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ORIGINAL RESEARCH

Differences in Healthcare Use Between Patients With Persistent and Paroxysmal Atrial Fibrillation Undergoing Catheter-Based Atrial Fibrillation Ablation: A Population-Based Cohort Study From Ontario, Canada

Andrew C. T. Ha, MD, MSc; Harindra C. Wijeysundera, MD, PhD*; Feng Qiu, MSc; Kayley Henning, MPH; Kamran Ahmad, MD; Paul Angaran, MD, MSc; David H. Birnie, MD; Eugene Crystal, MD; Andrew H. Ha, MD; Jeff S. Healey, MD, MSc; Peter Leong-Sit, MD, MSc; Bhavanesh Makanjee, MD; Pablo B. Nery, MD; Damian P. Redfearn, MD; Allan C. Skanes, MD; Atul Verma, MD*

BACKGROUND: Patients with persistent atrial fibrillation (AF) undergoing catheter-based AF ablation have lower success rates than those with paroxysmal AF. We compared healthcare use and clinical outcomes between patients according to their AF subtypes.

METHODS AND RESULTS: Consecutive patients undergoing AF ablation were prospectively identified from a population-based registry in Ontario, Canada. Via linkage with administrative databases, we performed a retrospective analysis comparing the following outcomes between patients with persistent and paroxysmal AF: healthcare use (defined as AF-related hospitalizations/emergency room visits), periprocedural complications, and mortality. Multivariable Poisson modeling was performed to compare the rates of AF-related and all-cause hospitalizations/emergency room visits in the year before versus after ablation. Between April 2012 and March 2016, there were 3768 consecutive patients who underwent first-time AF ablation, of whom 1040 (27.6%) had persistent AF. The mean follow-up was 1329 days. Patients with persistent AF had higher risk of AF-related hospitalization/emergency room visits (hazard ratio [HR], 1.21; 95% CI, 1.09–1.34), mortality (HR, 1.74; 95% CI, 1.15–2.63), and periprocedural complications (odds ratio, 1.36; 95% CI, 1.02–1.75) than those with paroxysmal AF. In the overall cohort, there was a 48% reduction in the rate of AF-related hospitalization/emergency room visits in the year after versus before ablation (rate ratio [RR], 0.52; 95% CI, 0.48–0.56). This reduction was observed for patients with paroxysmal (RR, 0.45; 95% CI, 0.41–0.50) and persistent (RR, 0.74; 95% CI, 0.63–0.87) AF.

CONCLUSIONS: Although patients with persistent AF had higher risk of adverse outcomes than those with paroxysmal AF, ablation was associated with a favorable reduction in downstream AF-related healthcare use, irrespective of AF type.

Key Words: ablation ■ atrial fibrillation ■ outcomes research ■ registry

Catheter-based atrial fibrillation (AF) ablation is an effective therapy for patients with symptomatic AF. Current AF guidelines strongly endorse ablation, particularly for symptomatic patients with AF in whom medical therapy is not effective.[1–3] These recommendations are largely based on studies that

Correspondence to: Andrew C. T. Ha, MD, MSc, Peter Munk Cardiac Centre, Toronto General Hospital, University Health Network, 200 Elizabeth St, Toronto, Ontario, Canada M5G 2C4. E-mail: Andrew.ha@uhn.ca

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*Dr Wijeysundera and Dr Verma contributed equally to this work as co–senior authors.

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CLINICAL PERSPECTIVE

What Is New?

- From a prospectively identified, population-based cohort of consecutive catheter-based atrial fibrillation (AF) ablation in Ontario, Canada, the risk of death, periprocedural complications, and time to first AF-related hospitalization or emergency room visit was higher among patients with persistent AF relative to those with paroxysmal AF.
- Irrespective of AF type (persistent or paroxysmal AF), patients who underwent catheter-based AF ablation had lower rates of AF-related hospitalization or emergency room visit in the year after ablation when compared with the year before ablation.

What Are the Clinical Implications?

- Among patients undergoing catheter-based AF ablation, clinicians should be cognizant that the patient's AF type (persistent or paroxysmal) is an important marker of adverse outcomes after ablation.
- Although the rate of AF-related hospitalization or emergency room visit was high within the first 30 days after ablation, catheter-based AF ablation was associated with an overall reduction in the rates of AF-related healthcare use within the first year.
- Additional research is needed to delineate whether AF ablation is associated with downstream cost savings for healthcare systems, and future research on the efficacy of catheter-based AF ablation should focus on healthcare use as a key outcome.

Nonstandard Abbreviations and Acronyms

ER	emergency room
HCU	healthcare use
PY	person-years

enrolled patients with paroxysmal AF with single procedural success rates of up to 70% to 80%.[3,4] The success rate of ablation for patients with persistent AF is typically lower, often with the need for repeat ablation.[4,5]

To date, efficacy measures of AF ablation in clinical trials have focused on freedom from AF recurrence and/or improvement in patients' quality of life.[6–9] There is a paucity of data on how reductions in AF recurrence may translate to impact healthcare use (HCU), such as downstream hospitalization or emergency room (ER) visits, particularly on a population-based level.[10–14] Understanding these resource implications is particularly important given the current climate of fiscal constraint. Accordingly, we sought to address this knowledge gap by using data from a population-based registry in Ontario, Canada, to evaluate HCU between patients with persistent and paroxysmal AF who underwent catheter-based ablation. We hypothesize that AF-related HCU would be reduced among patients who undergo ablation. Given that patients with persistent AF are likely to have a greater burden of medical comorbidities, we hypothesize that their postablation outcomes would be less favorable than those with paroxysmal AF.

