

# Correlation between postoperative cardiac risks factors, functionality and hospital length of stay

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## ABSTRACT

**Introduction:** Cardiac surgery (CS) may be associated with several organic repercussions responsible for the appearance of cardiac risk factors during the postoperative period. These, associated with prolonged hospital length of stay (LoS), may trigger critical manifestations in individuals undergoing this surgical procedure. **Objective:** To investigate the relationships between postoperative cardiac risk factors, LoS, and changes in functioning state. **Methods:** Patients undergoing reconstructive, substitutive, or corrective cardiac surgeries were evaluated. The presence of postoperative cardiovascular risks was assessed using the InsCor score, while LoS and functionality were collected from medical records. **Results:** One-hundred patients with a mean age of 59.2±12.3 years were included. Significant correlations between functionality and both the hospital and Intensive Care Unit (ICU) LoS ( $p<0.0001$ ,  $\rho=0.56$ ;  $p=0.002$ ,  $\rho=0.29$ , respectively), as well as between hospital LoS and the number of comorbidities ( $p=0.003$ ,  $\rho=0.28$ ) were found. No significant relationships were observed between the number of postoperative risk factors and LoS. **Conclusion:** Functionality and comorbidities are associated with increased hospital and ICU LoS in patients undergoing cardiac surgery.

**Keywords:** thoracic surgery; postoperative period; International Classification of Functioning, Disability and Health.

## INTRODUCTION

Cardiovascular diseases are among the leading causes of mortality and disability worldwide (31% of all deaths per year) and affect most adults over 60 years. In Brazil, this condition is responsible for almost one-third of all deaths<sup>1,2</sup>. When clinical and pharmacological interventions are insufficient to maintain the patient's health, invasive surgical correction appears as a safe and efficient alternative<sup>3-5</sup>.

Cardiac surgery (CS) involves detailed surgical manipulation, anaesthesia, prolonged mechanical ventilation, cardiopulmonary bypass, and pleural drains. It has several organic repercussions and leads to a critical postoperative period that implies the need for intensive care. For this reason, severe sequelae and challenging conditions are present

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in the postoperative period and may evolve to death<sup>6-9</sup>, as shown in a retrospective study evaluating patients undergoing the re-intubation process during the postoperative period of CS<sup>10</sup>. Of 119 patients, 48 died with associated complications such as pneumonia (52.6%), renal failure (42.4%), and transient gas exchange disorders (51%).

The main preoperative factors contributing to postoperative risk factors in cardiac surgeries are age, gender, previous medical history, preoperative medications, and intraoperative risk factors (i.e., type of surgery, duration of cardiopulmonary bypass, and hospital LoS)<sup>11</sup>. Also, hospital LoS generally causes discomfort, stress, anxiety, and depression, which may affect tissue oxygenation and favour the development of postoperative complications<sup>12-14</sup>. In a retrospective cohort study conducted with 4963 patients undergoing CS, Yu et al.<sup>15</sup> showed that patients who had prolonged intensive care unit (ICU) stay (>4 weeks) presented significantly lower long term survival rates (63.3%, 56.4% and 41.1% in 6 months, one year and two years, respectively) than those discharged between one to two weeks (84.4%, 80.0% and 75.3% in 6 months, one year and two years, respectively).

In context, this study aimed to investigate the relationships between postoperative cardiac risk factors and changes in functionality and both hospital and ICU LoS.

## METHODS

### Study Design and Population

This is a cross-sectional and analytical study, with non-probabilistic sampling, obtained from convenience, carried out at the Centro Hospitalar João XXIII between May and October 2018.

Inclusion criteria were composed of patients of both sexes, aging >18 years old, and submitted to the following cardiac surgeries: reconstructive (myocardial revascularization and valve plasty), substitutive (valve replacement), or corrective (congenital heart disease correction). Patients who underwent other major surgeries, with functional limitations before CS, with previous non-cardiac diseases that could exacerbate the post-surgical condition, or who refused to participate in the study were excluded.

