



## Original article

## Perioperative morbidity and mortality of cardiac surgeries at the Instituto Nacional Cardiovascular, Lima, Peru, during 2023

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## ABSTRACT

**Objective.** Determine postoperative mortality and postoperative complications of patients undergoing cardiac surgery in the Cardiovascular Surgery Service of the Instituto Nacional Cardiovascular, EsSalud, Lima, Peru, in the year 2023. **Materials and Methods.** We carried out a descriptive, retrospective study of the patients' medical records. **Results.** In 2023, 538 cardiac surgeries were performed in our center; overall mortality was 5.6%; however, mortality from elective surgeries was 4.1%. The mortality of isolated coronary surgery was 1.9% and of isolated valve surgery was 0.7%. Stroke occurred in 1.5% of patients; re-operation due to bleeding was performed in 8.1% of cases. The most frequently performed surgery was valve surgery (either isolated or multivalvular) with 40.1% of cases, followed by coronary surgery with 28.6%. The hospital stay for coronary surgery had a median of 9.9 days (8-12), and for isolated valve surgery it was 12.8 days (10-14). **Conclusions.** The postoperative results of cardiac surgery at the National Cardiovascular Institute are acceptable and comparable to those of other international high-volume surgical centers.

**Keywords:** Cardiac Surgery; Mortality; Peru (Source: MeSH-NLM).

## RESUMEN

## Morbimortalidad perioperatoria de las cirugías cardíacas en el Instituto Nacional Cardiovascular, Lima, Perú, durante el año 2023

**Objetivo.** Determinar la mortalidad posoperatoria y las complicaciones posoperatorias de pacientes sometidos a cirugía cardíaca en el Servicio de Cirugía Cardiovascular del Instituto Nacional Cardiovascular, EsSalud, Lima, Perú en el año 2023. **Materiales y métodos.** Estudio descriptivo, retrospectivo, de las historias clínicas de los pacientes. **Resultados.** En el año 2023 se realizaron 538 cirugías cardíacas en nuestro centro, la mortalidad global fue del 5,6%; sin embargo, la mortalidad de cirugías electivas fue del 4,1%. La mortalidad de la cirugía coronaria aislada fue del 1,9% y de la cirugía valvular aislada fue del 0,7%. El *Stroke* se presentó en el 1,5% de pacientes, la reoperación por sangrado se realizó en el 8,1% de los casos. La cirugía más frecuentemente realizada fue la valvular (ya sea aislada o multivalvular) con el 40,1% de los casos, seguida de la coronaria con el 28,6%. La estancia hospitalaria de la cirugía coronaria tuvo una mediana de 9,9 días (8-12) y de la cirugía valvular aislada fue 12,8 días (10-14). **Conclusiones.** Los resultados posoperatorios de la cirugía cardíaca en el Instituto Nacional Cardiovascular son aceptables y comparables a los de otros centros internacionales de alto volumen de cirugías.

**Palabras clave:** Cirugía Cardíaca; Mortalidad; Perú (Fuente: DeCS-Bireme).

## Introduction

Cardiovascular disease is the leading cause of death worldwide, with more than 17.5 million deaths annually, of which 75% occur in low- and middle-income countries <sup>(1)</sup>. Over 17 million people die from surgically preventable conditions each year, yet only 6% of the 313 million surgeries performed globally are conducted in low-resource populations, highlighting the significant inequality in access to timely cardiovascular treatment <sup>(2)</sup>. Our hospital is a national referral centre for social security patients (EsSalud), and we treat a substantial proportion of patients who come from rural areas and typically belong to low socioeconomic strata.

During the COVID-19 pandemic, the volume of cardiac surgeries decreased significantly. The Centers for Disease Control and Prevention (CDC) reported that the age-adjusted mortality rate associated with heart disease increased in 2020, reaching its highest level since 2012. This suggests that the pandemic may have prevented the poorest and most marginalised patients from accessing hospitals, potentially leading to deaths at home due to acute coronary syndrome, critical aortic stenosis, or other treatable cardiovascular conditions <sup>(3)</sup>.

In Latin America, the development of cardiovascular surgery is led by Brazil, followed by Mexico, Argentina, and Colombia. Brazil is the only country in the region that, since 2014, has successfully implemented a national adult cardiac surgery registry. Known as BYPASS, this registry features a centralised database that currently collects data from 17 participating centres across the country and is continually expanding its network of contributing institutions <sup>(4)</sup>.

