

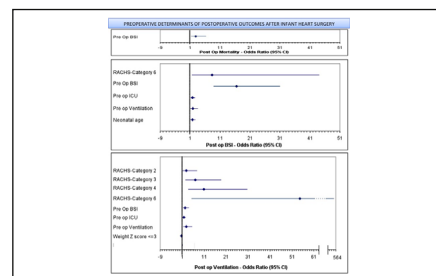
Preoperative Determinants of Outcomes of Infant Heart Surgery in a Limited-Resource Setting

N. Srinath Reddy, MD,^{*} Mahesh Kappanayil, FNB,^{*} Rakhi Balachandran, MD,[‡] Kathy J. Jenkins, MD, MPH,[§] Abish Sudhakar, MSc,^{*} G.S. Sunil, MCh,[†] R. Benedict Raj, MCh,[†] and R. Krishna Kumar, DM[‡]

We studied the effect of preoperative determinants on early outcomes of 1028 consecutive infant heart operations in a limited-resource setting. Comprehensive data on pediatric heart surgery (January 2010-December 2012) were collected prospectively. Outcome measures included in-hospital mortality, prolonged ventilation (>48 hours), and bloodstream infection (BSI) after surgery. Preoperative variables that showed significant individual association with outcome measures were entered into a logistic regression model. Weight at birth was low in 224 infants (21.8%), and failure to thrive was common (mean-weight Z score at surgery was 2.72 ± 1.7). Preoperatively, 525 infants (51%) needed intensive care, 69 infants (6.7%) were ventilated, and 80 infants (7.8%) had BSI. In-hospital mortality (4.1%) was significantly associated with risk adjustment for congenital heart surgery-1 (RACHS-1) risk category ($P < 0.001$). Neonatal status, preoperative BSI, and requirement of preoperative intensive care and ventilation had significant individual association with adverse outcomes, whereas low birth weight, prematurity, and severe failure to thrive (weight Z score < -3) were not associated with adverse outcomes. On multivariable logistic regression analysis, preoperative sepsis (odds ratio = 2.86; 95% CI: 1.32-6.21; $P = 0.008$) was associated with mortality. Preoperative intensive care unit stay, ventilation, BSI, and RACHS-1 category were associated with prolonged postoperative ventilation and postoperative sepsis. Neonatal age group was additionally associated with postoperative sepsis. Although severe failure to thrive was common, it did not adversely affect outcomes. In conclusions, preoperative BSI, preoperative intensive care, and mechanical ventilation are strongly associated with adverse outcomes after infant cardiac surgery in this large single-center experience from a developing country. Failure to thrive and low birth weight do not appear to adversely affect surgical outcomes.

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Preoperative determinants of infant CHD-surgical outcomes in limited-resource environment.

Central Message

Preoperative sepsis, preoperative intensive care, and ventilation are critical determinants of infant congenital heart disease surgical outcomes in limited-resource environments.

Perspective

There is limited data on determinants of infant heart surgery from developing world. This prospective study of 1028 infants from India systematically analyzed preoperative variables, identifying preoperative clinical state (BSI and the need for ICU and ventilation) as critical determinants of outcomes. Birth weight, failure to thrive, and prematurity did not adversely affect outcomes.

INTRODUCTION

Although merits of early correction of congenital heart disease (CHD) are well understood, infant heart surgery for CHD has only recently gained wider acceptance in developing countries.^{1,2} Congenital heart surgery (CHS) is a complex field and demands a high level of multidisciplinary expertise involving pediatric cardiologists, pediatric cardiac surgeons, and cardiac intensivists.³⁻⁶ It is highly resource intensive and the infrastructural demands are substantial.⁷ These challenges are further amplified in infant and newborn cardiac surgery.

