

EDITORIAL COMMENT

Boldly Going Where Few Have Gone Before

The Voyages of Cardiac Catheter Ablation*

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Since the first catheter ablation of the atrioventricular node in humans in 1983, catheter ablation for cardiac arrhythmias has undergone an extraordinary evolution (1), which has led to improved efficacy and presumably improved safety (2-4). Supraventricular tachycardia (SVT) ablation has become efficacious, curative, and safe. For atrial fibrillation (AF), catheter ablation improves AF burden and symptoms, although success rates are lower compared with SVT ablations (5,6). Transseptal access, previously only rarely performed 2 decades ago, has become routine and safer with the use of intracardiac echocardiography, but complication rates for AF ablation remain higher than those for SVT ablation. For ventricular tachycardia (VT) ablation, efficacy varies depending on the type of VT targeted. For certain idiopathic normal heart VTs, ablation can be curative and safe. For VT in structural heart diseases, such as ischemic and nonischemic cardiomyopathies, efficacy is lower, but the procedure often ameliorates symptoms and decreases implantable cardioverter-defibrillator shocks. However, in an increasing number of cases, VT is mapped and ablated in the epicardium, a space previously only entered accidentally, and that is associated with an inherently higher

risk of complications when intentionally accessed for ablation. Some cases, such as VT storm in end-stage heart failure, are palliative salvage procedures, taken on with the understanding that the risks are high.

In these contexts, the study by Hosseini et al. (7) in this issue of *JACC: Clinical Electrophysiology*, is a welcome comprehensive study that examined the use patterns and safety of catheter ablations in United States from 2000 to 2013 by using the Nationwide Inpatient Sample (NIS) database.

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USE PATTERNS

This study provides the most recent update in use patterns of catheter ablations for all causes, showing a 2.5-fold increase in procedures from 2000 (n = 18,096) to 2013 (n = 44,465). This increase was largely driven by the rise in AF ablation procedures, which increased 10-fold during the study period (from 2,644 in 2000 to 21,345 in 2013). Contributing factors for this steep rise included an increase in the number of trained interventional electrophysiologists, remarkable advancements in catheter and mapping technology, increased awareness in patients and referring physicians of the availability of ablation as a viable treatment option, and liberalization of guidelines for AF ablation. Although studies from other countries also demonstrated the rising popularity of cardiac ablation procedures (4,8-10), to our knowledge, this is the first study that comprehensively studied the use trends of catheter ablation in the United States.

One important caveat is that the NIS database only includes procedures performed on an inpatient basis. In our center, and likely throughout the country, most ablations are performed and coded as outpatient procedures, even with an overnight stay.

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TABLE 1 Complication Rates From Ablation Registries or Ablation Arms of Clinical Trials

	Current Study*	Spanish Registry (4)* 2015	Swedish Registry (9)* 2007	German Registry (14)* 2007	FIRE and ICE (15) 2016	MANTRA-PAF (16) 2012	TOCCASTAR Study (17)* 2015	VANISH Trial (18) 2016	SMASH VT (19)* 2007
All ablations	5.46	1.4	1.8	1.8					
SVT	3.29	0.3-1.3	0.7-1.8						
AF	7.21	4.3	2.9	2.4	Radiofrequency 12.8 Cryoballoon 10.2	14.2	Contact force 7.2 Noncontact force 9.1		
VT	9.90	5.2	6.4					16 events in 132 patients	4.7

Values are %, unless indicated otherwise. *In hospital or acute complication rates only.
 AF = atrial fibrillation; MANTRA-PAF = Medical Antiarrhythmic Treatment or Radiofrequency Ablation in Paroxysmal Atrial Fibrillation; SMASH VT = Substrate Mapping and Ablation in Sinus Rhythm to Halt Ventricular Tachycardia; SVT = supraventricular tachycardia; TOCCASTAR = TactiCath Contact Force Ablation Catheter Study for Atrial Fibrillation; VANISH = Ventricular Tachycardia Ablation versus Escalated Antiarrhythmic Drug Therapy in Ischemic Heart Disease; VT = ventricular tachycardia.

Adding to outpatient counts is the recent stance of Medicare to deny inpatient status for most uncomplicated ablation procedures with a single-night stay. Such procedures are less likely to be recorded in the NIS database. These factors likely result in underestimates of catheter ablation volumes that might cause a selective bias, undercounting simpler uncomplicated procedures that are more likely to be discharged after a short stay. Thus, it is certainly possible that the rate of rise of certain procedures may be even higher than that estimated by the NIS.