In Peru, the registry of adult cardiac surgery cases across various centres is scarce or nonexistent <sup>(5)</sup>. The Instituto Nacional Cardiovascular (INCOR) of Peru, founded in 1992, is the country's leading reference centre and performs the highest volume of cardiac surgeries. In 2022, the institution published its first report on cardiac surgery activity, titled "Analysis of Cardiac Surgeries and Operative Mortality at the Instituto Nacional Cardiovascular during 2022" <sup>(6)</sup>.

The present study aims to describe the outcomes of cardiac surgeries by pathology, as well as postoperative complications and 30-day mortality at the Instituto Nacional Cardiovascular during 2023, thereby continuing the institution's surgical registry.

## Materials and methods

### Study design

A descriptive, retrospective study was conducted in the Cardiovascular Surgery Department of the Instituto Nacional Cardiovascular, Lima, Peru. The primary objective was to

determine postoperative mortality by type of surgery, and the secondary objective was to identify postoperative complications (stroke, postoperative myocardial infarction, atrioventricular block) and other clinical variables.

### Study population

Medical records of all patients admitted to the Cardiovascular Surgery Department of the Instituto Nacional Cardiovascular of EsSalud, Lima, Peru, between January 1 and December 31, 2023, who underwent cardiac surgery.

### Variables

- **Mortality.** All-cause mortality within the first 30 days postoperatively.
- **Type of surgery.** Valvular surgery: procedures involving one or more interventions on the heart valves. Coronary surgery: isolated coronary artery bypass procedures, with or without cardiopulmonary bypass. Combined surgery: procedures combining valvular and coronary surgery in the same patient. Aortic surgery: procedures addressing various aortic conditions, including dissection, penetrating ulcer, intramural hematoma, aneurysm, and pseudoaneurysm.
- **Postoperative complications.** Assessed within the first 30 days after surgery. Stroke: infarction or transient ischemic attack documented in the medical record, confirmed by imaging (computed tomography [CT] or magnetic resonance imaging [MRI]) and/or clinical evaluation by a neurologist. Postoperative myocardial infarction: defined according to the Fourth Universal Definition of Myocardial Infarction <sup>(7)</sup>. Atrioventricular block: requiring implantation of a permanent pacemaker. Prolonged mechanical ventilation: orotracheal intubation lasting more than 48 hours in the postoperative period. Atrial fibrillation (AF): new diagnosis of paroxysmal or permanent AF occurring postoperatively.
- **Hospital stay.** Measured from the day of surgery until discharge, in days.

### Ethical aspects

The present study was approved by the Ethics and Research Committee of the Instituto Nacional Cardiovascular (046/2024 CEI - INCOR). Data confidentiality was also maintained throughout the study.

### Data analysis

Quantitative variables are presented as mean and standard deviation (SD) or as median and interquartile range (IQR), depending on the distribution assessed by normality criteria. Qualitative variables are expressed as counts and percentages. Frequency tables and graphs were used for data presentation. Cumulative incidence was calculated for postoperative mortality and complications.

## Results

In 2023, a total of 538 cardiac surgeries were performed, of which 364 (68%) were in male patients. **Figure 1** shows the distribution of surgeries by age group, with nearly 60% of patients aged between 60 and 79 years.

**Table 1** shows the distribution by type of surgery. Valvular surgery (either isolated or multivalvular) was clearly the most frequently performed procedure, with 216 cases (40.1%), followed by coronary surgery, which accounted for 28.6% of cases (154 surgeries). Notably, seven heart transplants were performed in 2023, and thirteen patients received mechanical circulatory support, either with Extracorporeal Membrane Oxygenation (ECMO) or long-term assist devices. At our centre, this therapy was used as a bridge to decision or recovery in patients with heart failure due to various causes not limited to postcardiotomy shock.

