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Original Article

Analysis of cardiac surgeries and operative mortality at the Instituto Nacional Cardiovascular during 2022

Gerber Polo-Gutierrez[1,a], **Harod Anders Silva-Tejada**[1,a], **Franklin Willy Martinez-Ninanqui**[1,a], **Victor Robles-Velarde**[1,b], **Josías Ríos-Ortega**[1,b]

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Authors' Affiliation
[1] Instituto Nacional Cardiovascular, Lima, Peru.
[a] Physician, Thoracic and Cardiovascular Surgery Resident
[b] Cardiovascular Surgeon

Correspondence
Gerber Polo-Gutiérrez

E-mail
ger1425.gp@gmail.com

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RESUMEN

Objective. To describe cardiac surgeries, their approaches, and determine operative mortality according to the type of surgery and the main complications recorded within 30 days postoperatively, performed at the National Cardiovascular Institute of Peru. **Materials and methods.** A descriptive study was conducted on all patients over 18 years of age who underwent cardiovascular surgery at the Instituto Nacional Cardiovascular "Carlos Alberto Peschiera Carrillo". **Results.** During the year 2022, a total of 503 cardiac surgeries were performed. Of the patients undergoing surgery, 63.6% (320) were males. Isolated valvular surgery, primarily aortic or mitral valve replacement, was the most frequent surgical procedure, with 136 surgeries (27.0%). This was followed by myocardial revascularization surgery with 110 procedures (21.9%). Throughout the year, there were 23 deaths, resulting in an overall mortality rate of 4.5%. The mortality rate for elective surgeries was 2.8%, while for emergency surgeries, it was 14.3%. The most common complication was paroxysmal atrial fibrillation (14.0%), followed by surgical site infection with 52 cases (10.3%). **Conclusions.** Valvular surgery, whether isolated or combined with other procedures, was the most frequently performed. The obtained mortality rate is considered acceptable for a reference center.

Keywords: Cardiac Surgical Procedures; Clinical Evolution; Peru (source: MeSH-NLM).

Introduction

Cardiovascular diseases (CVD) represent the leading cause of death worldwide, accounting for approximately 17.5 million deaths each year, of which 80% occur in low and middle-income countries [1]. Despite their high prevalence in these regions, there is a scarcity of precise and high-quality data, which may potentially underestimate the true magnitude of the problem worldwide. Cardiac surgery has recently been recognized as an integral part of national health systems; however, the Global Initiative for Cardiac Surgery indicates that nearly 6 billion people worldwide do not have access to safe cardiac surgical care when they need it [2].

The COVID-19 pandemic has further exacerbated health inequalities on a global scale. For instance, in Africa, it is estimated that there is only 1 cardiothoracic surgeon for every 4 million inhabitants [3]. This situation highlights the urgent need to incorporate cardiac surgery into the surgical plans of each country. To ensure access to cardiac surgical care for those without it, proper mapping of the state of cardiac surgery at the national level is crucial. Peru, cardiac surgery is predominantly concentrated in Lima, particularly in social security hospitals, due to resource scarcity in public hospitals [4,5]. The National Cardiovascular Institute of Peru serves as the primary referral center in the country for the treatment of cardiovascular diseases.

However, since its establishment in the 1990s, no research has been published on the outcomes of surgical treatment for these conditions. Therefore, the aim of the present study is to describe the main cardiac surgeries, their approaches, and determine operative mortality according to the type of surgery and the main complications recorded up to 30 days post-surgery performed at the National Cardiovascular Institute of Peru.

Materials and methods

Design and study population

A descriptive study was conducted using the surgical records from the Cardiovascular Surgery Department of the National Cardiovascular Institute "Carlos Alberto Peschiera Carrillo" and the clinical records program of EsSalud (SGSS). The institute serves as a specialized national referral center under the social security system in Peru (EsSalud) for the treatment of highly complex cardiovascular diseases, and it is located in Lima, the capital of Peru.

The study population included all patients over 18 years old who underwent cardiovascular surgery during the period from January 1 to December 31, 2022. All patients operated on during this period were included, without any exclusions.

Variables

The following variables of interest were included:

Type of surgery. The following subtypes of surgeries were analyzed: valvular surgery, involving one or more procedures on the heart valves; coronary surgery, isolated coronary artery bypass procedure; coronary surgery with multi-arterial grafts, involving two or more distal anastomoses with arterial conduits (mammary artery plus radial artery or double mammary artery); combined valvular surgery, procedures combining valvular and coronary surgery; aortic surgery, encompassing various conditions such as dissection, penetrating ulcer, intramural hematoma, aneurysm, and pseudoaneurysm; and other miscellaneous procedures with extracorporeal circulation (EC), including cardiac tumor surgery, hypertrophic cardiomyopathy, removal of infected pacemaker leads, and pulmonary thromboendarterectomy.