Risk factors affecting mortality and morbidity after CHD surgery have been studied extensively, and include surgical

^{*}Department of Pediatric Cardiology, Amrita Institute of Medical Sciences, Cochin, Kerala, India

[†]Department of Pediatric Cardiac Surgery, Amrita Institute of Medical Sciences, Cochin, Kerala, India

[‡]Department of Cardiac Anesthesiology-Critical Care, Amrita Institute of Medical Sciences, Cochin, Kerala, India

[§]Department of Cardiology, Boston Children's Hospital, Boston, Massachusetts

Address reprint requests to Mahesh Kappanayil, FNB, Department of Pediatric Cardiology, Amrita Institute of Medical Sciences, Ponekkara PO, Cochin, Kerala 682041, India. E-mail: maheshpeds@yahoo.co.in

complexity, length of cardiopulmonary bypass and circulatory arrest, duration of mechanical ventilation and intensive care, delayed sternal closure, and infection (bloodstream sepsis, wound sepsis, ventilator-associated pneumonia).⁸⁻¹² Most of these data are from units in the high-income countries. The possibility that there may be additional determinants of outcomes in low- and middle-income countries (LMIC) or resource-limited environments has not been adequately investigated. Although surgical numbers have been steadily increasing, the challenges have been considerable in limited-resource environments.

Pediatric heart care in LMIC is typified by overburdened units catering to large patient numbers, poverty, lack of education and awareness, disorganized health care systems, undernutrition, poor hygiene, concurrent infections, and delayed diagnosis.^{13,14} There are limited data on the outcomes of infant cardiac surgery and its determinants from the LMIC environment. Lack of robust databases and follow-up for outcomes have contributed to the paucity of quality data. Identification of specific factors can potentially allow establishment of targeted quality-improvement measures to address existing deficiencies.^{15,16}

It appears intuitive to assume that characteristics peculiar to LMIC environment for example, undernutrition, low birth weight (LBW), and poor preoperative clinical status may contribute toward worse outcomes as compared with the high-income countries.¹⁷⁻¹⁹ However, these issues have not been systematically studied.

We undertook this study to evaluate the effect of preoperative variables on the early surgical outcomes after infant heart surgery in our unit in Southern India, a typical limited-resource environment unit. We specifically examined the effect of LBW, failure to thrive (as surrogate for undernutrition), preoperative bloodstream sepsis, and the need for preoperative intensive care and ventilation, on in-hospital surgical outcome.

METHODS

Setting

The study was conducted in a single large-volume pediatric heart program located in an institution in South India. This nongovernmental institution, based on a not-for-profit model, caters to a population of ~30 million and performs approximately 700 cardiac operations in children annually. The pediatric cardiac program is substantially supported by philanthropic support, and is one among 2 large-volume units caring for patients with CHD in this

southern Indian state; smaller state-run and private institutions also cater to a smaller proportion of the patient load, predominantly simpler lesions in older children. As a center of excellence, the unit also caters to patients referred from other parts of the country, and overseas. A total of 2 pediatric heart surgeons and 5 pediatric cardiologists staff the program. A total of 3 pediatric cardiac anesthesiologists deliver intensive care with assistance from pediatric cardiology fellows and pediatric heart surgeons. Postoperative intensive care is delivered in a 10-bed dedicated intensive care unit (ICU) staffed by nurses with an average work experience of 18 months. The surgical case spectrum handled by the unit includes a comprehensive range of operations including neonatal cardiac emergencies, Norwood operation, complex biventricular repairs, and single-ventricle palliations, with the exclusion of pediatric heart transplant and extra corporeal membrane oxygenator services. The unit's experience with neonatal cardiac surgery and Norwood operation has been published previously.^{20,21} Unit expertise and policies allows surgery in infants with LBW, severe malnutrition, and infectious or non-infectious comorbidities. However, despite availability of expertise, limitation of resources at institutional, individual, and societal levels necessitates a conservative approach toward hypoplastic left heart syndrome.

The unit is a participating member of the International Quality Improvement Collaborative (IQIC) for CHS in developing world countries—a collaborative of health care teams from around the world working to create a culture of patient safety and sustainable quality-improvement infrastructures for children receiving CHS in developing world programs.²² The IQIC aims to reduce in-hospital mortality and 30-day mortality and major complications for children undergoing CHS in these programs.

Data Collection

A robust database of all CHSs was set up as a part of our institutional participation in the IQIC. The IQIC data are centrally stored and managed by Boston Children's Hospital.

Demographic and clinical data pertaining to patients undergoing CHD surgery was prospectively entered into the database, including information on preoperative status, clinical diagnosis (cardiac and noncardiac), surgical risk category (risk adjustment for CHS [RACHS]-1),²³ surgical procedure, surgical outcomes (mortality, ICU stay, duration of mechanical ventilation, bloodstream infection (BSI), and surgical-site infection), and 30-day survival. The

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