ORIGINAL ARTICLE

Results from the Argentine Registry of Cardiovascular Surgery ARGEN-CCV

Resultados del Registro Argentino de Cirugía Cardiovascular ARGEN-CCV

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ABSTRACT

Background: Cardiovascular surgery (CVS) is an essential tool in the treatment of heart disease, and its practice has undergone changes in recent years. In our setting, we have registries on CVS, but they date back more than 10 years. For this reason, a new study was required to understand the reality of CVS in Argentina.
Objective: The aim of this study was to evaluate the preoperative and operative characteristics and in-hospital course of patients undergoing CVS.
Methods: We conducted a prospective, multicenter cross-sectional study over a 13-month period (from July 2021 to August 2022), including consecutive patients > 18 years who underwent central CVS.
Results: A total 1515 patients were analyzed; 79% underwent elective surgery, 19% underwent urgent surgery, and 2% underwent emergency surgery. The types of surgery performed were coronary artery bypass grafting (CABG) in 46% of cases, heart valve surgery in 32%, combined surgeries in 19%, and ascending aorta surgeries in 3%. Mean age of patients was 64 ± 11 years, and 75% were male. Most (75%) surgeries used cardiopulmonary bypass (CPB); median (interquartile range, IQR) CPB time was 100 minutes (75-123) and median aortic cross- clamp time was 71 minutes (50-94). Compared with previous registries, there was a higher proportion of left main coronary artery disease, heart valve surgeries and combined procedures, in addition to the inclusion of aorta surgeries. The most common complications were atrial fibrillation (24%), low cardiac output syndrome (16%), renal failure (13%), and postoperative bleeding (10%). Overall mortality was 9.1%.
Conclusion: The ARGEN-CCV registry included more complex cases than previous registries. Overall in-hospital mortality was high, probably due to the level of complexity and the atypical context of the COVID-19 pandemic.

Key words: Cardiovascular surgery - Registry - Surgical outcomes

RESUMEN

Introducción: La cirugía cardiovascular (CCV) es una herramienta fundamental en el tratamiento de las enfermedades cardíacas y su práctica ha experimentado cambios en los últimos años. En nuestro medio tenemos registros sobre CCV pero de hace más de 10 años. Por ese motivo surgió la necesidad de realizar un nuevo estudio para conocer la realidad de la CCV en Argentina.
Objetivo: El objetivo de este trabajo fue evaluar las características prequirúrgicas, quirúrgicas y la evolución intrahospitalaria de pacientes que fueron sometidos a una CCV .
Material y métodos: Se realizó un estudio multicéntrico de corte transversal de 13 meses de duración (julio 2021 a agosto 2022) prospectivo, en que pacientes mayores de 18 años que se realizaron una CCV central fueron incluidos de manera consecutiva. Quedaron excluidas del registro las cirugías para reparación de cardiopatías congénitas y procedimientos periféricos, como así los casos de cirugías cardiovasculares debidas a trauma.
Resultados: Se analizaron 1515 pacientes de los cuales el 79 % recibieron cirugía programada, 19 % fueron de urgencia y 2 % de emergencia. Los tipos de cirugías practicadas fueron cirugía de revascularización miocárdica (CRM) 46 %, cirugía valvular 32 %, cirugías combinadas 19 % y un 3 % de cirugías de aorta ascendente. La edad media de los pacientes fue de 64 ± 11 años y el 75 % de los pacientes fue de género masculino. La mayoría (75 %) de las cirugías utilizaron circulación extracorpórea (CEC), la mediana (rango intercuartilo, RIC) del tiempo de CEC fue de 100 minutos (75-123) y la mediana del tiempo de clampeo aórtico fue de 71 minutos (50-94). En comparación con registros previos hubo mayor proporción de lesión de tronco de coronaria izquierda, cirugías valvulares y combinadas, y fueron incluidas cirugías de aorta. Las complicaciones más frecuentes fueron la necesidad de vasoactivos (72 %), la fibrilación auricular (24 %), el síndrome de bajo gasto cardíaco (16 %), la insuficiencia renal (13 %) y la hemorragia posoperatoria (10 %). La mortalidad global fue del 9,1 %.
Conclusión: En el registro ARGEN CCV se observaron casos más complejos que en los registros previos .La mortalidad general intrahospitalaria fue elevada, probablemente por el nivel de complejidad y el contexto atípico de la pandemia de COVID-19.