Operative mortality. Defined as all deaths, regardless of the cause, that occur during the hospitalization in which the operation was performed, even after 30 days.

Postoperative complications. Prolonged mechanical ventilation, defined as intubation lasting more than 48 hours in the postoperative period; stroke, confirmed by clinical suspicion and brain tomography; excessive bleeding, requiring surgical re-intervention for exploration and hemostasis review; Cardiac reoperation, involving a second operation with CPB to address surgical complications within the first 30 days after surgery; myocardial infarction, defined according to the fourth universal definition of myocardial infarction; mediastinitis, a deep surgical site infection requiring surgical re-intervention for cleaning.

Statistical analysis

The data were processed using the Microsoft Excel program and Stata version 15 (Stata Corporation, College Station, Texas, USA). Categorical variables are presented as absolute frequencies and percentages, whereas quantitative variables are presented as median and interquartile range (IQR) due to their non-normal distribution.

Ethical aspects

The ethical principles of the Declaration of Helsinki were respected, and all patient data are anonymous.

Results

A total of 503 cardiac surgeries were performed in 2022, of which 320 (63.6%) were conducted on male patients. Among the entire group of operated patients, 106 (21.0%) were below the age of 50, 75 (14.9%) were aged between 50 and 59, 165 (32.8%) were aged between 60 and 69, 140 (27.8%) were aged between 70 and 79, and 17 (3.3%) were above the age of 80.

Table 1 presents the volume of surgeries performed during each month of 2022. It is evident that the initial months of the year experienced a lower number of surgeries due to the gradual reactivation of healthcare activities after the strict lockdown period during the COVID-19 pandemic. Isolated valve surgery (mainly aortic or mitral valve replacement) was the most frequent surgical procedure, accounting for a total of 136 surgeries (27.0%). This was followed by myocardial revascularization surgery (coronary bypass) with 110 procedures (21.9%). It is noteworthy that 12 heart transplants were conducted throughout the entire year (2.4%).

Table 2 provides a detailed breakdown showing that aortic valve replacement was the most common valve surgery, accounting for 112 cases (51.9% of all valve surgeries and 22.3% of all cardiac surgeries performed in the year). Coronary surgery using two arterial grafts (left mammary artery + radial artery and bilateral mammary artery) was performed on 30 patients (27.2% of the total coronary surgeries).

Table 3 provides a description of the quantity and type of minimally invasive surgeries performed (49 surgeries, 9.7% of the total surgeries). Aortic valve replacement, either by mini-

Table 1. Types of surgeries performed at the Instituto Nacional Cardiovascular in 2022.

Type of surgery	Month												Total	%
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Congenital heart disease	0	2	6	3	5	3	1	1	3	1	0	1	26	5.2
Combined	6	6	3	2	3	8	1	4	5	3	1	1	43	8.5
Coronary	8	8	7	7	8	6	5	9	11	14	10	17	110	21.9
Aortic surgery with EC	3	2	8	5	5	4	3	3	4	3	7	4	51	10.1
Multivalvular	6	3	4	9	8	9	11	6	3	7	7	7	80	15.9
Isolated valvular	6	9	8	7	13	15	18	15	13	10	13	9	136	27.0
Repair of post-infarction mechanical complications	0	0	0	3	2	2	1	2	0	1	1	2	14	2.8
Other surgeries with CE	2	2	1	3	5	1	2	2	2	1	3	0	24	4.8
Heart transplantation	1	0	1	1	0	2	1	0	3	2	1	0	12	2.4
ECMO / Ventricular assistance	0	0	0	0	0	0	1	0	5	1	0	0	7	1.4

EC: extracorporeal circulation; ECMO: Extracorporeal Membrane Oxygenation.

thoracotomy or mini-sternotomy, was the primary minimally invasive surgery performed, accounting for 23 procedures (46.9% of all minimally invasive surgeries), followed by mitral valve surgery and atrial septal defects (ASD) closure.

Throughout the year, there were 23 recorded deaths, representing an overall mortality rate of 4.5%. However, when calculating the mortality rate for elective surgeries, it was 2.8%, whereas for emergency surgeries, it reached 14.3%. Isolated valve surgery (aortic valve replacement or mitral valve surgery), which was the most frequent procedure, exhibited a mortality rate of 0.8% in elective cases. Isolated coronary surgery had a mortality rate of 1.1% in stable patients but rose significantly to 40.0% in emergency cases. **Table 4** presents the mortality rates categorized by surgery types and patient conditions.

