

Assessment Outcomes Related on Prognostic For Children Undergoing Cardiac Surgery and Assessment of General Complications

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Abstract: This paper presents an in-depth analysis of statistics related to 138 patients who had their cardiac surgery in childhood, demographics, possible complications, and outcome-related risk factors. Demographic information shows that the patients have a mean age of 5.2 years, with different weights and heights, having an average weight of 19.8 kg and height of 105.2 cm. The distribution of the gender was fairly equal, as 50.7 percent of patients were male, and 49.3 percent were female, which indicates the absence of gender bias in the selection of surgical cases. The population under study was typified by its heterogeneous socioeconomic background, 36.2% of the patients belong to low-income families, which is why economic issues are significant in healthcare. It was also shown that 21.7% of the patients also had a predisposition of cardiac disease in their family, further justifying the role of genetics in the risk analysis. Various conditions were operated upon using surgical procedure, where atrial septal defect (ASD) and ventricular septal defect (VSD) take about 55.8 percent of all cases. The rates of complication were 14.5, which showed the total success of the surgical operations. The mean length of stay in hospital was 7 days, and this provided a possibility of analyzing the effectiveness of postoperative recovery. The data on risk factors revealed that there was a significant correlation with complications, and congestive heart failure had a correlation coefficient of 0.25, and Down syndrome had a correlation coefficient of 0.15. These factors were predetermined by means of statistical analysis, and the correlation between them and patient outcomes was decided. Logistic regression analysis was conducted, and it showed that an increase of 10 percent in the age of patients enhanced the risk of developing complications by 10 percent, whereas congestive heart failure was estimated to have an ODS of 1.85, meaning that the patients with this condition are even more predisposed to developing complications. Median survival and readmission were used as metrics of measurement, which demonstrates the value of aftercare and follow-up to achieve the best results in practice. The results can play a pivotal role in the determination of the factors that determine the success of a surgery, considering the risks and health conditions associated with age. This paper has emphasized the aspect of the potential to improve healthcare systems and deliver high-quality care, thus advancing the quality of life of children who have to undergo surgical intervention.

Keywords: prognostic, children, cardiac, surgery, complications, syndrome, quality of life, surgical.

INTRODUCTION

Pediatric cardiac surgery is one of the most challenging technically and clinically significant areas of modern medicine, as it integrates highly intricate congenital cardiac anatomies with the delicate physiology of paediatric growth and development. Five decades of advances in operative methods, perioperative care, anaesthesia, and post-operative care have significantly increased the survival rates and long-term quality of life of a considerable number of children with a congenital or acquired cardiac pathology (Modell, B. *et al.*, 2018). However, prognostic results are multifactorial and discriminative, and they depend on a plethora of patient-specific, disease-specific, procedure-related, and institutional variables. Clinicians, families, researchers, and policymakers cannot do without elucidation and dissemination of these prognostic variables so that they can make informed decision-making, predict complications, allocate resources, and design specific

interventions to reduce risks and optimize recovery (Liu, Y. *et al.*, 2019; Ellassal, A. A. *et al.*, 2022).

The key idea of prognostication in paediatric cardiac surgery is the understanding that children are not just a smaller version of themselves. Their unique physiology, that is, their increased growth rates, change in organ reserve, and inconsistent stress responses, requires paediatric risk-specific risk stratification and outcome measures. (Saxena, A. *et al.*, 2019) The development of prognostic models has been that of primitive and broad-based indices, with the advanced models taking into account the complexity of anatomy, haemodynamic status, comorbidities, genetic determinants, and the social determinants of health. These models attempt to forecast salient outcomes (such as mortality, length of hospital stay, re-intervention need, neuro-developmental sequelae, and functional status) and also estimate the likelihood and temporal distribution of

