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SCIENTIFIC ARTICLE - ORIGINAL

ORGANIZATIONAL ARCHITECTURE AND FORMAL COMMUNICATION LINKS IN A BRAZILIAN FAMILY-OWNED HOSPITAL

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ABSTRACT

Introduction: Family-owned hospitals face increasing pressure for professionalization, decision-making efficiency and clearer communication flows. Fragmented organizational structures may increase relational complexity, impair role definition and weaken internal governance. **Objective:** To analyze the redesign of the organizational architecture of a Brazilian family-owned hospital, focusing on the reduction of formal communication links and the strengthening of institutional governance. **Methods:** This was an analytical organizational study based on an institutional restructuring experience in a private family-owned hospital. The pre-intervention organizational chart, SWOT matrix, institutional climate records and the proposed organizational redesign were analyzed. Formal communication complexity was estimated using the formula n(n-1)/2, where n represents the number of managerial or equivalent positions connected to the decision-making flow. **Results:** The initial structure included 23 managerial or equivalent positions, corresponding to 253 potential formal communication links. After the intervention, the organizational chart was redesigned into 5 managerial positions directly linked to the executive structure, reducing potential formal communication links to 10. This represented an absolute reduction of 243 links and a relative reduction of 96.0% in estimated formal complexity. **Conclusion:** Organizational architecture redesign may be useful to reduce formal communication complexity in family-owned hospitals. Leaner structures may support governance, decision-making agility and institutional alignment in healthcare organizations operating in competitive and complex environments.

Keywords: Hospital governance, Organizational communication, Hospital administration, Family business, Health management.

INTRODUCTION

Family-owned hospitals occupy a relevant position in the Brazilian healthcare system but face increasing pressures for professionalization, economic and financial sustainability, responsiveness, and governance.[1-4] In a sector characterized by increasing complexity of

care, competition among hospital groups, greater regulatory requirements, and pressure for efficiency, the way an organization is designed is no longer merely an administrative issue but becomes a strategic component of management.[5,6]

Organizational architecture refers to the way an institution structures its processes, hierarchical levels, roles, responsibilities, and formal communication flows.[7,8] In hospitals, this design influences the speed of decision-making, the clarity of focal points, coordination between clinical and administrative areas, and the ability to translate strategic guidelines into operational execution.

Excessively fragmented structures may increase communication complexity and lead to overlapping responsibilities, gray areas in decision-making, and greater dependence on informal alignment.[7-9] In contrast, leaner organizational designs tend to promote role clarity, reduced variability in decision-making, and greater institutional predictability.

In the field of team management, Hackman highlighted the importance of work design and team size for collective effectiveness.[10] A simple way to estimate the potential complexity of communication among members of a group is the formula n(n−1)/2, in which n represents the number of connected members or positions. Although it does not replace a qualitative assessment of actual communication flows, this metric makes it possible to visualize the geometric growth of potential interactions as the number of positions increases.[10]

This study analyzes an experience involving the redesign of the organizational architecture of a Brazilian family-owned hospital, focusing on the reduction of formal communication links, the repositioning of management levels, and the implications for internal governance.

METHODS

Study Design

An analytical organizational study was conducted, based on a pre- and post-intervention analysis of the restructuring of the organizational architecture of a Brazilian private family-owned hospital. The study used retrospective institutional data related to the organizational chart, SWOT matrix, organizational climate records, and internal management redesign documents.

Setting

The study was conducted in a private family-owned hospital located in the Central-West region of Brazil, providing tertiary care and characterized by a high-complexity profile. The institution operated in a context of increased competition in the healthcare sector, with the entry of national hospital groups, increased professionalization of management, and the need for greater agility in decision-making.

Data Sources

Institutional documents related to the pre-intervention organizational chart, the SWOT matrix developed with the management group, organizational climate survey records, and the organizational chart proposed after the redesign were analyzed. The analysis focused on the structural elements of the organizational architecture rather than on the measurement of individual professional performance.

To avoid overlap with other studies derived from the same research program, organizational climate data were used only as contextual information to identify internal weaknesses in

communication and leadership. The main analysis of this manuscript focused on the formal design of the management structure and the estimation of formal communication links.

Organizational Intervention

The intervention consisted of redesigning the institutional organizational chart, with a reduction in the number of management positions or equivalent positions directly connected to the decision-making flow. The pre-intervention structure had 23 management positions or equivalent positions. After the restructuring, a new design was proposed with two intermediate executive levels and five management positions directly linked to the executive structure.

The objective of the intervention was to reduce fragmentation, strengthen formal focal points, improve the clarity of roles and responsibilities, and promote greater agility in the institutional decision-making process.

Estimation of Formal Communication Links

The potential formal complexity of communication was estimated using the formula $n(n-1)/2$, where n represents the number of management positions or equivalent positions directly related to the decision-making flow [10]. The formula was applied to the pre- and post-intervention scenarios to estimate the potential number of formal links among management positions.

The absolute change was calculated as the difference between the estimated number of links in the pre-intervention scenario and the post-intervention scenario. The relative reduction was calculated as the ratio between the absolute difference and the number of links in the initial scenario, multiplied by 100.

Ethical Aspects

The project that originated the institutional database used for the analysis was submitted to and approved by the institutional Research Ethics Committee under CAAE 62930122.5.0000.5075. The data used in this manuscript were treated in aggregate form, without individual identification of participants or disclosure of the institution's name in the body of the study.

RESULTS

Pre-Intervention Context

In the initial structure, the institutional organizational chart showed a high degree of management fragmentation, with 23 management positions or equivalent positions related to the decision-making flow. The combined analysis of the organizational chart, SWOT matrix, and institutional climate records indicated difficulties related to internal communication, role definition, integration between areas, and clarity of formal leadership references.[11,12]

Applying the $n(n-1)/2$ formula to the set of 23 management positions yielded an estimate of 253 potential formal communication links.[10] This result indicated high potential relational complexity, with a greater need for alignment among multiple decision-making points.

Organizational Redesign

After the situational analysis, a new organizational chart with a leaner structure was proposed, organized around five management positions directly linked to the executive

structure. The restructuring sought to concentrate responsibilities, reduce overlaps, and establish clearer focal points for institutional communication.

With five management positions or equivalent positions in the new design, the estimated number of potential formal links was reduced to 10. The absolute reduction was 243 potential links, corresponding to a relative reduction of 96.0% in estimated formal complexity.

Comparative Summary of the Pre- and Post-Intervention Scenarios

The comparison between the pre- and post-intervention scenarios is presented in Table 1. The sequence linking the organizational diagnosis, the proposed intervention, and the expected implications for governance is presented in Table 2.

Table 1. Comparison of Organizational Architecture and Formal Communication Links Before and After the Intervention.

Indicator	Pre-Intervention	Post-Intervention	Change
Number of management positions or equivalent positions	23	5	-18 positions
Potential formal communication links	253	10	-243 links
Relative reduction in estimated formal complexity	Reference	96.0%	Estimated reduction of 96.0%
Predominant organizational structure	Fragmented structure	Lean structure with focal points	Greater decision-making clarity

Source: Prepared by the authors based on institutional organizational redesign documents.

Table 2. Analytical Sequence of the Organizational Intervention.

Element Analyzed	Main Finding	Implication for Governance
Pre-intervention organizational chart	High number of management positions or equivalent positions	Increased formal communication complexity
SWOT matrix and institutional records	Weaknesses related to communication, leadership, and integration	Need for greater clarity of roles and focal points
Organizational chart redesign	Reduction to five management positions directly linked to the executive structure	Simplification of formal flows and greater decision-making agility
Estimated formal links	Reduction from 253 to 10 potential links	Lower potential relational complexity and greater institutional predictability

Source: Prepared by the authors.

DISCUSSION

This study describes an experience of redesigning the organizational architecture of a Brazilian family-owned hospital, demonstrating a substantial reduction in the estimated formal complexity of communication following the reorganization of the organizational

chart. The reduction from 253 to 10 potential formal communication links should not be interpreted as a direct measurement of all actual communication flows, but rather as a structural indicator of the simplification of the management design.[10]

The main finding is that organizational architecture can be used as a governance tool.[7-9] This result complements recent longitudinal evidence on the use of organizational maturity as a tool for quality governance in Brazilian hospitals.[13] By reducing the number of management points directly connected to the decision-making flow, the institution sought to create clearer formal references, reduce role overlap, and promote faster alignment among executive leadership, management positions, and operational areas.

In family-owned hospitals, the professionalization of management requires a balance between institutional tradition, established interpersonal relationships, and the need for formal structures capable of supporting growth.[1-4] Fragmentation of the organizational chart may represent either a historical legacy of incremental expansion or an attempt to accommodate departmental leadership. However, when not accompanied by clear responsibilities and formal coordination mechanisms, such fragmentation may hinder governance.

The application of the logic of formal communication links provides a simple and communicable representation for managers.[10] As the number of connected positions increases, the potential number of interactions increases nonlinearly. This phenomenon helps explain why apparently inclusive structures may become slow, noisy, or ineffective in contexts that require rapid responses.

The redesign of the organizational chart is also consistent with classical concepts of organizational structure.[7-9] Leaner models may promote coordination, accountability, and alignment, provided that they are accompanied by appropriate delegation, scope definition, structured communication, and monitoring of results. Simply reducing the number of positions, in isolation, does not guarantee improved governance; its value depends on the ability to translate the new design into decision-making routines, management forums, and clear agreement on responsibilities.

Another relevant point is that the intervention should not be viewed merely as administrative simplification. In healthcare organizations, communication between clinical and administrative areas influences response time, operational safety, patient experience, and institutional sustainability.[5,6,11,12,14-16] Therefore, redesigning organizational architecture may be an initial step toward strengthening clinical and administrative governance.

Practical Implications

The findings suggest that family-owned hospitals may benefit from periodic assessments of organizational architecture, especially when there are signs of communication noise, overlapping responsibilities, poor integration between departments, or slow decision-making.[1-4,7-10] The analysis of formal communication links can be incorporated as a simple tool to support organizational redesign.

For hospital managers, the practical contribution of this study lies in demonstrating that organizational charts are not merely graphical representations. They express choices regarding power, responsibility, communication, and governance. The clearer the formal design, the greater the capacity to align strategy and execution tends to be.[7-9,16]

Limitations

This study has limitations. It is an analysis of an institutional experience in a single hospital, which limits the generalizability of the findings. The estimation of formal communication links is a theoretical approximation and does not capture all informal flows within the organization. In addition, the study did not directly evaluate clinical, financial, or care-related outcomes associated with the intervention.

Another limitation is that organizational climate data were used only as diagnostic context, rather than as the primary outcome. Future studies may combine organizational architecture analysis, organizational social networks, performance indicators, and employee perceptions to more comprehensively evaluate the effects of structural interventions.[11,12,14-16]

CONCLUSION

The redesign of the organizational architecture of a Brazilian family-owned hospital was associated with a substantial reduction in the estimated formal complexity of communication, with a decrease from 253 to 10 potential links among management positions. The experience suggests that the analysis of organizational charts and formal links can support governance decisions, especially in family-owned healthcare institutions seeking professionalization, decision-making agility, and greater internal alignment.

Leaner organizational structures, when accompanied by clear roles and responsibilities, may promote communication, governance, and institutional competitiveness. Organizational architecture should be understood as a strategic hospital management tool, rather than merely as an administrative representation.

DECLARATIONS

Conflict of Interest: The authors declare that there are no conflicts of interest related to this manuscript.

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Data Availability: The aggregated data underlying the findings may be made available by the corresponding author upon reasonable request, subject to institutional confidentiality and research ethics requirements.

Author Contributions: The authors contributed to the conception of the study, analysis of institutional data, interpretation of the results, drafting, and critical revision of the manuscript.

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SCIENTIFIC ARTICLE - ORIGINAL

TRIPLE-NEGATIVE VERSUS NON-TRIPLE-NEGATIVE INVASIVE BREAST CARCINOMA: COMPARISON OF CLINICOPATHOLOGICAL CHARACTERISTICS, THERAPEUTIC PROFILE AND OUTCOMES IN A HOSPITAL COHORT

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ABSTRACT

Introduction: Triple-negative breast carcinoma (TNBC), defined by the absence of estrogen receptor, progesterone receptor, and HER2 expression, is an aggressive molecular subtype with unfavorable prognosis. Its characterization in Brazilian institutional cohorts contributes to understanding local disease particularities. **Objective:** To compare clinical-pathological characteristics, therapeutic profile, and clinical outcomes between triple-negative and non-triple-negative invasive breast carcinoma patients in a hospital cohort from Central-West Brazil. **Methods:** Retrospective cohort study with 97 patients with confirmed invasive breast carcinoma (DCIS excluded). Triple-negative (n=15) and non-triple-negative (n=82) groups were compared for sociodemographic, tumor, molecular, therapeutic, and outcome variables. Fisher's exact test was used for categorical and Mann-Whitney for continuous variables (significance level: 5%). **Results:** TNBC accounted for 15.5% of the cohort (n=15). The triple-negative group had significantly higher mean Ki-67 (54.0% vs. 15.5%; $p < 0.001$) and higher proportion of grade 3 tumors (40.0% vs. 9.8%; $p = 0.007$). Chemotherapy was performed in 93.3% of triple-negative vs. 51.2% of non-triple-negative cases ($p = 0.003$), predominantly neoadjuvant (93.3% vs. 22.0%; $p < 0.001$). No triple-negative patient received hormone therapy vs. 90.2% in the non-triple-negative group ($p < 0.001$). Death rates were significantly higher in the triple-negative group (26.7% vs. 2.4%; $p = 0.005$), as were recurrence rates (26.7% vs. 6.1%; $p = 0.030$). Kaplan-Meier curves demonstrated inferior overall survival in the triple-negative group (log-rank $p = 6.32 \times 10^{-4}$).
Conclusion: Triple-negative breast carcinoma was associated with higher tumor proliferation, greater use of neoadjuvant chemotherapy, and worse clinical outcomes compared to other subtypes. These findings reinforce the need for specific diagnostic and therapeutic strategies for this subgroup in regional clinical practice.