Palabras clave: Cirugía cardiovascular - Registro - Resultados quirùrgicos

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INTRODUCTION

Cardiac surgery is an area of medicine that has undergone remarkable development over recent decades, and Argentina is no exception. Cardiovascular surgery (CVS) and its postoperative care hold an outstanding position in clinical cardiology. This is because advances in surgical techniques, whether exclusively surgical, hybrid techniques (using percutaneous and surgical approaches), or minimally invasive procedures, require detailed knowledge of the processes involved in proper postoperative recovery. (1,2)

Over the last decade, percutaneous techniques have experienced significant progress, particularly in the field of aortic stenosis, opening the door to treating other conditions in a similar manner, which indicates a promising future. (3-5) Despite this, CVS is the procedure of choice in many clinical situations and the only possible approach in different clinical scenarios. Based on this, the characteristics of patients eligible for surgical techniques, the maneuvers, and the materials used vary over the years, and clinical registries are conducive to publicizing and analyzing these aspects. Furthermore, they help us understand the outcomes of interventions in real-life settings, as clinical trials often lack representativeness of the population, and their applicability to different populations is therefore unknown. Another important point is that results may vary within the same city, within a country, and, of course, in relation to other countries. Another important aspect is that the results may vary within the same city, within a country, and, obviously, in relation to other countries. Therefore, it is essential to have local records to understand the reality of cardiovascular surgery in areas of particular interest, such as in-hospital outcomes and mortality, among others, which permit comparison with data published in previous and international registries. Finally, they enable the development of risk prediction scores such as the EuroSCORE and the Society of Thoracic Surgeons (STS) score. (6,7) Argentina followed suit with the development of the ArgenSCORE, which was made possible by the history of national CVS records. (8,9)

It is well known that percutaneous coronary interventions have gained ground as a revascularization technique. For this reason, patients who are not candidates for these procedures, either due to their anatomical characteristics or difficulty of approach, currently undergo surgery in a more complex context. This advancement raises questions about the contemporary characteristics of patients undergoing CVS surgery and their outcomes. (10)

It is important to highlight that the registry period encompassed part of the SARS-CoV-2 pandemic, including the conclusion of the lockdown phase.

In this context, the Argentine Society of Cardiology, in conjunction with the Argentine College of Cardiovascular Surgeons, conducted a new study on cardiovascular surgery with the aim of determining the characteristics of patients undergoing central cardiovascular surgery and their in-hospital outcome based on the National Registry of Cardiovascular Surgery in Argentina (ARGEN-CCV).

Objectives

The aim of this study was to evaluate the preoperative and operative characteristics and in-hospital course of patients who underwent central cardiovascular surgery.

METHODS

The Argentine National Registry of Cardiovascular Surgery (ARGEN-CCV) was a cross-sectional, multicenter study conducted over 13 months, from July 2021 to August 2022. Patients were recruited from 48 public and private centers. Institutions with central cardiovascular surgery capabilities were invited to voluntarily participate. Data were collected on the REDCap platform, and the audit was performed using pre-established parameters on the platform to evaluate consistency and avoid missing data. No financial compensation was provided to the participating centers or researchers. The inclusion criteria were patients > 18 years admitted to the institution on an elective, urgent, or emergency basis for central cardiovascular surgery. These included coronary artery bypass grafting (CABG) surgery, heart valve surgery, combined surgery, and ascending aorta surgery. Surgeries for congenital heart defects, peripheral vascular surgery, and surgery due to trauma were excluded from the registry. Preoperative, operative, and postoperative data were obtained during the hospitalization period. The study was registered at ClinicalTrials.gov NCT0519916.

Statistical analysis

Continuous variables with normal distribution were presented as mean ± standard deviation, and those with non-Gaussian distribution as median and interquartile range (IQR 25-75). Qualitative variables were expressed as percentages. Comparisons between groups were performed using Student's t-test or Wilcoxon test according to the distribution for continuous data, and 2x2 tables were used, as well as the chi-square test with Yates's correction for continuity for categorical variables. A p-value < 0.05 was considered statistically significant. The analysis was performed in R.

