of the ICA

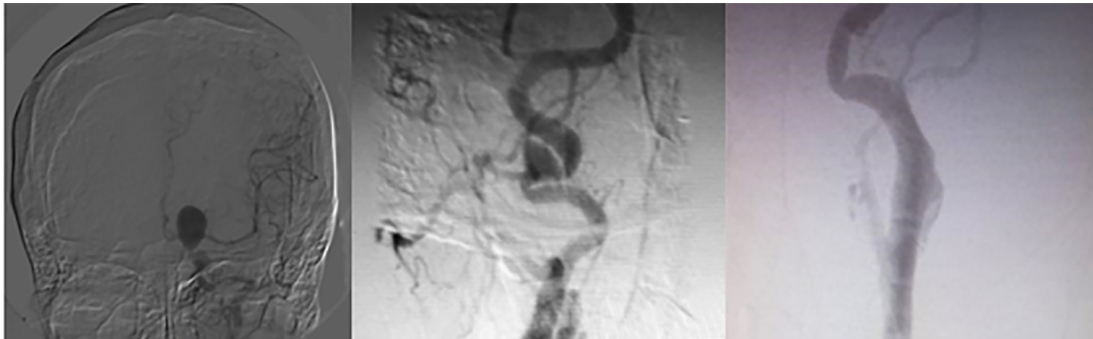
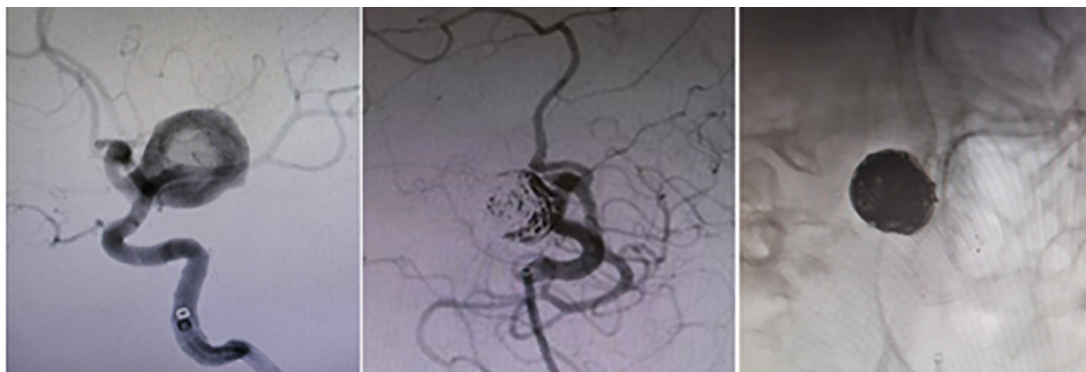


Fig. 2. A. Digital subtraction angiography. Giant M1 segment aneurysm of the left internal carotid artery (ICA) with a well-defined neck. **B.** Left ICA aneurysm was occluded using six controlled-release coils, leaving the wide neck unembolized. **C.** A 3.5-mm SILK flow diverter placed in the M2 segment of the left middle cerebral artery. The device is well-positioned against the arterial wall, completely covering the neck.



ticoagulation was the treatment of choice in most patients. In patients with spontaneous ICA dissections, primary arteriopathy is generally suspected; however, angiographic changes consistent with fibromuscular dysplasia are found in 10% to 20% of cases. Schievink et al. reported the case of a patient with Marfan syndrome and bilateral carotid artery dissection without underlying arteriopathy, in whom microscopic examination revealed medial cystic necrosis of the aorta, and the left ICA displayed the typical features of fibromuscular dysplasia. (3)

Internal carotid artery dissection is a common cause of ischemic stroke, whether of embolic or hemodynamic origin; the therapeutic approach should be determined based on the mechanism of cerebral ischemia. (4)

The treatment of choice is anticoagulation or antiplatelet therapy; other procedures are used when medical treatment has failed. Endovascular treatment involves direct aneurysm embolization, sustained-release coil embolization, or coil embolization with stenting. Surgery is reserved for complex lesions. In the multicenter study by Byrne et al. (6), flow diverters were used to treat ICA aneurysms, including saccular, fusiform, wide-neck, ruptured, or giant ventral aneurysms. Surgery was used only for complex lesions, large aneurysms with high risk of rupture, or radiological signs of expansion.

