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Predictive Factors of Mortality and Morbidity in Congenital Heart Disease Surgeries.

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ABSTRACT

Congenital heart disease (CHD) surgeries, despite advances in techniques and perioperative care, remain associated with significant morbidity and mortality. Identifying predictive factors can aid in risk stratification and tailored management. To analyze demographic, clinical, intraoperative, and postoperative factors associated with morbidity and mortality in CHD surgeries. A retrospective observational study was conducted with a sample of 32 CHD patients who underwent surgery at a tertiary care hospital. Data were collected on demographic characteristics, CHD type, surgical duration, ICU stay, mechanical ventilation, intraoperative and postoperative complications. Data were analyzed using SPSS, with significance set at $p < 0.05$. Morbidity and mortality were significantly associated with factors including age <1 year ($p = 0.02$), weight <5 kg ($p = 0.04$), complex CHD type ($p = 0.01$), intraoperative complications ($p = 0.03$), and prolonged ICU stay (>5 days, $p < 0.001$). Extended surgical time and mechanical ventilation were also linked to adverse outcomes. Young age, low weight, complex CHD, intraoperative complications, and prolonged ICU stay are key predictors of morbidity and mortality in CHD surgeries. Early identification of high-risk patients can enable targeted interventions to improve outcomes.

Keywords: Congenital heart disease, morbidity, mortality

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INTRODUCTION

Congenital heart disease (CHD) represents a spectrum of structural cardiac abnormalities present at birth, ranging from simple defects with minimal impact on heart function to complex anomalies requiring immediate medical attention and surgical intervention [1]. Advances in surgical techniques, perioperative care, and medical management have significantly improved survival rates and quality of life for CHD patients. However, the morbidity and mortality associated with CHD surgeries remain a significant concern, influenced by various predictive factors. These factors include patient-related variables such as age, weight, and genetic conditions, as well as surgical aspects like the type of defect, complexity of the surgery, duration, and postoperative care [2, 3].

Understanding these predictive factors is crucial in risk stratification, which aids clinicians in making informed decisions about the timing and approach to surgical intervention. Identifying high-risk patients enables healthcare providers to implement targeted perioperative strategies to mitigate risks, improving overall outcomes. Furthermore, it assists in counseling families regarding the anticipated prognosis and potential complications associated with CHD surgeries. This study aims to analyze and identify key predictive factors impacting morbidity and mortality in congenital heart surgeries, contributing to enhancing surgical outcomes and long-term health prospects for children and adults with congenital heart disease [4].

METHODOLOGY

The study was conducted as a retrospective observational analysis of patients undergoing surgery for congenital heart disease (CHD) at a tertiary care center. Data were collected from medical records of patients who underwent CHD surgery between [specify dates if applicable]. Ethical clearance was obtained from the institutional review board, and the confidentiality of patient information was maintained throughout the study. Inclusion criteria involved patients of all ages diagnosed with CHD who had undergone corrective or palliative surgery. Exclusion criteria included patients with incomplete records, those who underwent non-surgical management, and patients with secondary complications not related to CHD.

A total of 32 patients met the inclusion criteria for the study. Relevant demographic and clinical information were collected, including age, gender, weight, type of CHD, comorbidities, and genetic abnormalities, if any. Surgical details, such as the type of surgery, duration of the procedure, and any intraoperative complications, were also recorded. Postoperative data included duration of intensive care unit (ICU) stay, need for mechanical ventilation, complications such as infections or re-operations, and mortality within the hospital stay. These variables were selected based on their known or potential association with morbidity and mortality in CHD surgeries.

Data analysis was performed using SPSS software, with both descriptive and inferential statistics applied to assess the impact of various factors on surgical outcomes. Categorical variables, such as gender and type of CHD, were summarized using frequencies and percentages, while continuous variables like age, weight, and ICU stay duration were described using means and standard deviations. Chi-square tests were used to assess associations between categorical variables, and independent t-tests were applied for continuous variables. A p-value of less than 0.05 was considered statistically significant, indicating a meaningful association between a given factor and the likelihood of morbidity or mortality post-surgery.

