Reduced pleural drainage, length of stay, and readmissions using a modified Fontan management protocol

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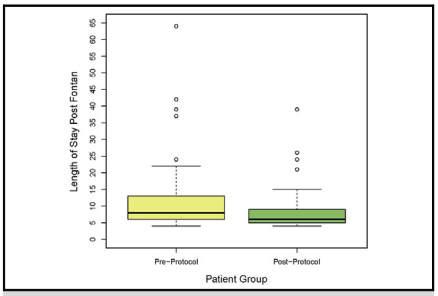
ABSTRACT

Background: Persistent pleural effusions after the Fontan procedure contribute to prolonged hospitalization and increased costs. We report our experience using a modified Wisconsin Fontan protocol to reduce chest tube drainage and hospital length of stay (LOS).

Methods: Single institutional retrospective chart review of 120 consecutive patients (60 before and 60 after initiation of our protocol) undergoing an extracardiac Fontan procedure from January 2004 to February 2007. Protocol influence was assessed by comparing group differences on duration of pleural drainage, requirement for nothing by mouth/total parenteral nutrition, hospital LOS, readmission for pleural effusion, and total hospital costs.

Results: Groups were similar in demographic characteristics, single ventricle morphology, preoperative hemodynamic parameters, and operative and immediate postoperative management. Median duration of pleural drainage and hospital LOS was reduced in the post- versus preprotocol groups: 4 days (interquartile range [IQR], 4-5 days) pre versus 6 days (IQR, 5-10 days) ($P < .0001$) and 6 days (IQR, 5-9 days) versus 8 days (IQR, 6-13 days) ($P = .005$), respectively. Pleural drainage lasting >1 week was also less common postprotocol: 23 (38%) before versus 7 (12%) after ($P = .001$). Fewer postprotocol patients required nothing by mouth/total parenteral nutrition to control effusions: 5 pre versus 0 post ($P = .06$), and fewer readmissions for effusions (14 before vs 7 after [$P = .1$]). An average total cost savings of 22% and readmissions savings of 29% resulted in nearly $500,000 in institutional savings over the study period.

Conclusions: A modified Fontan protocol resulted in reduced time to chest tube removal, hospital LOS, and chest tube drainage lasting >1 week. There was a strong trend toward avoiding nothing by mouth/total parenteral nutrition to control pleural effusion and lower hospital costs. (J Thorac Cardiovasc Surg 2015;150:481-7)



Comparison between groups in hospital length of stay measured in postoperative days.

Central Message

The use of a postoperative Fontan management protocol can reduce duration of chest tube drainage, hospital LOS, and hospital readmissions.

Perspective

Pleural effusions can complicate the postoperative course following the Fontan procedure. The use of a modified Fontan management protocol mitigates prolonged pleural drainage and shortens hospital length of stay. It may also lead to a reduction in the incidence of readmission and lower costs.

See Editorial Commentary page 488.

During the past 40 years, the Fontan procedure has undergone many modifications to improve postoperative mortality and morbidity in children with univentricular hearts. Despite these advancements, pleural effusions continue to be a challenging problem in the immediate postoperative period and a significant cause of morbidity and extended hospital length of stay (LOS). Currently, no definitive cause for pleural effusions has been identified. However, a number of potential factors include elevated pulmonary artery pressures (PAPs),[1-4] reduced ventricular function,[5,6] ventricle type,[7] prolonged mechanical ventilation, moderate-to-severe systemic atrioventricular valve regurgitation,[8] and longer cardiopulmonary bypass (CPB) and aortic crossclamp times.[9-11] Other variables such as benefit of conduit type (lateral tunnel vs extracardiac),[12] presence of fenestration,[13-16] intraoperative techniques such as the use of modified ultrafiltration,[17,18] off-pump techniques,[12,19] early extubation,[20,21] and specific medication use or postoperative management regimens[22-26] have been used in an attempt to reduce the incidence of pleural effusion and decrease hospital LOS.

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Abbreviations and Acronyms

CPB = cardiopulmonary bypass
CTICU = cardiothoracic intensive care unit
EC = extracardiac
IQR = interquartile range
LOS = length of stay
NP = nurse practitioner
OR = operating room
PAP = pulmonary artery pressure
TPN = total parenteral nutrition

Diuretic therapy, fluid restriction, and dietary modifications continue to be first-line treatment for persistent pleural effusions. Treatment may need to be escalated to further restrictions such as nothing by mouth with total parenteral nutrition (TPN) or, in extreme cases, pleurodesis or thoracic duct ligation. Some institutions have developed perioperative risk stratification strategies to guide patient selection and/or intra- and postoperative Fontan protocols to reduce the incidence of prolonged pleural effusions and the associated morbidities.[22-25]