Keywords: Triple negative breast neoplasms, Molecular subtype, Prognosis, Ki-67, Neoadjuvant chemotherapy.

INTRODUCTION

Triple-negative breast carcinoma (TNBC) is defined by the simultaneous absence of estrogen receptor (ER), progesterone receptor (PR), and human epidermal growth factor receptor 2 (HER2) expression. This molecular subtype accounts for approximately 15–20% of all invasive breast carcinomas and is recognized as having the most aggressive biological behavior, with a higher rate of cellular proliferation, a greater propensity for early systemic dissemination, and poorer overall survival compared with other subtypes.[1]

From a therapeutic perspective, the absence of the three main molecular targets — hormone receptors and HER2 — precludes the use of the two major classes of targeted therapy available for breast cancer treatment: hormone therapy and anti-HER2 agents. Systemic chemotherapy, preferably administered in the neoadjuvant setting, remains the mainstay of treatment, with pathological complete response rates ranging from 30% to 50%, depending on the regimen used. More recently, immunotherapy with the immune checkpoint inhibitor pembrolizumab has been incorporated into the neoadjuvant treatment of high-risk TNBC, representing a significant therapeutic advance for this subgroup.[2]

Characterizing the clinicopathological, therapeutic, and prognostic profile of TNBC in Brazilian institutional cohorts is relevant for several reasons. First, the epidemiological and molecular characteristics of TNBC may vary across populations, with a higher prevalence reported among younger women and women of African ancestry. Second, treatment patterns and clinical outcomes in Brazilian private healthcare settings may differ from those reported in large international clinical trials, particularly with regard to access to modern therapies. Third, regional data on TNBC in the Central-West region of Brazil remain scarce in the indexed literature.[3]

The present study aimed to compare clinicopathological characteristics, treatment profiles, and clinical outcomes between patients with TNBC and non-triple-negative breast carcinoma (non-TNBC) in a hospital cohort from a private healthcare institution in Goiás.

METHODS

The Study Design and Population

A retrospective cohort study was conducted with 97 patients with a histologically confirmed diagnosis of invasive breast carcinoma who were treated at a private referral hospital for oncology in Goiás (2007–2024). Two cases of ductal carcinoma in situ (stage 0) were excluded. The study was conducted in accordance with CNS Resolution No. 466/2012.

Definition of Groups

The triple-negative subtype was defined as the absence of ER, PR, and HER2 expression on immunohistochemical analysis. Patients were allocated to two groups: TNBC (n = 15) and non-TNBC (n = 82). The non-TNBC group included all other molecular subtypes: luminal A, luminal B, and HER2-enriched.

Variables Analyzed

The following variables were compared between groups: sociodemographic characteristics (age at diagnosis); tumor characteristics (clinical stage, tumor size, tumor grade, histological type, axillary involvement); molecular markers (Ki-67); surgical approach (type of surgery,

breast reconstruction); treatment modalities (chemotherapy — setting and type —, hormone therapy, and radiotherapy); and clinical outcomes (death and tumor recurrence).

Statistical Analysis

Between-group comparisons were performed using Fisher's exact test for categorical variables and the Mann–Whitney test for continuous variables (age, tumor size, and Ki-67), given the expected non-normality of the distributions. Overall survival was estimated using the Kaplan–Meier method and compared using the log-rank test. All analyses were performed using R software (version 4.x), with a significance level of 5%.

RESULTS

Prevalence and Overall Profile

TNBC accounted for 15.5% of the cohort (n = 15/97). Comparative characteristics between the groups are presented in Table 1. The mean age at diagnosis was 50.3 ± 10.3 years in the TNBC group vs. 55.8 ± 11.2 years in the non-TNBC group, with no statistically significant difference (p = 0.118), although there was a trend toward diagnosis at a younger age in the triple-negative group (Table 1).

Table 1. Comparison of Clinicopathological Characteristics, Treatment Profiles, and Outcomes Between the Triple-Negative and Non-Triple-Negative Groups (n = 97).

Variable	Triple-negative (n=15)	Non triple-negative (n=82)	p-value
Clinical Characteristics			
Age at diagnosis — mean ± SD (years)	50.3 ± 10.3	55.8 ± 11.2	0.118
Median (min–max)	53 (31–67)	56 (31–77)	—
Clinical stage			
I–II	12 (80.0%)	75 (91.5%)	0.183
III–IV	3 (20.0%)	7 (8.5%)	0.183
Tumor Characteristics			
Tumor size — mean ± SD (cm)	3.2 ± 2.2	2.3 ± 1.1	0.065
Median (min–max)	2.5 (0.9–10.0)	2.0 (0.5–6.0)	—
Tumor grade			
G1	2 (13.3%)	12 (14.6%)	0.007*
G2	7 (46.7%)	62 (75.6%)	—
G3	6 (40.0%)	8 (9.8%)	—
Ki-67 (%)			
Mean ± SD Média ± DP	54.0 ± 19.9	15.5 ± 12.8	< 0.001†
Median (min–max)	50 (10–80)	10 (5–60)	—
Axillary approach			
Negative	8 (53.3%)	61 (74.4%)	0.124
Positive	7 (46.7%)	21 (25.6%)	0.124
Histological type			
IDC	12 (80.0%)	68 (82.9%)	—

ILC	0 (0.0%)	7 (8.5%)	—
Inflammatory carcinoma	1 (6.7%)	1 (1.2%)	—
Other	2 (13.3%)	6 (7.3%)	—
Treatments Received			
Chemotherapy	14 (93.3%)	42 (51.2%)	0.003
Neoadjuvant	14 (93.3%)	18 (22.0%)	< 0.001
Adjuvant	0 (0.0%)	22 (26.8%)	0.020
Radiotherapy	13 (86.7%)	62 (75.6%)	0.508
Hormone therapy	0 (0.0%)	74 (90.2%)	< 0.001
Surgical Approach			
Quadrantectomy	10 (66.7%)	55 (67.1%)	1.000
Unilateral mastectomy	1 (6.7%)	15 (18.3%)	0.453
Bilateral mastectomy	4 (26.7%)	12 (14.6%)	0.264
Breast reconstruction	15 (100.0%)	72 (87.8%)	0.345
Clinical Outcomes			
Death	4 (26.7%)	2 (2.4%)	0.005
Tumor recurrence	4 (26.7%)	5 (6.1%)	0.030

IDC: invasive ductal carcinoma; ILC: invasive lobular carcinoma. *p-value for the overall distribution of tumor grade between groups using Fisher's exact test. †Mann–Whitney test for comparison of mean Ki-67 values.

Tumor and Molecular Characteristics

The TNBC group had a higher proportion of grade 3 tumors (40.0% vs. 9.8%; p = 0.007) and a significantly higher mean Ki-67 (54.0 ± 19.9% vs. 15.5 ± 12.8%; p < 0.001). Mean tumor size was larger in the TNBC group (3.2 ± 2.2 cm vs. 2.3 ± 1.1 cm), although the difference did not reach statistical significance (p = 0.065). Axillary involvement was more frequent in the TNBC group (46.7% vs. 25.6%), without reaching statistical significance (p = 0.124). Stage III–IV disease was observed in 20.0% of the TNBC group vs. 8.5% of the non-TNBC group (p = 0.183).

Treatment Profile

Marked differences in treatment patterns were observed between the groups. Chemotherapy was administered in 93.3% of TNBC cases vs. 51.2% of non-TNBC cases (p = 0.003). Notably, 93.3% of TNBC cases received neoadjuvant chemotherapy, compared with only 22.0% of the non-TNBC group (p < 0.001). No patient in the TNBC group received hormone therapy, compared with 90.2% of the non-TNBC group (p < 0.001) — an expected finding given the definition of the subtype, which excludes hormone receptor expression. Radiotherapy was administered in similar proportions (86.7% vs. 75.6%; p = 0.508). The type of surgery did not differ significantly between the groups, with quadrantectomy predominating in both (66.7% vs. 67.1%; p = 1.000).

Clinical Outcomes and Survival

The proportion of deaths was significantly higher in the TNBC group (26.7%; 4/15) than in the non-TNBC group (2.4%; 2/82; p = 0.005). Similarly, the proportion of recurrences was higher in the TNBC group (26.7%; 4/15) than in the non-TNBC group (6.1%; 5/82; p = 0.030).

Figure 1. presents the Kaplan–Meier curves of overall survival stratified by triple-negative subtype. The TNBC group showed lower overall survival than the non-TNBC group (log-rank $p = 6.32 \times 10^{-4}$) (Figure 1).

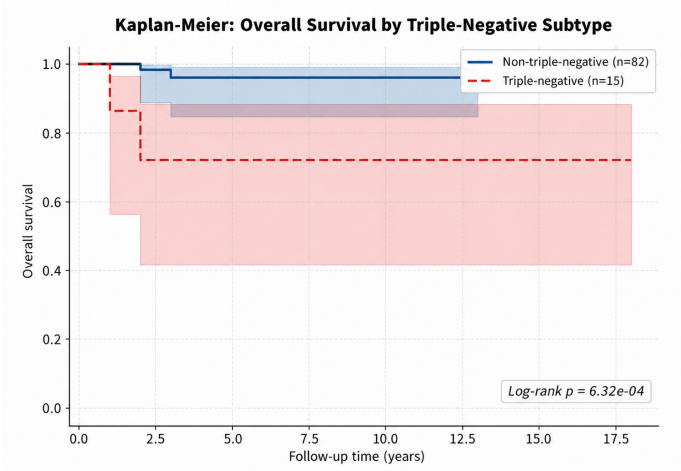

Figure 1. Kaplan–Meier curves of overall survival according to triple-negative subtype. The triple-negative group (n = 15) showed lower survival than the non-triple-negative group (n = 82). Log-rank $p = 6.32 \times 10^{-4}$.

DISCUSSION

This study compared the clinicopathological, therapeutic, and prognostic profiles of TNBC with those of other molecular subtypes in a private hospital cohort from the Central-West region of Brazil. The findings confirm patterns described in the international literature, with TNBC showing greater tumor proliferation, more frequent use of neoadjuvant chemotherapy, and poorer clinical outcomes compared with the non-TNBC group.[4]

The prevalence of TNBC in this cohort (15.5%) is consistent with global estimates, which range from 10% to 20% of invasive breast carcinomas. The trend toward diagnosis at a younger age in the TNBC group (50.3 vs. 55.8 years), although not statistically significant in this sample, is consistent with literature data indicating a higher incidence of TNBC among premenopausal women and women of African ancestry.[5]

The mean Ki-67 value of 54.0% in the TNBC group, significantly higher than the 15.5% observed in the non-TNBC group ($p < 0.001$), reflects the high cellular proliferation characteristic of this subtype. This finding has direct therapeutic implications: tumors with high Ki-67 are recognized as being more chemosensitive, supporting the preferential use of neoadjuvant chemotherapy in TNBC. The proportion of patients receiving neoadjuvant chemotherapy in this group (93.3%) was markedly higher than the 22.0% observed in the non-TNBC group, reflecting current clinical practice for this subtype.[6]

The higher proportion of grade 3 tumors in the TNBC group (40.0% vs. 9.8%; $p = 0.007$) is consistent with the more aggressive biological behavior of this subtype. High histological grade, together with elevated Ki-67, constitutes a profile of high proliferative activity and

aggressiveness that supports the more intensive therapeutic approach observed in this group. The trends toward greater axillary involvement (46.7% vs. 25.6%) and larger tumor size (3.2 vs. 2.3 cm), although not statistically significant in this sample, are consistent with the greater local aggressiveness of TNBC.[7]

The proportions of deaths (26.7% vs. 2.4%; p = 0.005) and recurrences (26.7% vs. 6.1%; p = 0.030) were significantly higher in the TNBC group, and the Kaplan–Meier curves confirmed lower overall survival in this group (log-rank p = 6.32×10^{-4}). These results are consistent with the literature reporting lower five-year survival rates for TNBC compared with luminal and HER2-enriched subtypes receiving targeted therapy.[8]

Several limitations should be highlighted. The TNBC group was small (n = 15), limiting the statistical power of the comparisons and the stability of the survival estimates. Confidence intervals for estimates in the TNBC group are necessarily wide, and the results should therefore be interpreted as exploratory. Detailed molecular subtype data (luminal A vs. luminal B and HER2-enriched) were not available for the non-TNBC group, precluding within-group comparisons. The lack of data on pathological complete response to neoadjuvant chemotherapy represents another relevant limitation in the prognostic characterization of TNBC in this cohort.[9,10]

CONCLUSION

Triple-negative breast carcinoma accounted for 15.5% of this cohort and exhibited tumor characteristics indicative of greater biological aggressiveness — higher Ki-67 and a greater proportion of grade 3 tumors — compared with the other subtypes. The treatment profile was characterized by the nearly universal use of neoadjuvant chemotherapy and the absence of hormone therapy, reflecting the molecular characteristics of this subtype. The proportions of deaths and recurrences were significantly higher in the triple-negative group, with lower overall survival confirmed by Kaplan–Meier analysis.