Ethical considerations

The ARGEN-CCV registry protocol was approved by the ethics committee of the Argentine Society of Cardiology.

RESULTS

A total of 1515 patients were enrolled in the registry, of whom 1202 underwent elective surgery (79%), 282 (19%) underwent urgent surgery, and 27 (2%) underwent emergency surgery. The types of surgeries performed were CABG in 700 cases (46%), heart valve surgery in 480 (32%), aorta surgery in 48 (3%), and combined procedures in 287 (19%). The mean age of the patients was 64 ± 11 years, and 75% were male. The risk factors included 77% of patients with hypertension, 29% with diabetes mellitus, 54% with dyslipidemia, and 16% who were active smokers. The body mass index was 28 kg/m² (IQR 23–33). In terms of clinical history, 13% had a previous heart attack, 15%

had heart failure, and 16% had moderate to severe ventricular dysfunction. Regarding prior CVS, 5% of patients had a history of CABG surgery, and 6% reported heart valve surgery. Regarding the assessment of surgical risk, the EuroScore predicted a median mortality of 1.5% (IQR 0.9–2.9), while the ArgenScore predicted a median mortality of 2.33% (IQR 1.1–4.7) (Table 1).

Cardiopulmonary bypass (CPB) was used in 75% of cases (Table 2). Median CPB time was 100 minutes (IQR 75-123) and median aortic cross-clamp time was 71 minutes (IQR 50-94).

The median duration of mechanical ventilation was 4 days, which had an inevitable impact on the median length of hospital stay (8 days; IQR 6-13). There were no significant differences in the outcomes of patients extubated within the first 6 hours compared to those who remained on mechanical ventilation beyond that time.

The most common postoperative complications found were atrial fibrillation (24%), low cardiac output syndrome (16%), renal failure (13%) (of which about one-third required dialysis), and postoperative bleeding (10%), most commonly due to clinical conditions. (See supplementary material)

Overall mortality was 9.1% (Table 3). Mortality by type of surgery was 6.8% after CABG, 7.9% after heart valve surgery, 30.4% after ascending aorta interventions, and 13% after combined procedures. Finally, when mortality was explored according to the urgency of the intervention, mortality rates for elective, urgent and emergency procedures were 7.9%, 11.3%, and 38.5%, respectively ($p<0.001$) (Table 4).

DISCUSSION

The ARGEN-CCV registry presents the results of cardiovascular surgery in Argentina after more than a decade since the last available data on the subject.

Our previous local registries were CONAREC III, which collected data of 1293 patients from 41 healthcare centers in Argentina in 1993, ESMUCICA, which recruited 2125 patients from four institutions in Buenos Aires between 1996 and 1997, and CONAREC XVI, which was carried out in 49 centers and recorded 2553 cases between 2007 and 2008. (11-13)

The distinctive feature of this project was that it took place during the unexpected SARS-CoV-2 pandemic. IIt should be noted that conducting the study during this period was not the objective; it was merely a coincidence. Therefore, the information was not collected for the purpose of analyzing the results of CVS in this particular context.

Nevertheless, 85 centers from 17 provinces were registered, though only about half actively participated by including at least one case (see supplementary material). In this study, nearly 80% of cases were elective surgeries. The remaining cases were urgent or emergency surgeries due to critical cardiac conditions.

Table 1. General preoperative characteristics

	n= 1515
Age, mean (SD)	64 (±11,4)
Male gender, %	74,6
Hypertension, %	77,2
Diabetes mellitus, %	29,3
Dyslipidemia, %	54,4
Current smoking, %	16,1
Chronic stable angina, %	11,7
History of myocardial infarction, %	12,7
History of heart failure, %	15,1
History of percutaneous coronary intervention, %	12,2
History of CABG surgery	4,6
History of heart valve surgery, %	5,6
History of stroke, %	4,8
History of moderate-severe COPD, %	8
History of peripheral vascular disease, %	9,5
History of left ventricular dysfunction, %	16,3
Mortality calculated by EuroSCORE, median (IQR)	1,5 (0,9-2,9)
Mortality calculated by ArgenSCORE, median (IQR)	2,33 (1,1-4,7)

CABG: coronary artery bypass grafting; COPD: chronic obstructive pulmonary disease; IQR: interquartile range; SD: standard deviation

Compared to previous records, the prevalence of diabetes mellitus has steadily increased, which is consistent with other sources, such as the national household survey. (14-16) In addition, we have observed a high percentage of patients undergoing CABG with left main coronary artery disease (38.1%), as previously published. (17) This observation contrasts with rates of 28.4% in the CONAREC XVI registry, 19% in the ESMUCICA registry, and 17.1% in the CONAREC III registry.