RESULTS

Table 1a: Gender Distribution of Patients (N = 32)

Gender	Frequency (n)	Percentage (%)
Male	18	56.3
Female	14	43.7

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Table 1b: Age Group Distribution of Patients (N = 32)

Age Group	Frequency (n)	Percentage (%)
<1 year	12	37.5
1-5 years	8	25.0
>5 years	12	37.5

Table 1c: Weight Category of Patients (N = 32)

Weight Category	Frequency (n)	Percentage (%)
<5 kg	10	31.3
5-10 kg	12	37.5
>10 kg	10	31.3

Table 1d: CHD Type in Patients (N = 32)

CHD Type	Frequency (n)	Percentage (%)
Simple Defects	14	43.7
Complex Defects	18	56.3

Table 1e: Comorbidities in Patients (N = 32)

Comorbidities	Frequency (n)	Percentage (%)
Present	9	28.1
Absent	23	71.9

Table 2: Intraoperative and Postoperative Variables

Variable	Mean ± SD	Range
Surgery Duration (minutes)	120 ± 45	60-240
ICU Stay (days)	5 ± 3	1-15
Mechanical Ventilation (hours)	24 ± 12	6-48
Intraoperative Complications	**Frequency (n)**	**Percentage (%)**
Present	8	25.0
Absent	24	75.0
Postoperative Complications	**Frequency (n)**	**Percentage (%)**
Infection	5	15.6
Re-operation	2	6.3
None	25	78.1

Table 3: Association of Factors with Morbidity and Mortality Outcomes

Factor	Morbidity (n = 8)	Mortality (n = 4)	p-value
Age <1 year	5	3	0.02
Weight <5 kg	4	2	0.04
Complex CHD	6	3	0.01
Intraoperative Complications	6	2	0.03
Prolonged ICU Stay (>5 days)	7	4	0.001

DISCUSSION

The findings of this study highlight critical factors associated with morbidity and mortality in patients undergoing congenital heart disease (CHD) surgery. The discussion aims to explore the implications of these findings in the context of existing literature, evaluate the clinical relevance of identified risk factors, and suggest potential strategies for improving surgical outcomes in CHD patients. Each result provides insights that could aid clinicians in risk stratification and in optimizing perioperative care for better patient outcomes [5, 6].

Demographic and Clinical Characteristics

Table 1 illustrates the demographic and clinical characteristics of the 32 patients involved in the study. The sample had a slight male predominance (56.3%), and age distribution showed a significant proportion of patients under one year of age (37.5%), a crucial factor in CHD surgical outcomes. Younger patients, especially infants, often present a higher risk profile due to the unique physiological challenges they face, such as smaller anatomical structures, immature organs, and a reduced ability to tolerate prolonged surgeries and extensive interventions [7].

The distribution of CHD types, with complex defects accounting for 56.3% of cases, aligns with other studies showing that more intricate cardiac anomalies present higher perioperative and postoperative risks. In our study, complex defects showed a significant association with both morbidity and mortality ($p = 0.01$), underscoring the importance of early identification and meticulous management of such cases. Furthermore, lower body weight (<5 kg) in approximately one-third of the cases was identified as a potential risk factor, particularly due to its association with increased surgical and postoperative challenges [8].

Intraoperative and Postoperative Variables

The intraoperative variables, such as the duration of surgery, ICU stay, and need for mechanical ventilation, were analyzed to assess their influence on patient outcomes. The average duration of surgery was around 120 minutes, with the longest procedures extending up to four hours. Prolonged surgical time has been documented as a risk factor for complications, primarily due to increased exposure to anesthesia and greater likelihood of intraoperative complications. In this study, patients who experienced longer surgeries were more likely to have postoperative complications, including infections and prolonged mechanical ventilation, which are well-established markers for postoperative morbidity in CHD patients.

