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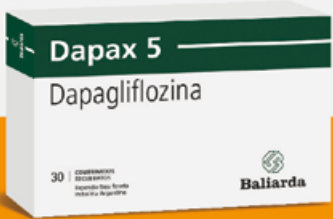
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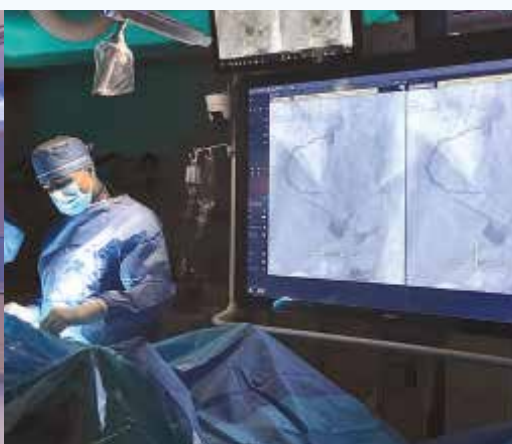
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Editorial

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Renal biomarkers in heart failure: an increasing need for sex-specific cardiovascular medicine.

Catalina Gallego¹, Ana G Múnera²

1 Clínica Somer. 2 Clínica Rosario Tesoro y Cardioestudio. Medellín, Colombia.

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Keywords:

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Sex factors; Patient readmission;

Renal function.

ABSTRACT

Heart failure exhibits high rehospitalization rates that compromise prognosis. Sex-stratified analysis of renal biomarkers and serum electrolytes emerges as an essential prognostic strategy. Recent evidence demonstrates that glomerular filtration rate predicts readmission in men, while serum calcium does so in women, with significant interactions between sex and creatinine/chloride. These findings underscore the need to abandon the "one-size-fits-all" approach in cardiology and develop sex-differentiated predictive models. Renal biomarkers, accessible and low-cost, offer opportunities for personalized risk stratification in post-discharge follow-up. Cardiovascular medicine must systematically incorporate biological sex perspective to optimize clinical outcomes.

Heart failure (HF) represents one of the most prevalent cardiovascular syndromes, with readmission rates reaching 50% within six months of hospital discharge. In this scenario, the article published in this issue provides relevant evidence on the prognostic usefulness of renal biomarkers and serum electrolytes, introducing a fundamental element: analysis differentiated by biological sex.

The authors, through an analysis of almost 2000 patients, show that renal biomarkers and measurement of serum electrolytes have a different prognostic value according to sex. This finding represent a call to drop the "one-size-fits-all" approach that is predominant in cardiology.

It is interesting to highlight in this publication, as in the male population, that a lower glomerular filtration rate (GFR) is significantly associated with a higher risk of readmission within six months; while in women, serum calcium emerges as the stronger predictor. This dichotomy suggests differentiated pathophysiological mechanisms, possibly reflecting different HF phenotypes, different neurohormonal responses, or mineral metabolism and renal function variations.

The association between lower GFR and greater risk in males reinforces the importance of cardiorenal syndrome. Renal dysfunction in HF is not just an epiphenomenon, but an independent predictor, reflecting the complex interaction between tissue perfusion, venous congestion, neurohormonal activation and pharmacological effects of fundamental therapies.

Calcium identification as a predictor exclusively in women raises questions about differentiated mechanisms. Could this be related to the bone mineral metabolism in post-menopausal women? Is there a relationship with HF phenotypes more prevalent in women, such as HF with preserved ejection fraction? Do

hormonal changes influence calcium homeostasis and its myocardial impact? These questions deserve all our interest and further research.

Significant interactions between gender and biomarkers like creatinine and chloride add complexity to the analysis. Creatinine may be less sensitive in women due to less muscle mass, which may lead to renal dysfunction underestimation if not interpreted in an appropriate physiological context. The differential association of chloride underscores its underestimated role as prognostic marker, considering its participation in resistance to diuretics and acid-base balance.

These findings have immediate practical implications. We tend to apply the same risk algorithms regardless of sex. However, evidence suggests considering differentiated biomarkers panels, with adjusted thresholds and specific estimations according to the biological profile of the patient.

This study reminds us that biological differences between men and women with cardiovascular diseases are not minor, negligible variations. Women have been underrepresented for decades in most cardiovascular clinical trials, and rarely specific analysis are made with appropriate statistical power. This gap has led to a cardiovascular medicine mainly designed for men.

In Latin America, where HF prevalence is still increasing and there are limitations in resources, the identification of accessible prognostic biomarkers becomes particularly relevant. The evaluated markers are widely available, are a routine and do not require sophisticated technology.

We should be cautious when interpreting this study. The retrospective design and the absence of information on ejection fraction, functional class and treatment limit our understanding of the clinical context. The evaluated outcome corresponds to re-

admissions by any cause, which may lead to a great heterogeneity at the time of analysis. Nonetheless, the study establishes the foundation for future research. Prospective, multicenter studies are required, including clinical, echocardiographic and therapeutic variables, validating these findings in diverse populations. It would be particularly important to explore whether these biomarkers in differentiated models do improve the identification of patients in high risk.

This study invites to systematically add the perspective of gender in cardiovascular research, from design to interpretation. The most recent guidelines have started to acknowledge these differences, but there is still a long way to go to achieve applicable recommendations.

To conclude, this study is a valuable contribution, reminding us that accurate medicine in cardiology should include the dimension of biological sex. Renal biomarkers and electrolytes, apparently simple tools, may provide differential prognostic information in an appropriate context.

As cardiologists, we should drop the “one-size-fits-all” paradigm and advance toward a truly personalized medicine, acknowledging the essential biological differences. Only thus we will be able to optimize the management of HF, readmissions will be reduced and prognosis and quality of life will improve, regardless of gender.

The challenge has been set. There is evidence. It is up to us to add it to our practice and to continue generating knowledge that would provide each patient with the best possible care, acknowledging their biological individuality as a crucial element in cardiovascular medicine.

BIBLIOGRAPHY

1. Guevata Tirado A. Biomarcadores renales y electrolitos como predictores de reingreso a emergencia a 6 meses en Insuficiencia cardíaca: análisis estratificado por sexo. *Rev Fed Arg Cardiol* **2026**; **55**: 26 - 32
2. McDonagh TA, Metra M, Adamo M, et al. 2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure. *Eur Heart J* **2021**; **42**: 3599 - 3726.
3. Oskouie S, Pandey A, Sauer AJ, et al. From hospital to home: Evidence-based care for worsening heart failure. *JACC Adv* **2024**; **3**: 101131.
4. Regitz-Zagrosek V. Sex and gender differences in heart failure. *Int J Heart Fail* **2020**; **2**: 157 - 181.
5. Deferrari G, Cipriani A, La Porta E. Renal dysfunction in cardiovascular diseases and its consequences. *J Nephrol* **2021**; **34**: 137 - 153.
6. Wilcox CS, Testani JM, Pitt B. Pathophysiology of diuretic resistance and its implications for the management of chronic heart failure. *Hypertension* **2020**; **76**: 1045 - 1054.
7. Van Ommen AMLN, Canto ED, Cramer MJ, et al. Diastolic dysfunction and sex-specific progression to HFpEF: current gaps in knowledge and future directions. *BMC Med* **2022**; **20**: 496.
8. Fasero M, Coronado PJ. Cardiovascular disease risk in women with menopause. *J Clin Med* **2025**; **14**: 3663.
9. Jiménez-Méndez C, Díez-Villanueva P, Bonanad C, et al. Fragilidad y pronóstico de los pacientes mayores con insuficiencia cardíaca. *Rev Esp Cardiol* **2022**; **75**: 1011 - 1019.
10. Borlaug BA, Jensen MD, Kitzman DW, et al. Obesity and heart failure with preserved ejection fraction: new insights and pathophysiological targets. *Cardiovasc Res* **2023**; **118**: 3434 - 3450.
11. Gherghina ME, Peride I, Tiglis M, et al. Uric acid and oxidative stress-relationship with cardiovascular, metabolic, and renal impairment. *Int J Mol Sci* **2022**; **23**: 3188.
12. Hanberg JS, Rao V, Ter Maaten JM, et al. Hypochloremia and diuretic resistance in heart failure: Mechanistic insights. *Circ Heart Fail* **2016**; **9**: e003180.
13. Lam CSP, Arnott C, Beale AL, et al. Sex differences in heart failure. *Eur Heart J* **2019**; **40**: 3859 - 3868.
14. Hsieh EM, Piña IL, Hernández AF, et al. Sex differences in the management and outcomes of heart failure with preserved ejection fraction. *J Card Fail* **2020**; **26**: 1007 - 1013.
15. Rossignol P, Hernandez AF, Solomon SD et al. Heart failure drug treatment. *Lancet* **2019**; **393**: 1034 - 1044.
16. Ponikowski P, Voors AA, Anker SD, et al. 2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure. *Eur Heart J* **2016**; **37**: 2129 - 2200.

Review Article

Contemporary use of antiarrhythmic drugs: practical messages for clinical cardiologists from the EHRA compendium.

Silvia Palomo-Piñón, Francisco J. Ramos-Carrillo.

Grupo de Expertos en Hipertensión Arterial México (Group of Experts on Hypertension from Mexico) (GREHTA).

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maladaptive mechanism.

ABSTRACT

Chronic kidney disease is a global public health problem characterized by high prevalence, underdiagnosis, and substantial morbidity and mortality, primarily driven by cardiovascular outcomes. It is currently recognized as a major independent risk factor for both atherosclerotic and non-atherosclerotic cardiovascular disease, with risk increasing in parallel with declining glomerular filtration rate and rising albuminuria. This association is explained by the synergistic interaction between traditional cardiovascular risk factors and non-traditional pathophysiological mechanisms that are highly prevalent in chronic kidney disease. These include mineral and bone disorder, anemia, volume overload, uremic toxins, oxidative stress, chronic inflammation, dysbiosis, and overactivation of the renin-angiotensin-aldosterone system and the sympathetic nervous system. Collectively, these processes promote endothelial dysfunction, accelerated atherosclerosis, and maladaptive cardiac remodeling, ultimately contributing to the high cardiovascular morbidity and mortality observed in this population.

INTRODUCTION

The cardiorenal metabolic continuum (CRM) favors cardiovascular risk (CVR), and chronic kidney disease (CKD) is part of it.¹ It is defined by an estimated glomerular filtration rate (eGFR) <60 ml/min/1.73 m² and/or structural anomalies and/or functional anomalies of the kidney for a time ≥3 months, with implications for health. It is classified in 5 stages according to eGFR and stratified in three categories of albuminuria (Table 1). The contribution of CKD to the continuum is complex, and there are mechanisms participating, related to the uremic milieu produced by a decrease in glomerular filtration (GF), where the effect of uremic toxins on the CV system is early.

In this review, we show the contribution of CKD to CVD in the CRM continuum, through a poor adaptation of initially adaptive mechanisms in the kidney in an attempt to maintain homeostasis. These internal changes are unique to patients with CKD and have devastating consequences.

THE SIGNIFICANCE OF CKD IN THE CONTINUUM**1) It is a CVR amplifier**

Type 2 diabetes (T2D) and hypertension (HTN) are the most prevalent causes of CKD and both increase CVR. However, there is an equally increased CVR in primary glomerular diseases, regardless of nephrotic syndrome and the extent of albuminuria. The estimated probability of a CV event in this population is 1.38

Renal and cardiovascular risk according to the CKD classification			
Category of albuminuria (in mg/g)			
Category of GFR (glomerular filtration rate in ml/min)	A1 Normal < 30	A2 Moderate 30–300	A3 Severe > 300
G1 > 90 Normal	Low risk	Low risk	Low risk
G2 60–89 Mild	Low risk	Moderate risk	High risk
G3a 45–59 Moderate	Moderate risk	High risk	Very high risk
G3b 30–44 Moderate	High risk	High risk	Very high risk
G4 15–29 Severe	High risk	Very high risk	Very high risk
G5 < 15 Renal failure	Very high risk	Very high risk	Very high risk
Low risk Moderate risk High risk Very high risk			



TABLE 1.
Categories of glomerular filtration (KDIGO 2024)

El Ambiente Urémico: El Puente entre la Enfermedad Renal y Cardiovascular

La Enfermedad Renal Crónica (ERC) no es solo una falla de filtración, sino un motor del continuum cardiorenal-metabólico. Mecanismos maladaptativos crean un "ambiente urémico" que daña directamente al corazón y los vasos sanguíneos.

Impacto y Progresión del Riesgo

Amplificación del Riesgo Cardiovascular

3.98x
MAYOR RIESGO
Riesgo de eventos en población general

Factor de Riesgo Independiente ERC

El riesgo aumenta exponencialmente conforme disminuye el filtrado glomerular.

El Punto Máximo en Diálisis

10 a 20
VECES SUPERIOR
Riesgo cardiovascular al de la población general.

Incremento del RCV vs. Población General

Superior a la población general **2.5 a 3** veces mayor

G1 - G2 (Inicial) G3 (Moderado) Terapia de Sustitución (TSFR)

Mecanismos de Maladaptación (Ambiente Urémico)

Hiperfiltración, Sobreactivación Neurohormonal (SRAA y SNS) y Sobrecarga Hídrica

Trastorno Mineral Óseo (PTH, FGF23 y Calcificación Vascular)

Toxicidad Sistémica (Toxinas Urémicas, Anemia, Estrés Oxidativo e Inflamación)

CENTRAL FIGURE

to 3.98 greater than in the population without CKD of the same age and sex.² This CVR is not static, but increases exponentially as GF decreases, and it reaches its peak in kidney failure replacement therapy (KFRT). Patients in stages G1-G2 present a CVR greater than the one observed in the general population, due to alterations in the CV system due to GF decrease.³ In the G3 stage, it increases 2.5 and 3 times, while in G4-G5 it may be up to 3.4 times greater in comparison with G1. During KFRT, it reaches values between 10 and 20 times more than in the general population, considering that 40%-50% of patients start this stage with CVD already established. After renal transplant, CVR is around 3.5% and 5%; nonetheless, it is still approximately 50 times more than the general population.⁴

2) It is an independent factor of CVR

Just as with T2D, plenty of studies have concluded that the association between CKD and CVD is synergic, strong, bidirectional, interdependent, of positive feedback loop and causal on multiple levels. Renal patients present atherosclerotic CVD (CAD, stroke and peripheral arterial disease) and nonatherosclerotic disease equally (heart failure, arrhythmia and sudden cardiac death), decreasing life expectancy.^{5,6}

CONTRIBUTION OF CKD TO THE CARDIORENAL-METABOLIC CONTINUUM

Progressive decrease of GF is the trigger of multiple adaptive mechanisms that attempt to maintain homeostasis of the internal milieu. Hemodynamic, hormonal, metabolic and structural adaptations have been described throughout the nephron, becoming widespread. The problem starts when they become "maladaptive" and accelerate GF drop, harming different organs and systems (*central figure*). The level of evidence of these data is high (1A and B).

1) Intrarenal adaptations: glomerular hyperfiltration

Also known as compensatory hyperfiltration, it is the first mechanism to activate because of decrease in the number of functional nephrons. It occurs due to afferent arterioles dilatation and vasoconstriction of efferent arterioles, with the subsequent increase of intraglomerular filtration, but the effect of the rest of the simultaneous adaptations produces a sustained elevation of the glomerular capillary pressure that damages the podocyte structures and allows albumin to go through. Over time, the mentioned structures scar and stop working (progressive sclerosis).^{7,8}

2) Renal and systemic neurohormonal adaptations

A) Overactivation of the renin-angiotensin-aldosterone system (RAAS)

At renal level, chronic vasoconstriction of efferent arterioles (that initially maintains GF) is the trigger to overactivate RAAS, as the macula densa perceives it as a chronic decrease in renal perfusion. Consequently, a reduction of effective intraglomerular pressure and overactivation of the systemic neurohormonal response occur, with retention of Na⁺ and H₂O, expansion of extracellular volume and increase in systemic blood pressure. The strong vasoconstrictor effect of angiotensin II and Na⁺ and H₂O retention stimulate non-hemodynamic mechanisms that favor vascular hypertrophy, cardiac fibrosis and endothelial function, which are enough per se to increase blood pressure and produce major CVD. Simultaneous overstimulation of aldosterone favors Na⁺ retention and pathological remodeling of cardiovascular tissues, contributing to progression of CVD and increase of adverse events. Over time, this mechanism ends with renal fibrosis, vascular stiffness, and alterations in cardiac remodeling, producing HF, arrhythmias and death.⁸

B) Overactivation of the sympathetic nervous system (SNS)

It is favored by the decrease in renal perfusion and the effective reduction of intraglomerular pressure previously described. This effect is initial, and over time it represents the main mechanism perpetuating cardiorenal damage, as it maintains a sustained increase in vascular tone, heart rate elevation, Na⁺ retention and increase in myocardial consumption of oxygen. These maladaptive changes generate fibrosis, vascular stiffness and alterations in cardiac remodeling. Sympathetic stimulation also favors renin release, further amplifying RAAS activation, and establishing a positive feedback loop that perpetuates cardiac and renal dysfunction.⁹

The combined effects of the RAAS and the SNS explain largely the high incidence of CVD, including left ventricular hypertrophy (LVH), HF, arrhythmias, CAD and sudden cardiac death. The therapeutic benefit of its pharmacological modulation has been documented with controlled clinical trials in populations with multimorbidity.⁸

3) Adaptations in the fluid and electrolyte balance: Na⁺ and H₂O

The decrease in the number of functional nephrons and GF, along with neurohormonal overactivation, increase the excreted fraction of Na⁺ and H₂O, and natriuresis occurs. This triggers the response of natriuretic peptides to favor natriuresis and vasodilation, in an attempt to restore fluid balance. As GF drop advances and volume overload exacerbates, there is resistance to the compensatory effect, in such a way that volume overload cannot be offset and filling pressure, hypertension disarray and arterial stiffness increase, thus contributing to LVH and HF. This condition has a poor outcome, particularly in patients in KFRT, as it is associated consistently with higher risk of CVD and mortality. Likewise, Na⁺ and H₂O retention may worsen albuminuria, a situation that accelerates renal impairment progression.¹⁰

4) Adaptations in acid-base balance

Kidneys maintain pH stable faced with GF drop by three basic mechanisms: 1) increase in excretion of acid by nephron (ammoniogenesis by remnant nephron); 2) reduction in serum bicarbonate by increase in titratable acid excretion; 3) respiratory compensation that decreases partial pressure of carbon dioxide (pCO₂). These mechanisms remain stable until the terminal stages of CKD, where the evident decrease in functional nephrons prevents fully compensating the acid load. Thus, chronic metabolic acidosis occurs, leading to stress and structural changes in the CV system, arterial stiffness, active chronic inflammation, instability of blood pressure and high risk of HTN, LVH, HF, CAD, strokes and death by CV origin.¹¹

5) Adaptations in mineral and bone metabolism

Mineral and bone disorder (MBD) starts early in CKD, although biochemically is documented when GF is <60 ml/min/1.73 m².^{12,13} It contributes to the presence of CVD by several interrelated mechanisms: 1) intact parathyroid hormone (PTH) elevation promotes hypertrophy, fibrosis and action by procal-

cific and proinflammatory pathways; its interaction with aldosterone contributes to endothelial dysfunction; 2) vitamin D2 and D3 deficiency favors the expression of renin and promotes inflammation and fibrosis, because it changes the vascular smooth muscle phenotype and fibroblast growth factor 23 (FGF23) signaling. These changes decrease the renal expression of Klotho (a protein that regulates phosphocalcic mechanism and inhibits vascular calcification), and produce LVH, HF, atrial fibrillation and CV death; 3) a reduction in phosphate excretion and uremic milieu favor vascular calcification in the intima (atherosclerosis) and media layers of vessels (arteriosclerosis); this makes them stiff, elevating systolic pressure, pulse pressure, increasing afterload and favoring LVH, which in turn affect subendocardial perfusion.^{13,14,15}

6) Hematological adaptations: anemia

Anemia contributes to CV events by multiple interrelated mechanisms, based on tissue hypoxia. This state is associated to hemodynamic adaptations and cardiac remodeling, activating compensatory responses such as increase in cardiac output (tachycardia, systolic volume alteration) and peripheral vasodilation. Less O₂ arterial content with greater myocardial demand leads to subendocardial ischemia, particularly in coronary arteries with coexisting atherosclerosis, predisposing to myocardial infarction or chronic angina. On the other hand, anemia worsens RAAS and SNS overactivation, systemic inflammation, increase in oxidative stress and loss in vasodilation mechanisms, damaging the endothelium and increasing atherosclerosis and thrombosis progression. It clinically worsens HTN and afterload, which is associated to LVH, as well as myocardial fibrosis.¹⁶

7) Systemic adaptations

There are several systemic compensatory mechanisms that end up maladapting to the uremic milieu. Their contribution to the CRM continuum is briefly described:

- A) Loss of balance between the production of reactive oxygen species (ROS) and antioxidant systems of cells by uremic milieu and endothelial damage causing oxidative stress, characterized by excess of reactive species and reduction of antioxidant species (e.g.: superoxide dismutase, glutathione peroxidase). This exacerbates endothelial dysfunction, decreases bioavailability of nitric oxide, favors arterial stiffness, as well as activation of proinflammatory and proatherogenic pathways.¹⁷
- B) The uremic milieu produces dysbiosis, favoring the production and absorption of toxic metabolites (such as p-cresyl sulfate and indoxyl sulfate), which increase systemic inflammation (increase of PCR, IL6, TNF α) and vascular lesion.¹⁸
- C) The effect of more than a hundred uremic toxins on endothelial cells, cardiomyocytes and vascular smooth muscle cells promote fibrosis, calcification, thrombosis and metabolic alterations, accelerating atherosclerosis and LVH. Jointly, these processes constitute a vicious cycle that accelerates the progression of CKD and elevates global CV morbimortality.¹⁹
- D) Finally, the convergence of the described mechanisms produces malnutrition, inflammation and accelerated atheroscle-

rosis syndrome (MIA syndrome). This complex phenotype is considered a multiplier of CVR, where early vascular ageing (EVA) is a preponderant characteristic. It is known that patients present CAD and stroke early. Malnutrition reduces the capacity of the body to repair tissue, increases susceptibility to infections, and thus, inflammation remains constant and active, promoting the mechanisms that favor atherosclerosis.²⁰

CONCLUSION

The contribution of CKD to the CRM continuum lies in physiological mechanisms maladapting, which starts with an attempt to maintain homeostasis in the internal milieu. The uremic milieu makes its initial physiological effect unsustainable, and it favors endothelial damage by multiple phenomena at intrarenal and systemic level. The clinical consequence is CVD and premature death, regardless of the cause of the aggression. CVD is exponential and is directly related to a decrease in glomerular filtration and albuminuria. It is necessary to seek for renal damage in any patients with CRM continuum components and implement a treatment without delay.

BIBLIOGRAPHY

1. Ndumele CE, Rangaswami J, Chow SL, et al. Cardiovascular-Kidney-Metabolic Health: A Presidential Advisory from the American Heart Association. *Circulation* **2023**; 148: 1606 – 1635.
2. Canney M, Gunning HM, Zheng Y, et al. The Risk of Cardiovascular Events in Individuals with Primary Glomerular Diseases. *Am J Kidney Dis* **2022**; 80: 740 – 750.
3. Palomo-Piñón S, Paniagua-Sierra JR. Structural and functional cardiac abnormalities during chronic kidney disease. *Rev Med Inst Mex Seguro Soc* **2017**; 55: S201 - 5209
4. Jankowski J, Floege J, Fliser D, et al. Cardiovascular Disease in Chronic Kidney Disease *Circulation* **2021**; 143: 1157 – 1172.
5. Marx-Schütt K, Cherney DZI, Jankowski J, et al. Cardiovascular disease in chronic kidney disease. *Eur Heart J* **2025**; 46: 2148 – 2160.
6. Noels H, van der Vorst EPC, Rubin S, et al. Renal-Cardiac Crosstalk in the Pathogenesis and Progression of Heart Failure. *Circ Res* **2025**; 136: 1306 – 1334.
7. Brenner BM, Lawler E V, Mackenzie HS. The hyperfiltration theory: a paradigm shift in nephrology. *Kidney Int* **1996**; 49: 1774 – 1777.
8. Xie X, Liu Y, Perkovic V, et al. Renin-Angiotensin System Inhibitors and Kidney and Cardiovascular Outcomes in Patients With CKD: A Bayesian Network Meta-analysis of Randomized Clinical Trials. *Am J Kidney Dis* **2016**; 67: 728 – 741.
9. Kaur J, Young B, Fadel P. Sympathetic Overactivity in Chronic Kidney Disease: Consequences and Mechanisms. *Int J Mol Sci* **2017**; 18: 1682.
10. Hung S, Lai Y, Kuo K, et al. Volume Overload and Adverse Outcomes in Chronic Kidney Disease: Clinical Observational and Animal Studies. *J Am Heart Assoc* **2015**; 4: e001918.
11. Collister D, Ferguson TW, Funk SE, et al. Metabolic Acidosis and Cardiovascular Disease in CKD. *Kidney Med* **2021**; 3: 753 - 761.
12. Kidney Disease: Improving Global Outcomes (KDIGO) CKD-MBD Update Work Group. KDIGO 2017 Clinical Practice Guideline Update for the Diagnosis, Evaluation, Prevention, and Treatment of Chronic Kidney Disease-Mineral and Bone Disorder (CKD-MBD). *Kidney Int Suppl* **2017**; 7: 1 – 59.
13. Li X, Feng L, Yang Z, et al. Effect of active vitamin on cardiovascular outcomes in predialysis chronic kidney diseases: A systematic review and meta-analysis. *Nephrology* **2015**; 20: 706 – 714.
14. Disthabanchong S, Srisuwarn P. Mechanisms of Vascular Calcification in Kidney Disease. *Adv Chronic Kidney Dis* **2019**; 26: 417 – 426.
15. Edmonston D, Grabner A, Wolf M. FGF23 and klotho at the intersection of kidney and cardiovascular disease. *Nat Rev Cardiol* **2024**; 21: 11 – 24.
16. Badura K, Janc J, Wąsik J, et al. Anemia of Chronic Kidney Disease—A Narrative Review of Its Pathophysiology, Diagnosis, and Management. *Biomedicines* **2024**; 12: 1191.
17. Ho H-J, Shirakawa H. Oxidative Stress and Mitochondrial Dysfunction in Chronic Kidney Disease. *Cells* **2022**; 12: 88.
18. Akchurin OM, Kaskel F. Update on Inflammation in Chronic Kidney Disease. *Blood Purif* **2015**; 39: 84 – 92.
19. Lim YJ, Sidor NA, Toniai NC, et al. Uremic Toxins in the Progression of Chronic Kidney Disease and Cardiovascular Disease: Mechanisms and Therapeutic Targets. *Toxins (Basel)* **2021**; 13: 142.
20. Chen S, Yang P, Lv H, et al. Inflammatory markers predict MIA syndrome progression and cardiovascular disease outcomes in maintenance dialysis patients. *BMC Nephrol* **2025**; 26: 654.

Original Investigation Reports

Determination of hemodynamic forces by Cardiac Magnetic Resonance as a marker of cardiovascular events.

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ABSTRACT

Introduction: in the Alto Valle of Rio Negro (RN) in 2017, a healthcare issue was identified where hospitals do not routinely use thrombolytics (TBL) for immediate treatment of ST-Segment Elevation Acute Coronary Syndrome (STEMI) and instead refer patients for primary percutaneous coronary intervention (PCI).

Objective: to formulate an early reperfusion project that includes pre-hospital/hospital thrombolysis and PCI under the "Infarction Code" (IC) protocol to reduce the years of potential life lost (YPLL) observed in this population and to increase patient engagement.

Materials and Methods: the project was formulated using the methodology of socio-sanitary project development from a perspective of macromanagement.

Results: prioritizing PCI as the main strategy, STEMI patients from hospitals in the Eastern Health Zone should be referred to Sanatorio Juan XXIII (Level A1) or Clínica Roca (Level A2). Patients from the Western Health Zone should be referred to Fundación Médica (Level A1) or Policlínico Modelo de Cipolletti (Level A2), with direct access to the hemodynamics room. The arrival times from Catriel and El Cuy are at the threshold for PCI within 120 minutes; therefore, these patients should receive (unless contraindicated) fibrin-specific TBL followed by referral for a pharmaco-invasive strategy.

Conclusions: the situation in the Alto Valle of RN requires immediate, collective, and coordinated actions among different stakeholders to enable network-based treatment of STEMI under the IC protocol, aiming to increase the average life years gained (LYG) and to enhance patient engagement.

ABBREVIATIONS

MRI: Magnetic resonance imaging
BB: Bright-blood sequence in MRI
FT: Feature tracking
HDF: Hemodynamic forces
LGE: Late gadolinium enhancement
CLBBB: Complete left bundle branch block
LVEF: Left ventricular ejection fraction
RVEF: Right ventricular ejection fraction
LV GLS: Left ventricular global longitudinal strain
LV GCS: Left ventricular global circumferential strain
LV GRS: Left ventricular global radial strain
HF: Heart failure
AMI: Acute myocardial infarction
CHF: Congestive heart failure
HFPEF: Heart failure with preserved ejection fraction
CD: Cardiac death
IQR: Interquartile range
CRT: Cardiac resynchronization therapy

INTRODUCTION

Heart failure (HF) is a clinical syndrome characterized by the presence or history of typical symptoms and/or signs secondary to a structural or functional alteration of the heart, leading to a reduction in output or an increase in filling pressures, whether in rest or in strain.¹

There are multiple etiologies leading to this development, and their characterization is essential. From HF with preserved ejection fraction to HF with decreased ejection fraction, the continuum of this syndrome presents multiple phenotypes, in which ventricular remodeling behaves not just as adaptation to the injury, but also as its consequence.^{2,3}

For this reason, physicians need to have tools available, enabling an adequate assessment for decision-making. One of the key aspects for this is the impact on myocardial structure compromise and its consequences on ventricular function, quality of life and survival of cardiovascular patients.

Currently, we have ventricular function and structure analysis tools, which anticipate changes in fiber strain. Examples are myo-

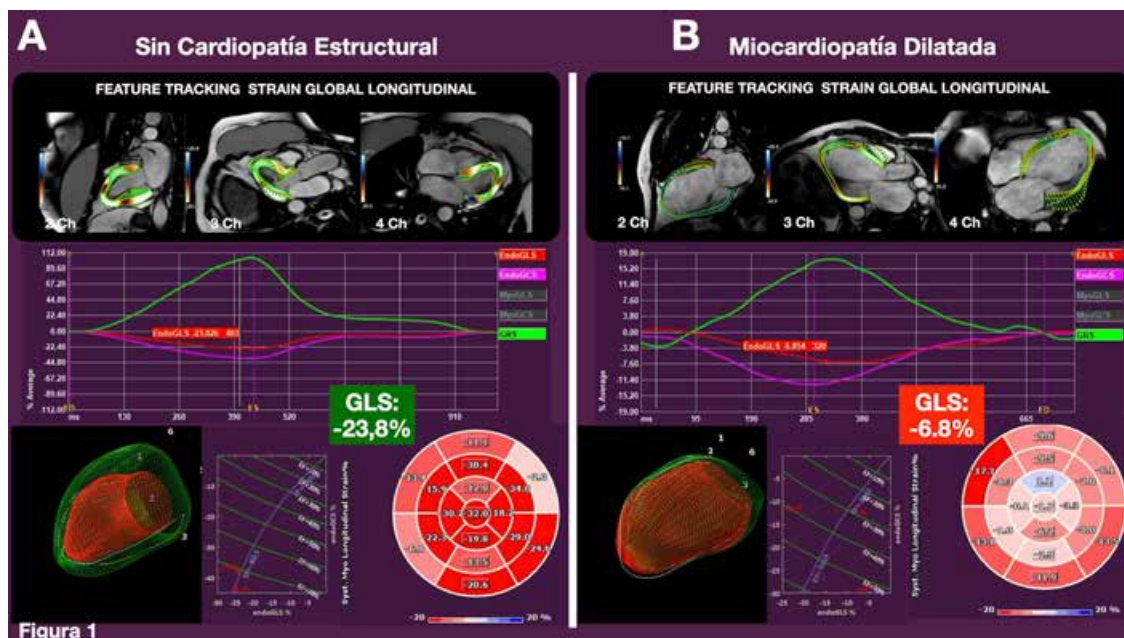


FIGURE 1.

Myocardial strain assessment by feature tracking in patients with and without structural disease

In the figure, we present two contrasting scenarios to illustrate GLS: a patient without structural pathology (A) and another with dilated cardiomyopathy (B). In the above section, we observe the endocardial delimitation made in bright-blood sequences for estimation by FT in 2-, 3- and 4-chamber views. In the central section, we show the global graph results of strain by curves: the red curve represents GLS, the purple one GCS and the green one GRS. Finally, the inferior part of the graph:

- From left to right: 3D model of left ventricular structure.
- A graph relating GLS (%) with GCS (%) jointly with LVEF, enabling a fast interpretation of the strain-function relation, very useful for the follow-up.
- Polar map for regional assessment of GLS by segments.

