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Factors associated with survival in patients who undergo peritoneal dialysis catheter placement following cardiac surgery ☆

Arin L. Madenci [a], Alexander P. Stoffan [b], Satish K. Rajagopal [c], Joshua J. Blinder [c], Sitaram M. Emani [d], Ravi R. Thiagarajan [c], Christopher B. Weldon [b,*]

[a] *University of Michigan Medical School, Ann Arbor, MI, USA*
[b] *Department of Surgery, Boston Children's Hospital and Harvard Medical School, MA, USA*
[c] *Department of Cardiology, Boston Children's Hospital and Harvard Medical School, MA, USA*
[d] *Department of Cardiac Surgery, Boston Children's Hospital and Harvard Medical School, MA, USA*

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Abstract

Purpose: Pediatric post-cardiac surgery patients are at risk for acute kidney injury and intraabdominal hypertension. The present study assesses indications and outcomes of postoperative peritoneal dialysis catheter (PDC) placement in this population.

Methods: We retrospectively reviewed single-institution patients who underwent PDC placement post-cardiac surgery between 1999 and 2011 ($n = 55$). Baseline, clinical course, and outcome data were recorded pre- and post-PDC. We used multivariable logistic and Cox analyses to assess factors associated with mortality.

Results: In-hospital mortality of the study cohort was 67.3% ($n = 37$). Peritoneal dialysis was performed in 21 patients (38.2%). Five patients (9.1%) experienced adverse events related to PDC placement. Greater post-PDC decreases in abdominal girth (adjusted odds ratio [OR] = 2.43; $P = 0.02$) and BUN (OR = 1.06; $P = 0.04$) were associated with survival. Additionally, preoperative ventilator independence (hazard ratio [HR] = 1.18; $P < 0.01$) and lower creatinine (HR = 8.32; $P < 0.01$), as well as greater post-PDC decrease in inotrope score (HR = 1.33; $P < 0.02$) were associated with survival.

Conclusions: In-hospital mortality of the study cohort was 67%. Less severe pre-PDC renal impairment, increased pre-PDC abdominal girth, and greater post-PDC improvement of abdominal girth, renal function, and inotrope requirements were associated with survival. Prospective trials are needed to assess appropriate indications and timing of PDC placement, with consideration of more aggressive treatment for intraabdominal hypertension.

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* Corresponding author. Department of Surgery, Children's Hospital Boston, Boston, MA 02115, USA.
E-mail address: christopher.weldon@childrens.harvard.edu (C.B. Weldon).

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Pediatric patients who undergo cardiac surgery are at risk for multiple complications, including acute kidney injury (AKI) and intraabdominal hypertension (IAH). Both morbidities are closely linked to postoperative fluid balance disturbances as well as low cardiac output syndrome [1] and capillary leak syndrome [2,3]. In particular, renal insufficiency affects over 10% of children who undergo cardiopulmonary bypass and further aggravates fluid overload and extravasation [4–7]. Severe IAH exacerbates renal dysfunction by increasing renal venous pressure [8]. Urgent placement of a peritoneal dialysis catheter (PDC) is at times performed to decompress the abdomen and improve cardiorespiratory and renal function. In severe cases, peritoneal dialysis may be performed to temporarily replace renal function.

However, the benefit of peritoneal access is unclear. The proportion of patients receiving PDCs who utilize the catheter for peritoneal dialysis is unknown. If the PDC functions merely as a conduit to drain a hypertensive abdomen, then a temporary decompressive catheter would be equally effective and less co-morbid than a tunneled, permanent PDC, because complications related to PDCs may occur in up to 20% of patients [5]. Furthermore, the suitability of a PDC to adequately decompress the abdominal cavity in cases of IAH has not been definitively proven and, as such, more aggressive intervention (i.e. decompressive laparotomy) may be warranted. However, the timing and indications for this step are unknown. The purpose of this study, therefore, is to assess the indications and outcomes of post-cardiac surgery PDC placement.

1. Methods

1.1. Patient population

An institutional review board-approved, retrospective review was conducted of the medical records of patients who underwent cardiac surgery between January 1999 and December 2011 at Boston Children's Hospital. Patients who underwent postoperative permanent PDC implantation following cardiac surgery met inclusion criteria. Each cardiac surgery and PDC placement was performed by 1 of 10 and 1 of 14 experienced surgeons, respectively. Patient demographics, cardiac diagnoses, perioperative data, and outcomes were collected. Physiological variables were also recorded, including abdominal girths, BUN and serum creatinine, ventilator settings, and medication dosages. Estimated glomerular filtration rate (GFR) was calculated by the Schwartz formula and used to assess renal function prior to PDC placement, according to the pediatric-modified RIFLE criteria (pRIFLE). The RIFLE classification system was originally developed by the Acute Dialysis Quality Initiative and modified for use in children. pRIFLE strata are assigned based on incremental decreases in GFR or oligoanuria and classified as: Risk, Injury, Failure, Loss and End-stage renal disease [9]. The pRIFLE criteria have been validated for use in critically ill children [10]. Increased abdominal girth was used as a proxy for IAH [11]. Surgical complexity was assessed for by the Risk Adjustment for Congenital Heart Surgery (RACHS-1) risk categories [12,13]. RACHS-1 categories range from 1 to 6, with 6 indicating the highest risk category. Determination of RACHS-1 risk category is primarily based on surgical case complexity and also takes into consideration patient characteristics such as age at the time of operation, prematurity, presence of major non-cardiac structural anomaly, and multiple cardiac procedures (Appendix) [12]. If a patient could be grouped into two or more RACHS-1 categories, the highest risk score was used. If a patient was unable to be assigned a RACHS-1 category (e.g. patients undergoing heart transplantation or missing data), the patient was designated "Unassigned." Patient inotrope score was calculated based on maximal requirements over a 24-h period. Inotrope score has been validated in this population to predict postoperative morbidity such as prolonged ventilation requirement [14]. Inotrope score is determined based on the formula: [1]

$$\begin{aligned}\text{Total inotrope score} &= \text{dopamine } (\mu/\text{kg}/\text{ min}) \\ &+ \text{dobutamine}(\mu/\text{kg}/\text{ min}) \\ &+ \text{adrenaline/epinephrine}(\mu/\text{kg/min}) * 100 \\ &+ \text{phenylephrine}(\mu/\text{kg}/\text{ min}) * 100 \\ &+ \text{noradrenaline/norepinephrine}(\mu/\text{kg}/\text{ min}) * 100.\end{aligned}$$

1.2. Outcomes

The primary outcome of the study was in-hospital mortality. Secondary outcomes included 24 h post-PDC change of renal laboratory tests, inotrope score, ventilator settings, and 7-day post-PDC change in abdominal girth (centimeters [cm]).

1.3. Statistical analysis

We tabulated patient demographics, cardiac diagnoses, cardiac surgery perioperative data, PDC implantation perioperative data, and outcomes, reporting percentages based on available data. Chi-square and Fisher's exact tests, where appropriate, were used to compare categorical variables between survivors and non-survivors; continuous variables were assessed using the Mann–Whitney *U* test. Multivariable association with mortality was evaluated using logistic regression with stepwise elimination. Survival analysis was performed using the Kaplan–Meier method for univariable analysis of categorical variables. Additionally, multivariable Cox regression was performed using the stepwise method. Survival time was calculated as duration in days from cardiac operation to death. Patients were censored when discharged from the hospital. Patients with missing data were excluded from each univariable and multivariable analysis. A *P* value