The main complication recorded was paroxysmal atrial fibrillation, with a frequency of 14.0% in the first 30 days of the postoperative period. Surgical site infection was the second most common complication, with 52 cases (10.3%). Excessive postoperative bleeding that required re-intervention for hemostasis revision occurred in 8.1% of cases. A total of 10 patients had confirmed stroke based on brain computed tomography imaging and suggestive clinical symptoms (2.0% of the total). **Table 5** displays the main complications recorded.

Table 6 displays the length of stay in the Intensive Care Unit (ICU) and the total hospital stay. Heart transplant surgery had the longest ICU stay with a median of 11 days (range: 10-14) and the longest hospital stay with a median of 25 days (range: 22-29). Myocardial revascularization surgery had a median ICU stay of

Table 2. Types of surgeries performed based on the procedure at the Instituto Nacional Cardiovascular in 2022.

Type of surgery	n	%
Valvular Surgery	216	100
Isolated Valvular Surgery	136	63.0
Aortic Valve Replacement	112	51.9
Mitral Valve Replacement	10	4.6
Pulmonary Valve Replacement	3	1.4
Tricuspid Valve Replacement	2	0.9
Tricuspid Valve Repair	5	2.3
Aortic Valve Repair	2	0.9
Mitral Valve Repair	2	0.9
Multivalvular Surgery	80	37.0
Three-valve Surgery	17	7.9
One Valve Replacement + One Repair	42	19.4
Two Valve Replacements	17	7.9
Two Valve Repairs	4	1.9
Coronary Artery Surgery	110	100
Mammary Artery + Saphenous Vein	78	70.9
Mammary Artery + Radial Artery	20	18.1
Bilateral Mammary Artery	10	9.1
Saphenous Vein Only	2	1.8
Combined Surgery	43	100
Aortic Valve Replacement + Revascularization	23	53.0
Mitral Valve Replacement + Revascularization	9	21.1
Double Valve Replacement + Revascularization	8	19.0
Mitral Valve Repair + Revascularization	3	7.0

Table 3. Surgeries performed by minimally invasive approaches at the Instituto Nacional Cardiovascular in 2022.

Type of surgery	n	%
Minimally Invasive Surgeries	49	100
Aortic Valve Replacement	23	46.9
Upper Ministernotomy	8	
Right Anterior Minithoracotomy	15	
Aortic Valve Replacement + Ascending Aorta Surgery	02	4.1
Mitral Valve Surgery by Minithoracotomy	16	32.7
Mitral Valve Replacement	2	
Mitral Valve Replacement + Tricuspid Valve Repair	8	
Mitral Valve Repair	1	
Mitral Valve Repair + Tricuspid Valve Repair	4	
Mitral Valve Repair + Tricuspid Valve Repair + Closure of ASD	1	
Closure of Atrial Septal Defect (ASD) by Minithoracotomy	7	14.3
Secundum ASD	1	
Secundum ASD + Tricuspid Valve Repair	4	
Sinus Venosus ASD	2	
Minimally Invasive Myocardial Revascularization	1	2.0

ASD: atrial septal defect.

2.5 days (range: 2-4) and a median hospital stay of 8 days (range: 7-12). Isolated valve surgery (aortic valve replacement or mitral valve surgery) had an ICU stay median of 3 days (range: 2-5) and a hospital stay median of 10 days (range: 8-16).

Discussion

During the year 2022, a total of 503 cardiac surgeries were performed. Isolated valve surgery, primarily involving aortic or mitral valve replacement, was the most common surgical procedure, accounting for 136 surgeries (27.0%), followed by myocardial revascularization surgery with 110 procedures (21.9%). Throughout the year, there were 23 recorded deaths, resulting in an overall mortality rate of 4.5%. The mortality rate for elective surgeries was 2.8%, while for emergency surgeries, it was 14.3%.

In this study, we have reported, for the first time, the overall cardiac surgical activity in our hospital, which complements the scarce published studies from other centers at the national and Latin American levels [6-8]. Regarding the monthly analysis, we observed a decrease in the number of surgeries during the first two months compared to the rest of the year 2022. This indicates that our center was not immune to the impact of the pandemic, with January and February being the months closest to the post-pandemic stage. A similar phenomenon was observed in the Spanish registry of cardiovascular surgery for 2020, which showed a nearly 20% reduction in activity in this context [9].

