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¿Qué tienen
en común
tomar dos litros
de agua por día
y la Sal Light
Dos Anclas?

VOS.

Vos sos de los que eligen cuidarse.
Y nosotros de los que elegimos crear una sal para vos.
Una sal mucho más saludable, pura y con la mayor calidad.
Porque entre una vida llena de energía,
y la Sal Light Dos Anclas, hay algo en común.

Y SOS VOS.

Sal Light Dos Anclas.
Tenemos algo en común.

DOS ANCLAS *Light*

Sugerimos que las personas con dieta restringida en sodio o potasio
consulten a su médico.

Editorial

Prevention and diagnosis of hypertension in the paediatric age. Golden opportunity in primary prevention.

Livia T Machado H[1], Carlos I Ponte-Negretti[2].

1 Director of Unit of Pediatric Nutrition NUTRICONSULT. 2 Director of the Cardiac Metabolism Unit La Floresta. Caracas, Venezuela.

A diagnosis of hypertension (HTN) in children and adolescents is imprecise, although from several decades ago guidelines have been published, probably because of the lack of epidemiological studies that would determine its prevalence in the children and teenager populations[1,2,3]. HTN is probably better defined as values of systolic blood pressure (SBP) ≥95th percentile and/or diastolic blood pressure (DBP) ≥95th percentile[1]. Ideally, each Latin American country should have reference tables of their own to diagnose HTN in pediatric ages, as well as treatment algorithms, both non-pharmacological preferably, and pharmacological when necessary.

For the diagnosis of hypertension in adolescents, guidelines differ in the ages at which static thresholds are adopted: the AAP suggests 130/80 mmHg from 13 years of age; the European Society of Hypertension (ESH) suggests 140/90 mmHg since age 16. It is important that once any target has been chosen, it should be applied in all successive visits.

In this issue of the Revista of the Federación Argentina de Cardiología (Argentine Federation of Cardiology), an epidemiological paper is presented, evaluating BP values in teenagers and their relationship with nutrition state, in high school students, in the city of La Plata, Argentina[4].

In spite of the study being made in apparently asymptomatic teenagers, a high prevalence of elevated pressure figures was found: nearly 20%, mainly in males with overweight or obesity. These findings exceed the figures in other local or national studies, and even those reported in international consensuses on hypertension in children and adolescents[1,2,3,5]. For this reason, it is essential to verify the findings in the affected population, which could be associated to an increase in overweight and obesity in the pediatric age[1,5].

Although in the study other variables were investigated, such as abdominal circumference, food consumption habits and physical activity, they were not shown in the discussion or the conclusions. Making a multivariate analysis with these variables would have been extremely important to better understand the causes of the problem and to be able to take preventive measures. Likewise, family history, smoking, alcohol consumption and sedentary life should have been added to the study, as these variables are frequently associated, besides obesity, with HTN in adolescents.

We consider that this study is very important because of its findings, which should be reviewed, with the aim of stopping the increase in the appearance of cardiovascular diseases since the early decades of life, by preventive population intervention and the promotion of good health habits[6].

The strongest message of this study is understanding the absolute need to properly measure BP in all children since age 3, at least once a year; mainly in patients with obesity, with family history, and sedentary life, or in patients with any pathology associated to HTN in the first visit and all following visits[1,2,3]. Besides this, the article should be considered a wake-up call to promote structured campaigns, with a high impact, to prevent obesity in children and adolescents, with the aim of increasing physical activity, minimizing sedentary activities, improving food consumption habits, mainly restricting ultra-processed food, salt and added sugar consumption; and also, establishing strong measures to completely restrict smoking (in any of its forms) and alcohol consumption in this population.

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Editorial

Health care team-based strategy to control hypertension

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There are no conflicts of interest to disclose.

Hypertension is the most important modifiable risk factor for cardiovascular diseases (CVD) and mortality throughout the world, and particularly in Latin America[1]. Treatment of patients with hypertension entails a combination of medications and healthy lifestyles, and a proper adherence to these interventions is associated to a significant decrease in the risk of CVD and overall mortality[2,3]. In spite of the properly established and efficient treatment options, the prevalence of hypertension is still increasing, and most patients remain uncontrolled, particularly in low-income and middle-income countries, where health care systems present deficient resources, both in human and supply terms. This is reflected in very low levels of awareness, treatment and control of hypertension and other associated cardiovascular risk factors; therefore, it is necessary to develop and implement innovative strategies that would allow improving the number of people with hypertension that have properly controlled levels of blood pressure; i.e. less than 140/90 mmHg, contributing to reaching the goal of reducing mortality by CVD in 30% by 2030, as agreed by the governments of the world[4,5].

The project Health Outcomes Prevention and Evaluation 4 (HOPE 4) was aimed at proving that a wide and inclusive strategy, based on the thorough identification of local obstacles and the implementation of actions to overcome them, is better than usual care. The project developed in different stages, and included people with a new diagnosis of hypertension or that was poorly controlled, in Colombia and Malaysia, two countries with middle incomes, with ethnical, cultural and religious differences. The first stage consisted of identifying in each country and within the local context, the obstacles for a proper management and control of hypertension in patients going to hospitals in the two countries. The main obstacles identified were related to transportation costs to reach the medical center, with the cost of medications, with waiting times before the appointment and the medical visit, and the little time granted by specialists[6,7]. With these results, we then implemented an innovative model based on using non-medical health care workers (nursing assistants, non-medical technicians) to monitor patients in their homes.

Non-medical technicians were backed by primary care physicians and by family members and the community, and were in charge of providing home treatment for free, combining two or three antihypertensive drugs in a single pill and a statin. Simplified guidelines were followed, on management procedures and medication dosing through tablets. For this, in a second stage, a properly structured educational program was designed and implemented, to train non-medical technicians[8]. Besides the content on the disease load, the pathophysiology of the cardiovascular system, and CVD risk factors, the study plan also included evaluations as modular tests, exercises in class and structured clinical tests. These evaluations were indicators to properly adopt the contents of the study plan, as well as to prepare to work in the field. Fifty one technicians completed the training study plan successfully, with an average score of 93.19% in the module tests, and 84.76% in the structured clinical tests. The study plan was adapted to the Technical Package Hearts by the World Health Organization, released in 2016 to improve the management of CVD in primary health care. Non-medical technicians were trained and the medications to be used were defined in a standardized and universal manner, consisting in Colombia of a combination at fixed daily doses of candesartan 16 mg with amlodipine 5 mg as half dose, candesartan 32 mg with amlodipine 5 mg as full dose, and when triple therapy was needed, a pill of valsartan 80 mg with amlodipine 5 mg and hydrochlorothiazide 25 mg, all accompanied by a rosuvastatin 10 mg pill per day. We implemented a third stage consisting of a controlled trial of parallel arms, randomized by groups, made in 30 urban and rural communities in Colombia and Malaysia[9]. In brief, this third stage of the HOPE 4 trial entailed a multidimensional intervention, consisting of three main elements provided as a package: a) community screening, detection, treatment and control of risk factors of cardiovascular diseases by non-medical technicians (along with local physicians), guided by tablets with simplified management algorithms, decision support and counseling programs; b) local supply, free of charge, of the combination of antihypertensive medications and statins

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administered by the technicians, but overviewed by physicians; and c) support by an appointed participant considered supportive of the treatment (friend or family) to improve adherence to medications and healthy habits. The technicians made the initial selection, enrollment and follow-up, both in intervention and control communities. In the control communities, no structured intervention was provided, but they did receive local literature on cardiovascular diseases and recommendations to consult their usual local medical care provider. All communities completed a 12-month follow-up (97% data of living participants; n=1299). Reduction in the Framingham risk score for cardiovascular disease risk in 10 years was -6.40% (95% CI: 8.00 to -4.80) in the control group, and -11.17% (-12.88 to -9.47) in the intervention group, with a change difference of -4.78% (95% CI: -7.11 to -2.44, p<0.0001). In the intervention group, there was a greater absolute reduction in systolic blood pressure of 11.45 mmHg (95% CI: -14.94 to -7.97), and a reduction of 0.41 mmol/L (95% CI: -0.60 to -0.23) in LDL (both p<0.0001). The change in the control state of blood pressure (<140 mmHg) was 69% in the intervention group versus 30% in the control group (p<0.0001). There were no safety problems with the intervention[10].

To conclude, the comprehensive care model of the HOPE 4, managed by trained technicians, advised by primary care physicians, and with the participation of relatives as adherence and healthy behavior encouragers, led to a substantial reduction in the estimated risk of CVD, mainly through improvements in blood pressure, LDL levels, adherence to medication and some healthy behaviors. These results led us to suggest that the HOPE 4 strategy could help to reach the proposed targets of the Action Plan of the General Assembly of the United Nations to reduce early death by CVD to a third, recommending for health care systems of middle-to-low income countries to implement strategies like those of the HOPE 4, adapted to local scenarios[11,12].

In this issue of the Revista of the Argentine Federation of Cardiology, an article by Rizo-Rivera et al, is being published on the efficacy of the HOPE 4 strategy, in comparison with the conventional strategy for hypertension control in Nicaragua: the ARJÉ trial[13]. The authors compare the efficacy of the HOPE 4 strategy adapted to the scenario of Jinotega, Nicaragua (HOPE-4J), with the conventional strategy to improve control of hypertension, through a community trial in the adult hypertensive population who went to consult at the Clínica Cardiológica of the Hospital Victoria Motta. Hypertensive patients, controlled or not, were assigned to an intervention group with the HOPE-4J strategy and a control group where conventional strategy was applied. In the intervention group, 136 patients were included, of whom 132 completed the trial (97.05%) and 135 in the control group, of whom 131 completed the trial (97.03%). The HOPE-4J strategy consisted of using non-medical health care staff (nurses), using combined therapy at low doses in chronotherapy, and integration of people close to the patients providing support to adhere to the antihypertensive treatment in the long term. After the initial evaluation and another one 6 months later, they observed that patients monitored by the HOPE-4J strategy had a greater and

better control of their blood pressure, with a greater reduction in systolic blood pressure, of 13.3 mmHg in the intervention group over the control group, and of 4.1 mmHg in diastolic blood pressure. At the end of the intervention, 81.3% of patients in the intervention group reached the blood pressure goals. The authors concluded that there is a clear benefit in the HOPE-4J strategy over conventional strategy.

This study shows that the HOPE-4J strategy, in spite of differing from the original one, particularly because of the location where the follow-up of patients was conducted (hospital vs home), in the composition and form of presentation of the antihypertensive therapy (isolated combination vs combination in a single pill) and in the training of non-medical technicians (professional nurses vs nursing assistants) is useful to improve hypertension control, and proves that a hypertension control strategy based on the health care team, with community participation and adapted to the local conditions is efficient, well accepted and easy to implement.

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Review Article

Chronic coronary syndromes – guideline changes and a new nomenclature

Juan Carlos Kaski

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ARTICLE INFORMATION

ABSTRACT

Our understanding of the pathogenesis, clinical presentation, diagnosis, and management of angina pectoris has evolved substantially over the past few decades. Newer international guidelines have recently been published that provide recommendations for the diagnosis and management of ischaemic syndromes which are aligned with the advances in the pathogenesis of ischaemic myocardial syndromes. In parallel to those very welcome updates of the European guidelines I argue in this manuscript that nomenclature changes are required to better reflect the large spectrum of phenotypes and clinical presentations that come to our attention in clinical practice and currently grouped under the term chronic coronary syndromes. The latter term does not truly reflect the important contribution that non-obstructive coronary causes and non-vascular causes of both myocardial ischaemia and myocardial infarction make to the pathogenesis of ischaemic heart syndromes. This manuscript represents a viewpoint about the need for a more comprehensive and accurate nomenclature that helps clinicians to plan stratified treatments based on specific pathogenic mechanisms rather than focusing on epicardial coronary artery obstructions as the key mechanism underlying myocardial ischaemia.

Chronic coronary syndromes (CCS) affect many people worldwide and the number continues to rise due to many factors that include, among others, improved survival after myocardial infarction, better diagnostic tools, and increased awareness among patients and general practitioners. The new 2024 ESC Guidelines have highlighted the importance of different mechanisms that lead to CCS over and above coronary atherosclerotic obstructions and the role of personalised risk stratification and management[1]. Patients with angina despite angiographically normal coronary arteries (ANOCA/INOCA) now feature with class I indications in the 2024 guidelines regarding diagnostic tests required to identify these conditions and the implementation of stratified management strategies. Indeed, acknowledging the findings by different investigators and large trials regarding the mechanisms responsible for angina pectoris the 2024 ESC Guidelines on the management of CCS have incorporated new recommendations regarding the pathophysiological role of both epicardial coronary arteries and the coronary microcirculation of the heart, diagnostic strategies to investigate myocardial ischaemia and microvascular dysfunction, risk stratification of angina patients, and both the diagnosis and the management of vasospastic syndromes[1,2,3].

Additions to the 2024 ESC guidelines on the management of CCS represent a long overdue clinical need, given the high prevalence of ANOCA/INOCA worldwide. The 2019 CCS ESC guidelines reported that among patients with typical angina aged 50–59 years, 68% of men and 87% of women did not have obstructive coronary stenoses, and the Coronary Microvascular Angina (CorMicA) trial showed that approximately 45% of patients presenting with stable angina did not have CAD at angiography[4,5]. Along these lines, a US registry of 400,000 patients with suspected CAD referred to diagnostic coronary angiography only 38% of patients had obstructive CAD[6]. In INOCA/ANOCA patients' myocardial ischaemic syndromes are caused by coronary artery spasm, a vasodilatory abnormality of the coronary microcirculation or a combination of both. Identifying these phenotypes (clinical presentations) is of paramount importance for treatment and the 2024 ESC guidelines recommend that symptomatic patients with ANOCA/INOCA undergo invasive coronary functional testing to identify the underlying pathophysiological "endotypes" and to guide medical therapy[1].

The newer ESC recommendations for the diagnosis and management of CCS can have a major clinical impact but so would un update of the nomenclature that is currently used to refer to myocardial ischaemia syndromes. Recently, we argued that the clinical terminology needs changing to more accurately define and classify chronic ischaemic heart disease conditions[7]. Importantly, consensus has been

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reached among major international cardiovascular societies regarding the classification of acute coronary syndromes (ACS) a similar agreement, however, would be necessary regarding the nomenclature used to define chronic stable manifestations of myocardial ischaemia. At present, major American and European Cardiovascular Societies and cardiologists around the globe use many different terminologies to refer to stable, non-acute myocardial ischaemia syndromes, i.e. 'stable coronary artery disease' (CAD), 'stable ischaemic heart disease' (SIHD), 'chronic coronary syndromes' (CCS), and 'chronic coronary disease' (CCD). This lack of uniformity conspires against the understanding of mechanisms and clinical implications and management of these more stable conditions. Indeed, while the 2019 ESC guidelines introduced the term "CCS" to align it with the well accepted term "acute coronary syndrome - ACS" to identify acute myocardial ischaemia syndromes, the 2023 American guidelines proposed the use of the term "chronic coronary disease" (CCD)[4,8]. Although these discrepancies my look irrelevant, they can cause confusion and fail to define stable conditions in a comprehensive and accurate fashion. In a recent article by Boden et al we highlighted the need to achieve a more uniform, more widely accepted terminology that helps clinician to identify the different patient subgroups and mechanisms currently encompassed under the flawed term "coronary artery disease" that focuses almost exclusively on obstructive coronary atherosclerosis as the main cause of myocardial ischaemia and angina[7].

Although obstructive CAD has for decades been viewed as the most common cause of angina, strong and ever-growing scientific evidence confirmed that there are many important *non-obstructive* causes of myocardial ischaemia that cannot be easily included under the broad terms CCS or CCD supported by international societies. The reason being that coronary epicardial obstructions are not the only cause of myocardial ischaemia or MI, which can occur in the presence and in the absence of obstructive CAD[9]. We have recently argued in favour of "a practical, accurate nomenclature that should fully reflect the totality of potential obstructive and non-obstructive causes of ischaemia occurring in both the acute and the non-acute clinical settings"[7].

A new, accurate, contemporary classification that is comprehensive, inclusive, based on pathogenesis, and clinically relevant should allow not only the accurate identification of pathogenic subgroups but also help to manage these patients in a personalised fashion.

Myocardial ischaemia, and the myocardium at the centre of the definition and moving away from a terminology based only on "coronary" and "disease".

Myocardial ischaemia represents the final common pathway by which different mechanisms lead to symptoms, myocardial damage, and major adverse cardiovascular events. While obstructive CAD is a very important cause of myocardial ischaemia in acute and chronic settings, keeping the focus only on epicardial CAD has slowed down progress in the understanding and management of myocardial ischemia for decades. As myocardial ischaemia can be triggered by a multitude of mechanisms other than obstructive CAD it is only logical that the nomenclature accurately reflects the situation.

Moving away from a terminology that endorses the concept that obstructive CAD is the only reasonable cause of myocardial ischaemia is vital at this point. The use of terms such as 'disease' or 'lesion' immediately draws attention towards epicardial coronary artery stenoses that need to be treated by revascularisation. The new terminology should address both coronary and non-coronary causes of myocardial ischaemia. The term 'ischaemic syndrome', as proposed recently by our group, better indicates that angina and ischaemia can have many pathogenetic causes compared with the term 'coronary disease'. Incorporating the newly proposed terminology does not mean to negate the extremely important role of epicardial coronary obstruction or coronary stenoses as a cause of ACS or more chronic clinical presentations[7]. Our proposed changes aim to highlight the fact that the widely used term 'coronary' does not include the many *non-coronary* causes of myocardial ischaemia, such as microvascular dysfunction, extramural microcirculatory compression, microvascular embolization, capillary rarefaction, and myocardial oxygen diffusion abnormalities. Moving away from the term "coronary" and adopting the term "ischaemic syndrome" may help cardiologists to think about other important causes of angina and ischaemia that we often fail to consider. This may also help devising more effective diagnostic strategies that incorporate functional tests rather than just relying on anatomical tests such as coronary computed tomography angiography (CCTA). Currently proposed strategies based on CCTA often fail to identify INOCA patients, as individuals with no obstructive coronary arteries are usually reassured without further tests or are considered to have "non-cardiac" pains. Moreover, the treatment of patients with stable myocardial ischaemia would also benefit from such an approach, as treatments would then be directed to the pathogenic or causal mechanisms.

WHY A NEW NOMENCLATURE IS NEEDED

As mentioned above, in a recent paper jointly published in the European Heart Journal and Circulation we argued that "a classification system that uses 'chronic' or 'stable' as the contrasting description of 'acute' does not accurately depict the full measure of subsequent cardiovascular risk associated with the condition, and likewise may perhaps convey an inadvertent misperception of a clinically benign condition"[7]. We, therefore, propose the term *"myocardial ischaemic syndromes"* (MIS) as a more accurately way to encompass the diverse clinical presentations of myocardial ischaemia and the diverse mechanisms that can cause myocardial ischaemia in the acute and non-acute settings. The proposed new classification system is as follows: 'myocardial ischaemic syndromes' encompassing subcategories such as 'acute myocardial ischaemic syndromes' (AMIS) and

'non-acute myocardial ischaemic syndromes' (NAMIS). We prefer the term "non-acute" to "chronic" as we believe that in the medical world the word "chronic" refers to a condition 3 months or longer in duration that may get worse over time and can be controlled but not cured. Obstructive CAD may fall under this category but not necessarily all other forms of myocardial ischaemia can be encompassed by this terminology. Importantly, we proposed to retain 'ACS' as a subcategory of AMIS which in turn will encompass STEMI, NSTEMI, and unstable angina, and identify both epicardial coronary artery causes and non-coronary causes (MINOCA). Patients with chronic angina and myocardial ischaemia who have obstructive, flow-limiting epicardial coronary stenoses would be classified as having a NAMIS due to obstructive coronary disease, and those with chronic angina and/or myocardial ischaemia caused by mechanisms other than obstructive CAD will be called NAMIS, which will include stable obstructive CAD and stable angina caused by non-obstructed arteries, or INOCA.

We should not forget that non-obstructive functional mechanisms of ischaemia often co-exist with anatomic obstructive CAD, hence ischaemia of microvascular origin should not be considered to exclude a co-existing obstructive problem and *vice versa*, the presence of obstructive CAD does not exclude the possibility of microvascular dysfunction as a synergistic trigger of ischaemia in a given individual.

In conclusion, our proposed classification into 'AMIS' and 'NAMIS' should help providing greater conceptual clarity and unify what can at present be considered to represent a competing and rather confusing nomenclature. By better harmonizing different pathophysiologic causes of angina, myocardial ischaemia and MI, the newly proposed nomenclature should allow more accurate diagnostic testing and stratified therapeutic strategies.

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Original Investigation Reports

Potassium level in acute coronary syndrome: remembering the best balance

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ABSTRACT

Introduction: potassium is among the cations highly categorized as essential in human life. In the cardiovascular system, the changes in this electrolyte have the ability to influence and modify the electrophysiological properties of the myocardial cells and influence the generation and conduction of heart impulses. For this reason, the different alterations in the levels of this electrolyte will have a direct impact on the prognosis and mortality of patients with acute myocardial infarction. Therefore, potassium homeostasis is essential to prevent adverse events in patients with cardiovascular disease.

Objective: to present an updated overview of the published literature regarding the importance of the ideal balance in potassium levels in patients with acute coronary syndrome.

Method: an integrative review of the literature was carried out in the PubMed database with the following terms: potassium and acute coronary syndrome, potassium and physiology; MeSH terms: potassium AND myocardial infarction; potassium AND arrhythmias, cardiac/mortality.

Conclusions: given the influence of dyskalemia on triggering severe arrhythmias, strict monitoring of fluctuations in this ion should not be overlooked in patients with AMI, in whom the optimal range should be between 3.5 and 4.5 mEq/L.