Cava and colleagues[22] published 1 of the first postoperative medical strategies to reduce the incidence of pleural effusions in Fontan patients. The medical strategy showed a significant decrease in chest tube duration from 15 to 6 days and hospital LOS from 18 to 9 days.[22] However, hospital readmission rates for pleural effusion were not examined because the protocol ended with the removal of the last pleural chest tube. Recently, Sunstrom and colleagues[26] showed improved outcomes and reduced LOS from 13 to 8 days using a Fontan intraoperative and postoperative management strategy named the PORTLAND (peripheral vasodilation, oxygen, restriction of fluids, technique of surgery, low-fat diet, anticoagulation [including antithrombin III management], no ventilator, and diuretics) protocol. The PORTLAND protocol shares many of the medical strategies used by Cava and colleagues.[22]

The purpose of our study was to describe the efficacy of our modified Fontan management protocol to reduce the duration of pleural drainage, hospital LOS, readmissions for pleural effusion, and health care costs.

PATIENTS AND METHODS

Patient Selection

Beginning in March 2006, we initiated our modified Fontan protocol. A retrospective review was performed of 125 consecutive patients who underwent a Fontan procedure who were discharged from the hospital during the 3-year period from January 2004 to February 2007. Patients were excluded if they died in the hospital (n = 2) or underwent a Fontan conversion (n = 3) for a total of 120 patients (60 preprotocol and 60 postprotocol) included in the analysis. A comparative design was used to assess group differences related to duration of pleural drainage, hospital LOS, readmission rates, and health care costs. Variables of interest included age, gender, weight, ethnicity, insurance type, ventricle type, diagnosis, preoperative hemodynamic parameters, presence of fenestration, concomitant procedures, extubation in the operating room (OR), median number of days until the last chest tube removed, amount of chest tube drainage 24 hours before removal, hospital LOS, need for nothing by mouth/TPN or pleurodesis, hospital readmissions for pleural effusion with and without chest tube reinsertion, and total hospital costs. The institutional review board at our institution approved this study as meeting ethical and legal requirements. Individual consent was waived.

Institutional Practice/Operative Technique

Since 2001, the practice at our institution has been to perform the modified Fontan procedure using an extracardiac (EC) conduit technique. Only 2 pediatric cardiothoracic surgeons were performing surgery during the study period. The EC Fontan procedure was performed consistently using CPB without aortic crossclamp unless a concomitant intracardiac procedure was performed. Modified ultrafiltration was rarely performed. After discontinuing CPB, if the central venous pressure was >18 mm Hg, with a transpulmonary gradient >12 mm Hg, then placement of a fenestration was considered. If a fenestration was needed, a 4-mm direct side-to-side anastomosis of the EC conduit to the right atrial free wall was performed. The majority of patients were extubated in the OR. Patients were typically in the cardiothoracic intensive care unit (CTICU) for 3 days with the remainder of hospital stay in the telemetry unit. The postoperative anticoagulation regimen consisted of warfarin with a goal international normalized ratio of 1.5 to 2.0 for conduit prophylaxis.

Cardiac Catheterization and Echocardiogram Data

All patients underwent a preoperative Fontan cardiac catheterization and echocardiogram assessment. The mean PAP and transpulmonary gradient were documented. The degree of atrioventricular valve regurgitation and single ventricle function were obtained from the echocardiogram report.

Modified Fontan Management Strategy Protocol

The postoperative Fontan protocol was adapted from Cava and colleagues'[22] published protocol at Children's Hospital Wisconsin (Table 1). The protocol was revised to coincide with our institutional practices and reviewed by the medical directors of the heart institute, CTICU, and pharmacy before implementation (Table 2). Once the protocol received internal approval, it was disseminated to private practice cardiology groups to solicit feedback and promote outpatient follow-up. The cardiothoracic surgery nurse practitioners (NPs) educated the nursing staff and other members of the health care team (ie, intensivists, fellows, and resident physicians), especially in the CTICU, where the protocol would be initiated. The NPs monitored adherence to the protocol in both the inpatient and outpatient settings.

Outcome Measures

The main outcome variables were duration of pleural drainage, hospital LOS, readmissions, and health care costs. Persistent pleural effusion was defined as chest tube drainage lasting >1 week. Hospital LOS included the day of admission to the day of discharge. All Fontan patients were admitted to the hospital the day of surgery. Hospital readmission for recurrent pleural effusion was a readmission within 30 days of hospital discharge. Hospital cost savings are defined as the money saved based on total costs as a result of protocol implementation.

Statistical Methods

Boxplots were created using R version 3.1.1 (R Foundation for Statistical Computing, Vienna, Austria) and all other analyses were conducted with the Statistical Package for the Social Sciences 2014 edition (IBM-SPSS Inc, Armonk, NY). Preliminary analysis of patient characteristics among the pre- and postprotocol groups were summarized using descriptive statistics and differences were compared using the Mann Whitney *U*