complications which might alter the course of recovery (Eltorai, A. S. 2019). Even though acute postoperative mortality has significantly decreased in most centres, it is an outcome variable that remains a focal point, especially in high-risk groups, such as neonates with complex single-ventricle physiology, Norwood-type palliation, or with patients with high levels of pre-operative organ dysfunction. Incremental improvements in perioperative care would produce clinically significant gains in survival rates in these subgroups (Larsen, S. H. *et al.*, 2005). However, mortality itself is not quite sufficient to measure the postoperative evolution. As a result, recently developed prognostication models focus on composite outcomes that combine the accumulation of mechanical ventilatory ventures, mechanical ventilatory ventures, length of inotropic assistances, liver and hepatic malfunction, re-hospitalization, neuro-developmental, and health-related quality of life. These composites acknowledge the fact that survival does not mean a high morbidity that encumbers the long-term prognostication and allocation of family resources (Hatherill, M. *et al.*, 1997; Fang, Y. *et al.*, 2024).

The field of neuro-developmental and functional outcomes is a highly important area in the prognostication of paediatric cardiac surgery (Karagoz, I. *et al.*, 2025). Longitudinal studies have demonstrated that children with complex congenital heart disease children are at a higher risk of subtle to severe neuro-developmental deficits compared to their counterparts, despite no apparent neurological impairments (Yang, Z. *et al.*, 2025). Based on this, neuro-developmental surveillance has become part of the daily routine of prognostic assessment as it is recognized that effective surgical correction is only a portion of the future prognosis of the child (Liu, J., & Zhang, F. 2025). Early identification of at-risk children helps to initiate early rehabilitation, family counselling, and educational intervention of such children to improve functional outcomes and enable their participation in society (Matsushita, F. Y. *et al.*, 2023). The ability to predict unfavorable outcomes and detect early signs of organ stress with the inclusion of laboratory biomarkers, including serum lactate, base deficit, creatinine, inflammatory cytokines, and brain natriuretic peptide, has enhanced the ability of haemodynamic and imaging assessment. These models make the communication between clinicians and families, resource distribution, and notice about targeting

interventions to reduce modifiable risks more accessible (Ranucci, M. *et al.*, 2010).

Follow-up surveillance of complications after surgery in children, after paediatric cardiac surgery, has a broad spectrum which includes early, procedure-specific issues, and late effects of surgery which may be identified in later growth and development (Chioléro, R. L. *et al.*, 2000). In general, post-operative complications include respiratory (atelectasis, pneumonia, prolonged mechanical ventilation), arrhythmias and conduction abnormalities, haemorrhage and transfusion-related complications, renal dysfunction, hepatic dysfunction, and metabolic complications. (Nygaard, U. *et al.*, 2023) The subsets have different prognostic, length-of-stay, and resource use implications. As an illustration, long-term mechanical ventilation and high inotropic workload is usually an indication of significant myocardial injury or a society-wide inflammatory reaction, indicating a longer recovery period and a higher chance of developing readmittance issues like respiratory failure or renal failure. Even temporary renal impairment may interfere with fluid balance, electrolyte balance, and pharmacokinetics, thus possibly affecting neuro-development and somatic growth. The nutritional absorption pathway and coagulation pathway may be compromised by hepatocellular dysfunction, increasing the chances of haemorrhagic or thrombotic events (Kapoor, P. M. *et al.*, 2016). Hematological disorders, coagulation disorders, and exposure to transfusion are linked to increased infectious risk, dysfunction of the body, and hospitalization.

The thing is that infection is another critical complication area with significant prognostic consequences. Children who are subjected to cardiac surgery are oftentimes exposed to invasive equipment, extracorporeal circuits, and extended periods of hospitalization, which intensifies the risk of bloodstream infection, mediastinitis, pneumonia, and catheter-related infections. Therefore, antimicrobial stewardship and strict infection control measures may be considered essential components of a prognosis-aware approach as they decrease the rate of complications and improve outcomes.