GLS: global longitudinal strain; GCS: global circumferential strain; GRS: global radial strain; LVEF: left ventricular ejection fraction.

cardial strain measured by transthoracic echocardiography and/or magnetic resonance imaging (MRI). It is also possible to estimate the onset of mechanical contraction by myocardial mechanical synchrony evaluation with Phase analysis with gated SPECT in myocardial perfusion studies. These elements have proven to generate incremental prognostic value for the method they accompany, and subsequently, they may prove their impact on regional and global myocardial function.^{4,5,6} Recent studies have introduced the evaluation of left ventricular hemodynamic forces (HDF) as a promising method for mechanical and noninvasive evaluation of the interaction between the left ventricle and intracardiac blood movement, which could be valuable in the study of different cardiomyopathies. The HDFs evaluated by MRI allow to contemplate the intimate interaction of the blood pool with endocardial tissue, analyzed by myocardial movement and represented by left ventricular wall motion velocity, reconstructed by myocardial global longitudinal strain (GLS) and the amount of blood going through the valves (applying the principle of conservation of mass). The average gradients of intraventricular pressure may be estimated by a mathematical model that, taking advantage of the balance of the moment, integrates left ventricular geometry and the movement of the wall with the areas of the aortic and mitral valve orifices. Projected in specific directions within the left ventricle, this HDF may be broken down into longitudinal and transversal components. This concept of myocardial mecha-

nical functional estimation is validated by 3D phase contrast or 4DFlow, and has the potential to facilitate the determination of intraventricular gradients, not requiring to make patients undergo invasive procedures.⁷ It is for this reason that this study was set out to assess hemodynamic forces in a population of patients who underwent MRI to determine its capacity and usefulness as a cardiovascular prognostic marker.

METHODS

An analysis was made retrospectively of patients who underwent conventional MRI due to different indications, in an institution of outpatient diagnosis. The follow-up of patients by a post-study phone interview and analysis of digital clinical history between years 2015 and 2023. In follow-up, major cardiovascular events were analyzed, such as myocardial infarction (AMI), heart failure admission (HFA) and cardiovascular death (CD), as well as the composite endpoint of AMI + HFA + CD.

Image acquisition

Philips Achieva and Prodrive MRI devices were used, of 1.5 T, for anatomical assessment and volume quantification. The acquired images were synchronized by ECG of permanent registry and active coordination of apnea. Late gadolinium enhancement (LGE) images were obtained approximately 10 minutes after administering contrast.

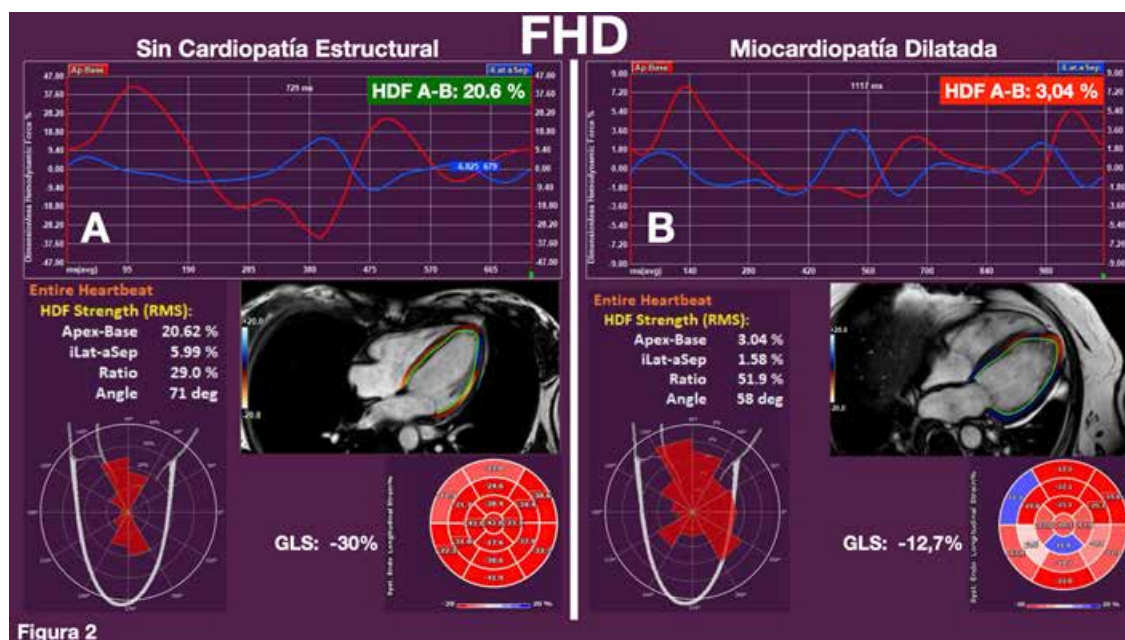


FIGURE 2.

Assessment of hemodynamic forces (HDF) in patients with and without structural disease

Assessment of hemodynamic forces (HDF) in a patient with no structural disease (A) and another with dilated cardiomyopathy (B). In both cases, graphs are shown that represent the evolution of HDFs over the cardiac cycle, both in the apex-base direction (red) and lateral-septal direction (blue). Quantitative analysis and visualization: quantitative variables of HDF are shown, along with a polar map (at the left in every case). This polar map shows the intensity weighted of the forces and its orientation in degrees and dimensions, outlining the left ventricle. We observe a noticeable difference between the two examples. In the patient with dilated cardiomyopathy (B), the representation of HDF is less linear in regard to the 90° axis, indicating a decrease both in the apex-base and lateral-septal HDFs. Supplementary information: the figure also includes screen captures of BB images in 4-chamber views. Myocardial strain assessment by FT technique of GLS is shown, as well as its results in the polar map in both cases. This information, along with the aortic and mitral valve areas, allows the estimation of HDF by MRI.

HDF: apex-to-base hemodynamic forces; **Lateral-to-septal HDF:** septal-to-lateral hemodynamic forces; **BB:** bright blood sequence; **FT:** feature tracking; **GLS:** global longitudinal strain; **MRI:** magnetic resonance imaging.

Image analysis

The following parameters were analyzed: end diastolic volume (EDV), end systolic volume (ESV), left ventricular ejection fraction (LVEF), right ventricular ejection fraction (RVEF) by BB images. LGE images were quantified automatically with signal intensity (SI) >6 of the mean on the myocardium following the model of 17 segments of the AHA, excluding the apex.

Strain analysis and HDF by feature tracking

By Feature Tracking (FT) technique, the endocardial edges were defined in the telesystolic and telediastolic frame. Then, by continuous monitoring with the post-processing software, myocardial shortening was estimated in the cardiac cycle (myocardial strain), thus calculating GCS on the long axis and GRS on the short axis. Diffusion-weighted imaging (DWI) was estimated: this is a parameter to assess regional ventricular function by FT, assessing wall movement toward the inside of the chamber and contractility (Figure 1).^{6,8}

Analysis of ventricular hemodynamic forces

Once GLS measurements in 2-, 3- and 4-chamber views were obtained by the HDF add-on tool of the software, we proceeded to manually draw aortic annulus dimensions in 3-chamber views and mitral annulus in 4-chamber views, automatically es-

timating inlet and outlet area of the left ventricular blood pool.

By this process, different measurement parameters are determined, such as amplitude ones, contemplating the three hemodynamic forces: namely, once force from the apex to the base, one force from the lateral to the septal wall, and one force from the inferior to the anterior wall, although the latter are annulled, so they are not expressed.

Simultaneously, temporality parameters are measured; these measures are associated to cardiac cycle events, derived from the hemodynamic forces, and finally orientation parameters, that are measures associated to the direction of the vector of the left ventricular forces. Provide a comparison between longitudinal forces (apex-base) and transversal forces (septal-lateral/anterior-inferior) (Figure 2).⁹

The apex-to-base, lateral-to-septal FHDs are reported as quantitative means, adjusted by LV volume, adjusted to gravity and blood flow density. These parameters are presented as percentages, allowing a comparison between individuals.^{9,10} They may be observed in real time, in a dynamic way, according to the selection of the phase of the cardiac cycle of interest by software interphase with a polar map of weighed intensity, which reflects the orientation of the vector in degrees and the respective orientation in regard to the overlapped outlined figure of the left ventricle.

TABLE 1.
Characteristics of the population in the study

Characteristics of the population	Total of patients (N° 126)
Age (years)	53 ($\pm$ 1575)
Male gender (%)	78 (62)
Hypertension (%)	73 (58)
Smoking (%)	13 (103)
Diabetes Mellitus (%)	16 (127)
Dyslipidemia (%)	46 (365)
Previous TCA (%)	7 (56%)
Functional parameters in MRI	
LVEF (%)	538 ($\pm$ 149)
RVEF (%)	495 ($\pm$ 108)
Amount in % of late gadolinium enhancement	39 ($\pm$ 78)
LV Global Longitudinal Strain	-193 ($\pm$ 64)
RV Global Longitudinal Strain	-318 ($\pm$ 385)
Parameters of hemodynamic forces by MRI	
Apex-to-base HDF	169 ($\pm$ 10)
Lateral-to-septal HDF	3 ($\pm$ 138)
Vector angle HDF	731 ($\pm$ 45)
AB/SL HDF	207 ($\pm$ 143)
Clinical follow-up	
Non-cardiac death (%)	2 (16)
Admission due to HF (%)	15 (119)
Acute myocardial infarction (%)	3 (24)
Cardiac death (%)	9 (71)
Composite endpoint (CD.HFA.AMI) (%)	24 (19)

TCA: transcatheter coronary angioplasty; RVEF: right ventricular ejection fraction; LVEF: left ventricular ejection fraction; HDF: hemodynamic forces; HF: heart failure; CD: cardiac death; HFA: heart failure admission; AMI: acute myocardial infarction; RV: right ventricle; LV: left ventricle.

Statistical analysis

The data analyzed of quantitative variables are presented as mean and standard deviation for those with normal distribution, and median with interquartile ranges (IQR) for those with non-normal distribution. The differences between groups were analyzed by t-test or Mann-Whitney for continuous variables and X2 or Fisher's exact test for categorical variables. Pearson correlation coefficient was used to examine the association between continuous parameters. Survival multivariate analyses with Cox proportional hazards model were carried out to evaluate the hazard ratio (HR) and 95% confidence interval (95% CI). Kaplan-Meier curves were estimated for the apex-base HDF and lateral-septal HDF variables. The statistical analysis was carried out with the commercial software Wizard Pro-2 Mac OS, SPSS, and open-source Jamovi.

TABLE 2.
Clinical and MRI characteristics according to groups

Variable	Apex-to-base HDF > 75% (N° 105)	Apex-to-base HDF < 75% (N° 21)	Significance
Age	54 (IQR 427-663)	62 (IQR 55-67)	P=003
CLBBB (%)	48	286	P<001
CRBBB (%)	48	0	P=031
Hypertension	628	333	P=001
Smoking	76	238	P=003
Dyslipidemia	352	428	P=051
Diabetes Mellitus	95	286	P=002
RVEF	525 (49-56)	36 (267-48)	P<001
LVEF	60 (54-65)	28 (21-41)	P<001
LGE percentage amount	0 (0-3)	5 (0-19.3)	P=001
LV GLS	-218 (24-191)	-96 (117 - 79)	P<001
RV GLS	-297 (338-266)	-228 (299-171)	P<001
Apex-to-base HDF	164 (126 - 224)	62 (45-65)	P<001
Composite event	10 (952%)	14 (66%)	P<001

CLBBB: complete left bundle branch block; CRBBB: complete right bundle branch block; RVEF: right ventricular ejection fraction; LVEF: left ventricular ejection fraction; LGE: late gadolinium enhancement; HDF: hemodynamic forces; GLS: global longitudinal strain; LV: left ventricle; RV: right ventricle.

RESULTS

Study population

A total of 137 patients underwent MRI during the follow-up period between years 2015 and 2023, of whom 126 could complete the MRI re-evaluation and the FT technique for HDF analysis. The main clinical and MRI characteristics are summarized in *Table 1*. The mean age of patients was 53.7 years ($\pm$ 15.7), of whom 78 (62%) were males. The pre-established composite event had a 19% incidence (n=24). The apex-to-base HDF presented a cutoff value of 7.5% to identify patients who would develop a major event, with an area under the ROC curve of 0.829 (95% CI 0.725-0.934), $p<0.0001$, 91% sensitivity and 59% specificity (*Figure 3A*); 66% of patients (N=14) with apex-to-base HDF <7.5% presented a composite event, while only 9.5% (N=10) presented it, with apex-to-base HDF >7.5% (*Table 2*). The time median for the appearance of a major event was 104 months for the group with apex-to-base HDF, in comparison with 89 months in the depressed HDF group (*Figure 3B*).

Analysis of ROC curves of HDF variables was also conducted, as lateral-septal and vector angle. The two variables presented significant ROC curves, with the lateral-septal HDF presenting an AUC of 0.787 (95% CI 0.680-0.893), $p<0.0001$, with a cutoff value of 2.44%, and vector angle HDF presenting an AUC of 0.720 (95% CI 0.593-0.846), $p=0.001$, cutoff value of 69. Given the slight superiority of apex-base HDF to classify patients, it was decided to continue with it as the comparison variable in the study.

In *Table 2*, the significant differences presented by patients are shown, both in terms of clinical history and MRI parameters.

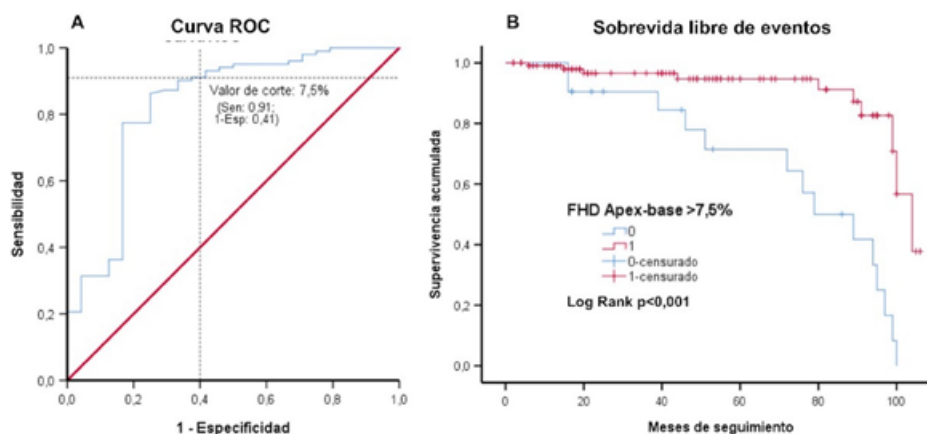


FIGURE 3.

Analysis for the determination of the cutoff point of apex-to-base HDF optimizing risk prediction of incidence of a composite event

A. ROC curve: it was used to determine the sensitivity and specificity of a cutoff point of 7.5% of apex-to-base HDF, selected as it maximizes the incidence of the composite event.

B. Kaplan-Meier (Log-Rank) survival analysis: it allowed to manifest the evolution of two population groups discriminated by a cutoff point of apex-to-base HDF of more than 7.5%.

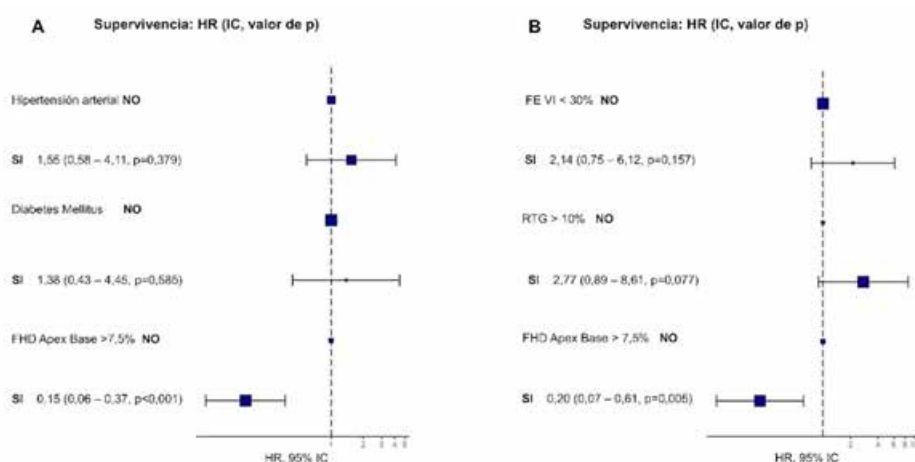


FIGURE 4.

Multivariate analysis of clinical predictors and of MRI for the development of composite event

A. Impact of apex-to-base HDF of more than 7.5% in relation to classical cardiovascular risk factors.

B. Impact of apex-to-base HDF of more than 7.5% in relation to risk markers acknowledged in literature with severe ventricular dysfunction (LVEF <30%) and significant necrotic load (LGE 10% of the left ventricle).

HR: hazard ratio; CI: confidence interval.

A multivariate analysis was made to learn the value of hemodynamic forces in comparison with clinical history and previously validated MRI parameters. Given the low numbers of events, the use of a variable was estimated for each 10 patients that presented the event, so it was compared with another two variables only. In a multivariate analysis that included the clinical risk factors described in the bibliography for the development of major events, the presence of apex-base HDF lower than 7.5% presented an adjusted hazard ratio value of 6.49 (95% CI 2.73-15.45, $p < 0.001$); while the other predictors were not significant (Figure 4A).

Another multivariate analysis that included the main measurement of MRI according to the risk cutoff determined by bibliography (LVEF <30% and LGE >10%) showed that the presence of apex-base HDF lower than 7.5% presented an adjusted hazard ratio value of 4.90 (95% CI 1.69-14.68, $p = 0.005$); while the other predictors were not significant (4B).

DISCUSSION

In this population, analyzed retrospectively, it was observed that HDF presented a statistically significant capacity at the time of separating patients with appearance of composite adverse event in comparison with conventional clinical risk factors and with measurements estimated by MRI such as LVEF and LGE.

Cardiovascular assessment is constantly evolving, transcending LVEF as the only risk parameter. Adding dynamic fluids analysis, such as flow mechanics vortices, offers a new perspective on the complex hemodynamic interaction and cardiovascular disease load. This approach conceptualizes the intrinsic relationship between myocardial tissue and blood flow with the early consequences of ventricular remodeling.^{11,12} The introduction of HDF assessment in clinical practice through MRI may entail an advancement in the assessment of patients in heart failure.¹³ The novelty of this model lies in its capacity to estimate the main characteristics of the hemodynamic force vector from the dynamics of endocardial tissue, not requiring the direct measurement of blood flow velocity within the left ventricle.⁷

This approach could be applicable in the follow-up of patients with heart failure with preserved ejection fraction (HFpEF), or those with marked compromise in the left ventricular architecture, dyssynchronous and with severe deterioration of LVEF, due to its capacity to evaluate cardiac dynamics, in the identification of dyssynchrony pattern and the response to cardiac resynchronization therapy (CRT).^{2,14}

In patients with advanced heart failure and complete left bundle branch block (CLBBB), Eriksson J. et al. analyzed the impact of cardiac dyssynchrony by HDF. Its findings revealed signifi-

cant differences in filling patterns and flow distribution between patients with CLBBB and dyssynchrony, suggesting HDF could be useful to predict the response to CRT.¹⁵ The author highlights the substantial alteration of systolic and diastolic patterns, both in quantity and quality. The delay and mechanical asynchronous activation, often accompanied by widened QRS, generate an increase in transversal HDF (lateral-septal HDF), leading to dissipation of the energy generated. The alignment generated by CRT, measured by HDF, is an important marker of response to the treatment.¹⁵

It is known that currently, MRI has consolidated as an invaluable tool in the comprehensive evaluation of cardiac function. Its advantages include thorough tissue characterization, high spatial resolution, and thorough functional evaluation. MRI allows to categorize the causes of ventricular dysfunction, differentiate it from other diseases as infiltrative and pericardial disorders, and to provide prognostic information by techniques like late gadolinium enhancement and parametric mapping.^{16,17} In this regard, HDFs show a significant correlation with LGE extent, particularly the apex-base and lateral-septal HDFs, suggesting a direct connection between HDF and fibrosis and myocardial remodeling. This finding is supported by the recent study published by Shao et al., where 63 patients with type 2 diabetes and 50 healthy volunteers were evaluated. In this study, in spite of left ventricular ejection fraction (LVEF) and myocardial strain not showing statistically significant differences between groups, a noticeable alteration was observed in the HDFs of diabetic patients. This suggests that HDFs could work as an early and sensitive marker of subclinical myocardial dysfunction, even in the absence of alterations detectable by conventional parameters.¹⁸

The findings of our study, just as with the study by Shao et al., would be in line with the idea that HDFs could provide more accurate functional information, and more sensitive to changes, in comparison with the conventional parameters of MRI.

Limitations

This registry was based on the observation of an outpatient population of general and derived character for different evaluations, which may present selection biases in the population. The rate of events in relation to the sample could be small, and it would be a challenge to continue recording data to increase it for a future analysis.

CONCLUSIONS

In our study, the presence of apex-base HDF of less than 7.5% was associated significantly to a greater incidence of the composite event in regard to patients with a value of more than 7.5%.

The functional analysis of HDF could enhance the value of conventional MRI, providing a new instrument for control and functional monitoring of patients with suspicion or impact of cardiovascular disease.

It is necessary to perform a greater number of studies, with selected populations and longitudinal follow-up, to determine the true prognostic and diagnostic power of this novel technique.

BIBLIOGRAPHY

1. Fernández A, Thierier J, Fairman E, et al. Consenso de Insuficiencia Cardíaca. *Rev Arg Cardiol* **2023**; 91: 1 - 80.
2. Maydana M, Nasca P, Colque R, et al. Recomendaciones de la Federación Argentina de Cardiología para el manejo de pacientes con insuficiencia cardíaca con fracción de eyección preservada. *Rev Fed Arg Cardiol* **2024**; 53 (Supl. 2): 3 - 21.
3. Filomena D, Cimino S, Monosilio S, et al. Impact of intraventricular haemodynamic forces misalignment on left ventricular remodelling after myocardial infarction. *ESC Heart Fail* **2022**; 9: 496 - 505.
4. Gutierrez L, Peñafof F. Nuevas herramientas diagnósticas en insuficiencia cardíaca: análisis de fase mediante SPECT-Gatillado para evaluación de sincronía miocárdica. *Rev Fed Arg Cardiol* **2013**; 42: 102 - 112.
5. Buss SJ, Breuninger K, Lehrke S, et al. Assessment of myocardial deformation with cardiac magnetic resonance strain imaging improves risk stratification in patients with dilated cardiomyopathy. *Eur Heart J Cardiovasc Imaging* **2015**; 16: 307 - 315.
6. Scatteia A, Baritussio A, Bucciarelli-Ducci C. Strain imaging using cardiac magnetic resonance. *Heart Fail Rev* **2017**; 22: 465 - 476.
7. Pedrizzetti G. On the computation of hemodynamic forces in the heart chambers. *J Biomech* **2019**; 95: 109323.
8. Hegeman R, McManus S, Toth A, et al. Reference Values for Inward Displacement in the Normal Left Ventricle: A Novel Method of Regional Left Ventricular Function Assessment. *J Cardiovasc Dev Dis* **2023**; 10: 474.
9. Vallenga F, Airale L, Tonti G, et al. Introduction to Hemodynamic Forces Analysis: Moving Into the New Frontier of Cardiac Deformation Analysis. *J Am Heart Assoc* **2021**; 10: e023417.
10. Laenens D, van der Bijl P, Stassen J, et al. Introduction to hemodynamic forces by echocardiography. *Int J Cardiol* **2023**; 370: 442 - 444.
11. Pedrizzetti G, La Canna G, Alfieri O, et al. The vortex—an early predictor of cardiovascular outcome? *Nat Rev Cardiol* **2014**; 11: 545 - 553.
12. Pedrizzetti G, Sengupta PP. Vortex imaging: new information gain from tracking cardiac energy loss. *Eur Heart J Cardiovasc Imaging* **2015**; 16: 719 - 720.
13. Lapinskas T, Pedrizzetti G, Stoiber L, et al. The Intraventricular Hemodynamic Forces Estimated Using Routine CMR Cine Images: A New Marker of the Failing Heart. *JACC Cardiovasc Imaging* **2019**; 12: 377 - 379.
14. Vos JL, Raafs AG, Henkens M, et al. CMR-derived left ventricular intraventricular pressure gradients identify different patterns associated with prognosis in dilated cardiomyopathy. *Eur Heart J Cardiovasc Imaging* **2023**; 24: 1231 - 1240.
15. Eriksson J, Zajac J, Alehagen U, et al. Left ventricular hemodynamic forces as a marker of mechanical dyssynchrony in heart failure patients with left bundle branch block. *Sci Rep* **2017**; 7: 2971.
16. Mahrholdt H, Wagner A, Holly TA, et al. Reproducibility of chronic infarct size measurement by contrast-enhanced magnetic resonance imaging. *Circulation* **2002**; 106: 2322 - 2327.
17. Messroghli DR, Moon JC, Ferreira VM, et al. Clinical recommendations for cardiovascular magnetic resonance mapping of T1, T2, T2* and extracellular volume: A consensus statement by the Society for Cardiovascular Magnetic Resonance (SCMR) endorsed by the European Association for Cardiovascular Imaging (EACVI). *J Cardiovasc Magn Reson* **2017**; 19: 75.
18. Shao G, Cao Y, Cui Y, et al. Impaired hemodynamic forces assessed by routine CMR and its determinants in different duration T2DM patients with normal IV function and myocardial strain. *Front Cardiovasc Med* **2025**; 12: 1460094.

Original Investigation Reports

Renal biomarkers and electrolytes as predictors of 6-month emergency readmission in heart failure: analysis stratified by sex

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ABSTRACT

Introduction: cardiovascular diseases represent the leading cause of mortality and hospitalization worldwide. Among them, non-ST-segment elevation acute coronary syndromes are a common manifestation. In Argentina, disparities in access to specialized services hinder a uniform approach to this condition.

Objective: the RENASCA.AR registry aimed to characterize the clinical, therapeutic, and evolutionary profile of patients with NSTEMI across different levels of healthcare in the country.

Methods: a prospective, multicenter study was conducted, including 679 patients hospitalized in 31 centers between November 2022 and December 2024.

Results: the mean age was 63 years, and 27.1% were women. The most frequent clinical presentation was NSTEMI (65%), followed by unstable angina (25%) and MINOCA (10%). Coronary angiography was performed in 90% of patients, with a median time to procedure of 22 hours. The overall rate of percutaneous coronary intervention (PCI) was 67%, significantly higher in men than in women (67% vs. 45%; $p < 0.001$). In-hospital mortality was 1.4%, and the composite event rate (death and/or decompensated heart failure) was 11.1%, with a higher prevalence in women than men (15.2% vs 9.6%; $p < 0.04$).

INTRODUCTION

Heart failure (HF) constitutes one of the main causes of hospital admission and readmission in the elderly.¹ Particularly, readmissions to ER services during the first six months after hospital discharge are frequent and are associated to a high care load, more morbidity and worse clinical outcome.² In spite of therapeutic advancements and ambulatory monitoring, an early identification of patients in higher risk of readmission is still a relevant clinical challenge.

In such scenario, renal biomarkers and serum electrolytes are supplementary tools when evaluating hemodynamic state, renal function and metabolism in patients with HF, which, although not properly standardized parameters in this clinical group, may reflect in a more dynamic manner changes in renal perfusion, congestion and fluid and electrolyte balance, particularly in contexts of diuretics or circulating volume fluctuations.³ Furthermore, they are available in routine and present a low cost, making them useful to predict adverse clinical events, such as readmission to the ER in a long term. However, their specific prognostic value in the immediate post-hospital period in patients previously admitted due to HF has not been fully established.

Moreover, the biological differences between men and women may influence progression of HF, the response to treatment and the biochemical profile associated to decompensations.⁴ These

differences may modify the predictive value of certain biomarkers, underscoring the need for studies exploring associations differentiated by biological sex.

This study had as its goal to assess the association between different renal biomarkers and serum electrolytes and the risk of readmission to the ER within 6 months, in patients previously hospitalized due to heart failure, by survival analysis stratified by sex. This approach seeks to offer evidence for a more accurate and personalized risk stratification, with potential implications in clinical follow-up and therapeutic decision-making.

MATERIALS AND METHODS

Design and population

A retrospective cohort study was carried out using a secondary database from the public repository PhysioNet; specifically, the data set called "Hospitalized patients with heart failure: integrating electronic healthcare records and external outcome data" (version 1.3). This database includes clinical, laboratory and follow-up information from 2009 patients hospitalized due to heart failure in a tertiary hospital, specialized in cardiovascular diseases, from December 2016 to June 2019.

The original inclusion of patients was based on diagnostic criteria for heart failure from the European Society of Cardiology (ESC), which consider the presence of compatible symptoms

and signs, elevation of natriuretic peptides (BNP >35 pg/mL or NT-proBNP >125 pg/mL), and electrocardiographic alterations of cardiac function.⁵

For this analysis, 1904 patients were included, with complete information on clinical variables, renal biomarkers and serum electrolytes, besides the outcome of readmission to the ER within 6 months. Cases with invalid follow-up times or with missing data for the main variables were ruled out, thus guaranteeing a depurated sample for the survival analysis.

Variables and measurements

The variables analyzed in this study included sociodemographic, biochemical and clinical outcome data. Sex (male/female) and age (in years) were considered as the main sociodemographic variables. Between renal biomarkers and serum electrolytes, we evaluated: creatinine ($\mu\text{mol/L}$) and cystatin C (mg/L); all of them obtained by standard biochemical methods, recorded in the original repository. The glomerular filtration rate (GFR) was estimated in mL/min/1.73 m^2 and considered as a renal function indicator.

The main outcome was readmission to the ER within the six months after hospital discharge, encoded as dichotomous variable (yes/no). This readmission corresponded to any cause, as the repository did not specify the etiology of the event or allowed to differentiate specific readmissions due to heart failure from other clinical reasons.

These measurements were obtained from standardized clinical registries, and were selected because of their availability and clinical relevance in a context of renal function evaluation during hospitalization due to heart failure.

Statistical analysis

A descriptive and comparative statistical analysis was made to characterize the population of patients admitted due to heart failure, differentiated by sex. To compare the means of renal biomarkers and serum electrolytes, as well as other continuous variables between women and men, Student's t-test was applied for independent samples, with estimation of 95% confidence intervals and estimation of the effect size by Cohen's d, with the aim of assessing the magnitude of the differences observed. Cohen's d values were interpreted according to the following ranges: small effect (0.20-0.49), medium effect (0.50-0.79) and large effect (≥ 0.80).

Subsequently, Cox regression models were applied to analyze the association between biomarkers and the risk of readmission to the ER within 6 months. Stratified models by sex were developed, as well as models with sex x renal biomarkers and serum electrolytes interactions, with the aim of exploring the modifying effects of sex on the associations. The associations were expressed as hazard ratios (HR) with their respective 95% confidence intervals, and global adjustment of the model was evaluated by verisimilitude test (global Chi-square test).

Survival analyses included both events and censored cases, and those with missing data were ruled out. All analyses were made with a $p < 0.05$ significance level, using the IBM SPSS Statistics software, version 27.

Ethical considerations

This investigation was based on the analysis of a secondary database from the PhysioNet repository, used following the PhysioNet Restricted Health Data License 1.5.0 terms. As the data had already been collected, anonymized and did not contain information that would lead to the identification of individuals, an informed consent was not required. This study was made according to the ethical principles of the Declaration of Helsinki and other international regulations about the use of secondary data in scientific research.

The database and its complementary files are publicly available at the following link:

<https://doi.org/10.13026/wd7p-qy77>

RESULTS

The analyzed sample was made up by approximately 1900 patients, admitted due to heart failure, of whom most were women and adults older than 70 years. As to biomarkers, the adjusted values showed a moderately preserved renal function in average, with a glomerular filtration rate (GFR) within the expected clinical range and serum levels of creatinine, urea, uric acid and cystatin C compatible with mild to moderate renal dysfunction. Electrolytes such as potassium and chloride were within physiological margins, although with some variability. In the six-month follow-up, a little less than half of patients presented readmission

TABLE 1.
Descriptive statistics of renal biomarkers and electrolytes (N=1904)

A. Descriptive statistics				
Variable	Minimum	Maximum	Mean	Standard deviation
GFR (mL/min/1.73 m ²)	5	150	68.66	36.61
Creatinine ($\mu\text{mol/L}$)	35	600	108.92	79.12
Urea (mmol/L)	1.58	45.63	9.57	5.55
Uric acid ($\mu\text{mol/L}$)	100	900	483.02	169.66
Cystatin C (mg/L)	0.4	6	1.84	0.95
Potassium (mmol/L)	2.2	7.5	3.98	0.71
Chloride (mmol/L)	85	115	101.79	6.05
B. Categorical variables				
Variable	Category	N	%	
Age	Up to 69 years	546	28.7 %	
	70 years or more	1358	71.3 %	
Readmission to the ER within 6 months	Occurred event	876	46.0 %	
	Censored	1028	54.0 %	
Sex	Men	845	44.4 %	
	Women	1059	55.6 %	

to the ER, highlighting the clinical relevance of monitoring this population after discharge (Table 1).