The study was approved by the research ethics committee of the State University of Paraíba (UEPB) (CAAE: 00169118.5.0000.5187), according to the Declaration of Helsinki. All individuals involved signed an informed consent form.

### Clinical evaluation

After patient authorization, the following clinical data (from before and after surgery) were collected from medical records during the hospital stay: age, sex, sociodemographic data, blood pressure, heart rate, type of cardiac surgery, diagnosis of recent myocardial infarction, reoperations, valve surgery, creatinine level, ejection

fraction, respiratory rate, oxygen saturation, temperature, weight, height, body mass index, body surface, smoking, alcohol consumption, number of comorbidities, and any other cardiac complications that may have affected the participants of study.

### Postoperative risk factors

The InsCor risk score was used to analyze the postoperative risk factors<sup>16</sup>. This score was created by remodeling and simplifying other consolidated scores (i.e., EuroSCORE and 2000BP) and proved to be adequate for predicting mortality in patients undergoing coronary and/or valvar heart disease in Brazil.

The following variables composed the score: age >70 years, sex, coronary revascularization and valvar surgeries, myocardial infarction <90 days, reoperation, surgical treatment of the aortic and tricuspid valves, creatinine <2mg/dL, ejection fraction <30%, and the number of events (i.e., cardiac complications). The final score varies from 0 to 30 points, and the patient is classified into three categories: low risk (0-3), medium risk (4-7), and high risk ( $\geq 8$ )<sup>16</sup>.

### Functionality

Functionality was quantified using the International Classification of Functioning, Disability and Health (ICF). The ICF offers a comprehensive framework for understanding functioning and disability from a dynamic bio-psycho-social perspective and is structured into a hierarchy starting with the above-mentioned components, then chapters, followed by categories. The model includes four components: 1) body functions and structures, 2) activities and participation, 3) environmental factors, and 4) personal factors. For this study, only the body function component and its chapters were used. Changes in the functioning state were analyzed according to a context in which a reduced functional capacity after CS leads to organic complications<sup>11,17,18</sup>.

### Length of stay

The date of hospital admission, as well as the hospital and ICU length of stay (in days), were continuously monitored and included in data analysis. The hospital length of stay was calculated as the difference between the date of hospital admission and discharge.

### Statistical analysis

Data are shown as mean  $\pm$  standard deviation and 95% confidence interval (95% CI). The Shapiro-Wilk test was used to assess data normality. Comparisons between surgery categories (reconstructive, corrective, and substitutive) were performed using the Kruskal-Wallis test. In the event of a statistically significant difference, Dunn's *posthoc* test was applied to identify the difference between groups. Spearman's correlation coefficient ( $\rho$ ) was used to verify relationships between cardiac risk factors in the postoperative period and both the LoS (i.e., ICU and hospital) and the number of changes in the functioning state, as well as between

the number of changes in functionality and the number of associated comorbidities.

Descriptive and inferential analyses were conducted using GraphPad Prism software (La Jolla, California) version 7.01. For all statistical analyses, a significance level of  $p < 0.05$  (2-sided) was adopted.

## RESULTS

The study included 100 patients (59% male and 41% female) with a mean age of  $59.2 \pm 12.3$  years. Of the 100 surgeries performed, 61 were myocardial revascularization (40 performed in male and 21 in female patients), 35 were valve replacement (18 in

male and 17 in female patients), and 4 were congenital heart disease corrective surgery (one male and three female patients). Arterial hypertension (57%) and diabetes mellitus (22%) were the most prevalent comorbidities (Table 1).