In asymptomatic patients, the size of a carotid aneurysm requiring intervention remains controversial, with experts recommending repair for diameters

ranging from 15 to 30 mm, although it is generally accepted that aneurysms with a diameter >20 mm should be treated.

Conflicts of interest

None declared.

(See conflicts of interest forms on the website).

Ethical considerations

Not applicable.

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Cardiopulmonary Ultrasound at Discharge

Ecografía cardiopulmonar al alta

MARÍA ALEJANDRA ALVARADO¹.

A constant challenge in patients with heart failure (HF) is the “vulnerable period” following discharge. Hospital discharge marks the period of greatest vulnerability, during which persistent residual congestion—often undetectable on clinical examination—set patients on a path toward early readmission or even death. Traditionally, we have relied on clinical evaluation. However, it is not always sufficient and often proves misleading, as subjective decongestion does not always reflect true tissue decongestion.

This is where congestion assessment using complementary imaging tools, such as cardiopulmonary ultrasound, is no longer merely a technological option but has become a clinical necessity. While echocardiography provides information on left ventricular filling pressures, right ventricular function, and inferior vena cava dynamics, pulmonary ultrasound offers a direct view of the pulmonary parenchyma. By quantifying B-lines, it is possible to objectively determine the extent of interstitial edema long before it becomes clinically apparent.

In this regard, some authors highlight the importance of real-time imaging assessment. Platz et al. demonstrated that residual congestion detected by pulmonary ultrasound is associated with worse short- and long-term outcomes in patients hospitalized for heart failure, underscoring the importance of pulmonary ultrasound. (1) Similarly, the PROFUND-IC registry reported by Pérez-Herrero et al. highlighted the prognostic value of pulmonary ultrasound and inferior vena cava assessment in elderly patients with acute heart failure (AHF). (2)

The recent study by Iroulart et al. is an ambitious study involving elderly, typically frail population hospitalized for “pure” AHF, after excluding secondary causes of HF. The authors evaluated the prognostic value of a cardiopulmonary ultrasound protocol before hospital discharge. Notably, the B-line count at discharge was the only variable that independently predicted readmission or death at 180 days. A thresh-

old of seven B-lines doubled the risk of adverse events, with a specificity of 86%. Other echocardiographic findings, including the septal and lateral E/e' ratios, inferior vena cava dilation, and pulmonary systolic pressure, were associated with the endpoint in the univariate analysis, whereas ejection fraction and left atrial volume were not. (3)

The study focuses on the time of hospital discharge, a critical stage in clinical decision-making, when risk stratification becomes particularly valuable. These findings compel us to reconsider our discharge criteria and what constitutes therapeutic “success” in patients with AHF. Relying solely on clinical criteria while ignoring persistently elevated ultrasound markers of congestion is equivalent to sending patients home with subclinical decompensation. Cardiopulmonary ultrasound should not be regarded as an isolated test, but rather as a cornerstone for guiding real-time diuretic titration, allowing therapy to be individualized to achieve truly safe decongestion.

Ethical considerations

Not applicable.

Conflicts of interest

None declared.

(See authors' conflict of interests forms on the web).

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REV ARGENT CARDIOL 2026;94:239-240. <https://doi.org/10.7775/rac.v94.i2.20997>

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AUTHORS' REPLY

We thank the authors of the letter for their interest in our work and their insightful comments.

We agree that the post-discharge period represents a particularly vulnerable stage for patients with acute heart failure, during which persistent residual congestion plays a central role in the risk of rehospitalization and mortality. We also share the view that imaging tools, particularly pulmonary ultrasound, complement traditional clinical assessment by providing objective information on the degree of decongestion.

As the authors highlight, our results showed that the number of B-lines at discharge was the parameter with the highest independent prognostic value for death or rehospitalization at 180 days, whereas other echocardiographic markers of congestion were associ-

ated with the endpoint only in the univariate analysis. These findings are consistent with previous evidence and reinforce the concept that residual pulmonary congestion is an important target in pre-discharge assessment.

