Trends in Patient Characteristics and Outcomes of Coronary Artery Bypass Grafting in the 2000 to 2012 Medicare Population

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Background. The purpose of this analysis was to examine the trends in patient characteristics and outcomes in patients who underwent coronary artery bypass grafting (CABG) over a 12-year period in the Medicare database.

Methods. The study included 1,264,265 isolated CABG procedures in the Medicare population from January 2000 through November 2012. Comorbidities were determined using International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnostic codes. Trends in patient characteristics and hospital outcomes were assessed with Cochran-Armitage trend tests. Long-term survival was examined with Kaplan-Meier survival curves.

Results. The median age was 74 years. Comorbidity profiles increased significantly over time. The number of patients undergoing CABG decreased from 131,385 in 2000 to 71,086 in 2012. The majority of patients underwent multivessel revascularization (13.5% single-vessel CABG, 35.2% 2-vessel CABG, 32.1% 3-vessel CABG, and 15.7% ≥4-vessel CABG). The percentage of patients undergoing 1- and 2-vessel revascularization increased over time, whereas that of ≥3-vessel CABG decreased. Single internal mammary artery (IMA) use increased from 75.6% to 88.6%. Median length of stay (LOS) was 8 days. Thirty-day mortality decreased from 4.2% to 3.0%. Hospital mortality fell from 4.0% in 2000 to 2.7% in 2012 (odds ratio [OR], 0.73; 95% confidence interval [CI], 0.69–0.77). Survival was 93% at 6 months, 91% at 1 year, 84% at 3 years, and 76% at 5 years. Five-year survival changed little over time (range, 75%–77%).

Conclusions. Despite rising comorbidities in Medicare patients undergoing CABG, hospital mortality fell significantly from 2000 to 2012. When adjusted for comorbidities, this signified a 27% reduction in hospital mortality. IMA use increased during the study period, and there was a trend of decreased use of 3 or more grafts.

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In the past 2 decades, significant advances have occurred in the management of coronary artery disease, including improved medical therapy and advances in both percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG). In CABG specifically, with publications such as the SYNTAX trial, there is increasing information on the clinical value of PCI versus CABG [1]. Changing clinical guidelines, as well as the Appropriate Use Criteria for Coronary Revascularization from the American College of Cardiology Foundation Appropriate Use Criteria Task Force, Society for Cardiovascular Angiography and Interventions, Society of Thoracic Surgeons, American Association for Thoracic Surgery, American Heart Association, American Society of Nuclear Cardiology, and the Society of Cardiovascular Computed Tomography in 2009, have helped guide clinicians and patients in their revascularization approach [2, 3]. As a result, it is likely that there have been changes in both patient characteristics and operative strategies. Improvements in operative mortality for isolated CABG have been previously reported in the Society of Thoracic Surgeons (STS) database from 2000 to 2009 [4]. Although the STS database contains many more clinically significant patient variables, center participation has not been uniform until more recently [5, 6]. Additionally, outcomes are better for STS participating centers compared with nonparticipating centers. Furthermore, long-term data on a national scale remains sparse in the elderly, who compose an increasingly high proportion of the US population and use of health care resources [7]. Therefore the goals of this study were to examine the trends in patient characteristics as well as short- and long-term outcomes in the Medicare database from 2000 to 2012.

Patients and Methods

Data were obtained from the Centers for Medicare and Medicaid Services (CMS) using the CMS Virtual Data Research Center. The Vital Status File was used to provide the most recent death information for the study

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Abbreviations and Acronyms

CABG = coronary artery bypass grafting
CMS = Centers for Medicare and Medicaid Services
COPD = chronic obstructive pulmonary disease
DM = diabetes mellitus
IMA = internal mammary artery
IQR = interquartile range
LOS = length of stay
MI = myocardial infarction
PCI = percutaneous coronary intervention
PVD = peripheral vascular disease
SNF = skilled nursing facility
STS = The Society of Thoracic Surgeons
TIA = transient ischemic attack

cohort. The study was approved by the institutional review board, which waived the requirement for informed consent.