In the sample of patients hospitalized due to heart failure (N=1904), significant differences were observed between men and women in several biomarkers. Men presented higher levels of creatinine (119.86 vs. 100.95 $\mu\text{mol/L}$), urea (10.10 vs. 9.18 mmol/L) and uric acid (519.61 vs. 456.39 $\mu\text{mol/L}$), with statistically significant differences ($p < 0.001$), and small to moderate effect sizes ($d = 0.17$ - 0.38). Cystatin C was also slightly higher in men (1.90 vs. 1.80 mg/L; $p = 0.022$), with a low effect size ($d = 0.10$). No significant differences were found in GFR ($p = 0.773$), calcium ($p = 0.134$) or potassium ($p = 0.065$); although chloride was slightly higher in men (102.26 vs. 101.44 mmol/L; $p = 0.003$; $d = 0.14$). These findings indicate a biochemical and renal profile discretely more altered in males (Table 2).

In the Cox regression model stratified by sex, differential associations between biomarkers and the risk of readmission to the ER within 6 months were identified. In men, each 1 ml/min decrease in GFR was significantly associated with a relative increase of 0.7% in the risk of readmission (HR=1.007; 95% CI: 1.002-1.013; $p = 0.01$), while in women this association was not significant. On the contrary, calcium showed a strong as-

sociation with a greater risk only in women (HR=2.212; 95% CI: 1.347-3.633; $p = 0.002$), with no effect in males. Likewise, age ≥ 70 years was associated with a greater risk only in women (HR=1.308; 95% CI: 1.021-1.676; $p = 0.034$). Other markers like creatinine, uric acid, potassium, chloride, urea and cystatin C did not show statistically significant associations in none of the groups. The global model was significant for both sexes, with less adjustment in women ($\chi^2 = 27.88$; $p = 0.001$) than in men ($\chi^2 = 18.09$; $p = 0.034$). These results show possible sex-specific differences in the mechanisms associated to readmission due to heart failure (Table 3).

In the 6-month follow-up, events were recorded in 43.3% of men and 41.3% of women, with censorship rates slightly higher than 50% in both sexes, and a percentage of lost data of less than 6%. Cox regression models showed a significant global adjustment in both groups, being more marked in women ($\chi^2 = 27.88$; $p = 0.001$) than in men ($\chi^2 = 18.09$; $p = 0.034$).

In the Cox regression model that included interactions between renal biomarkers and serum electrolytes and sex, significant associations were identified with the risk of readmissions to the ER within 6 months. Every 1 ml/min decrease in GFR was associated with a relative increase of 0.5% in risk (HR=1.005; 95% CI:

TABLE 2
Comparison of biomarkers between men and women (N=1904)

Variable	Mean males (SD)	Mean females (SD)	Means difference (95 % CI)	P value	Cohen's d
Creatinine ($\mu\text{mol/L}$)	119.86 (69.64)	100.95 (84.50)	18.91 [11.90 – 25.92]	< 0.001	0.24
Urea (mmol/L)	10.10 (5.54)	9.18 (5.52)	0.92 [0.43 – 1.41]	< 0.001	0.17
Uric acid ($\mu\text{mol/L}$)	519.61 (169.93)	456.39 (164.49)	63.22 [48.35 – 78.09]	< 0.001	0.38
GFR (ml/min/1.73 m ²)	68.95 (37.50)	68.46 (35.97)	0.49 [-2.81 – 3.78]	0.773	0.01
Cystatin C (mg/L)	1.90 (0.93)	1.80 (0.96)	0.10 [0.01 – 0.18]	0.022	0.1
Calcium (mmol/L)	2.29 (0.17)	2.30 (0.19)	-0.012 [-0.028 – 0.004]	0.134	-0.07
Potassium (mmol/L)	4.02 (0.65)	3.96 (0.74)	0.058 [-0.003 – 0.119]	0.065	0.08
Chloride (mmol/L)	102.26 (6.01)	101.44 (6.05)	0.82 [0.29 – 1.36]	0.003	0.14

TABLE 3.
Results of Cox regression analysis: comparison of associations by sex

Variable	HR males (95% CI)	P	HR females (95% CI)	p
GFR	1.007 (1.002–1.013)	0.01	1.000 (0.996–1.005)	0.904
Creatinine	0.997 (0.995–1.000)	0.101	1.002 (0.999–1.004)	0.139
Uric acid	1.001 (1.000–1.001)	0.108	1.001 (1.000–1.001)	0.143
Calcium	0.785 (0.425–1.452)	0.441	2.212 (1.347–3.633)	0.002
Potassium	0.999 (0.835–1.196)	0.994	1.104 (0.977–1.248)	0.113
Chloride	0.993 (0.975–1.010)	0.398	0.989 (0.973–1.004)	0.154
Age ≥ 70 years	1.020 (0.790–1.317)	0.881	1.308 (1.021–1.676)	0.034
Urea	0.985 (0.957–1.013)	0.296	0.998 (0.972–1.025)	0.887
Cystatin C	1.082 (0.905–1.293)	0.388	0.876 (0.727–1.055)	0.163

1.000-1.010; $p=0.04$) and higher levels of uric acid ($HR=1.001$; 95% CI: 1.000-1.002; 95% CI: 1.000-1.002; $p=0.031$) were significantly associated with a higher risk. Besides, significant interactions were observed for creatinine ($HR=1.004$; 95% CI: 1.000-1.007; $p=0.045$) and chloride ($HR=0.981$; 95% CI: 0.968-0.995; $p=0.007$), indicating an effect differentiated by sex in the relationship of these biomarkers with the outcome. The model showed a significant global adjustment ($\chi^2=42.13$; $gl=17$; $p<0.001$), with 1904 records analyzed (94.8% of the total), a rate of events of 42.1% and a censorship of 52.7%. These findings highlight the relevance of considering interactions by sex in the prognostic analysis of patients with heart failure (Table 4).

From the initial 2009 records, 1904 cases were included (94.8%) in the analysis, with 42.1% of events observed and 52.7% of censorship. There were 105 cases ruled out (5.2%) due to lost values, without the presence of negative times or censorship before the event closest to the defined strata. The Cox regression model showed a significant global adjustment ($\chi^2=42.13$; $gl=17$; $p<0.001$), with consistent improvement in regard to the pass and the previous block.

DISCUSSION

The results of this study provide relevant evidence on the prognostic usefulness of renal biomarkers and serum electrolytes in hospital readmission due to HF in a 6-month follow-up after discharge. From the analysis stratified by sex, differential associations were observed, reinforcing the need to consider the biological and clinical profile of men and women at the time of estimating the risk of decompensation and readmission.

In men, it was observed that each 1 ml/min decrease in GFR estimated upon hospital admission was associated to a relative

increase in the risk of readmission to the ER within 6 months ($HR=1.007$; $p=0.01$), coinciding with literature that emphasizes the relationship between renal dysfunction and poor prognosis in HF. A lower GFR may reflect a decrease in renal perfusion secondary to low cardiac output, greater sodium and fluid retention, and greater volume load, which in turn is translated into a greater risk of clinical decompensation.^{6,7} Moreover, GFR also has an impact on the pharmacokinetics of diuretics and neurohormonal blockers, which may alter their efficacy and increase the risk of adverse events.⁸

In contrast, between women admitted due to HF, the serum level of calcium was the main predictor for readmission within 6 months, with a robust association ($HR=2.212$; $p=0.002$). This finding may suggest, hypothetically, a more relevant role of bone mineral and calcium metabolism on certain phenotypes of female HF. Calcium is crucial in myocardial contractility, cell excitability and excitation-contraction coupling;⁹ for this reason, alterations in their levels may reflect, as a pathophysiological possibility, changes in intracellular signaling or even mechanisms associated to diastolic dysfunction, a pattern described with a higher frequency in women with HF and preserved ejection fraction (HF-pEF).¹⁰ Likewise, it is possible that in postmenopausal women, hormone changes may influence calcium homeostasis, affecting bone metabolism and cardiovascular response to hemodynamic stress.¹¹ Nevertheless, these explanations should be considered a hypothesis, as this study does not have echocardiographic parameters or hormone markers available.

Another relevant finding was the association between advanced age (≥ 70 years) and a greater risk of readmission within 6 months, only in women ($HR=1.308$; $p=0.034$). This result could be explained by a greater degree of frailty, less functional reserve

TABLE 4.

Cox regression model for readmission to the ER within 6 months: renal biomarkers, serum electrolytes and interactions with sex (N=1904)

Variable	B	SE	Wald	p	HR	HR 95% CI
GFR	0.005	0.003	4.237	0.04	1.005	1.000 – 1.010
Creatinine	-0.002	0.001	2.159	0.142	0.998	0.995 – 1.001
Uric acid	0.001	0	4.64	0.031	1.001	1.000 – 1.002
Calcium	0.032	0.276	0.013	0.908	1.033	0.601 – 1.775
Potassium	0.01	0.092	0.012	0.913	1.01	0.844 – 1.209
Chloride	0.001	0.007	0.045	0.833	1.001	0.988 – 1.016
Age ≥ 70 years	0.155	0.09	2.965	0.085	1.168	0.979 – 1.394
Urea	-0.015	0.015	1.024	0.312	0.985	0.958 – 1.014
Cystatin C	0.082	0.089	0.837	0.36	1.085	0.911 – 1.292
Sex $\times$ GFR	0.004	0.003	1.876	0.171	1.004	0.998 – 1.011
Sex $\times$ Urea	0.012	0.02	0.356	0.551	1.012	0.973 – 1.052
Sex $\times$ Creatinine	0.004	0.002	4.029	0.045	1.004	1.000 – 1.007
Sex $\times$ Cystatin C	-0.224	0.13	2.967	0.085	0.799	0.619 – 1.031
Sex $\times$ Calcium	0.59	0.324	3.318	0.069	1.804	0.956 – 3.405
Sex $\times$ Potassium	0.088	0.111	0.621	0.431	1.092	0.878 – 1.358
Sex $\times$ Chloride	-0.019	0.007	7.257	0.007	0.981	0.968 – 0.995
Sex $\times$ Uric acid	0	0.001	0.8	0.371	1	0.999 – 1.001

and a greater load of comorbidities that are usually present in the female gender, contributing to a more unstable clinical course.¹² Elderly women with HF frequently present a clinically complex phenotype, with hypertension, obesity, diastolic dysfunction and greater sensitivity to volume changes, which may increase the likelihood of decompensation and unscheduled visits to the ER.¹³

In the model that included interactions between sex and biomarkers, it was found that both a lower GFR (HR=1.005; $p=0.04$) and more elevated levels of uric acid (HR=1.001; $p=0.031$) were associated to a higher risk of readmission within 6 months, in the whole sample. Uric acid, a marker of purine and oxidative stress metabolism, has been linked to neurohormonal activation and chronic inflammatory state, which may explain its prognostic value.¹⁴ However, beyond its global associations, it was particularly remarkable that creatinine (HR of interaction = 1.004; $p=0.045$) and chloride (HR of interaction = 0.981; $p=0.007$) presented significant interactions with sex.

The interaction between sex and creatinine indicates that the prognostic effect of this biomarker varies according to sex, possibly with greater clinical weight in women. As creatinine is influenced by muscle mass, women (with less lean body mass in average) may present relatively low levels in spite of compromised renal function, which make even mild increases to be clinically relevant.¹⁵ This suggests that diagnostic thresholds based on creatinine may underestimate the risk in women if not properly adjusted for their physiological context.

On the other hand, the significant interaction between sex and chloride reinforces its role as an underestimated marker in HF. Chloride, besides participating in the acid-base balance, regulates renal tubular reabsorption and loop diuretics action.¹⁶ The greater sensitivity to chloride in women could be due to differences in neurohormonal response, as well as possibly to renal pharmacokinetics or even a bigger incidence of hypochloremia secondary to treatments with diuretics.¹⁷

Although other biomarkers like urea, cystatin C, potassium and creatinine did not show significant individual associations in models by sex, their interpretation should not be dismissed. It is possible that its influence is expressed indirectly or in combination with other clinical factors not evaluated in this analysis, like type and dose of treatment, ventricular ejection fraction or nutritional state.

The results of this cross-sectional study suggest possible clinical and translational implications for the follow-up of patients admitted due to heart failure (HF). The association of calcium upon readmission to the ER observed only in women may indicate a road to explore for the development of monitoring strategies differentiated by sex, particularly considering hormonal and bone mineral context. Likewise, the relationship between GFR and greater risk of readmission in men raises the hypothesis that renal profile may influence post-admission prognosis. Finally, the interactions found between sex and biomarkers like creatinine and chloride substantiates the need to research predictive models sensitive to biological differences. These findings should be interpreted cautiously and validated through longitudinal studies before drawing clinical applications or therapeutic decisions.

The findings observed pose different questions requiring ex-

ploration in future studies. Why does calcium predict readmissions only in women? Does mineral metabolism or postmenopausal hormonal state influence on the clinical course of heart failure (HF)? Do current formulas underestimate GFR in women with HF? Does differentiated diuretic management explain the association with chloride? Could more accurate predictive models be developed that would incorporate sex-specific biological interactions? These questions reflect the complexity of the clinical approach in HF and underscore the need for longitudinal and multicenter investigations that would delve into the pathophysiological differences between men and women, fostering a more personalized, equitable and efficient approach for the care of this condition.

This study presents limitations that should be taken into account when interpreting its results. The retrospective observational design prevents establishing causal relationships, being limited to identifying associations. Furthermore, the outcome analyzed corresponds to readmissions to the ER by any cause, since the database does not allow to distinguish whether the events were due to heart failure decompensation or other clinical motives, and it does not discriminate between single or multiple readmissions. No key clinical variables were included either such as functional class, ejection fraction or pharmacological treatment, which may have influenced on the outcomes. The lack of data on inflammatory and neurohormonal biomarkers, or liver function restricts a more comprehensive pathophysiological evaluation. Although interactions per sex were analyzed, no differences by comorbidities, etiology or age groups were considered, which may affect the applicability of the findings to more diverse and complex populations.

To conclude, this study showed significant differences by sex in renal biomarkers and serum electrolytes, and their association with the risk of readmission to the ER within 6 months in patients previously admitted due to heart failure. Men showed higher levels of creatinine, urea and uric acid, while in women the association of calcium with a greater risk of readmission stood out. Moreover, there were significant interactions between sex and biomarkers like creatinine and chloride, which highlights the need for sex-differentiated prognostic approaches.

These findings substantiate the addition of sex-specific variables in the clinical interpretation of renal biomarkers and electrolytes, favoring a more personalized risk stratification and more accurate therapeutic decision-making, particularly in the post-discharge follow-up by heart failure.

BIBLIOGRAPHY

- Oskouie S, Pandey A, Sauer AJ, et al. From hospital to home: Evidence-based care for worsening heart failure. *JACC Adv* 2024; 3: 101131.
- Antoun I, Alkhayer A, Alkhayer A, et al. Six-month emergent readmissions following hospitalization for atrial fibrillation amid the Syrian conflict: A real-world observational cohort study. *J Cardiovasc Electrophysiol* 2025; 36: 582 – 588.
- Wilcox CS, Testani JM, Pitt B. Pathophysiology of diuretic resistance and its implications for the management of chronic heart failure. *Hypertension* 2020; 76: 1045 – 1054.
- Regitz-Zagrosek V. Sex and gender differences in heart failure. *Int J Heart Fail* 2020; 2: 157 – 181.

5. McDonagh TA, Metra M, Adamo M, et al. 2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure. *Eur Heart J* **2021**; 42: 3599 – 3726.
6. Deferrari G, Cipriani A, La Porta E. Renal dysfunction in cardiovascular diseases and its consequences. *J Nephrol* **2021**; 34: 137 – 153.
7. Abe M, Hemmi S, Kobayashi H. How should we treat acute kidney injury caused by renal congestion? *Kidney Res Clin Pract* **2023**; 42: 415 – 430.
8. Wilcox CS, Testani JM, Pitt B. Pathophysiology of diuretic resistance and its implications for the management of chronic heart failure. *Hypertension* **2020**; 76: 1045 – 1054.
9. Kurihara S, Fukuda N. Regulation of myocardial contraction as revealed by intracellular Ca²⁺ measurements using aequorin. *J Physiol Sci* **2024**; 74: 12.
10. Van Ommen AMLN, Canto ED, Cramer MJ, et al. Diastolic dysfunction and sex-specific progression to HFpEF: current gaps in knowledge and future directions. *BMC Med* **2022**; 20: 496.
11. Fasero M, Coronado PJ. Cardiovascular disease risk in women with menopause. *J Clin Med* **2025**; 14: 3663.
12. Jiménez-Méndez C, Díez-Villanueva P, Bonanad C, et al. Fragilidad y pronóstico de los pacientes mayores con insuficiencia cardíaca. *Rev Esp Cardiol (Engl Ed)* **2022**; 75: 1011 – 1009.
13. Borlaug BA, Jensen MD, Kitzman DW, et al. Obesity and heart failure with preserved ejection fraction: new insights and pathophysiological targets. *Cardiovasc Res* **2023**; 118: 3434 – 3450.
14. Gherghina M-E, Peride I, Tiglis M, et al. Uric acid and oxidative stress-relationship with cardiovascular, metabolic, and renal impairment. *Int J Mol Sci* **2022**; 23: 3188.
15. Park Y-M, Jankowski CM, Ozemek C, et al. Appendicular lean mass is lower in late compared with early perimenopausal women: potential role of FSH. *J Appl Physiol* **2020**; 128: 1373 – 1380.
16. Rodan AR. Regulation of distal nephron transport by intracellular chloride and potassium. *Nephron* **2023**; 147: 203 – 211.
17. Hanberg JS, Rao V, Ter Maaten JM, et al. Hypochloremia and diuretic resistance in heart failure: Mechanistic insights: Mechanistic insights. *Circ Heart Fail* **2016**; 9: 10.1161/CIRCHEARTFAILURE.116.003180 e003180.

Original Investigation Reports

National registry of non-ST-segment elevation acute coronary syndromes in Argentina (RENASCA.AR).

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ABSTRACT

Introduction: cardiovascular diseases represent the leading cause of mortality and hospitalization worldwide. Among them, non-ST-segment elevation acute coronary syndromes are a common manifestation. In Argentina, disparities in access to specialized services hinder a uniform approach to this condition.

Objective: the RENASCA.AR registry aimed to characterize the clinical, therapeutic, and evolutionary profile of patients with NSTEMI across different levels of healthcare in the country.

Methods: a prospective, multicenter study was conducted, including 679 patients hospitalized in 31 centers between November 2022 and December 2024.

Results: the mean age was 63 years, and 27.1% were women. The most frequent clinical presentation was NSTEMI (65%), followed by unstable angina (25%) and MINOCA (10%). Coronary angiography was performed in 90% of patients, with a median time to procedure of 22 hours. The overall rate of percutaneous coronary intervention (PCI) was 67%, significantly higher in men than in women (67% vs. 45%; $p < 0.001$). In-hospital mortality was 1.4%, and the composite event rate (death and/or decompensated heart failure) was 11.1%, with a higher prevalence in women than men (15.2% vs 9.6%; $p < 0.04$).

Conclusions: RENASCA.AR revealed a high use of invasive strategies and low overall mortality, although with significant sex-related differences. This registry provides key insights into the current management of NSTEMI in Argentina and highlights the need to improve access and equity in cardiovascular care.

INTRODUCTION

Cardiovascular diseases constitute the main cause for hospital admission and mortality at world level.¹ This category encompasses a wide range of clinical presentations, from stable and asymptomatic patients to acute events. The latter, called acute coronary syndromes (ACS), include unstable angina (UA), non-ST elevation myocardial infarction (NSTEMI) and persistent ST elevation myocardial infarction (STEMI).²

In Argentina, different levels of complexity coexist in the health care system, which originates different diagnostic and therapeutic strategies. This makes it indispensable to have an adequate coordination of the health care system, both at national and regional level. For this, it is essential to have accurate information on the prevalence, treatment and complications of ACS, also considering the barriers that make it difficult to have timely access to adequate diagnosis and management, according to the current guidelines and protocols.

Different cross-sectional registries made in Argentina have enabled a characterization of epidemiological, clinical and the-

rapeutic aspects of ACS for several years, showing important disparities in terms of diagnostic delays, reperfusion strategies and revascularization modalities.^{3,4} The Buenos Aires 1 registry, published in 2020, included 1100 patients from centers in said province, and showed a predominantly invasive therapeutic approach in patients with non-ST elevation acute coronary syndrome (NSTEMI), with low prevalence of in-hospital complications and during follow-up.⁵ More recently, the ReSCAR registry, which included 984 patients with ACS, reported an in-hospital mortality of 3.7%.⁶ We should emphasize that both registries were made in centers with high complexity, with 24-hour availability of coronary unit and hemodynamic service.

However, given the wide geographical extension of our country, numerous small towns, and/or distant from large urban centers, do not have the complexity needed for the appropriate care for ACS. In these regions, often there are no coronary units available, specialists or access to hemodynamics, so patients are usually cared for initially in non-specific critical areas, such as polyvalent intensive care units.

TABLE 1.
Participating centers per province

Province	Center	Main investigator(s)
BUENOS AIRES	Clínica Pergamino Nueva Clínica Chacabuco de Tandil	Estefania Matijacevich Patricia Maccarone
CORDOBA	Clínica Universitaria Reina Fabiola Instituto Modelo de Cardiología Sanatorio Allende Nueva Córdoba	Raul Barcudi Mauro Quiroga Juan Pablo Ricarte Bratti
CORRIENTES	Hospital San Juan Bautista Instituto de Cardiología Juana Cabral	Christian José Monjes Stella Maris Macin
JUJUY	Clínica Nuestra Señora de Fátima	Richard Allen Callaway
MENDOZA	Hospital Central de Mendoza Hospital Enfermeros Argentinos Hospital Español del Sur Mendocino Hospital Regional de Malargüe Hospital Schestakow Policlínica Privada San Rafael	Javier Ignacio / Leonardo Ripa Carlos Hopp / Walther Marín Daniel Mauro / Lucila Ebbecke Celeste Vera / Roberto Cortéz Susana Marzana Maria Eugenia Baez
SALTA	Hospital San Bernardo IMAC Sanatorio San Roque	Alejandro Amoroso / Javier Belmont Aníbal Abraham / Débora Campos Sergio Argiro / Florencia König
SAN JUAN	Hospital Público Descentralizado	Esteban López Marinaro
SANTA FE	Hospital de Emergencias Clemente Alvarez Hospital Español de Rosario Instituto Cardiovascular de Rosario Sanatorio Aliare Sanatorio Americano Sanatorio Británico Sanatorio Delta Sanatorio Diagnóstico Sanatorio Julián Moreno	Marcelo Marino Edgardo Daniel Miraglia Gerardo Zapata Marcelo Elías Abraham Mauricio Priotti Luis Keller Sebastián García Zamora Miguel Hominal Julieta Storlini
TUCUMAN	Centro Modelo de Cardiología Centro Privado de Cardiología Hospital General Lamadrid de Monteros Instituto de Cardiología de Tucumán	Lorena Lopez Javier Hasbani Esteban Rengel Esteban Rengel

In this scenario, and with the aim of obtaining a more representative view of the current situation in Argentina, it was proposed to develop a National Registry of NSTEMACS (Registro Nacional de SCA sin elevación del segmento ST en la República Argentina – RENASCA.AR). This registry sought to collect updated information on the prevalence, treatment, complications and mortality of said pathology in different levels of health care throughout the country.

OBJECTIVES

Main objective:

To provide objective information on the field of NSTEMACS, a particularly frequent manifestation of ischemic heart disease.

Secondary objectives:

1. To describe the demographic characteristics, risk factors, clinical presentation, risk stratification and therapeutic strategies upon admission and during evolution.
2. To assess the prevalence of hemodynamic, electrical and ischemic complications, as well as in-hospital mortality in patients admitted due to NSTEMACS.

MATERIALS AND METHODS

Descriptive and prospective study, which included patients

admitted due to NSTEMACS since November 2022 until December 2024, in a total of 31 centers throughout the country, listed in *Table 1*. The invitation to the participating centers was made through dissemination by the Argentine Federation of Cardiology (FAC).

To be included in the registry, the patients should meet the following criteria:

- Inclusion criteria:
 - Signing the informed consent form (ICF)
 - Being older than 18 years
 - Clinical diagnosis of NSTEMACS at the time of admission
- Exclusion criteria:
 - Impossibility to make a follow-up
 - Patient with main diagnosis different from NSTEMACS
 - Impossibility or refusal by patient to obtain the ICF.

The different clinical presentations, electrocardiographic and laboratory findings were analyzed, as well as the therapeutic strategy adopted by each center to manage NSTEMACS. Stratification was carried out in all cases by the commonly applied ischemic risk (GRACE) and bleeding (CRUSADE) scores.^{7,8}

A follow-up was made by clinical and/or phone contact in 30 and 180 days, with the goal of detecting cardiovascular events during follow-up. The following were considered cardiovascular

TABLE 2.
Basal characteristics of the population

Age (median, range)	63 years (24-95)
Male gender	72.9% (495)
Risk factors	
Hypertension	75.1% (510)
Dyslipidemia	55.2% (375)
Smoking	61.3% (416)
Active	32.5% (221)
Former	28.8% (195)
Diabetes Mellitus	29.1% (197)
BMI > 30	29.1% (197)
Hereditary/familial history	17.8% (121)
Sedentary life	72.4% (491)
Cardiovascular history	
Coronary artery disease	34.6% (235)
Previous infarction	23.8% (162)
Previous angioplasty	26.3% (178)
Previous MRS	4.3% (29)
Heart failure	7.6% (52)
Peripheral vascular disease	7.9% (53)
Comorbidities	
Chronic kidney disease	5.4% (37)
COPD	5% (34)
Stroke	3.9% (26)

BMI: body mass index; MRS: myocardial revascularization surgery; COPD: chronic obstructive pulmonary disease.

events: death, AMI, stroke, bleeding and need for new unscheduled revascularization at the time of discharge. To assess bleeding, the Bleeding Academic Research Consortium (BARC) classification was used.⁹

The primary endpoint (PEP) of evaluation was considered to be the combination of in-hospital death and/or admission by decompensated heart failure (DHF).

Electrocardiographic patterns were analyzed, considering negative T waves, ST-segment elevation and normal electrocardiogram (ECG), seeking to determine their association with coronary anatomy and events (PEP).

DEFINITIONS

The following definitions were used:

- **NSTEMI:** event of acute myocardial necrosis of ischemic origin, documented by elevation and/or decrease of cardiac biomarkers (preferably cardiac troponin), with at least a value above the 99th percentile of the upper limit of reference, in absence of persistent ST-segment elevation in ECG, and in a scenario of symptoms of myocardial ischemia. Evidence of ischemia could manifest by compatible symptoms, ischemic electrocardiographic changes other than ST elevation, new al-

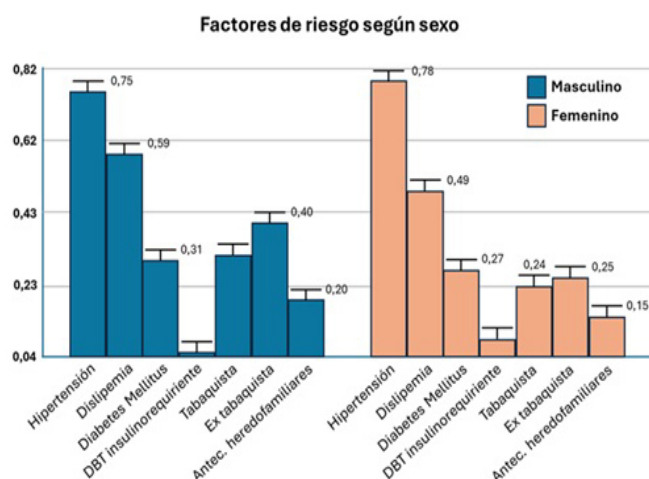


FIGURE 1.
Cardiovascular risk factors according to sex
DM: Diabetes Mellitus.

terations of myocardial contractility, or loss of viable myocardium in imaging studies, or angiographic findings compatible with acute CAD.

- **UA:** ACS characterized by the presence of acute myocardial ischemia, clinically manifesting by chest pain or ischemic equivalent of recent onset, of appearance in rest, of progressive intensity or with decreasing threshold, with no evidence of myocardial necrosis, defined by absence of elevation and/or decrease in cardiac biomarkers (preferably troponin) above the 99th percentile of the upper limit of reference.
- **Myocardial infarction with non-obstructive coronary arteries (MINOCA):** ACS meeting the universal diagnostic criteria of AMI, where coronary angiography shows absence of obstructive CAD, defined as stenosis <50% in all epicardial coronary arteries, without an evident alternative clinical cause explaining the presentation (for instance, myocarditis or cardiomyopathy by stress, etc.)

Ethical considerations

All participants in the registry were given the ICF before being included. In this document, the aims of the study, the data collected and the measures adopted for their protection were explained in detail. Likewise, authorization was requested from patients to use said information and to be able to contact them during follow-up. They were informed that their participation was completely voluntary and that their decision to participate or not would not affect in any way their relationship to the center where they were admitted. The ICF was created by the Scientific Committee of the Registry and subsequently approved by the Department of Research of FAC.

Statistical analysis

The statistical program Infostat of the National University of Córdoba was used. Continuous variables were analyzed by the Kolmogorov-Smirnov or Shapiro-Wilk tests. Those with normal distribution were expressed as mean and standard deviation;

TABLE 3.

Analysis of electrocardiographic pattern according to the presence of events

ECG pattern	No events (n=604)	With events (n=75)	OR (95% CI)	p
No changes	30.9% (187)	9.3% (7)	0.18 (0.08 - 0.40)	<0.0001
AF rhythm	3.9% (24)	13.3% (10)	4.4 (2.01 - 9.74)	<0.0001
CRBBB	7.9% (48)	18.6% (14)	2.8 (1.44 - 5.49)	<0.002
ST depression	26.9% (163)	56% (42)	3.7 (2.25 - 6.13)	<0.001
Negative T waves	36.9% (223)	41.3% (31)	2.7 (2.31 - 5.44)	NS

ECG: electrocardiogram, AF: atrial fibrillation; CRBBB: complete right bundle branch block; CI: confidence interval; NS: not significant

those with non-normal distribution as median and interquartile range, analyzed by Student's t test or nonparametric test, as it corresponded. Qualitative variables were expressed as percentages and number of cases; and in bivariate analysis of evaluation of associated factors, ratios were compared by Chi-squared test or Fisher's exact test according to assumptions and expected frequencies. In all cases, $p < 0.05$ values were considered significant.

RESULTS

During the period analyzed, a total sample of 679 patients was constituted, from whom 184 (27.1%) were women, and with an average age of 63 years (24-95 range). The average age in men was 62.8 years (24-92); while in women it was 66.1 years (37-95). A significantly lower range was observed in patients of the male gender (13 years less than in women).

In regard to cardiovascular risk factors, hypertension was the most prevalent one (75.1%), followed by dyslipidemia (55.2%); 29.1% reported previous diagnosis of diabetes mellitus (5.4%, type 1); 32.5% of patients were smokers at the time of admission (active smoking), although exposition to smoking was 61.3% (former and current smokers); 29.1% presented obesity upon admission ($\text{BMI} > 30$), being morbid ($\text{BMI} > 40$) in just 5% of cases. The rest of the basal characteristics of the sample are presented in Table 2.

When analyzing risk factors related to sex, we found that smoking (both currently and formerly) was statistically more frequent in men than in women: currently smoking men 32% vs 24% of women; $p < 0.043$; 95% CI 1.50 (1.01-2.22) (Figure 1). Forty percent of men and 25% of women were former smokers; $p < 0.0006$; 95% CI 1.99 (1.32-2.96). No significant differences were found between men and women in regard to the rest of the risk factors evaluated.

When evaluating the ECG of admitted patients, we found that 3 main electrocardiographic patterns stood out: negative T waves (37%), ST-segment depression (30%) and ECG with no changes (32%); 9% presented complete right bundle branch block (CRBBB) and 5% complete left bundle branch block (CLBBB); 95% presented at the time of hospital admission in sinus rhythm, while just 5% presented atrial fibrillation (AF).

Ischemic/bleeding risk stratification was carried out in all cases by the GRACE and CRUSADE risk scores, respectively. An average GRACE score of 120 points was verified (median 115, P25: 93, P75: 145), as well as an average CRUSADE score of 26 points (median 24, P25: 16, P75: 34). Using these scores and their 75th

percentile allowed to differentiate a 25% of the population with GRACE score of high risk (> 145) and 25% with CRUSADE score > 34 points, corresponding to moderate to high risk of bleeding.