Isolated aortic valve replacement or combined with coronary artery bypass grafting was the most frequently performed valvular surgery, with 127 cases, representing 23.6% of all cardiac surgeries performed during the year (538) (**Table 2**). Regarding coronary surgery, the most common revascularisation technique was the use of the left internal mammary artery to the left anterior descending artery combined with a saphenous vein graft (84 patients, 54.4% of all coronary surgeries). However, the use of more than two arterial grafts (left internal mammary artery + radial artery or bilateral mammary arteries) was performed in 61 patients, accounting for 39.6% of all coronary surgeries (**Table 2**). **Table 3** presents the types of

minimally invasive cardiac surgeries performed during 2023. A total of 66 procedures were carried out, representing 12.3% of all cardiac surgeries.

Overall mortality (**Table 4**, **Figure 2**) was 30 patients, representing 5.6%. However, when considering only elective surgeries, total mortality was 4.1%. For coronary surgery, the overall rate (elective + emergency) was 1.9%, while isolated valvular surgery had an overall mortality rate of 0.7%.

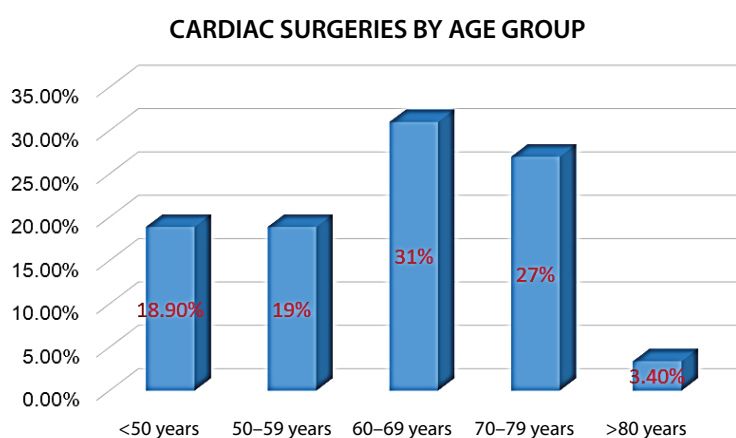
Regarding postoperative complications, stroke occurred in 1.5% of patients, and atrioventricular block requiring permanent pacemaker implantation was observed in 1.5% of all surgeries. Reoperation due to excessive bleeding was necessary in 43 patients (8.1% of all procedures). **Table 5** presents all observed complications. Additionally, **Table 6** shows hospital stay and intensive care unit (ICU) stay by type of surgery.

## Discussion

In 2023, a total of 538 cardiac surgeries were performed at our centre, with an overall mortality rate of 5.6%. Stroke occurred in 1.5% of patients, and reoperation due to bleeding was required in 8.1% of cases. The most frequently performed procedure was valvular surgery, followed by coronary surgery. The median hospital stay for coronary surgery was 9.9 days, while for isolated valvular surgery it was 12.8 days.

The total number of surgeries performed in 2023 (538 procedures) exceeded the number reported in 2022 (503 procedures) at our centre. This increase is likely attributable to improved resource availability following the pandemic<sup>(6)</sup>.

Most patients who underwent surgery were men aged between 60 and 79 years. In line with this, data from the Spanish



**Figure 1.** Distribution of surgeries by age. The highest proportion of patients was concentrated in the 60–79-year age group.

**Table 1.** Types of cardiac surgery performed at INCOR in 2023.

Type of surgery	Month												Total	%
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Coronary surgery	14	13	16	11	12	20	19	14	7	8	9	11	154	28.6
Isolated valve surgery	18	20	18	9	8	6	5	11	11	13	10	9	138	25.6
Multivalve surgery	6	2	12	9	8	5	7	5	3	7	10	4	78	14.5
Combined valve	3	5	2	5	12	4	2	2	3	4	0	1	43	8.0
Aortic surgery	4	2	4	4	5	2	1	2	5	1	9	5	44	8.2
Other surgeries with CPB	3	1	1	3	4	2	2	3	0	4	6	1	30	5.6
Congenital heart disease surgery	2	2	3	4	3	1	1	1	4	2	2	0	25	4.7
ECMO/Mechanical circulatory support	0	1	0	0	0	0	1	2	2	2	1	4	13	2.4
Heart transplant	0	0	0	1	1	0	2	0	3	0	0	0	7	1.3
Post-infarction mechanical complications	0	0	0	0	1	1	2	0	1	0	1	0	6	1.1

CPB: cardiopulmonary bypass; ECMO: extracorporeal membrane oxygenation.