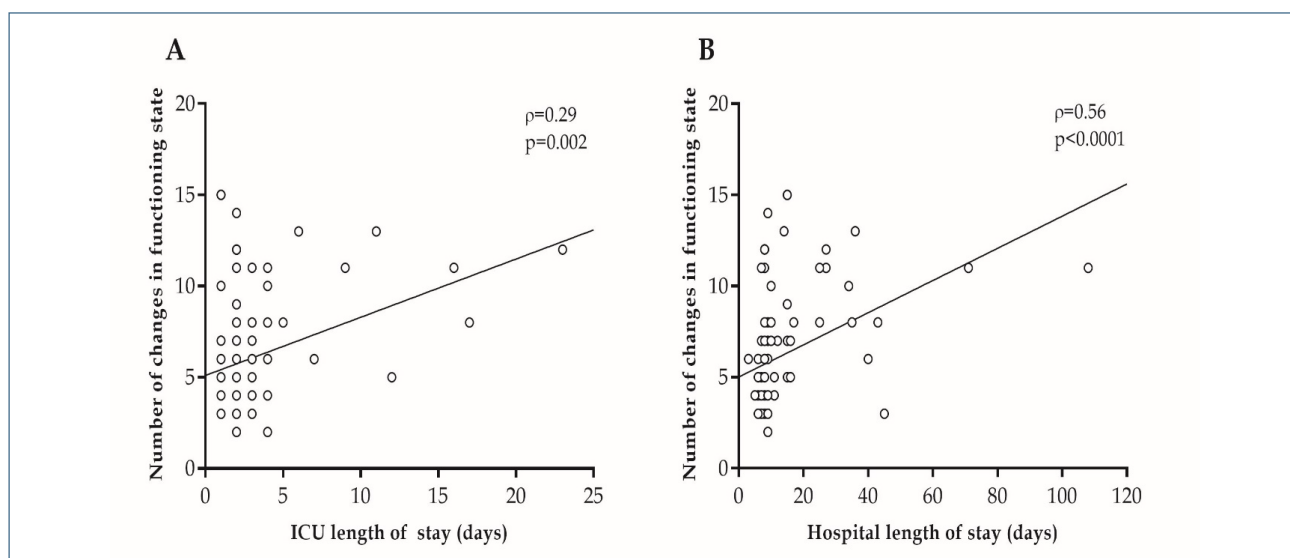
Significant correlations were observed between the number of changes in the functioning state and both the ICU ( $p = 0.002$ ,  $\rho = 0.29$ , 95%CI=0.098 – 0.469) and hospital LoS ( $p < 0.0001$ ,  $\rho = 0.56$ , 95%CI=0.412 – 0.690) (Figure 1). Significant relationships were also found between the hospital LoS and the number of comorbidities ( $p = 0.003$ ,  $\rho = 0.28$ ; 95% CI=0.092 – 0.463).

Regarding changes in functionality according to ICF chapters, the changes in sensory and pain functions (96%) were the most prevalent in the postoperative moment, followed by

**Table 1:** Profile and characteristics of the patients included in the study.

	All (n=100)	MR or plasty (n=61)	VR (35)	CHDC (4)
Age (years)	59.2 ± 12.3	62.2 ± 9.4	56.6 ± 12	30.5 ± 5.7
Weight (Kg)	70 ± 13	72 ± 11	66 ± 15	68 ± 9.7
Height (cm)	1.60 ± 0.07	1.60 ± 0.07	1.60 ± 0.08	1.58 ± 0.03
BMI (Kg / m2)	27 ± 4.2	27 ± 3.8	25 ± 4.9	27 ± 3.1
SBPi (mmHg)	121 ± 14	125 ± 14	116 ± 14	117 ± 9.5
DBPi (mmHg)	77 ± 9	79 ± 9.3	74 ± 8	75 ± 5.7
SBPf (mmHg)	120 ± 16	122 ± 15	116 ± 18	120 ± 14
DBPf (mmHg)	75 ± 10	77 ± 10	70 ± 10	77 ± 5
HRi (bpm)	76 ± 15	76 ± 16	75 ± 14	83 ± 13
HRf (bpm)	76 ± 13	78 ± 14	74 ± 9	85 ± 16
Number of comorbidities	1 ± 0.7	1 ± 0.6	0.7 ± 0.6	1.2 ± 0.9
LoS - ICU (days)	3.3 ± 3	3 ± 2.4	3.7 ± 4.4	2.7 ± 0.5
LoS Hospital (days)	12 ± 14	14 ± 17	10 ± 5.7	7.5 ± 0.5
Changes in functioning	6 ± 3.1	6 ± 3.1	5.8 ± 3.4	4.7 ± 1.2
InsCor	3.3 ± 1.1	3.4 ± 1.0	3.4 ± 1.2	1.2 ± 0.5