We believe that integrating cardiopulmonary ultrasound into the assessment of patients hospitalized with acute heart failure offers an opportunity to optimize risk stratification and guide future therapeutic strategies. However, prospective studies specifically designed to determine whether an ultrasound-guided strategy can improve clinical outcomes will be needed.

We once again thank you for your comments, which help emphasize the importance of objectively assessing congestion in this high-risk population.

Juan María Iroulart

A Look at the Reality of Cardiovascular Rehabilitation in Argentina

Una mirada a la realidad de la rehabilitación cardiovascular en Argentina

NICOLÁS MATIAS D'AMELIO^{1, 2}.

Cardiovascular rehabilitation (CVR) is a proven practice within the continuum of secondary cardiovascular prevention, with a proven impact on reducing mortality and readmissions.⁽¹⁾ Patients who adhere to rehabilitation programs experience improvements in their functional capacity and quality of life, as well as an increased ability to work and/or remain active, achieve greater autonomy, and, consequently, reduce the need for special care, disability, and loss of social productivity, all of which translate into lower workplace absenteeism, lower social costs, and greater economic participation. ^(2–4)

The study published in the Argentine Journal of Cardiology titled “RENACER-CV: National Registry of Cardiovascular Rehabilitation Centers in Argentina” by Ignacio Davolos et al. ⁽⁵⁾ sought to provide accurate information on the organizational characteristics, geographic coverage, human resources, care modalities, and equipment of CVR centers throughout the country. This is a clear example of how SAC's councils—in this case, the Exercise Cardiology Coun-

cil—as well as its research and health policy divisions, can help identify opportunities for improvement and regional development at the national level.

The results obtained from the registry show an uneven distribution of CVR centers across Argentina, with a strong concentration in the Province of Buenos Aires and the Autonomous City of Buenos Aires, highlighting a regional inequity that limits effective access to this intervention and demonstrating a significant structural barrier for large segments of the population.

In addition to the aforementioned geographic limitations, the registry revealed serious economic and health coverage shortcomings that emerge as an additional factor contributing to inequity, demonstrating that the lack of health insurance is one of the main factors limiting participation in CVR programs.

As a result, it is imperative to highlight the research group's efforts to gather accurate, high-quality information on the current state of CVR programs in Argentina. It is a call for the political spectrum to

REV ARGENT CARDIOL 2026;94:240-241. <https://doi.org/10.7775/rac.v94.i3.21017>

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act from the perspective of health planning, using the available information to guide public policy decisions and management of the Argentine health system.

Ethical considerations

Not applicable.

Conflicts of interest

None declared.

(See authors' conflict of interests forms on the web).

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AUTHORS' REPLY

We thank Dr. D'Amelio for reviewing our paper and for his comments.

We agree that cardiovascular rehabilitation is a fundamental strategy for secondary prevention and that the regional disparities and access barriers identified by RENACER-CV represent significant challenges for cardiovascular care in Argentina.

One of the registry's main objectives was precisely to describe the current state of cardiovascular rehabilitation programs in our country, providing evidence to highlight gaps in care and guide future actions aimed at improving access to and coverage of this intervention.

We appreciate the interest shown in our work and agree on the importance of continuing to generate local data that contributes to the development of health policies and organizational strategies aimed at more equitable cardiovascular care.

Ignacio Dávalos, Ivana Paz, Facundo Balsano, et al



Dr. José Antonio “Cacho” Navia: A Leading Figure of Argentine Cardiac Surgery

Dr. José Antonio “Cacho” Navia: un referente de la cirugía cardíaca argentina

Writing a few lines in memory of Dr. José Antonio “Cacho” Navia inevitably means recalling a fundamental part of the Argentine cardiac surgery history.

After graduating as a physician and earning his Doctor of Medicine degree from the Faculty of Medical Sciences at the National University of La Plata, he returned to his beloved city of Mar del Plata to pursue his professional career in general and thoracic surgery at Hospital Marítimo. From his earliest years, he demonstrated a solid clinical background, the result of his beloved mentor’s influence, Dr. Manzino, of Hospital de Clínicas, who played a decisive role in shaping his deep empathy and commitment to patient care.

