# Predictors for use of temporary epicardial pacing wires after pediatric cardiac surgery

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**Objective:** The objectives of this study were (1) to determine the use of temporary epicardial pacing wires to diagnose and treat early postoperative arrhythmias in pediatric cardiac surgical patients and (2) to determine the predictive factors for the need of pacing wires for diagnostic or therapeutic purposes.

**Methods:** We collected preoperative, intraoperative, and postoperative data in a prospective, observational format from patients undergoing pediatric cardiac surgery between August 2010 and January 2011 at a single academic children's hospital.

**Results:** A total of 157 patients met the inclusion criteria during the study period. Of these 157 patients, pacing wires were placed in 127 (81%). Pacing wires were used in 25 patients (19.6%) for diagnostic purposes, 26 patients (20.4%) for therapeutic purposes, 15 patients (11.8%) for both diagnostic and therapeutic purposes, and 36 patients (28.3%) for diagnostic or therapeutic purposes. Need for cardioversion in the operating room, presence of 2 or more intracardiac catheters, severely reduced ventricular ejection fraction, and elevated serum lactate level at the time of operating room discharge were found to be independent predictors for the use of pacing wires. The only complication noted in the cohort was a skin infection at a pacing wire insertion site in 1 patient. A permanent pacemaker was required in 8 (6.2%) of all patients with temporary pacing wires.

**Conclusions:** Our data support the use of temporary epicardial pacing wires in approximately 30% of children after congenital heart surgery. We found the need for cardioversion in the operating room, presence of 2 or more intracardiac catheters, severely reduced ventricular ejection fraction, and high serum lactate level at the time of discharge from the operating room to be independent predictors of the use of pacing wires in the early postoperative period. (J Thorac Cardiovasc Surg 2012;144:557-62)



Arrhythmias are a well-known complication after cardiac surgery in children with congenital heart defects.[1-4] Temporary epicardial pacing wires are used in the perioperative period both for diagnosis of arrhythmias and for treatment of a variety of abnormalities of cardiac rhythm. Some centers have advocated for discontinuing the routine placement of temporary pacing wires.[5] The argument for this change in practice is that temporary pacing wires are associated with serious postoperative complications, and the incidence of postoperative arrhythmias and heart block are now low because of improvements in myocardial protection and surgical techniques. The data on the complications associated with the use and removal of pacing wires are limited, with isolated case reports describing events, including cardiac perforation, tamponade, foreign body retention, wire migration, and wire-induced arrhythmias.[6-13] In contrast, other centers have demonstrated the routine use of temporary pacing wires without major complications.[14,15] Attempts to define predictors for the use of pacing wires after pediatric cardiac surgery have also been made.[14,15] Moltedo and colleagues[14] demonstrated the length of cardiopulmonary bypass (CPB) and aortic cross-clamp time to be predictors of the need for pacing wires after pediatric cardiac surgery. By using hemodynamic improvement as the primary outcome, Ceresnak and colleauges[15] demonstrated that the occurrence of intraoperative arrhythmias, use of circulatory arrest, and Fontan procedure were independent predictors for hemodynamic improvement with postoperative pacing.

Because of the conflicting recommendations and limited published data on this topic, we prospectively evaluated our institutional experience with the use of temporary epicardial pacing wires in pediatric cardiac surgical patients. The purpose of our study was to determine the following:

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**Abbreviations and Acronyms**
CPB = cardiopulmonary bypass
TEE = transesophageal echocardiogram

(1) the use of pacing wires to diagnose or treat early postoperative arrhythmias, (2) the predictive factors for the need of temporary epicardial wires, and (3) the complications associated with the use or removal of temporary pacing wires.

## MATERIALS AND METHODS

We performed a prospective, observational study with patients admitted to Stanford University's pediatric cardiovascular intensive care unit. The institutional review board of the Stanford University Medical Center approved the study, and the need for informed consent was waived. All patients aged 1 day to 18 years undergoing surgical repair or palliation of congenital heart defects from August 2010 to January 2011 at Lucile Packard Children's Hospital were included in the study. The primary outcome variable evaluated in our study was the use of temporary epicardial pacing wires for diagnostic or therapeutic purposes, or both. Patients who underwent ligation of patent ductus arteriosus, repair of coarctation of aorta via lateral thoracotomy, and implantation of a permanent pacemaker as a primary procedure were excluded. The decision to implant temporary atrial or ventricular epicardial pacing wires was made by the cardiac surgical team in the operating room, and the decision to use and remove the pacing wires was made jointly by the cardiac intensive care and surgical teams. The diagnostic uses of pacing wires included evaluation of the cardiac rhythm and the diagnosis of tachyarrhythmias and bradyarrhythmias. The use of pacing wires for diagnostic purposes was typically prompted by inadequate information on surface electrocardiogram recordings. The therapeutic uses of pacing wires included increasing the heart rate to augment blood pressure, establishing atrioventricular synchrony, performing overdrive pacing of junctional rhythms, suppressing ectopy, and terminating tachyarrhythmias. The use of pacing wires for therapeutic purposes was typically due to hemodynamic instability or signs and symptoms of low cardiac output syndrome (eg, inadequate urine output, low mixed venous oxygen saturation, elevated serum lactate, or metabolic acidosis).

