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ORIGINAL RESEARCH

Heart Surgery in End-Stage Renal Disease: Is Outcome Worse for African American Patients?

Jonathan O. Nwiloh[1] and Chamberlain I. Obialo[2]

[1]Section of Cardiothoracic Surgery, St. Joseph's Hospital, Atlanta, GA. [2]Section of Nephrology, Morehouse School of Medicine, Atlanta, GA. Corresponding author email: Jnwiloh@gtcvsurg.com

Abstract: General results of open heart surgery in end-stage renal disease patients (ESRD) have been well-documented. However, it is unknown if the African American subgroup with known decreased access to advanced healthcare services and a higher prevalence rate of ESRD have a worse long-term survival after heart surgery. Thirty of 150 African American patients who underwent open heart surgery by a single surgeon at an urban community hospital between 1996 and 2010 were identified to have ESRD and were on chronic maintenance hemodialysis prior to surgery. Clinical and outcome data from both groups were retrospectively analyzed. There were no significant differences in the baseline demographic characteristics of the patients, but the ESRD cohort showed a significantly higher prevalence of peripheral vascular and cardiovascular diseases [$P < 0.001$]. Compared to the non-ESRD subjects, the predicted logistic EuroSCORE was 16.4% vs. 9.4%, [$P < 0.001$], while the observed 30 days operative mortality was 16.6% vs. 4.2% [$P < 0.02$], respectively. In isolated coronary artery bypass graft cases, operative mortality was 20.8% and 3.0%, respectively. The 5- and 10-year post-surgery survival was 40% and 25% vs. 72% and 57% [$P < 0.01$], respectively, in the ESRD and non-ESRD groups. Operative mortality and survival was worse in ESRD patients compared to non-ESRD patients based on their preoperative risk scores. Although the operative mortality of our ESRD patients was high, long-term survival was comparable to reports from both the United States Renal Data System and a Japanese ESRD cohort.

Keywords: heart surgery survival, ESRD, African Americans

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Introduction

Data from the United States Renal Data System (USRDS) has consistently shown that compared to Caucasians, African Americans (AA) have a higher incidence and prevalence of end-stage renal disease (ESRD).[1,2] These cohorts of patients are also at an increased risk of cardiovascular related morbidity and mortality.[3] In patients requiring heart surgery, the risks for operative mortality and morbidity are higher compared to non-ESRD patients.[4] While several studies have previously addressed the outcome of heart surgery in patients with ESRD, no studies have specifically examined long-term survival in AA with ESRD.

Methods

This study was approved by the institutional review board and individual patient consent was waived. The records of 150 AA patients, including 30 with ESRD who had open heart surgery performed by a single surgeon at an urban community hospital between April 1996 and December 2010 were retrospectively reviewed. Outcomes were compared between ESRD and non-ESRD cohorts for operative mortality and long-term survival. The two groups were unevenly matched as this was not a randomized study, but a case control study. All patients with ESRD were on maintenance hemodialysis for at least 3 months prior to surgery. Amongst the non-ESRD cohorts, 40 (33.3%) patients had moderately decreased renal function with glomerular filtration rate less than 60 mL/min. However, a separate subgroup analysis or comparison was not performed for this cohort. All surgeries were performed using median sternotomy with standard techniques with either cardiopulmonary bypass with moderate systemic hypothermia or off pump coronary artery bypass (OPCAB) for patients undergoing isolated coronary artery bypass surgery.