INTRODUCTION

Potassium is within the cations highly categorized as indispensable for human life; it is essential for the maintenance of intracellular homeostasis in all cells, but it is critical in excitable cells, within which we find muscle cells (among them, cardiomyocytes) and brain cells.[1] Potassium has a key role in action and resting potentials. At cardiovascular level, the modifications in this electrolyte have the ability of influencing and modifying the electrophysiological properties of the resting membrane potential in the myocardial cells and influencing on the generation and conduction of impulses of the heart. From this knowledge springs the significance, probably left out over time, on the impact of the different alterations of potassium levels on the prognosis and mortality of patients with acute myocardial infarction (AMI). A variety of studies have been described, which have proven a considerable increase in cardiovascular and overall mortality in patients with MI, associated to disorders known as hypokalemia (serum potassium lower than 3.5 mmol/L) and hyperkalemia (serum potassium greater than 5.0 mmol/L), that are the result of failures in the mechanisms of kidney removal and ATPase sodium potassium pump activity, with homeostasis of potassium being essential to prevent adverse events in patients with cardiovascular disease[2,3,4,5,6,7,8,9].

BACKGROUND

During the decade of 1950, it was reported that hypokalemia reduced the fibrillation threshold in isolated rabbit hearts.[10] Later, relatively small observational studies showed an association between hypokalemia and the risk of ventricular arrhythmias in patients with acute myocardial infarction.[11,12] Since then, clinical guidelines, including the guideline for ST-segment elevation myocardial infarction of the American College of Cardiology (ACC) and the American Heart Association (AHA), recommend keeping potassium levels above 4.0 mmol/L (recommendation class I), although with a very low level of evidence (level of evidence C).[13,14] Even values above 4.5 mmol/L have been suggested, not establishing an upper limit. These guidelines in time have been questions, as the studies where such recommendations are given emerge from very small observational cohorts; with these studies having been, as well, made before the implementation of the updated treatment

for AMI, among which we have management with beta blockers and early reperfusion therapy.[15] Likewise, many institutions have implemented guidelines to start a reposition when potassium serum levels decrease below certain "target" values[16].

PATHOPHYSIOLOGY

To better understand the deleterious effects of alterations in potassium levels in MI, it is important to review its physiology. The amount of total potassium in human beings is estimated in approximately 50 mmol/L/Kg of body weight. From this concentration, 98% is within the cells of the body, and just 2% is within extracellular fluid.[16,17] The main regulator of potassium levels in the organism are the kidneys, which favor excretion of most of the ingested potassium; but there are other mechanisms that may favor the movement of potassium between the intra and extracellular milieu.[17] All of these mechanisms favor maintaining a narrow range of extracellular potassium concentration, critical for a proper operation of the Na+-K+-ATPase pump, mainly located in the excitable cells such as those of the muscle and the brain. Thus, in literature, normal potassium levels between 3.5-5.3 mmol/L are accepted; but these levels in a pathophysiological context such as acute myocardial infarction may have an adverse impact on the main outcomes such as arrhythmias and mortality.[17]

To this moment, there is no exact description of the pathophysiology by which potassium serum levels alterations significantly influence on the deterioration of prognosis in patients with MI.[3] However, in relation to this, the significance of the association between MI-induced stress and systemic metabolic changes has been described, such as increase in plasma concentrations of catecholamines, free fatty acids, glucose, glycerol, cortisol and cyclic adenosine monophosphate (cAMP), causing stimulation of the sodium-potassium-ATPase pump, which would lead to the movement of potassium within cells, thus explaining the appearance of hypokalemia in the acute phase of MI, a condition that has shown to be associated with a significant increase in the risk of ventricular arrhythmias and very poor outcomes in patients with MI (13.5% of patients with ST-elevation MI presented ventricular fibrillation).[17] Arrhythmogenicity is attributed to several conditions: cell hyperpolarization, increase in resting myocardial potential, automaticity and excitability, influenced by the potassium that regulates cardiac repolarization. Thus, hypokalemia would extend action potential, would increase QT dispersion, and would predispose patients to the presentation of deadly arrhythmias.[17] Hyperkalemia has also proven to be one of the main factors of risk of all-cause mortality in patients with an established cardiovascular disease and a deteriorated renal function.[17] It has been associated to a larger size of infarction in gamma scan, and an increase in Killip class in patients with ST-segment elevation myocardial infarction (STEMI).[17,18]

Taking into account all of the above, it has been suggested that fluctuations in serum potassium may be highly related to higher rates of mortality in cardiovascular patients. This reflects an intricate metabolic and hormonal dysfunction, favoring major associated complications such as acute heart failure, kidney failure and significantly more severe infarction[18].

DYSKALEMIAS

Dyskalemias are abnormalities in potassium levels that may endanger the life of patients, resulting from potentially fatal cardiac arrhythmias, being relatively common in clinical practice.[2,18] Hyperkalemia has presented more frequently in men with a high prevalence of cardiovascular risk factors (hypertension, diabetes mellitus, dyslipidemia), besides base heart disease and chronic kidney disease. In a hyperkalemic state, severe arrhythmias occur more frequently, in comparison with the hypopotassemia group. In this group with hyperkalemia, the arrhythmias that present more frequently are in decreasing order: high degree atrioventricular block, ventricular fibrillation and monomorphic ventricular tachycardia.[2] In a study carried out by Allan Rivera Juárez et al, in Madrid, Spain, it also became evident that hyperkalemia developed more frequently in patients taking renin-angiotensin-aldosterone system inhibitors (RAASI).[2] These medications, just as with acute kidney lesion, nephropathy by contrast, beta blockers and angiotensin converter-enzyme inhibitors (ACEIs), distort the balance toward a potentially severe hyperkalemia (>5.0).[10,19]

In relation to hypokalemia, the demographic profile most frequently found has been in women with an advanced age, preserved renal function and use of diuretics of the thiazide type, which just as with sympathetic secretion within the first hours of STEMI distort the balance toward hypopotassemia (K <3.5).[2] In this group, the arrhythmias most frequently identified in the Allan Rivera Juárez et al study were polymorphic ventricular tachycardia, ventricular fibrillation and monomorphic ventricular tachycardia.

MATERIALS AND METHODS

An integrative review of literature was made in the PubMed database, under the following terms: potassium and acute coronary syndrome, potassium and physiology; MeSH terms: potassium AND myocardial infarction; potassium AND arrhythmias, cardiac/mortality.

Ethical considerations

The ethical aspects of this research study were carried out based on the criteria from the Belmont Report, adjusted to its principles in regard to individuals, beneficence and justice, and the declaration of Helsinki of the World Medical Association from 1964. Likewise, it followed the Venezuelan legislation and its medical deontology code from 1985 (currently valid) in its title V, chapter 4, in regard to research in human beings.

DISCUSSION

In this topic review, we comparatively analyzed the re-definition of what constitutes the "ideal" or normal rang-es of K serum levels in patients with ACS, taking into account the fundamental role that this electrolyte plays in cardiovascular patients, and the adverse effects entailed by potassium level alterations, which may end up being potentially fatal. Thus, a significant increase was found in the number of observational studies that point out the strong relationship between abnormal K serum levels and negative outcomes after MI, mentioning in them both reduced and elevated serum levels, along with their fluctuations.[2,4,5,6,7,8,9,11,15,16,17,18] In studies such as the one by Abhinay et al, where a questioning was made on the initial parameters adopted by the American College of Cardiology (ACC) and the American Hearth Association (AHA), where it was suggested to maintain potassium levels above 4.0 mmol(L. even >4.5 mmol/L, a risk twice greater was observed for mortality in patients with an average post-admission K level of 4.5 to less than 5.0 mEq/L in comparison with patients who had levels of 3.5 to less than 4.0 mEq/L. These findings were reproduced in the studies by A. Kaya et al and by M. Colombo et al, with evidence of mortality of more than 29% (n=40) in patients with potassium serum concentration (PSC) ≥5.0 mEq/L, in whom the same risk of mortality also proved to increase in this group in up to 96% in one year. The opposite occurred in patients with PSC of 3.5 to 4.0 mEq/L, in whom mortality was strongly less (12.6% n=134), even in the long term. These results destabilized the parameters suggesting high K serum levels in the acute phase as post-admission of MI, and by which the recommendations grow increasingly stronger, suggesting that the optimal range of K serum levels in patients with MI should be between 3.5 and 4.5 mEq/L.[20,21].

CONCLUSIONS

Given the influence of dyskalemias on triggering severe arrhythmias, we should not overlook the strict monitoring of the fluctuations of this ion in patients with MI. A thorough and early electrocardiographic monitoring is advised, along with an aggressive management of dyskalemias, both borderline and severe, taking into account the high risk of mortality in these patients, a risk that may last after hospital discharge, as these fluctuations have proven to be associated to an increase in mortality in the short and long term, among other negative outcomes. It is recommended for physicians to periodically and closely monitor potassium serum levels in patients with MI, mainly in those with associated comorbidities and use of potassium-sparing medications. Finally, according to the evidence from the recent observational studies, which end up questioning and redefining the initial guidelines for the maintenance of levels above 4.5 and 5.0 mEq/L of serum potassium, considering their relationship with the increase in mortality, an optimal range is established in patients with MI between 3.5 mEq/L and 4.5 mEq/L.

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Original Investigation Reports

Blood pressure and nutritional status in students attending state and urban secondary schools in La Plata's suburbs

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ABSTRACT

Introduction: This study examines the relationship between blood pressure (BP) and nutritional status in adolescents attending public urban secondary schools in the suburbs of La Plata, considering both hypertension (HTN) and pre-hypertension (pre-HTN) as variables of interest.

Materials and Methods: A total of 655 students aged 12 to 18 years from urban public secondary schools were evaluated. Weight, height, waist circumference, and BP were measured using standardized methods. Nutritional status was determined according to WHO cut-off points, and BP was assessed based on the Consensus on Cardiovascular Prevention in Childhood and Adolescence. Statistical analyses were performed using SPSS and R Studio, employing chi-square tests, ANOVA, and binary logistic regression.

Results: 18.1% of the adolescents presented BP alterations: 8.7% with HTN and 9.5% with pre-HTN. HTN was more prevalent among males and those with overweight or obesity. Obesity increased the likelihood of pre-HTN by 4.4 times and HTN by 2.8 times.

Conclusion: the high prevalence of elevated BP in adolescents and its strong association with overweight and obesity highlight the need for preventive interventions. Promoting healthy lifestyles from an early age is crucial to reduce the risk of cardiovascular diseases in the future.

INTRODUCTION

Elevated blood pressure (EBP) in the adolescent population is a problem that has been increasing in interest due to an increase and impact on health over life. EBP, understood as prehypertension (PHTN) and hypertension (HTN), added to the increase in prevalence of overweight and obesity in the children and teenager population are important risk factors for the development of cardiovascular diseases in adulthood.[1]

Previously conducted studies in Argentina provided evidence on the prevalence of HTN. Some of them suggest that HTN in the Argentine adolescent population ranges between 2% and 7%.[2,3,4]

On the other hand, the strong association between EBP and excess weight in children from 6 to 12 years is of great interest in the peri-urban areas of Gran La Plata (La Plata's suburban area), where it was registered that 44.9% of school students presented overweight, and among them, 19.4% EBP.[5]

The investigations quoted focused on HTN, not delving into PHTN prevalence, a condition that deserves equally significant attention.[6,7]

For all of this, and besides excess weight being a concerning factor in the studied population due to its prevalence, it also predisposes EBP.[8,9,10,11] The aim of this study was to analyze the relationship between blood pressure (BP) and the nutritional status of adolescents who go to state and urban high schools in Gran La Plata, including the analysis both of HTN and PHTN as variables of interest.

It is expected that the findings of this investigation may contribute to a better understanding of the factors that influence on the cardiovascular health of adolescents, and may provide relevant information for the design of preventive interventions and public health programs addressed to this population.

MATERIALS AND METHODS

From this section onward, in this study we use the term "adolescent" indistinctly, regardless of gender.

The size of the sample was estimated on the universe of students that attend the state high schools of Gran La Plata. For the selection, a probabilistic design was applied, considering the students enrolled in urban high schools reported by the General Direction of Culture and Edu-

cation of the Province of Buenos Aires.[12,13] In this regard, taking into account that the school enrollment is 45,681 students, and with a heterogeneity of (p) 0.5, a 95% confidence interval (Zα =1.96) and an accuracy (d) of 4%, the size of the sample was estimated in 592 students.

During the second semester of year 2023, students with ages from 12 to 18 years were surveyed, excluding those with chronic diseases or pathological condition (according to the school registry certificate) that could alter the nutritional status or the BP; those who did not have the parental or guardian's written consent; those that even having it, refused to participate, and those older than 19 years, with the aim of maintaining the same diagnostic criteria.

The nutritional status was evaluated by trained professionals, through the registry of: a) body weight (W), which was measured by a TANITA portable digital scale (100 g of accuracy), previously calibrated, with the student dressed with light clothing, which was subtracted from the total weight; b) height (H), using a SECA vertical anthropometer (1 mm of accuracy), barefoot and with the head in Frankfurt plane; and c) waist perimeter (WP), which was measured at the front, during exhalation and standing, taking as reference the middle point between the upper edge of the iliac crest and the inferior edge of the 12th rib, with a Lufkin non-stretching measuring tape.[14] With the latter, the waist-to-height ratio (WHtR) was estimated, from the formula WP divided by H.[15,16]

The WHO Anthro plus software, version 1.0.3 was used, and to determine the nutritional status, the cutoff points proposed by the Word Health Organization (WHO) were adopted, corresponding to: z score ≤ -1 low weight: > -1 and < +1 normal weight; > +1 and < +2 overweight, and ≥ +2 obesity.[17,18] Likewise, the reference used to determine cardiovascular risk by WHtR was WHtR for men >0.51 and for women >0.50.[16]

As to blood pressure (BP) measurement, the registry was made after the students had at least 10 minutes of rest. Blood pressures, systolic (SBP) and diastolic (DBP), were measured with an OMRON digital sphygmomanometer (model: HEM-7120) and cuff adjusted to the arm perimeter. Three measurements were made with a 5-minute interval between each, to then average the three measurements, taking as reference the mean for analysis.

BP was determined, using as reference the data from the Consensus on cardiovascular prevention in childhood and adolescence.[19] For those younger than 16 years, the presence of HTN was considered according to sex, age and height, when SBP, DBP or both were greater than the 95 percentile: PHTN when SBP, DBP or both were between the ≥90 and <95 percentiles; and normotensive (NT) when SBP, DBP or both were below percentile 90. For those older than 16 years, HTN was considered when SBP was 140-159 mmHg and/or DBP was 90-99 mmHg; PHTN when SBP was 130-139 mmHg and/or DBP was 85-9 mmHg; NT when SBP was <130 mmHg and DBP <85 mmHg.[19]

In a parallel way to measurements, a semi-structured and self-administered survey was made, where questions were asked about: a) social determinants: gender, age, payment of Universal Allowance per Child (AUH), living conditions; b) aspects related to meals (within and outside the school): frequency of meals, main meals, consumption of food in the school, knowledge about front-of-package nutrition labeling; c) physical activity (within and outside of school).

STATISTICAL ANALYSIS

For the analysis of data, the SPSS software, version 25 was used, and to categorize variables, the R studio software. The Chi-square test was used for categorical variables, and analysis of variance (ANOVA) for quantitative ones. Before implementing the last test, the homoscedasticity and the normality of the sample were verified, using the Leven test and the Kolmogorov-Smirnov test, respectively. To explore the probability of occurrence between the nutritional status and BP, a binary logistic regression analysis was carried. A level of significance <0.05 was considered for the descriptive analysis, and sample calibration was made based on population parameters (sample weighting).

Ethical considerations

The protocol was approved by the Central Committee on Ethics, Ministry of Health of the Province of Buenos Aires (ACTA-2023-13810308-GDEBA-CECMSALGP). Likewise, authorization was requested from the Regional Office of the Direction of Culture and Education, District Inspectors, directors of educational institutions, and the family/ guardian's consent and agreement from the students was requested.

RESULTS

In the study, there were 655 students who participated, with an average age of 14.4 years, and a range from 12 to 18 years; 55.3% (n=362) were women, while 44.7 (n=293) were men, with no significant difference per age (p=0.2452).

In relation to the nutritional status, 1.7% (n=11) presented low weight, 66.4% (n=435) an appropriate weight, 21.5% (n=141) overweight and 10.4% (n=68) obesity. In relation to WHtR, 83.8% (n=549) did not present cardiovascular risk, while 16.2% (n=106) presented risk probabilities.

It was observed that 18.1% had BP alterations, with 8.7 (n=57) corresponding to HTN and 9.5% (n=62) to PHTN. The prevalence of HTN was greater in men and in students with obesity and overweight, significantly differentiating from each other (p: 0.018 and p: 0.001, respectively); while no differences were observed for AUH (p: 0.778). In relation to PHTN, only significant differences were found in the nutritional status (p: <0.000), where overweight and obesity were the most prevalent categories *(Table 1)*.

The mean value of SBP was 115.57 mmHg (SD: 12.35) and of DBP 68.84 mmHg (SD: 7.84). Significant differences were observed in the mean values of SBP and DBT

between males and females (p: <0.000 and p: 0.0029, respectively). However, no differences were found between those receiving the AUH and those who didn't and in terms of the area where the school was located *(Table 2)*.

On the other hand, it was found that the means of SBP and DBP increase in relation to weight increase (p: <0.000). In this regard, students with obesity showed the highest mean BP. Something similar happens with WHtR, where means are higher in those presenting cardiovascular risk *(Table 2)*.

In regard to the association between nutritional status and BP, through binary logistic regression, the results revealed that both the overweight and the obesity categories showed significant associations with hypertension in teenagers *(Table 3)*. Particularly, the overweight category showed a significant increase in the probability of HTN (OR = 1.81); while the obesity category showed an even

greater increase in the probability of it (OR = 2.88). in relation to PHTN, it was found that only obesity was significantly associated (OR = 4.43).

DISCUSSION

This study allows to know the state of BP (and how it is related to the nutritional status) in 655 students from state and urban high schools from Gran La Plata, including HTN and PHTN as variables of interest.

Results reveal a concerning prevalence of BP alterations, where nearly 2 in every 10 students had EBP, with 8.7% corresponding to the HTN group and 9.5% to PHTN. The figures of HTN are mildly superior to studies made previously in Argentina, where the prevalence in the mentioned population ranges between 2% and 7%.[2,4,7,20]

In relation to PHTN, the prevalence found underscores the importance of focusing not just on HTN, but also in

TABLE 1.
Description of categorical variables according to HTN and PHTN.

Variable	Category	HTN (% and n)	P value*	PHTN (% and n)	P value*
Sex	Female	6,4 (23)	0,018	9,4 (34)	0,920
	Male	11,6 (34)		9,6 (28)	
AUH	Yes	9,5 (21)	0,778	12,3 (27)	0,225
	No	9,2 (19)		8,7 (18)	
BMI/A	Low weight	-	0,001		<0,000
	Proper weight	6,2 (27)		7,6 (33)	
	Overweight	11,3 (16)		10,6 (15)	
	Obesity	20,6 (14)		20,6 (14)	

HTN: hypertension: **PHTN:** pre-hypertension; **AUH:** universal allowance per child; **BMI/A:** body mass index for the age
* Square chi; statistical significance: p value: <0.05

TABLE 2.
Mean difference (ANOVA) between categorical variables and SBP and DBP.

Variable	Category	n	SBP (mean)	P value*	DBP (mean)	P value*
Sex	Female	362	112,84	<0,000	69,64	
	Male	293	118,94		67,86	
Place	La Plata	439	115,07	0,209	68,66	0,596
	Berisso	160	117,08		69,32	
	Ensenada	56	115,16		68,91	
AUH	Yes	220	116,10	0,911	69,17	0,672
	No	207	116,13		69,53	
BMI/A	Low weiht	11	112,36	<0,000	67,82	0,000
	Proper weight	435	113,79		67,91	
	Overweight	141	117,24		68,97	
	Obesity	68	123,97		74,71	
WHtR	Normal	549	114,65	<0,000	68,03	<0,000
	Risk	106	120,33		73,07	

AUH: universal allowance per child; **BMI/A**: body mass index for the age; **WHtR:** weight-to-height ratio; **SBP:** systolic blood pressure; **DBP:** diastolic blood pressure.
* **ANOVA test:** statistical significance: **p value:** <0.05

TABLE 3.
Logistic regression for the association between overweight and obesity on hypertension and pre-hypertension.

	Variable	B	SE	Wald	P value*	OR	95% CI
HTN	Overweight	0,596	0,31	3,79	0,052	1,81	0,99 - 3,30
	Obesity	1,06	0,35	9,25	0,002	2,88	1,46 - 5,69
	Constant	-2,626	0,18	207,08	0,000	0,07	
PHTN	Obesity	1,49	0,30	24,20	0,000	4,43	2,45 - 8,01
	Constant	-2,595	0,15	278,22	0,000	0,07	

HTN: hypertension; **PHTN:** pre-hypertension; **B:** beta coefficient; **SE:** standard error; **Wald:** Wald index
* Statistical significance: **p value:** <0.05

its previous state, PHTN, as it could be an early indicator of cardiovascular risk in adolescents, and if uncontrolled, progress into HTN in young adults.[6,21]

The nutritional status and PHTN are consistent in this study, mainly in relation to overweight and obesity. In this regard, it was observed that 10.6% of students showed overweight and 20.6 obesity, in comparison with 7.6% of adolescents with an appropriate weight.

On the other hand, HTN is also a significant problem in public health.[22] In this study, a higher prevalence of HTN was observed in males (11.6%) in comparison with women (6.4%), with this difference coinciding with other authors.[2,23] With respect to nutritional status, 20.6% of students with obesity and 11.3% of those with overweight were hypertensive, in comparison with just 6.2% with proper weight.

The inclusion of logistic regression in the study provides an additional dimension to learn about the association between nutritional status and EBP. This analysis indicates that the evaluated students with overweight or obesity present a significantly higher probability of developing PHTN or HTN in comparison with those with proper weight. In particular, in this analysis we highlight that adolescents with obesity have a 4.4 greater probability of developing PHTN, and in terms of HTN, those presenting obesity have a 2.8 times higher chance of developing it.