MATERIAL AND METHOD

This research employed a retrospective design in order to measure the results of 138 children from different hospitals from Iraq who had cardiac operations. The Institutional Review Board was

provided with ethical approval. The sample size was 0-18 years old patients who have gone through any of the subsequent forms of cardiac surgery: atrial septal defect (ASD) repair, ventricular septal defect (VSD) repair, or tetralogy of Fallot correction. The exclusion criteria were patients with missing medical history and emergency patients, where Data Collection through Electronic health record data were mined and contained demographic factors (age, sex, height, weight, socioeconomic status), primary diagnoses, and family history of cardiac disease. Specific variables were also obtained as follows:

- Surgical Information: Nature of surgery done and hospital stay (days).
- Risk factors: Pre-existing medical conditions, such as congestive heart failure, Down syndrome, and pulmonary hypertension.

- Outcomes: Survival rates, complications (type and severity), and readmission rates.
- Statistical analysis: SPSS analyses were done. The demographic variables and complications were exposed to descriptive statistics (mean \pm standard deviation, frequencies, and percentages).
- Correlation analysis: Pearson correlation coefficients were used to determine the relationship between risk factors and the incidence of complications.
- Logistic regression: Multivariate analysis of logistic regression was conducted to determine the predictors of postoperative complications, and odds ratios (ORs) and 95% confidence intervals were reported.

RESULTS

Table 1-Initial diagnosis of the results for 138 patients according to age, height, weight, and risk factors

Demographic Variable	Mean \pm SD	Frequency	% of Total Patients
Age (Years)	5.2 \pm 4.3	—	—
Weight (kg)	19.8 \pm 5.1	—	—
Height (cm)	105.2 \pm 15.4	—	—
Gender	Male: 70	70	50.7%
	Female: 68	68	49.3%
Socioeconomic Status	Low Income: 50	50	36.2%
	Middle Income: 70	70	50.7%
	High Income: 18	18	13.0%
Family History Variable	Frequency	% of Total Patients	Family History Variable
Family History of Heart Disease	30	21.7%	Family History of Heart Disease
Surgery Type	Frequency	% of Total Patients	Surgery Type
Atrial Septal Defect (ASD)	42	30.4%	Atrial Septal Defect (ASD)
Ventricular Septal Defect (VSD)	35	25.4%	Ventricular Septal Defect (VSD)
Tetralogy of Fallot	30	21.7%	Tetralogy of Fallot
Others	31	22.5%	Others
Risk Factor	F	P%	----
Congestive Heart Failure	10	7.2%	
Down Syndrome	6	4.3%	
Pulmonary Hypertension	8	5.8%	

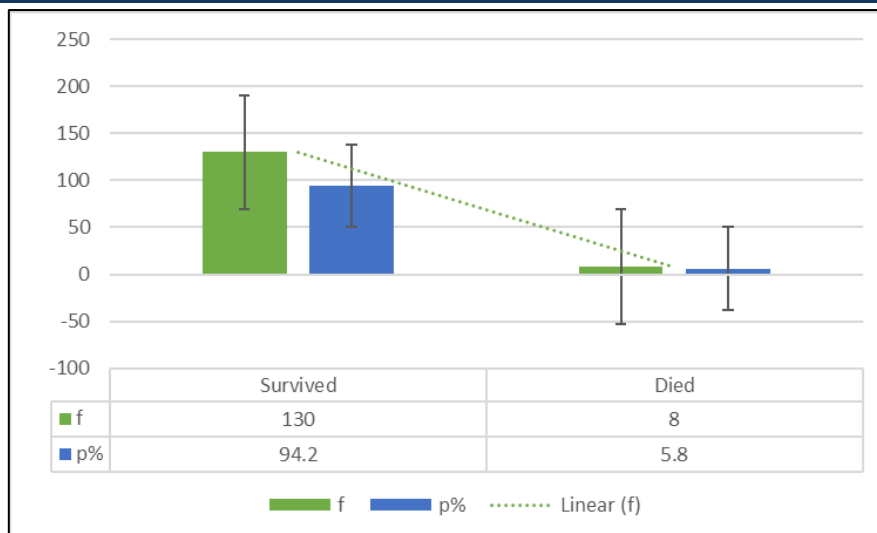


Figure 1- Distribution of patients according to Prognostic Outcomes - Survival

Table 2- Evaluating the satisfactory outcomes according to the general complications encountered in this study