All Medicare beneficiaries 65 years of age or older who underwent CABG from January 2000 through November 2012 were considered for inclusion. Nonisolated CABG procedures were excluded. Additionally, all patients with less than 12 months of Part A coverage were excluded. We also excluded all patients who underwent concomitant catheter ablation and those who were discharged against medical advice. Patients coming from hospitals that performed fewer than 5 CABG procedures in a given year were also excluded.

CABG was coded as emergent if it was performed on the day of admission and the admission source was 1 of the following: transfer from another hospital, transfer from a skilled nursing facility (SNF), transfer from another health care facility, or admission to the emergency department. If CABG was performed after the admission date, the status was coded as urgent. CABG that occurred on the day of admission with the patient coming from home was coded as elective.

Comorbidities were determined using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnostic codes from all hospitalizations occurring in the 1-year period preceding the admission for CABG. Acute myocardial infarction (MI) diagnosis was based on the primary diagnosis during the CABG admission. Atrial fibrillation determination was based on documentation before the index visit using the Chronic Condition Warehouse earliest indication of atrial fibrillation as well as the primary and secondary ICD-9-CM diagnostic codes from hospitalizations during the 12-month period before the index admission. Hospital mortality was defined as death during the index hospitalization.

Cochran-Armitage trend tests were used to assess trends over time for patient characteristics, operative characteristics, and hospital outcomes. To produce adjusted odds ratios (ORs), hierarchical logistic regression (using Proc GLIMMIX; SAS Institute, Cary, NC) was used to account for clustering within hospitals as well as baseline characteristics (age, sex, race, admission status, acute MI, history of acute MI, hypertension, diabetes, peripheral vascular disease [PVD], stroke, heart failure, chronic obstructive pulmonary disease [COPD], renal failure, atrial fibrillation, and year). Long-term survival was examined with Kaplan-Meier survival curves. All analyses were performed using SAS Enterprise Guide, version 7.1 (2014, SAS Institute, Cary, NC).

Results

Baseline Characteristics

The baseline characteristics of the study cohort are presented in Table 1. The study population consisted of 1,264,265 patients. There was a steady decrease in the number of patients undergoing CABG, from 131,385 in 2000 to 71,086 in 2012. Median age was 74 years (interquartile range [IQR], 70–78). The majority of CABG operations were performed in men. Women composed only 32.7% of the patients overall, and in fact the percentage of women undergoing CABG decreased slightly over time from 34.8% in 2000 to 29.8% in 2012. Ninety percent of patients were white, with a slight change over time in these demographics (91.8% in 2000 to 88.5% in 2012). The majority of the operations (67.7%) were urgent, 28.8% were elective, and 3.5% were emergent. Over time, the proportion of elective admissions increased, the proportion of urgent admissions decreased, and the proportion of emergent admissions remained relatively constant, with a modest decrease in the most recent 3 years of the study period.

Over time, the incidence of patients with an acute MI presentation increased from 20.8% in 2000 to 27.0% in 2012, as did the proportion of previous MI before the CABG hospitalization (10.6% in 2000 to 17.4% in 2012). Comorbidity profiles increased significantly over time, most notably for the incidence of hypertension (55% in 2000 to 84.6% in 2012), diabetes mellitus (DM) (27.4% in 2000 to 45.2% in 2012), PVD (3.9% in 2000 to 7.8% in 2012), and renal failure (3.9% to 21.1%). The incidence of heart failure, COPD, and atrial fibrillation increased only modestly, whereas a history of previous stroke or transient ischemic stroke (TIA) remained relatively constant over time (4.1% overall). Although the proportion of patients who underwent PCI (percutaneous transluminal coronary angioplasty or stenting) during the index visit before the CABG operation increased slightly over time from 1.2% in 2000 to 2.1% in 2012; overall these patients composed only a small minority of the patients undergoing CABG (1.7%) (Table 1).

Operative Characteristics

The majority of patients underwent multivessel revascularization (single-vessel CABG, 13.5%; 2-vessel CABG, 35.2%; 3-vessel CABG, 32.1%; and $\geq$4-vessel CABG, 15.7%) (Table 2). The percentage of patients undergoing 1- and 2-vessel revascularization increased over time, from 11.9% to 16.4% and from 32.1% to 38.4%,