In regard to the incidence of excess weight (EW) and HTN, similar data were found by Quinteros F et al, in rural state primary education schools, where through logistic regression they found that EW had 2.6 times more chances of developing HTN.[5]

In accordance with what has been stated, obesity plays a significant role in the development of PHTN and HTN, which could be justified by several pathophysiological mechanisms.[24] Obesity is associated with metabolic changes, endothelial dysfunction, increase in resistance to insulin and increase in sympathetic nervous system activity, all of which may contribute to the increase in SBP and DBP in this population.[25,26]

Besides the pathophysiological mechanisms associated with obesity, it is essential to consider the influence of other factors such as food rich in sodium and low in fibers, sedentary lifestyle, smoking, among others. These factors may interact in a complex manner with the weight of individuals, further exacerbating risks.[27]

As to the limitations of the study, it is important to mention that the sample was limited to students in urban state high schools from Gran La Plata, which may limit a generalization of results to other populations. In this line, it is also understood that the cross-sectional nature of it prevents performing a follow-up along time. However, we emphasize that for BP measurements standardized methods were used, adding value by performing three measurements to take BP variability into account, which would yield a more accurate diagnosis. Moreover, this research study stands out as it is one of the few studies in the country considering PHTN in this population, and this is a strength.

CONCLUSIONS

This investigation provides an approach to the situation of teenagers going to urban state high schools in Gran La Plata, in relation to BP and its link with the nutritional status.

In the surveyed population, there is a high prevalence of EBP, which highlights the significance of not only taking HBP into account, but PHTN as well, as both are considered risk factors for the development of cardiovascular diseases in the adult population. Furthermore, considering that the prevalence of excess weight has been steadily increasing in the population, and that there is a high association with the probability of EBP, we underscore the significance of interventions to promote healthy lifestyles since an early age. We suggest exploring this by new investigations, to learn about the incidence of other cardiovascular risk factors, to carry out specific preventive interventions in this population.

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Original Investigation Reports

Impact Analysis of an Early Reperfusion Project for Patients with ST-Elevation Acute Coronary Syndrome in the Public Area of Alto Valle de Rio Negro

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ARTICLE INFORMATION

ABSTRACT

Introduction: the public hospitals of Rio Negro (RN) lack a system to enable the rapid treatment of ST-Elevation Acute Coronary Syndrome (STEMI). The ex-ante estimation of the impact of a project is valuable for the political decision to implement it.

Objective: to estimate Life Years Gained (LYG) with an early reperfusion project.

Materials and Methods: a counterfactual approach was used to estimate the LYG following the patient recruitment proportion observed in the Integrated Network of Rosario.

Results: Projecting the patient recruitment observed in the Integrated Network, Rosario, 66.28 patients would be recruited within the first year, 99.43 in the second, 108.38 in the third, 123.55 in the fourth, and 131 in the last year. Reperfusion times would decrease from an average of 336 minutes (2017) to 240, 180, and 120 minutes by the end of the project. The LYG would increase from 4.75 LYG in the first year to 33.43 LYG in the last year, with a total of 95.34 LYG accumulated over 5 years.

Conclusions: the impact of an early reperfusion project would improve the health situation, obtaining a total of 95.34 LYG over 5 years with 529 patients treated.

INSTITUTIONS WHERE THE RESEARCH WAS CARRIED OUT

Public hospitals in Alto Valle de Río Negro:

East area:

1- Hospital General Roca
2- Hospital Ingeniero Huergo
3- Hospital Allen
4- Hospital Villa Regina
5- Hospital El Cuy.
6- Hospital Cervantes
7- Hospital Chichinales

West area

8- Hospital Cipolletti
9- Hospital Cinco Saltos
10- Hospital Campo Grande
11- Hospital Catriel. Directora
12- Hospital Fernández Oro

Private centers

1- Clínica Roca
2- Sanatorio Juan XXII
3- Policlínico Modelo de Cipolletti

Medical Foundation of Río Negro and Neuquén.

INTRODUCTION

Cardiovascular diseases (CVD) constitute the main mortality cause in the world. In Argentina a yearly incidence of Acute Myocardial Infarction (AMI) of 24.5/10,000 inhabitants is estimated, and for ST-segment elevation acute coronary syndrome (STEACS), 41.9/10,000 inhabitants per year, with an overall in-hospital mortality of 8.8%.[1,2,3,4]

In Alto Valle de Río Negro a sanitary problem has been detected; i.e. hospitals depending from the Ministry of Health of the Province do not have hemodynamic centers with PTCA available, and it seems an algorithm adjusted to local conditions is not being followed, by which patients referred to private centers to undergo PTCA are not usually administered fibrinolytic agents for the immediate care of AMI.[5] A lack of an organization is observed, which would allow tending to STEACS according to the recommended protocols to decrease total ischemic time (TIT) and to increase the detection of patients, as observed in the integrated care network of the city of Rosario[5,6,7,8].

A project of intervention in this case would be a lower unit of resource allocation by which a program is materialized within a policy. It is the planning and realization of a set of activities addressed to solving a sanitary problem of a social sector in a given territory area, and being able to evaluate their impact is essential.

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Impact evaluations are a particular type of evaluation, attempting to answer a specific cause-and-effect issue: "attributability". It is centered on the changes that may be directly attributable to the program. In the case of the project to be designed and implemented, the expected effect is the Life Years Gained (LYG) or the prevented Years of Potential Life Lost (YPLL).

The *ex ante* estimation of the probable impact of a project is valuable for the political decision of implementing it analyzing its potential effects, which would enable establishing a replicable mode.

The hypothesis is that an early reperfusion project for STEACS patients in the public sector of the Alto Valle de Río Negro would achieve a significant impact.

GENERAL AIM

To analyze the impact of an early reperfusion project for patients with STEACS in the public sector of Alto Valle de Río Negro, based on data obtained in 2017. For this goal, it will be necessary to analyze the characteristics of the population, estimate the YPLL of the patients observed, the unregistered YPLL, and estimate how many LYG would be achieved with an early reperfusion project designed over 5 years (2020-2024).

MATERIALS AND METHODS

A cross-sectional, epidemiological analysis was made on the health care situation of patients older than 18 years with STEACS, in the public area of Alto Valle de Río Negro in 2017, based on primary information sources. The methodology is explained according to the specific posited goals:

Characteristics of the population: general aspects were evaluated, in relation to the care provided for STEACS in Alto Valle de Río Negro and the times used until reperfusion. Centers in Alto Valle were identified: public and private, w/wo Coronary Unit, w/wo Agreement with Public Health. In Alto Valle de Río Negro, there is no public offer for hemodynamic services, and they are provided by services hired in the private sector. The requirements requested by the Committee on Ethics for Evaluation of Human Health Investigation Projects (CEEPISH) were met.

For the observed population, the following inclusion criteria were taken into account:

- Suspicion of ST-segment elevation MI ≥1 mV in two limb leads or ≥2 mV in two contiguous precordial leads.
- Infarction evolved with new Q waves of less than 36 hours of evolution.
- Suspicion of inferoposterior infarction (ST-segment horizontal depression from V1 to V3).
- New or assumed to be new complete left bundle branch block (CLBBB).

Exclusion criteria:

- Severe or unstable extra-cardiac organic pathology, that could reduce life expectancy to less than one year.

Definitions:

Pain-to-first medical contact time: time elapsed between the onset of symptoms suggesting ischemia and the First Medical Contact (FMC), expressed in minutes.

Window time (WT): time interval in minutes since the onset of symptoms until the onset of infusion with thrombolytic agents or onset of TCA.

Door-to-needle time (DTNT): time interval in minutes since the arrival at the institution and the onset of infusion of thrombolytics.

Door-to-balloon time (DTBT): time interval in minutes since the arrival at the institution until balloon inflation.

YPLL observed in the studied population: to obtain this datum, vital statistics from the Ministry of Health were used as secondary source, taking into account the mean age of death by cardiovascular event described and life expectancy (LE 75 years), estimated in 2017, applying the following formula:

$(\sum (EV- X_i) \cdot f_i) / N$

Where:

LE: life expectancy;

X_i: age class mark

f_i: number of deaths by age group.

N: total of deaths per MI (Cod CIE-I21).

YPLL unrecorded due to lack of patient detection: for this estimation, the expected population of patients with STEACS was taken into account, according to their incidence in Alto Valle in 2017, and the difference between the YPLL found and the expected YPLL was obtained, according to the information published by vital statistics. For the statistics, the population of the province was considered, of whose total, 49.8% corresponds to Alto Valle. Forty percent would correspond to STEACS, according to the bibliography, and of these, 34.6% would have hospital insurance. Subsequently, the number of patients and YPLL that should have been detected with STEACS was estimated, as well as the difference between them and the YPLL observed, which allowed to obtain the YPLL lost due to lack of patient detection.[2,10]

LYG or impact evaluation: the impact or causal effect of a program (P) on a result of interest (Y) was obtained applying the following formula:

$\Delta = (Y/P=1) - (Y/P=0)$

The causal impact (Δ) of a program (P) on a result (Y) is the difference between the result (Y) with the program, when P=1; and the same result (Y) without the program, when P=0.

The counterfactual analysis was made in regard to the specific mortality rate and the LYG obtained as secondary source.

YPLL are divided by the population studied, and are compared with a hypothetical situation of studying and designing the implementation of a project over 5 years (2020-2024), taking into account the expected STEACS cases, the estimated national rate of infarctions/10,000 inhabitants with no medical insurance, and the rate of increase of detection of patients with the Rosario Infarction Code (52%, 150%, 9%, 14% and 28%, respectively).[5,6]

Based on the highest WT obtained in the population studied (2017), a reduction in YPLL was estimated, assuming that the project would allow decreasing reperfusion time until reaching one of 120 minutes as advised, along with a higher number of patients detected with the program. The proportion of patients per year was projected, in whom a reduction in times would be reached as the program advanced, where in the first year, only 5% would reach 120 minutes until reperfusion, in the second year 10%, in the third year 25%, in the fourth year 30%, and 60% in the last year of the project.

The LYG were obtained from the difference between the YPLL w/wo the project, according to the following formula:

N° of cases expected x rate of increase of the Rosario Infarction Code.

N° of cases expected = 40% of the total of expected patients with diagnosis of MI according to the population for year of analysis, incidence of STEACS, % of patients with hospital insurance, and the corresponding proportionality was assigned according to time of delay.

The measurement of said impact was obtained as LYG, according to the following formula:

LYG=YPLL(t) – YPLL (t+1)

YPLL=Deaths * provincial YPLL

T=year of project

(t+1) = subsequent year

Ethical considerations:

The main author states under oath to know and follow the international, national and provincial legal and ethical regulations: Nuremberg Code, Declaration of Helsinki, the CIOMS/WHO International Ethical Guidelines for biomedical research and experimenting in human beings; the CIOMS/WHO International Guidelines for Ethical Evaluation in Epidemiological Studies; the Operational Guidelines for Ethical Committees evaluating protocols of the WHO 2000, the UNESCO 2005 Declaration of Bioethics and Human Rights, and the valid national regulations of the Ministry of Health of the Nation.

Statistical analysis

Quantitative variables are expressed as means accompanied by standard deviation, and percentages were used to express qualitative variables.

When the median was chosen, the interquartile range was used as an appropriate measurement of variability with their respective maximal value, having previously verified the normal distribution by Kolmogorov-Smirnov test.

RESULTS

Clinical characteristics of the population

The survey of patients with diagnosis of STEACS was made since January 1 to December 31, 2017, in 16 centers. Twelve (12) of them were public and four (4) private. The latter are hired because in Alto Valle there is no public offer of hemodynamics services. The characteristics of the population are detailed in *Table 1*.

There were 45 patients identified with STEACS, of whom, 26 meet the inclusion criteria, with an average age upon admission of 56.77±9.19 years; for men 56±9 years and 60±8 years for women. The patients that were not included in this study were not living in Alto Valle.

From the total of patients admitted, 3 (11.54%) received fibrinolytic treatment with streptokinase (SK), and were later referred for a hemodynamic test. From those admitted for coronary angiography, 88.46% underwent TCA, of whom 73.08% were PTCA. In the case of patients referred for PTCA, a median pain-to-first medical contact time was observed of 60 minutes (IQR: 30-210), WT of 200 minutes (IQR: 120-480), and a median of DTBT of 20 minutes (IQR; 16-20), showing a wide dispersion of data.[5] In the case of rescue TCA, the median of pain-to-first medical contact was 105 minutes, WT of 165 minutes and DTBT of 97 minutes in delayed TCA of 60 minutes, with no other recordings about the other times. WT in PTCA had a mean of 336±290 minutes *(Table 2)*.

YPLL observed in patients with STEACS: of 26 patients included with STEACS, there were 25 patients with good course and a deceased one, of 60 years of age, representing 15 total YPLL, 0.58 YPLL per STEACS, and a mortality rate of 3.85% *(Table 3)*.

Unregistered YPLL due to lack of detection of patients: the population estimated in Río Negro is 718,646 inhabitants according to the INDEC (National Institute of Statistics and Censuses); 49.8% live in Alto Valle, 357,230 inhabitants; 34.6% has hospital insurance. The estimated incidence of infarction is 24.5 MI/10,000 inhabitants, equivalent to 875.21 MI; of these, 302.82 had no medical insurance; of these, 40% (n=121.12) with STEACS, representing the cases that should have been admitted for treatment in 2017.[2] Assuming as valid the rate of mortality of the ARGEN-IAM study (8.81%) and the YPLL reported by province (6.08), 11 deaths were expected, a total YPLL of 65.05 and 0.54 of YPLL per case in Alto Valle with just public medical insurance. In this population, 15 total YPLL were found, indicating that a total of 50.5 YPLL and 0.53 YPLL per case were not recorded due to lack of detection of patients.[4,11]

LYG or impact evaluation

In the investigation made in 2017, 121.12 patients with STEACS should have been found in Alto Valle. Considering in the studied population a WT mean of 336 minutes, the estimated population with the project for the years of its implementation, and obtaining as secondary benefit a higher detection of patients following the proportion observed in the Rosario Integrated Network, 66.28 patients would be detected in the first year of the project, and 131 in the last. The proportion of patients per year was estimated, who would reach a reduction in times as the program advanced: in the first year, just 5% would reach 120 minutes until reperfusion, and in the last year, 60% *(Table 4)*.

The project takes as starting point the higher WT observed (336 min). A total of 66.28 cases would be expected in the first year, 39.77 of whom would be within the most prolonged WT, with a total of 5.06 deaths and 30.76 total YPLL. As the project advances, in the last year, 131 cases would be achieved, 6.04 deaths and 36.75 total YPLL,

TABLE 1.
Clinical characteristics of the population

Variable	n	Mean
Age (years) upon admission	26	56,77±3,77
Variable	**n**	**%**
Male gender	26	80,77%
HTN	26	65,40%
Not known	26	30,80%
Dyslipidemia	26	50,00%
Not known	26	34,60%
T1D	26	11,54%
T2D	26	11,54%
No diabetes	26	42,31%
Not known	26	34,62%
Smoker	25	52,00%
Former smoker	25	26,90%
Sedentary lifestyle	25	88,00%
Previous MI	26	3,85%
Previous TCA	26	3,85%
Previous stroke	26	7,69%
PREVIOUS USE OF ASA	11	27,27%
With antithrombotic therapy	22	90,91%
With thrombolytics	25	88,00%
No hemodynamic complications	25	88,00%
With recurrent angina	25	96,00%
With arrhythmias	25	80,00%
No mechanical complications	25	96,00%

TABLE 2.
Pain-to-first medical contact time, window time and door-to-balloon time expressed in minutes

Pain/FMC	Percentile 25	Median	Precentile 75
Type of TCA			
Primary TCA	30	60	210
TCA/rescue	30	105	180
TCA/delayed	60	60	60
Window time	**Percentile 25**	**Median**	**Precentile 75**
Type of TCA			
Primary TCA	120	200	480
TCA/rescue	90	0,165	240
TCA/delayed			
Puerta / Balón	**Percentile 25**	**Median**	**Precentile 75**
Type of TCA			
Primary TCA	16	20	20
TCA/rescue	14	97	180
TCA/delayed			

PTCA: Primary transluminal coronary angiography

From a counterfactual approach, it is estimated that the application of an early reperfusion project under a protocol of infarction code would improve the situation of these patients, decreasing the times until reperfusion and detecting a higher amount per year of project.

DISCUSSION

In this study, the impact of an early reperfusion project over 5 years was evaluated in a counterfactual manner, decreasing the times until reperfusion and detecting a greater amount of patients as a secondary benefit, following the registry obtained with implementation of the Rosario Infarction Code.[6]

In the evaluation of sanitary programs, the control group constitutes a problem. A priori, a reference value or zero point of variables to be measured later should be defined. Regrettably, in a sanitary investigation, it is rare to find experimental designs offering high degrees of evi-

and there would no longer be patients with prolonged WT (336 min) *(Figures 1 and 2, Table 4)*.

The detection of new patients and the improvement in times until reperfusion would allow to obtain, over 5 years, an accumulated figure of a total 95.34 LYG, and 0.83 LYG per case, and a total of 529 patients receiving treatment *(Figure 3)*.

TABLE 3.
Deaths by MI, CIE IA21 Río Negro 2017[11]

Not known	Deaths		YPLL PER AGE		
	Number	%	YPLL	Mean YPLL	%
40-44	3	3,80%	97,5	32,50	20,31%
45 - 49	1	1,27%	27,5	27,50	5,73%
50 - 54	1	1,27%	22,5	22,50	4,69%
55 - 59	8	10,13%	140	17,50	29,17%
60 - 64	7	8,86%	87,5	12,50	18,23%
65 - 69	11	13,92%	82,5	7,50	17,19%
70 - 74	9	11,39%	22,5	2,50	4,69%
75 Y +	38	48,10%			
Not known	1	1,27%			
Total	79	100,00%	480	6,08	100,00%

TABLE 4.
Impact of YPLL and LYG per year of project

Year of the project	WTM	Cases	Deaths	YPLL	YPLL/cases	LYG	LYG/cases
Year 1	336	39,77	3,50	21,30	0,54	0,00	0,00
	240	13,26	0,89	5,40	0,41	1,70	2,57%
	180	9,94	0,53	3,25	0,33	2,08	0,03
	120	3,31	0,13	0,81	0,24	0,97	0,01
	Total	66,28	5,06	30,76	1,51	4,75	0,07
	Mean			7,69	0,38	1,19	0,02
	Deviation			9,27	0,12	0,92	0,01
Year of the project	**WTM**	**Cases**	**Deaths**	**YPLL**	**YPLL/cases**	**LYG**	**LYG/cases**
Year 2	336	49,72	4,38	26,63	0,54	0,00	0,00
	240	24,86	1,67	10,12	0,41	3,19	0,03
	180	14,91	0,80	4,87	0,33	3,12	0,03
	120	9,94	0,40	2,42	0,24	2,91	0,03
	Total	99,43	7,24	44,04	1,51	9,22	0,09
	Mean			11,01	0,38	2,31	0,02
	Deviation			10,90	0,12	1,54	0,02
Year of the project	**WTM**	**Cases**	**Deaths**	**YPLL**	**YPLL/cases**	**LYG**	**LYG/cases**
Year 3	336	0,00	0,00	0,00	0,00	0,00	0,00
	240	48,77	3,27	19,86	0,41	6,26	0,06
	180	32,51	1,75	10,62	0,33	6,80	0,06
	120	27,10	1,08	6,59	0,24	7,93	0,07
	Total	108,38	6,10	37,07	0,98	20,99	0,19
	Mean			9,27	0,33	7,00	0,06
	Deviation			8,31	0,18	3,57	0,03
Year of the project	**WTM**	**Cases**	**Deaths**	**YPLL**	**YPLL/cases**	**LYG**	**LYG/cases**
Year 4	336	0,00	0,00	0,00	0,00	0,00	0,00
	240	24,71	1,66	10,06	0,41	3,17	0,03
	180	61,78	3,32	20,17	0,33	12,92	0,10
	120	37,07	1,48	9,01	0,24	10,85	0,09
	Total	123,55	6,46	39,25	0,98	26,94	0,22
	Mean			9,81	0,33	8,98	0,07
	Deviation			8,25	0,08	6,14	0,05
Year of the project	**WTM**	**Cases**	**Deaths**	**YPLL**	**YPLL/cases**	**LYG**	**LYG/cases**
Year 5	336	0,00	0,00	0,00	0,00	0,00	0,00
	240	6,55	0,44	2,67	0,41	0,84	0,01
	180	45,85	2,46	14,97	0,33	9,59	0,07
	120	78,60	3,14	19,11	0,24	23,00	0,18
	Total	131,00	6,04	36,75	0,98	33,43	0,26
	Mean			9,19	0,24	8,36	0,06
	Deviation			9,29	0,18	10,68	0,08

dence at national or international level; therefore, counterfactual approaches can be applied. This term means any episode that has not occurred in the currently observable universe by human research, but that could have happened. The outcomes are lives or LYG. Although controversial, it is an approach used for the evaluation both of biological models and social and sanitary projects[9].

Impact evaluation is focused on the results that are closer to the end aims of a given project. The key characteristic of a good impact evaluation is that it acknowledges that most outcomes are affected by a variety of factors.

The feasibility of a proper impact evaluation will be possible depending on the characteristics of the project proper, of its goals and design. If not possible, or its design is not correct, the counterfactual estimate will not be reliable, and there will be uncertainty as to whether the outcomes would have occurred anyways, regardless of the project.

One of the few papers evaluating the impact in reduction of YPLL was developed in India: the TN-STEMI (Tamil Nadu STEMI) program, focused on a fast identification and treatment of STEACS, based on an integrated medical care network around the four tertiary care facilities with cardiovascular services of high complexity; the "hub" hospitals and the "spoke" hospitals organized in a network.[12]

After implementing it, a reduction in mortality of 3.4% was obtained. The LE in Tamil-Nadu (2010-14) was 72.7 years

for women and 68.6 years for men, yielding the outcome of 4381 YPLL before the implementation, and 3273 YPLL after it; estimating the usefulness of the program in 1108 LYG.

Besides the experience in the city of Rosario, times were reduced also in the El Cruce Hospital Network, in Florencio Varela, Province of Buenos Aires, increasing the proportion of patients receiving thrombolytics within the recommended DTNT, with a similar tendency in the DTBT reduction. The program was associated with an increase in reperfusion of 28.5% and a significant reduction in times.[6,13]

Candielo et al, evaluated the impact of a formal evaluation and feedback system on the decrease in reperfusion times in centers with PTCA, that participated of the Iniciativa SSL Argentina.[14,15] Patients with STEACS were included, from 46 centers with PTCA available, and each center received a report monthly, comparing their DTBT with the rest of the centers in a blind manner, as well as an individual report and suggestions for improvement, observing a significant reduction in DTBT and in the FMC-balloon time in the global population, with no differences in TIT, with an increase of patients with DTBT within recommendations. The monthly evaluation and feedback of outcomes allowed to better organize the care centers.