METHODS

Analytic methods and/or study materials can be made available to researchers to reproduce the results or to replicate this study in other data sets. Patient-level data will not be available because of privacy regulations in Ontario, Canada. Qualified researchers trained in human subject confidentiality protocols may contact Dr Wijeysundera, Dr Verma, and Dr Ha to request access to the analytic methods and study materials.

Design

We conducted a retrospective cohort study from a prospectively collected, population-based registry of patients who underwent AF ablation in Ontario. Ontario is Canada's most populous province, with ≈14.6 million inhabitants, constituting ≈38% of the national population. All residents in Ontario receive universal health coverage from a single payer, the Ministry of Health and Long Term Care of Ontario. We adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for reporting of a cohort study.[15]

Data Sources

The study population consisted of consecutive patients undergoing AF ablation in the province of Ontario between April 1, 2012, and March 30, 2016. Patients were prospectively identified, and their demographics were collected by an ablation database within the CorHealth Cardiac Registry. CorHealth is a nonprofit agency funded by the Ministry of Health and Long Term Care, which tracks and collects information on all invasive cardiac procedures performed in Ontario. For each AF ablation procedure, institutions must complete and electronically submit a registry form to CorHealth. This electronic form includes information pertaining to the patient's demographics, cardiac history, AF

type (paroxysmal or persistent), and intraprocedural details. Each data field collected by the CorHealth Cardiac Registry is predefined in a data dictionary. The CorHealth registry also uses populated entries to calculate the CHA_2DS_2-VASc score (Congestive heart failure [1 point], Hypertension [1 point], Age ≥65-74 years [1 point], Age ≥75 years [2 points], Diabetes mellitus [1 point], Prior stroke, transient ischemic attack, or arterial thromboembolism [2 points], Vascular disease [1 point], or Female sex [1 point]). The registry also calculated the HATCH score (Hypertension [1 point], Age ≥75 years [1 point], Transient ischemic attack or stroke [1 point], Chronic obstructive pulmonary disease [1 point], or Heart failure [1 point]) to predict AF progression from paroxysmal to persistent.

We then linked patients identified in the AF ablation cohort to health administrative databases to supplement baseline medical comorbidities and to ascertain outcomes based on the *International Classification of Diseases, Tenth Revision* (*ICD-10*), coding system. These data sets were linked using unique encoded identifiers and were analyzed at ICES (Toronto, Canada). The following administrative databases were used: Registered Persons Database, Canadian Institute for Health Information Discharge Abstract Database, Canadian Institute for Health Information Same Day Surgery, National Ambulatory Care Reporting System database, Ontario diabetes mellitus database, Ontario hypertension database, and the Ontario chronic obstructive pulmonary disease database. Socioeconomic status was determined on the basis of neighborhood income from 2006 or 2014 Canadian Census data for patients who underwent ablation before or after January 1, 2014, respectively. Prescription data of patients who were aged ≥65 years were obtained from the Ontario Drug Benefits database.

Study Population

The study cohort consisted of patients who underwent catheter-based AF ablation in Ontario, Canada, between April 1, 2012, and March 31, 2016, constituting 4 fiscal years. Patients were excluded if they did not have a valid Ontario Health Insurance Plan number or who were <18 years of age at the time of ablation. For patients who underwent >1 AF ablation during the study period, the first AF ablation was identified as the index event. The patient's AF type (paroxysmal or persistent) was defined according to criteria set forth by current AF clinical guidelines.[1–3] The end of the study follow-up period was December 31, 2017, or the day of the patient's death, whichever occurred first.

Outcomes

The primary outcome of this study was AF-related HCU, defined as a composite of AF-related hospitalization or ER visit. AF must be listed as the most responsible diagnosis (main diagnosis code I48) to qualify as an AF-related hospitalization or ER visit. This code had a specificity of 93.0% (95% CI, 91.6%–94.2%) and a sensitivity of 96.6% (95% CI, 94.1%–98.2%) in the Canadian Institute for Health Information National Ambulatory Care Reporting System database when compared with chart abstraction.[16] Secondary outcomes were (1) overall HCU based on all-cause hospitalization or ER visit, (2) mortality, and (3) periprocedural complications. A periprocedural complication was defined as having any of the following outcomes which resulted in hospitalization or ER visit within 30 days of ablation: bleeding, transfusion, cardiac, respiratory, vascular, neurologic, non–central nervous system thromboembolic, lower extremity, renal, infectious, venous thrombotic, or a medical event requiring surgical or interventional management. These outcomes were identified from the Canadian Institute for Health Information Discharge Abstract Database or National Ambulatory Care Reporting System database. A list of codes used in the identification of periprocedural complications is listed in Tables S1 and S2. All study outcomes were defined using *ICD-10* codes.