Our study highlights that valvular surgeries are the most frequent, which aligns with the findings in Mexico, where similar results are reported, with isolated valvular surgery being the most common, followed by coronary surgery [7]. However, this differs from the records in developed countries like the United States, where coronary surgery predominates (70%) [10]. In Argentina, Lowenstein *et al*. report that coronary surgery is the most frequent, surpassing valvular surgeries [6]. Meanwhile, in Brazil, Gomez *et al.* report that myocardial revascularization surgery is the most performed, accounting for 48.8%, followed by valvular surgery (23.3%) [11].

Indeed, within the realm of valvular surgeries, isolated aortic valve replacement remains the most common procedure, a finding similar to the results reported by Lowenstein *et al.* and the 2022 registry of The Society of Thoracic Surgeons (STS) [6,10].

Regarding the grafts used in coronary surgery, the combination of mammary artery plus saphenous vein was the most commonly used, accounting for 70.9%. In second place, multi-arterial grafts (mammary artery plus radial artery and double mammary artery) represented 27.3%, which is higher compared to the results reported in the STS 2022 registry, where these grafts were used in 14.3% of coronary surgeries [10]. In our

Table 4. General mortality, according to the surgical timing and type of surgery at the Instituto Nacional Cardiovascular in 2022.

Type of surgery	Elective		Emergency		Total number of cases (elective and emergency).	Total number of deaths (over the total of the surgery subtype).
	Total n	Mortality n (%)	Total n	Mortality n (%)		
Repair of congenital heart diseases	26	0	0	0	26	0
Combined surgery	38	3 (7.9)	5	0	43	3 (6.9)
Coronary artery surgery	95	1 (1.1)	15	6 (40.0)	110	7 (6.3)
Aortic surgery with EC	43	3 (7.0)	8	2 (25.0)	51	5 (9.8)
Multivalvular surgery	76	3 (3.9)	4	0	80	3 (3.7)
Isolated valvular surgery	127	1 (0.8)	9	1 (11.0)	136	2 (1.5)
Post-infarction mechanical complications	3	0	11	1 (9.0)	14	1 (7.1)
Other surgeries with EC	18	1 (5.5)	6	0	24	1 (4.1)
Heart transplantation	0	0	12	1 (8.3)	12	1 (8.3)
ECMO / Ventricular assistance	0	0	7	0	7	0
Overall	426	12 (2.8)	77	11 (14.3)	503	23 (4.5)

EC: extracorporeal circulation; ECMO: Extracorporeal Membrane Oxygenation.

study, it was observed that the radial artery graft was used as the second arterial conduit in 18.1%, which aligns with the STS registry [10]. The increased use of this graft in our institution during 2022 is based on the findings of studies led by Gaudino and by Quereshi, which demonstrated that the use of radial artery grafts for coronary revascularization resulted in a lower rate of adverse cardiac events and higher graft patency at 5 years of follow-up compared to saphenous vein grafts [12-14].

Lowenstein *et al.* found that the most frequent combined surgery is aortic replacement plus coronary revascularization, accounting for 79.5% [6]. However, in our center, this subtype of intervention resulted in 53%, which is consistent with the findings from the last three years of the STS registry [15,16].

Regarding the data on emergency surgery, coronary surgery was the most frequent, accounting for 19.5% (15 out of 77 cases), followed by heart transplantation at 15.6% (12 out of 77 cases). As a national referral center, heart transplantation constitutes a significant proportion of emergency cases. The findings of Mitrev and Anguseva also indicate that coronary surgery was the most common cardiac surgical intervention in the emergency context, but with a higher percentage (45.47%). This higher value is likely attributed to their study encompassing a larger number of patients and a longer follow-up period [17].

Currently, cardiac surgery aims to adopt less invasive approaches and achieve faster patient recovery. In our study, we utilized minimally invasive techniques in 9.7% (49 out of 503) of all cardiac surgeries performed in 2022, which is a lower percentage compared to the 38.7% reported by STS in 2021 [15]. The lower adoption of this approach in our study is attributed to the requirement of having trained personnel and the availability of additional resources.

Regarding postoperative complications, atrial fibrillation was the most frequent in our results, with an incidence of 14% in the 30-day period after surgery. This complication is also the most common in the findings of the STS registry, occurring in 26% of patients undergoing coronary artery bypass grafting and in 27% of patients undergoing isolated valve replacement [18]. However, these data differ from the results of Pahwa *et al*., where postoperative bleeding was the most frequent complication at 47.3%, followed by postoperative atrial fibrillation at 32% [19].