The implementation of the infarction code in Mexico allowed for an increase in the reperfusion of STEACS from 34.9% to 71.4%. The group with no reperfusion decreased from 65.2% to 38.6% at the expense of an increase in the use of thrombolytics (25.5% vs 40.1%) and PTCA increased

from 9.4% to 31.3%. In-hospital mortality decreased from 21.1% to 9.4%.[16]

Similar results were observed in Chile after the AUGE Plan (Plan of Universal Access of Explicit Rights), and in Brazil, after the implementation of the Minas-Telecardio-Project.[17,18]

In the STENT FOR LIFE in Europe, important results were achieved, when regional networks were applied for the treatment of MI, observing an increase in the number of procedures per million inhabitants, along with a decrease in mortality.[19,20] In Spain, for instance, a decrease was observed in patients treated with thrombolytics (37% to 3%), rescue PTCA (11% to 4%) and with no reperfusion (21% to 4%), in comparison with a significant increase in PTCA (31% vs 89%). Mortality rate within 30 days in PTCA decreased from 7.7% to 5.6%.

In countries like China, results also showed improvements.[21] The DTNT median decreased from 48 to 33 minutes, and the average DTBT from 133 to 89.5 minutes.

An efficient organization shortens the times entailed by moving the patient and offers better results in mortality and morbidity, as proven in the AIR-PAMI, DANAMI and PRAGUE studies.[22,23,24,25]

The Care Network for STEACS is a policy with evidence of effectiveness and efficiency.[6,17,24,25,26]

As detailed previously, in the public sector of Alto Valle early reperfusion for STEACS is not available, and there is a significant number of patients that do not have access to health care.

The public hospitals of the province lack the necessary facilities and human resources for PTCA in patients with STEACS, only available in a limited number of private centers; emergencies are dealt with by general doctors and ICUs are polyvalent; furthermore, fibrinolytic treatment is underused and referral to private centers for PTCA as a priority strategy is clearly not observed, with no proper control of times until care is given.

An early treatment impacts on the mortality of patients with STEACS; to achieve this, it is essential to manage net-
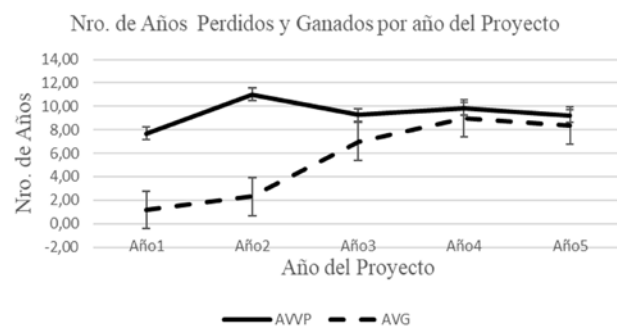
FIGURE 1.
Number of years lost and gained by year of the project
YPLL: Years of potential life lost; **LYG:** Life years gained
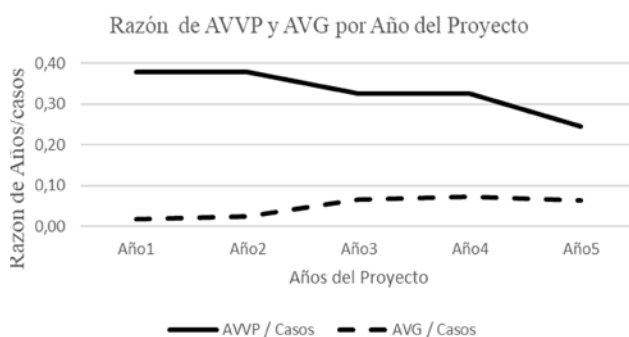

FIGURE 2.
Rate of YPLL and LYG per year of the project
YPLL: Years of potential life lost; **LYG:** Life years gained
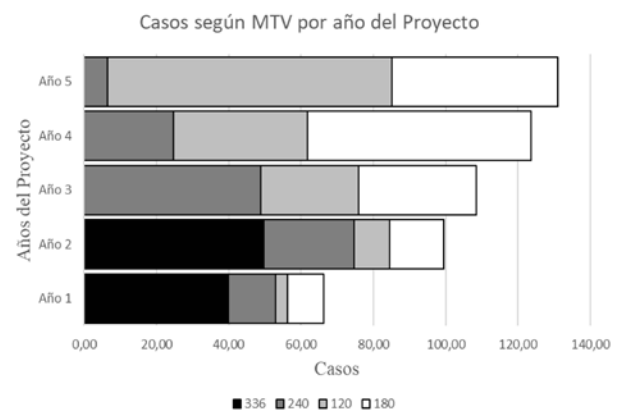

FIGURE 3.
Number of cases according to WTM per year of the project
WTM: Window time mean in minutes; **D:** Deaths; **YPLL:** Years of potential life lost; **LYG:** Life years gained

works focusing on the reduction of times until reperfusion. A counterfactual analysis could be controversial, but it is an approach used in social or sanitary projects, and in this preparation an *ex ante* evaluation is always necessary. Therefore, we consider this estimation valid.

Limitations

As limitations we should consider that only patients with diagnosis of STEACS were included in the study (2017), which is a low number in comparison to what is expected.

There is a continuous, prospective registry of patients with STEACS; times until reperfusion were obtained from information provided by personal medical or technical and/or family records, verifying a significant underrecording.

The times since admission to the hemodynamics center until reperfusion were recorded by just two of the four interventionist centers, data that may present biases.

Mortality was only recorded during the in-hospital period; no registry was found specifying how many and which were the related admissions in days or months after the event; the follow-up data within 6 months and one year could have provided very valuable information so as to be able to evaluate the impact of reperfusion on survival in the mid and long term.

The reported mortality rate by province corresponds to mortality by ischemic diseases of the heart; the YPLL reported by the province correspond to the IAM-CIE I21 code. There is no rate corresponding to mortality by STEACS, so this rate was inferred from a combination of sources and methods. There are no specific records taking into account the characteristics of infarction (STEACS/NSTEACS, type of infarction, etc.) showing a lack of regulation in the endogenous information channel and the implementation of an instrument to collect data.

The impact does not emerge from a randomized controlled study, but from a counterfactual approach, with less degree of evidence.

CONCLUSIONS

From a counterfactual approach, it is estimated that the impact of the implementation of an early reperfusion project in Alto Valle de Río Negro would improve the situation of patients, decreasing reperfusion times and detecting more patients per year of the project, obtaining over 5 years, 95.34 total LYG and 0.83 LYG per case with 529 patients receiving care.

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Original Investigation Reports

Efficacy of the HOPE 4 strategy compared with conventional strategy for the control of hypertension in Nicaragua. Arjé trial

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ARTICLE INFORMATION

ABSTRACT

Introduction: control of patients with hypertension is insufficient globally. There are different strategies to achieve this goal, but they have very rarely been compared in Latin America.

Objective: to compare the effectiveness of the HOPE 4 strategy adapted to the context of Jinotega (HOPE-4J) with conventional strategy in the control of hypertension.

Methods: adult patients with hypertension enrolled in the *Clinica de Falla Cardiaca* in the *Hospital Victoria Motta* were included during the period of study. The patients were divided into 2 arms: the HOPE 4 group and control group with the traditional Family and Community Health Model of Nicaragua (MOSAFC). An initial evaluation was conducted, and another one done in 6 months in a double-blind manner to compare hypertension control parameters in both groups.

Results: Relative Risk (RR) was determined and NNT - number necessary to treat to make a comparison with the control group. A RR of 0.1510 and an NNT of 3.35 showed positive results for the HOPE-4J strategy.

Conclusions: The HOPE 4 strategy modified to fit the population in Jinotega shows overall improvement over the MOSAFC. A comprehensive model was conducted by medical and non-medical staff and family members that helped the overall reduction of poorly controlled hypertension.

INTRODUCTION

Every year there are 1.6 million deaths by cardiovascular diseases in the region of America, of which around half a million are people older than 70 years.[1] Cardiovascular disease is the most common cause of death in Nicaragua and at world level, and hypertension is its main risk factor. However, less than 40% of people with hypertension have a controlled blood pressure, so control of HTN is the goal of many programs to improve prevention and care for such diseases.[1,2,3,4,5]

In Nicaragua, epidemiological studies and studies in patients consulting due to cardiological reasons have been made, and a prevalence of hypertension has been estimated in the Nicaraguan population of 28%. Only 72% of these patients know they are hypertensive, and the percentage of control of this disease is just 36%.[2,6]

The main obstacles detected for the PURE *(Prospective Urban Rural Epidemiology)* study to explain the lack of control of hypertensive patients are: 1) the cost of transportation of people from their home to the ambulatory consultation; 2) the cost of medications, which decreases availability of medication; and 3) the time lost by people to move from community centers and to wait for medical care.[7]

Based on the findings of the PURE study, a group of investigators designed the HOPE 4 strategy (A community-based comprehensive intervention to reduce cardiovascular risk in hypertension), to improve control of hypertensive patients.[7,8] The intervention consisted of a comprehensive package of three fundamental pillars: 1) use of nonmedical health care staff (nursing assistants along with primary care physicians) to detect, treat and control cardiovascular risk factors at community level, supported on algorithms of simplified management, and on programs of counseling by tools like tablets; 2) supply of antihypertensive medications and statins free of charge; and 3) participation of relatives and friends to support the participants in terms of adherence to medication, and the adoption and maintenance of healthy lifestyles. With this strategy, they achieved improving hypertension control in the intervention group, which doubled control in comparison with the control group (69% vs 30%; p<0.0001), proving the effectiveness of a comprehensive intervention to improve hypertension control and reduce the risk of cardiovascular disease in people from two countries with middle income.[8]

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Based on these data, the following problem question was posited:

What is the efficacy of the HOPE 4 strategy in hypertension control in comparison with the conventional strategy in Nicaragua?

MAIN OBJECTIVE

The objective of this study was to evaluate the efficacy of the HOPE 4 strategy, adapted to the context of Jinotega as a community intervention program for hypertension control, within the urban population of Jinotega during the January 2022-October 2022 period.

MATERIALS AND METHODS

A community trial was conducted in the adult hypertensive population who come to consult at the Cardiology Center of the *Hospital Victoria Motta*, of the city of Jinotega, Nicaragua, who were detected during the months of January 2022-March 2022, and a follow-up of at least 6 months was carried out.

Sample and type of sampling

A sequential sampling was made; each patient was assigned in a randomized sequential manner to the group of intervention and the control group. The sample was constituted by all hypertensive patients detected during January and February of year 2022, who met the inclusion criteria and did not present exclusion criteria. There were 841 patients evaluated over a period of three months, of whom 271 met the necessary requirements *(Figure 1)*. Two groups were constituted: the intervention group, with 136 patients, of whom 132 completed the study (97.05%), and 135 patients in the control group, of whom 131 completed the study (97.03%).

Inclusion criteria:

1. Hypertensive patients diagnosed by cardiology specialists in the hospital, defined as patients with average blood pressure from two pressure measurements during consultation, of more than 140 mmHg of systolic pressure or 90 mmHg of diastolic pressure, and in antihypertensive pharmacological therapy.
2. Minimum age of 18 years at the time of starting the study.
3. Voluntary agreement to participate in the study.

Exclusion criteria:

1. Women who reported being pregnant or in puerperium.
2. People who presented some physical or cognitive disability, preventing them from participating properly in the study.

Data collection

An initial double blind evaluation was made, determining the level of initial hypertension control in both groups of patients. The tool for information collection was applied as initial census based on the STEPS instrument and the ELIET-Hifari study, in both groups.[5] The work team for the initial evaluation was made up by a cardiology specialist, a bachelor of science in nursing and an internist. Blood pressure was measured according to the recommendations of the American Heart Association and the STEPS Manual indications. Automatic digital sphygmomanometers were used, of the Omron M6 Comfort HEM-7321-E brand (Kyoto, Japan), validated by the British and Irish Hypertension Society and the European Society of Hypertension, according to the International Protocol for use in adults, obese and elderly patients.[6] Once the initial diagnostic evaluation was obtained, the HOPE4-J strategy was implemented in the intervention group, and the conventional strategy in the control group, for a period of 6 months. Six months after the initial evaluation of each patient, a second evaluation was made to determine the state of the intervention and control groups.

Intervention group: modified HOPE-4 strategy (HOPE4-J).

The strategy was composed by four pillars:

1. Non-medical health staff

The people in charge of the follow-up were bachelors of science in nursing, previously trained by cardiologists, to carry out the monthly control and follow-up, with drug titration for each of the participants of the study. The nurses in charge of the follow-up made drug titration, did not prescribe new medication, and if a prescription for new medications was needed, a physician member of the investigation team had to assess it. The algorithm used, which the nurses followed, was based on the one by the National Institute for Health and Clinical Excellence for hypertension, as this is a simple algorithm; it is practical and based on evidence (applying an algorithm is not another strategy; it is just applying a series of steps suggested in clinical practice guidelines).[4] A consultation was available, for the follow-up of hypertension, under the responsibility of a base nurse and a support assistant nurse, to carry out the basal nursing work if a substitution was needed.

FIGURE 1.
Flowchart of the study

2. Use of combined therapy in low doses in chronotherapy .

In the intervention group, medications free of charge were used, included in the basic list of medications of the Ministry of Health. Medications with bioequivalence and assured for patients during the study:

1. LosarDenk® (losartan): 100 mg orally once a day, after waking up.

2. NifediDenk® (retard nifedipine): 20 mg orally after waking up and before going to bed.

3. AmloDenk® (amlodipine): 5 mg orally when going to bed.

4. Atenolol: 50 mg orally, when waking up and when going to bed.

5. Hydrochlorothiazide: 25 mg orally when waking up.

The treatment protocol included antihypertensive chronotherapy. In the case two or more drugs are needed, one of them will be indicated before going to bed (nighttime, when the patient is getting ready for sleep), and another one when waking up (morning time, when the patient sits up after sleeping). No fixed doses were used, as they are not available free of charge in Nicaragua.

Likewise, the patients within therapeutic targets at the time of the first evaluation followed the same doses of antihypertensive drugs used, and their follow-up was made according to the conventional MOSAFC (*Modelo de Salud Familiar y Comunitario* – Model of Family and Community Health) strategy if in the control group, but when in the intervention group, chronotherapy was applied. In the patients of the intervention group, who were outside of the targets, the treatment was readjusted with a follow-up every 2 weeks by the nursing staff until the therapeutic goals were met, after a monthly follow-up. In the patients of the control group, who were outside of the targets, the treatment was readjusted and the usual follow-up was made according to the national program.

Both the first evaluation of the study of the patients in the intervention group and the control group, and the second evaluation in 6 months, were conducted blind by a cardiologist to avoid biases.

3. Integration of people close to the patients, who would support adherence in the long term to the antihypertensive treatment.

The third strategy that was taken in this investigation was integrating a person chosen by the patient, so that they would monitor and support with their presence in all the follow-up consultations, adherence to changes in lifestyle and compliance with the pharmacological treatment.

4. Interconsultation calls

The consultation on hypertension, led by the nurses, was given to the patients in the intervention group, Tuesdays from 8 am to 11 am, at the hospital of the study. This day, the nurses in charge could interconsult with the cardiologist participating in the study. The interconsultations (WhatsApp videoconferences) were addressed to clarifying doubts in the management of patients. It was done in a planned timetable during the intervention in the consultation.

Control group: conventional MOSAFC strategy.

The control group followed the conventional MOSAFC strategy of the Ministry of Health. Next, we describe the conventional strategy.

1. Frequency of follow-up

The patients diagnosed as hypertensive received a monthly pharmacological treatment and were incorporated to the program of chronic patients; a monthly review was made to provide their treatment. In the case the patient missed their appointments persistently, they were visited at their home for their management at their houses.

2. Ensure medications according to the basic list of medications

Antihypertensive medications were indicated, free of charge, established and available by the program. They are:

- *Hydrochlorothiazide:* 25 mg per day.
- *Hydrochlorothiazide/amiloride:* 50 / 5 mg per day.
- *Enalapril:* 10 mg every 12 hours.
- *Nifedipine:* 20 mg every 12 hours.
- *Atenolol:* 100 mg per day.

The medications were indicated in a hypertensive patient, and doses were selected by the attending physician on the day of the monthly visit.

3. Club of chronic patients and strategies for control and adherence.

a. Club of chronic patients: its foundation is group therapy.

b. Mobile medical centers: where talks are given to the population, and the care for chronic diseases is emphasized.

c. Program of care for people with chronic diseases (Programa de Atención de Personas con Enfermedades Crónicas - PAPEC), where through a management census of chronic diseases, the 13 main chronic diseases are handled.

Data analysis

Data were analyzed following the grounds of descriptive and inferential statistics. They were introduced and processed in the statistical program IBM SPSS, version 22, for Windows Vista.

This study is a randomized community trial, designed to evaluate the efficacy of a strategy of intervention in comparison to a conventional strategy in patients with hypertension; therefore, the proper statistical indicators were used for this type of study.

Evaluation indicators

To evaluate the efficacy of the strategies, five key indicators were used: changes in systolic blood pressure, changes in diastolic blood pressure, relative risk (RR), relative risk reduction (RRR), and number needed to treat (NNT).

1. Changes in systolic blood pressure.

Defined as the number of mmHg by which the mean of systolic blood pressure changed from its initial figures to six months later, in both groups.

2. Changes in diastolic blood pressure.

Defined as the number of mmHg by which the mean of diastolic blood pressure changed from its initial figures to six months later, in both groups.

3. Relative risk (RR)

Relative risk was used to compare the probability of an adverse event (not achieving the blood pressure targets of less than 140 mmHg of systolic blood pressure and 90 mmHg of diastolic blood pressure in reevaluation 6 months later), in the group of intervention in comparison with the control group. RR was estimated as the ratio between the incidence of the event in the intervention group and the incidence of the event in the control group. This indicator allows to determine whether the new strategy reduces (RR<1) the risk of event in comparison to the conventional strategy.

4. Relative risk reduction (RRR):

Relative risk reduction was used to quantify the proportion of risk reduction in the intervention group in comparison with the control group. RRR was estimated as 1 – RR. This indicator shows the relative efficacy of the intervention in terms or risk reduction of adverse events.

5. Number needed to treat (NNT)

Number needed to treat was used to quantify the clinical effectiveness of intervention. NNT was estimated as the inverse of the absolute difference of risks (1/(risk in the control group – risk in the intervention group)). This indicator shows how many patients need to receive the new intervention to prevent an additional adverse event in comparison with the conventional strategy. A low NNT indicates a more efficient intervention.

A target patient was defined as the one presenting average blood pressures after 6 months, in their reevaluation, of less than 140 mmHg for systolic blood pressure and less than 90 mmHg for diastolic blood pressure.

Data were analyzed using the abovementioned statistical software. Hypothesis tests were carried out to compare the incidences of events between the two groups, and 95% confidence intervals were estimated for RR, RRR and NNT, to evaluate the accuracy of estimations. A p value <0.05 was considered statistically significant.

In this investigation, total cardiovascular risk evaluation was not performed, because the conventional strategy did not consider the indication of statins to hypertensive patients.

Bias control

The main bias to control was the confirmation bias by investigators. For this reason, double blind was applied. In this case, neither patients nor evaluators knew if the patient was the intervention or control group.

Ethical considerations

This study was made according to the ethical considerations detailed in the declaration of Helsinki, and was sent to the Ministry of Health of the Department of Jinotega for approval. Authorization was requested from the Local System of Comprehensive Health Care (Sistema Local de Atención Integral de Salud- SILAIS), Jinotega, the highest organization under the authority of the Ministry of Health of each department.[9] Each participant was explained the reason for the investigation, its scope and the expected benefits for the population. Later, their signed consent was requested from them to participate in the study, having been given a brief description previously, about the contents of the questionnaire. For this purpose, a format of informed consent, recommended by the WHO, was used with the relevant modifications.

RESULTS

A final control group of 131 patients was obtained, in whom the conventional strategy was applied, and an intervention group of 132 patients, in whom the HOPE4-J strategy was applied for 6 months. In *Tables 1 and 2*, the characteristics of both groups are shown. No significant differences are observed between the control groups and the intervention groups, p≥0.05.

In *Table 3*, the results in blood pressure changes are shown, in the control and the intervention groups, since initial control until 6 months later. A reduction in mean systolic blood pressure is observed, of 13.3 mmHg, greater in the intervention group over the control group; likewise, a bigger reduction is verified in the mean of diastolic blood pressure of 4.1.

In *Figure 2*, it is observed that at the end of the intervention, 39.1% of patients in the intervention group achieved blood pressure goals within 6 months versus 81.3% in the intervention group.

In epidemiology, the probability of occurrence of an event is called risk, typically getting sick, although also dying or healing (the term "hazard" is also used, particularly if the event is death). The quotient between the risk in the group with the intervention factor and the risk in the control group as index of association is called relative risk (RR).[10]

As this is an intervention study in a cohort of patients, the relative risk, the relative risk reduction and the number needed to treat to achieve the aim in comparison with the control group were determined. An RR of 0.1510 was obtained (95% CI 0.0708-0.3221), with an RRR of -29.8115 (95% CI -207876 - -38.8353) and NNT of 3.35, with these being very positive results for the HOPE4-J strategy *(Tables 3 and 4)*.

DISCUSSION

The thesis to conduct this pilot study, with the aim of evaluating the HOPE-4 strategy in the urban population of the city of Jinotega, Nicaragua, was that a poor control of hypertension in Nicaragua could be improved with the HOPE-4 strategy, appropriate for the context of Jinotega (HOPE4-J)[2,6]

In Nicaragua, in previously published studies, a prevalence of hypertension has been estimated in the Nica-

raguan population in 28%, 27.8 of whom ignore they are hypertensive, and the control percentage of this disease is just 36%.[2,6]

In the objective, it was observed that an individual undergoing the HOPE-4J strategy has a relative risk of 0.151 of not controlling their blood pressure. This means there is an 85% chance of controlling their blood pressure with the HOPE4-J strategy, in comparison with conventional strategy. Also, the number needed to treat to achieve blood pressure control in comparison with the conventional strategy is just 3.35, with a relative risk reduction of 0.84.