Exposure

The exposure of interest was AF type (paroxysmal or persistent AF).

Statistical Analysis

Non-normally distributed continuous variables were reported as medians with 25th and 75th percentiles and compared with the Kruskal-Wallis test. Normally distributed continuous variables were reported as means with standard deviations and compared with the Student's *t*-test. Categorical variables were reported as proportions and were compared using the χ^2 statistic. For the primary outcome analysis of AF-related HCU, the rate of AF-related hospitalizations and ER visits was reported as cases per 100 person-years (PY) during the year before index ablation and after discharge from ablation. In addition, rates were reported during the following phases of the periablation period: 1 to 30, 31 to 90, and 91 to 365 days before ablation and 1 to 30, 31 to 90, and 91 to 365 days after discharge from ablation. These phases were chosen to examine for potential temporal effects. We used a multivariable generalized estimating equation for Poisson regression modeling to examine the association between AF type (persistent versus paroxysmal) on rates of AF-related hospitalizations or ER visits before and after ablation, using time as an offset term and incorporating an interaction term for AF type×time. The

generalized estimating equation model allowed us to account for clustering of outcomes in the preablation and postablation period as well as overdispersion. A similar analytic approach was performed to evaluate all-cause HCU.

The analysis of all other secondary outcomes, except for periprocedural complications, was performed by time-to-event analyses, with the date of index ablation as time 0. Multivariable Cox regression analyses were performed to assess the association of AF type (paroxysmal versus persistent) with study outcomes. We used cause-specific hazard competing risk models to analyze nonfatal outcomes and to account for the competing risk of death. Statistical measures of association were reported as hazard ratios (HRs) with 95% CIs. Periprocedural complications occurring within 30 days after index ablation were classified as binary outcomes (yes or no). Multivariable logistic regression analysis was performed to assess the association between AF type and occurrence of periprocedural complications. For this analysis, statistical measures of association were reported as odds ratios with 95% CIs.

All models were adjusted for the following factors: AF type (paroxysmal versus persistent), age, sex, rural residence, Charlson comorbidity score, CHA_2DS_2-VASc score, diabetes mellitus, hypertension, chronic obstructive pulmonary disease, stroke/transient ischemic attack/non–central nervous system thromboembolism, history of myocardial infarction, history of cardiovascular disease, history of any vascular disease, history of percutaneous coronary intervention or coronary artery bypass grafting surgery, sleep apnea, income (divided in quintiles), and left ventricular ejection function. For analyses examining the rates of hospitalization or ER visits, statistical measures of significance were reported as rate ratios (RRs) with corresponding 95% CIs. For all outcomes, a 2-sided $P<0.05$ was considered to be statistically significant. Statistical analyses were performed with SAS 9.4 (SAS Institute, Cary, NC).

Ethics

This study was approved by the institutional review board at Sunnybrook Health Sciences Centre (Toronto, Ontario, Canada). All data pertaining to the project are housed and analyzed by CorHealth and ICES, which are prescribed entities under Ontario's health information privacy legislation (section 45 of

Table. Baseline Characteristics of Patients Undergoing Paroxysmal and Persistent AF Ablation

Characteristic	Paroxysmal AF (N=2728)	Persistent AF (N=1040)	*P* Value
Age, y	59.64±10.39	60.75±10.04	0.003
Age >65 y	846 (31.0)	351 (33.8)	0.107
Men	1821 (66.8)	756 (72.7)	<0.001
Heart failure	492 (18.0)	313 (30.1)	<0.001
Diabetes mellitus	472 (17.3)	186 (17.9)	0.674
Hypertension	1699 (62.3)	681 (65.5)	0.069
COPD	358 (13.1)	172 (16.5)	0.007
Stroke/TIA	59 (2.2)	25 (2.4)	0.654
Non-CNS thromboembolism	17 (0.6)	8 (0.8)	0.622
PVD	20 (0.7)	11 (1.1)	0.324
MI	104 (3.8)	37 (3.6)	0.713
CABG	56 (2.1)	35 (3.4)	0.019
PCI	186 (6.8)	75 (7.2)	0.671
LVEF, %			<0.001
≥50	1571 (57.6)	529 (50.9)	
35–49	116 (4.3)	102 (9.8)	
<35	38 (1.4)	53 (5.1)	
Not recorded	1003 (36.8)	356 (34.2)	
CHA_2DS_2-VASc score, mean±SD	1.94±1.49	2.12±1.58	0.001
CHA_2DS_2-VASc score			0.006
0	477 (17.5)	173 (16.6)	
1	725 (26.6)	239 (23.0)	
2	655 (24.0)	230 (22.1)	
3	457 (16.8)	205 (19.7)	
≥4	414 (15.2)	193 (18.6)	
HATCH score, mean±SD	1.28±1.26	1.63±1.46	<0.001
HATCH score			<0.001
0	803 (29.4)	258 (24.8)	
1	1098 (40.2)	344 (33.1)	
2	328 (12.0)	135 (13.0)	
≥3	499 (18.3)	303 (29.1)	
Charlson score, mean±SD	0.31±0.77	0.40±0.88	0.001
Charlson score category			
0	2215 (81.2)	786 (75.6)	<0.001
1	292 (10.7)	157 (15.1)	
≥2	221 (8.1)	97 (9.3)	
Rural residence	414 (15.2)	194 (18.7)	0.009
Income quintile			
1 (Lowest)	314 (11.5)	118 (11.3)	0.268
2	419 (15.4)	153 (14.7)	
3	498 (18.3)	200 (19.2)	