Preoperative risk scoring was performed using the logistic EuroSCORE for operative mortality. In addition, because of the known inaccuracies of the EuroSCORE in valve patients, the Society of Thoracic Surgeons' (STS) predicted risk of mortality (PROM) was also used for patients undergoing either isolated valve surgery or combined valve/coronary artery bypass graft (CABG) with supported risk models. Post-hospital discharge follow-up occurred through office or hospital visits, telephone calls, and use of the social security death index (SSDI), which is an administrative database of death records in the United States Social Security office. Patients with no death record as of April 1, 2011 were considered to be alive. Death was defined as all-cause mortality. All data were entered into an Excel spread sheet and transferred to an SAS file (SAS Institute Inc., Cary, NC, USA) for statistical analysis. Categorical variables were reported using number and percent of observations, while continuous variables were reported as mean ± standard deviations. Survival rates were calculated using the actuarial Kaplan Meier method. Continuous variables were analyzed using the 2 tailed *t*-test while categorical variables were compared using the Pearson chi square. A *P*-value of less than 0.05 was considered statistically significant.

Results

The baseline demographic characteristics for the two groups of patients are summarized in Table 1. All the procedures were either elective or urgent, except for two ESRD cases that underwent emergency surgeries. Of the 30 ESRD patients, 24 (80.0%) underwent isolated CABG, 7 of 30 (29.2%) were OPCAB; 2 of 30 (8.3%) were second-round CABG. Three patients (10.0%) had either valve replacement or repair, one patient had combined CABG/valve, and two patients had aortic root replacement using a St. Jude's valve conduit. The internal mammary artery was utilized in all 24 patients who had isolated CABG. The mean number of grafts per patient was 3.16 ± 0.89. For patients who required valve surgery, two had mechanical valves, one had pericardial valve, and

Table 1. Baseline demographics and select variables.

Variables	ESRD	No ESRD	*P* value
N	30	120	
Age (yr.)	59.30 ± 5.25	61.61 ± 2.11	0.36
BSA (m^2)	1.87 ± 0.13	1.94 ± 0.06	0.61
Gender (% female)	53.3	50.8	0.81
EF (%)	45.0 ± 4.47	45.13 ± 2.56	0.96
Euro score	16.41 ± 5.34	9.14 ± 2.85	0.01
Smokers (%)	48.2	39.9	0.38
Hypertension (%)	100	89.1	0.06
Diabetes (%)	60.0	52.1	0.44
PVD (%)	50.0	21.0	<0.001
CVD (%)	28.6	6.1	<0.001
Endocarditis (%)	10.7	0.00	<0.001

another had mitral valve repair with a Carpentier Edwards annuloplasty ring. Three patients (10.0%) had either preoperative or intra-operative insertion of intra-aortic balloon pump (IABP). Of the 120 non-ESRD patients, 99 (82.5%) had isolated CABG, and 20 (20.2%) of these were OPCAB. Fourteen (11.7%) were isolated valve repair/replacement and 3 (2.5%) were combined CABG/valve, 3 (2.5%) were aortic root replacement with St. Jude's valve conduit, and 1 (0.8%) closure of atrial septal defect. The left internal mammary artery (LIMA) was used in 96 (96.9%) of patients undergoing isolated CABG and the mean number of grafts per patient was 3.21 ± 0.99. A mechanical valve was used in 9, tissue valve in 3, and annuloplasty ring in 5 patients. Eighteen patients (15.0%) had either preoperative or intra-operative insertion of intra-aortic balloon pump.

The overall mean predicted logistic euroscore in the ESRD patients was 16.4%, while observed operative mortality was 16.6%. In the 4 patients with isolated valve or valve/CABG, PROM score was 4.2%, but there were no operative mortality in this subgroup. The mortality in the isolated CABG subgroup was 20.8% (5/24). The causes of death were apneic respiratory arrest, stroke, cardiogenic shock, ischemic bowel, and pneumonia.