When the operative characteristics were analyzed, the procedures requiring CPB exhibited shorter times compared to those reported by previous registries. In the ARGEN-CCV registry, the CPB time was 90 minutes (IQR 70-110 minutes) during CABG surgery, compared to 98 minutes in the ESMUCICA registry and 96 minutes in the CONAREC III registry. A similar finding was observed with heart valve surgeries. (11-13)

A high rate of vasoactive drug use was observed during postoperative care, and one-third of patients entered the recovery room extubated. This latter data is available for the first time in national registries.

Atrial fibrillation was the most common postoperative complication. The incidence of low cardiac output syndrome was slightly lower than that reported in the CONAREC XVI registry, and renal failure remained at a similar incidence as in previous reports, with approximately 30% requiring dialysis. Postoperative bleeding requiring transfusions occurred in around 10% of patients, which appears to remain at historical levels.

Table 2. Operative data

	n= 1515
Need for surgery, % -Elective -Urgent -Emergency	 79,5 18,7 1,8
Type of surgery, % -CABG surgery -Valve surgery -Aortic surgery -Combined surgery	 46,2 31,7 3,2 18,9
Use of CPB, %	74,9
CPB time, median (IQR)	100 (75-123)
Aortic cross-clamp time, median (IQR)	71 (50-94)

CABG: coronary artery bypass grafting; CPB: cardiopulmonary bypass; IQR: interquartile range

Table 3. Postoperative complications

	n= 1515
Intubation duration in days, median (IQR)	4 (2-10)
Atrial fibrillation, %	24,0
Postoperative myocardial infarction, %	3,3
Low output syndrome, %	15,7
Renal failure , %	13,4
Bleeding, % -Medical bleeding -Surgical bleeding	10,6 62,7 37,3
Mediastinitis, %	0,9
Sepsis, %	6,0
Stroke, %	3,3
Length of hospital stay, median (IQR)	8 (6-13)
Mortality, %	9,1

IQR: interquartile range

Table 4. Mortality according to type and necessity of surgery

	Elective	Urgent	Emergency	p-value
Type of surgery, %				
-CABG	40,8	70,6	33,3	
-Heart valve	36,4	14,2	7,4	
-Aorta	2,5	2,5	40,7	
-Combined	20,5	13,5	18,5	
Mortality, %	7.9	11.3	38.5	<0.001

CABG: coronary artery bypass graft

Table 5. Comparison of Argentine cardiovascular surgery registries

	Argen-CCV n = 1515 (2021-22)	CONAREC XVI n = 2553 (2007-08)	ESMUCICA n = 2125 (1996-97)	CONAREC III n = 1293 (1992-93)
Age, mean (SD)	64 (±11)	63 (±11)	-	
Male, %	1130 (74,6)	1912 (74,9)	1558 (73)	1045 (80,8)
Hypertension, n (%)	1168 (77,2)	1948 (76,3)		754 (58,3)
Smoking habits, n (%)	235(15,5)	987 (38,3)		720 (55,7)
Dyslipidemia, n (%)	821 (54,4)	1443 (56,5)		744 (57,5)
Diabetes, n (%)	442 (29,3)	635 (24,9)	354 (16,6)	272 (21)
History of CHF, n (%)	229 (15,1)	453 (17)		64 (5)
COPD, n (%)	124 (8)	240 (9,4)		
CABG surgery, n (%)	700 (46,2)	1465 (57,4)	1493 (70)	1293 (100)
Heart valve surgery, n (%)	480 (31,7)	528 (20,7)	395 (18,6)	
Combined surgery, n (%)	287 (18,9)	312 (12,2)	176 (8,3)	
Moderate/severe left ventricular dysfunction, n (%)	246 (16,3)	607 (23,8)	275 (13)	541 (42)
Overall mortality, n (%)	134 (9,1)	196 (7,7)	110 (5,1)	152 (11,7)