Complication	F	P%
Total Complications	20	14.5%
Length of Stay (Days)	Median: 7	—

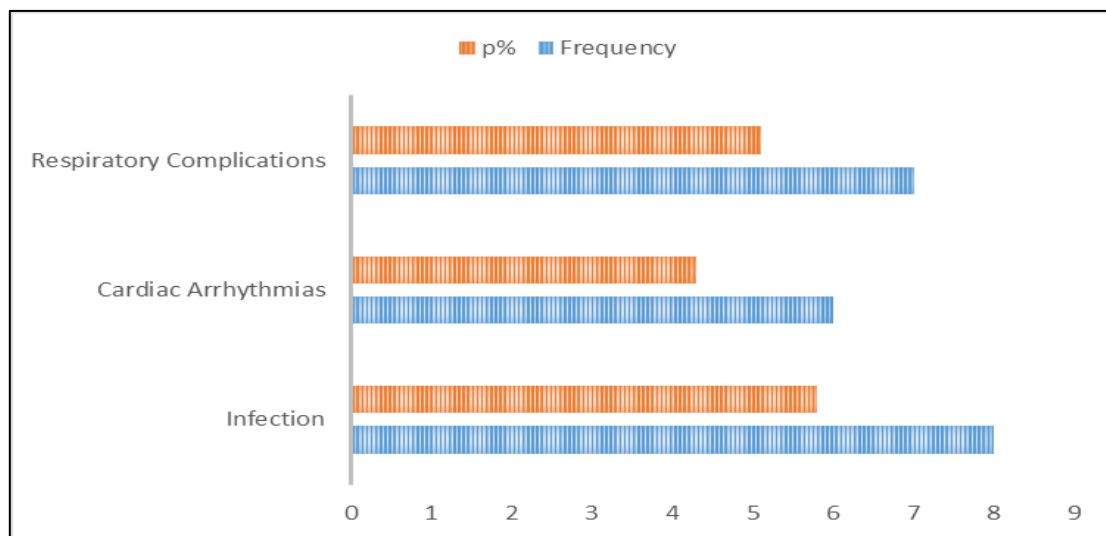


Figure 2- Distribution of patients according to Specific Complications Detected

Table 3- Assessment Correlation of Risk Factors with Complications

Risk Factor	Correlation Coefficient (r)
Congestive Heart Failure	0.25
Down Syndrome	0.15
Pulmonary Hypertension	0.20
Age	0.10

Table 4- Rate outcomes according to Logistic Regression Results for Complications

Variable	Odds Ratio (OR)	95% Confidence Interval	p-value
Age	1.10	1.02 - 1.18	0.015
Congestive Heart Failure	1.85	1.20 - 2.86	0.005
Down Syndrome	1.30	0.68 - 2.52	0.402
Pulmonary Hypertension	1.56	0.81 - 3.00	0.178