Table 1. Continued

Characteristic	Paroxysmal AF (N=2728)	Persistent AF (N=1040)	*P* Value
4	601 (22.0)	258 (24.8)	
5 (Highest)	896 (32.8)	311 (29.9)	

Values are mean±SD or number (percentage). AF indicates atrial fibrillation; CABG, coronary artery bypass grafting; CHA_2DS_2-VASc, Congestive heart failure (1 point), Hypertension (1 point), Age ≥65-74 years (1 point), Age ≥75 years (2 points), Diabetes mellitus (1 point), Prior stroke, TIA, or arterial thromboembolism (2 points), Vascular disease (1 point), or Female sex (1 point); CNS, central nervous system; COPD, chronic obstructive pulmonary disease; HATCH, Hypertension (1 point), Age ≥75 years (1 point), TIA or stroke (1 point), Chronic obstructive pulmonary disease (1 point), or Heart failure (1 point); LVEF, left ventricular ejection fraction; MI, myocardial infarction; PCI, percutaneous coronary intervention; PVD, peripheral vascular disease; and TIA, transient ischemic attack.

Ontario's Personal Health Information Privacy Act, regulation 329/04, section 18). This permits ICES to receive and use health information without the need for patient-level written consent for the purposes of analysis and compilation of statistical information about the healthcare system of Ontario, Canada. This information is strictly intended for the purpose of analysis and/or compiling statistical information with respect to the management of, evaluation, or monitoring of the allocation of healthcare resources. No personal identification information is identified in the reporting of results. ICES is fully compliant with the Ontario Health Information Privacy law, with privacy practice approved by the Ontario Privacy Commissioner.

RESULTS

Study Cohort

Between April 1, 2012, and March 30, 2016, there were 4513 patients who underwent AF ablation in 10 Ontario centers. Fifteen (0.3%) patients were excluded because of age <18 years or missing age/sex/income quintile. In addition, 687 (15.2%) patients were excluded as they had previous AF ablation before the start date