SAFETY PATTERNS

Hosseini et al. (7) reported an overall complication rate of 5.46% with catheter ablations. The complication rate was highest for VT (9.9%), followed by AF (7.21%), and lowest for SVT (3.29%). Despite advances in catheter ablation technologies over the years, the study reported a significant increase in complication rates across the 14-year period for all indications of catheter ablations, which is startling and troubling. The overall mortality rate for catheter ablation procedures was 0.34%, with VT ablations showing the highest rate (1.8%). Actual complication rates in certain types of ablation might also be underestimated. The NIS yields only inpatient complications and would miss complications that present after hospital discharge, such as atriopharyngeal fistula, pulmonary vein stenosis, or atypical atrial flutters or tachycardias after AF ablation.

However, there are significant limitations and complexities inherent in the interpretation of reported complication rates using the NIS. The selection bias against patients undergoing uncomplicated catheter ablation procedures, and who are more likely to be discharged after a short stay, might lead to falsely high complication rates because those with complications tend to get admitted. The actual procedure denominator, which should include

outpatient procedures, is unknown. With an increase in the number of ablations performed as an outpatient procedure in recent years, the bias for recent years might be worse compared with previous years.

Complexity in selection of International Classification of Disease-Ninth Revision (ICD-9) codes for determination of complications can also confound interpretation of NIS analyses. For example, a previous study from the NIS on hospital complications with AF ablation between 2000 and 2010 (11) similarly reported an increase in complications from 5.3% to 7.5%. During this same period, the current study reported an increase from 3.1% to 9.26%; the differences might be explained by subtle differences in the ICD-9 codes used for analysis of complications. Moreover, the current study excluded patients who had codes that indicated a pacemaker was implanted during the hospitalization, because their analysis showed that ~13% of patients who underwent catheter ablation had a pacemaker implanted during the same hospitalization. This was surprisingly high and presumably unlikely to be due to ablation complications because the rate of post-ablation atrioventricular block was estimated to only be ~1%. However, this approach might lead to an underestimation of conduction system disease complications, as well as some mystery as to why initial codes were selected for such a high proportion of catheter ablation patients with pacemakers implanted during the same hospitalization.

Although it is unclear whether the inpatient bias of the NIS over- or underestimates certain types of complications after catheter ablation, the overall increases in reported complication rates remains a concern. The investigators postulated that the rise in complication rates could partly be attributed to higher age and comorbidity status of ablation patients, or to the increasing number of procedures in low-volume centers, which were shown (in the present study and in previous studies) to have higher

complication rates (11-13). The acute complication rates provided by single-center registries, most prospective clinical trials, and registries from other countries appeared to be lower (Table 1), although there were some notable exceptions, particularly in prospective clinical trials in which complications were likely reported more robustly than in voluntary registries. Moreover, trials that included events that developed after hospital discharge reported higher complication rates for AF or VT ablation in the range of 10% to 15%. Although it was possible that lower rates from registry sources were reported from mid- to high-volume centers, most of the clinical trials included highly experienced centers (14). With increasing complexity of ablations, such rises in reported complication rates should serve as warnings to our field. Cardiac electrophysiologists are taking on more complex atrial and ventricular ablations, puncturing and venturing into spaces, such as the left atrium, which is pierced transseptally, or the epicardium, which is broached transdiaphragmatically, and only rarely endeavored in the early 2000s. Careful outcome studies for new technologies and compulsive complications tracking by all hospitals, no matter what their volume, are imperative to

show that our advances are doing good rather than creating harm.

Thus, Hosseini et al. (7) should be congratulated on providing a much-needed update and focus on the national use and real-world safety patterns and complications of catheter ablations in recent times. Although the study is limited by the multiple caveats of an administrative database that is inclusive of only patients designated as inpatients, corroborating data support the conclusions that catheter ablations are more prevalent, and suboptimal complication rates are not declining.

As interventional electrophysiologists trek into new spaces, exploring new technology and tools at “warp” speed, we have increased the success rates of our battle against arrhythmias and given new life to many in our civilization. However, we need to remain continually watchful for trends in outcomes and safety signals, to work diligently to reduce risks associated with these procedures, and to remember our “Prime Directive”—first, do no harm.

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