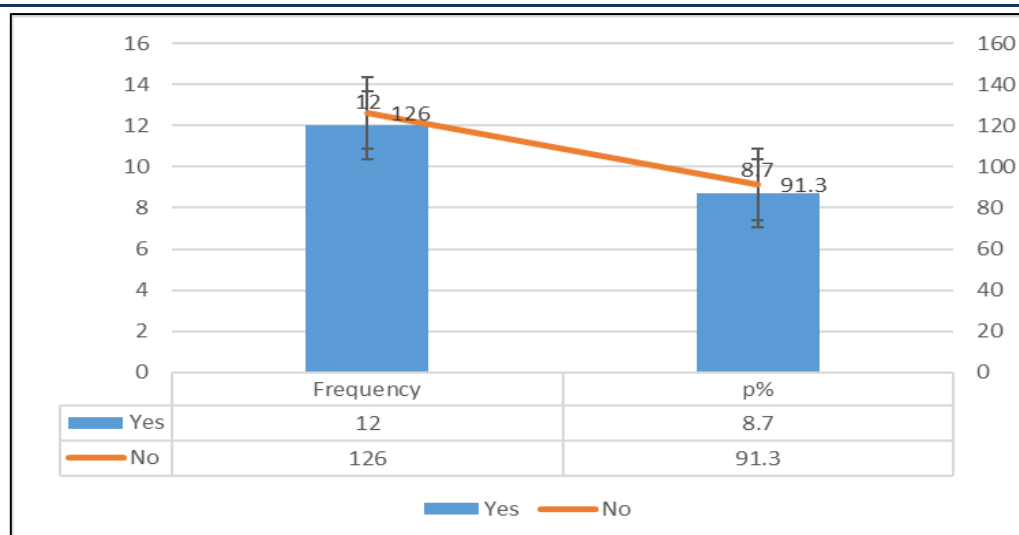


Figure 3- Final finding which related to the readmission rates of 138 Iraqi

DISCUSSION

Table 1 gives significant demographic data. The average age was 5.2 years (standard deviation 4.3), which shows that the subjects under study were of a large age group which was distributed widely, and hence the complexity of their conditions. The physical characteristics of the patients (mean weight = 19.8 with standard deviation = 5.1 kg and mean height = 105.2 with standard deviation = 15.4 cm) indicate the mean weight and height of the patients, and they can influence the outcome of the surgery and the number of complications.

About gender, the findings indicate that 50.7 per cent of the patients were men and 49.3 per cent were women. This ratio shows that there is an excellent gender balance, and it may indicate the absence of discrimination in the choice of cases in the study.

With regard to socioeconomic background, 36.2% of the patients belonged to low-income families, which forms one of the most significant aspects of influencing the general health in general. The statistics also reveal that 30 patients (21.7%) had a family history of cardiac disease, and this highlights that genetic factors could affect the outcome. As it is demonstrated in Table 2, 14.5 percent of patients had complications, which might be considered moderate when it comes to surgical procedures. The average length of stay (7 days) is an indicator of a fairly quick recovery. This brings forth the necessity of enhancing the treatment conditions in relation to complications and the length of stay, which may decrease the overall cost of treatment.

The correlation coefficient of the risk factors and complications is shown in Table 3. As an illustration, it demonstrates that congestive heart failure is found to have a correlation coefficient of 0.25, meaning that it is moderate associated with the prevalence of complications; thus, preventive measures should be taken. The correlation coefficient between Autism (Down syndrome) and Autism is 0.15, which means that the association is not very strong but significant. All these numbers indicate the need to evaluate the medical history of children in the preoperative period to make appropriate decisions.

The findings of logistic regression, which is a powerful tool of evaluating the relationship between variables and risk factors, are given in Table 4. The regression results show that the age of the patient increases the likelihood of complications by 10 in every 10 percent (OR = 1.10). Whereas congestive heart failure depicts an ODS of 1.85, which implies that patients with CHF are more likely to develop complications, the type of Down syndrome depicts an ODS of 1.30, which is not significant ($p=0.402$), and thus further research on the matter is essential in order to know its actual effect.

Figure 3 connects the results connected with readmission rates. The interpretation of these numbers may be useful as the ratio shows the need to enhance the efficiency of follow-up care and increase the rates of following treatment recommendations.

The situation in the literature on pediatric cardiac surgery always presents a complicated description. There are patient factors, particularities of each procedure, and hospital environment that

determine prognostic outcomes. Multicenter registries, retrospective cohort, and prospective research studies all have concurred that mortality is important but not the sole outcome that is significant. A more comprehensive picture of the patient's course and long-term prognosis can be obtained through composite measures of morbidity, such as long mechanical ventilation, prolonged ICU stay, high-dose inotropic support, kidney or liver complications, infections, arrhythmias, and neurodevelopmental problems. The results point to the necessity of meticulous risk stratification, which involves not only short-term postoperative risk but also long-term functional outcomes of children and their families.