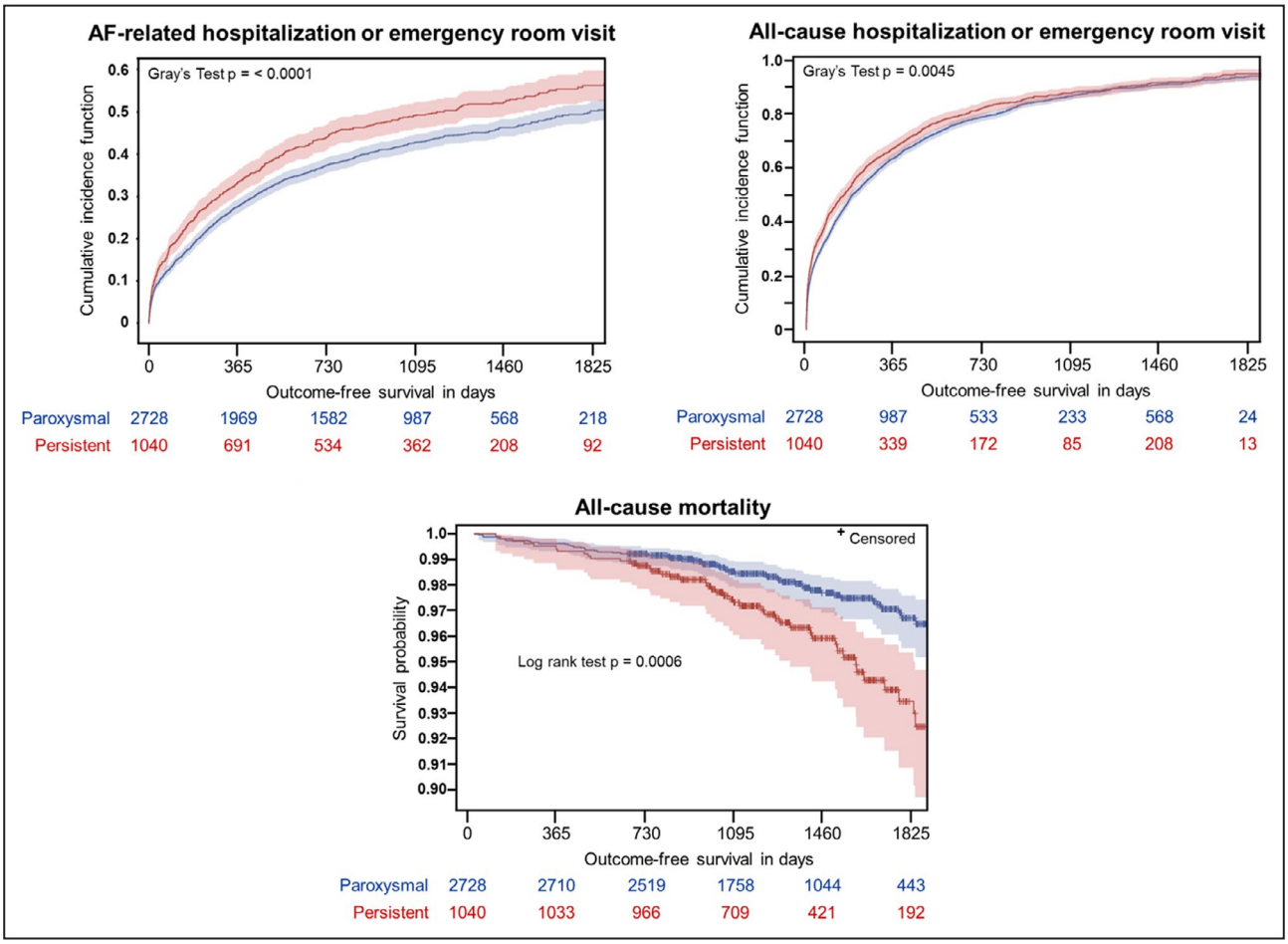

Figure 1. Rates of atrial fibrillation (AF)–related hospitalization or emergency room (ER) visit, all-cause hospitalization or ER visit, and all-cause mortality among patients who underwent catheter-based AF ablation, stratified by AF type (persistent or paroxysmal).

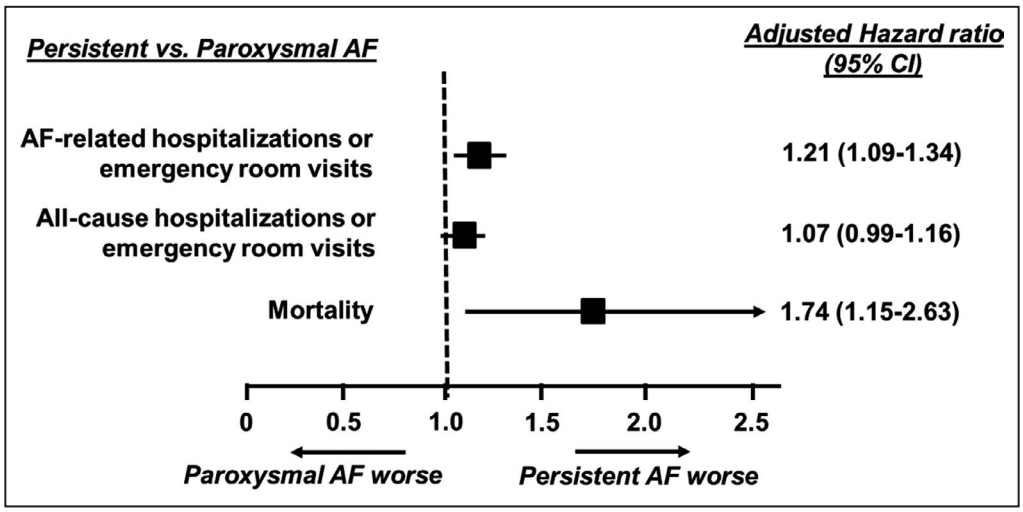

Figure 2. **Multivariable regression analysis of outcomes between paroxysmal and persistent atrial fibrillation (AF) patients undergoing catheter-based AF ablation.**

of the study cohort. After excluding another 43 (1.1%) patients with missing data on AF type, the final cohort consisted of 3768 patients who underwent de novo AF ablation in Ontario (Figure S1). The mean follow-up period was 1329 days, and 2467 (65.5%) patients had at least 3 years of follow-up.

There were 2728 (72.4%) patients with paroxysmal and 1040 (27.6%) patients with persistent AF in the final ablation cohort. The baseline characteristics of the study cohort are shown in the Table. Compared with patients with paroxysmal AF who underwent ablation, patients with persistent AF were slightly older (60.8±10.0 versus

