Assessing surgical risk for adults with congenital heart disease: Are pediatric scoring systems appropriate?

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Background: Patients with congenital heart disease are frequently surviving into adulthood, and many of them will require surgery. Currently, there is no validated risk scoring system for adult congenital heart surgery, and predicting outcomes in these patients is challenging. Our objective was to determine if commonly used pediatric congenital heart disease surgery risk scores are also applicable to adults.

Methods: Four hundred fifty-eight adult (age ≥18 years) operations involving cardiac surgery for congenital heart disease between 2000 and 2010 at a single institution were studied retrospectively. The pediatric scores evaluated were the Risk Adjustment for Congenital Heart Surgery (RACHS-1) score, the Aristotle Basic Score, and the Society of Thoracic Surgery–European Association for Cardio-Thoracic Surgery (STAT) Congenital Heart Surgery Mortality score. Receiver operating characteristic (ROC) curves were generated to assess the ability of the scoring systems to predict mortality, major adverse events (stroke, renal failure, prolonged ventilation, prolonged coma, deep sternal infection, reoperation, and operative mortality), and prolonged length of stay (>7 days).

Results: Of 458 operations, there were 16 (3%) deaths, 94 (21%) major adverse events, and 90 (20%) prolonged lengths of stay. Four hundred thirty (94%) of the operations were included in all 3 scoring systems and the ROC analysis. For mortality, areas under the ROC curve were 0.91, 0.91, and 0.65 for the Aristotle, STAT, and RACHS-1 scores, respectively. For major adverse event, areas under the ROC curves were 0.81, 0.76, and 0.61 for the Aristotle, STAT, and RACHS-1 scores, respectively. For prolonged length of stay, areas under the ROC curve were 0.82, 0.76, and 0.61 for the Aristotle, STAT, and RACHS-1 scores, respectively.

Conclusions: Pediatric risk scoring systems such as Aristotle, STAT, and RACHS-1 offer prognostic value in adults undergoing congenital heart surgery. The scores are predictive of mortality, major adverse events, and prolonged lengths of stay. The STAT and Aristotle systems fared best. (J Thorac Cardiovasc Surg 2014;147:666-71)

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Patients with congenital heart disease are frequently surviving into adulthood. In 2000, the number of adult patients with congenital heart disease in the United States was estimated to be between 650,000 and 1.3 million.[1-3] More importantly, the prevalence of severe congenital heart disease has increased by 85% in adults compared with 22% in children, consistent with the notion that the greatest survival trend has occurred in patients with more severe disease.[1-4] As adults, many of these patients with complex conditions will require surgery.

Currently, there is no validated risk scoring system for adult congenital heart surgery, and predicting outcomes in these patients is challenging. In children, the Risk Adjustment for Congenital Heart Surgery (RACHS-1) scoring system, the Aristotle scoring system, and the Society of Thoracic Surgery–European Association for Cardio-Thoracic Surgery (STAT) Congenital Heart Surgery Mortality scoring system have been used to stratify risk and predict/compare outcomes.

The purpose of this study was to determine if commonly used pediatric congenital heart disease surgery risk scores were also applicable to adults. The prognostic value of the pediatric scoring systems with respect to mortality, major adverse events, and length of stay in adult was evaluated in patients with congenital heart disease.

METHODS

A retrospective cohort study of 458 consecutive operations on adult patients (age ≥18 years) with a previous history of congenital heart disease, who underwent cardiac surgery at a single, large, academic center between January 1, 2000, and December 31, 2010, was performed. For all operations, the surgical procedure was attributed to congenital cardiac pathology. Institutional Review Board approval was obtained for this retrospective study, and individual patient consent was waived.

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Abbreviations and Acronyms

EACTS = European Association for Cardiothoracic Surgery
RACHS-1 = Risk Adjustment for Congenital Heart Surgery
ROC = receiver operating characteristic
STAT = Society of Thoracic Surgery–European Association for Cardio-Thoracic Surgery
STS = Society of Thoracic Surgeons

Scoring Systems

The RACHS-1 scoring system, the Aristotle basic scoring system, and the STAT Congenital Heart Surgery Mortality scoring system were evaluated. Using tables from the landmark articles on the RACHS-1, Aristotle, and STAT scoring systems, we assigned each operation a score within each system.[5-7] For the RACHS-1 system, the scale ranged from 1 to 6.[5] For the Aristotle basic system, the scale ranged from 1.5 to 15, and a corresponding basic complexity level between 1 and 4 was assigned (level 1, 1.5-5.6; level 2, 6-7.8; level 3, 8-9.5; level 4, 10-15).[6] For the STAT score, the scale ranged from 0.1 to 5.0, and a corresponding mortality category level between 1 and 5 was assigned (level 1, 0.1-0.3; level 2, 0.4-0.7; level 3, 0.8-1.2; level 4, 1.3-2.6; level 5, 2.9-5.0).[7] In each scoring system, a higher score indicates a higher risk of mortality. For patients undergoing multiple procedures, the procedure with the highest level was scored.