In regard to pharmacological treatment, although 94.1% received aspirin at the time of admission, 77% were treated with dual antiplatelet therapy (DAPT). Clopidogrel turned out to be the second most used antiplatelet agent (71.1%), followed by ticagrelor (16.8%) and prasugrel (12.1%). During admission, 87.3% received anticoagulation, preferably with low molecular weight heparin (58.2%); 93.9% received treatment with statins upon admission.

Coronary angiography (CAG) was carried out in 89.9% of patients ($n = 611$), not verifying a significant difference in the use of invasive strategy due to gender (90% in men vs 88% in women; $p = \text{NS}$). In regard to vascular access, radial artery access was used in most cases (radial artery 82% vs femoral artery 18%). The global median at the time of performing the CAG was 22 h (P25: 9 h – P75: 45 h). When analyzing said interval according to gender, it was observed that there was a delay in the case of women (women 27 h, interquartile range 15-46 vs men 21 h, interquartile range 7-44). The studied patients were categorized within 12 h: men 36% vs women 21%, $p < 0.009$, OR 2.1 (95% CI: 1.35-3.27).

As to coronary anatomy, it was observed that 34.5% of patients presented lesion in one vessel, 26.5% in two vessels, and 20.9% in three vessels. In 18% ($n = 110$), there were no angiographically significant obstructions (NASO).

When evaluating the final diagnosis within NSTEMACS, 25% corresponded to patients with UA, 65% to NSTEMI and 10% to patients with MINOCA.

With regard to revascularization, the global rate of coronary angioplasty (TCA) was 67%, which was significantly greater in men (men 67% vs women 45%; $p < 0.001$; OR 2.4; 95% CI 1.68-3.54).

The events reported during the in-hospital phase were analyzed, observing a prevalence of AF of 3%, DHF 10.4% and mortality 1.4%, with PEP presenting a rate of 11.1%. This event composite turned out to be significantly greater in women (9.6% in men vs 15.2% in women; $p < 0.04$; OR 1.69; 95% CI 1.02-2.80). No statistically significant difference was observed in mortality in regard to sex (1% in men vs 2.2% in women, $p = \text{NS}$).

Seeking to determine if some ECG pattern was associated to greater clinical risk, two groups were defined: those that presented clinical events (group with PEP) and those that did not present them (group without PEP), as shown in Table 3.

TABLE 4.

Analysis of electrocardiographic pattern according to coronary anatomy

ECG pattern	NASO (n=110)	With lesions (n=510)	OR (95% CI)	P
No changes	50% (55)	30% (153)	0.18 (0.08 - 0.40)	<0.0001
AF	5.4% (6)	4.9% (25)	4.4 (2.01 - 9.74)	NS
CRBBB	6.3% (7)	8.8% (45)	2.8 (1.44 - 5.49)	<0.002
ST depression	15.4% (17)	31.9% (163)	2.65 (1.38 - 5.10)	<0.001
Negative T waves	31.8% (35)	38% (194)	3.1 (2.53 - 7.31)	NS

ECG: electrocardiogram, AF: atrial fibrillation; CRBBB: complete right bundle branch block; NASO: no angiographically significant obstruction; CI: confidence interval; NS: not significant.

TABLE 5.

Pharmacological treatment upon discharge

Antiplatelet drugs	
Aspirin	91.6% (614)
Clopidogrel	62.8% (421)
Ticagrelor	12.3% (82)
Prasugrel	14.9% (99)
DAPT	90.2% (604)
Beta blockers	81.7% (547)
ARB/ACEI	71.1% (476)
MRA	16.7% (112)
Statins	96.4% (646)
High intensity	91.6% (614)
Anticoagulation	7.3% (49)
VKA	1.9% (13)
DOAC	5.3% (35)

DAPT: dual antiplatelet therapy; ARB: angiotensin II receptor blocker; ACEI: angiotensin converting enzyme inhibitor; MRA: mineralocorticoid receptor antagonist; VKA: vitamin K antagonist; DOAC: direct oral anticoagulant.

We should highlight that the ECG pattern without alterations was present in 40% of cases, with 31% belonging to patients without PEP; while in the group with PEP this proportion was considerably less (9%).

On the other hand, ST depression, CRBBB and the presence of AF are significantly present in the group of patients presenting PEP. The presence of negative T waves and CLBBB in this group of patients did not present a significant difference.

Subsequently, ECG findings and their association with coronary anatomy were analyzed, showing a greater prevalence of normal ECG in patients with NASO; and ST depression in patients with significant lesions (*Table 4 and Figure 2*).

DISCUSSION

This analysis is part of a multicenter registry that included patients with NSTEMI (UA and NSTEMI) admitted for evaluation and treatment. The analyzed sample is made up by patients from 37 centers distributed in 9 provinces of Argentina, each with a different level of complexity, infrastructure and referral network.

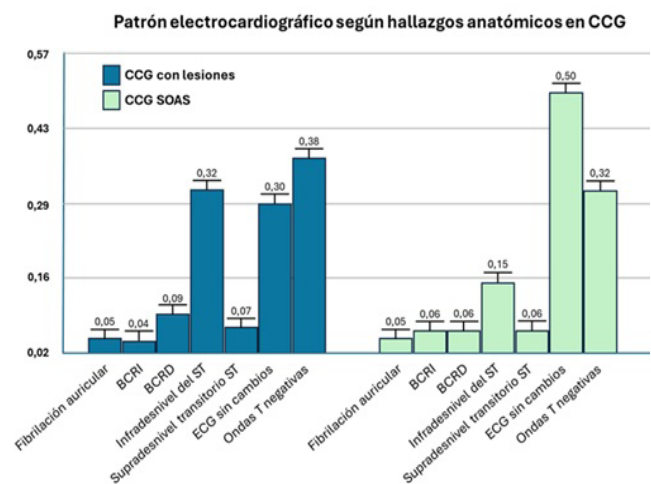


FIGURE 2.

Electrocardiographic pattern according to anatomical findings in CAG. CAG: coronary angiography; NASO: no angiographically significant obstruction; CLBBB: complete left bundle branch block; CRBBB: complete right bundle branch block; ECG: electrocardiogram.

Within demographic factors, a clear predominance of men was found, who, in turn, were younger. This finding confirms the data reported in other multicenter registries, both national and worldwide.^{6,10,11,12}

It is interesting to highlight that, although 5% of patients presented AF at the time of admission, 3% did it during in-hospital course, which represents a total prevalence of 8% in this population. This is very interesting due to the impact of the decision of antithrombotic treatment.

A low proportion of patients did not present an abnormal pattern in ECG at the time of admission. This last piece of information should be underscored, as it implies that there is a low percentage of patients presenting HF and/or death with normal ECG at the time of hospital admission. This confirms that, on occasions, the mere fact of the presence of an ECG with no alterations does not entail low risk.

As to the medical treatment, we should emphasize that most patients (nearly 3 in 4) received DAPT upon admission. This is relevant, since although contemporary guidelines do not recom-

mend a systematic pre-treatment use (Class III indication in NSTEMACS), it was administered in most cases.¹³ A possible reason is time to CAG > 24 h in most cases, as the consensus on antithrombotic therapy of FAC advises.¹⁴ On the other hand, use of powerful P2Y12 receptor inhibitors was significantly low, just as in all national registries.

As mentioned previously, most patients were evaluated by CAG, reaching 90%. This piece of information becomes relevant, considering that not all participating centers had a coronary unit or availability of a hemodynamic laboratory. In the Epi-Cardio registry, invasive management was reported in 51.8% of patients with NSTEMACS, while in the ReSCAR registry, which included only high-complexity centers, this rate was significantly higher, reaching 84%.^{6,15}

Likewise, there were no significant differences observed in the indication of invasive strategy between men and women. The authors consider that this finding is particularly important, as in most international registries the rate of interventionism has been significantly less in women.^{16,17,18,19} Nevertheless, a significant difference was evident in the time until performance of CAG between both sexes, with a bigger delay in women. When categorizing the times in different intervals (< 3 h, < 12 h and > 24 h), the statistical difference remained consistently in favor of the male gender.

Although mortality seems to be low, mainly in comparison with other local registries (1.4% vs 2.7% in Buenos Aires, 1 and 3.7% in ReSCAR), it is considered appropriate for the group of patients, according to what was explained before with risk scores.

Limitations

The main limitation in this study, common to this type of designs, is the selection bias. Although a wide participation of centers with different levels of complexity and from different regions of the country, approximately half of patients were included in just six centers of reference. Moreover, the consecutive inclusion of all patients admitted in each institution was not guaranteed, which introduces an inclusion bias. This situation could have influenced the low rate of reported events. Finally, the absence of an audit or external control of the uploaded data represents a possible source of error or loss of information at the time of the analysis.

CONCLUSIONS

This registry showed a high rate of use of CAG in the diagnosis of ACS. There were no significant differences between men and women as to the indication of the mentioned study. The global mortality of the cohort was low. However, a higher rate of angioplasty was registered in men in comparison to women, just as with a higher incidence of subsequent clinical events.

Carrying out registries like RENASCA.AR constitutes a valuable tool to learn about medical practice and clinical results in Argentina. Although it presents limitations inherent to the observational design and the selection of participating centers, it allows to approach the health care reality of patients in institutions members of FAC.

These findings reinforce the need to continue promoting multicenter registries with a prospective base that would enable identifying disparities, optimizing therapeutic strategies and improving health care quality in populations with ACS at national level.

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BIBLIOGRAPHY

1. Steg G, James S, Atar D, et al. ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation. *Eur Heart J* 2012; 33: 2569 – 2619.
2. Thygesen K, Alpert JS, Jaffe AS, et al. Fourth Universal Definition of Myocardial Infarction. *J Am Coll Cardiol* 2018; 72: 2231 - 2264.
3. Blanco P, Gagliardi J, Higa C, et al. Infarto agudo de miocardio. Resultados de la Encuesta SAC 2005 en la República Argentina. *Rev Argent Cardiol* 2007; 75: 163 - 170.
4. Gagliardi J, Charask A, Higa C, et al. Infarto agudo de miocardio en la República Argentina. Análisis comparativo en los últimos 18 años. Resultados de las Encuestas SAC. *Rev Argent Cardiol* 2007; 75: 171 - 178.
5. Costabel J, Zaidel E, Rivero M, et al. Registro multicéntrico prospectivo de pacientes hospitalizados por síndrome coronario agudo sin elevación del segmento ST en centros de alta complejidad. Resultados intrahospitalarios y evolución a 6 meses. *Rev Argent Cardiol* 2020; 88: 308 - 316.
6. Rivero M, Feder J, Procopio G, et al. Registro de síndromes coronarios agudos en centros de alta complejidad de Argentina. *ReSCAR 2022. Rev Argent Cardiol* 2023; 91: 205 - 211.
7. Eagle K, Lim M, Dabbous O, et al. A validated prediction model for all forms of acute coronary syndrome: estimating the risk of 6-month postdischarge death in an international registry. GRACE Investigators. *JAMA*. 2004; 291: 2727 - 2733.
8. Subherwal S, Bach R, Chen A, et al. Baseline Risk of Major Bleeding in Non-ST-Segment-Elevation Myocardial Infarction: The CRUSADE (Can Rapid risk stratification of Unstable angina patients Suppress ADverse outcomes with Early implementation of the ACC/AHA guidelines) Bleeding Score. *Circulation* 2009; 119: 1873 - 1882.
9. Mehran R, Rao SV, Bhatt DL, et al. Standardized bleeding definitions for cardiovascular clinical trials: A consensus report from the Bleeding Academic Research Consortium (BARC). *Circulation* 2011; 123: 2736 – 2747.
10. Alabas O, Gale C, Hall M, et al. Sex Differences in Treatments, Relative Survival, and Excess Mortality Following Acute Myocardial Infarction: National Cohort Study Using the SWEDEHEART Registry. *J Am Heart Assoc* 2017; 6: e007123.
11. Ten Haaf M, Bax M, ten Berg J, et al. Sex differences in characteristics and outcome in acute coronary syndrome patients in the Netherlands. *Neth Heart J* 2019; 27: 263 – 271.
12. Khraishah H, Alahmad B, Alfaddagh A, et al. Sex disparities in the presentation, management and outcomes of patients with acute coronary syndrome: insights from the ACS QUIK trial. *Open Heart* 2021; 8: e001470
13. Byrne R, Rossello X, Coughlan J, et al. 2023 ESC Guidelines for the management of acute coronary syndromes. *Eur Heart J* 2023; 44: 3720 – 3826.
14. Barcudi R, Bono J, Ramos, et al. Documento de consenso sobre terapia antitrombótica en enfermedad coronaria del Comité de Cardiopatía Isquémica de la Federación Argentina de Cardiología. *Rev Fed Arg Cardiol* 2022; 51 (Suplemento 3): 4 - 35.

15. Gagliardi J, De Abreu M, Mariani J, et al. Motivos de ingreso, procedimientos, evolución y terapéuticas al alta de 54.000 pacientes ingresados a unidades de cuidados intensivos cardiovasculares en la Argentina. Seis años del Registro Epi-Cardio. *Rev Argent Cardiol* **2012**; 80: 446 - 454
16. Mariani J, Antonietti L, Tajer C, et al. Diferencias de género en el tratamiento de síndromes coronarios agudos: resultados del registro Epi-Cardio. *Rev Argent Cardiol* **2013**; 81: 307 - 315
17. Haider A, Bengs S, Luu J, et al. Sex and gender in cardiovascular medicine: presentation and outcomes of acute coronary syndrome. *Eur Heart J* **2020**; 41: 1328 - 1336
18. Arora S, Stouffer G, Kucharska-Newton A, et al. Twenty-Year Trends and Sex Differences in Young Adults Hospitalized with Acute Myocardial Infarction. *Circulation* **2019**; 139: 1047 - 1056
19. Olivencia Peña L, Bueno Cavanillas A, et al. Síndrome coronario agudo en la mujer. Diferencias de género. *Medicina Clínica* **2011**; 137: 623 – 630.

Original Investigation Reports

Inter-American Registry of Influenza and Pneumococcal Disease Vaccination (CorVacc). Subanalysis of Results in Argentina.

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ABSTRACT

Introduction: In Argentina, the influenza and pneumococcal disease mortality rate has increased in recent years.

Objective: the objective of this sub-analysis of the Inter-American Registry of Influenza and Pneumococcal Disease Vaccination (CorVacc) is to determine vaccination rates and analyze the factors that influence them in Argentina.

Materials and methods: A cross-sectional survey of the general population was conducted in 19 Latin American countries. Adults over 18 years of age completed a 34-question online survey. The data were grouped into seven categories: demographic, socioeconomic, and vaccination profile.

Results: 2,128 responses out of 21,389 were obtained from Argentina; 61% (n = 1,349) of the participants were female, and the mean age was 46.59 ± 15.88 years; 58.23% of the sample received annual influenza vaccination, 49.67% received the pneumococcal disease vaccine, and 88.33% received at least three doses of the COVID-19 vaccine. Low educational attainment and poor confidence on vaccines were the main barriers to vaccination. Older individuals and healthcare professionals received vaccines more frequently.

Conclusions: the vaccination rate in Argentina is lower than that recommended by ministerial authorities and medical practice guidelines. The Inter-American Registry of Influenza and Pneumococcal Disease Vaccination (CorVacc) identified some of the implementation barriers. Public health authorities and health funders will be able to use this information to design their action plans.

INTRODUCTION

In Argentina, according to official data, the rate of mortality by influenza and pneumococcal disease grew since 2020 until 2022, while that of COVID-19, after a peak in 2021, significantly reduced. Deaths by these pathologies exceed those produced by cerebrovascular diseases or diabetes, among others, thus constituting a sanitary challenge.¹

The National Vaccination Schedule specifically includes the influenza vaccine for health care staff, strategic staff whose performance is key to maintain essential functions, in individuals between 2 and 64 years with documented risk factors or preexisting diseases, and in all people since 65 years of age, not requiring medical indication; besides, in the latter, it is recommended to evaluate vaccination against pneumococcal disease and apply it if it corresponds. The Ministry of Health of Argentina considers risk factors: obesity, diabetes, respiratory diseases, heart diseases, congenital or acquired immunodeficiency, hemato-oncology

diseases, transplant and/or people with chronic kidney disease in dialysis, among others, that should be credited in a medical prescription or other types of documents.²

Argentina is in a transition stage in relation to vaccination against pneumococcus, as the vaccine with 20 serotypes will replace the current scheme with 13 serotypes. It is recommended for the vaccine to be applied in individuals from 5 to 64 years when immunocompromised, with cochlear implant and cerebrospinal fluid fistula, not immunocompromised (chronic heart disease, chronic pulmonary disease, diabetes mellitus, alcoholism, chronic liver disease, smoking), and in hematopoietic cells transplant; and in individuals >65 years, who do not require medical indication or the presence of comorbidities or cardiovascular risk factors.³

The National Campaign of Vaccination against COVID-19, started on December 2020, considers people are in high risk of severe COVID-19 when they are older than 50 years, pregnant

people, and immunocompromised people since 6 months of age. Likewise, it defines individuals in intermediate risk of severe COVID-19 or high exposition to SARS-CoV-2 in their jobs, as those who are younger than 50 years with nonimmunosuppressive comorbidities (chronic diseases or obesity), health care staff and strategic staff. Finally, with low risk of severe COVID-19 as those who are between 6 and 49 years old, with no comorbidities.⁴

Beyond the previous recommendations, a subanalysis of the CorCOVID-LATAM study showed that, in Latin American Spanish-speaking countries, in cardiometabolic patients, who had not presented COVID-19 infection, the rate of vaccination against influenza was only 46.5% and against pneumococcus even less, 24.6%. Argentina presented the highest rates of vaccination in the region, against influenza and pneumococcus, 87% and 65% respectively.^{5,6}

The Inter-American Vaccination Registry of Influenza and Pneumococcus (CorVacc) developed a survey in the general population of 19 Latin American countries, including 21,389 individuals, with the aim of determining the frequencies of vaccination to prevent these infections and analyze the factors that influence these rates. Vaccines against influenza were applied in 74.2%, against pneumococcus in 35.8%, and against SARS CoV-2 in 96.9%. Health care professionals, obese or hypertensive individuals, and those with older age presented the highest chances of receiving vaccines.⁷ Confidence on vaccines and the knowledge perceived by physicians about vaccination directly affect the prescription to patients and vaccination of professionals.⁸

The goal of this subanalysis of the Inter-American Vaccination Registry of Influenza and Pneumococcus (CorVacc) is determining the frequencies of vaccination to prevent these infections and analyzing the factors that influence them.

MATERIALS AND METHODS

Study population

CorVacc is an observational study. A total of 19 countries in the Latin American region participated prospectively. Outpatients older than 18 years, who granted their informed consent to participate, were included. Patients younger than 18 years and those who could not grant their informed consent were excluded from the study.⁹

Informed consent

Patients were informed about the aim of the survey and the anonymity of the replies. No identifiable personal data were collected. The approval of the Inter-American Society of Cardiology (IASC) was obtained. The authors have followed the protocols of confidentiality of the IASC, obtaining the informed consent of patients, having the approval of the Committee of Ethics. The SAGER guidelines have been followed, according to the nature of the study.

Design of the study

An on-line cross-sectional survey was developed, with 34 questions, by Google forms (Mountain View, CA). The research team invited patients to complete the questionnaire in person or by e-mail, social media, phone calls and printed questionnaires.

The survey was divided into three sections: 1) questions that examine the demographic profile of patients; 2) questions that examine their cardiovascular risk profile; and 3) questions that examine their vaccination profile.

The questionnaire had different types of questions, including dichotomous, Likert scale questions, of multiple choice and open-ended. The questions were of obligatory response and could select multiple replies, according to the content of the question. Confidence and knowledge on vaccines are categorized by a Likert scale from 0 to 10, where 0 represented no confidence or knowledge, and 10 a lot of confidence or knowledge.

The validity and reliability of the survey were evaluated by Cronbach's alpha and exploratory factor analysis with the results of the first thousand surveys.

Organization of the study

An announcement was made for cardiologists and other physicians from Latin American countries to join the team of collaborators of the CorVacc study. A total of 19 countries were represented. Countries were divided according to a pre-established geographical distribution, in the following manner:

- North and Central America and the Caribbean region: Mexico, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, Panamá, Cuba, Puerto Rico and Dominican Republic;
- Andean region: Venezuela, Colombia, Ecuador, Bolivia and Peru;
- Southern cone region: Paraguay, Chile, Uruguay, Brazil and Argentina.

It is estimated that the total population of Latin American countries is approximately 662 millions. A sample size of 20,000 surveys was estimated to achieve a margin of error of 5%, a confidence level of 90% and distribution error of 50%.

Survey

The survey platform was specifically designed to register patients in this study. To optimize the rate of response, periodical reminders were sent by mail, SMS or social media. Furthermore, information was published periodically on the progress of surveys per country. The survey had 34 questions.

Statistical analysis

Continuous variables appear as mean and standard deviation if they follow a normal distribution, and as median and interquartile range if they do not. Normal distribution was evaluated by the Shapiro-Wilk and Kolmogorov-Smirnov tests. Unpaired Student's t-test or Mann-Whitney U test were used to compare continuous variables between vaccinated and non-vaccinated people, as it corresponded. Bivariate comparisons were made between confidence score and knowledge about vaccines >8 in comparison to <8 by Fisher's exact test for categorical variables, and by unpaired t-test or Mann-Whitney test for continuing data. A >8 response was considered as high confidence or high knowledge about the vaccine. Categorical variables are expressed as percentages and were compared between vaccinated and non-vaccinated individuals by Pearson's χ^2 test. All statistical analyses were made with the SPSS software

for Windows, version 29.0 (IBM Armonk, NY, USA), and a bilateral p value <0.05 was considered statistically significant.

RESULTS

The CorVacc Argentina substudy included 2,128 individuals, representing 9.93% of the total of CorVacc participants; 61% ($n = 1349$) were female, and the mean age was 46.59 ± 15.88 ; 42.99% of the sample was in the age range from 41 to 60 years, showing that the age of the individuals included in CorVacc Argentina was greater than in the global study (Figure 1).

From the study population, 18.19% ($n = 387$) lived in towns with 100 to 500 thousand inhabitants, and 38.9% ($n = 828$) in cities of more than 500,000 inhabitants; 68.28% ($n = 1453$) were active workers; 22.5% ($n = 571$) had public health coverage; 50.11% ($n = 1272$) had medical insurances, and 25.75% ($n = 649$) prepaid medicine; 22.65% reported history of hypertension; 21.52% overweight or obesity; 13.35% some type of dyslipidemia; 6.34% type 2 diabetes, and 5.92% were smokers. The frequencies of CAD or heart failure were less than 3%; 45.3% did not receive any medication, while 30.83% consumed 2 or more medications daily.

In Table 1, the frequency of vaccination and confidence in the vaccine to prevent the infection by influenza is shown in the general population, in physicians, individuals with education up to high school and in individuals ≥ 61 years.

The percentage of physicians that know what the vaccination season is in Argentina is 97.15%, and 90.51% state that there are vaccination campaigns in our country for influenza and pneumococcus.

In Table 2, the frequency of vaccination and confidence in the vaccine to prevent the infection by pneumococcus is shown in the general population, in physicians, individuals with education up to high school and in individuals ≥ 61 years.

In Table 3, the frequency of vaccination, number of doses received and confidence in the vaccine to prevent infection by COVID-19 is shown in the general population, in physicians, individuals with education up to high school and in individuals ≥ 61 years.

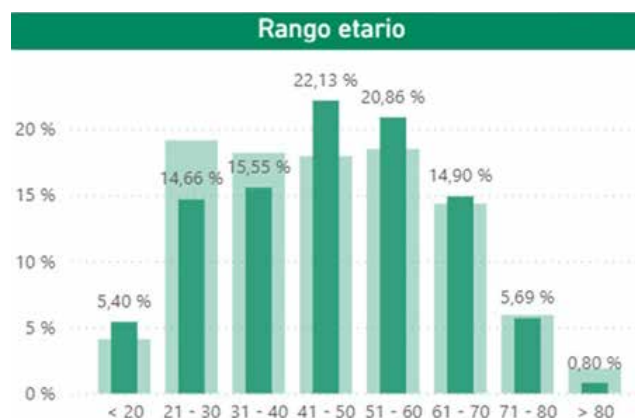


FIGURE 1.
CorVacc Argentina vs Global CorVacc age intervals

DISCUSSION

The CorVacc Argentina substudy showed that at least 60% and 50% of the sample received the vaccine against influenza and pneumococcus, respectively; while close to 99% received the vaccine against COVID-19, and more than 88% received at least 3 doses of it. The educational level and age of the interviewed

TABLE 1.

Frequency of vaccination and confidence on the vaccine against influenza

	GLOBAL	PHYSICIANS	EDUCATION UP TO HIGH SCHOOL	> 61 YEARS
N	2128	527	479	317
Yearly	58.32%	84.06%	50.94%**	65.62%*
Never	24.95%	7.21%	31.73%	18.61%
Never/irregular	38.1%	14.81%	49.03%	34.38%
Confidence > 8	71.62%	87.86%	65.34%***	70.98%

* $p < 0.01$; ** $p < 0.0025$ *** $p < 0.05$

Frequency of vaccination and confidence on the influenza vaccine in the global sample of Argentina, in physicians, level of education reached, and individuals aged ≥ 61 years.

Level of education reached: individuals who reported having completed high school.

TABLE 2.

Frequency of vaccination and confidence on the vaccine for pneumococcus

	GLOBAL	PHYSICIANS	EDUCATION UP TO HIGH SCHOOL	> 61 YEARS
N	2128	527	479	317
Yes	49.67%	57.87%	49.27%	63.09%*
Confidence > 8	75.29%	91.84%	68.47%**	74.15%

* $p < 0.01$; ** $p < 0.005$

Frequency of vaccination and confidence on the vaccine for pneumococcus in the global sample of Argentina, in physicians, level of education reached and individuals aged ≥ 61 years.

Level of education reached: individuals who reported having completed high school.

TABLE 3.

Frequency of vaccination, number of doses and confidence on the COVID-19 vaccine

	GLOBAL	PHYSICIANS	EDUCATION UP TO HIGH SCHOOL	> 61 YEARS
N	2128	527	479	317
Yes	98.64%	98.67%	98.75%	98.42%
> 3 doses	88.33%	88.62%	76.62%*	84.23%
Confidence > 8	54.27%	63.76%	50.1%	55.71%

* $p < 0.001$

Frequency of vaccination, number of doses and confidence on the vaccine for COVID-19 in the global sample of Argentina, in physicians, education reached and individuals aged ≥ 61 years.

Level of education reached: individuals who reported having completed high school.

individuals had a significant impact on these data, as the frequency of vaccination was less in individuals with level of education up to high school, and on the contrary, more frequent in participants ≥ 61 years. These vaccination levels in Argentina could be due, partly, to the low level of confidence of the population on vaccines, which reaches relevant levels of less than 75% of the sample for influenza and pneumococcus, and less than 55% for COVID-19, being even less with a low educational level. On the other hand, we should highlight that only 58% of physicians received the anti-pneumococcal vaccine, a highly surprising information, considering that 92% of them have a high level of confidence in the vaccine, and more than 90% acknowledge the existence of vaccination campaigns. In this scenario, the attitude and experience of professionals of health, along with the restrictions and obstacles in the health care system, should be considered at the time of evaluating the frequency of vaccination. Given that the three vaccines analyzed are all covered by the state, not requiring any expense by individuals, access issues are ruled out as a justification for the low rates of immunization, and confers more weight to other possible causes.

Just as it was expressed, health care authorities have been including for several years, the vaccine against influenza in the yearly calendar for the groups in higher risk, being available free of charge in vaccination clinics, hospitals and public health centers throughout the country.¹⁰ Likewise, pneumococcal conjugate vaccine is also included in the yearly calendar, being provided with state coverage to people older than 65 years.¹¹

A consensus document on the role of vaccination in adults to prevent cardiovascular events by the Argentine Federation of Cardiology, the Argentine Society of Cardiology and the Argentine Council of Cardiology Residents indicates that all people with cardiovascular pathologies constitute a risk group and require yearly vaccination against influenza, regardless of age; and also, all people working in the health care area should be vaccinated yearly, including administrative and technical staff.¹² In this same context, a consensus document by the Inter-American Society of Cardiology and the World Heart Federation considers vaccination against influenza in people older than 65 years should be administered yearly, even in absence of cardiovascular disease or cardiovascular risk factors, with class I recommendation and level of evidence B from non-randomized clinical trials.¹³ In the CorVacc Argentina, 84.06% of physicians and 65.62% of participants ≥ 61 years received the vaccine against influenza, which shows a mismatch between national and regional recommendations, and their implementation in the country.

On May 2022, the Centers for Disease Control and Prevention (CDC) of the US developed a 3-community project to attempt to identify the factors affecting the confidence on and demand for the COVID-19 vaccination. It was possible to determine and encode by general inductive analysis the processes leading to people hesitating over vaccination, to identify their causes and to build the internal skills to lead the community to a better assessment and an effective use of information on the vaccine.¹⁴ This type of studies show the need to generate communication and implementation strategies, so that scientific knowledge and guideline recommendations may not be just a simple statement

of data, but for them to be applied in daily health care practice, and thus, revert both at community and professional level the poor results shown in the CorVacc study.

Limitations

The Inter-American Vaccination Registry of Influenza and Pneumococcus (CorVacc) was an open, anonymous and voluntary survey, which may have generated a certain degree of bias in the sample. Certain groups, such as people who live in rural areas or small towns, or those with limited access to health care or computer services, could be underrepresented. Therefore, the data reported are based on the replies in the survey, in different areas with different degrees of access to medical care. In this scenario, it is possible for vaccination and confidence rates to be overestimated.

CONCLUSIONS

The data from Argentina in the Inter-American Vaccination Registry of Influenza and Pneumococcus (CorVacc) show that the frequency of vaccination and confidence on vaccines is significantly less than what is recommended, in spite of having total coverage by the health care system. In different subgroups, like older individuals, health care professionals, and individuals with lower educational level, the data obtained are even more alarming.

It is necessary to generate communication and implementation strategies for scientific knowledge and guideline recommendations to be applied in daily health care practice.

The public health authorities and healthcare financiers may use the information obtained from the Inter-American Vaccination Registry of Influenza and Pneumococcus (CorVacc) to design their plans of action.

BIBLIOGRAPHY

1. Organización Panamericana de la Salud. Indicadores básicos Argentina 2024. Disponible en <https://iris.paho.org/items/13655c32-515a-4b95-bc91-6298f5dfbd3b> Acceso 12 de Diciembre de 2025.
2. Ministerio de Salud. Calendario Nacional de Vacunación. Vacuna Antigripal. Disponible en <https://www.argentina.gob.ar/salud/vacunas/antigripal> Acceso 7 de Diciembre de 2025.
3. Ministerio de Salud. Calendario Nacional de Vacunación. Vacuna contra el Neumococo. Disponible en <https://www.argentina.gob.ar/salud/vacunas/neumococo> Acceso 7 de Noviembre de 2025.
4. Ministerio de Salud. Manual de Vacunación. 20 de Agosto de 2024. Disponible en https://www.argentina.gob.ar/sites/default/files/2021/01/lineamiento_tecnico_pfizer_monovariante_692024.pdf Acceso 7 de Diciembre de 2025.
5. Santi RL, Márquez MF, Piskorz D, et al. Ambulatory Patients with Cardiometabolic Disease and Without Evidence of COVID-19 During the Pandemic. The CorCOVID LATAM Study. *Glob Heart* 2021; 16: 15.
6. Sosa Liprandi Á, Zaidel EJ, Lopez Santi R, et al. Influenza and Pneumococcal Vaccination in Non-Infected Cardiometabolic Patients from the Americas during the COVID-19 Pandemic. A Sub-Analysis of the CorCOVID-LATAM Study. *Vaccines (Basel)* 2021; 9: 123.
7. Wyss F, Lopez-Santi R, Piskorz D, et al, On Behalf of The CorVacc Study investigators. Immunization and Cardiovascular Disease in Latin America. The CorVacc Study: Results. *Global Heart* 2025; 20: 108.
8. Piskorz D, Wyss Quintana F, López Santi R, et al. Latin American physicians' perception toward vaccination. A CorVACC-AMERICA study sub-analysis. Latin American physicians' perception toward vaccination. A CorVACC-AMERICA study sub-analysis. *Arch Cardiol Mex*; en prensa.

