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Readmission and resource utilization after orthotopic heart transplant versus ventricular assist device in the National Readmissions Database, 2010–2014[☆]

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ABSTRACT

Background: As the technology of ventricular assist devices continues to improve, the morbidity and mortality for patients with a ventricular assist device is expected to approach that of orthotopic heart transplantation. The present study was performed to compare perioperative outcomes, readmission, and resource utilization between ventricular assist device implantation and orthotopic heart transplantation, using a national cohort.

Methods: Patients who underwent either orthotopic heart transplantation or ventricular assist device implantation from 2010 to 2014 in the National Readmission Database were selected.

Results: Of the 12,111 patients identified during the study period, 5,440 (45%) received orthotopic heart transplantation, while 6,671 (55%) received ventricular assist devices. Readmissions occurred frequently after ventricular assist device implantation and orthotopic heart transplantation, with greater rates at 30 days (29% versus 24%, $P=.005$) and 6 months (62% versus 46%, $P < .001$) for the ventricular assist device cohort. Cost of readmission was greater among ventricular assist device patients at 30 days (\$29,115 versus \$21,586, $P=.0002$) and 6 months (\$34,878 versus \$20,144, $P=.0106$).

Conclusion: Readmission rates and costs for patients with a ventricular assist device remain greater than their orthotopic heart transplantation counterparts. Given the projected increases in ventricular assist device utilization and limited transplant donor pool, further emphasis on cost containment and decreased readmissions for patients undergoing a ventricular assist device is essential to the viability of such therapy in the era of value-based health care delivery.

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Introduction

Nearly 6.5 million Americans live with heart failure (HF), a condition accounting for an estimated \$35 billion of annual health care expenditure in the United States.¹ Mortality after inpatient admission for HF has been estimated to be as great as 35% within 1 year and 75% within 5 years.² HF leads federal funding mandates, and a disproportionate amount of resources are aimed at the management of advanced HF. With the combination of an aging population and increasing burden of ischemic heart disease, the prevalence of end-stage HF continues to rise.^{3,4}

Although orthotopic heart transplantation (OHT) is widely accepted as the gold standard therapy for end-stage HF, ventricular assist devices (VADs) have improved outcomes for patients with advanced HF in the past decade and have been used increasingly as bridge-to-transplantation (BTT) and destination therapies (DT).^{1,5–8} Seco et al.⁹ demonstrated equipoise in survival, acute rejection, or allograft vasculopathy in their meta-analysis of short- and long-term outcomes between OHT and BTT therapies. No further differences were demonstrated in postoperative mortality, stroke, renal failure, or bleeding.

Although the implantation of VAD is considered safe and effective, adverse events during VAD support can lead to poor outcomes and multiple readmissions, a costly consequence for the patient and the health care system alike. As experience with using BTT and DT as a VAD, it is possible that durable VAD therapy could afford patients similar outcomes compared with OHT, thereby decreasing

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Table 1
Demographic characteristics of patients undergoing OHT versus VAD in NRD 2010–2014.

	OHT, n (%)	VAD, n (%)	P value
Discharges	5,440	6,671	
Sex			
Male	4,049 (74)	5,214 (78)	.049
Female	1,391 (26)	1,456 (22)	
Age	51.9 (± 6.45)	55.5 (± 6.60)	.018
Mean Elixhauser Index	5.74 (± 1.08)	6.68 (± 1.11)	.041
Payer			
Medicare	1,966 (36)	3,141 (47)	<.001
Medicaid	609 (11)	690 (10)	
Private insurance	2,613 (48)	2,559 (39)	
Self-pay	20 (0)	54 (1)	
No charge	2 (0)	2 (0)	
Other	182 (3)	177 (3)	
Median household income			
Lowest (0–25)	1,352 (25)	1,778 (27)	.167
Middle Low (26–50)	1,358 (25)	1,744 (27)	
Middle High (51–75)	1,267 (24)	1,567 (24)	
Highest (76–100)	1,371 (26)	1,459 (22)	
Hospital classification			
Government	714 (13)	704 (11)	.105
Nonprofit	4,713 (87)	5,912 (89)	
Private	13 (0)	55 (1)	
Bed size			
Small	156 (3)	104 (2)	<.001
Medium	210 (4)	393 (6)	
Large	5,075 (93)	6,173 (93)	
Comorbidities			
Prior stroke	174 (3.2)	287 (4.3)	.138
Hyperlipidemia	1,854 (34.1)	2,286 (34.3)	.931
Angina	113 (2.1)	90 (1.3)	.188
Coronary artery disease	2,087 (38.4)	2,629 (39.4)	.609
Cardiogenic shock	1,687 (31)	3,448 (51.7)	<.001
Endocarditis	535 (9.8)	1,259 (18.9)	<.001
Prior CABG	74 (1.4)	154 (2.3)	.035
Chronic lung disease	447 (8.2)	903 (13.5)	.012
Peripheral vascular disease	215 (4)	357 (5.4)	.014
Chronic kidney disease	2,000 (37)	3,023 (45)	<.001
Chronic liver disease	101 (1.9)	102 (1.5)	.515
Diabetes	306 (5.6)	426 (6.4)	.379
Anemia	3,106 (57.1)	3,843 (57.6)	.839
Coagulopathy	2,211 (40.6)	2,198 (33)	<.001
Frailty	144 (2.6)	310 (4.6)	.005
Obesity	547 (10.1)	1,071 (16.1)	<.001

OHT, orthotopic heart transplantation; VAD, ventricular assist device; CABG, coronary artery bypass grafting.

ing the dependence on the transplant donor pool.¹⁰ The present study was performed to compare resource utilization, mortality, and readmissions between patients receiving VAD and OHT, using a national cohort from 2010 to 2014.

Methods

Data source

The National Readmissions Database (NRD) is a nationally representative, all-payer inpatient administrative registry of acute care hospitals in the United States, provided by the Healthcare Cost and Utilization Project in sponsorship with the Agency for Healthcare Research and Quality. It contains more than 17 million discharges with appropriate hospital weights to estimate more than 36 million annual US hospitalizations from 2010 to 2014. Patient-level diagnostic and procedural data, hospital characteristics, and estimates of inpatient hospital supercharges were derived from the database. Additional estimates of hospital cost-to-charge ratios and diagnosis-related group (DRG) adjustments were utilized to estimate hospitalization costs and account for disease severity. This study was deemed exempt by the Institutional Review Board of the University of California, Los Angeles.

Study population

Adult patients undergoing isolated OHT or VAD placement between January through June annually from 2010 to 2014 were sampled from the NRD. Study cohorts were identified using the International Classification of Diseases, 9th edition, clinical modification (ICD-9 CM) procedural codes for OHT (37.51) and VAD (37.66). Patient and hospital identifiers were randomized within each year. Thus, data for 6-month readmission risk was calculated based on patients undergoing primary surgery during the first 6 months of each year of data in order to allow for uniform and adequate follow-up. Patients undergoing concomitant mitral valve surgery and coronary artery bypass graft were excluded. Comorbidities and complications associated with cardiovascular disease and cardiac surgeries were identified using previously validated ICD-9 CM procedure codes.

Study outcomes

The primary study outcomes of interest were inpatient mortality and 30-day readmission. Secondary outcomes included duration of stay, overall cost of hospitalization, and postoperative complications, including stroke, myocardial infarction, infection, and arrhythmia. The NRD provides hospital charges for each admission,

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