In 1970, fascinated by the groundbreaking news about coronary bypass surgery coming from the Cleveland Clinic, he decided to apply to train in cardiac surgery there. He was accepted into one of the world’s most prestigious institutions at a historical moment in the development of this technique. After two years of intense work and learning, he returned to Argentina with an excellent education and joined Dr. René Favaloro’s team, playing an active role in establishing coronary revascularization surgery in Argentina and in training a new generation of cardiovascular surgeons.

In 1990, he became head of the Cardiovascular Surgery Department at Hospital Italiano of Buenos Aires. This phase represented one of the most notable periods of his professional career, as he led one of the most important cardiac surgery programs in Argentina and Latin America.

His leadership left a profound mark on the specialty. Among his major achievements were the creation of the country’s first aortic valve homograft bank, which allowed optimizing the treatment of young patients with infectious endocarditis; the strengthening and expansion of the heart transplant program, which culminated in the first heart-lung transplant performed in Argentina; and the creation of an advanced mechanical circulatory support program, which enabled to treat patients using state-of-the-art technology available worldwide.

He was a tireless traveler, driven by a constant intellectual and scientific curiosity. He went around the world in search of knowledge, innovations, and advances that could be applied to benefit patients in our country. His active participation in the international cardiology community helped establish and enhance the prestige of Argentine cardiac surgery globally.

He acted as president of the Argentine Society of Cardiology in 1987 and of the Argentine College of Cardiac Surgeons in 1989, always distinguishing himself through his energy, work capacity, and commitment to teaching, research, and the training of new generations of specialists.

Research and technological development were among his other great passions. He participated in the design and development of left ventricular assist devices for patients with end-stage heart failure, as well as cannulae, specialized catheters, and stent-free biological valve prostheses for minimally invasive implantation. His final project, on which he worked

enthusiastically until his last days, was an innovative device designed to reduce the risk of stroke during endovascular procedures.

In 2002, he was elected Full Member of the National Academy of Medicine, an institution he later presided over. He was also a member of numerous international scientific societies and served as Visiting Professor and Researcher at prestigious universities, including Purdue University (Indiana, United States), the University of California, Irvine (United States), and Juntendo University (Tokyo, Japan).

It is difficult to summarize in a few lines the magnitude of the scientific and personal legacy of professionals like him, who honor our country with a life dedicated to knowledge, innovation, and service.

I had the immense good fortune to know him closely from a very young age. I admired him, looked up to him as a role model, and found in him a paradigm of professional and human excellence. Reflecting today on his countless achievements evokes a mixture of sadness at his passing and deep admiration for the magnitude of his legacy.

He was my mentor and also my brother José's. We both tried to follow the path he laid out, inspired by his values, his dedication, and his passion for medicine. I

used to tell him, jokingly, that he was "too smart to be a cardiac surgeon"; he would respond with a smile. He was constantly spearheading projects, promoting change, and seeking to develop cutting-edge technologies in a context that often seemed unfriendly to innovation.

He was a wise, observant, generous man who was deeply empathetic toward his patients. Recently, several of his colleagues summed him up with a phrase as simple as it was powerful: "what a great surgeon and what a great person." There is probably no better way to describe someone of his standing.

Dear "Cacho" Navia: Men of your stature are not bid farewell; they are remembered and honored. You will live on in the memories of your surgeon nephews, of those who had the privilege of knowing you, in the generations of professionals you trained, and in each of the projects you led with vision and enthusiasm.

Your contribution to Argentine cardiac surgery was immense and enduring. Your legacy will continue to inspire those who follow the path you helped build.

Rest in peace, dear "Cachito".

Dr. Daniel Navia
Cardiac Surgeon. Buenos Aires 2026.



Dr. Jose Luis Barisani

*The Free Essence of Recall Shall Not Die
Without Letting Memory Know that I Will Return*

José Luis and I shared every endeavor, clinging to the sensations our skin reflected. In the face of such pain upon your passing, I can only write to linger within this sadness that has cracked my soul.

*This sadness is profound, but it fades away
into nostalgia
and leaves us a tear, a prelude, and the
warm melancholy
of the evening suns that drag us
into the shadows.*

We were companions in those places where life borders on death, brothers in joy and sorrow, survivors of doubts and memories, of so many shared places where emotion is fearless. Your daily reaching out to each of us, your commitment to those in mourning, your reflections and the refuge you offered to those on the path of knowledge—all of this knew neither pause nor retreat. Your presence had that aura of a magical benefactor.