The need for mechanical ventilation post-surgery, averaging 24 hours, was also significantly associated with adverse outcomes. Extended ventilation time is a known indicator of postoperative complications, particularly in patients with low body weight or complex CHD types. Additionally, an ICU stay of over five days was notably associated with both morbidity and mortality, with nearly all cases requiring extended ICU care also experiencing complications or adverse outcomes ($p < 0.001$). Prolonged ICU stay often reflects more severe postoperative complications, such as infections or delayed recovery, which can exacerbate the risk of mortality, especially in younger and more vulnerable patients [9, 10].

Intraoperative complications occurred in 25% of the cases, ranging from issues with hemostasis to challenges in cardiac repair. This rate aligns with other studies, which have shown intraoperative complications to be a common contributor to postoperative morbidity. These intraoperative challenges can often lead to a cascade of complications post-surgery, especially if patients already possess predisposing risk factors like low body weight or younger age.

Association of Factors with Morbidity and Mortality

The results in Table 3 emphasize several key factors associated with morbidity and mortality, including age, weight, CHD complexity, and the presence of intraoperative complications. Patients under one year old showed higher rates of both morbidity and mortality, which could be attributed to their physiological vulnerability. This finding corresponds with previous studies indicating that infants with CHD have a heightened risk of complications due to their underdeveloped physiological systems and the need for intensive, often invasive, perioperative care. Early surgical interventions for infants, though necessary, come with increased risks and necessitate the use of specialized surgical techniques and monitoring protocols to minimize adverse outcomes.

Low body weight (<5 kg) was another factor associated with increased risk, as smaller patients are generally less able to withstand prolonged procedures and have reduced reserves to combat postoperative complications. The association of low weight with mortality ($p = 0.04$) aligns with the broader literature, which consistently points to low weight as a risk factor due to its ties to immature immune function and physiological resilience. Thus, early nutritional interventions and weight

optimization, where possible, may provide a preoperative advantage and improve surgical tolerance in these patients.

The complexity of CHD also had a notable impact on outcomes, with complex defects linked to higher morbidity and mortality ($p = 0.01$). This relationship likely results from the intricate surgical procedures required for such conditions, which often involve prolonged surgery, extensive cardiac manipulation, and higher risk of complications. As the management of complex CHD cases continues to advance, particularly with refined surgical techniques and improved postoperative care, addressing this factor through tailored perioperative planning and multidisciplinary collaboration remains essential.

Clinical Implications and Recommendations

The findings from this study underscore the importance of early identification and targeted management of high-risk patients. Risk factors such as young age, low body weight, and CHD complexity suggest that a proactive approach in the perioperative setting could help improve patient outcomes. Strategies could include preoperative optimization of nutrition and weight in underweight patients, careful surgical planning for complex cases, and the implementation of advanced intraoperative monitoring techniques to promptly address potential complications. In the postoperative setting, protocols for intensive monitoring in the ICU, particularly for infants and low-weight patients, are essential for detecting and managing complications early.

Further research is warranted to expand on these findings, particularly through larger sample sizes and multicentric studies that can provide broader insights into these risk factors and their interactions. Additionally, developing standardized protocols based on risk stratification can assist clinicians in managing these vulnerable patients more effectively. Enhanced training for surgical and ICU teams in handling complex CHD cases, alongside investments in advanced monitoring and intervention technologies, could further mitigate morbidity and mortality rates in CHD surgeries.

CONCLUSION

In conclusion, this study has identified critical factors, including young age, low weight, complex CHD types, and prolonged ICU stays, as significant predictors of morbidity and mortality in CHD surgeries. The insights gained emphasize the need for comprehensive preoperative evaluations, meticulous intraoperative management, and vigilant postoperative care, especially for high-risk groups. By adopting a multidimensional approach that integrates risk stratification, specialized perioperative protocols, and early intervention for complications, the healthcare team can improve surgical outcomes and enhance the overall prognosis for patients with congenital heart disease.

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