9. Wyss F, Lopez-Santi R, Piskorz D, et al. Immunization and cardiovascular disease in Latin America. The CorVacc study: rationale and design. *Arch Cardiol Mex* **2025**; 95: 144 - 152.
10. Ministerio de Salud. Calendario Nacional de Vacunación. Vacuna antigripal anual. Disponible en <https://www.argentina.gob.ar/salud/vacunas/novedadantigripal> Acceso 12 de Noviembre de **2025**.
11. Ministerio de Salud. Calendario Nacional de Vacunación. Disponible en <https://www.argentina.gob.ar/sites/default/files/2025-01-v2-calendario-nacional-vacunacion.pdf> Acceso 12 de Noviembre de **2025**.
12. García-Zamora S, Pulido L, Sosa-Liprandi MI, et al. Documento de Consenso sobre el rol de la vacunación en adultos para la prevención de eventos cardiovasculares. Posicionamiento conjunto de la Federación Argentina de Cardiología (FAC), Sociedad Argentina de Cardiología (SAC) y el Consejo Argentino de Residentes de Cardiología (CONAREC). *Rev Fed Arg Cardiol* **2025**; 54 (Suplemento 7): 3 - 23.
13. Liprandi ÁS, Liprandi MIS, Zaidel EJ, et al. Influenza Vaccination for the Prevention of Cardiovascular Disease in the Americas: Consensus document of the Inter-American Society of Cardiology and the World Heart Federation. *Glob Heart* **2021**; 16: 55.
14. Frazee Jami L, Asif Amimah F, Zajac J. Case Studies of Rapid Community Assessment Implementation to Improve Vaccine Confidence and Demand During the COVID-19 Vaccine Rollout. *Journal of Public Health Management & Practice* **2025**; DOI: 10.1097/PHH.0000000000002308.

Original Investigation Reports

Echocardiography in Argentina: training, professional practice, and current challenges.

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Health Care Workforce;
Medical Technology;
Working Conditions;
Professional Training.

ABSTRACT

Objectives: to describe the current characteristics of echocardiography practice in Argentina, including training, equipment, working conditions, use of advanced techniques, and reported difficulties.

Materials and Methods: observational, descriptive, cross-sectional study based on a voluntary digital survey administered to cardiologists performing echocardiography in Argentina. Demographic, occupational, training, and technological data were collected. Responses included both closed and open questions, the latter subsequently categorized for descriptive analysis.

Results: a total of 173 professionals from all regions of the country responded. Median age was 42 years and median professional experience 10 years. Only 12% worked exclusively in echocardiography, and most worked in two or more institutions. The predominant contractual modality was payment by percentage of the study's cost. The median number of monthly studies was 100, with higher volumes among those working exclusively in the private sector ($p < 0.007$). Availability of advanced technology varied: 62% reported access to software for left ventricular deformation analysis and less than 30% for other chambers. Forty-three percent were trained in transesophageal echocardiography and stress echocardiography. The main reported difficulty was low remuneration, followed by high clinical demand and lack of professional recognition.

Conclusions: echocardiography practice in Argentina shows a solid professional foundation but is characterized by heterogeneous training, substantial technological gaps, and fragile working conditions that primarily affect remuneration. Coordinated policies on certifications, continuous training, and technological integration are required to strengthen the quality and equity of echocardiographic practice nationwide.

INTRODUCTION

Echocardiography is a central diagnostic tool in modern cardiology. It is a noninvasive technique, with a relatively low cost, that enables evaluating patients in real time. Practically, all cardiovascular diseases can be evaluated by this method. Furthermore, its portability and versatility allow using it in different scenarios, including critical symptoms, OR and hemodynamic laboratories. Consequently, in recent years its indications have expanded continually, consolidating as a first-line method in the evaluation of cardiovascular pathology.¹

However, the growth of new modalities and techniques, such as 3D echocardiography, stress echocardiography, transesophageal echocardiography (TEE), strain analysis and myocardial work, among others, has increased the method's complexity, leading to a need to train in a structured manner.² For this reason, the main scientific societies have established certification systems and levels of competency addressed to ensure minimum standards of quality.

In Argentina, although there are certification programs backed both by the Argentine Federation of Cardiology (FAC) and other societies, joining them is not a mandatory requirement to practice, which translates into a marked heterogeneity both in training and in the competencies of those working with the method.

Between the main problems affecting echocardiographers, low fees stand out. This forces many specialists to perform in multiple institutions to maintain their income. Thus, quantity is held more valuable than the quality of the tests. This has a negative impact in two ways: first, the perception within cardiology of the value of the method, and second, the personal motivation to keep high standards of training and updating.

Moreover, echocardiographic practice in Argentina develops in a wide variety of health care contexts (public, private and mixed), with dissimilar availability of human resources, equipment and advanced technology.

These points make it necessary to know the health care reality in our country. For this reason, this study attempts to describe the characteristics of echocardiographic practice in Argentina, including aspects of training, equipment, working conditions, and problems of usual practice.

AIMS

- **Main objective:**
to describe the current characteristics of echocardiography practice in Argentina.
- **Secondary objectives:**
 - Characterizing education and training ways of echocardiographers in the country.
 - Analyzing the working conditions and main hiring modalities.
 - Evaluating devices, digitization, and infrastructure of echocardiography laboratories, including analysis software and imaging management systems availability.
 - Exploring the practice and resources available for advanced techniques, like TEE and stress echocardiography.
 - Examining the associations between the volume of studies carried out, professional experience, and work environment.
 - Identifying the main difficulties reported in daily practice and their relationship with demographic and work variables.
 - Describing the current participation and future interest in research within the community of Argentinian echocardiographers.

MATERIALS AND METHODS

Design and population of the study

An observational, descriptive and cross-sectional study was carried out, using a survey exclusively addressed to cardiologists who perform echocardiography studies in Argentina. Participation was voluntary and with no financial compensation. The questionnaire remained available between May and June 2025.

The only exclusion criterion was not performing echocardiographic tests.

The study did not require evaluation by an ethics committee, as it was anonymous, voluntary and without intervention on patients.

The survey was anonymous with the purpose of scientific analysis; nevertheless, a space to state contact data was provided with the aim of constituting a national data base of echocardiographers interested in future academic and/or research activities.

Data collection instrument and procedure

The instrument was a digital form made with the Google Forms platform; made up by 44 questions, both closed and open-ended. Its design was based on the experience of the members of the Committee on Echocardiography of FAC, and it was subjected to an internal validation process by consensus between its members.

The questionnaire explored different thematic domains, but it was mainly divided into 9 sections:

- Demographic data and professional activity
- Characteristics of the main place of work
- Education and human resources
- Digitization and reports
- Professional activity
- Software and technology
- TEE
- Stress echocardiography
- Participation in investigations.

The survey was disseminated through three supplementary channels:

- Submitted by e-mail to professional contacts;
- Instant messaging (WhatsApp) by phone number;
- QR code available within the framework of the National Conference of Cardiology 2025.

A number of approximately 300 professionals was reached, from whom 173 completed the survey, representing a rate of response of 57.7%.

Variables and operative definition

The variables analyzed were both continuous and categorical (mainly dichotomous variables) and included:

- Demography: age, gender, geographical region.
- Work: type of institution (public, private, personal office), monthly number of studies, modalities used, years of experience.
- Education: level of formal training, participation in courses or certifications.
- Perception: opinion on difficulties, need to update and assessment of professional acknowledgement.

Open responses were encoded and categorized in an inductive manner by consensus between two investigators for their descriptive analysis.

Statistical analysis

Data analysis was made by the Jamovi software, version 2.7.6 (The Jamovi Project, Sydney, Australia). The categorical variables were expressed as absolute frequencies and percentages; continuous variables as mean $\pm$ standard deviation (SD) or median and interquartile range (IQR), as it corresponded. Distributions normality was evaluated by the Kolmogorov-Smirnov test.

For the comparisons between groups, the following statistical methods were used:

- Categorical variables: Chi-square test or Fisher's exact test, according to the expected frequency.
- Continuous variables: Student's t-test or ANOVA for normal distributions; Mann-Whitney U test or Kruskal-Wallis test for non-normal distributions.

Likewise, linear associations between continuous variables were explored by Pearson's correlation coefficient (or Spearman's when the assumptions of normality were not met). The correlation force was interpreted according to the magnitude of r : weak (0.10-0.39), moderate (0.40-0.69), or strong (≥ 0.70).

A p value < 0.05 was considered statistically significant.

RESULTS

Replies from 173 professionals from all provinces of Argentina were received, with a distribution by regions as observed in *Figure 1A*.

There were 52 women (30%). The age of the surveyed people was 42 years (37-50), with an echocardiographic experience of 10 years (5-18). Only 12% reported exclusive dedication to this activity, and most worked in two centers (1-3); although some did it in up to 6 institutions. Practice in the private sector was predominant (53.8%); although 29.8% combined the practice in public and private institutions. Moreover, 10 (5.8%) surveyed individuals worked exclusively in their private office, and 2 (1.2%) did it only in university institutions.

In terms of professional education, 60% of surveyed people had trained in a national scientific society, and lower proportion did it in other ways. Only a small group (4.8%) did not have a formal education, while 26 (15%) reported more than one training modality.

Payment per percentage of the value of the study was the most frequent hiring modality, although in some cases different fee modalities coexisted, including direct contracts with financiers, payments per study or formal working relationships. All these data are summarized in *Table 1*.

The number of echocardiographic devices available in the main place of work was 2 (1-3). The most frequent commercial brands were General Electric and Philips, as shown in *Figure 1B*. In several centers, devices of more than one brand coexisted.

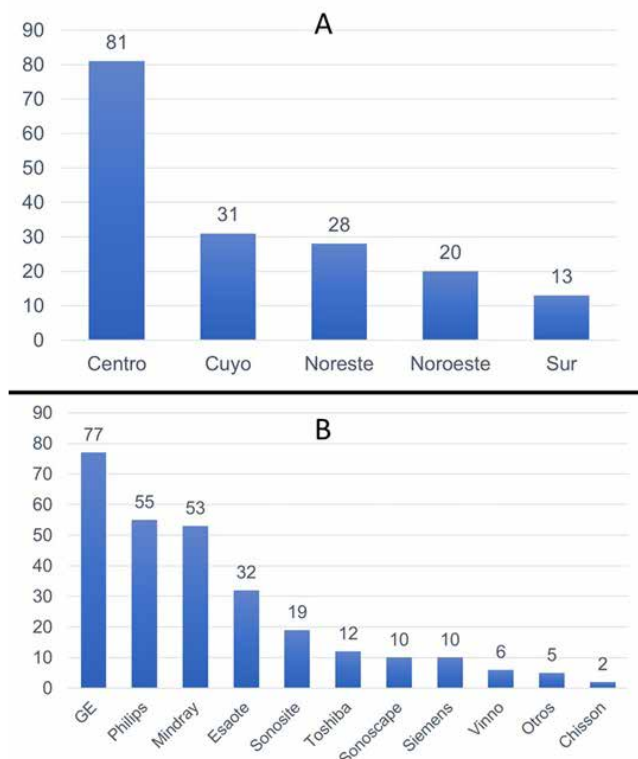


FIGURE 1.

A) Regions of work of the surveyed professionals; B) distribution of the main brands of echocardiographs in work centers.

The operative characteristics of the centers, including admission, human resources and digital equipment availability, are summarized in *Table 2*.

The number of echocardiograms per month made by the surveyed professionals was 100 (60-200). There was no evidence of a significant correlation between the number of studies made

TABLE 1.

Main characteristics of the population

Variable	n (%) or median (IQR)	
Personal and professional data		
Age	42	(37–50)
Years as echocardiographer	10	(5–18)
Echocardiography exclusively	21	(12.1)
Number of centers where they work	2	(1–3)
Work environment		
Work only in the private sector	93	(53.8)
Work only in the public sector	18	(10.4)
Work in the private and public sectors	50	(28.9)
Training		
National scientific society	104	(60.1)
International scientific society	25	(14.5)
University	57	(32.9)
Other	16	(9.2)
Fee modality		
Percentage of the value of the study	76	(43.9)
Legally hired	22	(12.7)
Fixed amount per study	28	(16.2)
Agreement with medical association	10	(5.8)
Direct contract with medical insurance or prepaid medicine companies	31	(17.9)

TABLE 2.

Main characteristics of centers

Variable	n (%) or median (IQR)	
Centers with admission	123	(71.1)
24 h availability for studies	108	(62.4)
Delay < 24 h for admitted patients	79	(45.7)
Delay > 48 h for admitted patients	6	(3.5)
Human resources		
Presence of fellows	50	(30.1)
Presence of technicians / echocardiographers	21	(12.1)
Digitization		
Electronic health record available	146	(84.4)
Remote image evaluation (PACS or others)	89	(51.4)

h: hours; EHR: electronic health record; PACS: Picture Archiving and Communication System.

and the years of experience as echocardiographer ($r=0.087$; $p=0.254$). A relationship was indeed found with making more tests per month when working exclusively in the private sector (150 vs 88 tests; $p=0.007$), as observed in *Figure 2*.

The practices related with echocardiographic data processing, the preparation and delivery of reports are summarized in *Table 3*.

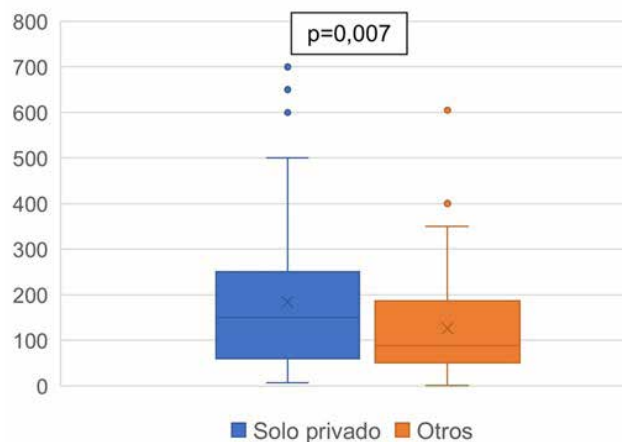


FIGURE 2.
Number of echocardiograms made per month

TABLE 3.
Data processing and preparation of echocardiographic reports

Variable	n (%) or median (IQR)	
Data processing		
Measurements are made only in the echocardiograph	147	(85.0)
Measurements made only in external software	16	(9.2)
Measurements made in both ways	10	(5.8)
Time to delivery of report		
Immediate delivery	77	(44.5)
Delivery within 24 h	118	(68.2)
Delivery within 24–48 h	36	(20.8)
Delivery > 48 h	19	(11.0)
Means to deliver the report		
Printed	94	(54.3)
Loaded into the EHR	88	(50.9)
Sent by WhatsApp	45	(26.0)
Sent by e-mail	41	(23.7)
Modality to write the report		
Manual	119	(68.8)
With preconfigured template	82	(47.4)
Dictated	16	(9.2)

h: hours; EHR: electronic health record.

Making measurements by using an external software was significantly more frequent in those working exclusively in the private sector ($p=0.010$).

Software availability for advanced techniques was variable, with left ventricular strain analysis being predominant (*Figure 3A*).

From the surveyed professionals, 49 (28.3%) manifested being trained both in TEE and in stress echocardiography (*Figure 3B*), with a smaller number trained in only one of the methods. Table 4 provides details on the volume of tests performed, the assistance available during procedures, challenge methods and sedation used, and the places where these practices are usually conducted.

In *Figure 4*, it is possible to observe the difficulties reported in practice. The main one was low professional fees in 121 (69.9%). This perception was not associated with age ($p=0.706$), the region of the country ($p=0.351$), the number of monthly studies ($p=0.437$), the years of experience ($p=0.690$), or the fee modality: percentage ($p=0.199$), direct contract with medical insurance or prepaid medicine companies ($p=0.768$), formal legal hiring ($p=0.847$), a fixed amount per study ($p=0.245$) or agreement through a medical association ($p=0.480$).

Other difficulties mentioned were lack of time due to high health care demand in 67 (38.7%), lack of professional acknowledgement in 56 (32.4%), obsolete or low-quality equipment in 34 (19.7%) and difficulty to access continuous education in 26 (15.0%). These did not present significant associations with other variables either.

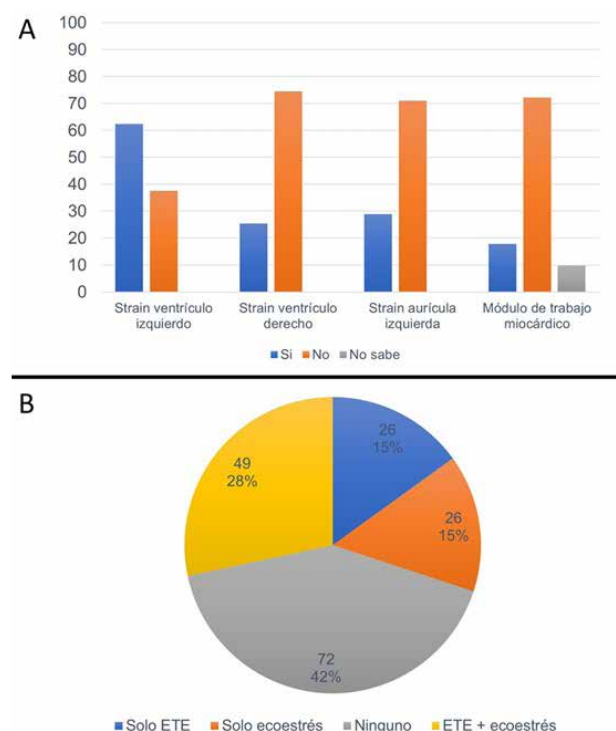


FIGURE 3.
A) Availability of software for advanced techniques of echocardiographic analysis; B) training on TEE and stress echocardiography

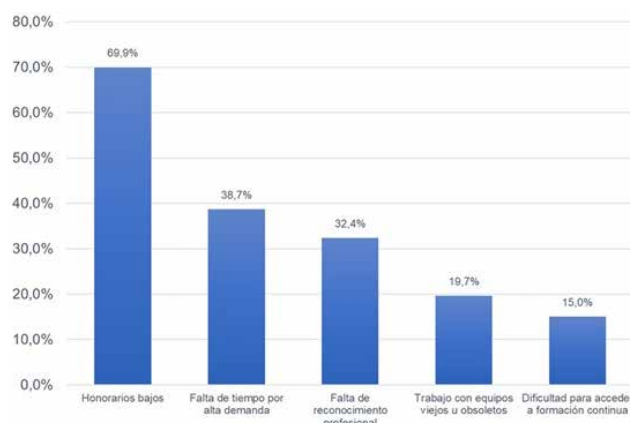


FIGURE 4.
Main difficulties perceived in the practice of echocardiography

TABLE 4.
Characteristics of the practice of TEE and stress echocardiography

Variable	n (%) or median (IQR)	
Transesophageal echocardiogram		
Professionals who perform TEE	75	(43.4)
TEE studies performed by the operator (n=75)	6	(3–10)
3D TEE available (n=75)	39	(52)
TEE with assisting nurse (n=75)	40	(53.3)
Sedation / anesthesia methods		
Local anesthesia with lidocaine (n=75)	72	(96)
Availability of sedation (n=75)	57	(76)
Frequency of use of sedation (n=75)	25	(5–90)
Place where TEE can be performed with sedation		
Echocardiography laboratory (n=75)	29	(38.7)
Coronary unit (n=75)	45	(60)
OR (n=75)	7	(9.3)
Unit of digestive endoscopy (n=75)	3	(4)
Stress echocardiography		
Professionals performing stress echocardiography	75	(43.4)
Stress studies by operator (n=75)	10	(2–20)
Nursing care (n=75)	40	(53.3)
Without 12-lead ECG (n=75)	12	(16)
Challenge method used		
Bicycle (n=75)	62	(82.7)
Treadmill (n=75)	8	(10.7)
Dobutamine (n=75)	27	(36)
Dipyridamole (n=75)	8	(10.7)

TEE: transesophageal echocardiogram

Participation in investigations at the time of the survey was 32 (18.5%). Research was not associated to working in the private sector ($p=0.209$) or in the public sector ($p=0.833$). However, 137 (79.2%) manifested a wish to participate in future work or initiatives.

In regard to regional distribution of the different aspects evaluated in the survey, there were no significant differences found between the regions in terms of years of experience as echocardiographer ($p=0.091$), the number of echocardiograms made per month ($p=0.546$), the absence of formal training in echocardiography ($p=0.755$), exclusive dedication to echocardiography ($p=0.527$), the availability of technicians for image acquisition ($p=0.533$), the presence of fellows in centers ($p=0.987$), or the availability of myocardial strain analysis ($p=0.435$) and/or of myocardial work ($p=0.727$). There were no regional differences found in terms of training for TEE ($p=0.935$) and/or stress echocardiography ($p=0.458$), in the fee modalities or in the difficulties reported. In this last aspect, a non-significant tendency was observed ($p=0.06$) toward a higher frequency of obsolete equipment in the Central and Cuyo regions.

DISCUSSION

Echocardiography constitutes a central diagnostic tool for cardiology. However, this study shows that there is a marked variation in the usual practices, level of education and certification, access to technology and knowledge of advanced techniques between the different institutions and health care systems. Thus, a detailed characterization of the professional reality is presented, identifying strengths, inequalities and opportunities for improvement.

The surveyed population proved to be relatively young (42 years), indicating a professional group with several years of experience (10 years), but still in a relatively early stage of their career. This suggests a strong foundation on which it is possible to continue the educational and professional development. However, only 12% dedicates exclusively to echocardiography.

It was observed that most of the surveyed individuals worked in more than one center. The predominant fee modality was payment per percentage of the total value of the study. This combination shows a reality of a low level of formal hiring and dependency on multiple workplaces. Thus, the configuration of a fragmented work model emerged, which forces to sustain high volumes of activity to maintain an income and limits professional foreseeability.

This leads to the main difficulty being insufficient fees, mentioned by nearly 70% of the surveyed professionals, in agreement with what was reported in other areas of Argentinian cardiology, where 96.8% of cardiologists reported an income less than expected, and more than 60% reported multiple employments.³ The perception of insufficient salaries did not show an association with age, experience, the region of the country or fee modality, suggesting a structural problem, not an individual one. This situation, added to the health care overload, coincides with factors linked to professional burnout previously described in cardiologists throughout the country.⁴

One of the central findings in the study is the marked heterogeneity in the training modalities. Although most of the surveyed

people trained in national scientific societies or in universities, there is no unified or compulsory system for certification in the country, unlike what is being proposed by international societies. Furthermore, the available programs present variability both in the educational modality (in person, distance or mixed), and in the obligatoriness of access to practices, use of advanced techniques and teacher supervision, making it difficult to standardize competences and generating differences at the level of education reached.

Both the American Society of Echocardiography (ASE) and the FAC propose graded models of training. In them, after an established number of studies made and interpreted, the specialist is certified in different levels. Level 2 allows echocardiographers to interpret transthoracic studies independently after a formal period of structured training. Level 3 adds competences in TEE, stress echocardiography and advanced techniques, and it is the standard to run echocardiography laboratories or to perform educational activities.^{5,6}

This approach coincides with what was pointed out in the European field. García Fernández (2017) describes that training in echocardiography is a gradual and supervised process, through which technical abilities should be acquired to guarantee quality, safety and the protection of patients. The lack of an obligatory national system of certification, in this scenario shows a gap between real training and the recommended standards.⁷

In the practice of echocardiography in Argentina, obtaining certifications or advanced training is not usually associated to a financial increase, whether from an institution or in the value of a study. This, added to the high workload and the scarce differential in the values collected when using complex techniques, may discourage looking for continuous education or specialization in TEE or stress echocardiography.

In agreement with these findings, the system of "Certification to perform practices of echocardiography in cardiology" of FAC received in recent years a very limited number of requests. This displays a gap between the current regulations and the daily health care reality. For this reason, there is a need to advance toward systems of certification, recertification and mentorship, coordinated by national scientific societies, articulating institutional interests and the real chances and needs of specialists.

Another relevant aspect is technological disparity. Although most of centers have echographs from brands that allow for more complex analyses, only 62% have software available to evaluate left ventricular strain and less than 30% for the right ventricle or the left atrium. These techniques are increasingly more used and appear in several diagnostic algorithms of the different cardiovascular diseases. According to international recommendations, the laboratories that train specialists should have offline analysis stations, PACS and advanced tools of post-processing, particularly to obtain a level 2 or level 3 certification.⁵ Less availability of these technologies outside the private sector shows a gap that may affect complex diagnoses, follow-up of critical patients and clinical research in the public area, where investments and advancements are usually slower than in the private sector.

Although electronic health records were available in 84% of centers, report delivery exceeded 48 hours in 11% of cases. This

time exceeds the IAC standards (2025), which suggest that outpatient studies should be reported the following working day at most.⁸ It is important to review the processes in each center to optimize delivery times so that patients may have access to timely treatments or diagnoses.

Training in TEE and stress echocardiography was also limited, since only 43% of the surveyed professionals reported having trained in both. These modalities are essential in the evaluation of valvulopathies, ischemic heart disease and structural interventions, so its scarce dissemination suggests the existence of additional access and training obstacles, possibly linked to the low number of studies made by specialists trained in these modalities, and the scarcity of programs that include supervised practices, whether with simulators or real patients.

Finally, although only 18.5% of the surveyed people participates currently in investigations, 79% manifested an interest in doing it. This gap between wishing and chance represents a significant potential to strengthen the national scientific production through collaborative networks and multicenter projects, which in the midterm may improve echocardiographic practice and facilitate the adoption of advanced techniques. In fact, a recent study by Zapata et al. showed that 84% of Argentinian cardiologists consider that scientific societies play a key role in their continuous education, reinforcing the need for entities like FAC to promote mentorship programs, collaboration networks and access to research.³

This study presented the typical limitations of a cross-sectional design and a voluntary survey, with the risk selection and self-report bias. Although participation had a national scope, regional distribution may not reflect accurately the real proportion of echocardiographers in our country. Nonetheless, the composition of the sample was coherent with other previously published national surveys on medical practice, work stress and burnout. We should emphasize that inclusion was restricted to professionals performing echocardiography studies, so the participants necessarily represented the interested and active individuals in this practice, so extrapolation to other cardiologists, not directly linked to the method, could be limited.

Jointly, the results outline Argentinian echocardiography on a solid professional foundation, but riddled by inequality in technological resources, heterogeneous education and fragile working conditions. This survey may constitute a starting point to promote standardization protocols, formal certification, continuous education and technological integration; strengthening the echocardiographic practice in the country.

CONCLUSIONS

This survey describes comprehensively, for the first time, the professional, educational and technological reality of echocardiography in Argentina, showing a young and expanding community, but with heterogeneous training, limited formal certification, technological gaps and fragile working conditions. These findings underscore the need to advance toward coordinated policies of certification, continuous education and technological integration, that would strengthen quality and equity in the practice of echocardiography in our country.

BIBLIOGRAPHY

1. Gillam LD, Marcoff L. Echocardiography: Past, Present, and Future. *Circ Cardiovasc Imaging* **2024**; 17: e016517.
2. Nair P, Chen-Tournoux A, Almufleh AS, et al. 2023 CCS/CSE Standards for Physician Training and Maintenance of Competence in Adult Echocardiography: Executive Summary. *Can J Cardiol* **2023**; 39:1302 - 1306.
3. Zapata G, Farez BG, Echazarreta D, et al. Crisis en la atención de enfermedades cardiovasculares y condiciones laborales de los cardiólogos del país. Encuesta de la Federación Argentina de Cardiología. *Rev Fed Arg Cardiol* **2024**; 53: 224 - 227.
4. Ávalos-Oddi A, Castillo-Costa Y, D'Imperio H, et al. Encuesta burnout (¿estás quemado?) en Especialistas de Cardiología SAC. *Rev Argent Cardiol* **2023**; 91: 413 - 421.
5. Wieggers SE, Ryan T, Arrighi JA, et al. 2019 ACC/AHA/ASE advanced training statement on echocardiography (revision of the 2003 ACC/AHA clinical competence statement on echocardiography). *J Am Coll Cardiol* **2019**; 74: 377 - 402.
6. Federación Argentina de Cardiología. Certificación en Ecocardiografía. **2025**. Disponible en <https://fac.org.ar/docencia/certificacion/certificacion-ecocardiografia.php> Acceso 22 de Febrero de 2026.
7. García Fernández M. La formación y acreditación en ecocardiografía: un reto complejo con múltiples caminos. *Rev Ecocardiogr Pract Otras Tec Imag Card* **2017**; 6: 1 - 3.
8. Intersocietal Accreditation Commission. IAC Standards and Guidelines for Adult Echocardiography Accreditation. Elkridge MD: IAC **2025**; 1 - 89. Disponible en <https://intersocietal.org/programs/echocardiography/standards/> Acceso 22 de Febrero de 2026.

Original Investigation Reports

Women who provide care: perceptions about cardiovascular death among Argentine female health professionals.

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ABSTRACT

Introduction: cardiovascular disease is the leading cause of death among women worldwide. However, awareness of this condition, even within the healthcare sector itself, appears to be insufficient. The main objective of this study was to identify the perception of cardiovascular disease as the leading cause of death among female healthcare professionals.

Methods: descriptive, cross-sectional study conducted between 2020 and 2021. Argentine female health care professionals with access to electronic devices and the internet were included.

Results: the final sample consisted of 1,089 surveys. The mean age was 43.1 ± 10.8 years, and the mean time since graduation was 16.2 ± 10.7 years. A total of 58.7% were involved in teaching activities, and 1.2% were retired. Cardiovascular disease was not identified as the leading cause of death in women by 62.5% of participants. Only 25.9% had primary care physicians. Moreover, 59.3% reported not having undergone a clinical check-up in the previous year, and 59.9% indicated seeking informal consultations with colleagues to address health concerns. Blood pressure measurement was reported in 18.6% of gynecological visits and 62.7% of clinical check-ups.

Conclusions: six out of ten health care professionals did not recognize cardiovascular disease as the leading cause of death among women. Self-care practice was low. Blood pressure measurement during medical check-ups was infrequently reported.

INTRODUCTION

Cardiovascular disease (CVD) is the main cause of death between women throughout the world; however, the level of awareness about this problem is still alarmingly low.^{1,2,3,4} Although most CVD mortality rates recorded are above 65 years of age, at world level it is estimated that 45% of women older than 20 years present some type of CVD, and less than half of pregnant women reach their pregnancy with good cardiovascular health.^{1,5,6} In Argentina, CVD is responsible for each every three female deaths, equivalent to a death every 11 minutes.^{1,5}

In this scenario, hypertension (HTN) stands out as the main cardiovascular risk factor (CVRF) in this population group. HTN is less prevalent in women than in men until menopause, a time when it is equal and later exceeds that of men. Although women usually achieve BP control more efficiently with treatment, the risk associated to HTN, as well as the damage to the target organ, is greater in them, likely due to hormonal factors, differences in vascular function and biases in clinical management.^{4,7,8}

In spite of the magnitude of this information, there is an inadequate perception of CVRF by women themselves, who usually prioritize gynecological conditions as their main concern for their health.^{2,9,10} They have not only been observed to present a greater tendency to associate CVD to males, but also to minimize their susceptibility to it, attributing symptoms to other causes.¹⁰

Although we might expect, as has already been proposed, that this low perception is related to educational level or access to information, we must point out that a third of the world population has access to internet, that in Argentina 89 out of every 100 people have a smartphone, and that the population has a wide possibility of access to other media such as TV, radio and the press.^{2,11}

In such context, it is pertinent to consider the role of the health care staff as source of information and guidance for the community. Several studies have shown that health care professionals tend to underestimate the risk of CVD in women,

particularly in young ones. It has been reported that only 40% of women receive a cardiovascular evaluation during routine clinical controls; that, when faced with similar clinical symptoms, women are classified mistakenly as in low risk categories in a greater proportion than men; and that, in view of an acute coronary event, the chances of receiving recommended invasive or pharmacological treatments according to clinical practice guidelines are lower when dealing with female patients.^{1,9,10,12}

Before this situation, in which both patients and professionals seem to underestimate real CVRFs in women, it is relevant to delve into what perception do women performing health care jobs in the health care field have on this problem, what level of understanding to they have on the factors conditioning their health and how do they manage their own risk factors.

The main goal of this study was to identify the perception of CVD as the first cause of death in health care professionals. As secondary aims, we set out to describe the level of self-care and the frequency of medical controls in this population.

MATERIALS AND METHODS

Design: descriptive, cross-sectional study. Professional health care women were included, added consecutively since December 2020 to December 2021.

Population: adult, female health care professionals, living in Argentina, with access to electronic devices and internet, who agreed voluntarily to fill out the survey.

Selection criteria for the sample and sampling: individuals were added by consecutive sampling considering the following sample selection criteria:

- **Inclusion criteria:** female biological gender, older than 18 years of age, living in Argentina, health care professionals who graduated from college careers of disciplines related to health such as: medicine, nursing, nutrition, pharmacy, physical therapy, active or retired.
- **Exclusion criteria:** living and/or practicing their professions in countries other than Argentina, health care workers with non-college specialized technical education.

Procedures: an instrument was prepared, based on two previous studies made in Argentina and Uruguay that were applied to the general population.^{2,9} The survey had 52 questions. The reply options included: a) multiple choice from a pre-established list; b) dichotomous replies (yes or no); and c) perceptions assessed by a scale of very frequent, quite frequent, moderately frequent, hardly frequent or not frequent at all. The survey can be checked in the Supplementary Material.