Outcomes

Operative mortality, presence of a major adverse event, and length of hospital stay greater than 7 days were chosen as the 3 primary outcomes. Operative mortality was defined as a death occurring during the surgical hospital stay or within 30 days of surgery. Because of the infrequency of individual complications, a composite adverse event outcome was used. The major adverse event composite outcome variable was positive if the patient had any of the following major complications: stroke, renal failure, prolonged ventilation, deep sternal infection, reoperation, and operative mortality. All patients were followed until the time of discharge to determine the occurrence of a primary outcome.

The Society of Thoracic Surgeons (STS) database was used to define the list of major adverse events.[8] Stroke was defined as a neurologic deficit caused by a disturbance in cerebral perfusion that did not resolve within 24 hours. Renal failure was defined by a serum creatinine level greater than 2.0 and twice the preoperative level, or by a new requirement for dialysis. Prolonged ventilation was defined as any requirement for mechanical ventilation more than 24 hours postoperatively. Deep sternal infection was defined as a sternal infection within 30 days of surgery, requiring all of the following conditions: (1) wound or mediastinal exploration with excision of tissue, (2) positive wound culture, and (3) treatment with antibiotics. Reoperation was defined as surgery performed for any reason within 30 days of surgery. Operative mortality included (1) all deaths occurring during the hospital stay when the operation was performed and (2) those deaths occurring after discharge from the hospital, but within 30 days of the procedure.

Analysis/Statistics

The occurrences of mortality, major adverse events, and prolonged lengths of stay were summarized for the entire cohort. For those patient operations with a score from each scoring system, logistic regression was used to generate receiver operating characteristic (ROC) curves to assess the ability of each scoring system to predict each of the 3 primary outcomes. For the Aristotle and STAT systems, the raw scores were used. Higher area under the ROC curve indicated better discriminatory

TABLE 1. Frequency of operations performed (in descending order)

Procedure name	n
Pulmonary valve repair	142
Tricuspid valve repair	29
Conduit reoperation	28
Atrial septal defect repair, patch	25
Aortic root replacement, mechanical or bioprosthetic	24
Valvuloplasty, tricuspid	19
Atrial septal defect repair, patch + partial anomalous pulmonary venous connection repair	16
Fontan revision or conversion (redo Fontan procedure)	16
Mitral valve repair	15
Transplantation, heart	14
Valvuloplasty, mitral	14
Aortic valve replacement, mechanical or bioprosthetic	11
Pulmonary artery, reconstruction (plasty), branch, central (within the hilar bifurcation)	10
Aortic valve closure (aortic valve septal defect) repair, partial (incomplete)	8
Double chamber right ventricle repair	8
Ventricular septal defect repair, patch	8
Coronary artery bypass	7
Ross procedure	7
Coarctation repair, end-end	5
Valvuloplasty, aortic	5
Aortic stenosis, supravalvular, repair	4
Cardiac tumor resection	4
Anomalous origin of coronary artery repair	3
Aortic aneurysm repair	3
Arrhythmia surgery, atrial, surgical ablation	3
Coarctation repair, interposition graft	3
Partial anomalous pulmonary venous connection, scimitar, repair	3
Anomalous systemic venous connection repair	2
Aortic arch repair	2
Aortic stenosis, subvalvular, repair	2
Bidirectional cavopulmonary anastomosis (bidirectional Glenn procedure)	2
Ventricular assist device	2
Aortic arch repair + ventricular septal defect repair	1
Aortic dissection repair	1
Aortic root replacement, homograft	1
Aortic root replacement, valve sparing	1
Atrial septal defect partial closure	1
Konno procedure	1
Left atrial appendage excision	1
Patent ductal arteriosus closure, surgical	1
Pericardiectomy	1
Right ventricular outflow tract procedure	1
Septal myectomy	1
Shunt, systemic to pulmonary artery, modified Blalock-Taussig shunt	1
Sinus of Valsalva, aneurysm repair	1
Transplantation, lung(s)	1
Total	458

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