These findings reinforce the importance of early identification of the triple-negative subtype at diagnosis to guide specific therapeutic strategies and of closer clinical follow-up in this subgroup. Larger patient series and the incorporation of data on response to neoadjuvant chemotherapy are needed to enable more robust prognostic analyses of TNBC in the regional context.

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VISUAL MANAGEMENT OF NURSING SCHEDULES FOR WORKFORCE BALANCING AND REDUCTION OF OVERTIME COVERAGE: A LONGITUDINAL QUALITY IMPROVEMENT STUDY

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ABSTRACT

Introduction: Fluctuations in care demand and staff availability can lead to imbalances in nursing schedules and the need for extraordinary coverage. Visual management can support the identification of these imbalances and the reallocation of staff, yet its application to workforce balancing remains underexplored. **Objective:** To evaluate the association between implementation of a visual nursing schedule management system and changes in overtime coverage, personnel costs, and indicators of care demand and workforce allocation. **Methods:** A longitudinal quality improvement study was conducted in a private tertiary hospital in Midwestern Brazil. August 2025 was defined as the baseline period. The intervention began in September 2025 and was followed through May 2026. The system integrated schedules, absenteeism, hospital occupancy, staff redeployment, open positions, turnover, overtime coverage, and costs. Monthly descriptive measures were analyzed for a workforce comprising 132 nursing technicians and 28 registered nurses. **Results:** Overtime coverage decreased from 143 events at baseline to a post-implementation monthly mean of 23.4, an 83.6% reduction. Monthly costs decreased from BRL 32,693.00 to a mean of BRL 6,071.42, an 81.4% reduction. Hospital occupancy remained high, with a post-implementation mean of 82.27%. During the same period, weighted absenteeism was 1.37% and the mean staff redeployment rate was 3.39%. **Conclusions:** Implementation of visual management was associated with sustained reductions in overtime coverage and related costs without a reduction in care demand. The findings suggest that greater operational visibility and structured staff redeployment may improve hospital workforce balancing.

Keywords: Nursing staff, Hospital, Quality improvement, Absenteeism, Hospital costs, Efficiency, Organizational, Hospital administration.

INTRODUCTION

Nursing workforce management is a central determinant of hospital performance, as the availability and appropriate allocation of professionals are directly related to

continuity of care, patient safety, staff experience, and financial sustainability. In highly complex hospital settings, variations in absenteeism, open positions, turnover, and daily occupancy may generate operational imbalances, which are frequently compensated for by overtime coverage, double shifts, or overtime.[1-3]

Visual management is a relevant component of Lean Healthcare and seeks to make operational conditions visible, standardize responses, and support timely decision-making. In hospitals, visual tools have been applied to patient flow, safety, team communication, and process improvement. However, their specific use to balance the nursing workforce and reduce coverage costs remains underexplored.[4-9]

The intervention analyzed was based on the hypothesis that a structured visual system could reveal staffing deficits and surpluses at an early stage, facilitate internal redeployment, and reduce reactive and costly solutions. The objective of this study was to evaluate the association between the implementation of visual management of nursing schedules and trends in overtime coverage, the corresponding costs, and indicators of workforce demand and allocation.

METHODS

Study Design

A longitudinal, single-center quality improvement study structured according to the SQUIRE 2.0 recommendations. Routinely collected operational and administrative data were used, with comparison between one baseline month and nine months of post-implementation follow-up.[10]

Setting and Workforce

The study was conducted in a highly complex private hospital located in the Central-West region of Brazil. The dashboard monitored 64 beds distributed across inpatient units, a general intensive care unit, a coronary care unit, the emergency department, and clinical support areas. The workforce comprised 160 professionals: 132 nursing technicians and 28 nurses. Seven professionals served as float staff to support workforce balancing across units, without expansion of the total workforce.

Intervention

The implementation of visual management began in September 2025. The tool integrated nursing schedules, absenteeism, hospital occupancy, staff redeployment, open positions, turnover, overtime coverage events, and associated expenses. Clinical leadership used the dashboard to monitor staffing deficits and surpluses and decide on internal redistribution before authorizing overtime coverage.

The intervention logic was: visual monitoring of the workforce; early identification of deficits and surpluses; structured redeployment; improved staff balancing; reduction in overtime coverage; and reduction in operational costs.

Data Sources and Definitions

Data were extracted from institutional spreadsheets and business intelligence dashboards. Overtime coverage was defined as each individual record of additional paid work associated with a staffing deficit, including open positions, leaves of absence, medical certificates,

vacations, onboarding of a new employee, or other recorded operational needs. The monthly cost corresponded to the sum of the amounts paid each month.

Context indicators were hospital occupancy, absenteeism, redeployment rate, open positions, and turnover. The redeployment rate corresponded to the proportion of internal staff movements recorded in the institutional dashboard. August 2025 was defined as the baseline month. The post-implementation period comprised September 2025 through May 2026.

Data Analysis

Frequencies, monthly means, proportions, and percentage changes were calculated. The post-implementation mean was compared with the baseline month value. Monthly trend graphs and a Pareto analysis of the main reasons for coverage were prepared. Due to the availability of only one pre-intervention month, no formal interrupted time-series analysis or causal inference was performed.

Ethical Aspects

The study exclusively used aggregated and anonymized operational data, without access to identifiable information from patients or professionals. No clinical interventions or additional data collection were performed. The institutional ethical framework may be provided to the journal upon request.

RESULTS

Setting Characteristics

The workforce analyzed comprised 160 nursing professionals working 12- and 8-hour shifts. The 132 nursing technicians represented 82.5% of the workforce, and the 28 nurses, 17.5%. Seven float staff members were incorporated into the workforce and allocated to operational flexibility. The characteristics of the setting are presented in Table 1.

Table 1. Characteristics of the setting and the nursing workforce.

Variable	Value
Total nursing workforce	160
Nursing technicians	132
Nurses	28
Nursing technicians working 12-hour shifts	109
Nursing technicians working 8-hour shifts	23
Nurses working 12-hour shifts	24
Nurses working 8-hour shifts	4
Float nursing professionals	7
Monitored beds	64

Coverage and Costs

In the baseline month, 143 overtime coverage events were recorded, at a cost of R$ 32,693.00. During the nine post-implementation months, the monthly mean was 23.4 coverage

events and R$ 6,071.42, corresponding to reductions of 83.6% and 81.4%, respectively. The lowest level was observed in April 2026, with 13 coverage events and a cost of R$ 3,699.00. In May 2026, there was an increase to 28 coverage events and R$ 7,847.99; even so, these values remained 80.4% and 76.0% below baseline, respectively.

Baseline hospital occupancy was 80.48%, and the post-implementation mean was 82.27%.

Table 2. Monthly evolution of operational and financial indicators.

Month	Phase	Coverage	Cost	Occupancy	Repositioning	Absenteeism
Aug/25	Baseline	143	R$ 32,693.00	80.48%	-	-
Sep/25	Post	30	R$ 7,550.25	83.42%	4.26%	1.93%
Oct/25	Post	28	R$ 7,070.50	79.60%	3.32%	1.63%
Nov/25	Post	23	R$ 5,777.00	82.60%	2.39%	0.75%
Dec/25	Post	19	R$ 5,001.00	79.39%	4.20%	1.75%
Jan/26	Post	35	R$ 8,373.00	81.10%	3.50%	1.72%
Feb/26	Post	18	R$ 5,314,00	80,99%	2.30%	1.30%
Mar/26	Post	17	R$ 4,010,00	88.28%	2.48%	1.19%
Apr/26	Post	13	R$ 3,699.00	80,84%	3.70%	1.10%
May/26	Post	28	R$ 7,847.99	84.20%	4.35%	0.89%

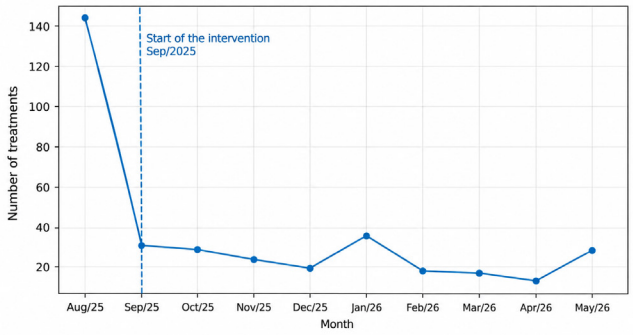

Figure 1. Monthly evolution of extraordinary coverages. The dashed line indicates the start of the intervention in September 2025.

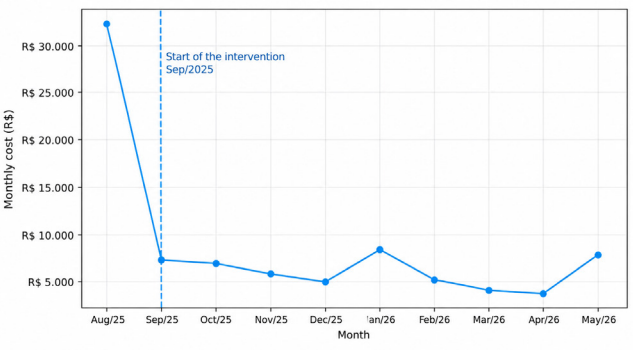

Figure 2. Monthly evolution of costs related to extraordinary coverages.

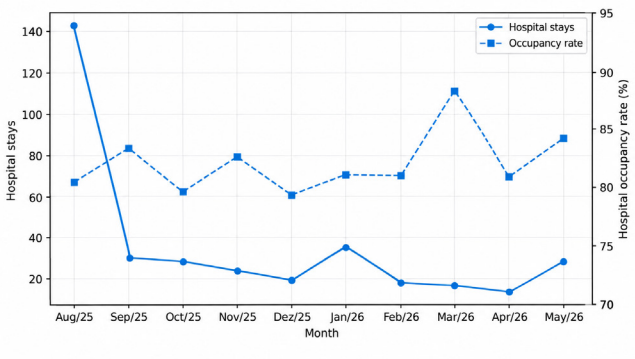

Figure 3. Monthly evolution of extraordinary coverage in relation to hospital occupancy.

Weighted absenteeism during follow-up was 1.37%, while the mean redeployment rate was 3.39%. The monthly series is presented in Table 2 and Figures 1 to 3.

Table 3. Main reasons for extraordinary coverage.

Reason	Events	Cost	%	% accumulated
Open position – termination	126	R$ 31,692.25	35.6%	35.6%
Sick leave	91	R$ 22,433.15	25.7%	61.3%
Accompaniment of new employee	32	R$ 7,801.17	9.0%	70.3%
Open position – leave of absence	29	R$ 7,681.00	8.2%	78.5%
Holidays	15	R$ 3,395.00	4.2%	82.8%
Suspension – administrative measure	14	R$ 3,806.00	4.0%	86.7%
Dialysis = Hemodialysis	13	R$ 2,426.00	3.7%	90.4%
Shortage	11	R$ 2,307.00	3.1%	93.5%
Integration	5	R$ 1,601.00	1.4%	94.9%
Rescheduling	4	R$ 1,334.00	1.1%	96.0%

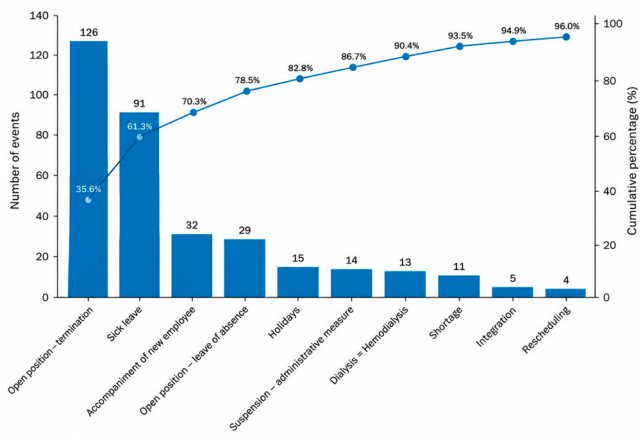

Figure 4. Pareto analysis of the main reasons for extraordinary coverage.

The units with the highest participation were the General ICU, 4th Floor, Emergency Department, 5th Floor, and CCU, which accounted for 81.1% of the events (Table 4).

Table 4. Units with the highest number of extraordinary coverage events.

Department/Unit	Events	Cost	%	Cumulative %
General ICU	77	R$ 18,704.75	21.8%	21.8%
4th Floor	72	R$ 20,219.65	20.3%	42.1%
Emergency	55	R$ 13,550.34	15.5%	57.6%
5th Floor	42	R$ 10,382.00	11.9%	69.5%
UCO	41	R$ 9,999.50	11.6%	81.1%
6th Floor	38	R$ 8,246.50	10.7%	91.8%
CME (Central Sterile Services)	15	R$ 3,202.00	4.2%	96.0%
Surgical Center	8	R$ 1,776.00	2.3%	98.3%
Diagnostics	2	R$ 371.50	0.6%	98.9%
Coordination	2	R$ 481.50	0.6%	99.4%

DISCUSSION

Main Findings

The implementation of visual management of nursing schedules was temporally associated with a substantial reduction in overtime coverage and related costs. This result occurred with sustained hospital occupancy and in the presence of factors that could increase the need for coverage, such as open positions, turnover, and absenteeism. The partial increase observed in May 2026 did not eliminate the observed operational effect, as the indicators remained substantially below baseline.