The predicted logistic EuroSCORE in the non-ESRD group was 9.4% and observed mortality 4.2% (5/120). Two females undergoing valve surgery died of cardiogenic shock and sepsis. In patients with isolated CABG, one female had postoperative intensive care unit cardiac arrest from LIMA spasm, another female developed cardiac arrest during permanent pacemaker implant for postoperative heart block and one male died from a cerebrovascular accident. The mortality in patients with isolated CABG was 3.0% (3/99). Of the 17 isolated valve and valve/CABG patients with available risk models, PROM score was 2.8% and observed mortality 11.7% (2/17). The operative mortality between the different surgical subgroups is summarized in Table 2. Major morbidity in the ESRD cohort occurred in 4 patients (13.3%) and included one case each of prolonged ventilation, stroke; re-exploration for bleeding, and gastrointestinal event. In the non-ESRD cohort, major morbidity occurred in 20 (16.6%) patients, including prolonged ventilation in10 patients, re-exploration for bleeding in 6 patients, one case each of stroke, complete heart block, pneumonia, and gastrointestinal event. Comparatively, predicted logistic EuroSCORE in the ESRD and non-ESRD patients was 16.4% vs. 9.4%, respectively ($P < 0.01$). Overall observed 30 days post-operative mortality (OM) was 16.6% (5/30) vs. 4.2% (5/120), respectively ($P < 0.02$). The hazard risk was significantly higher in the ESRD than the non-ESRD group. [HR, 2.74; 95% CI (1.371–5.479), $P < 0.0043$]. In the ESRD group, mean follow-up was 44.8 ± 44.4 months (range 2–130 months) and in the non-ESRD group it was 58.8 ± 41.7 months (range 2–178 months).

Table 2. Subgroups operative mortality.

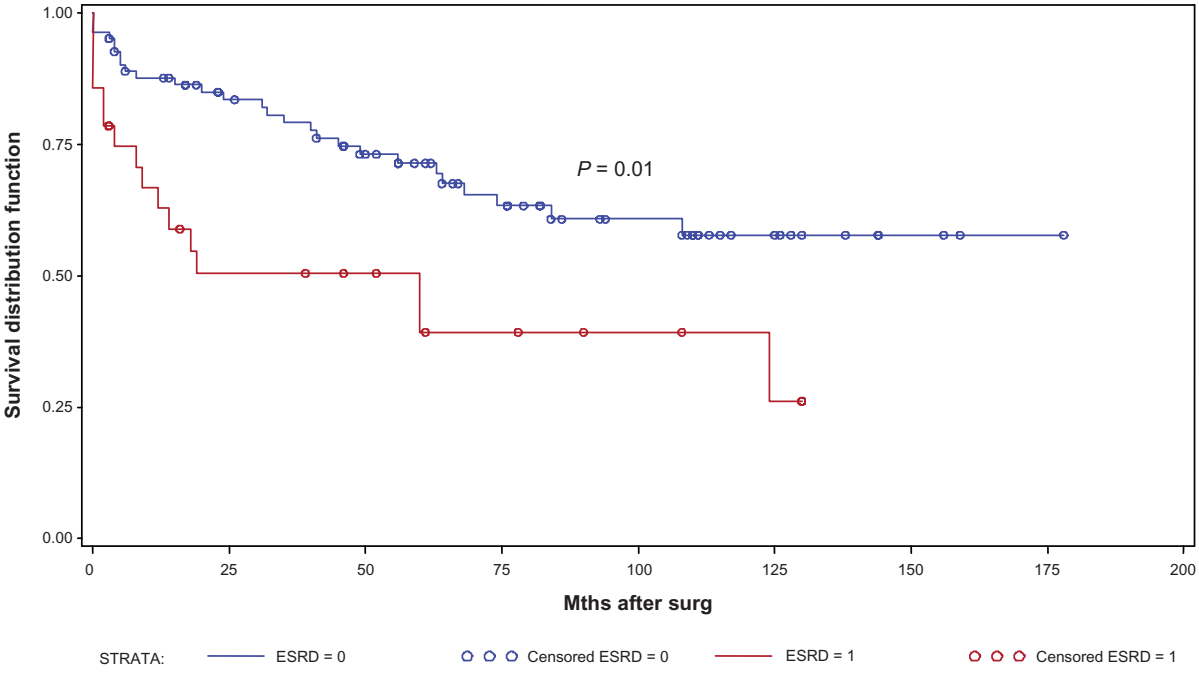
Surgical procedure	ESRD patients	Non ESRD patients
Isolated CABG	20.8% (5/24)	3.0% (3/99)
Valve & Valve/CABG	0% (0/4)	11.7% (2/17)
Aortic root replacement	0% (0/2)	0% (0/3)