Schwalm et al, in the original study, did not publish the RR or the NNT, which would enable a specific comparison of the results of this study with those, but positive results are indeed verified when using the HOPE-4 strategy.[8] This modified model of the HOPE-4, appropriate to the context, led to a substantial reduction in the percentage of non-controlled hypertensive patients.

Other studies like those of Peiris and Tian, who also used nonmedical health care staff, displayed a modest

increase in the taking of antihypertensive medication by patients, not translated in a blood pressure reduction.[11,12] In this study, a great effectiveness of the HOPE4-J strategy was observed, something very important for an intervention based on the community. Just as with the original study by Schwalm et al, a significant reason for the success of the HOPE4-J strategy was that the package of intervention was explicitly addressed to all the obstacles preventing the control of a hypertensive patient in the context of a given country, a step that is omitted frequently in the development of complex interventions.[8] The strategy based on care being given by nonmedical staff jointly with specialist physicians that guided them through videoconferences and support by the family (tripod of success),

TABLE 1.
Comparison of ages according to the group of the study

Age of groups					
Group	N	Mean	Standard deviation	P value	P valor
Age Control	131	67.20	12.819	0.572393	
Intervention	132	66.27	13.931		

N: number of patients

FIGURE 2.
Percentage of patients who reached blood pressure targets

TABLE 2.
General characteristics of the groups

Variable	Value	Intervention		Control		
		Absolute frequency	Percentage frequency	Absolute frequency	Percentage frequency	P value
Sex	Male	53	40.2%	50	38.1%	0.741
	Female	79	59.8%	81	61.9%	
Smoker	Yes	8	7.9%	11	8.4%	0.485
	No	124	92.1%	120	91.6%	
BMI	Normal weight	19	14.4%	26	19.8%	0.485
	Overweight	72	54.5%	80	61.0%	
	Obesity	41	31.1%	25	19.2%	

BMI: body mass index

TABLE 3.
Changes in blood pressure

	Basal		In 6 months		Differences (Intervention-Control)	P value
	C	I	C	I		
SBP (mean) mmHg	150.7	151.1	-8.9	-22.2	-13.3	< 0.0001
DBP (mean) mmHg	88.1	88.7	-3.1	-7.2	-4.1	< 0.0001

C: control group; **I:** intervention group. **SBP:** systolic blood pressure: **DBP:** diastolic blood pressure: **mmHg:** millimeters of mercury
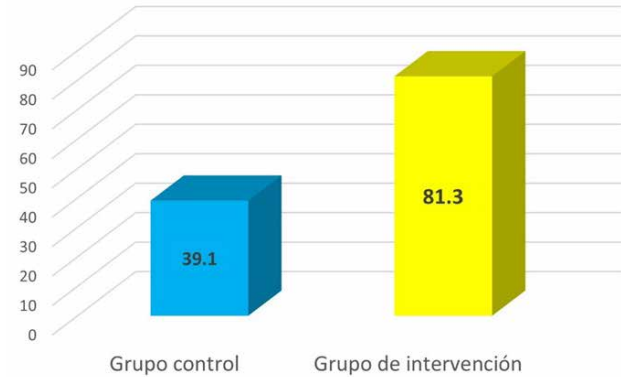
Parameter of risk base			
	Estimated	Low	High
Relative risk	0.1510	0.0708	0.3221
Difference of risk	-29.8115	-38.8353	-20.7876

associated to the supply, free of charge, of bioequivalent antihypertensive medications of high quality, achieved the primary aim by far.

This study, as well as the original HOPE-4 study, improves our understanding of how nonmedical health care staff can be more effective in the reduction of risk and cardiovascular events.[8,13] First, with a proper training and supervision, they may put into practice in an efficient way, a strategy based on an algorithm as a support system to achieve the targets of blood pressure, and providing counseling to people in regard to their risk of cardiovascular disease.[8] The effect of nonmedical staff on counseling and education of patients and their close person about their disease, about a better lifestyle and self-control, about the significance of adhering to the treatment, is shown by the improvement in several health behaviors and significant reductions in blood pressure in the intervention group of this investigation and the original investigation.[8,13]

Just as with the original study, the HOPE4-J intervention also entailed sharing tasks, in a collaborative model involving nonmedical staff, physicians and family members, according to what was recommended by the WHO.[14] This strategy is focused on breaking the barriers of the health care systems of middle and low income in comparison to the scarcity of physicians, and supports policies that would stop limiting the capacity of nonmedical staff to prescribe medications in patients in follow-up.[8,13] By training nonmedical staff and supporting them with telemedicine and algorithms designed for a defined target, they are capable of diagnosing hypertension and providing a proper follow-up.[14]

This study used an intervention based on care given in follow-up consultations of chronic patients. The participants were enrolled in their usual follow-up consultations, this is a difference from the original study, where patients were enrolled outside medical consultations. In the original HOPE4 study, and in this study, important obstacles were overcome to solve health problems; obstacles of the system related to cost and availability of antihypertensive medications for patients and families with low and middle income, providing bioequivalent medications of high quality and low cost at local level and free of charge.[8,13]

Using bioequivalent drugs in the treatment of hypertension is essential to guarantee therapeutic efficacy and the safety of patients. These medications ensure that patients receive a consistent and reliable treatment. Bioequivalence guarantees that generic drugs would have the same bioavailability as brand medications, which leads to similar clinical effects and reduces the risk of variability in the response to the treatment. Besides, using bioequivalent drugs may decrease the costs of treatment, making the management of hypertension more accessible for a greater number of people.

It has been properly established that control of hypertension is better achieved using combinations in low doses of antihypertensive agents; an approach backed by several guidelines.[3,4,5]

Although the medication free of charge is an important component of the intervention, and could explain the big effects on blood pressure reduction, it is probably not accountable for the whole effect of the HOPE4-J strategy. Other studies have shown an extra benefit when sharing tasks with nonmedical staff, in spite of the medications being provided with no charge, both in the intervention and the control groups.[14,15] The results show that the nonmedical staff evaluate blood pressure with accuracy, effectively determine if patients are within targets or no, manage the contraindications of medications and can put into practice the treatments and recommendations given by physicians. This supports the need to consider changes in regulations that would allow the trained nonmedical staff to prescribe a limited amount and a number of medications commonly used, such as safe antihypertensive medications.[8,15]

The HOPE4 intervention adapted to Jinotega (HOPE4-J) actively involved the family and friends of participants as support for the treatment and management of their hypertension. These close people were encouraged to help patients to improve their adherence to medications, acquire and improve healthy lifestyles, as well as comply with the planned appointments with the health care staff. This strategy has proven to be effective to improve adherence to medications and to decrease mortality in patients with HIV.[13,16] More than 90% of participants in the intervention had a close person present during the intervention visits, which suggests they were actively involved in the mission of patients to achieve control of their disease.

This study confirms what has been proposed in the original HOPE4 study, in terms of its findings and those of this study being widely applicable in different contexts of low and middle income countries.[8,13]

CONCLUSIONS

The HOPE4 strategy, modified for Jinotega (HOPE4-J), shows a clear benefit over conventional strategy and encourages the performance of larger studies, putting into practice this methodology and pillars to show their benefits at national level. A comprehensive model of care, led by trained nonmedical staff with physicians and family members, guided by specialists by videoconference, with bioequivalent medications of high quality and free of charge, led to a substantial reduction in the poor control of hypertension.

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Original Investigation Reports

Pulmonary annular plane systolic excursion. Comprehensive evaluation of the right ventricle with tetralogy of Fallot and pulmonary stenosis

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ABSTRACT

Objectives: surgery has improved the survival of patients with tetralogy of Fallot and pulmonary stenosis. Pulmonary regurgitation is the most frequent complication, requiring cardiac MRI to decide on reintervention. The objective was to evaluate the function of the right ventricular outflow tract through excursion of the pulmonary annulus by echocardiogram and its relationship with ejection fraction by MRI.

Methods: patients were included who had repaired tetralogy of Fallot and pulmonary stenosis, with recent cardiac MRI (within the last year), and who had the following elements measured by Doppler echocardiogram: pulmonary annular plane systolic excursion, tricuspid annular plane systolic excursion, right ventricular S wave tissue Doppler velocity, and right ventricular fractional area change. They were compared with right ventricular ejection fraction.

Results: Seventy patients were included, with tetralogy of Fallot in 65.7%. Pulmonary annular plane systolic excursion was greater in the group with preserved right ventricular ejection fraction: 10.8 vs 9.1 mm (p=0.021). Pulmonary annular plane systolic excursion showed a weak but statistically significant correlation coefficient with right ventricular ejection fraction (r 0.27 p < 0.05) and with tissue velocity S (r 0.31 p < 0.01) but not with tricuspid annular plane systolic excursion.

Conclusions: pulmonary annular plane systolic excursion is related to right ventricular ejection fraction and most indices of right ventricular systolic function.

INTRODUCTION

Tetralogy of Fallot (TOF) is the most common form of congenital heart disease (CHD) producing cyanosis, with an incidence of 0.1/1000 live births. It is a congenital disease that presents: overriding aorta of less than 50%, right ventricular (RV) outflow tract obstruction, non-restrictive ventricular septal defect, and RV hypertrophy.[1,2] It is the most frequent cyanotic CHD after one year, and it represents 10% of all congenital heart diseases.[3] Long term survival is still increasing, and residual complications are more frequent in adulthood.[4]

Congenital pulmonary valve stenosis (PVS) represents 7 to 10% of CHD, frequently accompanied by right ventricular hypoplasia and outflow tract hypertrophy, which may require a widening with transannular patch.[4,5]

Although surgery has improved quality of life in both pathologies, it is not a cure, and hearts in these patients persists with structural, anatomical and electrophysiological alterations.[6] Pulmonary valve regurgitation is the most frequent reason for reintervention in patients with TOF and repaired PVS.[7,8]

According to the last guideline from the European Society of Cardiology, acting on a severe pulmonary valve regurgitation is class I when symptomatic.[2] Otherwise, pulmonary insufficiency should meet at least one criterion of the following: objective systolic dysfunction of the right ventricle; indexed volumes by magnetic resonance (end diastolic volume >160 ml/m2 and end systolic volume >80 ml/m2), progression of tricuspid valve regurgitation at least to moderate; right ventricular outflow tract obstruction with pressure greater than 80 mmHg.[2] In the US guideline, both for PVS and TOF, just the presence of moderate pulmonary valve regurgitation, but with worsening in the functional class not attributable to another cause, is considered a class I indication of valve replacement.[4] As to asymptomatic patients, there should be RV systolic function worsening or dilatation in a progressive manner.[4]

Currently, the gold standard of RV systolic function is cardiac MRI; but not all patients have access to it, whether because it is not possible for a patient proper, both physically (carriers of pacemakers, defibrillators, etc.) and psychologically (claustrophobia), or owing to the health care system, whether public or private.[9]

Echocardiography is the first-line diagnostic method for these patients due to it being widely available.[10] In the evaluation of the right chambers, use of tricuspid annular
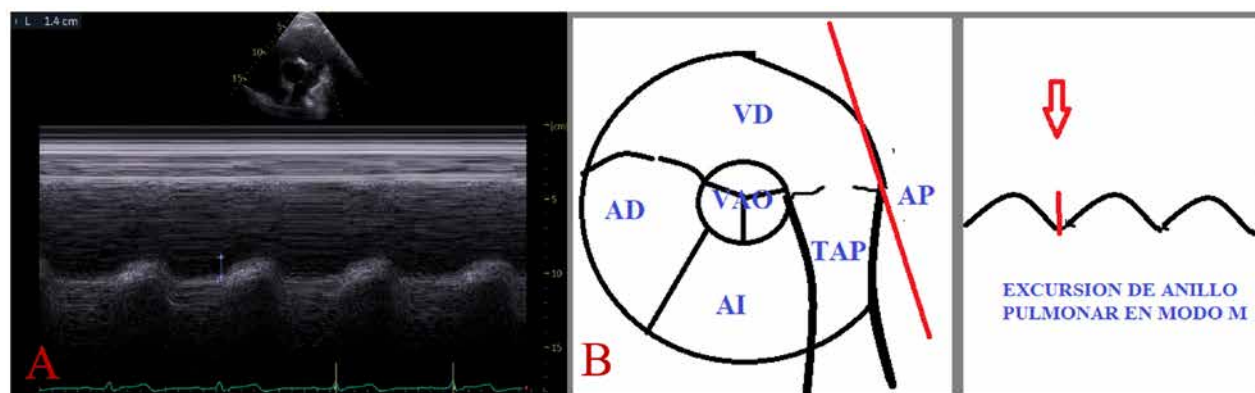
FIGURE 1.

Image A: pulmonary annular plane systolic excursion (PAPSE) by M mode of echocardiogram, in patient with tetralogy of Fallot.

Image B: outline of left parasternal short axis view at the level of the great vessels, with a red line, representing M mode from the transducer.

RA: right atrium; **LA:** left atrium; **PA:** pulmonary annulus; **PAT:** pulmonary artery trunk; **RV:** right ventricle.

At the right: representation of PAPSE in M mode. The arrow indicates where the measurement was made.

plane systolic excursion (TAPSE) is described, as well as right ventricular S wave tissue Doppler velocity (RV S') and right ventricular fractional area change (FAC).[10] However, all these measurements do not evaluate the outflow tract or the infundibulum, which significantly contribute to RV pump function.

Therefore, it would be desirable to have tools available that would allow to more appropriately select patients who should be referred for the performance of cardiac MRI before the suspicion of RV dysfunction.

The aim of this study was to evaluate, in patients with congenital pathology of the RVOT (TOF and PVS), the relationship between pulmonary annular plane systolic excursion (PAPSE), RV ejection fraction (RVEF) by cardiac MRI, and with the other assessment methods for the RV by ultrasound.

The secondary aim was to describe the characteristics of TAPSE, PAPSE and RVEF by cardiac MRI according to the specific pathology.

MATERIALS AND METHODS

This was an observational, analytical, cross-sectional study. It was conducted in a single tertiary center, the *Hospital Vall d'Hebron*, Barcelona, Spain, from 2019 to 2023.

Inclusion criteria

Patients older than 18 years, with diagnosis of TOF or PVS, who were evaluated by cardiac MRI in the year before being included.

Exclusion criteria

Patients in whom no data of Doppler echocardiogram PAPSE could be obtained because of a poor acoustic window.

All patients gave their informed consent to participate in the study.

The study received the authorization of the Committee on Education and Institutional Investigation.

The demographic data, clinical characteristics and cardiac MRI data were collected retrospectively from the clinical history, since year 2019 until February 2023.

Comprehensive Doppler echocardiogram was made, according to the international guidelines.[10]

Valve regurgitations were assessed, both left and right, quantifying their severity from level 0 to IV: when they were absent "0", "I" mild regurgitation, II-III moderate, IV severe. Pulmonary valve stenosis was evaluated, whether infundibular, valvular o supravalvular, and quantified according to the last guideline of congenital heart diseases: mild stenosis when peak gradient is less than 36 mmHg, moderate with peak gradient between 36 mmHg and 64 mmHg, and severe when greater than 64 mmHg.[2]

The following were considered right ventricular function markers, as recommended by the last joint guidelines of the American and European Societies for cardiac chamber evaluation by Doppler ultrasound: TAPSE, with the reference value being greater or equal to 17 mm; RV S', greater than 9.5 cm/s; FAC, greater than 35%, and finally, to assess the right ventricular outflow tract function, PAPSE was assessed.[10] For the measurement of this variable, a parasternal short axis view was used for the great vessels. Particular attention was given to the adjustments to optimize the visualization of the right ventricular outflow tract, the pulmonary valve and the trunk and proximal segments of the pulmonary artery branches. Next, the M mode line was placed in the lateral region of the pulmonary annulus. PAPSE measurement was made by measuring the difference between the systolic and diastolic planes in mm, with leading edge to leading edge technique in the M mode *(Figure 1, images A and B).*

As to the assessment by cardiac MRI, the study protocol includes, in a standardized fashion, the measurement of end diastolic volumes (EDV), end systolic volumes (ESV) of both ventricles, and right and left ejection fraction. Right ejection fraction was considered preserved when greater than 47%.

Statistical analysis

In the descriptive analysis, quantitative variables were evaluated by means and standard deviation (SD), or by median and percentiles 25-75, and patients with TOF and PVS were compared by student's t-test (or Mann-Whitney U test when necessary). Qualitative variables were described by percentages, and were compared by the Chi-square test.

To assess the strength of the association between variables (TAPSE, FAC, RV S' and RVEF by MRI with PAPSE), Spearman's rank correlation coefficient was used.

Besides, patients were divided in 2 groups:

A: preserved RVEF (greater than 47%).

B: deteriorated RVEF (47% or less).

PAPSE was compared in both groups by Mann-Whitney U test.

A p value of less than 0.05 was considered statistically significant.

RESULTS

There were 70 patients included, with a mean age of 41 years (SD 10), of whom 31.4% were women. The diagnosis of TOF was the cause of repair surgery in 65.7%, while in the rest of the cases it was PVS; and 61.4% was in functional class (FC) I, 37.1% in FC II, and the remaining 1.4% in FC III at the time of the study.

The median of time until repair surgery was 3.7 years (percentiles 25-75: 1.4-7.9 years).

The median of time since repair surgery until the echocardiographic test was 37.1 years (percentiles 25-75: 28-41 years).

In regard to the time between echocardiogram and MRI, it was 4 months (percentiles 25-75: 1-7.25 months).

In *Table 1,* the values of TAPSE, PAPSE, RV S', FAC, LVEF values are shown, as well as cardiac MRI data.

PAPSE was greater in group A (with preserved RVEF) than in group B (with deteriorated RVEF): 10.8 vs 9.1 mm (p=0.021). The rest of the variables displayed the same behavior, as shown in *Table 2.*

PAPSE showed a weak rank correlation coefficient, but statistically significant with RVEF (r of Spearman 0.27, p lower than 0.05) and with RV S' (r of Spearman 0.31, p lower than 0.01). However, it did not show a significant relationship with TAPSE or FAC.

In *Figure 2,* dispersion diagrams are shown with the corresponding linear regression line.

When comparing the different RV variables according to the base pathology, it was observed that all of them are found in patients with TOF in comparison with patients with PVS, as shown in *Table 3* and in *Figure 3*.

DISCUSSION

In the standardized echocardiographic evaluation of the RV, the longitudinal function of it is mainly evaluated, by lateral wall test, mainly including the basal and middle or trabecular portion.[11] The recommended measurements are TAPSE, RV S' and FAC.[10] It is known that in the RV, fibers

TABLE 1.

Different RV variables

Variable	Media	SD
TAPSE (mm)	17,9	3,4
RV S' (cm/s)	9,8	2,5
PAPSE (mm)	10,1	4,1
FAC (%)	42,2	7,8
Right ventricular ejection fraction (%)	60,8	6,6
RVEF by MRI (%)	48,3	8,3
EDV by MRI (ml)	131,9	29,8
ESV by MRI (ml)	68,9	22,1

TAPSE: tricuspid annular plane systolic excursion; **RV S':** right ventricular S wave tissue Doppler velocity; **PAPSE:** pulmonary annular plane systolic excursion; **FAC:** fractional area change of the right ventricle; **RVEF:** right ventricular ejection fraction; **EDV:** end diastolic volume; **ESV:** end systolic volume.

TABLE 2.

Different RV variables

Variable	Group A	Group B	P value
TAPSE, mm (SD)	18.7 (3.3)	16.9 (3.6)	0.034
RV S', cm/s (SD)	10.5 (2.4)	8.7 (2.2)	0.003
FAC, % (SD)	44.1 (7.6)	39.1 (7.1)	0.009
PAPSE, mm (SD)	10.8 (3.4)	9.1 (4.7)	0.021

TAPSE: tricuspid annular plane systolic excursion; **RV S':** right ventricular S wave tissue Doppler velocity; **PAPSE:** pulmonary annular plane systolic excursion; **FAC:** fractional area change of the right ventricle;

TABLE 3.

Different RV variables

Variable	TOF	PVS	P value
RVEF by MRI, % (SD)	45.8 (7.1)	53.8 (8.4)	0.0001
TAPSE, mm (SD)	17.3 (3.5)	19.1 (2.6)	0.04
RV S', cm/s (SD)	9.1 (2.4)	11.3 (2.2)	0.001
FAC, % (SD)	39.9 (7.2)	45.9 (7.5)	0.005
PAPSE, mm (SD)	9.4 (3.6)	12.3 (4.1)	0.006

RVEF: right ventricular ejection fraction; **TAPSE:** tricuspid annular plane systolic excursion; **RV S':** right ventricular S wave tissue Doppler velocity; **PAPSE:** pulmonary annular plane systolic excursion; **FAC:** fractional area change of the right ventricle.

are arranged in a perpendicular way between the inflow and outflow tracts, and this makes its global evaluation by echocardiogram difficult.[12,13] Systolic function of the RVOT is largely concealed. Studies have been published evaluating the RVOT, assessing in M mode the right ventricular wall excursion at the level of the aortic valve in the short
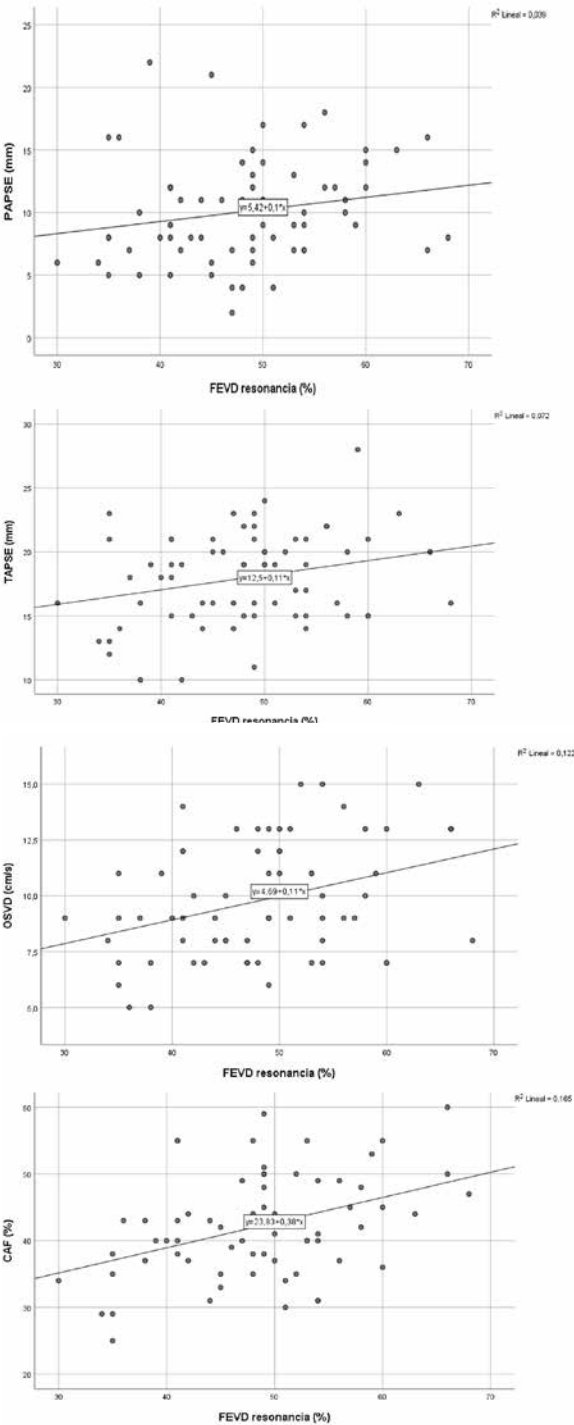
FIGURE 2.