CABG: coronary artery bypass grafting; CHF: congestive heart failure; COPD: chronic obstructive pulmonary disease

The mortality rate by type of surgery was 6.8% for CABG (previously published), while aorta surgeries had the highest mortality rate at 30.4%. This is the first national registry to report on these types of procedures, which are characterized by their technical complexity. Most of these surgeries were performed in an emergency context, which could explain the high mortality rate. Heart valve procedures had a mortality rate of 7.9%, while combined surgeries had a rate of 13%. Compared with previous studies, our registry included a higher proportion of heart valve and combined surgeries (Table 5). In this context, the overall mortality rate was 9.1%. This figure is higher than that of the last registry, the CONAREC XVI, conducted more than ten years ago. Several factors should be discussed in detail. As previously noted, patients in the ARGEN-CCV registry had a higher prevalence of left main coronary artery disease, diabetes, heart valve surgeries, and combined procedures. Additionally, the registry was conducted in the unique context of the COVID-19 pandemic. Specifically, part of the study population entered the registry during the period in which mandatory preventive social distancing was in effect, as decreed by the national executive branch. This had direct consequences for social behavior and affected the dynamics of the healthcare system, as documented in international and local reports (18–23). For this reason, it is difficult to assert that the characteristics of patients currently undergoing cardiac surgery are more complex than those in previous studies, because only the most complex cases could be operated on during the pandemic. A different sampling strategy might have mitigated this potential selection bias. In this registry, the cases that proceeded to surgery were more complex and were treated and recovered under atypical healthcare conditions. We cannot rule out that these factors contributed to the observed mortality.

Two of the most commonly used perioperative scores, the EuroSCORE and the ArgenSCORE, were measured in the study population. While this study

was not designed to validate these scores, the predicted mortality was clearly lower than the observed mortality. However, it has been noted in the literature that the EuroSCORE may underestimate mortality in populations other than the one for which it was developed. (24, 25).

One weakness of this registry was the lack of sampling planning in line with the circumstances of the pandemic. As previously stated, the objective was not to analyze cardiac surgery performance during the pandemic. Despite the stress on the healthcare system, the participating centers made an extra effort to contribute. However, even with voluntary participation, data collection could have been structured differently when considering these variables. As in previously published registries, variability among participating centers must also be acknowledged. Consequently, it is evident that the results do not reflect the reality of all institutions. It is reasonable to assume that a greater number of participating centers would be necessary to validate the findings of this registry.

CONCLUSIONS

The ARGEN-CCV registry included more complex patients than in previous studies, with severe left main coronary artery involvement, a higher proportion of heart valve surgeries and combined procedures, and ascending aorta surgeries (not included in previous registries). The overall in-hospital mortality was high, probably due to the level of complexity already described and the atypical context of the COVID-19 pandemic The ARGEN-CCV registry included more complex patients than in previous studies, with more frequent left main coronary artery involvement, a higher proportion of heart valve surgeries and combined procedures, and ascending aorta surgeries (not included in previous registries). The overall in-hospital mortality was high, probably due to the level of complexity already described and the atypical context of the COVID-19 pandemic.

Conflicts of interest

None declared.

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

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SUPPLEMENTARY MATERIAL. Complications