The overall mortality rate reported in our institution was greater than that reported by Salamanca *et al.* in a descriptive study conducted at a general hospital in Peru (4.5% vs. 0%) [8], taking into account that Salamanca *et al*. report a much lower number of cases and involved less complex cardiac interventions compared to our institution. However, our mortality rate is lower

Table 5. Postoperative complications.

Complication	n (%)
Prolonged mechanical ventilation	20 (4.0)
Stroke	10 (2.0)
Excessive postoperative bleeding	41 (8.1)
Cardiac reoperation	4 (0.8)
Permanent pacemaker	10 (2.0)
Paroxysmal atrial fibrillation	70 (14.0)
Perioperative myocardial infarction	6 (1.2)
Mediastinitis	3 (0.6)
Surgical site infection	52 (10.3)

than that reported by Rodríguez-Hernandez *et al.* (4.5% vs. 9.2%), lower than the Brazilian registry (4.5% vs. 6.4%), and similar to the rate indicated in the Spanish registry (4.5% vs. 5.5%), in the context of national referral centers where the surgical complexity more closely resembles that of our institution [7,9,11].

The mortality rate among the 110 patients who underwent coronary surgery was 6.3%, which was higher than the international mortality rate (2.7% to 4.9%) [7,9,10]. However, when considering only elective coronary surgeries, our mortality rate (1.1%) was under the mentioned international figures. It is important to note that these international registries do not differentiate between emergency and elective surgeries.

If we pay attention to our emergency coronary cases, we observe that our mortality rate (40%) is considerably higher than that reported in an American center by Schumer *et al.*, which is 8.7% [20]; however, it is closer to the rate reported by Oliveira *et al.*, who found a mortality rate of 36.4% in patients undergoing emergency coronary surgery at a public hospital in Southern Brazil [21]. In this scenario, a careful analysis of the factors underlying these data is required, thus presenting an opportunity to conduct a specific study on coronary surgery cases in our institution to obtain important insights for improving outcomes for these patients.

Regarding operative mortality for isolated valve replacement, we report a rate of 1.5%, which is slightly lower than the rate reported by Kim *et al.*, who indicated a mortality rate of 2.3% for this subtype of cardiac surgery [10]. Another slight difference also occurs in combined surgery, since the results reported by Siregar *et al*. indicate a mortality rate of 5.3% for combined surgery [22], whereas our result was 6.9%.

This study has some limitations, as it is retrospective and relies on information collected from medical records. Additionally, it was conducted at a single institution, which may restrict the generalization of the findings to other settings. It is also important to note that this study only reports on surgical procedures performed in 2022, potentially not representing trends over time or in other locations. Due to the lack of a national registry, with our institute being a referral center for cardiac pathology treatment, the initiative of this study is to create a database on cardiac and aortic pathology requiring surgical intervention. Despite these limitations, it is important to highlight that this is the first national-level report on cardiac surgery outcomes, underscoring the significance of our study.

In conclusion, valvular surgery, either isolated or in combination with other procedures, was the most frequently performed at our institution. We consider the mortality rate and frequency of complications to be acceptable and comparable to other referral centers. However, for coronary surgery, a careful

Table 6. Stay in the Intensive Care Unit and hospital stay according to the type of surgery.

Type of surgery	ICU stay (days)*	Hospital stay (days)*
Congenital heart diseases	6,5 (2-8)	11 (7-23)
Combined surgery	5 (2-12)	9 (8-28)
Myocardial revascularization	2,5 (2-4)	8 (7-12)
Aortic surgery with EC	4 (2-5)	11 (8-25)
Multivalvular	3 (3-5)	10 (8-17)
Isolated valvular	3 (2-5)	10 (8-16)
Repair of post-infarction mechanical complications	7 (5-8)	16 (14-20)
Other surgeries with EC	3 (2-7)	8 (7-15)
Heart transplantation	11 (10-14)	25 (22-29)

EC: extracorporeal circulation; ICU: intensive care unit
* Data expressed as median and interquartile range.

analysis is required, presenting an opportunity to conduct a specific study in this subtype of cardiac surgery, to obtain important data for improving outcomes for these patients.

Author contributions

GP-G: Conceptualization, Methodology, Validation, Project administration, Data Curation, Formal analysis, Visualization, Investigation, Resources, Software, Supervision, Writing - Original Draft, Writing - Review & Editing. JR-O: Conceptualization, Methodology, Validation, Project administration, Supervision, Writing - Review & Editing. VR-V: Supervision, Writing - Review & Editing. FWM-N: Data Curation, Formal analysis, Visualization, Writing - Original Draft, Writing - Review & Editing. HAS-T: Investigation, Resources, Software, Writing - Original Draft, Writing - Review & Editing.

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