Values are presented as mean ± standard deviation. MR: myocardial revascularization; VR: valve replacement; CHDC: congenital heart disease correction; SBPi: initial systolic blood pressure; DBPi: initial diastolic blood pressure; SBPf: final systolic blood pressure; DBPf: final diastolic blood pressure; HRi: initial heart rate; HRf: final heart rate; BMI: Body Mass Index; ICU: Intensive Care Unit; LoS-ICU: ICU length of stay; mmHg: millimeters of mercury; bpm: beats per minute; Kg: kilogram; cm: centimeters; Kg/m<sup>2</sup>: kilogram per square meter.



**Figure 1:** Relationship between the number of changes in functioning state and ICU (A) and hospital length of stay (b).

cardiovascular, hematological, immune, and respiratory system alterations (31%) (Table 2). Moderate chest pain was reported by 98% of the patients after surgery, mainly due to the sternotomy.

## DISCUSSION

Due to its complexity, the CS can lead to several structural and physiological changes. The resources used in this procedure, as well as the management, the clinical history of the patient, and the recovery conditions can trigger the appearance of possible complications and prolong the hospital LoS. The main findings of the present study are that pre-existing comorbidities and functional limitations contribute to a more extended hospital LoS after CS. This is a study that shows the impact of cardiac surgeries on functionality and the repercussions of risk factors in the postoperative period. The findings of this study are supported by Morais et al.<sup>19</sup>, who observed relationships between the number of changes in functioning state and hospital LoS in 22 patients undergoing CS. Also, a significant reduction in the functional independence of individuals admitted to the ICU was observed shortly after discharge in a multicenter study performed with 293 participants<sup>20</sup>.

The length of stay not only influences functioning but also impacts on mortality. Soppa et al.<sup>21</sup> assessed 108 patients in the postoperative period of CS and observed higher mortality rates in patients with a mean ICU LoS of 21 days compared with those hospitalized for seven days. Crawford et al.<sup>22</sup> observed that 41% of 2477 patients who underwent cardiac surgeries and presented multiple postoperative complications died, and these complications were correlated with hospital LoS. In the same study, renal failure and unplanned reoperation were associated with increased mortality (odds ratio: 108.4; 95% CI: 13.5 to 869.9;  $p < 0.001$ ). According to Lazar et al.<sup>23</sup> LoS is greater in those patients presenting at least one risk factor. Also, other prevalent postoperative cardiac risk factors that correlate with increased LoS are atrial fibrillation (arrhythmia), respiratory failure intubation time  $>48$ h, pneumonia, infections, surgical wound, and renal dysfunction<sup>24,25</sup>.

Another critical point of our research is related to functionality in the postoperative moment. Although no relationships were

found with functionality, cardiovascular risk is an important variable. Cordeiro et al.<sup>26</sup> assessed 52 patients undergoing CS in the postoperative period and observed that cardiac risk (evaluated using the EuroSCORE) was negatively associated with functional limitation. Apart from this, no other study using the ICF for cardiac care in the postoperative period was found, except during the rehabilitation period<sup>27</sup>. This demonstrates the lack of documentation by health professionals concerning functional classifications, as mentioned by Wenzel & Morfed<sup>28</sup>.

