Cost Analysis of Periprocedural Imaging in Patients Undergoing Catheter Ablation for Atrial Fibrillation

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Cardiovascular imaging is an important part of procedural planning and safety for catheter ablation of atrial fibrillation (AF). However, the costs of imaging surrounding catheter ablation of AF have not been described. Medicare fee-for-service data were used to evaluate Medicare expenditures before, during, and after catheter ablation for AF from July 2007 to December 2009. Among 11,525 patients who underwent catheter ablation for AF, the mean overall expenditure on the day of the procedure was $14,455 (SD $7,441). The mean imaging expenditure in the periprocedural period, which included the 30 days before the catheter ablation and the day of the ablation itself, was $884 (SD $455). Periprocedural imaging expenditures varied by the imaging strategy used, ranging from a mean of $557 (SD $269) for patients with electroanatomic mapping only to $1,234 (SD $461) for patients with electroanatomic mapping, transesophageal echocardiogram, and computed tomography or magnetic resonance imaging. Mean patient-level imaging expenditures varied by provider (mean $872, SD $249). Periprocedural imaging expenditures also varied by patient risk, with mean expenditures of $862 (SD $444) for patients with a $CHADS_2$ score of ≥2 compared with $907 (SD $466) for $CHADS_2$ score <2 ($p < 0.001$). In conclusion, periprocedural imaging accounts for approximately 6% of mean Medicare expenditures for catheter ablation of AF. The expenditures for periprocedural imaging vary both at the patient and at the provider level and they are inversely related to stroke risk by $CHADS_2$ score. **(Am J Cardiol 2014;114:266−271)**

The use of cardiovascular imaging increased dramatically over the last 15 years. From 1999 to 2004, cardiovascular imaging in Medicare patients increased by 14% a year with expenditures doubling from $1.6 billion to $3.2 billion.[1] Medicare has tried to slow the growth of imaging by reducing reimbursement.[2,3] Based on the increasing use of atrial fibrillation (AF) ablation and the role of periprocedural imaging, it is important to understand the impact of imaging on the cost of AF ablation in the current cost-conscious health-care environment. This analysis examines the expenditures for periprocedural imaging in AF ablation and how they contribute to overall expenditures for AF ablation within the Medicare program.

Methods

We received research identifiable files from the US Centers for Medicare & Medicaid Services for all patients who underwent intracardiac ablation of supraventricular tachycardia (*Healthcare Common Procedure Coding System* [HCPCS] code 93651) in 2007, 2008, and 2009. Medicare denominator files identified demographic data, enrollment information, and dates of death. Medicare inpatient, outpatient, and carrier claims files described costs, imaging received, and co-morbid conditions.

Patients underwent ablation between July 1, 2007 and December 31, 2009, were aged ≥65 years, and were enrolled in Medicare fee-for-service program at the time of and for the 6 months before the ablation. Not all cardiac catheter ablations were included.[4] We required that the catheter ablation claim include an associated primary diagnosis code for AF (*International Classification of Diseases, Ninth Revision, Clinical Modification* [ICD-9-CM] diagnosis code 427.31) and an HCPCS code for electronatomic mapping (HCPCS 93613). Patients with a history of atrioventricular node ablation (HCPCS 93650), anomalous atrioventricular excitation (ICD-9-CM 426.7), or paroxysmal supraventricular tachycardia (ICD-9-CM 427.0) were excluded to improve specificity. If a patient had >1 eligible ablation over the study period, only the earliest was included.[4]

Diagnosis codes from all claims in the 6-month period before ablation were used to identify co-morbid conditions. Previously validated coding algorithms were used to identify diabetes mellitus, ischemic heart disease, peripheral vascular disease, heart failure, hypertension, chronic pulmonary disease, chronic kidney disease, dementia, cancer, valvular heart disease, and previous stroke or transient ischemic attack.[5,6] Atrial flutter was identified by ICD-9-CM diagnosis code 427.32.

HCPCS codes in carrier claims identified imaging procedures. We searched for preablation transthoracic echocardiogram, transesophageal echocardiogram (TEE), chest

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This study was funded through support from GE Healthcare, Milwaukee, Wisconsin.

See page 270 for disclosure information.

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http://dx.doi.org/10.1016/j.amjcard.2014.04.031

Table 1
Baseline characteristics

Variable	Overall (n = 11,525)
Age, mean (SD)	71.6 (4.9)
Men	6,826 (59.2%)
White patients	11,130 (96.6%)
Black patients	155 (1.3%)
Atrial flutter	4,449 (38.6%)
Cancer	1,259 (10.9%)
Chronic kidney disease	830 (7.2%)
Chronic pulmonary disease	2,784 (24.2%)
Dementia	55 (0.5%)
Diabetes mellitus	2,576 (22.4%)
Heart failure	2,999 (26.0%)
Hypertension	9,260 (80.3%)
Ischemic heart disease	6,131 (53.2%)
Peripheral vascular disease	2,002 (17.4%)
Stroke/TIA	921 (8.0%)
Valvular heart disease	5,345 (46.4%)
CHADS2 score	
Mean (SD)	1.7 (1.1)
Score ≥2	5,909 (51.3%)
Inpatient procedure	6,593 (57.2%)
Procedure year	
2007	1,818 (15.8%)
2008	4,257 (36.9%)
2009	5,450 (47.3%)

SD = standard deviation.