*Your premature farewell still casts flames,
a sacrifice to the gods in uncertain days;
so profuse is the wound that never ceases
in tearing your departure away from existence.*

The past, in disguise, takes over its most remote origin. What had been forgotten and fossilized returns from the depths of memory. It is the resurrection of a new season. Imperceptible at first, it cannot escape the gestures and words that are gradually renewed. Once memory resurfaces, it grows in the shadow of its quietest return, from the last pain left by the sunset's copper. But at some point, it turns into turmoil

and chaos. It casts aside all preconceptions and surges forward. It does not weigh consequences or considerations. It tears down the commemorative plaques that resisted freedom. And the memories that had run away from their representation reappear for a last farewell before illuminating the path with the final trail of light they leave behind.

*I want to return with you to the depths
and believe that you are not dead, companion
of endeavors, apprentice of the nights
with their dreams.*

Memory is an act of atonement. It places us in a state of suffering. Stripped of aggression. It is memory that reveals our condition to its most extreme limit. Man needs it to give birth to his recollection. Thus, he arrives at sadness—the moment when the self can escape its own meaning and contemplate itself from outside it. In this vigil, there are no distractions; he only scrutinizes himself before a mirror, trying to see his inner self. Our entire memory is transformed into a point of extreme sadness, into a convergence that lies beyond pain. It borders on indifference, on the acceptance of our insignificance. These words bear the mark of being there to contemplate absences—of so many stories lived with you, my friend José Luis—that leave me without comfort.

Thus, we remain strangers to our surroundings, floating unassumingly, needing neither space nor time to occupy. I barely keep watch, as the seasons are subject to a hierarchy of complete freedom—the freedom that gives the self its understanding of a reality that is, in fact, circumstantial and random, regardless of destiny. It is the wrenching pain produced when awareness subjugates both sadness and emptiness,

the ultimate sources of liberation.

My friend, there was no peace during this time or any time to forget. To detail your extensive medical work in every hospital setting, at the Argentine Society of Cardiology (SAC) and in the Argentine Journal of Cardiology (RAC), would be so extensive that simply saying “José Luis Barisani” is enough for everyone to know of your career of professional and ethical commitment. I also know that this page, in the face of so much life spent in your company, is insufficient, but so is the pain that belongs to the human condition.

Now it is autumn. I can feel the crunch of yellowed, withered leaves under my feet. In my imagination, you have become me. The distances between us have shortened. You no longer wait on the other side of my confession, giving me strength. You walk within me through the mist the gray drizzle shows. Together we have navigated more than a few steps: fears, failures,

sufferings. And also the joys of accomplishing so much amid the events imposed on us by the uncertainty of fate.

José Luis, we will only be free when we accept sadness as the essential condition for our self-awareness. Then we can be reborn like the seasons, expecting nothing more than our inevitable twilight. Not out of ignorance, or out of slavery to it, but through our own decision to get rid of our idiosyncrasies through affection—even if that affection comes hand in hand with anguish.

*I want to return with you to the depths
and believe that you are not dead, companion
of endeavors, apprentice of the nights
with their dreams.*

Jorge Trainini

Patient-Centered Care: Moving Beyond the Slogan to Reality. Between Inequality and Inequity in the Argentine Healthcare System

Asistencia centrada en el paciente, cómo superar el lema para pasar al hecho. Entre la desigualdad y la inequidad del Sistema de Salud argentino

“Let us hold to high ideals and strive to achieve great things, because life always falls short, and we rarely achieve more than a fraction of what we hope for; by aiming high we will accomplish much more. For a steadfast will, nothing is impossible, there is no such thing as easy or difficult; what is easy is what we already know how to do, and what is difficult is what we have not yet learned to do well.”