One of the most important themes of the past research is the identification of major risk factors that can be confidently used to forecast the negative outcomes. Patients' issues like extremely young age (neonates), low birth weight, pre-term births, genetic syndromes or chromosomal disorders, and pre-operative dysfunction of organs are replicated as potent predictors of risk. These parameters probably indicate marked physiological reserve and increased susceptibility to perioperative stress, inflammation, and hypoperfusion. Prognosis is also always affected by the procedural variables. Increased mortality and morbidity are associated with longer cardiopulmonary bypass, application of circulatory arrest, intricacy of the lesion or procedure, and staged palliation. Risk trajectories are frequently initiated by the intraoperative and immediate postoperative period, with longer bypass time, more complicated reconstructions, initiating systemic inflammation, myocardial stunning, capillary leak, and organ dysfunction, which results in increased ventilation time, increased ICU or hospitalization, and increased resource consumption (Mir, T. *et al.*, 2006; Trujillo, L. M. G. *et al.*, 2025).

The risk is also determined by hospital characteristics. Complex procedures have better outcomes according to high volume and specialties, such as congenital heart programs, where the outcomes are not only survival-based but also family-based, like neurodevelopment, school readiness, and quality of life. When minor yet significant care areas are streamlined, such as early infants' feeding plans, neuroprotection measures, and extended follow-up, such results are more varied across centers. These observations support the idea of a systematic approach, combining the biology of patients with the care

environment, and make the point that the results are determined by the whole chain of care, not only heart pathology (Jacobs, M. L. *et al.*, 2021; O'Brien, S. M. *et al.*, 2009).

Neurodevelopmental outcomes have ceased to be a secondary issue but a prognostic outcome in most studies. Children who are exposed to complex congenital heart repairs develop insidious cognitive and behavioral impairments even without apparent peri-operative brain injury. It has been repeatedly observed in the literature that the intelligence of the neurodevelopmental trajectory can be influenced by perioperative determinants such as cerebral perfusion strategies, anesthesia time, blood-gas balance, inflammation, and post-operative hemodynamics. In the case of dual ventricle repairs, emphasis becomes on the long-term functional status, the absence of reintervention, and quality of life. Residual hemodynamics, arrhythmias, or valve problems accumulate morbidity there. In all areas, risk factors remain constant, though proportions vary depending on the type of procedure, which points to the necessity of lesion- and technique-specific prognostic equations. Systemic inflammatory biomarkers, lactate concentrations, kidney and liver function measurements, and natriuretic peptides are also linked to unfavorable postoperative outcomes in the form of prolonged ventilation, kidney damage, and prolonged stay. Imaging- echoes and cardiac MRI- provides information of ventricles' functioning, valve wellness, and anatomy prior to operation, changing risk estimations. These objective measures are complemented with clinical data, which enhances prediction and allows detecting the presence of high-risk patients at an earlier stage and administering targeted treatment in the form of the optimization of hemodynamics, neuroprotection, and increased monitoring after the operation. The literature, however, warns that biomarker increase in biomarkers may indicate general surgical stress instead of organ-specific damage, and it is important to note when they are taken. Therefore, biomarkers are most effective when used as a component of a multimodal prognostic model as opposed to individual predictors. Mortality is commonly reported, albeit with different definitions: hospital, 30-day, or 1-year mortality, and it is difficult to conduct a direct comparison. Composite scores that vary in composition and weightings are used to capture post-operative morbidity. The neurodevelopmental outcomes, the long-term development, and functional status

should also receive standardized assessment tools and regular follow-up schedules to make meaningful synthesis. A growing body of literature regarding the topic suggests that standardized reporting frameworks and core outcome sets in the research of pediatric cardiovascular surgery can be utilized to enable cross-study comparability, meta-analysis to help provide reliable guidance in practice and policy.

CONCLUSION

The correlation analysis of risk factors against complications revealed that the correlation coefficient of congestive heart failure was 0.25 whilst that of Down syndrome was 0.15 which showed that the relationship between the two factors and development of complications was moderate where Findings of the logistic regression indicated a 10 percent augmentation in the likelihood of troubles in each 10 percent augmentation in the age of the patient, and congestive heart failure had an ODS of 1.85 as well as we concluded Conclusively the research proposes collaborative measures between physicians, families to children and the community in the context of providing comprehensive healthcare that helps to enhance the quality of life among children undergoing cardiac surgery.

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