Characterization of health care utilization in patients receiving implantable cardioverter-defibrillator therapies: An analysis of the managed ventricular pacing trial

John Rickard, MD, MPH, David Whellen, MD, MPH, Lou Sherfesee, PhD, Brett J. Peterson, BS, Tara Nahey, DVM, PhD, Anthony S. Tang, MD, Kenneth A. Ellenbogen, MD, Alan Cheng, MD

From the Division of Cardiology, Cleveland Clinic Foundation, Cleveland, Ohio, Thomas Jefferson University, Philadelphia, Pennsylvania, and Medtronic, Mounds View, Minnesota.

BACKGROUND Implantable cardioverter-defibrillators (ICDs) are effective in terminating lethal arrhythmias, but little is known about the degree of health care utilization (HCU) after ICD therapies.

OBJECTIVE Using data from the managed ventricular pacing trial, we sought to identify the incidence and types of HCU in ICD recipients after receiving ICD therapy (shocks or antitachycardia pacing [ATP]).

METHODS We analyzed HCU events (ventricular tachyarrhythmia [VTA]–related, heart failure–related, ICD implant procedure–related, ICD system–related, or other) and their association with ICD therapies (shocked ventricular tachycardia episode, ATP-terminated ventricular tachycardia episode, and inappropriately shocked episode).

RESULTS A total of 1879 HCUs occurred in 695 of 1030 subjects (80% primary prevention) and were classified as follows: 133 (7%) VTA-related, 373 (20%) heart failure–related, 97 (5%) implant procedure–related, 115 (6%) system-related, and 1160 (62%) other. Of 2113 treated VTA episodes, 1680 (80%) received ATP only and 433 (20%) received shocks. Stratifying VTA-related HCUs on the basis of the type of ICD therapy delivered, there were 25 HCUs per 100 shocked VTA episodes compared with 1 HCU per 100 ATP-terminated episodes. Inappropriate ICD shocks occurred in 8.7% of the subjects and were associated with 115 HCUs. The majority of HCUs (52%) began in the emergency department, and 66% of all HCUs resulted in hospitalization.

CONCLUSION For VTA-related HCUs, shocks are associated with a 25-fold increase in HCUs compared to VTAs treated by ATP only. Application of evidence-based strategies and automated device–based algorithms to reduce ICD shocks (higher rate cutoffs, use of ATP, and arrhythmia detection) may help reduce HCUs.

KEYWORDS Health care utilization; ICD; Shocks; ATP; Hospitalization; MVP

(Heart Rhythm 2017;■:1–6) © 2017 Published by Elsevier Inc. on behalf of Heart Rhythm Society.

Introduction

Implantable cardioverter-defibrillators (ICDs) have been shown to reduce all-cause mortality in patients with systolic heart failure (HF).[1–3] Since their introduction over 30 years ago, ICD implant procedures have increased[4] and greater use of resources have been required for routine care, especially soon after ICD therapies have been delivered. The latter events have resulted in unscheduled visits to hospitals, emergency departments (EDs), and clinics, but the extent to which these services have been used remains poorly understood. Understanding this in the present era of cost containment is critical in an effort to identify ways to improve health care efficiency. The purpose of this investigation was to characterize health care utilizations (HCUs) in patients receiving ICD therapies, specifically focusing on differences between shocks and antitachycardia pacing (ATP) as well as venues of care (ED vs outpatient clinics).

Methods

Study design and participants

This is a post hoc analysis of data collected in the randomized, multicenter managed ventricular pacing (MVP) trial.[5] Briefly, patients aged 18 years and older who underwent a primary or secondary prevention ICD implant procedure per current clinical guidelines were enrolled from 2004 to 2006 at 84 centers globally and followed for up to 3 years from device implant. Patients with a need for pacing, in permanent atrial fibrillation, or having a life expectancy of <12 months were excluded. Ventricular tachyarrhythmias (VTAs), device therapies, and utilization of health care

Dr Rickard has received honorarium from Medtronic and Boston Scientific. Dr Sherfesee, Mr Peterson, Dr Nahey, and Dr Cheng are employed by Medtronic. **Address reprint requests and correspondence:** Dr John Rickard, Division of Cardiology, Cleveland Clinic Foundation, 9500 Euclid Avenue, J2-2 Cleveland, OH 44195. E-mail address: rickarj2@ccf.org.

1547-5271/$-see front matter © 2017 Published by Elsevier Inc. on behalf of Heart Rhythm Society. http://dx.doi.org/10.1016/j.hrthm.2017.03.040

services were collected. An ethics committee approved the MVP protocol at each participating center, and all subjects provided signed informed consent.