Interpretation

Lean Healthcare emphasizes transparency, flow, and waste reduction. In this study, visual management was applied to workforce allocation, making the relationship between schedules, absences, occupancy, redeployment, and costs visible. This arrangement facilitated faster and more structured decisions and reduced dependence on reactive responses.[4-7]

The relatively low weighted absenteeism suggests that the reduction in coverage was not solely due to a lower frequency of absences. Likewise, sustained occupancy indicates that the result was not explained by reduced demand for care. The most plausible interpretation is improved balancing of the existing workforce, supported by operational visibility, float staff, and internal redeployment.[11-14]

Hospitals frequently respond to variability in demand and staff availability through overtime or temporary hiring. Capacity and flow management strategies indicate that reducing avoidable variability and improving resource allocation can increase efficiency without compromising care delivery.[15-17]

In addition to operational tools, the ability to sustain improvements depends on organizational

maturity and governance structures capable of integrating monitoring, leadership, and decision-making. In a longitudinal study conducted in a Brazilian hospital, an evolution in organizational maturity was observed, with higher performance in the governance domain and progress in workforce management, reinforcing the importance of the institutional context for sustaining structured improvement interventions.[18]

Practical Implications

The tool can function as an operational control tower for nursing resources. Its implementation requires the definition of indicators, an update routine, transparent redeployment criteria, and active participation of leadership. The model has a relatively low technological cost and can be adapted to hospitals with different structures, provided that local staffing requirements and care complexity are taken into account.

Limitations

The study was conducted in a single hospital and used routinely collected administrative data. Only one pre-intervention month was available, limiting causal inference and precluding formal interrupted time-series analysis. There was no concurrent control group or direct assessment of clinical outcomes, staff experience, or missed care. The operational definitions of redeployment and coverage may limit direct comparability with other institutions.

Strengths

The study used real-world operational data, integrated financial and workforce indicators, and included hospital occupancy as a contextual measure. Follow-up through May 2026 included a month of partial rebound in coverage, allowing for a more conservative interpretation of the sustainability of the result.

CONCLUSION

Visual management of nursing schedules was associated with a substantial reduction in overtime coverage and staffing-related costs, without a reduction in hospital occupancy. The intervention increased the visibility of imbalances and supported the structured redeployment of available professionals, promoting better utilization of the existing workforce. Future studies should include longer baseline series, comparator groups, and measures of patient safety and staff experience.

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HOSPITAL MORTALITY DUE TO NEONATAL SEPSIS IN BRAZIL

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ABSTRACT

Introduction: Sepsis remains among the leading causes of neonatal mortality worldwide, constituting an important public health problem. **Objectives:** To describe and analyze mortality rates from early and late neonatal sepsis in Brazil between 2020 and 2025, showing the temporal evolution, place of occurrence, age, sex, and co-lor/race. **Methods:** This is a quantitative, cross-sectional and retrospective study, with a survey of confirmed cases of neonatal sepsis in the last five years. Data were obtained from the Department of Informatics platform of the Unified Health System. **Results:** A total of 12,142 deaths related to neonatal sepsis were recor-ded in Brazil. The highest number of occurrences was recorded in 2021 (n = 2,646). As of 2022, there was a downward trend in the absolute number of de-aths, with records of 2,344 in 2023 and 2,163 in 2024. Regarding geographic dis-tribution, the Southeast Region concentrated the highest number of deaths (n = 4,582), followed by the Northeast Region. There was a predominance of deaths in the early neonatal period, especially among newborns aged between 0 and 6 days, totaling 5,757 records. **Conclusions:** The results reinforce that factors rela-ted to the biological vulnerability of the newborn, especially prematurity, remain strongly associated with fatal outcomes due to neonatal sepsis, corroborating the evidence available in the literature. These findings highlight the need to streng-then strategies for prevention, early diagnosis, and timely management of neona-tal sepsis, particularly among higher-risk newborns.

Keywords: Brazil, Infant mortality, Pediatrics, Premature, Neonatal sepsis.

INTRODUCTION

Sepsis is a complex clinical syndrome resulting from a dysregulated response of the immune system to an infectious process. This phenomenon involves the simultaneous activation of pro-inflammatory pathways and immunosuppressive mechanisms, creating a state of immune imbalance that may progress to multiple organ dysfunction and high mortality. In pediatric intensive care units, this condition remains an important clinical challenge, requiring effective

strategies for early recognition and immediate therapeutic intervention.[1]

Infants constitute a particularly vulnerable group, since the immune system is still undergoing maturation, which favors intensified inflammatory responses to infectious agents.[2] In addition, the clinical course of sepsis may occur rapidly and unpredictably, with abrupt deterioration of the clinical condition, a circumstance that contributes significantly to increased mortality.[3]

In the neonatal period, sepsis is characterized as a clinical syndrome associated with the presence of systemic signs of infection accompanied by the identification of pathogenic microorganisms—including bacteria, viruses, or fungi—in sterile body fluids, such as blood or cerebrospinal fluid, during the first 28 days of life.[4] This condition remains among the leading causes of neonatal mortality worldwide, constituting an important public health problem [5]. Studies indicate that newborns affected by sepsis have a significantly higher probability of progressing to death when compared with those who do not develop systemic infection.[6]

The epidemiological distribution of neonatal sepsis demonstrates a higher incidence in low- and middle-income countries, where socioeconomic factors, structural limitations of healthcare services, and difficulties in accessing specialized care contribute to increased neonatal mortality. It is estimated that approximately 30% to 40% of neonatal deaths in these contexts are related to systemic infectious processes. In Brazil, data from the Mortality Information System (SIM) indicate that a significant proportion of infant deaths occurs during the neonatal period, with sepsis identified as one of the main factors associated with these outcomes.[7]

Among the most relevant risk factors for the development of neonatal sepsis are prematurity and low birth weight, especially in newborns weighing less than 1,500 grams. In this population, immune immaturity, associated with a greater need for invasive interventions and prolonged hospitalization, contributes to a significant increase in susceptibility to infections. Consequently, preterm newborns have a substantially higher risk of developing sepsis when compared with term newborns.[8]

In addition to neonatal factors, maternal and perinatal conditions also play a relevant role in the occurrence of sepsis. These include the presence of maternal infections during pregnancy, preeclampsia, congenital malformations, and low Apgar scores at birth. In situations in which diagnosis is delayed or treatment is not instituted in a timely manner, the clinical course may result in progressive worsening of the condition and an increased risk of mortality. In this context, strengthening strategies aimed at prevention, epidemiological surveillance, and early detection of the disease becomes essential, especially in more vulnerable populations.[3]

From a clinical perspective, the initial signs of neonatal sepsis may be nonspecific, which makes early diagnosis difficult. Behavioral changes, such as decreased responsiveness to the environment, irritability, persistent crying, difficulty sucking, feeding refusal, and lethargy, may represent initial manifestations of systemic infection with potential progression to sepsis.[9] In the presence of clinical suspicion, management should be immediate and systematic, including continuous monitoring of physiological parameters—such as heart rate, respiratory rate, blood pressure, peripheral oxygen saturation, body temperature, and urine output. In parallel, the collection of microbiological cultures from different sites before the initiation of antimicrobial therapy is recommended whenever possible.[2]

Empirical antibiotic therapy should be instituted early, preferably within the first hours after diagnostic suspicion, in order to reduce the risk of progression to septic shock

and organ failure. Supportive measures, such as fluid resuscitation, ventilatory support, and nutritional support, may also be necessary, and the patient should remain under continuous clinical monitoring to assess the therapeutic response and identify early the need for additional interventions, including the use of vasoactive drugs.[2]

Alongside treatment, preventive strategies play a fundamental role in reducing the incidence of neonatal sepsis. Strict adoption of hospital infection control measures, especially adequate hand hygiene by healthcare professionals, constitutes one of the most effective interventions for reducing the transmission of microorganisms in hospital settings. Additionally, the judicious use of invasive devices, such as venous catheters, and the appropriate indication of antibiotic prophylaxis in specific situations of infectious risk have demonstrated a positive impact on disease prevention.[10]

Care practices centered on humanized care, such as the kangaroo method and the encouragement of breastfeeding, have also been widely recognized for their benefits in the immunological protection of newborns, contributing to the reduction in the occurrence of neonatal infections and promoting better outcomes in child development.[11,12]

Given the relevance of the topic, the present study aims to describe and analyze mortality rates due to early- and late-onset neonatal sepsis in Brazil between 2020 and 2025, highlighting temporal trends, place of occurrence, age, sex, and color/race.

METHODS

This is a quantitative, cross-sectional, and retrospective study, with a survey of confirmed cases of neonatal sepsis over the last five years. Data were obtained from the platform of the Department of Informatics of the Brazilian Unified Health System (DATASUS).

The study was conducted at the national level with a population (N) of 12,142 patients with neonatal sepsis. The time frame for data analysis was from 2020 to 2025 (the last five years recorded on the data platform). Deaths by occurrence caused by neonatal sepsis in newborns from 0 to the 27th day of life were analyzed, covering the Brazilian national territory, without considering differences between regions. The study was based on category P36 (Bacterial sepsis of newborn) of the International Classification of Diseases (ICD-10). The results obtained were organized in tables using Microsoft Excel software.

No exclusion criteria were considered due to the methodological nature of the study. In addition, data from all macro-regions of Brazil (North, Northeast, Southeast, South, and Central-West) were analyzed to encompass variations in population density, socioeconomic characteristics, and climate. On this platform, clinical data cannot be accessed, only the number of deaths, which can be stratified by age (age group) and location.

It was decided to study neonates (zero to 27 days of life) who had a medical diagnosis of neonatal sepsis. The main cause of death was coded according to the guidelines of the World Health Organization, following the instructions of the physician responsible in any field of the death certificate (DC), according to code P36 of the International Classification of Diseases (ICD-10).

During the study, data containing the names of the reported individuals were not exported; therefore, their identities were kept confidential, with no need for the use of the Informed Consent Form (ICF) or approval by the Research Ethics Committee (REC).

RESULTS

This is an epidemiological, quantitative, cross-sectional, and retrospective study based on the analysis of deaths due to bacterial sepsis of the newborn recorded in the Mortality Information System (SIM/DATASUS) from 2020 to 2025.

During the period analyzed, 12,142 deaths related to neonatal sepsis were recorded in Brazil. The highest number of occurrences was recorded in 2021 (n = 2,646), followed by 2020 (n = 2,587) and 2022 (n = 2,402). From 2022 onward, a downward trend in the absolute number of deaths was observed, with 2,344 recorded in 2023 and 2,163 in 2024 (Table 1).

Table 1. Number of deaths due to neonatal sepsis (n = 12,142) for the years 2020 to 2025, Brazil.

ICD-10 Category	2020	2021	2022	2023	2024	2025	Total
Bacterial sepsis of newborn	2,587	2,646	2.402	2,344	2.163	-	12,142

Source: MS/SVSA/CGIAE - Mortality Information System – SIM.

Regarding geographic distribution, the Southeast Region accounted for the highest number of deaths (n = 4,582), followed by the Northeast Region (n = 3,992). Together, these two macro-regions accounted for approximately 70% of all deaths recorded during the period analyzed, demonstrating an important spatial concentration of mortality due to neonatal sepsis in the country (Table 2).

Table 2. Number of deaths due to neonatal sepsis (n = 12,142) by region between 2020 and 2025, Brazil.

Categoria CID-10	Região Norte	Região Nordeste	Região Sudeste	Região Sul	Região Centro-Oeste	Total
Septicemia bacteriana do recém-nascido	1.590	3.992	4.582	1.062	916	12.142

Source: MS/SVSA/CGIAE - Mortality Information System – SIM.

Regarding the place of occurrence of deaths, there was a marked predominance of the hospital setting, accounting for 12,028 records, corresponding to almost all reported deaths. The remaining deaths occurred in other healthcare facilities, homes, public roads, or other locations, representing a residual percentage of the total records (Table 3**).**

Table 3. Number of deaths due to neonatal sepsis (n = 12,142) by place of occurrence between 2020 and 2025, Brazil.

Region	Hospital	Other healthcare facility	Home	Via pública	Other	Unknown	Total
North Region	1,563	7	10	6	12	-	1,598
Northeast Region	3,943	19	8	11	8	-	3,989
Southeast region	4,559	11	4	1	8	-	4,583
South Region	1,062	-	-	-	2	-	1,064
Central-West Region	901	2	2	-	2	1	908
Total	12,028	39	24	18	32	2	12,142

Source: MS/SVSA/CGIAE - Mortality Information System – SIM.

The analysis of demographic characteristics (Table 4) demonstrated a predominance of deaths in the early neonatal period, especially among newborns aged 0 to 6 days, totaling 5,757 records, compared with 5,008 deaths observed among those aged 7 to 27 days. In both age groups, the Southeast Region had the highest numbers, with 2,067 deaths among newborns aged 0 to 6 days and 1,981 among those aged 7 to 27 days.

Regarding sex, a higher frequency of deaths was observed among male newborns (n = 6,781) compared with female newborns (n = 5,344). The highest concentration of male deaths was recorded in the Southeast Region (n = 2,516), followed by the Northeast Region (n = 2,268), a pattern similar to that observed for females (Table 4).