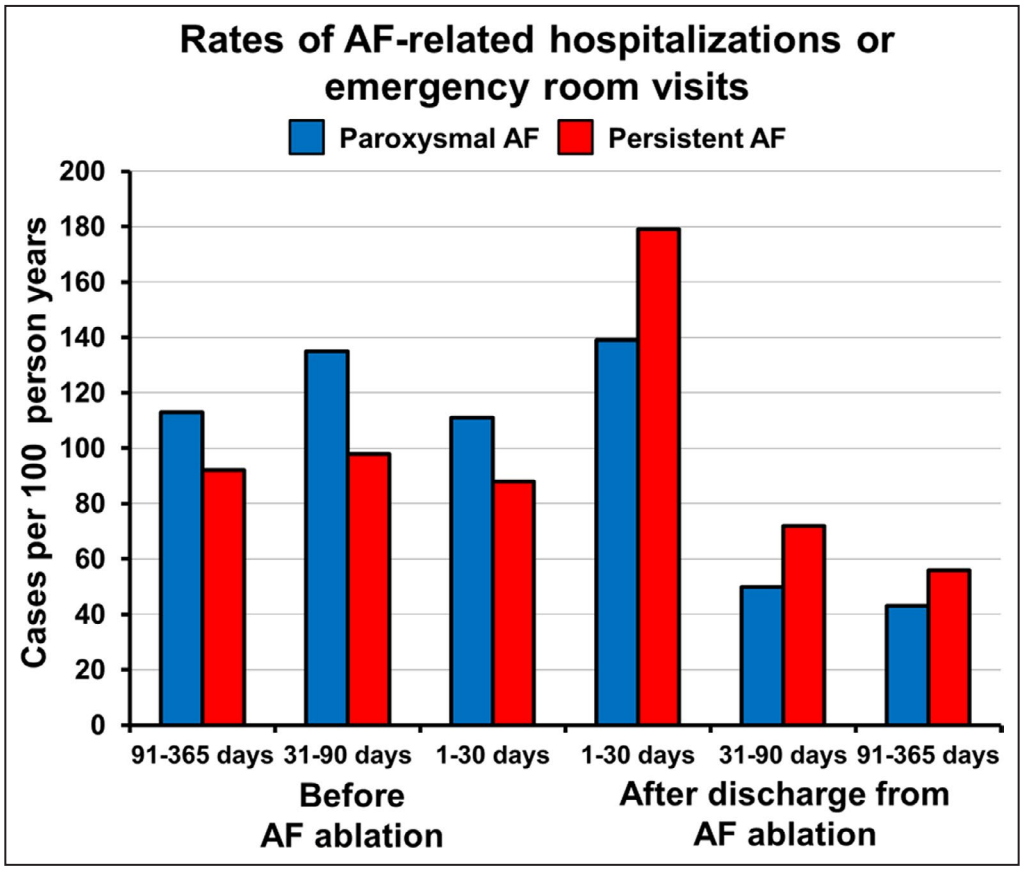

Figure 3. **Rates of atrial fibrillation (AF)–related hospitalizations or emergency room visits in the year before AF ablation and in the year after discharge from ablation, according to AF type.**

59.6±10.4 years; *P*=0.003), more likely to be men (72.7% versus 66.8%; *P*<0.001), more likely to reside in rural areas (18.7% versus 15.2%; *P*=0.009), more likely to have a history of heart failure (30.1% versus 18.0%; *P*<0.001), and more likely to have chronic obstructive pulmonary disease (16.5% versus 13.1%; *P*=0.007). In addition, patients with persistent AF had higher CHA_2DS_2-VASc scores (2.1±1.6 versus 1.9±1.5 points; *P*=0.002), HATCH scores (1.6±1.5 versus 1.3±1.3 points; *P*<0.001), and Charlson scores (0.40±0.88 versus 0.31±0.77 point; *P*=0.001) when compared with those with paroxysmal AF. The prevalence of previous stroke or transient ischemic attack was similar between the 2 groups (persistent versus paroxysmal AF, 2.4% versus 2.2%; *P*=0.65). Among the 1197 patients who were >65 years old, 947 (79.1%) were prescribed with an oral anticoagulant within 90 days before ablation. Of these 947 patients, 702 (74.1%) were treated with a direct oral anticoagulant (apixaban, dabigatran, or rivaroxaban). At 300 to 365 days after ablation, 661 of these patients (69.7%) continued with the same oral anticoagulant agent. Rates of oral anticoagulant continuation at 300 to 365 days after ablation ranged from 66% to 78% (Table S3).

AF-Related HCU

In the overall cohort, 29.1% of patients had at least one hospitalization or ER visit within 1 year after discharge from ablation (Figure 1). Patients with persistent AF had a 21% higher risk of AF-related hospitalization or ER visit relative to those with paroxysmal AF (adjusted HR, 1.21; 95% CI, 1.09–1.34) (Figure 2). In the year before ablation, the rate of AF-related hospitalizations or ER visits was 109 cases per 100 PY in the overall cohort. During the first year after discharge from ablation, the rate of AF-related hospitalizations or ER visits was 57 cases per 100 PY in the overall cohort, 68 cases per 100 PY for patients with persistent AF, and 53 cases per 100 PY for patients with paroxysmal AF. The temporal distribution of the rate of AF-related hospitalizations and ER visits in the year before and after index ablation for patients with persistent and paroxysmal AF is shown in Figure 3. In the first year after discharge from ablation, the rate of AF-related hospitalization or ER visits was highest within the first 30 days (148 cases per 100 PY). Subsequently, there was a 64% and 70% reduction in AF-related HCU between 31 to 90 days and 91 to 365 days after ablation (57 and 47 cases per 100 PY) when compared with the