Table 2
Medicare expenditures, overall and for imaging studies

Variable	Overall (n = 11,525)	
	Mean (SD)	Median (Q1; Q3)
Overall expenditures		
Pre-procedure, 6m prior	9,201 (11,023)	5,358 (2,643; 11,742)
Day-of-procedure	14,455 (7,441)	13,283 (11,670; 16,574)
Post-procedure, 6m following*	9,713 (15,595)	4,146 (1,952; 12,443)
Imaging expenditures		
Peri-procedure, 30d prior + day-of	884 (455)	747 (546; 1,111)
Pre-procedure, 30d prior†	375 (403)	223 (88; 577)
Intra-procedure‡	509 (191)	527 (420; 552)
Post-procedure, 6m following*	206 (334)	0 (0; 306)

d = day; m = month; Q = quartile; SD = standard deviation.
* Only reported for 8792 patients with complete 6m follow-up.
† Includes day-of-ablation transesophageal echocardiogram (TEE)/transthoracic echocardiogram (TTE) procedures.
‡ Includes intracardiac echocardiography (ICE) and electroanatomic mapping (EAM).

or cardiac computed tomography (CT), and chest or cardiac magnetic resonance imaging (MRI) in the 4 weeks before the ablation procedure date; intraprocedural intracardiac echocardiography (ICE) and electroanatomic mapping (EAM) on the same date as the ablation procedure; and postprocedural chest or cardiac CT, chest or cardiac MRI, transthoracic echocardiogram, and lung perfusion scanning (V/Q) in the 6 months after the ablation procedure. We assumed that TEE procedures on the day of the ablation were done before the ablation, and these TEE procedures were considered preprocedural for the purpose of this analysis. Rotational angiography was not included in the analysis, as there is no HCPCS code for this imaging technique.

We defined Medicare expenditures as the amount paid by both the Medicare program and the Medicare beneficiaries (or their supplemental insurance) for care received. Expenditures included payments on inpatient, outpatient, and carrier claims. Imaging expenditures were identified using specific line items from the outpatient and carrier claims. Expenditures were adjusted to 2009 United States dollars using the consumer price index medical care component.

We calculated overall expenditures in the 6 months before ablation (preprocedural), on the day of ablation (day-of-procedure), and in the 6 months after ablation (postprocedural). For patients who received their ablation as an inpatient, the institutional costs for the entire stay were considered to have occurred on the day of the ablation. We calculated imaging expenditures in the 30 days before ablation (preprocedural), during the ablation (intraprocedural), and in the 6 months after ablation (postprocedural). Only EAM and ICE were considered to have occurred during the ablation (intraprocedural). All other imaging procedures on the day of ablation were considered to have occurred during the preprocedural period. For imaging costs, the periprocedural period included both the preprocedural and intraprocedural periods. Only patients who were alive and enrolled in fee-for-service Medicare for the entire 6 months after their ablation were included in calculations of postprocedural overall and imaging expenditures.

To describe patient baseline characteristics, we use means with SDs for continuous variables and frequencies with percentages for categorical variables. We summarized expenditures using both means with SDs and medians with interquartile ranges. When comparing expenditures between groups defined by imaging strategy and $CHADS_2$ score, we tested for differences using Kruskal-Wallis tests. Providers were identified by 5-digit zip code and were only included in the variation analysis if they had at least 5 patients in the study population. All statistical analyses were performed using SAS software (version 9.3; SAS Institute, Cary, North Carolina).

Results

There were 11,525 Medicare patients who underwent ablation for AF. Patients had a mean age of 71.6 years, and their mean $CHADS_2$ score was 1.7 (Table 1). Most AF ablations were inpatient procedures (57.2%).

The median overall Medicare expenditure for patients on the day of the procedure was $13,283 (Q1 $11,670; Q3 $16,574), and the mean was $14,455 (SD $7,441; Table 2). Median total expenditures in the 6 months before the ablation were $5,358 (Q1 $2,643; Q3 $11,742) and the mean expenditures were $9,201 (SD $11,023). Total expenditures in the 6 months after ablation (median $4,146 [Q1 $1,952; Q3 $12,443] and mean $9,713 [SD $15,595]) were lower than before ablation.

Imaging expenditures in the periprocedural period had a median of $747 (Q1 $546; Q3 $1,111) and mean of $884 (SD $455) per patient. These imaging expenditures represent approximately 6% of the median and mean overall expenditures for the day of the procedure. The intraprocedural and preprocedural imaging expenditures were