Trends in Hospitalizations Among Medicare Survivors of Aortic Valve Replacement in the United States From 1999 to 2010

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Background. **Mortality rates after aortic valve replacement have declined, but little is known about the risk of hospitalization among survivors and how that has changed with time.**

Methods. **Among Medicare patients who underwent aortic valve replacement from 1999 to 2010 and survived to 1 year, we assessed trends in 1-year hospitalization rates, mean cumulative length of stay (average number of hospitalization days per patient in the entire year), and adjusted annual Medicare payments per patient toward hospitalizations. We characterized hospitalizations by principal diagnosis and mean length of stay.**

Results. **Among 1-year survivors of aortic valve replacement, 43% of patients were hospitalized within that year, of whom 44.5% were hospitalized within 30 days (19.2% for overall cohort). Hospitalization rates were higher for older (50.3% for >85 years), female (45.1%), and black (48.9%) patients. One-year hospitalization rate decreased from 44.2% (95% confidence interval, 43.5 to 44.8) in 1999 to 40.9% (95% confidence interval, 40.3 to 41.4) in 2010. Mean cumulative length of stay decreased from 4.8 days to 4.0 days ($p < 0.05$ for trend); annual Medicare payments per patient were unchanged ($5,709 to $5,737; $p = 0.32$ for trend). The three most common principal diagnoses in hospitalizations were heart failure (12.7%), arrhythmia (7.9%), and postoperative complications (4.4%). Mean length of stay declined from 6.0 days to 5.3 days ($p < 0.05$ for trend).**

Conclusions. **Among Medicare beneficiaries who survived 1 year after aortic valve replacement, 3 in 5 remained free of hospitalization; however, certain subgroups had higher rates of hospitalization. After the 30-day period, the hospitalization rate was similar to that of the general Medicare population. Hospitalization rates and cumulative days spent in hospital decreased with time.**

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Aortic valve disease is one of the most frequent types of valvular heart disease in the United States [1], and aortic valve replacement (AVR) in appropriate patients with severe stenosis or regurgitation can produce substantial improvements in symptoms and life expectancy [2]. Over time, rates of AVR in the United States have increased while mortality rates have declined [3]. Among Medicare beneficiaries undergoing AVR, 1-year mortality declined by 20% from 1999 to 2010. By 2010, almost 9 in 10 patients undergoing AVR were alive after 1 year [4].

Survival is often considered to be the success rate of the procedure, but there can be heterogeneity of experience among survivors. Hospitalizations indicate acute events of consequence and impose significant psychological and physical burden on patients, especially in the elderly [5]. There is a paucity of information on the risk of hospitalization among survivors of AVR, and how that has changed with time. Furthermore, there is little information on the timing, duration, causes, and costs of these hospitalizations and the characteristics of patients at higher risk of hospitalization. To date, no large, national studies have assessed and characterized these events. This information is important to better characterize the full range of outcomes among the vast majority of patients who survive the surgery, to provide information that can influence decisions, and to identify targets for improvement.

The Appendix Tables and Figure can be viewed in the online version of this article [http://dx.doi.dx.org/10.1016/j.athoracsur.2014.08.045] on http://www.annalsthoracicsurgery.org.

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Accordingly, we analyzed all data for Medicare fee-for-service beneficiaries who survived at least 1 year after AVR from 1999 through 2010 to describe the trend in hospitalization rates, cumulative hospitalization days, and associated costs and characterized individual hospitalizations by principal diagnosis, length of stay (LOS), and discharge disposition. We analyzed for differences by age, sex, race, and receipt of concomitant coronary artery bypass grafting (CABG).

Patients and Methods

Study Population

Using inpatient administrative claims data from the Centers for Medicare & Medicaid Services (CMS), we identified all Medicare Fee-for-Service beneficiaries who underwent an AVR between January 1, 1999, and December 31, 2010, and survived at least 1 year after the procedure. Aortic valve replacement was defined by the International Classification of Diseases, Ninth Revision, Clinical Modification procedure codes 35.21 (AVR with bioprosthesis) and 35.22 (AVR with mechanical prosthesis). We excluded patients who underwent aortic valve repair (35.11) or multivalvular surgery, ie, concurrent mitral (35.12, 35.23, 35.24) or tricuspid (35.14, 35.27, 35.28) valve repair or replacement, as well as those with endocarditis (421.0, 421.1, 421.9). We identified patients with concomitant CABG using the codes 36.10 to 36.16. If a patient had more than one AVR during an index year, we selected the first hospitalization. For patients who underwent AVR during 2010 we used 2011 claims data to permit 1-year follow-up. Institutional review board approval was obtained from the Yale University Human Investigation Committee.