Cardiac Surgery Registry 2021–2023 showed that 67.7% of operated patients were male, with a mean age of 68.3 years (SD: 12.8), and 44.1% were over 70 years old <sup>(8)</sup>. Similarly, the Society

of Thoracic Surgeons (STS) registry in North America reported that from 2015 to 2022, the mean age of patients undergoing coronary artery bypass surgery was 65.6 years <sup>(9)</sup>. These findings

**Table 2.** Most frequently performed cardiopulmonary bypass cardiac surgery subtypes at INCOR in 2023.

Valve surgery	N	%
<b>Isolated valve surgery</b>	<b>216</b>	<b>100</b>
Aortic valve replacement	138	63.9
Mitral valve replacement	96	44.4
Pulmonary valve replacement	22	10.2
Tricuspid valve replacement	2	0.9
Tricuspid valve repair	5	2.3
Aortic valve repair	3	1.4
Mitral valve repair	5	2.3
Multivalve surgery	5	2.3
Triple valve surgery	78	36.1
One valve replacement + one valve repair	12	5.6
Double valve replacement	48	22.2
Double valve repair	13	6
Coronary surgery	5	2.3
<b>Left internal mammary artery + saphenous vein graft</b>	<b>154</b>	<b>100</b>
Left internal mammary artery + radial artery graft	84	54.5
Bilateral internal mammary artery graft	45	29.2
Saphenous vein graft only	16	10.4
Combined surgery	9	5.9
<b>Aortic valve replacement + coronary revascularization</b>	<b>43</b>	<b>100</b>
Mitral valve replacement + coronary revascularization	31	72.1
Double valve replacement + coronary revascularization	5	11.6
Mitral valve repair + coronary revascularization	3	6.7
Reparación valvular mitral + revascularización	4	9.3

**Table 3.** Minimally invasive cardiac surgery at INCOR in 2023.

Type of surgery	N	%
<b>Total</b>	<b>66</b>	<b>100</b>
<b>Aortic valve replacement</b>	23	34.8
Upper mini-sternotomy	3	4.5
Right anterior mini-thoracotomy	20	30.3
<b>Mitral valve surgery via mini-thoracotomy</b>	17	25.8
Mitral valve replacement	7	10.6
Mitral valve replacement + tricuspid valve repair	7	10.6
Mitral valve repair + tricuspid valve repair	2	3
Mitral valve repair	1	1.5
<b>Tricuspid valve replacement via mini-thoracotomy</b>	2	3
<b>Atrial septoplasty via mini-thoracotomy</b>	14	21.2
Isolated atrial septoplasty	3	4.5
Atrial septoplasty + tricuspid valve repair	6	9.1
Atrial septoplasty + correction of partial anomalous pulmonary venous return	5	7.6
<b>Intracardiac tumour excision via mini-thoracotomy</b>	<b>10</b>	<b>15.2</b>
Cardiac myxoma	7	10.6
Fibroelastoma	1	1.5
Malignant tumours	2	3

are consistent with those observed at our centre and confirm that most patients requiring cardiac surgery are men aged 60–79.

At our centre, the most frequently performed procedure was valvular surgery, with aortic valve replacement being the most common, a finding very similar to the data reported in 2022<sup>(6)</sup>. However, these results differ from those of the STS Registry, which showed that coronary surgery was the most frequently performed procedure in North America (77% of operated cases

in 2023). This predominance of coronary surgery over valvular surgery is likely due to the significant decline in conventional aortic valve replacement and the substantial rise in transcatheter aortic valve implantation (TAVI) in these countries (USA and Canada)<sup>(9)</sup>. In Brazil, the BYPASS registry, which includes 17 cardiac surgery centres, reported that from April 2014 to April 2018, 910 patients underwent surgery for valvular disease, representing 26% of a total of 3,500 patients, with aortic valve replacement