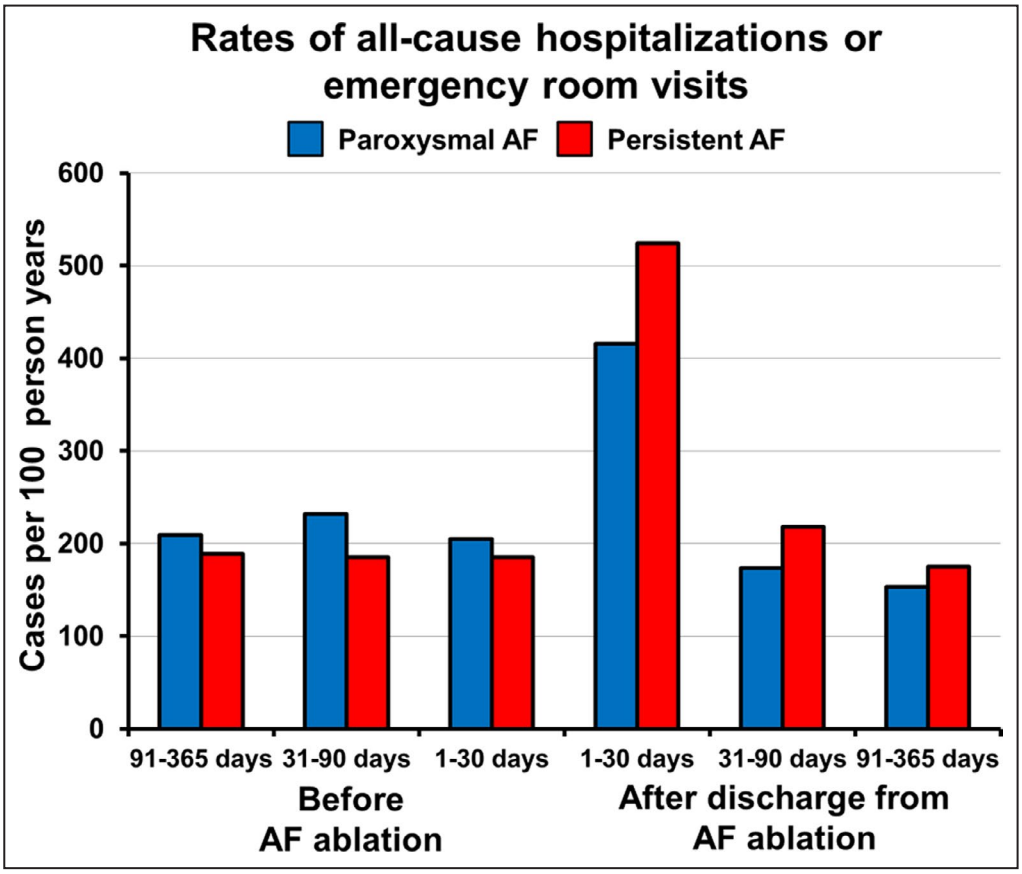

Figure 4. Rates of all-cause hospitalizations or emergency room visits in the year before atrial fibrillation (AF) ablation and in the year after discharge from ablation, according to AF type.

first 30 days after ablation. This pattern was observed for both AF types (Figure 3).

Using multivariable Poisson modeling, patients undergoing AF ablation had a 48% reduction in the rate of AF-related hospitalizations or ER visits within the first year after discharge from ablation when compared with the year before (adjusted RR, 0.52; 95% CI, 0.48–0.56; $P<0.0001$). The adjusted RR for AF-related hospitalization or ER visit was 0.74 (95% CI, 0.63–0.87; $P=0.002$) and 0.45 (95% CI, 0.41–0.50; $P<0.0001$) for patients with persistent and paroxysmal AF, respectively. This suggested that both groups of patients had fewer AF-related hospitalizations or ER visits in the year after ablation relative to the previous year. The magnitude of AF-related HCU reduction was more pronounced among patients with paroxysmal AF when compared with those with persistent AF ($P_{interaction}<0.0001$).

All-Cause HCU

The rate of all-cause hospitalization or ER visit within 1 year after discharge from ablation was 54.5% in the overall cohort (Figure 1). The risk of all-cause–related hospitalization or ER visit was similar between patients undergoing persistent and paroxysmal AF ablation (adjusted HR, 1.07; 95% CI, 0.99–1.16; $P=0.10$) (Figure 2). After adjustment with Poisson modeling, our study cohort had a 9% reduction in the rate of all-cause hospitalizations or ER visits in the year after discharge from ablation when compared with the year before (RR, 0.91; 95% CI, 0.87–0.96; $P<0.001$). When stratified by AF type, a 16% reduction in the rate of all-cause hospitalizations or ER visits was observed among patients with paroxysmal AF in the year after discharge from ablation when compared with the year before (adjusted RR, 0.84; 95% CI, 0.79–0.89; $P<0.001$). On the other hand, patients with persistent AF had a 12% increase in the rate of all-cause hospitalizations or ER visits in the year after discharge from ablation when compared with the year prior (adjusted RR, 1.12; 95% CI, 1.02–1.24; $P=0.02$). A statistically significant interaction was observed in the adjusted RRs between patients with paroxysmal and persistent AF ($P_{interaction}<0.0001$). The time course of all-cause HCU after ablation before and after index ablation, stratified by patients with persistent and paroxysmal AF, is shown in Figure 4.

Mortality

The mortality rates of the entire study cohort at 1 year and at the end of study follow-up were 0.45% and 2.60%, respectively (Figure 1). The median age of patients who died was 66 years. Patients undergoing persistent AF ablation were at higher risk of death when compared with those with paroxysmal AF (adjusted HR, 1.74; 95% CI, 1.15–2.63; $P=0.008$).