Regarding color/race, there was a predominance of deaths among individuals classified as mixed-race (pardo) (n = 6,632), concentrated mainly in the Northeast Region (n = 2,859), followed by the Southeast Region (n = 2,024). Among individuals classified as White, 4,079 deaths were recorded, with the highest concentration also in the Southeast Region (n = 2,130), reflecting differences in demographic and population distribution among the Brazilian macro-regions (Table 4).

Table 4. Number of deaths due to neonatal sepsis (n = 12,142) by demographic profile between 2020 and 2025, Brazil.

	Region					
	North Region	Northeast Region	Southeast region	South Region	Central-West Region	Total
Age						
0 to 6 days	910	1,837	2,067	502	441	5,757
7 to 27 days	550	1,637	1,981	455	385	5,008
Sex						
Male	885	2,268	2,516	591	521	6,781
Female	712	1,710	2,063	473	386	5,344
Ignored	1	11	4	-	1	17
Color/Race						
White	211	551	2,130	890	297	4,079
Black	16	104	189	30	9	348
Asian	1	4	3	-	2	10
Mixeed-race	1.152	2,859	2,024	109	488	6,632
Indígenous	98	27	9	9	31	174
Unknown	120	444	228	26	81	899

Source: MS/SVSA/CGIAE - Mortality Information System – SIM.

DISCUSSION

The present study characterized the epidemiological profile of deaths associated with neonatal sepsis in Brazil between 2020 and 2025, demonstrating that mortality remains concentrated among biologically more vulnerable newborns, especially those with low birth weight and prematurity. These findings reinforce the role of these conditions as prognostic determinants of neonatal sepsis and demonstrate that, despite advances in perinatal care, such factors remain strongly associated with fatal outcomes.

The influence of birth weight on neonatal mortality has been consistently described in the literature. Jovičić et al. [13] demonstrated an inversely proportional relationship between birth weight and survival, showing a progressive increase in lethality as weight decreases. The authors observed that low-birth-weight newborns had a more than sixfold probability of progressing to death when compared with neonates with adequate weight. Thus, low birth weight is shown to constitute one of the main markers of clinical severity in neonatal sepsis.

Similarly, Aguiar et al. [14], when analyzing deaths due to septicemia in the state of Bahia, identified a higher concentration of deaths among neonates weighing between 500 and 999 g, corroborating the pattern observed at the national level. Although the present study is unable to evaluate this variable, these studies suggest that the impact of low birth weight transcends geographic and healthcare differences, reflecting physiological limitations inherent to organ immaturity, reduced immune response, and greater susceptibility to infectious complications.

Prematurity was also closely related to the risk of mortality. The results of Afonso et al. [15] indicated a significant increase in the risk of death in newborns with a gestational age of less than 37 weeks, a result consistent with the findings of this study. However, while the present study demonstrated a higher frequency of deaths among extremely preterm newborns, Afonso et al. [15] observed a predominance among neonates born between 28 and 36 weeks.

On the other hand, the data presented by Aguiar et al. [14] demonstrated higher mortality among extremely preterm newborns, followed by very preterm newborns, more closely resembling the profile found in the present analysis. These differences probably reflect population variations, availability of neonatal intensive care, the profile of referral services, and the classification criteria used in each investigation. Nevertheless, the three studies converge in recognizing prematurity as one of the most relevant prognostic factors for mortality due to neonatal sepsis.

In the present study, a predominance of deaths among males was observed, a result that reproduces a trend widely described in national and international epidemiological studies. The greater vulnerability of male newborns has been attributed to the interaction between hormonal, immunological, and genetic factors, including later pulmonary maturation, differences in the inflammatory response, and greater susceptibility to severe infections during the neonatal period. Thus, although biological sex does not represent a modifiable factor, its identification as a risk marker may contribute to greater clinical surveillance in vulnerable groups.

Regarding distribution by color/race, the predominance of deaths among White newborns should be interpreted in light of the demographic composition of the population studied, not necessarily indicating a greater intrinsic risk associated with this variable. As discussed by Jesus et al. [16], racial inequalities observed in neonatal mortality frequently reflect structural differences related to socioeconomic conditions, timely access to specialized services, and the quality of maternal and child

healthcare. Therefore, the interpretation of racial data should simultaneously consider population distribution and the social determinants of health, avoiding simplified causal inferences.

The findings also reinforce the high lethality attributed to neonatal sepsis itself. Milton et al. [17] demonstrated that all-cause mortality progressively increases from neonates with clinical suspicion of sepsis to those with microbiologically confirmed infection, demonstrating a direct relationship between the diagnosis of sepsis and worsening prognosis. This observation complements the results of the present study by indicating that, regardless of demographic characteristics, the presence of systemic infection represents an important determinant of neonatal mortality.

Although different studies use distinct methodologies, populations, and diagnostic definitions, there is notable convergence regarding the main factors associated with unfavorable outcomes, such as prematurity, low birth weight, and confirmed sepsis, which remain consistently associated with increased mortality. In contrast, the divergences observed in the magnitude of lethality rates and distribution among subgroups demonstrate that contextual factors, such as regional differences in the organization of neonatal care, availability of intensive care units, local microbiological profiles, and the diagnostic criteria employed, exert an important influence on the results found.

In this context, Fleischmann et al. [18] highlight that the absence of internationally standardized definitions for neonatal sepsis and the scarcity of robust epidemiological studies hinder comparisons between countries and compromise estimates of the true global burden of the disease. This methodological heterogeneity may also explain some of the differences observed between national and international studies, reinforcing the need for standardization of diagnostic criteria and strengthening of epidemiological surveillance systems.

From a healthcare perspective, Strunk et al. [19] emphasize that, although early antibiotic therapy and intensive support remain fundamental pillars of treatment, preventive strategies have even greater potential to reduce mortality. Measures such as improving the quality of obstetric and neonatal care, strengthening protocols for the prevention of healthcare-associated infections, continuous training of multidisciplinary teams, and implementation of continuous quality improvement programs have demonstrated a significant impact on reducing the incidence and lethality of neonatal sepsis.

Thus, the findings of the present study reinforce the need for public policies aimed not only at the timely treatment of established sepsis, but mainly at the early identification of newborns at greater risk and the systematic adoption of preventive strategies capable of reducing neonatal mortality on a national scale.

CONCLUSIONS

The findings of this study demonstrate that neonatal sepsis remains an important cause of mortality in Brazil, with deaths concentrated in the early neonatal period and heterogeneously distributed among the country's macro-regions. A greater magnitude of mortality was observed in the first days of life, with a predominance among male newborns and a higher concentration of deaths in the Southeast and Northeast regions, reflecting both population distribution and the particularities of the organization of neonatal care in these locations.

The results reinforce that factors related to the biological vulnerability of the newborn, especially prematurity, remain strongly associated with fatal outcomes due to neonatal

sepsis, corroborating the evidence available in the literature. These findings highlight the need to strengthen strategies for the prevention, early diagnosis, and timely management of neonatal sepsis, particularly among newborns at greater risk.

From a public health perspective, the data presented highlight the importance of improving prenatal, perinatal, and neonatal care, with emphasis on the prevention of prematurity, improvement of care for critically ill newborns, and implementation of evidence-based care protocols. In parallel, strengthening epidemiological surveillance and the quality of national information systems is essential to monitor the temporal evolution of the disease, identify priority groups, and support the planning of public policies aimed at reducing neonatal mortality.

Finally, considering the high mortality burden associated with neonatal sepsis in the country, it is essential to expand national epidemiological studies capable of integrating clinical, obstetric, and microbiological information, allowing a more precise understanding of the determinants of this condition and guiding more effective interventions to reduce neonatal morbidity and mortality in Brazil.

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OVERALL SURVIVAL ACCORDING TO MOLECULAR SUBTYPES AND CLINICAL STAGING IN INVASIVE BREAST CARCINOMA PATIENTS: KAPLAN-MEIER ANALYSIS IN A HOSPITAL COHORT

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ABSTRACT

Introduction: Overall survival analysis according to molecular subtypes and clinical staging is essential for understanding prognosis in breast cancer. **Objective:** To estimate and compare overall survival of patients with invasive breast carcinoma according to clinical staging and main molecular subtypes in a hospital cohort from Central-West Brazil. **Methods:** Retrospective cohort study with 97 patients with confirmed invasive breast carcinoma, excluding ductal carcinoma in situ. Kaplan-Meier curves were compared by the log-rank test, stratified by staging (I–II vs. III–IV), triple-negative subtype, hormone receptor status, and HER2. Follow-up was estimated from the year of treatment initiation. **Results:** Mean estimated follow-up was 3.9 years (median: 3.0; range: 1–18 years). Six deaths (6.2%) and 9 recurrences (9.3%) were recorded. Advanced staging was associated with significantly worse survival (log-rank $p = 2.22 \times 10^{-10}$): death rate 50.0% vs. 1.1%. Triple-negative subtype showed worse survival vs. non-triple-negative (log-rank $p = 6.32 \times 10^{-4}$): 26.7% vs. 2.4% deaths. Hormone receptor negativity identified a higher-risk subgroup (log-rank $p = 6.27 \times 10^{-4}$): 22.7% vs. 1.3% deaths. HER2 status showed no significant difference (log-rank $p = 0.983$). **Conclusion:** Advanced staging, triple-negative subtype, and hormone receptor negativity were associated with worse overall survival. These findings reinforce the importance of molecular stratification and early diagnosis for prognostic individualization in breast oncology.

Keywords: Breast neoplasms, Survival analysis, Kaplan-Meier estimator, Molecular subtype, Prognosis.

INTRODUCTION

Survival analysis is a fundamental tool in prognostic research in oncology, allowing estimation of the probability of survival over time in populations with varying follow-up periods and incomplete events. In breast cancer, overall survival is determined by multiple clinical, pathological, and molecular factors, with clinical stage at diagnosis and the molecular profile of the tumor being the predictors with the greatest impact on the outcome.[1]

The molecular classification of breast cancer into subtypes — luminal A, luminal B, HER2-enriched, and triple-negative — has provided the basis for individualized therapeutic strategies and revolutionized the understanding of the biological behavior of the disease. The triple-negative subtype, due to the absence of hormone receptors and HER2 and the consequent lack of specific targeted therapies, has the poorest prognosis among the molecular subtypes. In contrast, hormone receptor-positive tumors exhibit less aggressive behavior and benefit from long-term adjuvant hormone therapy.[2]

In small hospital cohorts, the Kaplan–Meier method is particularly suitable for survival analysis because it does not impose parametric assumptions and naturally accommodates censored data. The log-rank test allows formal comparisons between subgroups, although with limited statistical power when the number of events is low — a limitation that should be explicitly considered when interpreting the results.[3]

The present study aimed to estimate and compare the overall survival of patients with invasive breast carcinoma according to clinical stage and the main molecular subtypes in a hospital cohort from the Central-West region of Brazil.[4]

METHODOLOGY

The Study Design and Population

A retrospective cohort study was conducted with 97 patients with a histologically confirmed diagnosis of invasive breast carcinoma treated at a private referral hospital for oncology in Goiás. Two cases of ductal carcinoma in situ (DCIS, stage 0) were excluded. The study was conducted in accordance with CNS Resolution No. 466/2012.

Definition of Follow-up Time

Follow-up time was estimated in years from the year treatment was initiated until 2025 (reference date), or until death when recorded. Patients without an event were treated as censored. This approach introduces imprecision in the estimation of exact follow-up times and is suitable for exploratory survival analyses using clinical service data.

Statistical Analysis

Overall survival curves were constructed using the Kaplan–Meier method and compared using the log-rank test, with stratification by: (1) clinical stage — early (I–II) vs. advanced (III–IV); (2) triple-negative subtype — present vs. absent; (3) hormone receptors — HR-positive (ER- or PR-positive) vs. HR-negative; and (4) HER2 status — positive vs. negative. All analyses were performed using R software (version 4.x) with the lifelines package. The significance level was set at 5%.

RESULTS

The Sample Characteristics and Follow-up

A total of 97 patients were included. The estimated mean follow-up was 3.9 years (median: 3.0 years; range: 1–18 years). Six deaths (6.2%) and 9 recurrences (9.3%) were recorded. Characteristics by subgroup are presented in Table 1, and the distribution of events is shown in Table 2.

Table 1. Sample Characteristics by Analysis Subgroup (n = 97).

Variable	n	%
Clinical stage		
Early (I–II)	87	89.7
Advanced (III–IV)	10	10.3
Molecular profile		
HR-positive	75	77.3
HR-negative	22	22.7
HER2-positive	19	19.6
HER2-negative	78	80.4
Triple-negative	15	15.5
Non-triple-negative	82	84.5
Estimated follow-up		
Mean (years)	3.9	—
Median (years)	3.0	—
Range (years)	1–18	—
Outcomes		
Death	6	6.2
Recurrence	9	9.3

HR: hormone receptors.

Table 2. Proportion of Deaths and Recurrences by Clinical and Molecular Subgroups (n = 97).

Subgroup	n	Deaths n (%)	Recurrences n (%))	p (log-rank)*
Clinical stage				
Early (I–II)	87	1 (1.1)	2 (2.3)	< 0.001
Advanced (III–IV)	10	5 (50.0)	7 (70.0)	< 0.001
Triple-negative subtype				
Non-triple-negative	82	2 (2.4)	5 (6.1)	< 0.001
Triple-negative	15	4 (26.7)	4 (26.7)	< 0.001
Hormone receptors				
HR-positive	75	1 (1.3)	2 (2.7)	< 0.001
HR-negative	22	5 (22.7)	7 (31.8)	< 0.001
HER2 status				
HER2-negative	78	5 (6.4)	5 (6.4)	0.983
HER2-positive	19	1 (5.3)	4 (21.1)	0.983

*p-value obtained using the log-rank test for the outcome of death between groups.