**Table 4.** Overall mortality by surgical timing and type of cardiac surgery at INCOR in 2023.

Type of surgery	Elective		Emergency		Total cases N	Total mortality (%)
	Total N	Mortality n (%)	Total N	Mortality n (%)		
Coronary surgery	127	3 (2.36)	27	0 (0)	<b>154</b>	<b>1.9</b>
Isolated valve surgery	138	1 (0.7)	0	0	<b>138</b>	<b>0.7</b>
Multivalve surgery	74	6 (8.1)	4	0 (0)	<b>78</b>	<b>7.6</b>
Combined surgery	41	2 (4.8)	2	0 (0)	<b>43</b>	<b>4.6</b>
Aortic surgery	36	3 (8.3)	8	3 (37)	<b>44</b>	<b>13.6</b>
Other surgeries with CPB	24	3 (12.5)	6	2 (33.3)	<b>30</b>	<b>16.6</b>
Congenital heart disease	25	1 (4)	0	0	<b>25</b>	<b>4.0</b>
ECMO/Mechanical circulatory support	0	0 (0)	13	3 (23)	<b>13</b>	<b>23.0</b>
Heart transplant	0	0 (0)	7	1 (14.3)	<b>7</b>	<b>14.2</b>
Post-infarction mechanical complications	0	0 (0)	6	2 (33.3)	<b>6</b>	<b>33.3</b>
<b>Total</b>	<b>465</b>	<b>19 (4.1)</b>	<b>73</b>	<b>11 (15)</b>	<b>538</b>	<b>5.6</b>

CPB: Cardiopulmonary bypass; ECMO: Extracorporeal membrane oxygenation.

**Table 5.** Postoperative complications.

Complication	N	%
Prolonged mechanical ventilation	18	3.3
Stroke	8	1.5
Excessive postoperative bleeding	43	8.1
Cardiac reoperation	9	1.7
Permanent pacemaker implantation	8	1.5
Paroxysmal atrial fibrillation	55	10.2
Perioperative myocardial infarction	4	0.7
Mediastinitis	3	0.5
Surgical site infection	40	7.4

being the most frequent valvular procedure (34% of cases) <sup>(10)</sup>. In Spain, valvular surgery is also the most common, accounting for between 52.1% and 57.6% of cases between 2021 and 2024 <sup>(8)</sup>.

Regarding mortality, our overall rate was 5.6%, slightly higher than that reported in 2022 (4.5%) and comparable to the rate observed in Spain between 2021 and 2023 (5.1%) <sup>(6,8)</sup>. The mortality rate for coronary surgery was 1.9%. The STS registry reported an average mortality of 1.91% among patients undergoing coronary artery bypass grafting (CABG) between 2015 and 2022 <sup>(9)</sup>. However, the Spanish registry analysis reported a mortality rate of 3.2% for isolated coronary surgery, while the BYPASS registry in Brazil reported a rate of 2.8% for the same procedure <sup>(8,11)</sup>. These data support the conclusion that our institution is a centre of excellence for performing coronary artery bypass surgery.

The mortality rate for isolated valve surgery (aortic or mitral) in our series was 0.7%. In comparison, the Spanish registry reported mortality rates of 7.1% and 2.2% for mitral and aortic valve replacements, respectively <sup>(8)</sup>. Meanwhile, the Brazilian

registry reported mortality rates of 5.1% and 5.0% for aortic and mitral valve replacement, respectively <sup>(10)</sup>. In our series, the highest mortality among elective surgeries was observed in aortic pathology. Among emergency procedures, the highest mortality was seen in patients with post-infarction mechanical complications and aortic pathology. The Spanish registry reported a 10% mortality rate for aortic surgery <sup>(8)</sup>.

Regarding complications, a systematic review of 174,969 patients found a postoperative stroke rate of 0.98% (95% confidence interval [CI]: 0.79–1.23%) and an operative mortality rate of 28.8% (95% CI: 17.6–43.4%) for strokes occurring in the early postoperative period, compared to 2.4% (95% CI: 1.9–3.1%) in patients without stroke <sup>(12)</sup>. Moreover, among 10,250 patients who underwent surgery at the University of Pittsburgh Medical Center between 2010 and 2017, the stroke rate was 2.16%. Operative mortality was significantly higher in patients who experienced a postoperative cerebrovascular accident (14.93% vs. 2.15%,  $p < 0.001$ ). Predictors of stroke included advanced age, known cerebrovascular disease, diabetes mellitus, and emergency surgery <sup>(13)</sup>. Our postoperative stroke rate was 1.5%, which is consistent with international data.