The instrument underwent a pilot test in the institution where the researches work, where mistakes were identified and corrected. Later, it was validated by a panel of three experts that evaluated the specificity of the content, the clarity of the questions, and the proposed reply options. The survey was distributed through the internet, e-mail, social media and WhatsApp, through the College of Physicians of Santa Fe, College of

Nurses of Santa Fe, Association of Internal Medicine of Rosario, Association of Hypertension of Rosario, and Association of Gynecology and Obstetrics of Rosario.

Definitions: for this study, the following definitions were adopted:

Self-perception: set of ideas a person has on themselves in a given field of action and time. It refers to the set of beliefs, attitudes, desires, values and expectations from the environment, that the individual integrates in their internal world and condition their judgements and opinions. Judgements and opinions are influenced by self-perception.¹³

Health check: according to the Argentinian ministry regulation, it is considered appropriate to undergo one yearly medical check-up to evaluate the general health state and to prevent diseases. The check-up is made in a segmental fashion according to age groups, between 10 and 19 years, and between 20 and 64 years to screen different pathologies. It should include anamnesis, vital signs, and complete physical examination. It may include auxiliary tests like laboratory, imaging or functional tests according to sex, age range, risk factors and history. Ideally, it should include guidance during evaluation.¹⁴

Gynecological check-up: according to the Argentinian regulations, it is considered appropriate to undergo the check-up once a year with the aim of preventing, detecting and treating early diseases related to the sex and reproductive health of women. It includes anamnesis, vital signs, breast exam, abdominal examination, vulva examination, speculscopy and bimanual pelvic examination. It may include auxiliary tests according to age range and risk, like mammography, pap smear, echography, laboratory tests, among others.¹⁵

General practitioner (GP): physician in charge of the general care of patients in a hospital or ambulatory, where people go for routine controls, management of chronic diseases, prevention and initial care of health issues. In adults, they are usually linked to specialties like internal medicine or family medicine.¹⁶

Statistical analysts: the SPSS software for Windows, version 21, was used. Qualitative variables are expressed in absolute values and percentages. Quantitative variables are presented as means with their standard deviations.

Ethical considerations: the study was made in agreement with the Declaration of Helsinki about investigations in humans. The identities of the participants were protected by a codification system, following the regulations in the National Law for the Protection of Personal Information (Law N° 25.326). Informed consent on the scope of research, its goals and data management was included in the first page of the survey, highlighting the voluntary aspect of the participation. The investigation was backed by the Committee of Education and Investigation of our institution.

RESULTS

From the 1119 surveys collected, 1089 were selected meeting the criteria established to be included in the final sample. The distribution of professions was: 67.8% doctors, 24.1% nur-

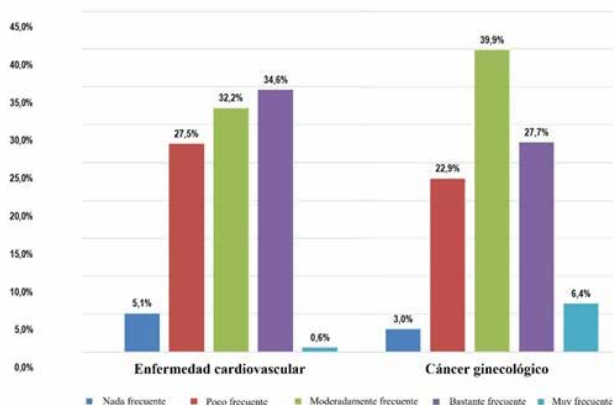


FIGURE 1.

Reported frequency of perception of CVD and GC between the female health care professionals surveyed

CVD = cardiovascular disease; GC = gynecological cancer.

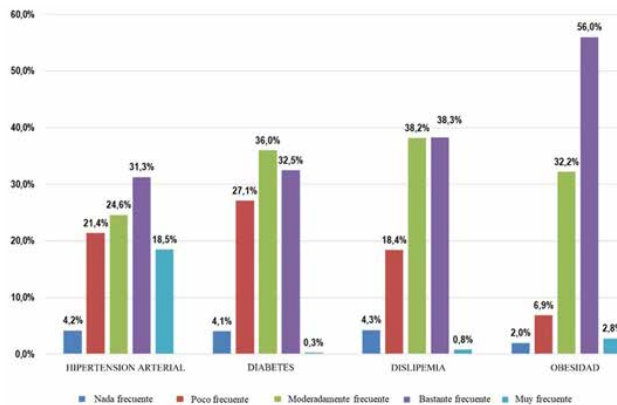


FIGURE 2.

Reported frequency of hypertension, diabetes, dyslipidemia and obesity between surveyed women

ses, 3.4% physical therapists, 3.05 nutritionists, 1.7% pharmacists. The average age was 43.1 ± 10.8 years, and the average time since graduation was 16.2 ± 10.7 years. Between the surveyed women, 58.7% reported to be also teaching besides their health care activities; and 1.2% reported being retired.

When asking about the perception of the main cause of death, CVD was identified only by 37.5% of participants, followed by gynecologic cancers (GC) in 35.7% and domestic violence in 14.5%.

When analyzing this perception according to the most representative professional groups, it was observed that between physicians, CVD held the first place (43.2%), while between nurses GC held the first place (33.4%) and CVD was third (23.1%).

The surveyed participants were requested to assess their perception of the frequency of CVD and GC in a scale from

“not frequent at all” to “very frequent”. Results are shown in *Figure 1*.

When asking about the frequency of perception of traditional CVRFs, such as HTN, diabetes, dyslipidemia and obesity, using an evaluation score from “not frequent at all” to “very frequent”, the results presented in *Figure 2* were obtained.

In regard to the presence of a GP, only 25.9% of participants said to have one. Among those who didn't, the most frequent reasons were: consulting specialists as needed (22.3%), simultaneous care by several specialists with no central doctor (18.6%), use of yearly gynecological control as the main instance to request tests (10.6%), self-management of health care (10.4%), frequent change of professionals in a non-stable manner (8.7%) and absence of periodical health check-ups (3.4%).

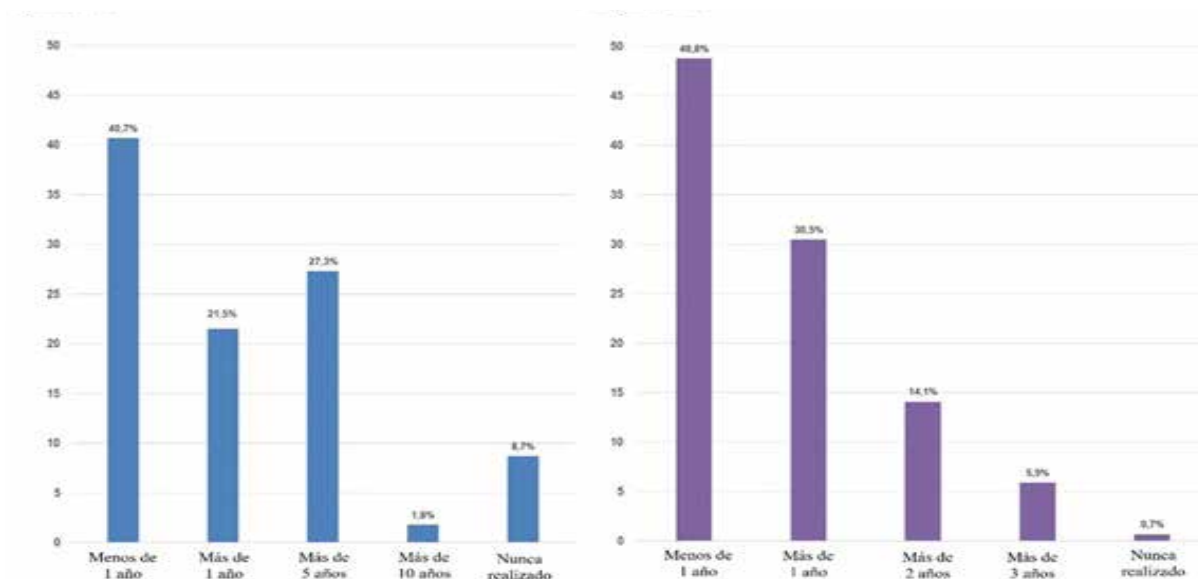
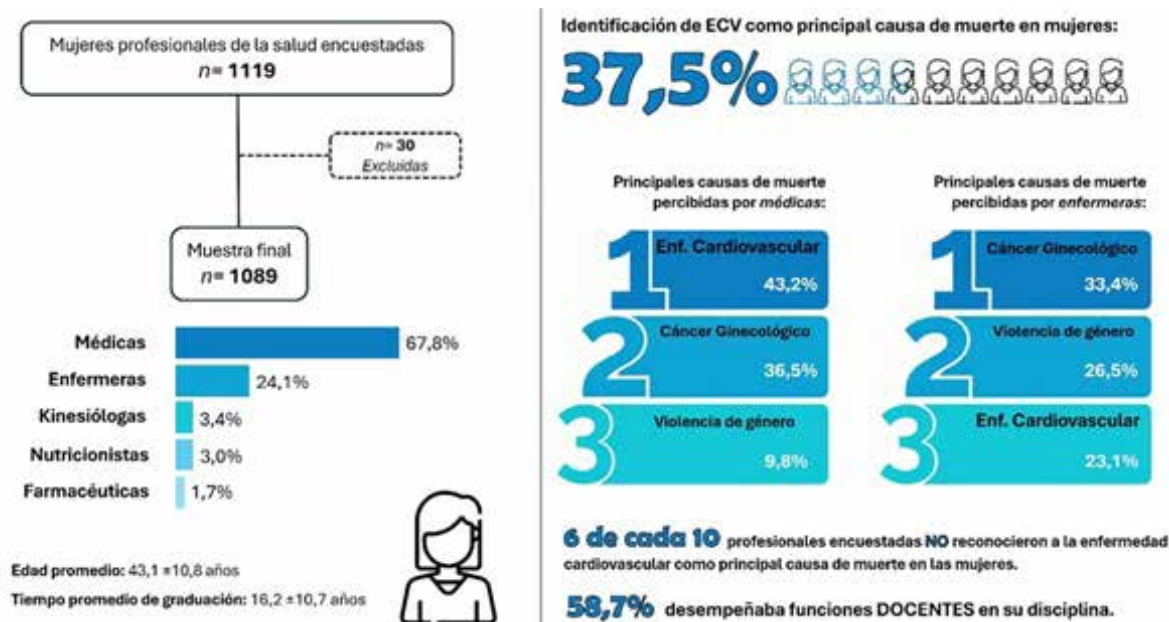


FIGURE 3A - 3B.

Reported frequency of health check-ups

3.A. Clinical. 3.B. Gynecological.



CENTRAL FIGURE

When asking about the last general health check-up, 40.7% of participants reported having done it within the last year. Between the remaining ones: 21.5% more than a year before, 27.3% more than five years before, 1.8% more than 10 years before, and 8.7% had not undergone a comprehensive clinical control ever (Figure 3A).

About the last gynecological control, 48.8% reported making it within the last year. The rest reported having done so more than one year before (30.5%), more than two years before (14.1%), more than three years (5.9%) and 0.7% reported not having undergone a gynecological control ever (Figure 3B).

Blood pressure (BP) measurement was reported in 18.6% of gynecological controls, and in 62.7% of clinical controls.

Fifty-nine percent expressed having requested informal consultations of the "hallway talk" type, to colleagues in regard to their own health.

DISCUSSION

In spite of advancements in information dissemination, health care education and technical knowledge proper of the group surveyed, there remains a concerning dissociation between scientific evidence and the perception of real risk. Six out of ten health care professionals did not identify CVD as the main cause of death in women, attributing it to GC, even when the most recent data from the Ministry of Health of Argentina confirm that CVD is indeed the leading cause, with 22.3% of female deaths, far above malignant tumors (16%) and respiratory diseases like pneumonia and influenza (10.7%).¹⁴

This phenomenon is not isolated. Del Sueldo et al. documented that only 16% of the general population of Argentinian women identified CVD as the main cause of death, while 46% thought it was due to oncological pathologies.² Likewise, Artucio et al. reported in Uruguay, that 62% of women identified

cancer as the first cause of death and less than 15% mentioned CVD.⁹ In the United States, Mosca et al. observed that less than 33% of women identified CVD as the main cause of death, and just 8% identified it as their greatest health concern, in spite of representing more than 500,000 female deaths per year.¹⁷

The perception of low frequency of CVRFs in women, in spite of their high documented prevalence, is information not only observed in this experience. The mismatch between belief and reality in regard to cardiovascular health has been described by Lichtman et al., who pointed out the female tendency to minimize CVRFs, underestimating symptoms and delaying specialized medical consultation.^{1,10,12,18} Merz et al. reported that 71% of women did not discuss cardiovascular health with their physicians, and that only 16% had been informed about risks, in spite of 74% presenting at least one CVRF.¹²

Underestimating CVRFs in young women does not constitute just an individual perception, but reflects structural deficiencies in the health care system. Different studies have identified five critical aspects: presentation with atypical symptoms, a low perception of risk by patients and health care teams, delaying to consult, inappropriate responses by the system, and scarce links to primary care. These conditions are translated into diagnoses delays, multiple consultations, higher rate of mistakes, less access to invasive studies, high number of early hospital discharges and scarce clinical indications upon discharge.^{10,12,17,18,19,20} This erasure of risk predisposes increasingly unfavorable cardiovascular profiles, particularly in a scenario where between 50% and 70% of professionals do not prioritize CVD as a relevant predicament in women.^{1,12}

The chain of oversights presented is neither a coincidence nor inevitable: it is the consequence of the structural bias ubiquitous in medical education and health care culture. This, in turn, constitutes an eloquent indicator of the need to critically

review educational programs, institutional stances, and social paradigms in terms of a gender-specific approach in health care.

This information stands in contrast with the advancements achieved in the field of sexual and reproductive health, where specific public policies, as vaccination against the human papillomavirus and campaigns for an early detection of GC, have achieved the modification of behaviors and a reduction in mortality.²¹ A similar phenomenon is observed in communication: while public awareness about breast cancer has increased continuously thanks to specific educational campaigns, awareness on CVD in women has been stagnant since 2006, particularly between younger women or women belonging to ethnic minorities.¹² These contrasts show that, when there is a political decision accompanied by continuous strategies, change is possible. Not replicating this model in cardiovascular prevention suggests the existence of deeper structural obstacles, among which a persistent overload in the roles that many women have to face stands out, outlined in the well-known “triple load”: professional work, household chores and raising children; this has a negative impact on self-care, makes a timely access to the health care system difficult, and limits the sustainability of such access over time.^{10,12} Local, regional and global studies have documented consistently that this accumulation of responsibilities restricts time, emotional and physical availability to prioritize health, even in women with a high educational level or full professional integration, such as health care professionals.^{21,22} These commitments compete with paying attention to symptoms or routine controls, generating an effect of systematic delay that in contexts of low perception of risk, worsens the neglect for cardiovascular health.

In this regard, the results of the study show it clearly: more than 60% of the surveyed professionals did not undergo a clinical control in the last year, seven in ten do not have a GP and close to 60% prefer informal consultations. In contrast, more than 80% did attend their yearly gynecological control, suggesting that specific campaigns are effective, but also that the health care model is still holding gynecological health as the central focus of female care. In fact, less than 20% of these controls included BP measurement.

These lost chances in health, occurring in eight every ten gynecological controls and in four every ten clinical controls, cannot be considered acceptable. It is necessary to devise anew college education programs, incorporating female cardiovascular health as a cross-disciplinary topic, and developing awareness campaigns addressed to health care professionals themselves. Different authors have pointed out the need to strengthen health care team training by adding gender-specific contents in curricula, and the development of educational strategies that would make the cardiovascular threat in women visible, promoting a proactive approach to risk and favoring internalizing these problems in daily clinical practice.^{12,23,24}

Finally, this gender-specific approach should go one step further: it is not just about making CVD visible in women, but also about adding the risk factors proper of women to clinical evaluation.^{1,4,8} Among them, those linked to their reproductive characteristics are acknowledged, such as the age of the first

menstrual period, early menopause due to primary ovarian insufficiency, hormone replacement therapy and polycystic ovary syndrome, as well as the conditions associated to adverse results in pregnancy, including gestational diabetes, premature birth, low neonatal weight and hypertensive disorders during pregnancy, like preeclampsia. Far from being transient events, these conditions are associated to a sustained increase in cardiovascular risk, through mechanisms linked to subclinical vascular damage, early onset of arterial stiffness and early development of subclinical atheromatosis, increasing the subsequent incidence of hypertension, ischemic heart disease, heart failure and strokes.^{4,8,25,26,27}

Concurrently, there are emerging CVRFs that, though they may be present in both sexes, affect women differently; for instance, autoimmune diseases, HIV infection and history of cancer. These conditions are associated with an early development of vascular disease, with reports of up to 50% of subclinical artery compromise in young women, even in the absence of traditional CVRFs and even when base diseases are in clinical remission.^{4,8,27,28} Excluding these factors in the usual stratification systems for CVRFs leads a mistaken classification in young women as being in low risk, limiting the timely implementation of preventive strategies. Recent evidence shows that many of these conditions are associated with subclinical vascular damage, even in the absence of traditional factors, making their inclusion crucial as risk enhancers for a proper reclassification, just as proposed in guideline for cardiovascular disease prevention in women of the Inter-American Society of Cardiology.^{4,25,28} Within this framework, it is necessary to review the current predictive algorithms and the development of specific tools for the female population. This study contributes a critical view on a widely known predicament, but still insufficiently approached. Exploring the perception of risk and self-care in women in the health care field allows to make cultural, institutional and structural factors visible, which perpetuate inequity in cardiovascular care.

The urgency is clear: educational interventions and campaigns addressed to end the cultural and clinical inertia that is erasing cardiovascular disease from the female health collective imagination are required. Strengthening knowledge, promoting regular controls and guaranteeing a fair access to the system is not just a debt with female health care professionals, but with all women. The next studies should advance on the analysis of specific obstacles, efficient prevention strategies and new approaches that would allow modifying this reality from within the system and consolidating an effective gender-specific approach.

Limitations

The study used non-probability convenience sampling, with non-controlled distribution of the survey through institutional channels and professional networks, which prevents knowing the total number of people exposed to the invitation and estimating a non-response rate. In this context, the presence of selection bias cannot be ruled out, with possible under or overrepresentation of specific professional subgroups, as well as

limitations in geographical representativeness, so the results should be interpreted as descriptive of the surveyed population, and may not necessarily be extrapolated to all female Argentinian health care professionals. As these are self-stated data, they can be susceptible of interpretation and memory biases.

CONCLUSIONS

Six in every ten professionals did not identify CVD as the main cause of death related to their sex. Awareness on this problem is low: more than 60% of surveyed women had not undergone a clinical check-up in the last year, 70% had no GP, and six in ten made informal consultations to solve health concerns. BP measurement was reported only in 62.7% of general clinical check-ups. Although 80% had attended a yearly gynecological control, BP measurement was reported in less than 20% of these consultations. The results show the urgency of integrating female cardiovascular health as a cross-disciplinary topic in college education and in continuous education programs, as well as formulating anew and developing specific awareness campaigns addressed to health care professionals.

BIBLIOGRAPHY

- Ghelfi AM, Staffieri GJ. Hypertension in non-pregnant women of childbearing age. *Med Clin (Barc)* 2022; 159: 101 – 105.
- Del-Sueldo M, Brienza S, Lorenzatti A, et al. Percepción, conocimiento y conductas preventivas sobre enfermedad cardiovascular en mujeres argentinas. *Rev Fed Argent Cardiol* 2022; 51: 68 – 77.
- Del-Sueldo M, Martell-Claros N, Abad-Cardiel M, et al. Health perception in menopausal women. *Int J Womens Health* 2018;10:655-661.
- Del-Sueldo MA, Mendonça-Rivera MA, Sánchez-Zambrano MB, et al. Guía de práctica clínica de la Sociedad Interamericana de Cardiología sobre prevención primaria de enfermedad cardiovascular en la mujer. *Arch Cardiol Mex* 2022; 92 (Supl): 1 - 68.
- Sosa Liprandi MI, Harwicz PS, Sosa Liprandi A. Causas de muerte en la mujer y su tendencia en los últimos 23 años en la Argentina. *Rev Argent Cardiol* 2006; 74: 297 - 303.
- American Heart Association. Go Red for Women. Dallas: American Heart Association. Disponible en <https://www.goredforwomen.org/en/> Acceso 26 de Febrero de 2026.
- Delucchi AM, Majul CR, Vicario A, et al. Registro Nacional de Hipertensión Arterial. Características epidemiológicas de la hipertensión arterial en la Argentina. Estudio RENATA 2. *Rev Argent Cardiol* 2017; 85: 354 - 360.
- Del Sueldo M, Fernández D, Ghelfi A, et al. Hipertensión arterial y riesgo cardiovascular en la mujer (1a Ed). Ciudad de Buenos Aires, Sociedad Argentina de Hipertensión Arterial 2023; pp 1 - 11.
- Artucio C, Giambruno M, Duro I, et al. Enfermedad cardiovascular en la mujer. Cómo la perciben, qué conocen y qué conductas de prevención adoptan las mujeres. *Rev Urug Cardiol* 2017; 32: 13 – 22.
- Lichtman JH, Leifheit-Limson EC, Watanabe E, et al. Symptom recognition and healthcare experiences of young women with acute myocardial infarction. *Circ Cardiovasc Qual Outcomes* 2015; 8: S31 – 538.
- Instituto Nacional de Estadística y Censos de la República Argentina. Acceso y uso de tecnologías de la información y la comunicación. Informes Técnicos Ciencia y Tecnología. 2020; 4: 1 – 16. Disponible en https://www.indec.gob.ar/uploads/informesdeprensa/mautic_05_20A36AF16B31.pdf Acceso 26 de Febrero de 2026.
- Merz CNB, Andersen H, Sprague E, et al. Knowledge attitudes, and beliefs regarding cardiovascular disease in women. The Women's Heart Alliance. *J Am Coll Cardiol* 2017; 70: 123 – 132.
- Ramírez Mera UN, Barragán López JF. University students' self-perception on the use of digital technologies for learning. *Apertura (Guadalajara, Jal)* 2018; 10: 94 – 109.
- Ministerio de Salud de la Nación Argentina. Dirección de Estadísticas e Información en Salud. Estadísticas vitales - Información básica. Año 2022. Buenos Aires: Ministerio de Salud 2023. Disponible en <https://www.argentina.gob.ar/salud/deis> Acceso 26 de Febrero de 2026.
- Seiref S, Alvarado Arichuluaga D, Bertin M, et al. Consenso FASGO 2024: Control ginecológico en la mujer sana. Buenos Aires: Federación Argentina de Sociedades de Ginecología y Obstetricia (FASGO) 2024. Disponible en https://www.fasgo.org.ar/images/Consenso_FASGO_2024_Control_Ginecologico_en_la_Mujer_Sana.pdf Acceso 26 de Febrero de 2026.
- Liss DT, Uchida T, Wilkes CL, et al. General Health Checks in Adult Primary Care. A Review. *JAMA* 2021; 325: 2294 - 2306.
- Mosca L, Jones WK, King KB, et al. Awareness, perception, and knowledge of heart disease risk and prevention among women in the United States. *Arch Fam Med* 2000; 9: 506 - 515.
- Schwartz LM, Woloshin S, Welch HG. Misunderstandings about the Effects of Race and Sex on Physicians' Referrals for Cardiac Catheterization. *N Engl J Med* 1999; 341: 279 – 283.
- Dattoli-García CA, Jackson-Pedroza CN, Gallardo-Grajeda AL, et al. Acute myocardial infarction: Review on risk factors, etiologies, angiographic characteristics and outcomes in young patients. *Arch Cardiol Mex* 2021; 91: 485 - 492.
- Huxley R, Barzi F, Woodward M. Excess risk of fatal coronary heart disease associated with diabetes in men and women: Meta-analysis of 37 prospective cohort studies. *Br Med J* 2006; 332: 73 - 76.
- Organización Panamericana de la Salud. Género y determinantes sociales de la salud. Washington D.C.: OPS 2019. Disponible en <https://iris.paho.org/handle/10665.2/51744> Acceso 26 de Febrero de 2026.
- Sen G, Östlin P. Gender inequity in health: why it exists and how we can change it. *Glob Public Health* 2008; 3(Suppl 1): 1 - 12.
- Mehta LS, Beckie TM, DeVon HA, et al. Acute myocardial infarction in women: a scientific statement from the American Heart. *Circulation* 2016; 133: 916 - 947.
- Redberg RF, Benjamin EJ, Bairey Merz CN, et al. A call for inclusion of sex and gender in cardiovascular medical education. *Circulation* 2015; 132: 1867 - 1869.
- Ghelfi AM, Lassus MN, Passarino FA, et al. Arterial stiffness detection in women with recent history of pre-eclampsia. *Hipertens Riesgo Vasc* 2025; 42: 3 – 12.
- Parikh NI, Gonzalez JM, Anderson CAM, et al. Adverse Pregnancy Outcomes and Cardiovascular Disease Risk: Unique Opportunities for Cardiovascular Disease Prevention in Women: A Scientific Statement From the American Heart Association. *Circulation* 2021; 143: E902 – E916.
- Ghelfi AM, Quintana R, Velez LL, et al. Arterial Stiffness and Cardiovascular Risk Reclassification in Patients with Autoimmune Rheumatic Diseases. *High Blood Press Cardiovasc Prev* 2025; 32: 439 - 450.
- Ghelfi AM, Staffieri GJ, Del-Sueldo MA, et al. Under-recognized cardiovascular risk enhancers in women: A call to rethink clinical assessment on risk stratification. *Am J Prev Cardiol* 2025; 21: 100942.

Position Statement

Over-the-counter Supplements and Cardiovascular Health: Position Statement of the Committee of Young Cardiologists of the Argentine Federation of Cardiology.

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ABSTRACT

Cardiovascular disease remains the leading cause of death in Argentina, underscoring the importance of strengthening preventive strategies grounded on healthy lifestyle habits. In parallel, the use of dietary supplements has increased significantly, driven by social media, marketing claims, and the widespread availability of over-the-counter products, despite the lack of rigorous control over their composition. Although many supplements are promoted as beneficial for cardiovascular health or physical performance, the scientific evidence supporting these claims is limited, and in some cases, their effects in patients with established cardiovascular disease or those receiving specific treatments remain unknown. In this context, the Committee of Young Cardiologists of the Argentine Federation of Cardiology considers it necessary to issue a position statement to promote evidence-based prescribing.

INTRODUCTION

Cardiovascular disease (CVD) is still the main cause of mortality in Argentina.¹ In spite of advancements made in diagnosis and treatment, its prevalence is still increasing, highlighting the importance of strengthening preventive strategies. Among them, quitting smoking, regular physical activity and healthy and balanced nutrition constitute essential foundations to reduce cardiovascular risk.²

The market of supplements has shown to be growing continuously: 57.6% of US adults consume some diet supplement, with a higher percentage in women (63.8%) than in men (50.8%). Those most demanded are collagen, magnesium and creatine.³ This phenomenon, with an increasing widespread use, is due to multiple factors: a wide dissemination in social networks, marketing strategies that promote health care benefits and physical performance, over-the-counter sales in pharmacies or health food stores. Furthermore, there is a growing tendency to self-diagnosis and search for “preventive” and “naturopathic” alternatives, without adequate professional guidance. This unrestricted access, along with an absence of rigorous pharmaceutical control over their content and purity, reinforces the need for a critical medical outlook.

Many of these products are presented as potentially beneficial for cardiovascular (CV) health, physical performance or

energy metabolism, but current scientific evidence supporting these statements is limited or inconsistent.⁴ In some cases, their impact is even unknown in patients with established CVD or under a specific pharmacological treatment, opening the possibility of unnoticed adverse interactions or effects.

This scenario poses a significant challenge, so the Committee of Young Cardiologists of the Argentine Federation of Cardiology considers fundamental to present a position statement about the use of over-the-counter diet supplements to promote evidence-based prescription.

COLLAGEN

Collagen is an essential structural protein of connective tissue, providing resistance and elasticity to skin, bones, cartilages and blood vessels.⁵

Several clinical studies have been carried out focused on the benefits of supplementing with collagen in indicators related to CVD. However, results were inconsistent. Some trials have delved into their possible impact on lipid profile and subclinical atherosclerosis markers, showing modest results, with low methodological quality.⁶ In a recent meta-analysis, reductions in fat-free mass, blood pressure and LDL cholesterol have been described, among others, after supplementing with collagen peptides for a few weeks, but with no long-term follow-up

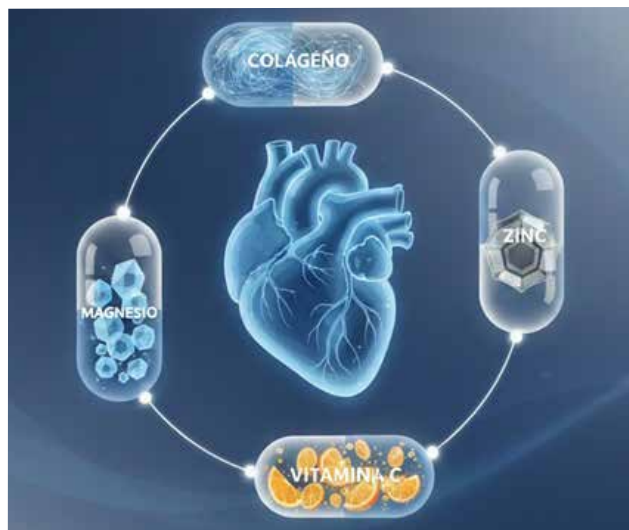


FIGURE 1.
Image created as an outline

or control of confounding factors. In the latter case, the general certainty of evidence for the different markers (using the GRADE guidelines) was low or very low.⁷

In general, oral collagen is well tolerated. The main issue lies in the variability of quality or purity of the available products, particularly in those sold over-the-counter, most with no close pharmaceutical control, which may contain additives, vitamins or undeclared minerals, or be contaminated. Co-formulation is frequent, and although generally safe, it may alter metabolic parameters in patients with renal or endocrine pathologies, or generate pharmacological interactions, mainly in polymedicated patients.

Up to this time, there are no quality randomized clinical trials proving a direct benefit of collagen consumption on CV events, endothelial function or blood pressure control. Therefore, using collagen with CV goals lacks enough evidence to be recommended, both in a health population and in people with established CVD.^{6,7}

From a cardiological point of view, unrestricted consumption of collagen supplements may generate a false feeling of safety or distract patients from effective and widely proven interventions, such as regularly practicing physical activity, a balanced nutrition, control of traditional risk factors and adherence to the indicated medical treatment. Consequently, using collagen should be limited to specific indications and under professional supervision, avoiding promoting it as CV prevention or care strategy.

VITAMIN C

Vitamin C (VitC) or ascorbic acid is an essential nutrient, that should be obtained from diet, as the human body does not produce it. It is in fruits, vegetables, vitamin supplements, energy drinks and diet cereals. Its function is fundamental in several stages of the human metabolism, with anti-inflammatory action and protective of the endothelium.^{8,9,10}

Severe diseases owing to its deficiency, such as scurvy, are rare, but observational studies have associated its deficiency to a greater risk of hypertension, endothelial dysfunction, heart disease, atherosclerosis, stroke, and cardiovascular mortality, but not suggesting widespread supplementation in the population.^{11,12}

Two systematic reviews showed that vitamin C supplementation leads to significant systolic blood pressure decrease in hypertensive patients, related to the effect on endothelial function.^{8,13}

For CAD, the supplement has not proven to decrease mortality or morbidity.¹⁴ No benefits have been observed either in the prevention of CVD in apparently healthy individuals.^{15,16,17,18}

In brief, there are not enough data to recommend routine supplementation with VitC with the single aim of primary prevention of CVD in the general population. Enough VitC and adequate ingestion should be prioritized through diet sources, like fruits and vegetables, as part of a balanced diet. Supplementation should be considered in specific cases and always under medical indication.

ZINC

Zinc is an essential trace element involved in multiple biological processes (protein synthesis, enzyme functions, maintenance of endothelial function, lipid and glucose modulation, antioxidant and immune defenses), and its deficiency has been related to immunodeficiency, endothelial dysfunction, chronic inflammation and greater risk of cardiovascular disease.¹⁹

There are no large reserves in the organism, so consuming it regularly in diet is fundamental, being obtained from animal (mainly) and vegetable sources, or even from supplements. Dosage is recommended in contexts of high risk or suspicion of deficit (inflammatory bowel diseases, severe burning, chronic kidney disease, or in vegetarian or vegan diets).²⁰

Meta-analysis and systematic reviews show that zinc supplementation may improve some cardiovascular risk factors, such as triglyceride reduction, total cholesterol, fasting glucose, and inflammatory markers such as C-reactive protein, but this was not proven to translate into a significant reduction in major cardiovascular events in cohort studies or clinical trials.^{21,22,23,24,25}

Prospective cohort studies have found that diet ingest of zinc is not significantly associated with a lower incidence of cardiovascular events, although low levels of serum zinc could be related with a greater risk in vulnerable populations, such as patients with type 2 diabetes or established CAD.²⁶ Furthermore, the quality of the evidence available is low and there is high heterogeneity between studies, limiting the recommendation of zinc as preventive strategy.²⁵

Therefore, although zinc may modulate metabolic and inflammation risk factors, there is not enough clinical evidence to recommend using it as supplement with the exclusive goal of preventing CVD in health adults, indeed recommending ingesting it through food rich in this mineral, as part of a complete and balanced diet. Its dosage is reserved only for specific cases of deficit risk or clinical suspicion.