Survival by Clinical Stage

Figure 1 presents the Kaplan–Meier curves stratified by clinical stage. The advanced-stage group (III–IV; n = 10) showed significantly lower overall survival than the early-stage group (I–II; n = 87), with a proportion of deaths of 50.0% vs. 1.1% (log-rank p = 2.22×10^{-10}).

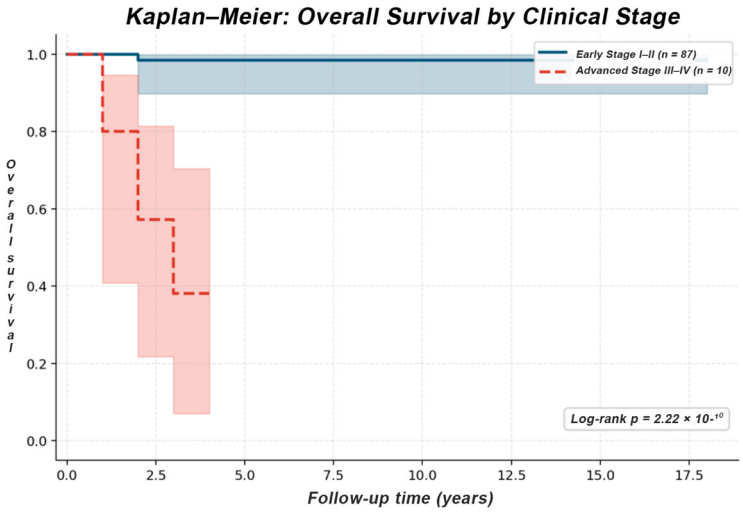

Figure 1. Kaplan–Meier curves of overall survival according to clinical stage. The advanced-stage group (III–IV; n = 10) showed significantly lower survival than the early-stage group (I–II; n = 87). Log-rank p = 2.22×10^{-10}.

Survival by Triple-Negative Subtype

Figure 2 presents the Kaplan–Meier curves stratified by triple-negative subtype. The triple-negative group (n = 15) showed lower overall survival than the non-triple-negative group (n = 82), with a proportion of deaths of 26.7% vs. 2.4% (log-rank p = 6.32×10^{-4}).

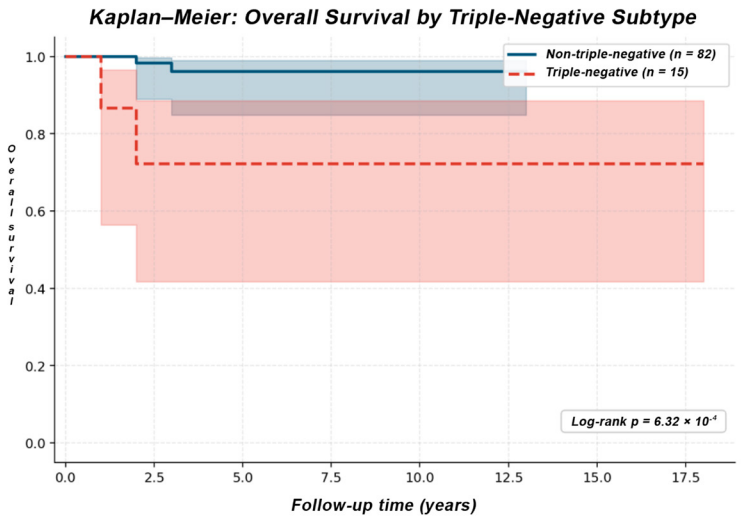

Figure 2. Kaplan–Meier curves of overall survival according to triple-negative subtype. The triple-negative group (n = 15) showed lower survival than the non-triple-negative group (n = 82). Log-rank p = 6.32×10^{-4}.

Survival by Hormone Receptor Status

Figure 3 presents the Kaplan–Meier curves stratified by hormone receptor status. The HR-negative group (n = 22) showed poorer survival compared with the HR-positive group (n = 75), with a proportion of deaths of 22.7% vs. 1.3% (log-rank p = 6.27×10^{-4}).

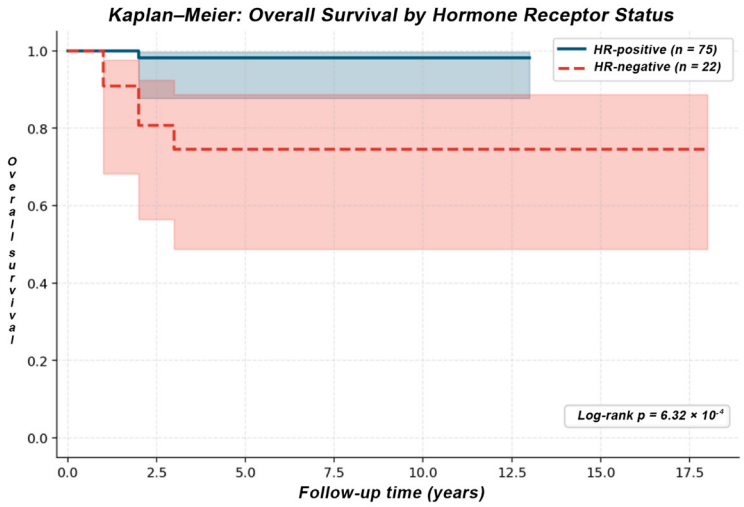

Figure 3. Kaplan–Meier curves of overall survival according to hormone receptor status. The HR-negative group (n = 22) showed lower survival than the HR-positive group (n = 75). Log-rank p = 6.27×10^{-4}.

Survival by HER2 Status

Figure 4 presents the Kaplan–Meier curves stratified by HER2 status. No significant difference in overall survival was observed between the HER2-positive (n = 19) and HER2-negative (n = 78) groups, with proportions of death of 5.3% and 6.4%, respectively (log-rank p = 0.983).

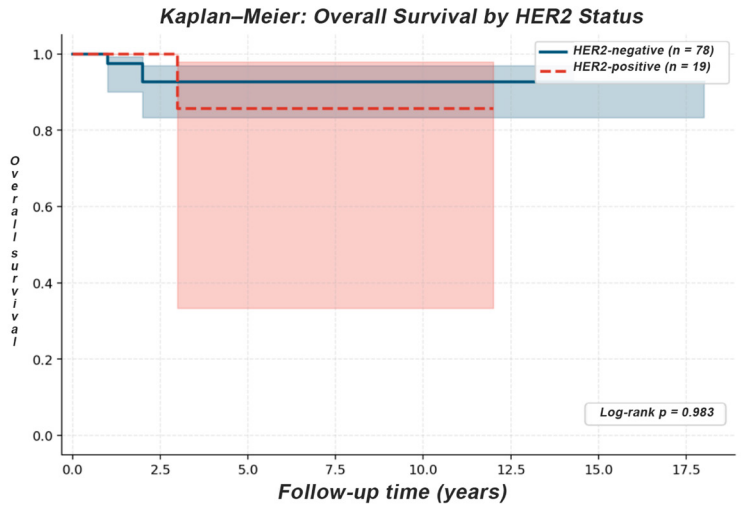

Figure 4. Kaplan–Meier curves of overall survival according to HER2 status. No significant difference was observed between the HER2-positive (n = 19) and HER2-negative (n = 78) groups. Log-rank p = 0.983.

DISCUSSION

The results of this analysis confirm well-established prognostic patterns, with a concentration of adverse events in the subgroups at higher clinical and molecular risk. The most pronounced difference was observed between the clinical stage groups: the proportion of deaths was 50% in the advanced-stage group vs. 1.1% in the early-stage group (log-rank $p = 2.22 \times 10^{-10}$). This gradient reflects both the greater tumor burden and the therapeutic limitations of locally advanced disease.[5]

The triple-negative subtype was associated with poorer survival (log-rank $p = 6.32 \times 10^{-4}$), with a proportion of deaths of 26.7% compared with 2.4% in the non-triple-negative group. This finding is consistent with the literature characterizing this subtype as having the most aggressive behavior among the molecular subtypes, given the absence of targeted therapies and the higher rate of cellular proliferation. The HR-negative group also showed poorer survival (log-rank $p = 6.27 \times 10^{-4}$), with 22.7% deaths vs. 1.3% in the HR-positive group — a result directly related to the overlap between HR negativity and biologically more aggressive subtypes, as well as the absence of benefit from adjuvant hormone therapy.[6]

The absence of a significant difference according to HER2 status ($p = 0.983$) is a finding that warrants contextualized interpretation. In private healthcare settings with access to anti-HER2 therapies — such as trastuzumab — the adverse prognostic impact of HER2 overexpression tends to be substantially attenuated by targeted treatment. The similar proportion of deaths between the HER2-positive (5.3%) and HER2-negative (6.4%) groups may therefore reflect the therapeutic benefit in this subgroup.[7]

The main limitations are the small number of events (6 deaths), which limits statistical power and the stability of survival estimates in the smaller subgroups, and the estimation of follow-up time based on the year of treatment — without precise dates of diagnosis and death — which introduces imprecision into the curves. These limitations are inherent to the retrospective nature and size of the cohort, and the results should be interpreted as exploratory.[8-10]

CONCLUSION

Advanced stage, the triple-negative subtype, and hormone receptor negativity were associated with poorer overall survival in this cohort of patients with invasive breast carcinoma, with statistically significant differences according to the log-rank test. HER2 status did not show a differential impact on survival, possibly due to the use of anti-HER2 therapies at the institution. These findings reinforce the importance of molecular stratification and early diagnosis for individualized prognostic assessment in breast oncology. Larger sample sizes and prospective data collection with precise dates are needed for more robust survival analyses.

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SCIENTIFIC ARTICLE - CASE REPORT

ANESTHETIC MANAGEMENT OF A PATIENT WITH AMYOTROPHIC LATERAL SCLEROSIS UNDERGOING FLEXIBLE URETERORENOLITHOTRIPSY: A CASE REPORT

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ABSTRACT

Introduction: Amyotrophic lateral sclerosis (ALS) is a progressive neurodegenerative disease characterized by motor weakness and respiratory impairment, increasing perioperative risk, particularly during anesthetic induction, ventilation, and extubation. **Case Report:** A 62-year-old female patient, 83 kg, ASA III, with a five-year history of ALS, an ALSFRS-R score of 10, and dependence on bilevel noninvasive ventilation (BiPAP), underwent flexible ureterorenolithotripsy with double-J stent placement. Preoperative evaluation revealed severe functional impairment and high respiratory risk. Total intravenous anesthesia with propofol and remifentanil using target-controlled infusion was performed without neuromuscular blocking agents, combined with bispectral index and train-of-four monitoring. Orotracheal intubation was successfully achieved using videolaryngoscopy (Cormack-Lehane grade I), followed by protective mechanical ventilation. The intraoperative course was uneventful, with hemodynamic stability and adequate oxygenation. At the end of the procedure, careful extubation was performed with immediate reconnection to noninvasive ventilation, and the patient was transferred to the post-anesthesia care unit under continuous monitoring without adverse events. **Discussion:** Anesthetic management in patients with ALS requires an individualized approach, considering reduced ventilatory reserve and unpredictable responses to neuromuscular blocking agents, highlighting the importance of strategies that preserve spontaneous ventilation and minimize respiratory depression. In this context, avoidance of neuromuscular blockers, combined with depth of anesthesia and neuromuscular monitoring, as well as early postoperative ventilatory support, proved effective in reducing the risk of respiratory complications. **Conclusion:** Risk anticipation, careful anesthetic titration, and immediate postoperative ventilatory planning are essential to optimize anesthetic safety in patients with advanced ALS.

Keywords: Amyotrophic lateral sclerosis, General anesthesia, Neuromuscular blocking agents, Noninvasive ventilation, Perioperative period.

INTRODUCTION

Amyotrophic lateral sclerosis (ALS) is a progressive neurodegenerative disease that affects upper and lower motor neurons, leading to progressive muscle weakness, bulbar dysfunction, and respiratory impairment over the course of the disease.[1]

Respiratory failure is the leading cause of morbidity and mortality in these patients, often already present in more advanced stages, with the need for home noninvasive ventilation.[2] In addition, bulbar dysfunction increases the risk of pulmonary aspiration, while respiratory muscle weakness impairs both spontaneous ventilation and postoperative weaning. In other words, even procedures considered minor carry a significantly higher risk compared with the general population.[3]

In the anesthetic context, these patients exhibit a variable response to neuromuscular blocking agents, with a risk of hyperkalemia associated with the use of succinylcholine and increased sensitivity to nondepolarizing agents.[1,3] In addition, there is greater vulnerability to respiratory depression induced by anesthetics and opioids, requiring cautious management and, whenever possible, strategies that preserve spontaneous ventilation.[2,4]

Therefore, anesthetic management should be carefully planned at all stages, including induction, maintenance, extubation, and ventilatory support in the immediate postoperative period, considering the high risk of extubation failure and reintubation in these patients.[2,4]

In view of this, the present report aims to describe the anesthetic management of a patient with advanced ALS undergoing flexible ureterorenolithotripsy, highlighting clinical decisions aimed at reducing respiratory and hemodynamic complications, with a focus on a safer perioperative period.