Postoperative bleeding requiring re-exploration is associated with reduced long-term survival and a higher risk of short-term adverse events, including operative mortality, stroke, renal and respiratory complications, and prolonged hospital stay <sup>(14)</sup>. The Mayo Clinic reported a reoperation rate for bleeding of 3.3% in patients undergoing cardiac surgery between 1993 and 2019. However, the Brazilian BYPASS registry found that the rate of major bleeding was 9.9% in valve surgery and 2.7% in coronary bypass surgery <sup>(10,11,15)</sup>. Our rate for 2023 was 8.1%, identical to that reported in 2022. We consider these rates to be significantly higher than those reported by centres of excellence. The reasons for this remain unclear, warranting further investigation.

One of the most common complications following cardiac surgery is postoperative AF, which significantly increases hospital length of stay. In a retrospective study conducted at two centres in Massachusetts involving 21,568 patients, the incidence of

**Table 6.** Postoperative intensive care unit and total hospital stay by type of cardiopulmonary bypass surgery at INCOR, 2023.

Type of surgery	ICU Stay (days)*	Total Hospital Stay (days)*
Myocardial revascularization	3.13 (2-5)	9.9 (8-12)
Isolated valve surgery	4.00 (3-6)	12.8 (10-14)
Multivalvular surgery	4.53 (3-6)	14.2 (11-19)
Combined surgery	5.00 (3-11)	16.4 (14-27)
Aortic surgery	3.81 (3-6)	16.9 (11-20)
Other surgeries with CPB	3.67 (3-6)	11.4 (9-18)
Heart transplant	10.00 (9-12)	24.0 (21-27)
Post-infarction mechanical complications	4.67 (4-7)	18.0 (16-22)
Congenital heart disease	5.45 (3-8)	14.0 (10-21)

CPB: cardiopulmonary bypass.

\*Data expressed as median and interquartile range.



postoperative AF was 40.8% in women and 38.8% in men; however, other authors have reported rates ranging from 50% to 60%<sup>(16,17)</sup>. In contrast, our series revealed a lower incidence of postoperative AF (10.2%). Hospital length of stay in our setting was longer compared to that reported by other centres. For example, the Spanish registry reported a median postoperative stay of 8 days (IQR: 6–13)<sup>(8)</sup>.

The extended length of stay may be partially attributable to the fact that a significant proportion of patients come from rural or remote areas of the country and are often unable to be discharged due to the lack of adequate facilities for postoperative care. Additionally, many patients remain hospitalised to optimise their international normalised ratio (INR) before discharge, which is particularly relevant given that valve surgery is our most frequently performed procedure.

Regarding the use of two or more arterial grafts in coronary artery bypass surgery, there was an increase from 27% in 2022 to 40% in 2023. In the Brazilian registry, only 6% of patients received either bilateral internal mammary arteries or a combination of left internal mammary artery and radial artery grafts<sup>(11)</sup>. According to the STS registry, among a total of 281,515 patients who underwent coronary bypass surgery between 2018 and 2019, only 5.6% received bilateral internal mammary arteries and 8.5% received a left internal mammary artery plus a radial artery graft<sup>(18)</sup>. Observational studies suggest that revascularisation

with multiple arterial grafts may improve long-term survival by approximately 15–20% compared to conventional coronary bypass techniques<sup>(19)</sup>.

At our centre, we have a minimally invasive valve surgery programme. In 2022, a total of 49 minimally invasive cardiac surgeries were performed (9.7%), while in 2023, this number increased to 66 (12.3%). It is well established that this type of surgery reduces hospital stay, postoperative bleeding, and pain<sup>(6,20)</sup>.

This study has several limitations, as it presents cardiac surgery outcomes from a single centre. It is a retrospective study, and the data collected may be subject to errors. However, the clinical record-keeping at our institution adheres to high-quality standards, given its status as a national referral centre. Moreover, the publication of this study is important, as there is limited data available on this topic in our country.

In conclusion, the postoperative outcomes of cardiac surgery at the Instituto Nacional Cardiovascular in 2023 are acceptable and comparable to those reported by other high-volume international cardiac surgery centres.

#### Authors' contributions

**HST, JSR, FMN:** Conceptualization, Investigation, Data Curation. **ZDC:** Validation, Supervision. **JRO:** Conceptualization, Investigation, Writing – Original Draft, Writing – Review & Editing.

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