MAGNESIUM

Magnesium (Mg) is the fourth most abundant mineral in the human body, playing a central role in multiple physiological processes. It participates in the production of energy, enzyme regulation and cell membrane stability. At cardiac level, it modulates electrical excitability, impulse conduction, myocardial contractility and vascular tone. Likewise, it intervenes in key mechanisms such as atherogenesis, thrombosis, and endothelial function, contributing to cardiovascular homeostasis maintenance.^{27,28}

Mg deficit has been related to electrical conduction alterations and major risk of arrhythmias, associated to a non-compensated increase in intracellular calcium. Although hypomagnesemia is linked to different cardiovascular alterations, current evidence does not support routine supplementation, except in documented or symptomatic cases. It is important to emphasize that the maximum tolerable level is applied only to supplementary sources, as the usual diet contribution does not reach excessive concentrations.²⁹

The amount of magnesium consumed depends on diet composition. Nuts, such as almonds or peanuts; legumes, like chickpeas and lentils, and leaf vegetables are outstanding natural sources. Daily recommendations are estimated in 400-420 mg for men and 310-320 mg for women, with slightly greater requirements during pregnancy.³⁰

Different epidemiological studies have analyzed the relationship between Mg levels and CVD. Two meta-analysis published in 2013 showed a significant inverse association between serum and diet levels of Mg and the risk of total cardiovascular events. A 0.2 mmol/L increase in serum Mg was associated to an approximate reduction of 30% in the risk of CVD, while a greater diet ingest was related to a 20-22% increase in the risk of ischemic heart disease. These associations showed a nonlinear relationship, with a greater benefit between 150 and 400 mg/day. A subsequent meta-analysis corroborated the inverse association between Mg levels and risk of CAD, hypertension and type 2 diabetes.^{31,32,33}

In a prospective cohort, diet ingest and plasma levels of Mg were associated inversely with mortality by CAD, a relationship partially mediated by hypertension. Likewise, more elevated concentrations of Mg were linked to a lower risk of sudden cardiac death in women.^{34,35}

More recently, a study published in the American Heart Association Journal showed that in patients with type 2 diabetes, an extended use of Mg supplements without medical prescription was associated with a lower risk of heart failure and of major cardiovascular events (MACE). Although results are promising, the authors emphasize the need for controlled clinical trials that would confirm causality.³⁶

Jointly, the evidence available supports that a greater ingest of Mg (whether through diet or through supplements) is associated with less incidence of cardiovascular risk factors, including metabolic syndrome, type 2 diabetes, hypertension and stroke. The inverse association between Mg consumption and metabolic parameters such as insulin resistance, hyperglycemia, dyslipidemia, and systemic inflammation may explain its protective effect on cardiovascular function.³⁷

In this scenario, promoting a diet rich in magnesium (based on fruits, vegetables, legumes, dry fruits and whole grains) constitutes a feasible and efficient strategy to prevent cardiovascular diseases and other related chronic pathologies.

CONCLUSIONS

Prevention is key to decrease the chance of suffering a cardiovascular disease. A healthy lifestyle with a varied and adequate diet plus physical exercise are the fundamental pillars on which medical prescription should be based. To this moment, there is no evidence supporting the ingest of collagen, magnesium, vitamin C or zinc supplements to improve CV events in a healthy population, as well as in carriers of CVD.

It is the interest of the Committee of Young Cardiologists of the Argentine Federation of Cardiology to provide information for colleagues for daily decisions on management, to promote indications based on scientific evidence, and to evaluate patients individually according to their needs and risks. Unnecessary expenses should be avoided, as well as replacing treatments with proved efficacy by supplements with no scientific support. We should foster interdisciplinary work between health care professionals on a predicament that is increasing, involving not just physical or esthetic performance, but also CV safety. This Committee believes the sanitary education of the population on a rational use of these products is important.

BIBLIOGRAPHY

1. Arriba AM, Gallardo LS, Günther RM, et al. Natalidad y Mortalidad 2022, síntesis estadística. Ministerio de Salud Argentina 2024; 9: 1 - 21. Disponible en https://www.argentina.gob.ar/sites/default/files/2020/12/sintesis_estadistica_nro_9_172024.pdf Acceso 2 de Marzo de 2026.
2. Visseren FLJ, Mach F, Smulders YM, et al. ESC Guidelines on cardiovascular disease prevention in clinical practice. *Eur Heart J* 2021; 42: 3227 - 3337.
3. Mishra S, Stierman B, Gahche JJ, et al. Dietary Supplement Use Among Adults: United States, 2017-2018. *NCHS Data Brief* 2021; 399: 1 - 8.
4. O'Connor EA, Evans CV, Ilev I, et al. Vitamin and Mineral Supplements for the Primary Prevention of Cardiovascular Disease and Cancer: Updated Evidence Report and Systematic Review for the US Preventive Services Task Force. *JAMA* 2022; 327: 2334 - 2347.
5. Alcaide-Ruggiero L, Molina-Hernández V, Granados M, et al. Main and Minor Types of Collagens in the Articular Cartilage: The Role of Collagens in Repair Tissue Evaluation in Chondral Defects. *Int J Mol Sci* 2021; 22: 13329.
6. Olabiyi A, de Castro Braz L. Cardiovascular Ischemia: Advancement and Potential Use of Collagen-Based Therapeutic Strategies. *Int J Mol Sci* 2025; 26: 9275.
7. Jalili Z, Jalili F, Moradi S, et al. Effects of collagen peptide supplementation on cardiovascular markers: a systematic review and meta-analysis of randomised, placebo-controlled trials. *Br J Nutr* 2023; 129: 779 - 794.
8. Guan Y, Dai P, Wang H. Effects of vitamin C supplementation on essential hypertension: A systematic review and meta-analysis. *Medicine Baltimore* 2020; 99: 19274.
9. Gegotek A, Skrzydlewska E. Antioxidative and anti-inflammatory activity of ascorbic acid. *Antioxidants* 2022; 11: 1993.
10. Ran L, Zhao W, Tan X, et al. Association between Serum Vitamin C and the Blood Pressure: A Systematic Review and Meta-Analysis of Observational Studies. *Cardiovasc Ther* 2020; 2020: 4940673.
11. Moser MA, Chun OK. Vitamin C and Heart Health: A Review Based on Findings from Epidemiologic Studies. *Int J Mol Sci* 2016; 17: 1328.
12. Morelli MB, Gambardella J, Castellanos V, et al. Vitamin C and Cardiovascular Disease: An Update. *Antioxidants* 2020; 9: 1227.

13. Ashor A, Lara J, Mathers J, et al. Effect of vitamin C on endothelial function in health and disease: A systematic review and meta-analysis of randomised controlled trials. *Atherosclerosis* **2014**; 235: 9 - 20.
14. Ye Z, Song H. Antioxidant vitamins intake and the risk of coronary heart disease: Meta-analysis of cohort studies. *Eur J Cardiovasc* **2008**; 15: 26 – 34.
15. Al-Khudairy L, Flowers N, Wheelhouse R, et al. Vitamin C supplementation for the primary prevention of cardiovascular disease. *Cochrane Database Syst Rev* **2017**; 3: CD011114.
16. Sesso HD, Buring JE, Christen WG, et al. Vitamins E and C in the prevention of cardiovascular disease in men: the Physicians' Health Study II randomized controlled trial. *JAMA* **2008**; 300: 2123 - 2133.
17. Ashor AW, Brown R, Keenan PD. Limited Evidence for a Beneficial Effect of Vitamin C Supplementation on Biomarkers of Cardiovascular Diseases: An Umbrella Review of Systematic Reviews and Meta-Analyses. *Nutrition Research* **2019**; 61: 1 - 12.
18. Jenkins DJA, Spence JD, Giovannucci EL, et al. Supplemental Vitamins and Minerals for Cardiovascular Disease Prevention and Treatment: JACC Focus Seminar. *J Am Coll Cardiol* **2021**; 77: 423 - 436.
19. Hara T, Yoshigai E, Ohashi T, et al. Zinc in Cardiovascular Functions and Diseases: Epidemiology and Molecular Mechanisms for Therapeutic Development. *Int J Mol Sci* **2023**; 24: 7152.
20. Rubio C, González Weller D, Martín-Izquierdo R, et al. Zinc: an essential oligoelement. *Nutr Hosp* **2007**; 22: 101 - 107 .
21. Nazari M, Ashtary-Larky D, Nikbaf-Shandiz M, et al. Zinc supplementation and cardiovascular disease risk factors: A GRADE-assessed systematic review and dose-response meta-analysis. *J Trace Elem Med Biol* **2023**; 79: 127244.
22. Khazdouz M, Djalalinia S, Sarrafi Zadeh S, et al. Effects of Zinc Supplementation on Cardiometabolic Risk Factors: a Systematic Review and Meta-analysis of Randomized Controlled Trials. *Biol Trace Elem Res* **2020**; 195: 373 - 398.
23. Pompano LM, Boy E. Effects of Dose and Duration of Zinc Interventions on Risk Factors for Type 2 Diabetes and Cardiovascular Disease: A Systematic Review and Meta-Analysis. *Adv Nutr* **2021**; 12: 141 - 160.
24. Ranasinghe P, Wathurapatha WS, Ishara MH, et al. Effects of Zinc supplementation on serum lipids: a systematic review and meta-analysis. *Nutr Metab* **2015**; 12: 26.
25. Nazari M, Nikbaf-Shandiz M, Pashayee-Khamene F, et al. Zinc Supplementation in Individuals with Prediabetes and type 2 Diabetes: a GRADE-Assessed Systematic Review and Dose-Response Meta-analysis. *Biol Trace Elem Res* **2024**; 202: 2966 - 2990.
26. Chu A, Foster M, Samman S. Zinc Status and Risk of Cardiovascular Diseases and Type 2 Diabetes Mellitus-A Systematic Review of Prospective Cohort Studies. *Nutrients* **2016**; 8: 707.
27. Pérez Navarro P, Martos Anguita E, Jiménez-Navarro M, et al. Niveles de magnesio y enfermedad cardiovascular: revisión sistemática y metanálisis. *Cardio-Clinics* **2021**; 56: 179 - 189.
28. Tangvoraphonkchai K, Davenport A. Magnesium and Cardiovascular Disease. *Adv Chronic Kidney Dis* **2018**; 25: 251 - 260.
29. Nielsen FH. Dietary Magnesium and Chronic Disease. *Adv Chronic Kidney Dis* **2018**; 25: 230 - 235.
30. Palomo V. Alimentos con magnesio fáciles de añadir a la dieta. *Nutriendo*, **2024**. Disponible en <https://www.academianutricionydietetica.org>. Acceso 21 de enero de 2026.
31. Qu X, Jin F, Hao Y, et al. Magnesium and the risk of cardiovascular events: a meta-analysis of prospective cohort studies. *PLoS One* **2013**;v8:ve57720.
32. Del Gobbo LC, Imamura F, Wu JHY, et al. Circulating and dietary magnesium and risk of cardiovascular disease: a systematic review and meta-analysis of prospective studies. *Am J Clin Nutr* **2013**; 98: 160 - 173.
33. Wu J, Xun P, Tang Q, et al. Circulating magnesium levels and incidence of coronary heart diseases, hypertension, and type 2 diabetes mellitus: a meta-analysis of prospective cohort studies. *Nutr J* **2017**; 16: 60.
34. Chiuve SE, Sun Q, Curhan GC, et al. Dietary and plasma magnesium and risk of coronary heart disease among women. *J Am Heart Assoc* **2013**; 2: e000114.
35. Chiuve SE, Korngold EC, Januzzi JL, et al. Plasma and dietary magnesium and risk of sudden cardiac death in women. *Am J Clin Nutr* **2011**; 93: 253 - 260.
36. Cheng Y, Zullo AR, Yin Y, et al. Nonprescription Magnesium Supplement Use and Risk of Heart Failure in Patients With Diabetes: A Target Trial Emulation. *J Am Heart Assoc* **2025**; 14: e038870.
37. Rosique-Esteban N, Guasch-Ferré M, Hernández-Alonso P, et al. Dietary Magnesium and Cardiovascular Disease: A Review with Emphasis in Epidemiological Studies. *Nutrients* **2018**; 10: 168.

Clinical Case

Extensive aortic dissection complicated by severe pericardial effusion and cardiac tamponade: a fulminant presentation.

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Extensive aortic dissection,
cardiac tamponade,
focused cardiac ultrasound.

ABSTRACT

Acute aortic syndrome includes various conditions such as aortic dissection, which has a high mortality rate. We present the case of a 67-year-old hypertensive male who presented with severe epigastric pain and hemodynamic instability. CT angiography revealed extensive aortic dissection from the aortic valve to the iliac artery bifurcation. A focused cardiac ultrasound showed aortic dilation and severe pericardial effusion. During surgical preparation, the patient developed cardiac tamponade and cardiac arrest, dying despite resuscitation. This case highlights the atypical presentation of extensive aortic dissection and the value of cardiac ultrasound in emergency settings.

INTRODUCTION

Aortic dissection is a cardiovascular emergency with high mortality, characterized by aortic wall layers splitting due to intimal tear. Its clinical presentation is variable, and an early diagnosis is essential for survival, as the risk of morbidity and mortality increases according to the times of onset, diagnosis and therapy implementation. Imaging, particularly computerized tomography and echocardiography, play a fundamental role in its detection. We present the case of a patient with atypical presentation of aortic dissection with hemopericardium as associated complication, with a fatal outcome, emphasizing the importance of an early diagnosis and an appropriate management.

CASE PRESENTATION

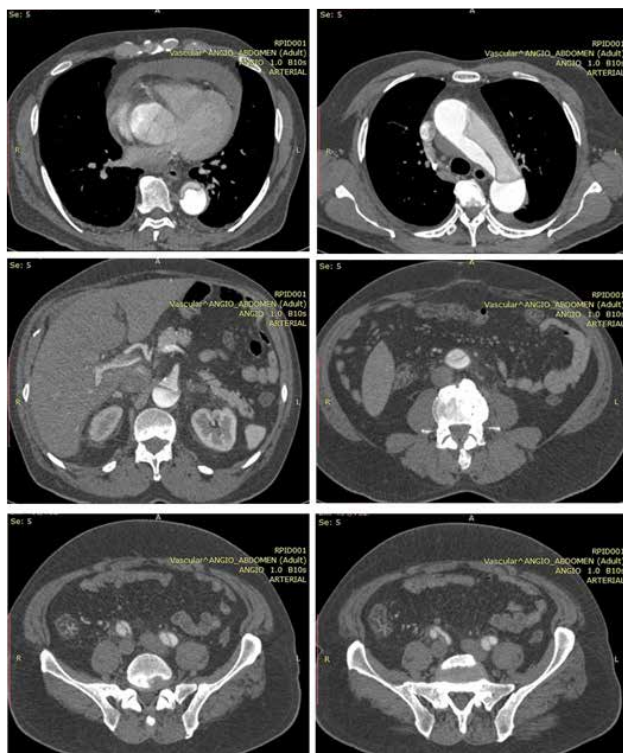
Male, 67-year-old patient: hypertensive, in treatment with amlodipine 10 mg/day and losartan 50 mg every 12 hours, who consulted the ER because of 4 days of burning epigastric pain, of maximal intensity, radiating toward the retrosternal region and left upper limb. Upon admission, he presented heart rate of 80 beats per minute, respiratory rate of 24 breaths per minute, blood pressure of 101/75 mmHg, temperature of 36.5°C and room air oxygen saturation of 97%. Distal pulses were normal, with no other relevant findings.

The initial laboratory tests showed neutrophilic leukocytosis, severe hypopotassemia, renal function compromise, normocytic normochromic anemia, uncompensated respiratory alkalosis, and positive troponins (*Table 1*). Chest X-rays showed mediastinal widening and cardiomegaly with no other alterations.

TABLE 1.

Results of biochemical tests

Laboratory tests	Results	Reference range
Leukocytes	15890 /mm ³	3.98 - 10.04 /mm ³
Neutrophils	10410 /mm ³	1.56 - 6.13 /mm ³
Hemoglobin	10.2 g/dL	11.2 - 15.7 g/dL
Mean corpuscular volume	83.4 fL	79 - 92.2 fL
Hemoglobin corpuscular media	26.9 pg	25.7 - 32.2 pg
Platelet count	330,000 /mm ³	182,000 - 369,000 /mm ³
Serum potassium	2.4 mmol/L	3.5 - 5.1 mmol/L
Serum sodium	139 mmol/L	137 - 145 mmol/L
Creatinine	3.1 mg/dL	0.52 - 1.04 mg/dL
Blood urea nitrogen (BUN)	19 mg/dL	9 - 20 mg/dL
Glycated hemoglobin	5.6 %	0.6 - 6.5 %
Quantitative Troponin I	106.6 ng/L	0 - 12 ng/L
Arterial blood gas:		
pH	7.46	7.35-7.45
SO ₂	96.8 %	94-98 %
pCO ₂	25.0 mmHg	35-48 mmHg
pO ₂	92 mmHg	83-108 mmHg
HCO ₃	21.1 mmHg	21-28 mmHg
BE	-4.9 mmol/L	-2 - 3 mmol/L

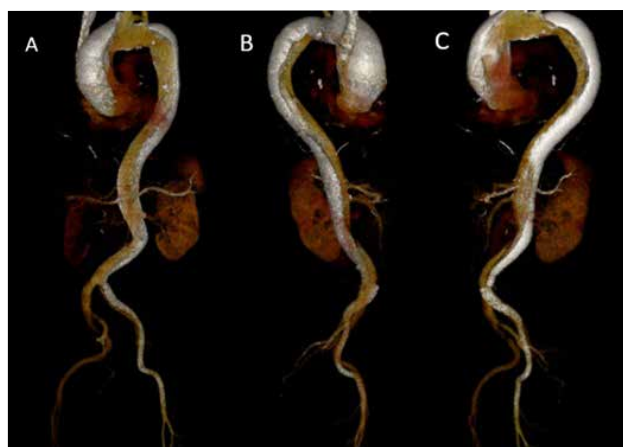
**FIGURE 1.****Thoracoabdominal CT angiography**

Extensive aortic dissection that starts at the aortic valve with true lumen smaller than false lumen, spreading to the aortic arch, descending thoracic aorta, suprarenal and infrarenal abdominal aorta, common iliac arteries and ending at the bifurcation.

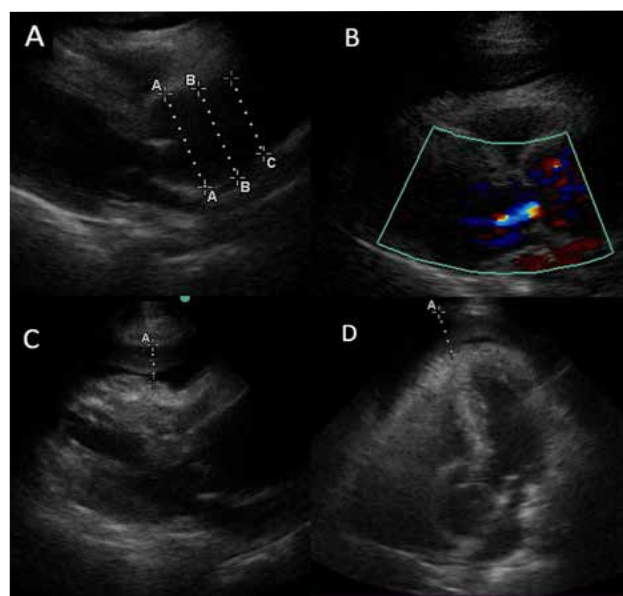
Under the diagnostic suspicion of acute aortic syndrome, CT angiography of chest and abdominal great vessels with 3D reconstruction was carried out, where extensive aortic dissection was visible from the valve plane, with no sigmoid arteries compromise, until the bifurcation of the common iliac arteries (*Figures 1 and 2*). Focused cardiac ultrasound (FoCUS) was carried out, finding aortic annulus, root and ascending aorta dilatation, generating moderate to severe aortic insufficiency, besides moderate to severe pericardial effusion, categorizing this aortic dissection as DeBakey I Stanford A (*Figure 3*).

Given the described findings, analgesic management, potassium replenishment and IV metoprolol administration was started. No IV antihypertensive management was added due to systolic blood pressure being <120 mmHg. Emergency surgery was indicated to replace ascending aorta (reconstruction of aortic root, coronary ostial reimplantation and valve replacement); however, before it, the patient presented hemodynamic deterioration and cardiorespiratory arrest. Resuscitation maneuvers were applied for 20 minutes, not achieving return to spontaneous circulation.

During cardiopulmonary resuscitation, speckle tracking echocardiography was carried out, where increase in pericardial effusion volume was observed, with compression of ventricular chambers and aortic lumen obliteration.

**FIGURE 2.****Three-dimensional CT angiography of thoracoabdominal aorta**

A) Anterior view; B) right lateral view; C) left lateral view.

**FIGURE 3.****FoCUS**

A) Preserved left ventricular systolic function. Ascending aorta dilatation (Sinus of Valsalva 4.9 cm, sinotubular junction 4.7 cm, ascending aorta 4.6 cm); B) moderate to severe aortic insufficiency; C) aortic dissection flap in proximal segment; D) moderate to severe anterior pericardial effusion, with diameter of more than 27 mm.

DISCUSSION

Classical aortic dissection is a medical emergency with high mortality, defined as the aortic wall layers splitting, with intimo-medial tear that leads to the formation and propagation of false lumen within the media.¹ The pathophysiological principle lies in the increase in pressure leading to the layers splitting, and there are two main factors leading to this development: structural weakness, as in the diseases affecting connective tissue by extracellular matrix alteration, and increase in aortic wall tension, as in the cases of hypertension.^{2,3} It is commonly classified according to the affected segment (Stanford and DeBakey classifica-

tions) and temporality (hyperacute, acute, subacute or chronic).⁴ It presents high mortality, particularly in the type-A shape, where it may reach up to 50% if not treated timely.^{1,5}

The risk factors for classical aortic dissection can be classified into general and modifiable. The former include genetic variants, bicuspid aortic valve and genetic disorders of the connective tissue, and the latter is hypertension, the most frequent comorbidity in aortic dissection, with a 45% to 100% prevalence, according to observational studies, as in the case of this patient.^{6,7,8} The most usual symptoms of aortic dissection are retrosternal, interscapular and abdominal pain, presenting abruptly and with a piercing nature, and that could be associated with pulse asymmetry or differential blood pressure between the upper limbs of >20 mmHg, focal neurological deficit, aortic regurgitation murmur, hypotension or shock.⁹

The diagnostic strategy of choice is CT angiography of the aorta. This allows to classify the extent of the dissection; in the case of this patient, we observe compromise of renal and superior mesenteric arteries, and it extends up to the bifurcation of the common iliac arteries; this aspect has been rarely reported in medical literature.^{10,11}

Within the complications reported we find shock state, recurring pain, refractory hypertension, peripheral and visceral ischemia, periaortic hematoma and pericardial effusion, with or without cardiac tamponade. Although transthoracic echocardiogram and Doppler echography, carotid or renal as it may correspond, are tests that allow characterizing the compromise thoroughly, in this patient, it was not possible to apply them as this resource was not available before his death. So, FoCUS was applied, which is a useful tool to identify direct signs of acute aortic compromise and cardiac or pericardial complications.^{12,13}

The treatment of pericardial effusion with tamponade is pericardiocentesis, which has been described as a low risk and effective procedure for cardiac tamponade by different etiologies; however, in this scenario, the most recent guidelines of the European Society of Cardiology from 2015 recommend controlled drainage in small amounts to maintain a systolic blood pressure of more than 90 mmHg, as greater amounts may worsen the leak and the hemodynamic state. Emergency subxiphoid pericardiotomy has been studied in comparison with emergency cardiopulmonary bypass, not finding one to be better than the other, so choosing the procedure should be based on the individual characteristics of patients and on the experience of surgeons.^{14,15}

CONCLUSIONS

Acute aortic dissection is a medical emergency with high mortality, which may present with complications, which worsen outcomes and the prognosis in the short term. Severe pericardial effusion, as a complication, conditioning cardiac tamponade and the extension of the dissection up to the iliac arteries is a presentation rarely reported in literature. We highlight the chance of using FoCUS in the ER as a useful tool for an early diagnosis and treatment.

BIBLIOGRAPHY

1. Vilacosta I, San Román JA, di Bartolomeo R, et al. Acute Aortic Syndrome Revisited: JACC State-of-the-Art Review. *J Am Coll Cardiol* **2021**; 78: 2106 - 2125.
2. Bossone E, Eagle KA. Epidemiology and management of aortic disease: aortic aneurysms and acute aortic syndromes. *Nat Rev Cardiol* **2021**; 18: 331 - 348.
3. Sayed A, Munir M, Bahbah EI. Aortic Dissection: A Review of the Pathophysiology, Management and Prospective Advances. *Curr Cardiol Rev* **2021**; 17: e230421186875.
4. Booher AM, Isselbacher EM, Nienaber CA, et al; IRAD Investigators. The IRAD classification system for characterizing survival after aortic dissection. *Am J Med* **2013**; 126: 730.e19-24.
5. Obel LM, Lindholt JS, Lasota AN, et al. Clinical Characteristics, Incidences, and Mortality Rates for Type A and B Aortic Dissections: A Nationwide Danish Population-Based Cohort Study From 1996 to 2016. *Circulation* **2022**; 146: 1903 - 1917.
6. Mussa FF, Horton JD, Moridzadeh R, et al. Acute Aortic Dissection and Intramural Hematoma: A Systematic Review. *JAMA* **2016**; 316: 754 - 763.
7. Inoue Y, Matsuda H, Uchida K, et al. Analysis of Acute Type A Aortic Dissection in Japan Registry of Aortic Dissection (JRAD). *Ann Thorac Surg* **2020**; 110: 790 - 798.
8. Zhou Z, Cecchi AC, Prakash SK, et al. Risk Factors for Thoracic Aortic Dissection. *Genes* **2022**; 13: 1814.
9. Carrel T, Sundt TM 3rd, von Kodolitsch Y, et al. Acute aortic dissection. *Lancet* **2023**; 401: 773 - 788.
10. Kam CT, Soliman M, Okafor N, et al. Extensive aortic dissection (Stanford Type A) presenting with confusion in a patient: a case report. *Radiol Case Rep* **2022**; 17: 3031 - 3034.
11. Gallego-Colon E, Jafari J, Yosefy C. Extensive Aortic Dissection from Aortic Root to Iliac Artery. *CASE (Phila)* **2020**; 4: 226 - 229.
12. Evangelista A, Isselbacher EM, Bossone E, et al; IRAD Investigators. Insights From the International Registry of Acute Aortic Dissection: A 20-Year Experience of Collaborative Clinical Research. *Circulation* **2018**; 137: 1846 - 1860.
13. Nazerian P, Mueller C, Vanni S, et al. Integration of transthoracic focused cardiac ultrasound in the diagnostic algorithm for suspected acute aortic syndromes. *Eur Heart J* **2019**; 40: 1952 -1960.
14. Lin CY, Wu MY, Tseng CN, et al. Surgical rescues for critical hemopericardium complicated by acute type A aortic dissection: Emergent subxiphoid pericardiotomy or cardiopulmonary bypass first? *PLoS One* **2020**; 15: e0229648.
15. Adler Y, Charron P, Imazio M, et al; ESC Scientific Document Group. 2015 ESC Guidelines for the diagnosis and management of pericardial diseases: The Task Force for the Diagnosis and Management of Pericardial Diseases of the European Society of Cardiology (ESC) Endorsed by: The European Association for Cardio-Thoracic Surgery (EACTS). *Eur Heart J* **2015**; 36: 2921 -2964.

Clinical Case

Transcatheter mitral valve implantation with Myval balloon-expandable device: clinical case and literature review.

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Degenerative mitral bioprosthesis,
Transcatheter mitral valve-in-valve,
Meril Myval™.

ABSTRACT

The transcatheter balloon-expandable heart valve prosthesis, Meril Myval™, has begun to be used in percutaneous repairs of dysfunctional mitral valve bioprosthesis (TMViV) as an alternative to surgical reintervention. Its effectiveness and security position it as a promising choice in percutaneous valvular interventions. In this case report, we provide detailed information on the implant technique of the Meril Myval™ system in a patient with dysfunction of surgical mitral bioprosthesis, and the available clinical data published for TMViV are reviewed.

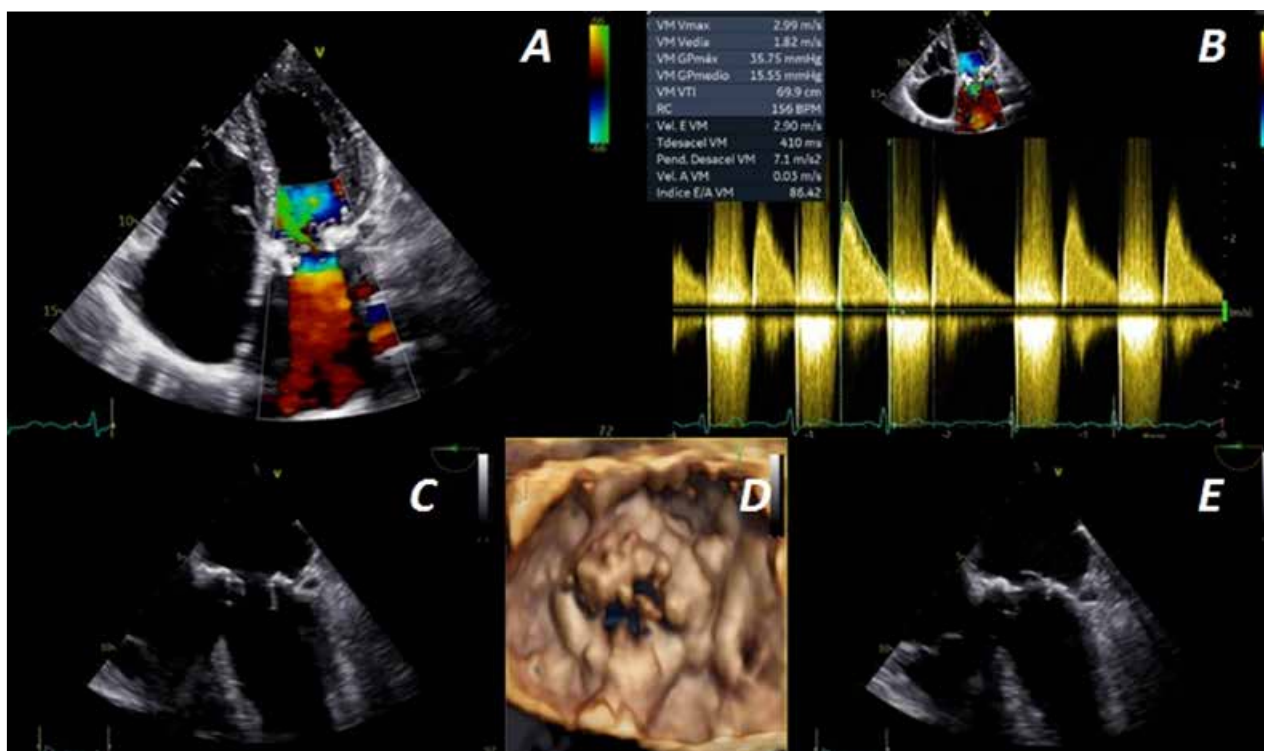
INTRODUCTION

Nearly a third of patients carriers of mitral bioprosthesis will require a new surgical repair within the 10 years after the initial surgery.¹ However, a new surgery is usually a procedure with a high rate of mortality.² Transcatheter repair of mitral bioprosthesis using balloon-expandable aortic valve (TMViV) was proposed more than a decade ago as an alternative to surgery in patients with degraded bioprostheses. In spite of the success and fast evolution of transcatheter bioprosthetic aortic valve repair, TMViV has not evolved as much. The Meril Myval™ device (Meril Life Sciences Pvt Ltd., Vapi, India) obtained the trademark from the European Union in 2018 after the Myval-1 trial for the treatment of aortic stenosis and subsequently for ViV procedures.^{3,4} Our work thoroughly describes the implant technique for the Meril Myval™ device in a patient with severe dysfunction of surgical mitral bioprosthesis, besides reviewing the literature about the safety and feasibility of the TMViV procedure.