Dispersion diagrams according to echocardiogram parameters with cardiac MRI. RVEF is observed in the coordinate axis, by MRI in %, and the parameters of ultrasound in the abscissa axis, quantified according to the parameters established by guideline (*).
Diagram 1: PAPSE relationship with RVEF. **Diagram 2:** TAPSE relationship with RVEF. **Diagram 3:** RV S' relationship with RVEF. **Diagram 4:** FAC relationship with RVEF.

RVEF: right ventricular ejection fraction; **PAPSE:** pulmonary annular plane systolic excursion; **TAPSE:** tricuspid annular plane systolic excursion; **RV S':** right ventricular S wave tissue Doppler velocity; **FAC:** fractional area change of the RV.
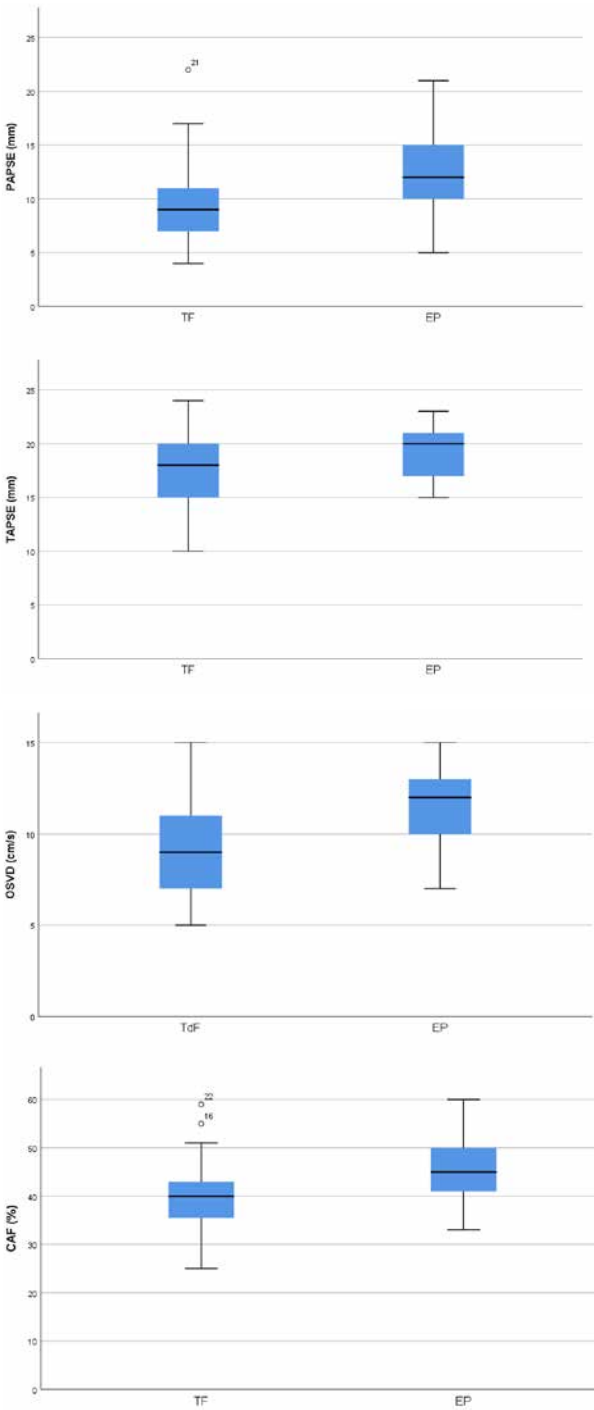
FIGURE 3.

Box plot, from 1 to 4, where echocardiogram values are observed, decreased in patients with tetralogy of Fallot.

TOF: tetralogy of Fallot; **PVS:** pulmonary valve stenosis; **PAPSE:** pulmonary annular plane systolic excursion; **TAPSE:** tricuspid annular plane systolic excursion; **RV S':** right ventricular S wave tissue Doppler velocity; **FAC:** fractional area change of the RV.

axis.[12,13,14] Although in these studies, the evaluated parameters of the RVOT were different (gradient vs fractional shortening), they reached a similar conclusion. The anomaly of these variables is related with structural and functional modifications of the RVOT, in patients with structural heart disease and pulmonary hypertension. However, none of these studies included patients with CHD.[12,13,14]

In this study, RVOT regional motility was evaluated in patients with CHD, who presented a pathology of this part of the RV (TOF and PVS). The aim was to specifically study this RV segment, which is not evaluated as routine and that guidelines do not consider.[10] This RV region could be directly and particularly affected, both by the pathology and by its repair. PAPSE was evaluated as a marker of regional systolic function, taking into account the RVOT influences on the total RVEF between 20% and 30%.[15]

PAPSE values were higher in patients with preserved RVEF and their correlation with RVEF, though weak, was statistically significant. Both TAPSE, FAC and RV S' also were significantly correlated with RVEF. On the other hand, only RV S' presented a statistically significant correlation with PAPSE. The absence of significant correlation between TAPSE and PAPSE could seem remarkable, as there is a good correlation between RV inflow and outflow tract, but this happens in healthy patients. On the contrary, in patients with TOF, this relationship between inflow and outflow tracts could be altered.[11,12,13,14,15,16] Thus, PAPSE measurement in these patients could supplement the other echocardiographic variables evaluating the RV, thus providing a fuller view of ventricular function. This more thorough evaluation, focused on a usually ignored segment, may potentially help attending physicians to decide on making a patient undergo a more complex and confirmatory test, such as cardiac MRI.

A study evaluated RVOT function by PAPSE by tissue Doppler imaging (TDI), and compared it with the values of TAPSE by TDI. Pediatric patients were included, with no structural alterations, on the one hand, and they were compared with patients with pulmonary hypertension, atrial septal defect and TOF. Although a relationship was found between these parameters, patients with TOF had lower values of systolic wave, both in PAPSE and in TAPSE.[16] In this study, this tendency between patients with TOF and PVS was also observed, leading to assessing them independently, as a secondary goal.

In this analysis, the patients with TOF had values of the traditional variables within normal limits, associated to lower PAPSE levels, with slightly depressed RVEF (average of 45.8%, SD 7.1) vs patients with PVS, in whom these echocardiographic parameters were normal values, with higher PAPSE values and preserved RVEF (RVEF 53.8%, SD 8.4) *(Table 3)*. It is possible for these differences to be due to the type of repair according to pathology; in patients with TOF, repair includes RVOT widening, with or without transannular patch, VSD closure, exposition to cardioplegia; while PVS repair may be less complex, whether by

percutaneous valvuloplasty or surgical repair.[11] Yasunobu Hayabuchi et al, after observing the difference of values by pulmonary annulus tissue Doppler between patients with TOF and other CHD went beyond, and studied this echocardiographic parameter in patients with history of repair surgery for RVOT obstructions, including pulmonary atresia, double outlet RV and TOF.[11,16] They found that the simpler the surgical intervention, the better the values of pulmonary annulus velocity by TDI. On the other hand, in patients presenting transannular patch, values are smaller.[11]

If the right ventricle is divided at the time of evaluating it in an MRI into 3 parts: inflow tract, trabecular portion and outflow tract, the portion most influencing the RVEF is the trabecular portion, both in healthy patients as in TOF carriers; but in the latter, the portion that is most affected is the outflow tract, with an ejection fraction of this portion up to 48% lower.[15] However, by increasing the end diastolic volume in the trabecular portion, as the end systolic volume in the infundibular portion, global RVEF may not be affected significantly.[15] The changes in the infundibulum could be due to the scar left by widening the outflow tract.[15] Ejection fraction may not drop drastically, as the rest of the ventricular body attempts to compensate, improving radial contraction.[17]

As PAPSE is a regional motility marker, the pathologies that were chosen to be assessed in this study have a characteristic in common: RVOT alteration. As developed through this discussion, it seems logical to think that the stress experienced by the myocardium since embryonic development until its repair is not the same; therefore, the way to compensate the alterations differ, and this is reflected in traditional parameters, as well as PAPSE by M mode.

Clinical implications

MRI is the gold standard to quantify right ventricular function, but there are limitations that make it unsuitable in some patients.MRI is the gold standard to quantify right ventricular function, but there are limitations that make it unsuitable in some patients.[9] It would be desirable to have a marker for right ventricular function to supplement those already established, that may allow to identify patients with CHD with a high probability of RV dysfunction, in whom a confirmation by MRI is necessary. PAPSE may help in this regard, adding information about RVOT function. The authors of this study consider that it could be used in a periodical follow-up of patients, along with other established parameters, to have a global assessment of RV function. More data are necessary to confirm these findings It would be desirable to have a marker for right ventricular function to supplement those already established, that may allow to identify patients with CHD with a high probability of RV dysfunction, in whom a confirmation by MRI is necessary. PAPSE may help in this regard, adding information about RVOT function. The authors of this study consider that it could be used in a periodical follow-up of patients, along with other established parameters, to have a global

assessment of RV function. More data are necessary to confirm these findings.

Limitations

It would be ideal to carry out PAPSE in healthy patients, to have a normal value of reference.

Due to the frequency of its presentation, we decided to include only patients with TOF and PVS. Pulmonary atresia and double outlet RV are less frequent, but because of their characteristics and repair, the RVOT are also affected, but were not included in this study.

Patients with CHD often present multiple interventions, so the suboptimal thoracic window could be an important limitation.

Another limitation was not having discriminated patients with transannular patch, to compare the PAPSE value in these patients vs the rest of enrolled patients.

CONCLUSIONS

PAPSE relates with RVEF and with most echocardiographic indices of RV systolic function, so the authors believe it is useful for the global evaluation of the RV in patients with TOF and PVS.

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Original Investigation Reports

Crisis in the care of cardiovascular diseases and working conditions of the country´s cardiologists. Survey of the Argentine Federation of Cardiology

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ABSTRACT

This study attempts to reflect, in the most representative way possible, the working and health conditions of cardiologists in our country, considering that they directly affect medical practices and indirectly affect the morbimortality of cardiovascular diseases.

Objective: to know the working, training and health conditions of cardiologists in our country.

Materials and methods: a simple survey was designed, which includes 20 questions. It was designed by the Medical Teleinformatics Center of the Argentine Federation of Cardiology (CE-TiFAC) and distributed using the structure of the FAC, through its 30 federated societies, 3 associations and 5 subsidiaries throughout the country.

Results: There were 633 cardiologists who completed the survey. The majority expresses not being able to rest enough and 83.9% report having had symptoms of work stress, with their work environment being hostile (regular or bad) in 38.4%. Training and continuous education is an unmet demand, with scientific societies being identified as a solution to this problem. Although the majority has no hope for the near future, a very high degree of commitment could be observed to change the situation.

Conclusions: the data provide us with a reflection of the significant dissatisfaction of cardiologists with their working and training conditions with a clear impact on their health. It highlights the need for union representation and support from scientific societies. We also highlight the importance of collaborative work between societies to address this very complex situation.

INTRODUCTION

The Argentine Federation of Cardiology (FAC), concerned with the working conditions and their repercussion on the health of cardiologists in the country, considers that the latter unavoidably affects their wellbeing and *mortality due to cardiovascular disease.*

Acute work stress and the burnout syndrome, referring to the subacute or chronic forms, are the expression of the consequences of the psychological demands of medical work.[1]

Its most relevant manifestation is characterized by a triad, including:

- emotional exhaustion, tiredness or lack of energy to cope with daily tasks,

- depersonalization, negative feelings or insensitive attitude by professionals, and

- decrease in the sense of personal realization, perception that achievements are behind expectations, less self-esteem and a feeling of frustration.

This situation affects not only those who are experiencing it, but also colleagues, patients and institutions, by decreasing quality of care and increasing the risk of medical error, with less safety for patients and with a strong impact on absenteeism. Due to these mechanisms, cardiovascular health, in what is strictly related to cardiologists, is compromised.[2,3,4]

Data from Argentina show a clear tendency to an increase, mainly during and after the COVID-19 pandemic.

From the FAC, both the National Executive Committee and the Department of Improvement of Medical Activities consider relevant to learn about the working conditions and the health of cardiologists in Argentina, to be able to carry out proposals to contain this situation. It is considered essential to conduct a joint action between scientific societies and public health authorities, working on projects to guarantee conditions and fees according to the transcendence of the work of cardiologists, and a compre-

hensive plan for the prevention, diagnosis, treatment and rehabilitation of cardiovascular diseases.

For this reason, a survey was conducted with the aim of learning about the working, training and health conditions of cardiologists in Argentina.

MATERIALS AND METHODS

A simple survey was designed, which included 20 questions about the following topics:

- surveyed population (3 questions)
- income and medical fees (3 questions)
- health of cardiologists (6 questions)
- training and studies (3 questions)
- representation (2 questions)
- perception of the future (3 questions).

It was carried out during the period between the months from December 2023 to March 2024, and it was designed by the Center of Medical Teleinformatics of the Argentine Federation of Cardiology (CETiFAC).

To guarantee the representativeness of the whole country of the surveyed data, the survey was distributed using the structure of FAC, through its 30 federated societies, 3 associations and 5 delegations all over the country. Besides, it was distributed through social networks through the area of communications.

Data were described as mean, median or range according to the characteristics of the variables. Results were presented in an inter-society roundtable during the 61st National Conference of Cardiology *(LXI Congreso Nacional de Cardiología),* carried out in the city of Rosario, on May 30th, 31st and June 1st, 2024.

RESULTS

During the term studied, a total of 633 replies were obtained. In regard to the surveyed population, 31.1% had less than 10 years as a cardiologist, 41.1% between 10 and 25 years, and 27.8% more than 25 years; 49.4% worked in public and/or private hospitals, and 51.6% only in private centers. The question, *"How many jobs do you have"* was answered in the following manner: 60.2% three or more, 24.6% two, and 15.2% one.

In relation to the questions addressed to income and medical fees, 96.8% answered that they were not in accordance with their work and training, 57.7% of cardiologists do not earn enough to save money, and 36% do not own a house.

Health of cardiologists: 46.4% do not perform an activity other than their profession usually, and 33.3% do not carry out physical exercises; 65.7% do not agree with the time available to share with their family; 65.1% manifests not resting enough. In *Figures 1 and 2*, the replies to the questions about burnout syndrome and working conditions are shown.

About continuous training and education, 71.4% report that in their workplace they are not offered chances for further education, and 68.7% that time not being enough is the main limitation for medical education and training;

84.4% consider that scientific societies play an essential role in their training *(Figure 3)*.

Two questions were focused on the union situation, considering that 57% of surveyed cardiologists thought that a union should negotiate their fees, and 91.8% manifested not feeling represented.

In the end, three questions were addressed to how do they perceive their future, with 77.7% replying that they have considered practicing their profession overseas, while 85.5% consider that their work situation will not change in a near future, and 90% of them having the intention of committing for this to happen *(Figure 4).*

DISCUSSION

The survey presented by the National Executive Committee and the Department of Improvement of Medical Activities has the aim of surveying the work situation and health conditions of the cardiologists of the country, attempting to make visible the difficulties related to them.

The authors consider that the survey was well represented in terms of distribution according to the time of specialization, and work place, whether public or private, so the collected replies reflect a common situation that occurs throughout the country, regardless of the age of the participants.

It was possible to observe a great demand in relation to income/fees received by the cardiologists of the country, highlighting a gap between training and the requirement for updating for the specialty, and the salary received. In relation to this issue, approximately 2 every 3 surveyed professionals manifest not having enough time for medical training and education, and that their workplace does not offer chances for it; 84% consider that scientific societies play a significant role to satisfy their needs of continuous education. In this regard, the FAC along with other scientific societies representing cardiology, hemodynamics and vascular and cardiovascular surgery in Argentina, have come together by signing a framework agreement for scientific and cultural collaboration, which commits them to work jointly to preserve the quality of medical practice, the health of patients, and the present and future of the profession.

The questions that may relate indirectly with work stress or burnout syndrome display a concerning situation for the cardiologists of Argentina, in relation to this topic.[5,6,7] A significant number of replies express the little time that physicians have available for their families, or some type of activity unrelated to their work, to perform physical activity or very few hours for resting. In comparison to other studies, this survey also manifested a high number of cardiologists (83.9%) who reported presenting or having presented at some time work stress symptoms, and in many cases, the work environment is defined as poor or hostile.

This survey leaves a message to be emphasized; i.e. although there is acknowledgement of low representative-

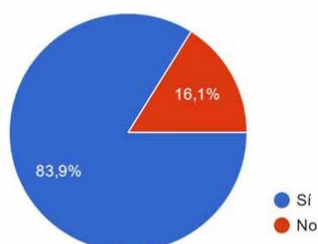12. ¿Padece o padeció aluna vez de síntomas de estrés laboral
633 respuestas

FIGURE 1.
Questions related to Burnout syndrome

13. ¿Cómo define el ambiente laboral de su trabajo?
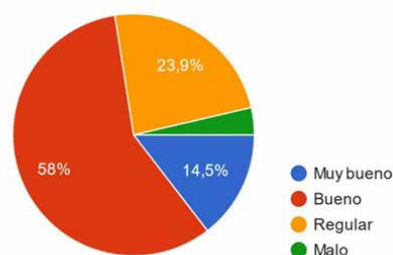633 respuestas

FIGURE 2.
Questions related to the work environment of the surveyed cardiologists

10. ¿Considera que las sociedades científicas cumplen un rol fundamental en su formación?
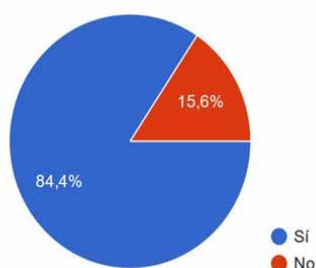
633 respuestas

FIGURE 3.
Continuous training and education

20. ¿Tiene ganas de comprometerse para que ello suceda?
633 respuestas
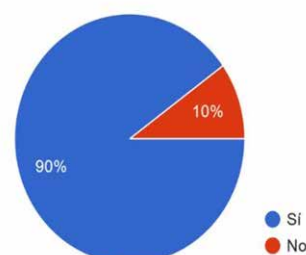
FIGURE 4.
Perception of the future. Work scenario and changes toward a near future

ness for the defense of their rights, and that in the near future the situation may not change, 90% manifest a commitment to have the current conditions modified.

The FAC along with other scientific societies promote a comprehensive plan for the prevention, diagnosis, management and rehabilitation of cardiovascular diseases.

Limitations

Aware of the heterogeneity and segmentation of work difficulties and conditions in the different regions of the country, this survey did not include the address or province of the surveyed individuals, nor their gender, which may make a more accurate approach to tackle problems more difficult. The lack of a multivariate analysis is also emphasized.

CONCLUSIONS

This survey shows the interest and commitment of the FAC for the working conditions and health of the Argentine cardiologists, considering their close relationship with the morbimortality of cardiovascular diseases. The data provide a reflection on the significant discontent due to their working and training conditions, with a clear re-

percussion on their health. It manifests also the need for union representation and accompaniment by scientific societies. Also, the importance of collaborative inter-society work is emphasized, to approach such complex scenario.

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Original Investigation Reports

Estimation of common carotid intima-media thickening using neural networks in adults with and without ischemic stroke

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ABSTRACT

Introduction: carotid intima-media thickening indicates potential atherosclerosis and risk of ischemic stroke. The objective was to predict the presence of carotid intima-media thickening using neural networks in adults with and without stroke.

Materials and methods: analytical and cross-sectional study of a secondary database of 600 patients with and without a history of ischemic stroke. The dependent variable was the intima-media thickness of the right and left common carotid artery (RCC and LCC). Biochemical markers frequently used in primary care, systolic and diastolic blood pressure, were used. Multilayer perceptron-type neural networks with area under the curve (AUC) were used.

Results: without a history of stroke, the perceptron predictive model for RCC was good (AUC=0.852). For LCC, it was acceptable (AUC=0.799). In patients with a history of ischemic stroke, the predictive model for RCC was good (AUC=0.826). The model for LCC was acceptable (AUC=0.789). In the absence of stroke, the neural network test had a percentage of correct predictions for right and left common carotid intima-media thickening of 81.30% and 79.20%, respectively. With a history of ischemic stroke, it was 82.80% and 91.50%, respectively.

Conclusions: the multilayer perceptron-type neural network model, based on tests performed in primary care, had a high capacity to correctly predict intima-media thickening of the common carotid artery in patients without a history of ischemic stroke.