In a pioneering study, Racca et al.<sup>27</sup> observed significant changes in the ICF activity and participation domains in 50 postoperative CS patients during cardiac rehabilitation. Unlike these results<sup>27</sup>, we observed that changes in the functioning state were mainly related to sensory levels and pain (98%) due to the surgical sternotomy incision followed by respiratory and cardiovascular complications. This corroborates the results of a meta-analysis assessing persistent pain in the postoperative period of CS<sup>29</sup>. Of the 11057 patients involved, 37% had persistent postoperative pain in the first 6 months, and 17% for more than two years. Moderate to severe pain varied between 49 to 53%, and the greatest level of pain was observed in regions capable of generating critical functional impacts, such as the sternum and lower limbs.

Postoperative pain management is essential since it is related to changes in respiratory mechanics and leads to rapid and shallow breathing, impaired gas exchange, and pulmonary complications<sup>30</sup>. Mazzeffi & Khelemsky<sup>31</sup> and Sasseron et al.<sup>32</sup> observed that pain in the surgical site delays rehabilitation, prolongs treatment duration, worsens quality of life, and may cause systemic sequelae, such as respiratory and cardiovascular disorders, stimulation of the sympathetic nervous system, as well as impaired muscle mobility and physical fitness. These factors may lead to functional impairments, prolonged recovery time, prolonged duration of opioid use, and higher health costs<sup>33,34</sup>. Even preoperative anxiety may contribute to postoperative pain<sup>35</sup>. As the higher the level of pain, the lower the functional independence<sup>36</sup>, it is essential to treat this condition in individuals who had undergone CS.

Corroborating with our results regarding comorbidities, Gimenes et al.<sup>37</sup> showed significant associations between pre-existing risk factors and postoperative complications in 58 patients

**Table 2:** Functional changes according to the ICF chapter related to body functions component.

ICF Component: <i>Body functions</i>	Changes in functioning state (%)
<b>Chapter 1</b> – Mental functions	17%
<b>Chapter 2</b> – Sensorial and pain functions	96%
<b>Chapter 3</b> – Voice and speech functions	-
<b>Chapter 4</b> – Functions related to cardiovascular, hematological, immune, and respiratory systems	31%
<b>Chapter 5</b> – Functions related to digestive system, metabolic, and endocrine systems	5%
<b>Chapter 6</b> – Functions related to genitourinary and reproductive systems	3%
<b>Chapter 7</b> – Functions related to movement and neuromusculoskeletal system	4%
<b>Chapter 8</b> – Skin functions and related structures	-

who underwent CS. Bonnet et al.<sup>38</sup> showed that individuals aging >80 years presented greater LoS in the postoperative period of CS mainly due to comorbidities, while Oliveira et al.<sup>39</sup> observed that diabetes mellitus was the main predictor of ICU LoS. In the present study, DM was predominant in 22% of the patients, together with overweight (49%) and arterial hypertension (57%). It is also important to highlight that overweight is an essential factor contributing to the burden of chronic diseases and disability. According to the WHO, if this condition is not treated, it can lead to severe health disorders<sup>40</sup>.

The low number of patients in the corrective surgery group is considered the main limitation of this study. However, congenital heart diseases are less prevalent compared to other cardiac

pathologies and, therefore, is not a common type of CS in clinical practice. Other limitations are that we performed a single-centre study and investigated the surgery groups instead of evaluating individualized surgical indications.

Finally, the medium- and long-term data after hospital discharge were not acquired, which could evidence important risk factors, changes in functionality, possible readmissions, and mortality rates.

In conclusion, functionality (measured using the ICF) and the number of comorbidities is associated with hospital and ICU LoS in patients undergoing cardiac surgery. Future studies are needed to elucidate these associations better and reinforce the adoption of better lifestyle habits to prevent cardiovascular diseases.

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