Non-dialysis-dependent Renal Dysfunction and Cardiac Surgery—An Assessment of Perioperative Risk Factors

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OBJECTIVE: In most reports, dialysis-dependent patients are known to be at increased risk for perioperative morbidity and mortality after cardiac surgical procedures.[1-7] However, the preoperative factors important for risk stratification of patients who have renal insufficiency but are not dialysis dependent are unclear. We set forth to ascertain preoperative risk factors important for predicting 2 endpoints: (1) dialysis at discharge and (2) hospital death.

DESIGN: A retrospective analysis.

SETTING: A tertiary referral center.

PATIENTS: From a database of patients undergoing cardiopulmonary bypass over a 6-year period, 150 patients were chosen for study based on their preoperative creatinine being greater than 1.5 mg/dl.

INTERVENTIONS: Routine monitoring and care of patients after their cardiac surgical procedures.

MEASUREMENTS AND MAIN RESULTS: Many preoperative, perioperative, and postoperative variables were measured. Multivariable regression was used for data analysis. There were 21 (14%) hospital deaths and 7 (5%) patients who were not on preoperative dialysis who required dialysis at discharge. Preoperative risk factors for hospital death were the patients' New York Heart Association (NYHA) class ($p = 0.004$) and emergency status ($p = 0.005$). Preoperative risk factors for dialysis at discharge were female gender ($p = 0.02$), emergency status of procedure ($p = 0.01$), and preoperative creatinine ($p = 0.03$).

CONCLUSIONS: These data allow for a more accurate assessment of risk stratification in this group of patients with renal insufficiency but who are not dependent on dialysis. Given the data presented here and other studies that report good outcomes for patients with renal disease after cardiac surgical procedures,[8-10] earlier operative intervention for coronary disease in this subset of patients might be warranted. (Curr Surg 62:64-70. © 2005 by the Association of Program Directors in Surgery.)

KEY WORDS: cardiac surgery, renal insufficiency, morbidity, mortality

INTRODUCTION

It has been estimated that up to 20% of patients undergoing cardiopulmonary bypass (CPB) may have some degree of renal insufficiency.[5,11] Patients with renal insufficiency who are dialysis dependent are known to be at increased risk of perioperative morbidity and mortality after the use of cardiopulmonary bypass.[1-4,7,12-15] In addition, it is well known that patients who develop acute renal failure postoperatively are at a substantially increased risk for perioperative mortality.[16-19]

Few studies addressing the risk factors for patients with non-dialysis-dependent renal insufficiency have been performed.[4,9,17,20] It might be expected that these patients are at an increased risk for perioperative morbidity and mortality, but exact preoperative factors important for accurate risk stratification in this group have not been clearly defined. To better address this issue, we present data from a retrospective analysis of patients who have undergone cardiopulmonary bypass at our institution over a 6-year period (1992 to 1998). Two endpoints were used for analysis: (1) mortality and (2) dialysis at discharge.

MATERIALS AND METHODS

From a database of patients who underwent cardiopulmonary bypass at our institution, we chose those patients who had a preoperative creatinine level above 1.5 mg/dl (n = 166, 1.5

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TABLE 1. Variables Measured

Preoperative Variables	Perioperative Variables	Postoperative Variables
Age	CPB time	Ionotrope use
Gender	Cross-Clamp time	Highest postoperative creatinine
Race (W,B,H,O)	Circulatory Arrest	Chest tube output
Body surface area	Coldest Temp on CPB	Postoperative Hgb
Albumin	Mean BP on CPB	Antibiotic for prophylaxis
Preoperative Hgb		Pulmonary complications
Preoperative creatinine		Time on ventilator
Preoperative dialysis status		Units of blood
Procedure		Creatinine
Emergency status		Atrial fibrillation
Procedure		Superficial wound infection
Liver disease		Sternal wound infection
Pulmonary disease		Vfib arrest
Peripheral vasc dis		Low cardiac output
Previous MI		Oliguria
Coronary artery disease		Dialysis at d/c
Type of valvular disease		Reoperation
Diabetes		Postop SGOT
Hypertension		ICU days
Cardiac medicines		Ward days
Ejection fraction		Postoperative dialysis
Balloon pump		Mortality
LVEDP		
New York heart class		
Reoperation		

Data were obtained from patients' hospital charts. Data were not used unless specifically documented in resident, attending, anesthesia, perfusionist, cardiac catheterization laboratory, or echo notes. Laboratory data were obtained from printed laboratory data forms available in patients' charts or from our hospitals' automated computer system. Operations were performed by 1 of 3 surgeons.

A procedure was defined as emergent if it was not a scheduled elective case and required immediate intervention. Urgent procedures were those that did not fall into either elective or emergent categories. NYHA class was obtained when documented and was defined in the usual manner. Race was categorized into 4 groups white, black, Hispanic, or other. Preoperative hemoglobin and albumin were chosen as markers of a patient's nutritional status. Oliguria is defined as urine output <30 cc/hr. Cardiac output was measured using a pulmonary artery catheter.

mg/dl upper limit of normal). The charts of these patients were then reviewed. Patients on dialysis preoperatively were excluded (n = 16) leaving 150 patients used in the final analysis.

In order to limit the initial selection bias, a large list of potential variables that might have predictive value on outcomes was chosen. Many of the variables chosen have been shown to influence operative outcomes, including age, preoperative creatinine level, sex, and race. Some specific variables chosen will be discussed below, but a rationale for each of the chosen variables will not be attempted here.

Table 1 lists the variables that were obtained and groups them into 3 categories: preoperative, perioperative, and postoperative variables.

Table 2 gives a demographic profile of the patients and lists their diagnosis, procedures, and NYHA class among other variables.

All statistical analysis was performed at the University of Alabama Hospitals by Dr. Naftel. Multivariable logistic regression was used for data analysis with 2 endpoints of interest: (1) in-hospital death and (2) dialysis at discharge. Data analysis was performed with the goal of identifying those preoperative variables that were important for risk stratification of patients undergoing procedures that required CPB. Further analysis of postoperative and perioperative endpoints was not performed, as the purpose of this paper was to address preoperative risk factors important for predicting outcome among patients undergoing cardiopulmonary bypass procedures.

RESULTS

A frequency histogram of preoperative creatinine is shown (Fig. 1). Mean preoperative creatinine was 2.2.

Twenty-one patients died in the hospital for an overall mortality of 14%. Table 3 lists the mortality of patients by procedure. Using multivariable analysis of preoperative risk factors associated with increased chance of in-hospital mortality only, NYHA class and emergency status of the patient were statistically important (Table 4). Interestingly, the degree of renal insufficiency, as measured by preoperative creatinine, did not have any predictive value for determining mortality in this setting (Fig. 2). A Cockcroft–Gault[21] correction for creatinine clearance as a function of age and body weight was performed. This analysis did not alter the observation that the degree of preoperative creatinine elevation was not an independent predictor of mortality.

There were a total of 11 patients who required postoperative dialysis. Seven patients had dialysis at discharge (4.6%). Of the remaining 4 patients, 2 had reversible renal failure and 2 suf-