Sinus bradycardia, junctional ectopic tachycardia, complete heart block, slow junctional rhythm, supraventricular and ventricular tachycardias, atrial flutter and atrial fibrillation, sinus tachycardia, frequent premature atrial, or ventricular complexes were considered critical arrhythmias. Sinus bradycardia was defined as an inadequate sinus rate for the age and hemodynamic condition of the patient or as a junctional escape rhythm in the absence of atrioventricular block or junctional ectopic tachycardia. The following minimal rates according to age were considered as bradycardia: 120 to 130 beats/min diurnal rate in neonates, less than 120 beats/min in children aged less than 1 year, 110 beats/min in children aged 3 to 4 years, 100 beats/min in children aged 5 to 7 years, less than 90 beats/min in children aged 8 to 11 years, and 85 beats/min in children aged 12 to 15 years.[3,16,17] Sinus tachycardia was defined as heart rate more than 180 beats/min in children aged less than 2 years and more than 160 beats/min in children aged more than 2 years. Frequent premature supraventricular or ventricular beats were diagnosed if their number exceeded 10 per minute.[3]

We collected preoperative variables, including age, sex, weight, degree of prematurity, need for preoperative medications, need for antiarrhythmic medications, thyroid disease, preoperative cardiomegaly, cardiac diagnosis, and diagnosis of trisomy 21 and 22q11 microdeletion. Risk adjustment for surgery was performed using the Risk Adjustment for Congenital Heart Surgery-1 method.[18] Intraoperative data included the procedure performed, CPB time, aortic crossclamp time, need for pacing coming off CPB, need for cardioversion or defibrillation in the operating room, volume of blood products administered, site of incision(s) (atrial, ventricular, or both), intraoperative ST-segment changes, and use of any antiarrhythmic medications. Postoperative variables included serum lactate level; ventricular ejection fraction on immediate postoperative transesophageal echocardiogram (TEE); inotrope score[19]; number and location of intracardiac catheters; dexemedetomidine use at the time of onset of arrhythmia; electrolyte abnormality as measured by potassium, calcium, and magnesium levels; serum lactate level; body temperature; arterial pH and inotrope score[19] at the time of onset of any arrhythmia; need and use of pacing wires for diagnostic or therapeutic purposes or both; duration of pacing wire implantation and of mechanical ventilation; and complications associated with use and removal of pacing wires, including death. The cardioplegia in our patients was standardized and induced using a solution of Plegisol (Hospira, Inc, Lake Forest, Ill) (sodium: 110 mEq/L, chloride: 160 mEq/L, potassium: 16 mEq/L, calcium: 2.4 mEq/L, magnesium: 32 mEq/L), with additional additives of potassium chloride (5 mEq/L) and sodium bicarbonate (10 mEq/L). Qualitatively reduced ejection fraction on postoperative TEE as judged by an independent, experienced echocardiographer constituted reduced ejection fraction for the purposes of study. Cardiomegaly was defined as a transverse diameter of the cardiac silhouette greater than or equal to 50% of the transverse diameter of the chest (increased cardiothoracic ratio) and was judged by an independent, experienced radiologist. The complications assessed included transmyocardial migration of a wire, cardiac perforation, pericardial effusion, cardiac tamponade, arrhythmias associated with removal of pacing wires, and retention of pacing wires after attempted removal. Patient charts, telemetry recordings, and electrocardiograms were reviewed for all patients included. In addition, we reviewed chest radiographs to assess the position of temporary pacing wires, as well as all echocardiograms performed after the removal of pacing wires to assess for pericardial effusion.

### Statistical Analysis

Continuous variables are presented as median (10th percentile, 90th percentile), and categoric variables are presented as counts and percentages. We performed univariable analyses to examine the associations between the patient characteristics and risk factors and the primary outcome variable. The *P* value was calculated using Pearson's chi-square test or Fisher exact test of independence for categoric variables and Wilcoxon rank-sum test for continuous variables. We also completed a redundancy analysis of the candidate predictors for multivariate logistic regression models along with variable clustering using Hoeffding's D statistic. A multivariable logistic regression analysis was performed to identify possible predictors associated with the need for pacing wires. Variables with a *P* value of .2 or less in the univariate analysis were entered in the multiple regression model. Any variable with 20% or more missing values or that occurred uncommonly ($\leq$5 subjects) was not considered for inclusion in the multivariate analyses. The model was expressed in terms of adjusted odds ratio, 95% confidence interval, and *P* value. Backward variable selection was used to help select variables. We performed several additional analyses to explore the findings of the multivariate model and investigate variables not selected. The model's goodness-of-fit was evaluated using the Hosmer–Lemeshow test, and the ability of the model to discriminate between outcomes was assessed using the c-statistic (which is equal to the area under the receiver operating curve). All analyses were performed using STATA/MP, Version 11.1 biostatistical software (StataCorp LP, College Station, Tex).

## RESULTS

A total of 157 patients met the inclusion criteria during the study period. Of these 157 patients, pacing wires were