Five- and 10-year survival for ESRD patients was 40% and 25%, compared to 72% and 57%, respectively, for non-ESRD patients ($P < 0.01$) (Fig. 1).

Discussion

Chronic kidney disease is a public health problem worldwide; in the United States, there has been a rising incidence and prevalence of renal failure as evidenced by the increasing enrollment of patients in the ESRD government-funded program over the past 3 decades.[1] The improved survival observed in dialysis patients in recent years has resulted in more ESRD patient being referred for open heart surgery.[5]

With this rising incidence of ESRD and an increasingly aging population, it is expected that the number of chronic dialysis patients requiring open heart surgery will likely continue to increase. ESRD patients are known to have an increased risk of death, particularly from cardiovascular disease[6] and therefore a resulting decreased life expectancy compared to their age-matched general population. ESRD patients have been reported to have a higher operative risk and lower long-term survival following open heart surgery compared to their non-ESRD cohorts.[3,4] Reasons for the worse outcomes include a higher incidence of comorbidities such as diabetes, hypertension, and hyperlipidemia, accelerated



No. at risk

Months	0	12	24	36	48	60	72	84	96	108	120
ESRD	30	25	17	13	13	11	7	6	6	4	4
Non-ESRD	120	115	100	85	75	65	55	45	26	20	20

Figure 1. Kaplan Meier survival curve for ESRD (Red) and non-ESRD (Blue) cohorts.

progression of atherosclerosis, and abnormal calcium metabolism with increased calcification of vessels in ESRD patients.[3,7]

Due to high operative risks, there was initial overall reluctance amongst the medical community to perform open heart surgery on ESRD patients, particularly in the absence of any prior randomized clinical trials that definitively demonstrated a survival advantage of CABG.[3,8] Enthusiasm, however, gradually increased with reports from small retrospective studies which showed encouraging operative mortality in dialysis patients.[9–12] Over the past decade, there has been a further decline in operative mortality as a result of improved surgical techniques and peri-operative management. Consequently the presence of ESRD is no longer considered by itself to be a contraindication for heart surgery. However, this remains a recognized independent risk factor for increased mortality and morbidity, as indicated by the predictive risk models developed from the multinational European adult cardiac surgery database and the STS database.

The New York State CABG registry showed that the 2- and 3-year survival for ESRD patients was 77% and 66% respectively,[13] while the USRDS database showed a 2-year survival of 56% for ESRD patients undergoing CABG.[5]

In the past decade, some medical professionals have advocated the use of the OPCAB when feasible in high-risk groups such as ESRD patients in order to decrease the deleterious effects of systemic inflammatory response and coagulopathy induced by cardiopulmonary bypass to help improve outcomes.[14,15] In a review of 13,085 patients in the USRDS database undergoing CABG between 2001–2006, Shroff et al[16] found no difference in hospital mortality between off-pump and on pump surgery (9.7% vs. 11.0%). However, OPCAB was associated with a modest increase in survival up to 1 year compared to the on-pump CABG cohort, but the survival benefits

were not discernible 2 years after surgery. In one of the largest single-center retrospective review of 245 ESRD patients, Rahmanian et al[5] noted a 3.9-times higher hospital mortality of 12.7% compared to 3.6% for non-ESRD patients. Dialysis patients presented with more comorbidities and more severe disease, as well as had lower long-term survival. One- and 5-year survival was 72.3% and 39.0%, respectively, vs. 94.2% and 83.2% in the control group. We are not aware of any comparative study on long-term post-heart surgery outcomes in AA with ESRD. This is particularly important since AA have a higher incidence of chronic kidney disease than Caucasians in the United States. Moreover, a higher percentage of AA are from low socioeconomic backgrounds with no health insurance. These factors have been previously shown to delay access to timely healthcare and to negatively impact outcome. However, most patients with ESRD are ultimately enrolled in the U.S. government-funded Medicare program that pays for dialysis treatments.