Patient Characteristics

We collected information on patients' age, sex, race (white, black, other), and comorbidities. Comorbidities included those used for profiling hospitals by the CMS 30-day mortality measures for acute myocardial infarction [6] and heart failure [7]. They were identified from secondary discharge diagnosis codes in the index hospitalization for AVR as well as principal or secondary diagnosis codes of all inpatient hospitalizations up to 1 year before. Comorbidity data from 1998 were used for patients hospitalized for AVR in 1999.

Outcomes

Primary outcome was all-cause hospitalization within 1 year of discharge for AVR. In addition, we studied mean cumulative LOS and annual Medicare payments per patient toward hospitalizations. Mean cumulative LOS was defined as the average number of hospitalization days (excluding the index hospitalization) per patient in the entire year after the index AVR hospitalization.

We further characterized individual hospitalizations by principal diagnosis, mean LOS (for all hospitalizations excluding the index hospitalization), and discharge disposition. Major discharge disposition included discharge to home, home with home care, skilled nursing facility, long-term care facility, hospice, or rehabilitation.

We reported Medicare payments as both unadjusted and adjusted for inflation. To calculate adjusted payments we used the annual Consumer Price Index inflation rate reported by the Bureau of Labor Statistics to adjust the dollar amounts with year 2000 expenditure as baseline [8]. We have chosen not to use the medical care component of the CPI for inflation adjustments because of expressed concerns that it can overstate the growth in health-care costs [9].

Statistical Analysis

We reported baseline characteristics in 2-year intervals and outcomes in alternate years to simplify presentation. We used the Cochran-Armitage test to examine the significance of trends and Cox proportional hazards regression model to assess annual trends in 1-year all-cause hospitalization rates, adjusted for patient characteristics. We fitted separate Cox models to assess the annual trends for age, sex, and race subgroups and with and without CABG groups. All models included an ordinal time variable, ranging from 0 to 11, corresponding to years 1999 (time = 0) through 2010 (time = 11), to represent the adjusted annual trends in 1-year hospitalization rate. All statistical analysis was conducted using SAS 9.3 64-bit version (SAS Institute Inc, Cary, NC). All statistical tests were two-sided at a significance level of 0.05.

Results

Patient Characteristics

Of the 337,846 patients who underwent AVR from 1999 to 2010, 293,853 patients survived to at least 1 year, comprising the study cohort. Patient characteristics are shown in Table 1. Between 1999/2000 and 2009/2010, the proportion of patients 85 years or older increased from 7.8% to 12.7%, whereas the proportion of female patients decreased from 42.3% to 39.9%. Patients increasingly had coexistent hypertension (54.1% to 62.9%), diabetes (20.8% to 25.9%), and renal failure (1.8% to 7.8%). The proportion of patients who underwent concomitant CABG along with AVR decreased from 56.2% to 44.8% (all p for trend < 0.05).

Outcomes

ONE-YEAR HOSPITALIZATIONS AFTER AORTIC VALVE REPLACEMENT. Overall, 43% patients had at least one hospitalization within 1 year of the index hospitalization for AVR. The 1-year crude hospitalization rate (95% confidence interval) decreased from 44.2% (43.5 to 44.8) in 1999 to 40.9% (40.3 to 41.4) in 2010. Crude hospitalization rates stratified by age, sex, race, and receipt of concomitant CABG are shown in Table 2. With time, the rate of 1-year hospitalizations decreased for all age groups. Among patients 85 years or older, who had the overall highest rate of hospitalizations, 1-year hospitalizations declined from 52.2% (49.8 to 54.7) to 48.0% (46.3 to 49.7), whereas in