Definitions	
Postoperative bleeding	500 mL in the first hour or > 400 mL in the second hour or > 300 mL in the third hour or > 200 mL in the fourth hour or > 100 mL in the fifth hour
Right ventricular dysfunction	Persistent hypotension, elevated (right atrium) ventricular filling pressures, low cardiac output requiring pharmacological and possibly mechanical intervention (TAPSE <17 mm or visually assessed RV dysfunction on echocardiography)
Low cardiac output syndrome	Systolic blood pressure < 90 mmHg, pale and cold skin, poor capillary refill, clouding of consciousness and oliguria, cardiac index < 2.2 L/min/m^2, pulmonary capillary pressure > 18 mmHg requiring inotropic agents and/or intra-aortic balloon pump (IABP)
Renal failure	Increase in creatinine levels > 50% of baseline value and/or requirement for hemodialysis
Stroke	Focal and/or diffuse brain injury confirmed by clinical findings and/or computed tomography scan with motor or sensory deficits at patient discharge
Psychiatric disorders	Any of the following: delirium, hallucinations, psychomotor agitation
Respiratory distress syndrome	Infiltrate in 4 quadrants - wedge < 18 mm Hg - PA/FI ratio < 200
Sepsis	Suspected or documented infection with target organ dysfunction and at least two of the following criteria: temperature > 38 °C°C or < 36 °C, white blood cell count greater than 12,000 uL or less than 4000 uL, tachycardia, tachypnea > 30 bpm, altered mental status, positive culture from primary site of infection, mean arterial blood pressure less than 70 mm Hg for at least two hours, poor distal perfusion

Participanting Ccnters

CEMIC, Autonomous City of Buenos Aires
Centro Gallego, Autonomous City of Buenos Aires
Clínica Bazterrica, Autonomous City of Buenos Aires
Clínica Colón, Mar del Plata, Province of Buenos Aires
Clínica Pasteur, Province of Neuquén
Clínica San Jorge, Province of Tierra del Fuego
Clínica Santa Clara, Province of Mendoza
Clínica Santa Isabel, Autonomous City of Buenos Aires
Clínica Zabala, Autonomous City of Buenos Aires
Fundación Favaloro, Autonomous City of Buenos Aires
Fundación para la Salud / Sanatorio San Roque de Salta / Hospital Privado Santa Clara de Asís, Province of Salta
HIEAYC San Juan de Dios, La Plata, Autonomous City of Buenos Aires
Hospital Alemán, Autonomous City of Buenos Aires
Hospital Británico, Autonomous City of Buenos Aires
Hospital Churruca, Autonomous City of Buenos Aires
Hospital Cosme Argerich, Autonomous City of Buenos Aires
Hospital de Clínicas José de San Martín, Autonomous City of Buenos Aires
Hospital Dr. Alberto Duhau, Autonomous City of Buenos Aires
Hospital Dr. César Milstein, Autonomous City of Buenos Aires
Hospital Italiano de Mendoza, Province of Mendoza
Hospital Privado de Mar del Plata, Mar del Plata, Autonomous City of Buenos Aires
Hospital Público descentralizado Dr. Guillermo Rawson, Province of San Juan
Hospital Santojanni, Autonomous City of Buenos Aires
Hospital Sirio Libanés, Autonomous City of Buenos Aires
Hospital Universitario Austral, Pilar, Autonomous City of Buenos Aires
Instituto Cardiovascular de San Luis, Province of San Luis
Instituto de Cardiología de Corrientes, Province of Corrientes
Instituto de Cardiología de Rosario "Dr. Luis González Sabathie", Rosario, Province of Santa Fe
Instituto Modelo de Cardiología Privado, Province of Córdoba
Leben Salud, Cipolletti, Province of Rio Negro
Policlínico Bancario, Autonomous City of Buenos Aires
Sanatorio Adventista del Plata, Province of Entre Ríos
Sanatorio Allende, Province of Córdoba
Sanatorio Anchorena San Martín, Autonomous City of Buenos Aires
Sanatorio Británico, Rosario, Province of Santa Fe
Sanatorio de la Cañada, Province of Córdoba
Sanatorio de la Trinidad Mitre,
Sanatorio de la Trinidad Quilmes, Province of Buenos Aires
Sanatorio de la Trinidad Ramos Mejía, Autonomous City of Buenos Aires
Sanatorio del Salvador, Province of Córdoba
Sanatorio Delta, Province of Santa Fe
Sanatorio Güemes ACE, Province of Chaco
Sanatorio Juan XXIII, Gral. Roca, Province of Río Negro
Sanatorio Dr. Julio Méndez, Avellaneda, Autonomous City of Buenos Aires
Sanatorio Pasteur, Province of Catamarca
Sanatorio Sagrado Corazón, Autonomous City of Buenos Aires
Sanatorio San Martín, Venado Tuerto, Province of Santa Fe