In a review of the impact of renal failure on cardiovascular diseases in AA, Cooper et al[17] stated that AA on hemodialysis live an average of 12 months longer than Caucasians. According to historical data from the USRDS database, the survival probability of patients after initiation of maintenance hemodialysis at one, two, and five years are 81%, 65%, and 34%, respectively.[1] Most deaths occurred due to cardiovascular events.

The 30-day operative mortality of 16.6% in our series is reflective of the comorbidities and severity of illness in our inner city AA population, and consistent with the predicted EuroSCORE mortality of 16.4%. Some contributory factors to this higher operative mortality include a delay in seeking medical attention and a high incidence of denial and refusal to follow recommended treatment that involves surgery until later in the disease course. This behavior reflects the culture and often limited educational status amongst the inner-city mostly poor AA population. Surgery is often only accepted after further delays with multiple hospital readmissions and progression of the illness with worsening left ventricular function. Even after surgery, many patients are non-compliant with their medications and recommended secondary risk prevention and lifestyle modifications strategies. Fortunately, hemodialysis patients have better access to their healthcare professionals on a regular basis, thereby allowing earlier physician intervention if needed. The long-term survival of 40% and 25% at 5 and 10 years, respectively, observed in our review are comparable to the observations from two other open heart surgery series on ESRD patients. Rahmanian et al[5] reported in a predominantly Caucasian population a 39.0% 5-years survival, while Nakatsu et al[18] reported 62.5%, and 22.6% 5- and 10-year survival, respectively, in a Japanese population. These observed 5-years survival rates post-heart surgery compares favorably with the USRDS database report of 34% after the onset of dialysis.[1] This clearly supports continued referral of suitable ESRD patients who are not amenable to medical or other less invasive therapies for heart surgery where indicated. Although multiple studies have shown that AA with ESRD have higher survival than their Caucasian cohorts,[17] the relatively younger age of AA at the time of ESRD diagnosis may be a contributing factor to this observed difference.

In conclusion, our study is limited by the retrospective design, small sample size, and represents the experience of a single surgeon. However, it is the only report on long-term outcome post-heart surgery in AA patients with ESRD. Although the STS has a robust database, a major drawback is lack of long-term survival data as follow-up is limited to one month post operatively. A future review linking the STS clinical database with an administrative data registry may help identify whether significant racial differences exist in ESRD patients following heart surgery. Despite the high-risk profile of these patients, surgery in suitable patients provides at least a similar or better life expectancy compared to the natural history of ESRD patients after onset of dialysis according to the USRDS report.[1]

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Author Contributions

Conceived and designed the experiments: JN. Analyzed the data: JN, CO. Wrote the first draft of the manuscript:

JN. Contributed to the writing of the manuscript: CO. Agree with manuscript results and conclusions: JN, CO. Jointly developed the structure and arguments for the paper: JN, CO. Made critical revisions and approved final version: JN, CO. All authors reviewed and approved of the final manuscript.

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As a requirement of publication the authors have provided signed confirmation of their compliance with ethical and legal obligations including but not limited to compliance with ICMJE authorship and competing interests guidelines, that the article is neither under consideration for publication nor published elsewhere, of their compliance with legal and ethical guidelines concerning human and animal research participants (if applicable), and that permission has been obtained for reproduction of any copyrighted material. This article was subject to blind, independent, expert peer review. The reviewers reported no competing interests.

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