Dr. Bernardo Houssay
(first Nobel laureate from
Argentina and Latin America)

Three cardiologists from an imaginary world—Sergio Nonrich, Mirza Ten, and Mario Halcón—continue to debate the current state of the healthcare system. They wonder why healthcare is not a priority for either political programs or the general public. In this regard, we physicians observe the progressive decline of the healthcare system, without a sustained responsiveness that would allow it to be placed on the agenda of various national and/or provincial governments. Although the health crisis caused by the pandemic highlighted the shortcomings of a system that cries out for reform, the political class continues to postpone a genuine debate. It is imperative to rethink a healthcare model that transcends economic interests and recovers its fundamental essence: guaranteeing health as a universal right.

The number of working hours devoted to medical care has likely been impacted as a result of meager fees. The time dedicated to healthcare in Argentina has shown a progressive decline that has not only affected care assistance but has also increased the level of dissatisfaction, leading to a rise in the prevalence of burnout among healthcare professionals. (1–3)

There is no defined, uniform health care plan for the various public hospitals and health facilities. The provision of health services depends on the availability of healthcare personnel (and their specialties), equipment, supplies, and care capacity (e.g., available

beds, appointment availability, etc.) at the time the demand arises. When demand exceeds supply, restrictions on access to health services emerge. Lack of systematic planning of the offer (or its financing) results in disparities among the different provinces.

The fragmentation and segmentation of the Argentine health system is not accidental; it stems from a historical lack of coordination among its three pillars (the state, the social welfare organizations, and the private sector) and from the country's federal nature itself. (Figure 1) These structural divisions have, to date, prevented the efficient integration of health care. According to our Constitution, primary responsibility for the regulation, financing, provision, and supervision of health care lies with the provinces. Coordination on health matters among the national government, the provinces, and the Autonomous City of Buenos Aires is carried out through the Federal Health Council (COFESA), established by Law 22 373, within whose framework federal health policies and actions in the country are coordinated. (4)

Sustainable solutions cannot be achieved in a health care system unless models of care, management, and financing are integrated. Our federal system (23 provinces and the Autonomous City of Buenos Aires) is characterized by fragmentation, segmentation, and a lack of coordination among its components, with a lack of care standards, unevaluated or suboptimal outcomes, in health emergency since 2002, with a high degree of dissatisfaction (from patients, healthcare personnel, and providers), unequal access and quality, with infrastructure and resource problems (shortage of hospital beds and healthcare personnel), and with insufficient funding (healthcare investment is low). (5)

When addressing disparities in healthcare, it is important to recognize the difference between equality and equity. Equality refers to the provision of the same care for all people and leads to policies that ensure everyone has the same resources. Health equity is the state



in which all people have a fair and equal opportunity to achieve their highest attainable level of health. Equity recognizes that those who have suffered exclusion or marginalization—both currently and historically—will generally require individualized resources to address the consequences of such exclusion and marginalization. From a healthcare perspective, we cannot reduce the patient to a client with varying levels of coverage; rather, we must view him as a citizen entitled to receive appropriate medical care. Equity takes into account barriers, circumstances, and conditions. In contrast, health inequity refers to differences that are unnecessary and preventable—and that are also considered unfair. Achieving equity requires eliminating barriers to health such as poverty, discrimination, and powerlessness, as well as their consequences—including lack of access to good jobs with fair wages, safe environments, education, housing, and quality medical care. (6)