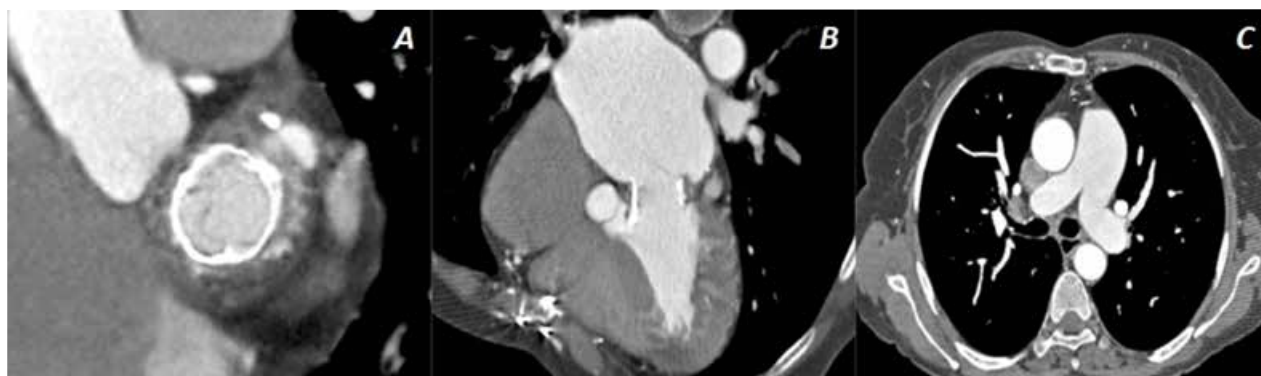
CLINICAL CASE

Female, 59-year-old patient with history of hypothyroidism, chronic kidney disease, subarachnoid bleeding secondary to traumatic brain injury solved surgically, and double mitral valve lesion with stenosis predominance, so she underwent surgical mitral valve replacement with porcine biological prosthesis N° 27, 15 years before her current consultation. In the follow-up, she developed permanent atrial fibrillation, so she received treatment with anti-vitamin K oral anticoagulants. Six months before, she presented FC III heart failure syndrome. In physical

examination, her fragile state stood out, being cachexic, with a tendency to hypotension, and systolic whooshing murmur 4/6 in mitral area radiating to the armpit. Transthoracic echocardiogram (TTE) was carried out showing normal left ventricle (EF 64%), biological mitral valve prosthesis with degenerative signs, posterior leaflet prolapse (flail), severe valve reflux (regurgitant volume 60 ml, regurgitant orifice 0.8 cm²), and severe increase in transvalvular gradients (mid gradient 13 mmHg). Furthermore, moderate failure of tricuspid valve, pulmonary systolic pressure 60 mmHg, dilated right ventricle and mild systolic function deterioration (TAPSE 15 mm, tissue Doppler S wave 9 cm/sec), and biatrial enlargement (*Figure 1*). Multislice CT coronary angiography revealed mitral valve bioprosthesis with annulus and three metal struts, with internal diameter of 21 mm, absence of peri-prosthetic orifices and hypodensities, pulmonary trunk dilatation, coronary arteries with no lesions, and area of the new left ventricular outflow tract (IVOT) of 295 mm² (*Figure 2*). Right heart catheterization identified medium pulmonary artery pressure of 52 mmHg, pulmonary capillary wedge pressure of 30 mmHg and pulmonary vascular resistance of 2 Wood units. Based on the high surgical risk of the patient (Euro Score 9.6%, STS morbimortality 20%, Argen-Score of in-hospital mortality 6%) and the findings observed in the different studies, the heart team opted for percutaneous repair of the mitral valve with implant of new bioprosthesis (TMViV). The procedure was made under general anesthesia and guided by transesophageal echocardiogram (TEE). Through right common femoral vein access, Mullins 8 Fr sheath was placed (Cook Medical Inc., Indianapolis, IN, USA),

**FIGURE 1.**

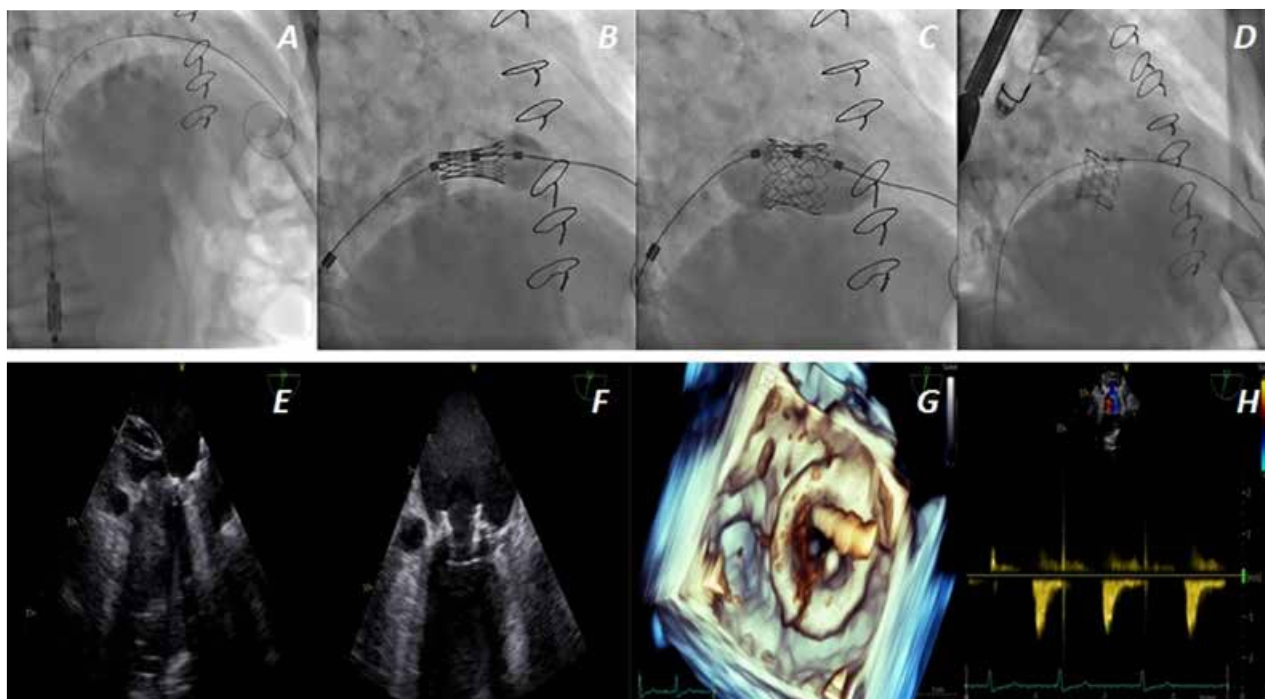
Ultrasound images before TMViV. A-B) Transthoracic color Doppler echocardiogram in 4-chamber view, showing dysfunctional mitral valve bioprosthesis, and continuous Doppler showing valve reflux and severely altered transvalvular gradients. C-D-E) Transesophageal echocardiogram in 2 and 3 dimensions.

**FIGURE 2.**

Cardiovascular multislice CT images before TMViV. A) Short axis of mitral valve prosthesis during diastole. B) Five-chamber view showing mitral bioprosthesis, and left ventricular outflow tract partially. C) Chest axial slice showing pulmonary trunk dilatation, secondary to marked pulmonary hypertension.

which was advanced toward the left brachicephalic vein, and later a Brockenbrough needle was inserted (Medtronic, Minneapolis, MN, USA) of 18 ga into the sheath, and was pushed toward the inferoposterior position of the interatrial septum. Subsequently, transseptal puncture guided by TEE, not requiring electrocauterization, and 100 UI/kg of sodium heparin was administered, the puncture needle was withdrawn, and the Mullins sheath was advanced toward the left atrium, which was exchanged by the Python 14 Fr sheath (Meril Life Sciences, Vapi, India), and a small stiff Safari double curve and distal curve guidewire was advanced toward the left ventricle apex (Boston Scientific, Marlborough,

MA, USA). Atrial septostomy was carried out with Mustang balloon (Boston Scientific) of 10 x 14 mm, expanded until 8 atm. No predilatation was conducted for the bioprosthesis. Next, the Meril Myval™ system was advanced (N° 23) and was placed through the surgical bioprosthesis, with a 15% position in the atrial side and 85% in the ventricular side. A slow deployment of the valve was made within the previous mitral bioprosthesis in the right caudal view, with rapid ventricular pacing (through the Safari guidewire) at 170 bpm and induced apnea. Later, rapid inflation was carried out to stretch the ventricular side. Once the valve was deployed, the images obtained by TEE were examined

**FIGURE 3.**

Images during TMViV. A-B-C-D) Angiographic recordings during positions, deployment and end result of Meril Myval™ bioprosthesis placement. E-F-G-H) Intraoperative TEE.

with the goal of evaluating the final position of the prosthesis, the transmitral gradients and the LVOT, para-valvular leaks and the degree of residual shunt (*Figure 3*). All the mentioned parameters were satisfactory, so the procedure was concluded. Finally, the venous access was closed by figure 8 suture technique and hemostasis was completed by manual compression. The patient was discharged with oral anticoagulation (vitamin K antagonists) with the goal of achieving a 2-3 INR. In the mid- and long-term follow-up, she presented a good clinical and echocardiographic evolution.

DISCUSSION

Surgical mitral bioprostheses are prone to fail over time due to their degeneration. As a surgery repeat could be of high risk, transcatheter replacement was started to be used in this type of patients, with the SAPIEN 3 prosthesis being initially used through transseptal and transapical accesses.^{5,6} In its start, TMViV showed a high rate of technical success (97%) and a relatively low mortality (5.4%) within 30 days after the intervention, making it an appealing technique.⁷ The Meril Myval™ prosthesis has started to be used for most of the aortic ViV procedures in countries like India, and it has also been described in patients with dysfunctional mitral bioprosthesis.⁸ It is a bovine pericardial prosthesis, of three valves and balloon-expandable, which also includes a 14 Fr sheath (Python) that could be dilated up to 18 Fr and allows access to all sizes of the Meril Myval™ system. In a TMViV registry in 20 patients with the Meril Myval™ system, mortality in 30 days was 5%, and 10% in one year.⁹ To this date, few studies (most of them registries) have evaluated the results of these procedures.

The first registries included old-generation balloon-expandable valves, and a significant proportion of patients underwent procedures by transapical access. A medium score of STS score in the VIVID registry was 13%, and 64% of patients underwent valve replacement by transapical approach. In the TVT registry, the STS score was 10%; 45% were transapical procedures. Mortality in 30 days in the VIVID and the TVT studies was 8% and 10%, respectively.^{10,11} In subsequent multicenter registries of patients treated by transseptal access, mortality within 30 days ranged between 5% and 6%.¹² In the multicenter MITRAL registry, all procedures were carried out by transseptal access and using the SAPIEN 3 valve, mortality rates within 30 days and within one year were both 3%.² One of the advantages that the Meril Myval™ prosthesis presents in comparison with the SAPIEN 3 is that the former is directly set on a release balloon, not requiring realigning the valve once it is outside the release sheath. Therefore, the Python sheath can be placed within the femoral vein and the inferior vena cava, and it also allows for a single 14 Fr size to be adapted to all prosthesis, besides enabling its withdrawal if necessary. It has a set of proximal and distal stoppers, guaranteeing a precise connection of the valve, and removing the risk of involuntary migration during introduction through the sheath or when passing the release system through the aorta. Implanting a transcatheter valve of the appropriate size is key: its size is based on the real internal diameter of the degenerated surgical valve prosthesis. Meril Myval™ is manufactured in intermediate and extra-large sizes, helping to implant valves of the appropriate size in most cases. Results in the long term should be evaluated through more thorough studies.

CONCLUSION

Transcatheter repair of dysfunctional mitral valve bioprosthesis with the Meril Myval™ prosthesis was made safely, with no morbimortality and a significant improvement in postoperative valve performance. Its availability in intermediate sizes and reduced costs in comparison to other bioprostheses turn it into the ideal prosthesis for TMViV.

BIBLIOGRAPHY

1. Lu Y, Yang Y, Wang W, et al. Transcatheter Mitral Valve-in-Valve Implantation with a New Transcatheter Heart Valve for Bioprosthetic Degeneration. *Front Cardiovasc Med* **2022**; 8: 783507.
2. Guerrero M, Pursnani A, Narang A, et al. Prospective Evaluation of Transeptal TMVR for Failed Surgical Bioprostheses: MITRAL Trial Valve-in-Valve Arm 1-Year Outcomes. *JACC Cardiovasc Interv* **2021**; 14: 859 – 872.
3. Jensen RV, Jensen JK, Christiansen EH, et al. Two case reports of transcatheter valve-in-valve implantation of Sapien 3 and MyVal in degenerated biological tricuspid prosthesis valves. *Eur Heart J Case Rep* **2022**; 6: ytac131.
4. Sharma SK, Rao RS, Chandra P, et al. First-in-human evaluation of a novel balloon-expandable transcatheter heart valve in patients with severe symptomatic native aortic stenosis: The MyVal-1 study. *EuroIntervention* **2020**; 16: 421 – 429.
5. Mohty D, Orszulak TA, Schaff HV, et al. Very long-term survival and durability of mitral valve repair for mitral valve prolapse. *Circulation* **2001**; 104(Suppl 1): 11 – 17.
6. Yoon SH, Whisenant BK, Bleiziffer S, et al. Transcatheter mitral valve replacement for degenerated bioprosthetic valves and failed annuloplasty rings. *J Am Coll Cardiol* **2017**; 70: 1121 – 1131.
7. Whisenant B, Kapadia SR, Eleid MF, et al. One-year outcomes of mitral valve-in-valve using the Sapien 3 transcatheter heart valve. *JAMA Cardiol* **2020**; 5: 1245 – 1252.
8. Ielasi A, Buono A, Medda M, et al. Transcatheter valve-in-valve implantation with a novel balloon expandable device in patients with bioprosthetic heart valve failure: A case series. *Cardiovasc Revasc Med* **2021**; 28S: 98 – 101.
9. Sankardas MA, Subban V, Kothandam S, et al. Clinical Outcomes Following Transcatheter Mitral Valve-in-Valve Replacement Using a Meril Myval Transcatheter Heart Valve. *Heart Lung Circ* **2024**; 33: 222 - 229.
10. Aziz M, Simonato M, Webb JG, et al. Mortality prediction after transcatheter treatment of failed bioprosthetic aortic valves utilizing various international scoring systems: Insights from the Valve-in-Valve International Data (VIVID). *Catheter Cardiovasc Interv* **2018**; 92: 1163 – 1170.
11. Guerrero M, Vemulapalli S, Xiang Q, et al. Thirty-day outcomes of transcatheter mitral valve replacement for degenerated mitral bioprostheses (valve-in-valve), failed surgical rings (valve-in-ring), and native valve with severe mitral annular calcification (valve-in-mitral annular calcification) in the United States: data from the Society of Thoracic Surgeons/American College of Cardiology/Transcatheter Valve Therapy Registry. *Circ Cardiovasc Interv* **2020**; 13: e008425.
12. Urena M, Brochet E, Lecomte M, et al. Clinical and haemodynamic outcomes of balloon-expandable transcatheter mitral valve implantation: a 7-year experience. *Eur Heart J* **2018**; 39: 2679 – 2689.

Clinical Case

Spontaneous coronary artery dissection and concomitant atherosclerotic disease

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ABSTRACT

Spontaneous coronary artery dissection (SCAD) is a rare cause of acute ST-elevation myocardial infarction (STEMI), mainly affecting young female patients. What is more infrequent is its being concomitant with atherosclerotic disease in non-dissected segments. We proceed to report the case of a 55-year-old female patient having been admitted due to inferior wall STEMI. The angiography revealed a type 2B SCAD image in the distal third of the right coronary artery, verified via intravascular ultrasound (IVUS). Conservative treatment was thus determined. Thirty days later, control angiography was performed showing angiographic improvement of the SCAD. Via IVUS, focal stenosis was assessed in the middle third of the anterior descending artery, confirming significant atherosclerotic plaque. Subsequently, revascularization was carried out with drug-eluting stent. Risks remain unknown in terms of ischemic events and SCAD recurrence in the follow-up in the presence of both entities.

INTRODUCTION

Spontaneous coronary artery dissection (SCAD) is a rare cause of acute coronary syndrome. Its prevalence is less than 3%; it generally presents in female patients with no coronary atherosclerosis and in people younger than 50 years.^{1,2}

SCAD is defined as coronary artery wall splitting, secondary to intramural bleeding, neither traumatic nor iatrogenic, with or without intima tear, creating a false lumen. This conventional definition of SCAD refers to non-atherosclerotic disease.

Two main pathophysiological mechanisms have been proposed: the first, the initial event is the generation of an intimal flap; the second, with no endothelial tear, characterized by the presence of bleeding within the tunica media. This vascular aggression leads to the formation of intramural bleeding, which may generate true arterial lumen compression and myocardial ischemia.³

Triggering factors are uncertain. The absence of typical risk factors and the aspect of vessels in intravascular images suggest that the pathophysiological mechanism is different from the atherothrombotic ischemic mechanism.⁴

In general, SCAD and atherosclerotic disease do not appear concomitantly. However, on very rare occasions, SCAD may also occur in patients with atherosclerotic disease in nondissected coronary segments.

It may be difficult to differentiate between atherosclerotic plaque dissection and conventional SCAD, particularly if there is evidence of atherosclerotic disease in nondissected segments;

hence the importance of intravascular images. Consequently, the treatment strategy will be different according to the angiographic diagnosis.

Registries of SCAD have excluded patients with associated atherosclerotic disease, so as to have uniform cohorts available, to define the natural history of conventional SCAD.⁵

Information on SCAD concomitantly with atherosclerotic disease is scarce, there being total clinical uncertainty about the etiology, treatment and distant clinical course.⁶

We present the case of a young female patient, admitted due to acute coronary syndrome.

CLINICAL CASE PRESENTATION

Female, 55-year-old patient. Smoker of 15 packages/year. History of dyslipidemia, relatives with CAD; she had hypothyroid disease and anxiety disorders. Previous medication: rosuvastatin 10 mg/day, T4 100 mcg/day, escitalopram 10 mg/day and alprazolam 2 mg/day.

She was admitted due to epigastric pain radiating to the sternal region having started 12 hours before. The symptom was triggered due to nautical sports activity using oars.

Admission ECG showed ST-segment elevation, deep negative T waves and Q waves in leads D2, D3 and aVF.

Emergency coronary angiography was carried out, with primary percutaneous coronary intervention. The dominant right coronary artery was a vessel with a good caliber, not atheromatous, with smooth walls in its proximal and middle third. From

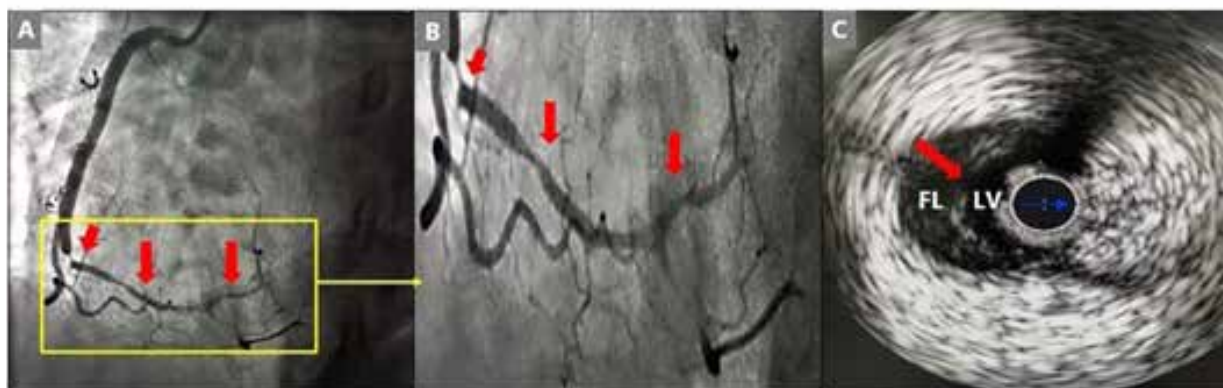


FIGURE 1.

Angiography (A-B) and IVUS images (C) of the right coronary artery

A) Type 2B SCAD in distal third of the RCA, in left anterior oblique view. The red arrows point out the sudden loss of diameter in the vessel, with diffuse thinning of true lumen light compressed by false lumen. B) Enhanced angiographic image of the distal third of the RCA with spontaneous dissection. C) Image obtained by IVUS catheter (blue arrow) shows the false lumen (FL), intima tear area (red arrow) and true lumen (TL).

the juncture of its middle third to the distal third it presents severe caliber reduction, diffuse and extending distally toward its terminal branches, with compromised epicardial flow. No angiographic thrombus is observed. This aspect of the vessel led to the most likely diagnosis of spontaneous RCA dissection (*Figure 1A-B*).

To confirm the diagnosis, intravascular ultrasound (IVUS) was conducted, showing loss of intima integrity corresponding to a dissection flap area, and true lumen compressed by false lumen (*Figure 1C*).

On the other hand, the left main coronary artery and the circumflex artery appear free from significant lesions. The anterior descending artery is a vessel with normal caliber and development, which at the level of the middle third, after the root of the diagonal branch, presents severe stenosis of 15 mm of length approximately, with regular edges, with preserved epicardial flow.

After confirmation of SCAD with the RCA as culprit vessel of the acute coronary event, it was decided not to carry out a primary percutaneous coronary intervention, choosing to follow a conservative management. She started dual antiplatelet treatment with aspirin (ASA) 100 mg/day and clopidogrel 75 mg/day, anticoagulation with low-molecular-weight heparin and rosuvastatin 40 mg/day. She coursed without complications, with preserved ventricular function assessed by echocardiogram. She was discharged on the fourth day. Medication upon discharge: bisoprolol 2.5 mg/day, ASA 100 mg/day, clopidogrel 75 mg/day, apixaban 10 mg/day (x 30 days), rosuvastatin 40 mg/day, escitalopram 10 mg/day, alprazolam 2 mg/day.

It was decided to schedule a new control coronary angiography within 30 days. The test showed improvement in the RCA flow (TIMI 3 flow), showing an evident regression of the dissecting hematoma image, with double lumen image persisting mainly at the level of the AV terminal branch (*Figure 2*).

The stance not to perform an intervention on the SCAD remained. Given the ambiguity of the angiographic image observed in the middle third of the anterior descending artery, IVUS catheter was advanced and focused stenosis was evaluated, ruling out the

presence of type 3 coronary dissection. IVUS showed fibrotic plaque, with luminal area of less than 3.5 mm², and plaque area bigger than 70%, proving significant coronary stenosis. Angioplasty was carried out in the vessel with drug-eluting stent of 3.0 x 32 mm of length at 16 atm, obtaining a satisfactory angiographic result (*Figure 3*).

She coursed without complications and she was discharged within 24 h after the procedure. Medication upon discharge: bisoprolol 2.5 mg/day, aspirin 100 mg/day, clopidogrel 75 mg/day, rosuvastatin 40 mg/day, escitalopram 10 mg/day, alprazolam 2 mg/day.

DISCUSSION

SCAD is a rare entity, but even more rare is its coexisting with atherosclerotic disease. The risk factors of SCAD include emotional and physical stress, connective tissue diseases, fibrous dysplasia, cocaine consumption, and genetic determinants are also described.⁷

The clinical case that is reported presents risk factors for both entities.

To make a diagnosis of SCAD, angiography is enough in most cases.

Arguments in favor of SCAD: 1) coronary tortuosity; 2) predilection for distal segments; 3) a predominant compromise of the anterior descending artery is reported in literature; 4) the false lumen starts and ends in a bifurcation branch; 5) coronary arteries are smooth in the other segments.⁸

According to the angiographic image, the following types of SCAD are described:

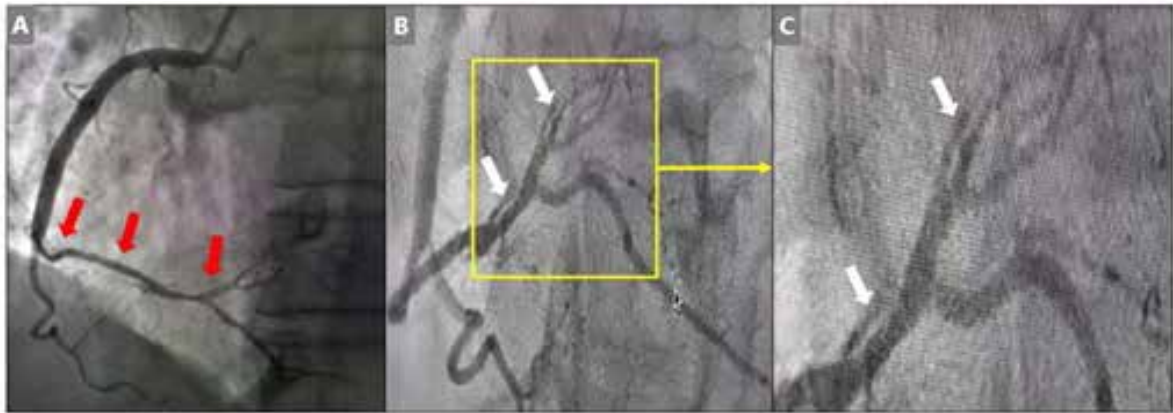
Type 1: image of double linear lumen with flap identification.

Type 2: diffuse and long stenosis in the vessel (more than 20 mm), located in the mid-distal segments of the artery.

-It is divided into two subtypes:

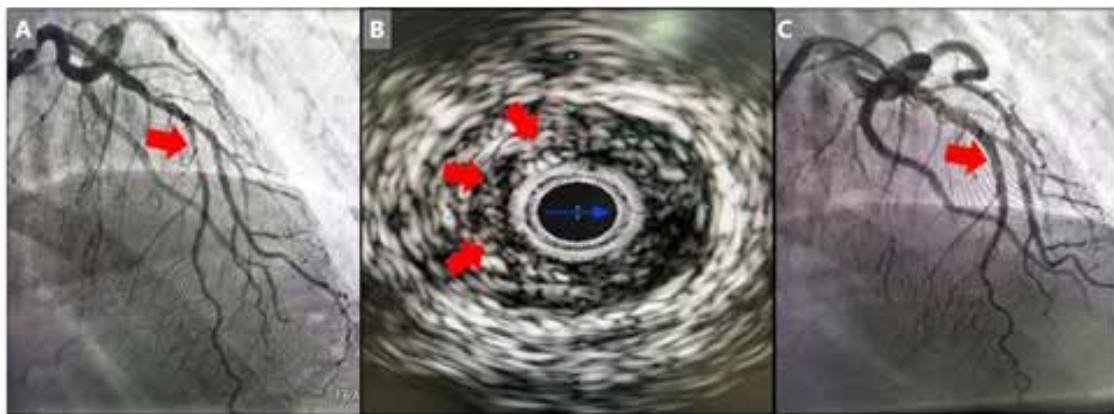
Type 2A: distal to the dissection, restoration of the normal diameter of the artery is observed.

Type 2B: stenosis remains up to the more distal segments.

**FIGURE 2.**

Angiographic control within 30 days of spontaneous dissection of the right coronary artery

A) Left anterior oblique view. Check the angiographic improvement in comparison with the basal image in Figure 1, recovering diameter and epicardial flow (red arrows). B) Front cranial view where characteristic image of double lumen is observed at the level of the main vessel of the RCA before distal bifurcation and at the level of one of its terminal branches. C) Enhanced image of the distal sector of the RCA with angiographic pattern, typical of dissection.

**FIGURE 3.**

Images of revascularization procedure

A) Angiographic evaluation of the RCA in front cranial view, with lesion in the middle third (red arrow). B) Image obtained by IVUS catheter (blue arrow) where eccentric fibrotic plaque is shown (red arrows) with criteria of severity. C) Final angiographic result after revascularization by 3.0 x 32 mm drug-eluting stent implant (red arrow).

Type 3: focal or tubular stenosis (<20 mm in general), almost indistinguishable in angiography from stenosis secondary to atherosclerotic lesion.

Type 4: complete occlusion of the true lumen by false lumen.⁹

The case presented is a type 2B SCAD in the RCA. Two likely diagnosis were discussed for the image in the middle third of the anterior descending artery: type 3 SCAD vs atherosclerotic plaque. The use of IVUS in the procedure scheduled within 30 days confirmed significant atherosclerotic plaque.

This is the main role of obtaining intracoronary images: confirming the diagnosis and guiding the treatment. It was decided to carry out IVUS in the acute phase on the culprit artery, and IVUS in the non-culprit artery in the control procedure.

Most SCADs do not require revascularization. There are no randomized clinical trials determining conclusively if the invasive

or conservative management is better. A preference for a conservative treatment is suggested.¹⁰

The general consensus is to provide dual antiplatelet therapy for a short period of 30 days, using beta blockers and statins. Anticoagulation: not advisable for chronic treatment; however, it may occur in the acute phase.^{11,12}

In hemodynamically unstable patients, percutaneous intervention is an option. The risks of intervening may entail inadvertently the insertion of the coronary guide wire in the false lumen, iatrogenic dissection, hematoma spreading, occlusion of lateral branches, inappropriate fixation of the stent after absorption of the intramural hematoma, etc.^{13,14}

As to the monitoring of patients with SCAD and its recurrence, there is scarce information. A recent publication of an Australian/New Zealand registry included 586 patients. During the 21-month follow-up, ischemic events and SCAD recurrences appeared in 8.6% and 3.6%, respectively.¹⁵

Although the evolution and prognosis of patients with SCAD in distant follow-up remains uncertain, we have even less information on those that present concomitant atherosclerotic disease.

CONCLUSIONS

Patients with atherosclerotic CAD may also present spontaneous SCAD. It is important to differentiate the etiology of dissection, as the therapeutic management is different. Intracoronary images by IVUS may be required to clarify the etiology if angiography is not conclusive to guide the management.

BIBLIOGRAPHY

1. Vanzetto G, Berger-Coz E, Barone-Rochette G, et al. Prevalence, therapeutic management and medium-term prognosis of spontaneous coronary artery dissection: results from a database of 11,605 patients. *Eur J Cardiothorac Surg* 2009; 35: 250 - 254.
2. Nishiguchi T, Tanaka A, Ozaki Y, et al. Prevalence of spontaneous coronary artery dissection in patients with acute coronary syndrome. *Eur Heart J Acute Cardiovasc Care* 2016; 5: 263 - 270.
3. Saw J. Spontaneous coronary artery dissection. *Interv Cardiol* 2015; 10: 142 - 143.
4. Wisecarver J, Jones J, Goaley T, et al. Spontaneous" coronary artery dissection: the challenge of detection, the enigma of cause. *Am J Forensic Med Pathol* 1989; 10: 60 - 62.
5. Saw J, Starovoytov A, Humphries K, et al. Canadian spontaneous coronary artery dissection cohort study: in-hospital and 30-day outcomes. *Eur Heart J* 2019; 40: 1188-1197.
6. Choi J, Yang C, Saw J, et al. Atherosclerotic Spontaneous Coronary Artery Dissection. *JACC Case Rep* 2023; 10: 101732.
7. Adlam D, Garcia-Guimaraes M, Maas A. Spontaneous coronary artery dissection: no longer a rare disease. *Eur Heart J* 2019; 40: 1198 - 1201.
8. Adlam D, Alfonso F, Maas A, et al. Committee. European Society of Cardiology, acute cardiovascular care association, SCAD study group: a position paper on spontaneous coronary artery dissection. *Eur Heart J* 2018; 39: 3353 - 3368.
9. Saw J. Coronary angiogram classification of spontaneous coronary artery dissection. *Catheter Cardiovasc Interv* 2014; 84: 1115 - 1122.
10. Combaret N, P Motreff. French National registry of spontaneous coronary artery dissections : "DISCO registry". *Ann Cardiol Angeiol* 2023; 72: 101684.
11. Hayes S, Tweet M, Adlam D, et al. Spontaneous coronary artery dissection: JACC state-of-the-art review. *J Am Coll Cardiol* 2020; 76: 961 - 984.
12. Rogowski S, Maeder M, Weilenmann D, et al. Spontaneous coronary artery dissection: angiographic follow-up and long-term clinical outcome in a predominantly medically treated population. *Catheter Cardiovasc Interv* 2017; 89: 59 - 68.
13. Lettieri C, Zavalloni D, Rossini R, et al. Management and long-term prognosis of spontaneous coronary artery dissection. *Am J Cardiol* 2015; 116: 66 - 73.
14. Tweet M, Eleid M, Best P, et al. Spontaneous coronary artery dissection: revascularization versus conservative therapy. *Circ Cardiovasc Interv* 2014; 7:777-786.
15. Dang Q, Psaltis P, Burgess S et al. The Australian-New Zealand spontaneous coronary artery dissection cohort study: predictors of major adverse cardiovascular events and recurrence. *Eur Heart J* 2025; 46: 2013 - 2023.

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