CASE REPORT

A 62-year-old female patient underwent flexible ureterorenolithotripsy with placement of a double-J catheter on January 12, 2026, at Hospital do Rim (HR). At the pre-anesthetic evaluation, she weighed 83 kg, was 185 cm tall, and had fasted for more than 8 hours for solids and more than 3 hours for liquids. She reported a diagnosis of ALS approximately five years earlier, with progressive muscle weakness below the neck and dependence on home noninvasive bilevel positive airway pressure ventilation (“Bilevel”), findings consistent with advanced stages of the disease. She was on continuous treatment with metformin, gabapentin 400 mg, and riluzole 50 mg, and reported an allergy to pregabalin. A history of previous surgical procedures was reported, although without detailed description.

Functional assessment was performed using the “Revised Amyotrophic Lateral Sclerosis Functional Rating Scale” (ALSFRS-R), an instrument widely used to assess the functional progression of ALS. The scale consists of 12 items, each scored from 0 to 4, resulting in a total score ranging from 0 to 48 points, with higher values indicating better functional capacity. The patient had a total score of 10 points, indicating severe functional impairment and a high perioperative respiratory risk. Observational studies have shown that patients with scores below 20 are at greater risk of respiratory failure and have a worse short-term prognosis.

On physical examination, she had good dental condition but reduced cervical mobility. She was classified as ASA III.

The patient was admitted to the operating room while using Bilevel, and preoxygenation with

positive pressure was performed. Total intravenous anesthesia with propofol and remifentanil in a target-controlled infusion system was chosen, a strategy that allowed continuous anesthetic titration and performance of the procedure without the need for neuromuscular blocking agents. Monitoring included continuous electrocardiography, pulse oximetry, noninvasive blood pressure, temperature monitoring, bispectral index (BIS), and neuromuscular monitoring with train-of-four (TOF), in accordance with recommendations for patients with neuromuscular disorders. Anesthetic induction was performed with propofol and remifentanil in a target-controlled infusion system, without the use of neuromuscular blocking agents. Orotracheal intubation was performed with the aid of a videolaryngoscope, with a Cormack-Lehane grade I view, using an 8.0 cuffed orotracheal tube. Tube position was confirmed by capnography and bilateral pulmonary auscultation. Anesthesia was maintained with propofol and remifentanil, with BIS values maintained between 30 and 40.

During the intraoperative period, the patient remained hemodynamically stable with adequate oxygenation. Ceftriaxone was administered for antibiotic prophylaxis, dipyrone for analgesia, and ondansetron and dexamethasone for prophylaxis of nausea and vomiting. At the end of the procedure, extubation was performed without complications, with immediate reconnection to Bilevel for ventilatory support, an approach recommended to reduce the risk of postoperative respiratory failure in patients with ALS. The patient was transferred to the post-anesthesia care unit in a hemodynamically stable condition.

DISCUSSION

Anesthetic management in patients with ALS should primarily consider the degree of functional and respiratory impairment, since reduced ventilatory reserve significantly limits the margin of safety in the perioperative period.[1,4] In this context, respiratory muscle involvement, which is often underestimated during clinical assessment, contributes to greater susceptibility to respiratory failure following anesthetic interventions, even in minor procedures.[2,4]

Given this physiological limitation, the choice of anesthetic technique should prioritize strategies that reduce respiratory depression, allow predictable recovery, and minimize factors associated with postoperative ventilatory failure.[1,4] In this regard, total intravenous anesthesia with propofol and remifentanil, as used in the present case, allowed adequate control of anesthetic depth, while also enabling the procedure to be performed without the need for neuromuscular blocking agents, which represents a relevant advantage in this patient profile.

The use of neuromuscular blocking agents, in turn, constitutes a critical aspect of anesthetic management in ALS. Succinylcholine should be avoided due to the risk of hyperkalemia resulting from upregulation of extrajunctional nicotinic receptors.[3] Additionally, nondepolarizing neuromuscular blocking agents may have a prolonged effect and an unpredictable response, particularly in advanced stages of the disease.[2] Therefore, whenever possible, avoidance of neuromuscular blockade should be considered as a safety strategy.

When the use of neuromuscular blocking agents becomes necessary, quantitative monitoring with TOF plays a fundamental role, allowing objective assessment of the degree of blockade and reducing the risk of residual blockade in the postoperative period.[2,3] This approach is particularly relevant in patients with neuromuscular diseases, in whom small pharmacodynamic variations may result in significant clinical impact.

Another determining factor in the outcomes of these patients is extubation management, which should be performed carefully, considering not only the level of consciousness but also ventilatory capacity, muscle strength, and adequate airway protection.[2,4] In this setting, the early use of noninvasive ventilation in the postoperative period, as observed in the present case, constitutes an important strategy for supporting the respiratory muscles and reducing the risk of ventilatory decompensation.[4]

Thus, successful anesthetic management in patients with ALS depends on the integration of knowledge of the pathophysiology of the disease, detailed functional assessment, and individualized decision-making, with a focus on preventing respiratory complications and optimizing postoperative recovery.

CONCLUSION

Anesthetic management in patients with advanced ALS requires an individualized approach, with emphasis on preserving respiratory function and reducing perioperative complications. In the present case, the use of total intravenous anesthesia without neuromuscular blocking agents, combined with careful extubation and immediate reconnection to noninvasive ventilation, proved to be an effective strategy for maintaining ventilatory stability in the immediate postoperative period, reinforcing that anticipation of respiratory complications, appropriate titration of anesthetic agents, and planning of postoperative ventilatory support are essential measures to optimize anesthetic safety in these patients.

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SCIENTIFIC ARTICLE - REVIEW

IMPACT OF PREHABILITATION ON CARDIAC SURGERY OUTCOMES: AN INTEGRATIVE REVIEW OF SYSTEMATIC REVIEWS

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ABSTRACT

Introduction: Prehabilitation, comprising physical exercise protocols and inspiratory muscle training, aims to optimize a patient's functional reserve prior to cardiac surgery. This strategy seeks to mitigate pulmonary complications, reduce hospital stay, and accelerate functional and mental recovery. However, clinical application remains challenging due to the lack of standardized universal protocols. **Objective:** To verify the efficacy of prehabilitation programs on clinical outcomes in patients undergoing cardiac surgery. **Methodology:** This is an integrative literature review, with a search conducted in the PubMed database between 2021 and 2026. The descriptors "prehabilitation" and "cardiac surgery" were used. The exclusive inclusion criterion was the selection of systematic reviews, aiming to synthesize the highest level of evidence available on the subject. **Results:** A total of 48 articles were identified, of which 13 systematic reviews were selected for analysis, encompassing a total sample of 16,752 patients. The findings demonstrate that prehabilitation promotes significant improvement in functional capacity, an expressive reduction in postoperative complications, and a decrease in hospital costs associated with shorter lengths of stay. **Conclusion:** Scientific evidence confirms the feasibility and efficacy of prehabilitation, whether in in-hospital or home-based settings. The method proves to be a determinant in improving peri- and postoperative outcomes, consolidating itself as an essential strategy in the cardiovascular care continuum.

Keywords: Preoperative exercise, Thoracic surgery, Postoperative complications, Breathing exercises, Functional Status.

INTRODUCTION

Primary Cardiovascular diseases (CVDs) are the leading cause of global morbidity and mortality. According to the World Health Organization (WHO), CVDs accounted for 19.8 million deaths in 2022, with acute myocardial infarction and stroke representing 85% of this total. In addition to their epidemiological impact, a critical socioeconomic disparity is observed, as

more than three-quarters of these deaths occur in low- and middle-income countries.[1]

In this context, cardiac surgery emerges as a fundamental therapeutic intervention, although it is an invasive, high-cost procedure with significant systemic clinical repercussions. Globally, surgical volume has shown exponential growth; in the United States, the increase reached 484% over a 26-year period.[2] In Brazil, the reality reflects this trend: between 2008 and 2018, the Unified Health System (SUS) recorded more than 1.1 million cardiovascular procedures, with myocardial revascularization and valve surgeries being the most common.[3]

Despite its essential role, surgery imposes severe physiological stress, triggering inflammatory and catabolic responses that may exacerbate sarcopenia and functional decline.[4] Added to this are psychological challenges, such as anxiety and depression, particularly in patients with multiple comorbidities and low cardiorespiratory reserve, factors directly associated with increased perioperative morbidity and mortality.[4,5] Postoperative pulmonary complications are especially noteworthy, with a prevalence of up to 95%, increasing the length of stay in the Intensive Care Unit (ICU), hospital costs, and readmission rates.[6]

While postoperative exercise-based rehabilitation is a well-established strategy, prehabilitation has emerged as a proactive and promising approach. Defined as the active preparation of patients during the preoperative period, it aims to optimize functional capacity and physiological resilience through aerobic exercise, resistance training, and inspiratory muscle training (IMT).[6–9] However, the implementation of prehabilitation still lacks consensus protocols, and the strength of the current scientific evidence has frequently been questioned regarding its reliability and standardization.[7]

More recently, the integration of technology into prehabilitation has been explored to enhance equity and continuity of care, potentially improving patient-centered outcomes such as pain, fatigue, and quality of life.[10] Given the need to clarify the actual impact of these interventions and to support evidence-based clinical practice, the present study aims to analyze and synthesize the effectiveness of prehabilitation programs in cardiac surgery, evaluating their impact on functional capacity, postoperative complications, length of hospital stay, and psychofunctional well-being.

METHODOLOGY

The present study is characterized as an integrative literature review designed to synthesize high-impact evidence on the effectiveness of prehabilitation in the setting of cardiac surgery. The bibliographic search was conducted in the PubMed database covering the period from 2021 to 2026 in order to ensure the currency of the scientific evidence. The search strategy was structured through the combination of the Medical Subject Headings descriptors “prehabilitation” and “cardiac surgery” using the Boolean operator AND.

As a primary inclusion criterion, only systematic reviews addressing interventions based on aerobic exercise, resistance training, and inspiratory muscle training (IMT) performed during the preoperative period were selected. The selection of studies focused on the analysis of clinical and hospital outcomes, establishing functional capacity, predominantly assessed by the Six-Minute Walk Test (6MWT), and length of hospital stay in both the intensive care unit (ICU) and hospital ward as comparison variables.

The analysis process involved evaluating the maintenance of these outcomes from

the preoperative to the postoperative period, allowing for the extraction of data from an aggregated sample of 16,752 patients. The interpretative synthesis sought to identify the effectiveness of exercise modalities in mitigating pulmonary complications and accelerating the return to baseline functional status, consolidating evidence from studies that could support the clinical feasibility of prehabilitation.

RESULTS

The results are presented in Table 1, which describes the authors, year of publication, and number of participants included in each study. The table also presents the objectives, interventions performed in the prehabilitation programs, and the main findings/conclusions reported by each group of authors. The article selection flowchart is presented in Figure 1.

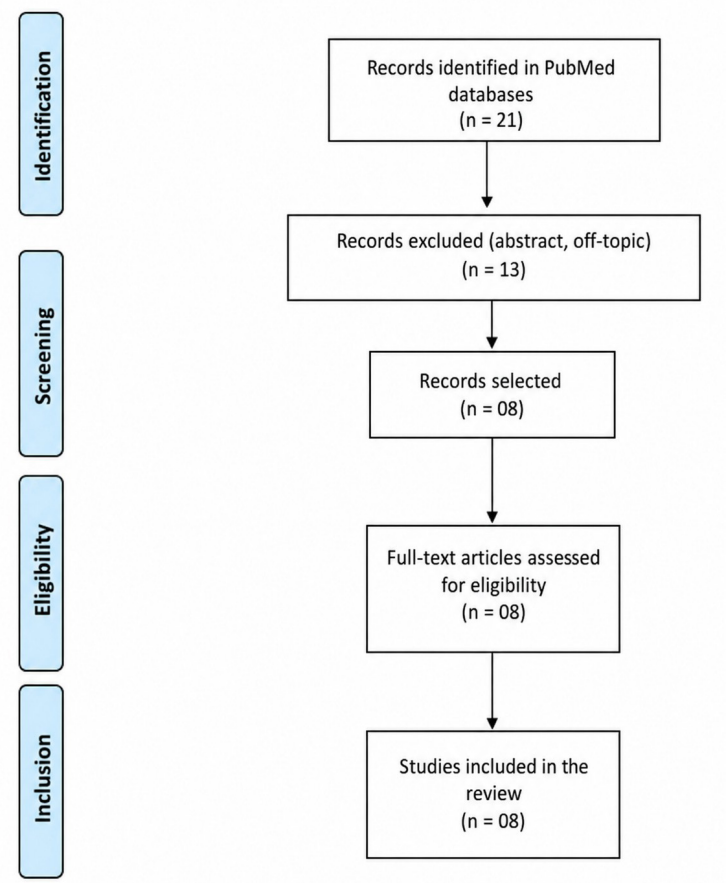

Figure 1. Flowchart for the selection and inclusion of articles in the present study.

Table 1. Results of the search for articles addressing prehabilitation in cardiac surgery.