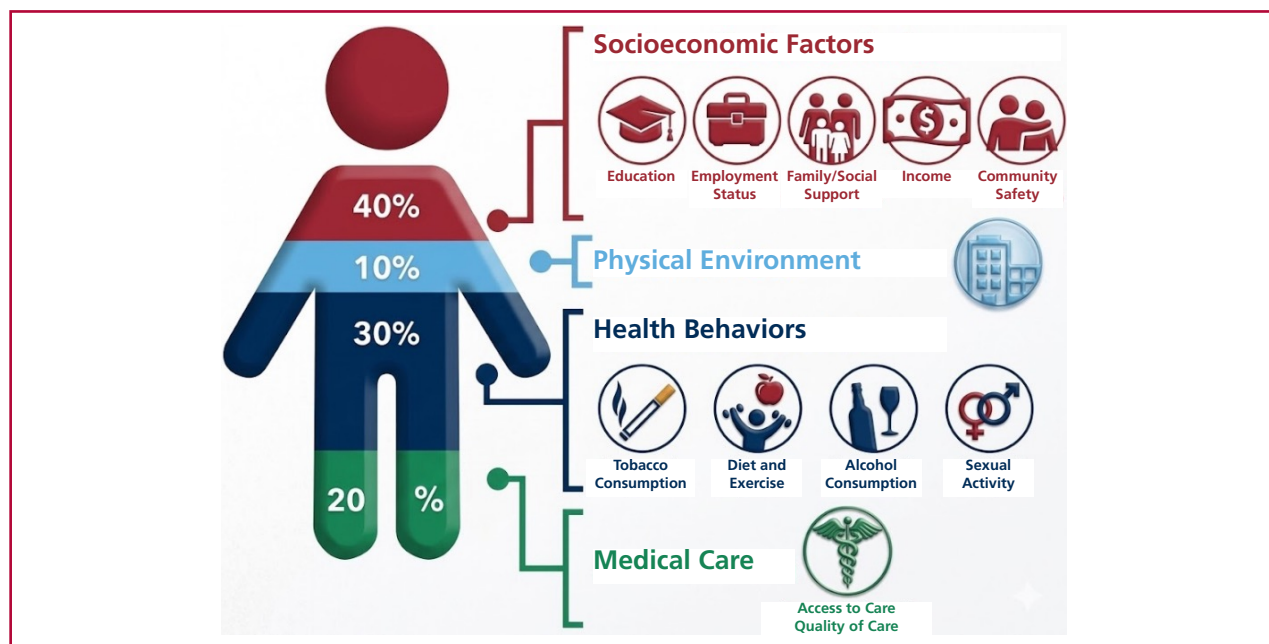
According to a survey by the Institute for Clinical Systems Improvement, 20% of a person's health and well-being is related to access to care and quality of services; however, 80% of health outcomes are determined by the physical environment, social determinants, and behavioral factors (Figure 2). Socioeconomic factors, such as employment status, social support, income, community safety, and physical and environmental settings are just as important as more routinely assessed health behaviors, such as tobacco use, diet and exercise, alcohol consumption, and sexual activity. (7, 8) In this sense, health is a multifaceted and complex issue linked to social, educational, and behavioral factors that involve stakeholders beyond healthcare personnel.

Furthermore, the health area does not function as a conventional market for several compelling reasons. There is a clear imbalance in access to information and a demand that, by its nature, does not respond to

Fig. 1. Estimated overall distribution of coverage by subsystem type 2022/23 (data provided by Prosanity Consultant)

Type of coverage	Population covered n	Share %
State Subsystem	16 500 000	36.00%
Social Security Subsystem (Social Insurance)	27 928 500	60.97%
Private Subsystem	6 321 500	13.57%
Total	50 750 000	110.54%
Argentine Population	45 808 000	100.00%
Population with more than one health plan	4 942 000	10.54%

Fig. 2. Determinants of health status (modified from Prog Cardiovasc Dis. 2024;82:55-60. <https://doi.org/10.1016/j.pcad.2024.01.005>)



price changes (inelastic). Since no individual can afford comprehensive care on its own, health insurance becomes indispensable. If we add the impact of external phenomena such as health crises, it is undeniable that an in-depth analysis, greater integration among stakeholders, and regulatory actions are required to correct these structural deficiencies. (9)

Improving access and achieving universal coverage depends on strategic regulation in four critical areas: financing, human resources training, drug supply, and the incorporation of technology. Without a solid institutional framework in these areas, the right to health remains unprotected. It is essential to: a) promote the training of high-quality, adequately compensated healthcare personnel; b) ensure funding through auditing and integrated management coupled with an outcome evaluation program; c) restructure the Mandatory Health Insurance Program (PMO); d) foster integration among system providers by sharing clinical information, costs, and expenses; and e) work towards the creation of a technology assessment agency.

CONCLUSION

Considering the challenges facing the healthcare system, it is urgent to strengthen the authorities' capacity to lead change processes. Effective transformation will only be possible if it is built collectively with all stakeholders (governance), focusing efforts on a common goal: achieving universal health coverage and access. The Argentine Society of Cardiology has decided to contribute to the debate of the healthcare person-

nel and the healthcare system situation through the creation of the 24 Leading Scientific Societies Forum.

Sergio Baratta ^{MTSAC},

President of the Argentine Society of Cardiology

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