Device programming

ICD programming was standardized. Devices were programmed to detect VTAs >171 beats/min for those with known slow ventricular tachycardia and >176 beats/min otherwise, with the number of intervals to detect ventricular fibrillation set to 18/24. Arrhythmias between 171 and 200 beats/min received ATP as the first 2 therapies, followed by shocks if necessary. Arrhythmias between 200 and 250 beats/min received ATP as the first therapy, followed by shocks if necessary.

Data collection

Demographic data were obtained at the baseline visit. Adverse events, HCUs, and arrhythmias stored on subjects' devices were collected during follow-up. HCUs included unscheduled clinic and urgent care visits, ED visits, and hospitalizations. Adverse events were defined as any undesirable clinical occurrence in a subject that is related to the subject's cardiovascular, pulmonary, or renal system or events in which the subject presented with symptoms compatible with fluid retention and/or decreased exercise tolerance. All available device-recorded spontaneous arrhythmias with electrogram information were adjudicated by an episode review committee as true VTA or non-VTA (eg, sinus tachycardia, atrial fibrillation, and oversensing).

End points

The first end point evaluated was the type of HCU. HCUs were classified as (1) VTA-related, (2) HF-related, (3) ICD implant procedure–related (such as pneumothorax or hematoma), (4) ICD system–related (including HCUs related to inappropriate shocks or system modifications), or (5) other (not related to HF or device). The second end point was the type of ICD therapy–related HCUs experienced by subjects, classified as related to a (1) shocked VTA episode, (2) ATP-terminated VTA episode, or (3) shocked non-VTA episode (inappropriately shocked). HCUs related to inappropriate shocks were considered a subclassification of ICD system–related HCUs for this analysis. End points were adjudicated by an independent adverse events committee and a subset of the MVP Steering Committee.

ICD therapy–related HCUs

VTAs were classified into the following subcategories (for the second end point of ICD therapy–related HCU types):

- Shocked VTA episode
- ATP-terminated VTA episode
- Untreated VTA
- Shocked non-VTA episode (inappropriately shocked)

Episodes that received both ATP and shocks were considered shocked VTA episodes. The committee reviewed all HCUs with corresponding documentation of arrhythmia or device therapy occurrence or for which the subject experienced an arrhythmia or device therapy 30 days prior. Adverse events, the 30-day history of device-detected and treated episodes, final episode adjudication from the episode review committee (VTA or non-VTA), and the HCU narrative were used to determine whether the HCU was related to device therapy.

Final classification of HCU type

The final classification of HCU relatedness for both end points were established hierarchically: (1) VTA with subclasses of (a) shocked, (b) ATP terminated, and (c) untreated; (2) HF; (3) ICD implant procedure; (4) ICD system (including inappropriate shock); or (5) other.

Table 1 Baseline demographic characteristics (N = 1030)

Characteristic	Value
Age (y)	62.2 ± 11.9
Sex: male	819 (79.5)
NYHA classification	
Class I	262 (25.4)
Class II	567 (55)
Class III	193 (18.7)
Class IV	2 (0.2)
LVEF (%)	34.8 ± 11.9
Dilated cardiomyopathy	859 (83.4)
Ischemic	644 (62.5)
Nonischemic	215 (20.9)
Sinus node dysfunction	40 (3.9)
Left bundle branch block	127 (12.3)
Right bundle branch block	84 (8.2)
Intraventricular conduction delay	32 (3.1%)
AV block (most recent)	170 (16.5)
First degree block	156 (15.1)
Second degree block	7 (0.7)
Third degree block	1 (0.1)
Supraventricular tachyarrhythmias	177 (17.2)
Paroxysmal supraventricular tachyarrhythmia	33 (3.2)
Atrial tachycardia	16 (1.6)
Atrial fibrillation, atrial flutter	141 (13.7)
Persistent	10 (1)
Paroxysmal	131 (12.7)
Ventricular tachyarrhythmias	455 (44.2)
Nonsustained VT	260 (25.2)
Sustained monomorphic VT	149 (14.5)
Sustained polymorphic VT	6 (0.6)
Unspecified sustained VT	16 (1.6)
Torsades de pointes	4 (0.4)
Ventricular fibrillation, ventricular flutter, cardiac arrest	82 (8)
ACE inhibitors or ARBs	850 (82.5)
β-Blockers	914 (88.7)
Diuretics	557 (54.1)
Amiodarone/sotalol	133 (12.9)
Reason for ICD therapy: primary indication	829 (80.5)

Values are presented as mean ± SD or as n (%).

ACE = angiotensin-converting enzyme; ARB = angiotensin receptor blocker; AV = atrioventricular; ICD = implantable cardioverter-defibrillator; LVEF = left ventricular ejection fraction; NYHA = New York Heart Association; VT = ventricular tachycardia.