INTRODUCTION

Stroke is the second cause of mortality in the world, with ischemic stroke being most frequent, with an estimated prevalence of 85% to 87%.[1] The remaining percentage corresponds to stroke of the hemorrhagic type.[2] Measurement of carotid intima-media thickness (CIMT) is an early atherosclerosis marker and ischemic stroke predictor.[3] Although it has been inferred that traditional cardiovascular risk factors, including an advanced age, hypertension, diabetes, dyslipidemia, smoking, and so on, lead to an increase in CIMT, the main associated factor is hypertension, influencing on the pathophysiology of carotid thickening due to generating hemodynamic, biochemical and humoral alterations, favoring its formation. Its chronicity increases the risk of thromboembolism in brain vessels, favoring the appearance of transient ischemic attacks or ischemic stroke.[4,5]

Carotid ultrasound in B mode is a noninvasive method that can evaluate carotid thickness.[6] However, this is not a technique used in a routine way in the general population. Certain altered biochemical, hemodynamic and anthropometric markers are associated with the formation of atheromas and progression of atherosclerosis, acknowledging between them lipids, glucose and hypertension.[7,8,9] These, in general, are requested as part of primary care and specialized medical consultations, which could be elements that provide evidence defining the suspicion about the possible presence of abnormal thickness.

The use of artificial neural networks, such as multilayer perceptron, could be a useful tool to build models based on nonlinear relationships, which may serve as an auxiliary method for clinical decision-making, as proven in diseases like type 2 diabetes mellitus.[2] In this regard, based on the pathophysiological proximity of alterations in biochemical and hemodynamic markers on carotid thickness, it is feasible to generate a sensitive enough algorithm to guide and for an early detection of this important ischemic stroke risk factor. For this reason, the goal of this investigation was to predict the presence of carotid intima-media thickness through neural networks in adults, with and without stroke.

MATERIALS AND METHODS

Design and population of the study

Analytical and cross-sectional study, from a secondary database from the F1000Research, which is an open access platform, where there is also uploading and exchanging of databases *(https://f1000research.com/)*. The database was uploaded by Salazar et al, who used it to carry out the article called *"Risk factors for ischemic stroke in China: a case-control study"*, whose goal was to determine whether uric acid, total bilirubin, serum creatinine, homocysteine, platelet-large

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cell ratio, mean platelet volume, width of red blood cell volume distribution and common carotid intima-media thickness were risk factors for ischemic stroke.[11] The database had a total of 600 adults since 18 years of age, of whom 400 had ischemic stroke and 200 had no history of this disease, in whom B mode carotid ultrasounds and laboratory tests were carried. There were no exclusion criteria, and no sampling or randomizing technique when selecting the total of the population that had the total of data required for the investigation. The characteristics of the population and the lab tests performed are observed in *Table 1.*

Variables and measurements

The dependent variable was right and left common carotid intima-media thickness, which, according to the information of the database, was obtained by Doppler echocardiography of the carotid arteries, using an automatic software. It was analyzed as categorical variable according to the cutoff point of ischemic stroke risk thickening, for which there is no universal consensus, having selected a cutoff point based on studies that suggest that the upper limit is around 0.9 mm.[12,13] The independent variables were those included in *Table 1*, which were age (in years), basal glucose, total cholesterol, triglycerides, low-density lipoproteins, high-density lipoproteins, serum creatinine, uric acid, total bilirubin, systolic blood pressure, diastolic blood pressure, with all of them being quantitative variables. The laboratory and blood pressure values, according to the reports in the secondary source of the database, were obtained in the hospital where the investigation was carried out. These laboratory markers were found in mmol/L, so they were converted to mg/dL by an online calculator[14].

Statistical analysis

Simple artificial neural networks were used, of the multilayer perceptron type, to determine the presence of right and left carotid intima-media thickenings, greater or equal to 0.9 mm. Neural networks are computed architectures, modeled in an analogous way to biological neural networks. In a similar way to biological neurons, where the processing capacity is a product of the strength of interconnections between nonlinear processing node arrangements.[15] Computed neural networks, also called perceptrons or connection models in multiple layers, have units similar to the nervous system neurons. These networks have the ability to identify patterns, are adaptive, perform tasks from previous examples, and therefore, are better for decision-making than traditional linear learning machines. Furthermore, they do not require an explicit programming.[16] The adjustments of hyperparameters of the perceptron were automatically predetermined by the neural network of the SPSS statistics 25 software.

Although the total population of the database was 600 people, there were data lost during the neural network training, since from 400 patients with ischemic stroke, there were 99 and 98 cases excluded for the right and left

TABLE 1.
Characteristics of the population studied

	Mean	SD
Age (years)	63.71	11.57
Basal glucose (mg/dL)	110.17	46.78
TC (mg/dL)	179.19	45.33
TG (mg/dL)	161.02	122.35
LDL (mg/dL)	94.43	32.37
HDL (mg/dL)	45.51	11.27
Cr (mg/dL)	0.80	0.35
UA (mg/dL)	5.29	1.5
TB (mg/dL)	0.73	0.32
SBP (mmHg)	142.24	21.43
DBP (mmHg)	83.09	12.02
	Frequency	**Percentage**
Sex		
Female	283	47.20
Male	317	52.80
Ischemic stroke		
No	200	33.30
Yes	400	66.70
HTN		
No	326	54.30
Yes	274	45.70
Diabetic patients		
No	482	80.30
Yes	118	19.70
Coronary artery disease		
No	586	97.70
Yes	14	2.30
Dyslipidemia		
No	558	93
Yes	42	7
RCC IM thickness		
≥0.9 mm	346	57.70
<0.9 mm	254	42.30
LCC IM thickness		
≥0.9 mm	350	58.30
<0.9 mm	250	41.70

TG: triglycerides; **HDL:** high-density lipoproteins; **LDL:** low-density lipoproteins; **SBP:** systolic blood pressure; **DBP:** diastolic blood pressure: **Cr:** serum creatinine; **UA:** uric acid; **TC:** total cholesterol; **TB:** total bilirubin; **RCC-IM thickness:** right common carotid intima-media thickness; **LCC-IM thickness:** left common carotid intima-media thickness; **HTN:** hypertension; **mmHg:** millimeters of mercury; **mg/dL:** milligrams per deciliter

carotid artery, respectively, representing a loss of data of 16.50 and 16.30%. For the 200 patients without history of ischemic stroke, there were 25 cases excluded for the left and right common carotid arteries, representing a loss of 6.25%. Likewise, as part of the results, the neural network included the area under the curve, determining whether

the model is acceptable, good and excellent, with ranges being 0.7-0.8; 0.8-0.9 and 0.9-1, respectively.[17] Likewise, the network analysis included the cross entropy loss, which quantifies asynchronous measurement between variables, defined as loss of function used in automatic learning to measure the performance of a classification model.[18]

Ethical considerations

This is a study from a secondary database, so there was no intervention or use or manipulation of biological samples, using only clinical records and anonymous data freely provided by the author of the original database, under creative commons license, so no evaluation by a committee on ethics was required. The supplementary information, included the data where the neural network training was done, is available by means of the following link: *https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/QSKKLD*

RESULTS

In patients with no history of ischemic stroke, the percentage of incorrect prognoses in the model training for the RCC and the LCC was 22.40% and 24.20%, respectively. For the test, it was 20 and 27.50%, respectively. In patients with history of ischemic stroke, the percentage of incorrect prognoses in the model training for the RCC and LCC was 22.80% and 24.80%, respectively, and in the test it was 28.40% and 26.30%, respectively. Cross-entropy loss was greater in the group of patients with history of ischemic stroke, which indicates that the performance of the model was lower *(Table 2)*.

In patients with no history of ischemic stroke, the neural network structure of the multilayer perceptron type to determine the presence of RCC and LCC intima-media thickening had hyperbolic function as the activation function for hidden layers, and softmax as output function of the output layer. The model for the RCC had 1 input layer with 8 units, 1 hidden layer with 6 units, and one output layer with 2 units. The area under the curve was 0.852, which indicates that it was a good predictive model. The

model for the LCC had an input layer with 8 units, a hidden layer with 6 units and an output layer with 2 units, with an area under the curve of 0.799, which indicates it was an acceptable predictive model *(Figure 1)*.

In patients with history of ischemic stroke, the structure of the neural network of the multilayer perceptron type to determine the presence of RCC and LCC intima-media thickening had hyperbolic function as activation function of the hidden layer, and softmax as output function of the output layer. The model for the RCC had one input layer with 11 units, 1 hidden layer with 4 units and one output layer with 2 units. The area under the curve was 0.826, which indicates a good predictive model. The LCC model has 1 input layer with 13 units, one hidden layer with 6 units and one output layer with 2 units, with an area under the curve of 0.789, which indicates that it was an acceptable predictive model *(Figure 2)*.

In the multilayer perceptron model test, the percentage of correct prognoses to determine the intima-media thickening in patients with no history of ischemic stroke for the RCC was 81.30% and 79.40% for thickenings ≥0.90 and <0.90, respectively. For the LCC it was 79.2% and 66.70%. In patients with history of ischemic stroke, the percentage of correct prognoses for the RCC was 82.80% and 54.10% for thickenings ≥0.90 and <0.90, respectively; while for the LCC it was 91.50% and 44.80% *(Table 3)*.

DISCUSSION

AUC analysis showed that the predictive models were higher in the RCC thickening study, and also, the number of variables included for the RCC were fewer than for the LCC. Since the aim of this investigation did not require to perform a comparative analysis of the characteristics of both arteries, whose anatomical origins differ (the right carotid artery originates in the brachiocephalic trunk and the left one is born in the aorta), and before the absence of studies analyzing this issue in depth, it is possible that the differences in the number of predictor variables for the efficiency of predictive model, which in turn, were fewer in regard to the RCC, are related to the characteristics

TABLE 2.
Summary of the neural network model to determine the presence of the common carotid artery intima-media thickening in adults with and without history of ischemic stroke

|		No history of ischemic stroke		With history of ischemic stroke	
		RCC	**LCC**	**RCC**	**LCC**
Training	**Cross entropy loss**	60.305	68.266	95.651	106.699
	Percentage of incorrect prognoses	22.4%	24.2%	22.8%	24.8%
	Stopping rule used	1 consecutive step(s) with no error decrease	1 consecutive step(s) with no error decrease	1 consecutive step(s) with no error decrease	1 consecutive step(s) with no error decrease
	Training time	0:00:00.03	0:00:00.02	0:00:00.05	0:00:00.07
Tests	**Cross entropy loss**	23.066	28.148	49.675	44.051
	Percentage of incorrect prognoses	20.0%	27.5%	28.4%	26.3%
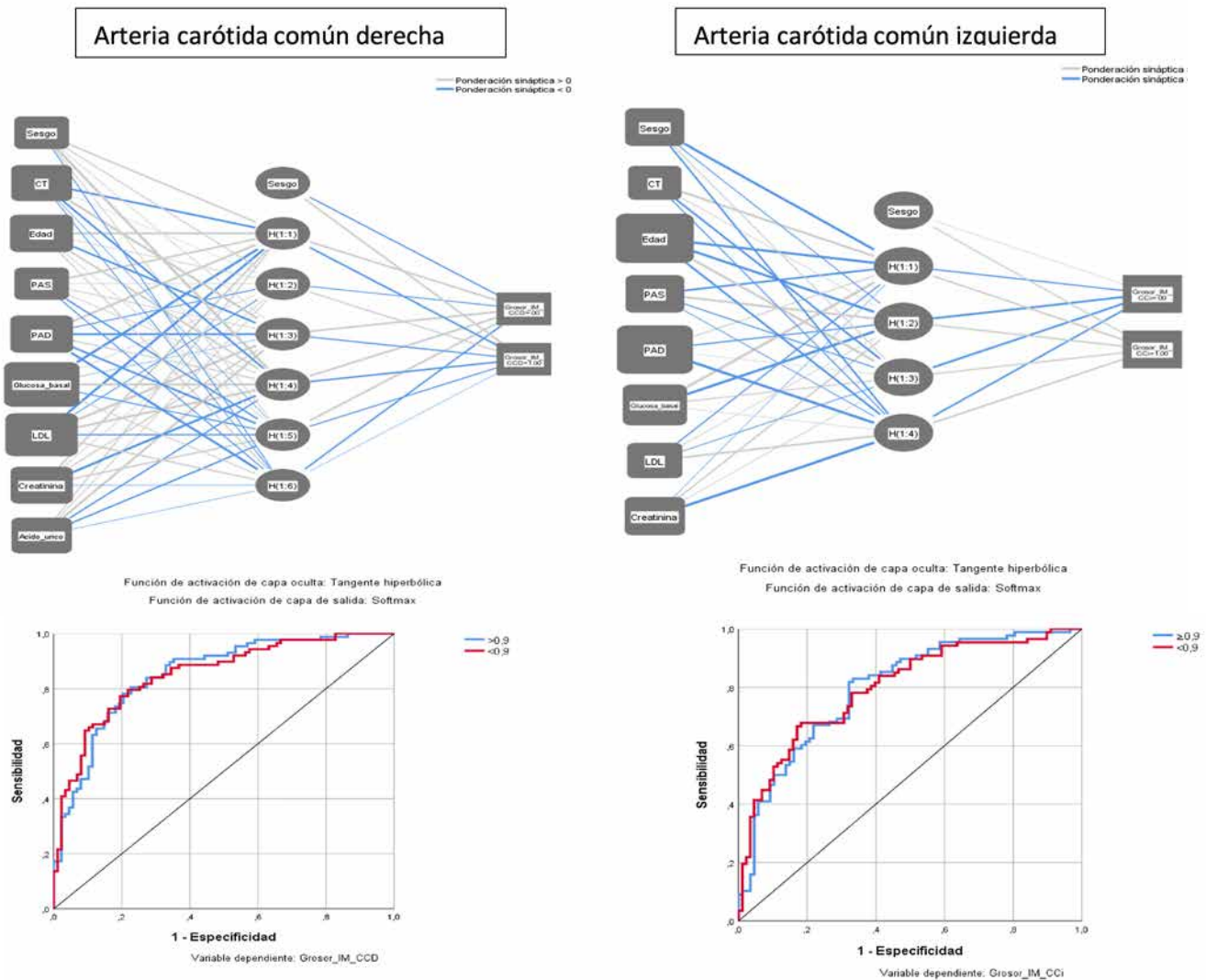
FIGURE 1.

Structure of network of the multilayer perceptron type with area under the curve for prediction of the presence of the right common carotid intima-media thickening from biochemical and hemodynamic parameters in adults with no history of ischemic stroke

TG: triglycerides; **HDL:** high-density lipoproteins; **LDL:** low-density lipoproteins; **SBP:** systolic blood pressure; **DBP:** diastolic blood pressure: **Cr: s**erum creatinine; **UA:** uric acid; **TC:** total cholesterol; **TB:** total bilirubin

associated to anatomical and hemodynamic factors. In relation to this, a study found that in young hypertensive and diabetic adults, there were significant differences in the lumen diameter and the intima-media thickness of the RCC and the LCC, being greater in the LCC, suggesting that the pressure differences are due to the anatomical origins of both vessels.[19]

It was observed that the percentages of correct prognoses were more elevated in the absence of ischemic stroke, where cross entropy was less in regard to the patients with history of stroke. As cross entropy is an indicator of the degree of adjustment between predictions and findings, it is advisable to use the neural network addressed to patients with no history of ischemic stroke, which entails considering it a supplementary system for clinical decision-making with a preventive approach, as well as to confirm subsequently the presence of intima-media thickening by carotid Doppler ultrasound.

Although this neural network is not 100% accurate, by being a supervised learning system, which has already been trained and tested, it has the possibility of being used to supplement clinical decisions about patients with risk factors for ischemic stroke. The laboratory and blood pressure results of patients with cardio-metabolic risk factors can be introduced in this neural network, with the aim of determining whether they can present abnormal carotid intima-media thickening, and therefore, primary care physicians and cardiologists, along with patients, will take diagnostic measurements to confirm or rule out this possibility, as well as going in depth into preventive pharmacological and non-pharmacological strategies, such as changes in lifestyle and diet, among others. In this regard, using trained neural networks can be a supplementary option for the clinical judgement of primary care physicians and specialists, allowing to analyze the possible presence of abnormalities in the intima-media thickening, based on
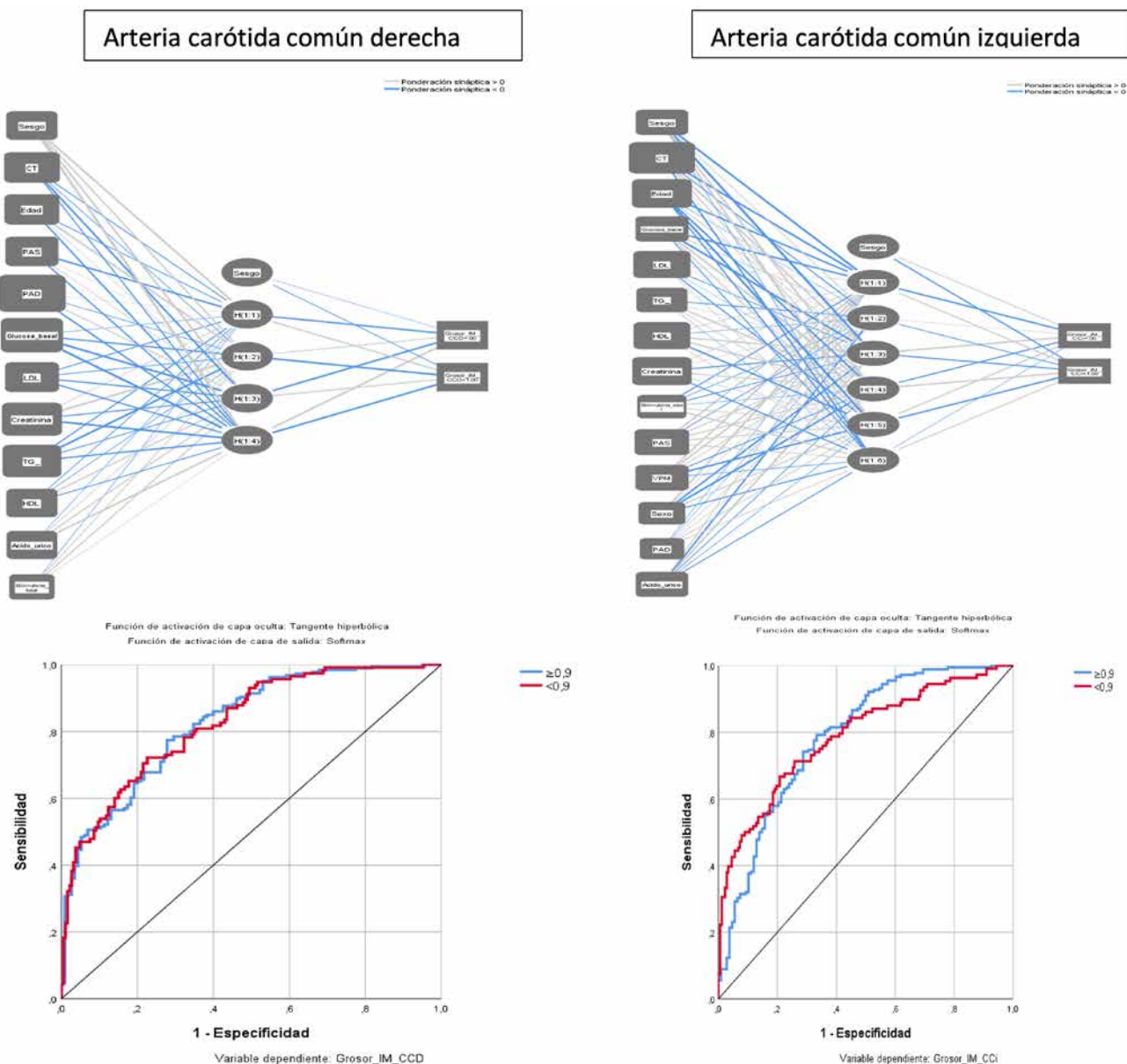
FIGURE 2.
Structure of network of the multilayer perceptron type with area under the curve for prediction of the presence of the right common carotid intima-media thickening from biochemical and hemodynamic parameters in adults with history of ischemic stroke.
TG: triglycerides; **HDL:** high-density lipoproteins; **LDL:** low-density lipoproteins; **SBP:** systolic blood pressure; **DBP: d**iastolic blood pressure: **Cr:** serum creatinine; **UA:** uric acid; **TC:** total cholesterol; **TB:** total bilirubin

routine laboratory tests, with low complexity and low financial cost, to later confirm or rule out this possibility by carotid Doppler ultrasound.

The limitations of this investigation were the neural network being designed to determine the carotid intima-media thickening in a qualitative way, so it is not possible to estimate the vascular wall thickness accurately. The sample size for groups with and without stroke was another limitation, so studies with a greater number of patients are required. Besides, the results could be affected by the measurements made with carotid Doppler ultrasound, recorded on the secondary database, as the measurements may present inter- and intra-observer variability. Also, although

a hypothesis was proposed explaining the differences in RCC and LCC thickening, no studies have been conducted explaining whether there are significant differences in this specific group of patients under the premise of this investigation. Likewise, the source of information was a secondary database, so there is a chance of information and data classification biases that could not be controlled.

To conclude, the neural network model, of the trained multilayer perceptron type, based on routine biochemical tests and blood pressure tests had a high capacity to predict the presence of carotid intima-media thickening in patients with no history of ischemic stroke.

TABLE 3.
Percentages of correct prognoses of the multilayer perceptron for the common carotid intima-media thickening in adults with and without history of ischemic stroke

		No history of ischemic stroke					
		RCC			LCC		
		Prognosticated			Prognosticated		
		≥0,9	<0,9	Correct percentage	≥0,9	<0,9	Correct percentage
Training	≥0,9	57	14	80.3%	53	11	82.8%
	<0,9	14	40	74.1%	19	41	68.3%
	Global percentage	56.8%	43.2%	77.6%	58.1%	41.9%	75.8%
Tests	≥0,9	13	3	81.3%	19	5	79.2%
	<0,9	7	27	79.4%	9	18	66.7%
	Global percentage	40.0%	60.0%	80.0%	54.9%	45.1%	72.5%
		With history of ischemic stroke					
		RCC			LCC		
		Prognosticated			Prognosticated		
		≥0,9	<0,9	Correct percentage	≥0,9	<0,9	Correct percentage
Training	≥0,9	113	15	88.3%	116	15	88.5%
	<0,9	32	46	59.0%	37	42	53.2%
	Global percentage	70.4%	29.6%	77.2%	72.9%	27.1%	75.2%
Tests	≥0,9	48	10	82.8%	43	4	91.5%
	<0,9	17	20	54.1%	16	13	44.8%
	Global percentage	68.4%	31.6%	71.6%	77.6%	22.4%	73.7%

RCC: right common carotid; **LCC:** left common carotid

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Clinical case

Anterolateral papillary muscle rupture

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ABSTRACT

Papillary muscle rupture after myocardial infarction is a rare complication. We report the case of a 68-year-old male, with severe acute mitral valve regurgitation as a consequence of anterolateral papillary muscle rupture. We describe the emergency mitral valve replacement and his postoperative evolution.