ARTICLE	AUTHOR/YEAR and Number of Patients Included	OBJECTIVE	TYPES OF PREHABILITATION INTERVENTIONS	MAIN FINDINGS/CONCLUSIONS
Efficacy of Prehabilitation Before Cardiac Surgery. A Systematic Review and Meta-analysis.[6]	Steinmetz *et al.*, 2020 (621 pacientes)	To evaluate the effect of prehabilitation involving functional exercise using the 6-Minute Walk Test (6MWT), Timed Up and Go (TUG), 5-meter gait speed, or the Short Physical Performance Battery (SPPB).	-Aerobic exercise; -Resistance training; -Respiratory exercises; -Health education; -Psychological support. †	Improvement in functional capacity (6MWT) during the preoperative and postoperative periods. Reduction in length of hospital stay and incidence of atrial fibrillation.
Prehabilitation Interventions for Cardiac Surgery to Prevent Postoperative Pulmonary Complications: Systematic Review and Meta-Analysis.[9]	Wang *et al.*, 2024 (2894 pacientes)	To investigate the effects of inspiratory muscle training (IMT), exercise, and health education on postoperative pulmonary complications (PPCs) and length of hospital stay.	-IMT; -Health education. †	Reduction in PPCs and length of hospital stay.
Exercise-Based Prehabilitation Before Cardiac Surgery: A Systematic Review, Meta-Analysis, Meta-Regression, and Proposal for a Clinical Implementation Model.[11]	Hurtado *et al.*, 2025 (873 patients)	To evaluate the effectiveness of prehabilitation programs on functional capacity and postoperative pulmonary complications through adapted exercise interventions.	- Resistance training; -Aerobic exercise; -IMT. †	Improvement in functional capacity. Reduction in length of hospital stay and PPCs.

Preoperative exercise training for adults undergoing elective major vascular surgery: A systematic review.[12]	Tew *et al.*, 2022 (197 patients)	To evaluate the benefits and harms of preoperative physical training in adults.	-Aerobic exercise; -Resistance training; -IMT †	Improvement in 6MWT distance. Reduction in ICU and hospital length of stay.

Prehabilitation exercise therapy before elective abdominal aortic aneurysm repair.[13]	Fenton *et al.*, 2021 (232 patients)	To evaluate the effects of physical exercise on morbidity and mortality in the prehabilitation and postoperative periods.	-Circuit training; -Aerobic exercise; -Resistance training; -HIIT. †	Reduction in mortality and PPCs.
Prevention and Reversal of Frailty in Heart Failure—A Systematic Review.[14]	Aili *et al.*, 2022 (41 patients)	To evaluate the effectiveness of cardiac rehabilitation and prehabilitation in reversing or preventing frailty.	- Balance exercises and resistance training. †	Improvement in frailty and quality of life.
Effects of Prehabilitation on Functional Capacity in Aged Patients Undergoing Cardiothoracic Surgeries: A Systematic Review.[15]	Costa *et al.*, 2021 (876 patients)	To evaluate the effectiveness of prehabilitation in improving functional capacity and physiological reserve during the preoperative and/or postoperative period in older patients.	- Physical exercise; -Nutrition; -Education; -Psychological support; -Aerobic and resistance training; -IMT. †	Improvement in physical fitness and return to preoperative functional status.

Post-Operative Outcomes of Pre-Thoracic Surgery Respiratory Muscle Training Vs. Aerobic Exercise Training: A Systematic Review and Network Meta-analysis.[16]	Kunadharaju *et al.*, 2023 (2070 patients)	To compare preoperative and postoperative outcomes using devices and aerobic exercise.	- IMT using a threshold loading device or respiratory muscle resistance device; -Aerobic and resistance exercises. †	Prevention of PPCs and pneumonia. Reduction in length of hospital stay.
Effect of Preoperative Respiratory Training on Perioperative Outcomes in Thoracic Surgery: A Systematic Review and Meta-Analysis.[17]	Zhu *et al.*, 2025 (199 patients)	To evaluate the effectiveness of preoperative respiratory training on pulmonary function, functional capacity, incidence of complications, and length of hospital stay.	- Pulmonary rehabilitation; -IMT. †	Improvement in the distance covered during the 6MWT. Reduction in PPCs.

6MWT: Six-Minute Walk Test; TUG: Timed Up and Go; SPPB: Short Physical Performance Battery; IMT: Inspiratory Muscle Training; PO: Postoperative; PPCs: Postoperative Pulmonary Complications; FC: Functional Capacity; RMT: Respiratory Muscle Training; PRT: Progressive Resistance Training; †: Compared with patients receiving standard preoperative care.

DISCUSSION

The literature demonstrates that patients undergoing cardiac surgery derive substantial benefits from diverse preoperative interventions. Such strategies range from circuit training and continuous moderate-intensity protocols to high-intensity interval training, in addition to inspiratory muscle training (IMT) using specific devices and aerobic and resistance exercises.[8,11] From a physiological perspective, physical exercise during this period enhances cardiorespiratory capacity and improves ventilatory efficiency. Furthermore, this preparation attenuates the inflammatory response resulting from surgical trauma, directly supporting the effectiveness of prehabilitation as a preventive measure.[17]

Regarding protocol design, a frequent integration of cardiovascular conditioning and strength training can be observed. In hospital settings, interventions usually prioritize aerobic, resistance, and high-intensity interval training protocols, although many publications lack detailed descriptions of exercise intensity or total intervention duration.[10,13] In contrast, data from the same review described outpatient and home-based practices more precisely, citing activities such as walking, running, or swimming performed three times per week. Strength training is generally prescribed three to five times weekly, using weights or elastic bands. This support is provided over a period ranging from one to twelve weeks before surgery, with the primary objective of building functional reserve to withstand surgical stress.[18]

Investigations conducted by Kunadharaju et al. reported programs lasting up to eight weeks, centered on preoperative aerobic exercise performed three to seven times per week, in sessions lasting between 30 and 60 minutes.[16] In a different approach, Fenton et al. described shorter interventions, ranging from one to six weeks, carried out predominantly in the home setting following an initial orientation phase.[13,16]

With regard to home-based practices, Aili et al. and Gimeno et al. detailed protocols lasting six weeks or longer, encompassing modalities such as balance training using the tandem position, backward walking for ten steps, and stair climbing. In terms of muscle strengthening, interventions included knee flexion exercises with ten repetitions and the functional sit-to-stand exercise, with progression based on increasing repetitions and reducing execution time.[14,19] Complementarily, Waite et al. found that an eight-week home-based protocol was capable of reducing frailty in patients, an outcome measured through improvements in handgrip strength and gait speed.[20]

Similarly, Rosenfeldt et al. described programs based on combined training, integrating aerobic and resistance exercises through the use of cycle ergometers, elastic bands, dumbbells, and body-weight exercises, with a target of 30 minutes per day.[21] Considerable methodological variability was observed between moderate continuous training and high-intensity interval training. Such variability reinforces that the adaptability of prehabilitation allows the transition between conservative approaches and protocols with greater metabolic demands, while always respecting the clinical profile of each individual.[2,11]

Costa et al. detailed an investigation involving 882 patients undergoing coronary artery bypass graft surgery under continuous moderate-intensity aerobic training or high-intensity interval training protocols. This individualized intervention, performed on a cycle ergometer or treadmill, lasted three weeks and consisted of sessions ranging from 10 to 30 minutes, administered two to three times daily, with a weekly frequency of up to seven days. Exercise intensity progressed from 60% to 80% of maximal work capacity or up to a score of 7 on the Borg Rating of Perceived Exertion scale. Participants were monitored for power output, distance, and exercise duration, with physical conditioning estimated through peak oxygen uptake and heart rate, demonstrating superiority in the 6-Minute Walk Test (6MWT) compared with the control group.[15] Additionally, the meta-analysis by Lai et al. demonstrated significant increases in forced expiratory volume in one second and forced vital capacity, further supporting the role of exercise in optimizing pulmonary function.[22]

In the same context, Diaz et al. and Steinmetz et al. reported that individuals participating in prehabilitation programs achieved an average increase of 30 meters in the 6MWT. This improvement is of considerable clinical relevance because it is directly associated with physical endurance and functional performance, also assessed by tests such as the Timed Up and Go (TUG) and gait speed.[4,6,11]

Interestingly, some findings suggest that shorter exercise programs may generate a greater clinical impact than prolonged interventions, possibly because of their closer temporal proximity to surgical stress. This phenomenon reinforces that the timing of intervention initiation is crucial and that even brief periods are capable of promoting substantial physiological adaptations.[16] Finally, D'Amico et al. and Steinmetz et al. demonstrated that early stabilization and reduced exposure to ICU-related stressors may decrease the incidence

of delirium and facilitate a faster transition to lower-complexity care settings.[5,6]

However, Wang et al.[2] and Hurtado-Borrego et al.[11] demonstrated that interventions involving physical exercise and inspiratory muscle training (IMT) are associated with improvements in dyspnea, increased maximal inspiratory pressure, and reductions in postoperative pulmonary complications (PPCs). A reduction in hospital length of stay was also observed, ranging from one to three days depending on the protocol.

According to Kunadharaju et al., prehabilitation reduced postoperative complications that may be related to procedural factors such as the type of surgery, incision site, operative time, and anesthetic technique. Patient-related factors include age over 60 years, ASA classification ≥ 2, the presence of chronic obstructive pulmonary disease, congestive heart failure, and functional dependence.[16] Yau et al. observed a reduction in postoperative atrial fibrillation, particularly among patients aged 65 years or younger. However, no significant results were identified in patients above this age range.[23]

Evidence suggests that IMT contributes favorably to surgical clinical outcomes. Steinmetz et al. observed reductions of 24 hours in hospital stay and six hours in ICU stay, whereas Hulzebos et al. reported reductions exceeding three days and 21 hours, respectively.[10,24] Such findings indicate earlier functional recovery and reduced exposure to nosocomial risks. Supporting this trend, a study involving 3,508 patients demonstrated that multimodal prehabilitation (IMT, resistance training, and cycle ergometry) reduced hospital stay by 0.3 days.[5] Additionally, Wang et al. found that ventilatory exercises and bronchial hygiene techniques not only mitigated postoperative pulmonary complications but also reduced ICU stay by 2.2 hours and total hospitalization by 1.8 days.[2]

Among the components of prehabilitation, inspiratory muscle training (IMT) also contributes to improved alveolar ventilation, reduced atelectasis, enhanced cough effectiveness, and pulmonary recruitment.[2] This modality has been widely investigated as a complement to physical exercise, especially in patients with limitations for aerobic activities. Studies such as that by Evangelodimou et al. demonstrated improvements in respiratory muscle strength and pulmonary function using progressively intensified protocols ranging from 30% to 80% of maximal inspiratory pressure, performed in two daily sessions.[8] Similarly, Hulzebos et al. employed daily 20-minute sessions using devices such as the Threshold IMT©, beginning at 30% of maximal inspiratory pressure with progression guided by the Borg scale. This resulted in increased inspiratory muscle strength and endurance during the first four preoperative weeks. In the postoperative period, the median length of hospital stay was reduced to 7 days (range: 5–41 days) compared with 8 days (range: 6–70 days) in the usual care group.[24] There are also shorter protocols lasting one week, involving incentive spirometry, emphasis on a 2–3 second inspiratory pause, and bronchial hygiene techniques such as controlled coughing. Another approach included 15-minute sessions performed six times per week, combining IMT with educational guidance and techniques such as the active cycle of breathing techniques and huffing.[7] High-intensity IMT is safe in this population provided that training load is progressed appropriately. However, a standardized protocol has not yet been established, and superiority among different intensity levels cannot currently be determined.[8]

Evidence has shown that resistance exercises contribute to improvements in functional capacity (assessed by the 6-Minute Walk Test) and reductions in hospital length of stay. These

effects are related to optimization of cardiorespiratory and musculoskeletal function, as well as attenuation of the impacts of general anesthesia and surgical trauma. Targeting large muscle groups also appears relevant in preventing preoperative sarcopenia and promoting functional autonomy during the immediate postoperative period.[11]

Despite the positive outcomes observed, this review identified limitations that warrant caution in interpreting the data. The main barrier lies in the marked heterogeneity of prehabilitation protocols, particularly regarding the lack of standardization of training variables such as intensity, total intervention duration, and weekly frequency. This disparity makes it difficult to establish an optimal dose-response relationship for patients awaiting cardiac surgery. In addition, a lack of detailed descriptions regarding the exercise modalities employed was observed. The absence of specifications concerning training volume, equipment used, and exercise progression severely compromises the reproducibility of studies in hospital or outpatient clinical practice. Another relevant issue is the selection bias present in some systematic reviews, which often fail to stratify patients according to frailty level or surgical complexity, potentially masking variations in intervention effectiveness among different cardiovascular risk profiles.

CONCLUSION

The scientific evidence compiled in this review demonstrates that prehabilitation programs based on inspiratory muscle training (IMT), aerobic exercise, and resistance training are effective in optimizing functional capacity, physical fitness, and distance covered during the 6-Minute Walk Test (6MWT), in addition to mitigating frailty and promoting improvements in quality of life. Such interventions were consistently associated with reductions in postoperative pulmonary complications (PPCs), mortality, and length of hospital and intensive care unit stays. Furthermore, a positive impact was observed on important psychological factors, including reductions in anxiety and depression levels. Prehabilitation is established as a feasible and highly relevant strategy in perioperative cardiac surgical care, contributing directly to improved clinical outcomes. However, the marked heterogeneity and lack of specificity in current protocols still limit the reliability and reproducibility of the findings. Future investigations establishing rigorous criteria regarding intervention dosage and outcome standardization are essential to support the systematic implementation of this approach in clinical practice.

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