INTRODUCTION

Acute mitral valve regurgitation (MVR) is rare, but it would be a complication of acute myocardial infarction. It is caused by subvalvular apparatus dysfunction, associated or not to papillary muscle rupture (PMR) or not.[1] The latter manifests with hemodynamic deterioration and cardiogenic shock, which if left untreated presents a high mortality[2,3,4] Anterolateral (AL) papillary muscle rupture is more infrequent, due to its double coronary flow; while the posteromedial one (PM) is irrigated by a single coronary artery.[5,6] The case of pa atient with acute MVR, severe due to AL PMR, is presented along with his treatment and course until discharge.

CLINICAL CASE PRESENTATION

Male, 68-year-old patient, with history of hypertension and dyslipidemia, referred from another medical center, with diagnosis of severe MVR. He arrived to said center hypotensive, reporting morning precordial pain, palpitations and dyspnea, with atrial fibrillation (AF) of high response and cardiogenic shock. He was sedated and intubated for mechanical ventilation (MV) and electrical cardioversion (ECV), having conducted ultrasound control previously and amiodarone load dose. In electrocardiogram (ECG) control, sinus rhythm was verified with lateral compromise. Transesophaeal echocardiogram (TEE) was conducted, confirming severe MVR by AL PMR, so he was referred.

He was admitted to our institution hemodynamically unstable, sedated, with inotropic and vasopressor support. Immediately, emergency coronary angiography (CAG) was carried out, which reports left main coronary artery (LMCA) with mild diffuse lesion; anterior descending artery (ADA) of good caliber, calcified, with severe segmental distal lesions after second diagonal artery (D2); circumflex artery (Cx) of medium caliber, with moderate to severe ostium disease and moderate to severe stenosis at the origin of the obtuse marginal artery; right coronary artery (RCA) with no significant lesions *(Figures 1 and 2).* When the study ended, intra-aortic balloon pump was placed, and the patient was moved to the OR for emergency surgery. During preparation, a probe was introduced for transesophageal echocardiogram (TEE), enabling to confirm massive bileaflet MVR by AL PMR.

Under general anesthesia, median sternotomy was carried out. Also, aortic cannulation in both venae cavae and venous sinus, and placement of aortic vent. Transseptal atriotomy was made following the Guiraudon approach. Papillary muscle head prolapse was observed *(Figure 3)*. Valve extraction and mechanical prosthesis number 29 replacement were carried out, partially preserving the posterior leaflet *(Figures 4 and 5)*. The time of extracorporeal circulation (ECC) was 139 minutes, with an aortic clamping time of 94 minutes. As myocardial protection, 1200 ml of Del Nido cardioplegic solution were used by anterograde pathway in aortic root and retrograde by cannula in the coronary sinus. Before declamping, bypass was carried with saphenous vein toward the ADA and lateral ventricular branch of the Cx artery. ECC completion with inotropic support.

Postoperative evolution was difficult to manage, as expected, characterized at first by vasoplegia, treated immediately after exiting the OR. Once the symptoms of the first days were under control, and sedation being decreased, with poor awakening, brain computed axial tomography (CAT) was conducted, yielding a diagnosis of stroke. Hypodense left occipital cortico-subcortical area was report-
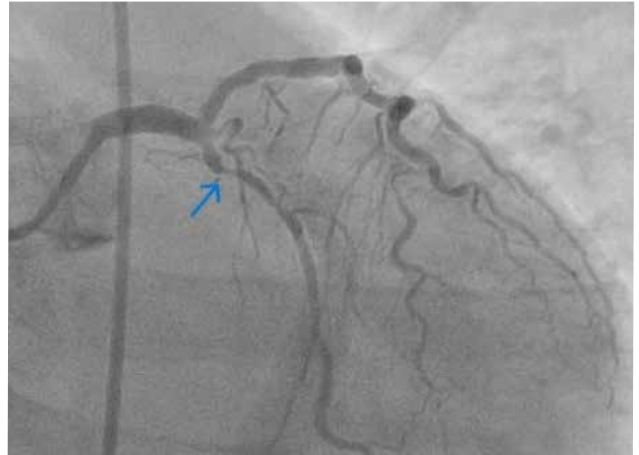
FIGURE 1
Anterior descending artery (ADA) lesion.

FIGURE 2
Obtuse marginal branch of the circumflex artery (Cx).

FIGURE 3
Prolapse of anterolateral papillary muscle head.

FIGURE 4
Anterior leaflet and papillary muscle head.

ed, with partial compromise of thalamic nucleous, compatible with ischemic focus of subacute evolution. He was sedated once again, and anticoagulation was started aiming at embolic cause; but it had to be suspended due to the stroke turning hemorrhagic. Massive transfusion was conducted, and electrical cardioversion was applied due to AF leading to decompensation. Extended intubation was not exempt from infection and led to tracheostomy. He also presented kidney failure, requiring dialysis. In spite of a failed attempt due to disorientation and bronchoaspiration, and extended mechanical ventilation with antibiotic treatment and rehabilitation, he was weaned from the breathing machine. He presented a favorable course, and he could move, with difficulties due to mild residual left brachiocrural hemiparesis. Finally, after a two-month hospitalization, with no drugs, and with improvement of kidney function and within oral anticoagulation range, he was discharged.
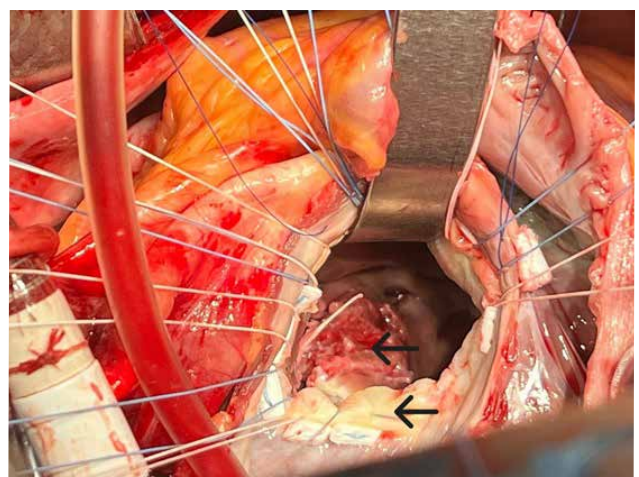

FIGURE 5
Mitral annulus with posterior leaflet preserved and papillary muscle rupture area.

DISCUSSION

PMR usually occurs within the first five days after AMI. Its incidence is of around 2.3% and presents a mortality of 80% within the first week and 94% within the first two months.[5] it could be the consequence of a new infarction in an untreated area, and in general lesions are small, subendocardial, with health tissue around.[1,2,3,4]

PM PMR is complicated with a frequency of three to six times above the AL one.[5,6,7] This is due to coronary flow. While PM is irrigated by the posterior descending artery (PDA), RCA or Cx branches according to dominance, the AL PM has circulation through the diagonal branch of the ADA and the lateral branch of the Cx.[4,5,6,7,8] Likewise, MVR and its symptoms are more severe in the AL PM lesion, which presents a single head; while the PM one is usually divided into two or more segments.[2,3]

Echocardiogram, both transthoracic and transesophagic, is very useful in the differential diagnosis of whether there is rupture or not of the papillary muscle, with a sensitivity ranging from 65% to 85%.[5,7,8,9] A previous CAG, when clinical symptoms allow it, is very useful for planning in the case revascularization is needed, as it influences the outcome.[4,5] The implant of intra-aortic balloon pump could be very useful in patients with severe hemodynamic compromise.[4]

Although PMR repair has been described, infarcted tissue being friable and its difficulty make the treatment of choice to be myocardial revascularization.[2,3] It was described for the first time in this context, in year 1965.[10] Concomitant coronary revascularization prevents the risk of new infarctions, decreasing the risk of mortality, which is estimated in 25% to 40%, depending on the preoperative hemodynamic state, and it improves survival in the long term.[4,7,11]

CONCLUSIONS

MVR due to PMR is a rare complication of AMI, even more so of AL PMR. An early diagnosis by TTE and emergency surgery with myocardial revascularization decrease the risk of mortality. The implant of intra-aortic balloon pump allows to improve the hemodynamic symptoms. CAG should be done as early as possible, to estimate a possible revascularization in the procedure.

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Clinical case

Caseous mitral annulus calcification. Case report.

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ARTICLE INFORMATION

ABSTRACT

Liquefactive necrosis of the mitral annulus is a benign process that can cause abnormal mitral valve function. Although its prevalence is low, this is probably explained by clinical and/or imaging underdiagnosis. For this reason, there is currently no consensus on the optimal management of this entity. It is considered a dynamic process, which may resolve spontaneously becoming mitral annulus calcification.

INTRODUCTION

Mitral annular calcification (MAC) is a chronic degeneration of the fibrous annulus of the mitral valve (MV), mainly affecting the posterior annulus.[1] It is a degenerative process, frequent in the population with an advanced age, in average 69 years, female, with hypertension (HTN) and type 1 diabetes (T1D), and/or in young patients with chronic kidney disease, alterations in calcium metabolism or severe MV prolapse. Liquefactive necrosis or caseous calcification of the mitral annulus (CCMA) is a variant of MAC, less known and rarely described.[2]

The most frequent location is the posterior annular region of the MV, unlike mitral annular calcifications, generally affecting the medium base of the posterior leaflet. It may also affect other segments of the mitral annulus, adopting U or C outlines.[3,4]

CLINICAL CASE

Female, 73-year-old patient, with HTN, dyslipidemia, type 2 diabetes (T2D), not requiring insulin, leading a sedentary life, with overweight (BMI 27), functional class I due to dyspnea. She was scheduled to be admitted to the *Sanatorio Británico* of the city of Rosario for a cardiovascular surgery of cardiac mass resection. Within the pre-surgical tests, physical examination was normal. Laboratory tests did not show significant anomalies, particularly inflammation markers (erythrocyte sedimentation rate and C-reactive protein were within normal limits); coronary angiography did not show angiographically significant lesions,

and echocardiogram showed: left ventricular end-diastolic diameter 47 mm, left ventricular end-systolic diameter 30 mm, LV ejection fraction 65%, interventricular septal thickness 10 mm, aortic root diameter 30 mm, left atrial anteroposterior diameter 27 mm, normal right chambers, mitral valve: in posterior leaflet, image of 30 mm x 15 mm with clear edges, homogeneous, echogenic, adhered to the leaflet body until its insertion, not affecting the subvalvular apparatus, generating mild mitral valve insufficiency.

Cardiac magnetic resonance imaging (MRI) displayed an oval mass of 35x15 mm in the posterior mitral annulus, ventricular wall, in the muscle insertion, with characteristics compatible with calcification. No edema or late enhancement was observed in the cardiac muscle *(Figures 1 and 2)*.

Surgery was made through median sternotomy, and extracorporeal circulation was implemented by the ascending aorta and bicaval cannulation. Myocardial protection was achieved by anterograde administration of Del Nido cardioplegic solution.

Mitral annulus and endocardial surface proximal to the annulus were macroscopically normal; but a large intramyocardial mass was observed, located in the region of the posterior mitral annulus, with calcium "crust" surrounding whitish matter of caseous appearance. An incision was made on the posterior mitral annulus; approximately 6 ml of caseous matter was drained *(Figure 3)*. The chamber was explored entirely, and the annular incision extended to P2, P3 and along the medial commissure, revealing a chamber compatible with CCMA *(Figure 4)*. Calcium and the caseous matter were removed from the annular chamber completely. The posterior mitral annulus was excised along the incision because it was necrotic and calcified. After the removal, the posterior mitral valve was reconstructed, using an autologous pericardial patch in the ventricular and atrial sides.
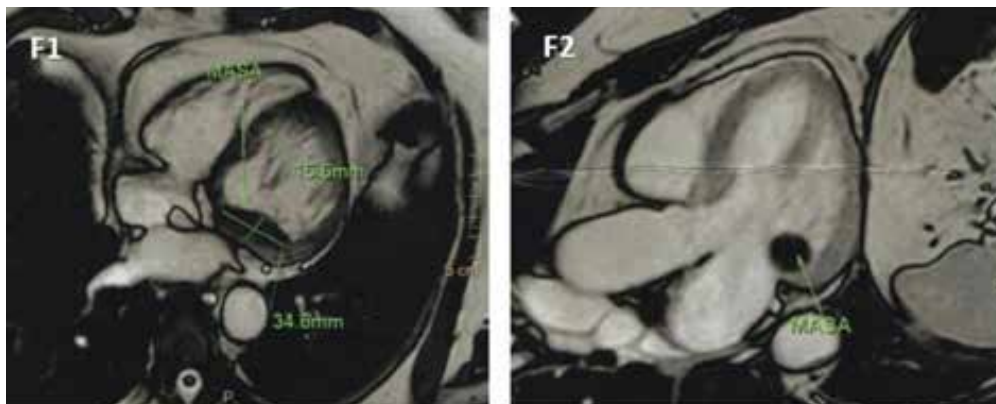
FIGURES 1 AND 2.
Cardiac Magnetic Resonance Imaging (MRI): oval mass in the posterior annulus, ventricular wall.
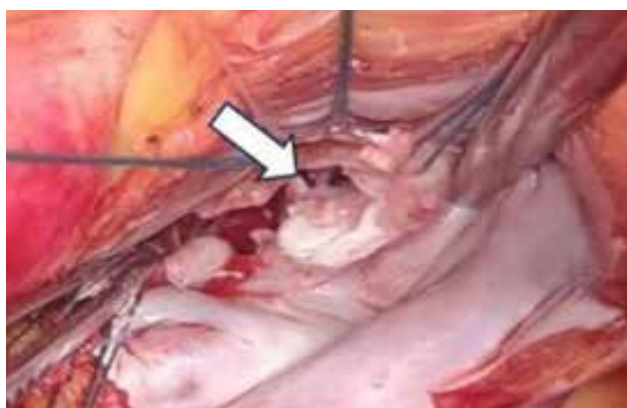

FIGURE 3.
Caseous collection in the posterior mitral annulus.

FIGURE 4.
Caseous calcification of the mitral annulus (CCMA).

Later, the MV was replaced, preserving the subvalvular apparatus, corresponding to segments A1, A3 and P1. It was not possible to preserve the subvalvular apparatus corresponding to segments P2 and P3. An N 27 biological mitral prosthesis was implanted, and later the patient was separated from the cardiopulmonary bypass with no problems. The intraoperative transesophageal echocardiogram showed a proper operation of the mitral valve prosthesis and a decrease in the annular chamber size. The biopsy of the extracted matter reported an acellular core region, surrounded by eosinophils, macrophages and lymphocytes, characteristic of caseous matter, with multiple calcifications and necrosis areas in the periphery. During the postoperative period, she coursed with no complications and was discharged 72 h after the surgical procedure. Currently, she remains asymptomatic.

DISCUSSION

MAC usually starts between the posterior atrioventricular groove and the base of the posterior mitral leaflet, although it may affect the whole annulus. CCMA is a rare evolution of a calcified mitral annulus due to caseous transformation of the internal matter[5]. The precise mechanism involved in liquefaction and caseification is not known clearly, although it is believed that macrophages loaded with lipids may be involved in said process.[2,3]

It has been described that patients in dialysis, with altered calcium-phosphate metabolism, present conditions related to the development of caseous necrosis.[6]

Although the exact prevalence of this pathology is unknown; bibliographic data show a prevalence of MAC of 10.6%; while only 0.64% correspond to CCMA.[3] In a study of necropsies, the prevalence of MAC is 2.7%.[1] This discrepancy, is probably due to clinical and imaging underdiagnosis.[7]

Multimodal use of images is the study methodology for this pathology. Although the sensitivity and specificity of each method is unclear, Doppler echocardiogram is the first-line study, where CCMA is characterized by an anechoic center, with cystic appearance, surrounded by a hyperechoic calcified annulus, which does not usually produce acoustic shadow; however, when this calcification is thick, it produces ultrasound beam attenuation.[2] In cardiac CT, CCMA appears as a rounded or semilunar mass, surrounded by a calcified capsule, whose content is of variable density.[8]

Cardiac MRI is considered the technique of choice in doubtful cases. The most frequent findings include a well-defined mass with hyperintense center and hypointense edge, isolated from the adjacent myocardium and the posterior mitral valve in contrast-enhanced T1-weighted fast spin-echo images.[9]

Although it is considered a benign process, it may cause an abnormal flow through the MV, associated to chronic MI, and less likely, to mitral valve stenosis. The most common clinical manifestations are: palpitations and dyspnea; in some cases, syncope (secondary to atrioventricular blocks) due to the closeness of the atrioventricular node and the conduction system.[3,7]

Systemic embolisms have been described, leading to strokes, retinal artery occlusion and acute coronary syndrome. Embolization mechanisms include migration of small calcified pieces secondary to surface ulceration.[3,5]

The most important challenge is to carry out a differential diagnosis, since it should be done with other cardiac masses such as tumors (most commonly myxomas), abscesses and vegetations. Therefore, the clinical context and using multimodal imaging are fundamental in the process of decision-making.[8,10,11,12]

Currently, there is no consensus on the optimal management of this entity, as it is considered a dynamic process, that could resolve spontaneously, becoming a MAC or evolving with the previously mentioned complications. Current data suggest a conservative medical treatment when diagnosis is certain and there are no hemodynamic alterations in the MV.[6]

Surgical intervention indications include: valve dysfunction, embolisms or impossibility to rule out a tumor. The latter was the reason why in this case surgery was chosen.

As to the type of procedure, mitral valve replacement is preferred to repair, since an aggressive removal may increase the risk of left ventricular puncture, and cardiac chamber unroofing only would still expose necrotic remains to the systemic blood flow.[6] For this reason, a technique of non-reversible annular suture is advised.

CONCLUSIONS

MAC is a chronic degeneration of the fibrous annulus of the mitral valve, and CCMA is a rare evolution of a calcified mitral annulus due to caseous transformation of the internal matter. This case highlights the importance of a multidisciplinary, clinical-imaging-surgical approach to define the best treatment strategy.
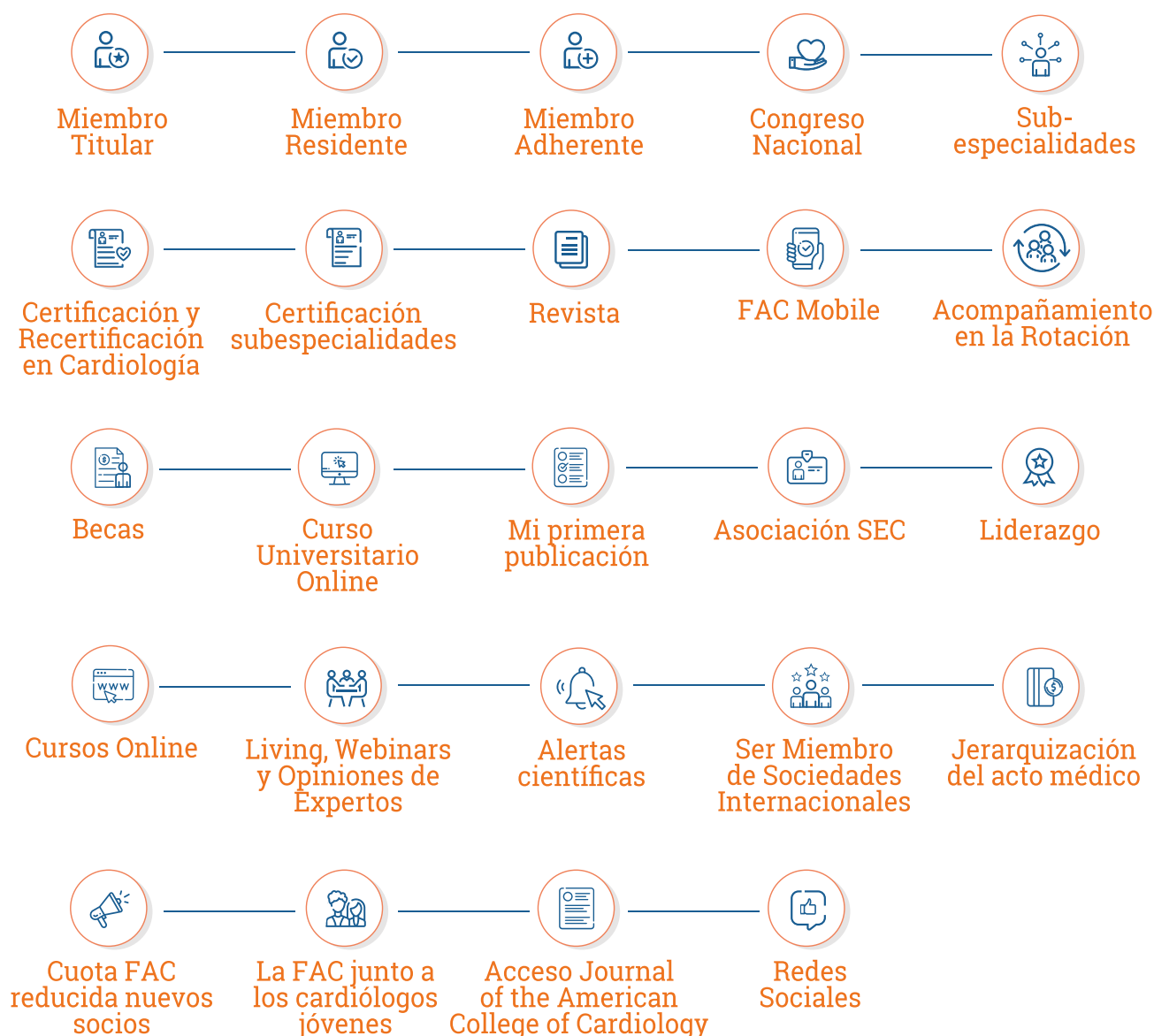
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