Complications

The incidence rates of any periprocedural complication occurring within 7 and 30 days after AF ablation were 6.6% and 7.4%, respectively. Patients with persistent AF had higher odds of periprocedural complications within 30 days after ablation compared with those with paroxysmal AF (odds ratio, 1.36; 95% CI, 1.02–1.75).

The full results of multivariable regression models evaluating AF-related hospitalization/ER visit, mortality, and periprocedural complications were shown in Tables S4 to S6.

DISCUSSION

There are 3 important findings in this contemporary, population-based study of patients undergoing catheter-based AF ablation in Ontario, Canada. First, patients undergoing persistent AF ablation had a greater comorbidity burden along with higher mortality and complication rates when compared with patients with paroxysmal AF. This was reflected by trends toward greater risk of all-cause hospitalization or ER visits among patients with persistent AF. Second, we observed that ablation was associated with a reduction in the rate of AF-related hospitalizations or ER visits in the first year after ablation when compared with the year before ablation. Third, although patients with persistent AF were more likely to have adverse outcomes, our study showed that ablation, irrespective of AF type, was associated with a significant reduction in downstream AF-related HCU.

Healthcare Use

Few studies have addressed whether AF ablation reduces the rates of hospitalizations before and after the procedure. There is a need to define whether this invasive intervention may yield downstream benefits because patients experience high rates of hospitalization or ER visits during the early (<30 days) postablation phase.[10] This is an important consideration because randomized trials have reported mixed results on the impact of AF ablation on death and stroke.[17,18] Our study showed that AF ablation was associated with a 48% reduction in the rate of AF-related hospitalizations or ER visits in the year after ablation when compared with the year before. Our findings, derived from a population-based cohort of consecutive patients undergoing AF ablation, were consistent with a recent analysis from the Truven Health MarketScan database in the United States by Guo et al, which reported a 56% reduction of AF-related hospitalizations after ablation.[11]

Interestingly, our data on the time course of AF-related HCU showed the highest use during the first 3 months, followed by a substantial reduction

between 3 and 12 months after ablation. The first 3 months after ablation is considered to be a period during which AF-related hospitalization or ER visits are high because of arrhythmia recurrences, presumably related to the postablation "healing phase." In fact, most clinical trials censor arrhythmic events occurring during the first 3 months (the so-called "blanking period").[3] Previous studies reported hospitalization rates of up to 8% in the first 90 days, which were similarly observed in our patient cohort.[11–14] On the other hand, whether HCU remains elevated at beyond 3 months after ablation is not well defined. Our study showed that hospitalization from 91 to 365 days was 14.5%, which was higher than those reported by other studies.[11] However, unlike other study cohorts, which examined subsets of the overall population undergoing AF ablation, our results were based on an entire population-based cohort of patients undergoing AF ablation who were prospectively and consecutively identified. This approach likely yielded less biased estimates when compared with studies that examined only portions of the entire ablation population or restricted their study cohort according to patients' insurance status.

The temporal distribution of AF-related hospitalizations or ER visits in our study showed that the high rate during the first 30 days after ablation was balanced by subsequent reduction of events from 91 to 365 days after ablation, resulting in an overall lowering of event rates in the year after ablation when compared with the year before. This phenomenon was observed regardless of AF type, as evidenced by a reduction of 55% and 26% in the rate of AF-related hospitalizations or ER visits for patients with paroxysmal and persistent AF, respectively. This finding supports the notion that catheter-based ablation for patients with paroxysmal AF is effective in reducing downstream AF-related HCU. Despite the higher risk of adverse outcomes experienced by patients with persistent AF after ablation, their downstream AF-related HCU profile was also favorable.

Among patients with persistent AF, we observed a 12% increase in their rate of all-cause hospitalization or ER visit in the year after ablation when compared with the year before ablation. On the other hand, the proportion of these visits due to AF-related hospitalization or ER visits decreased from 49% to 32% over the same timeframe. Therefore, the increase in HCU after ablation for patients with persistent AF was related to non-AF causes. In this patient subset, the decrease in the rate of AF-related HCU after ablation was offset by a small increase in HCU attributable to non-AF diagnoses. This might be explained by the fact that patients with persistent AF exhibited greater medical comorbidity burden than those with paroxysmal AF, as suggested in the Table.

Clinical Implications

Our findings are pertinent to physicians, patients, and health policy makers because they may assist in planning of HCU around the time of ablation and calculating the cost-benefit ratio for various types of patients with AF. Furthermore, by understanding the time course of HCU after ablation, an important quality improvement focus should consist of interventions to mitigate early hospital readmission or ER use.

Limitations

Our study has several limitations. Although patients were prospectively and consecutively identified, the possibility of missing and/or erroneous categorization could still have occurred in our study. Although a distinguishing aspect of our study was our ability to identify the AF type (persistent versus paroxysmal) of each patient, 2 caveats need to be considered. First, categorization of AF type was dependent on the electrophysiologist who completed the CorHealth AF ablation registry form. Although the delineation of persistent versus paroxysmal AF was based on accepted definitions in consensus documents/guidelines, misclassification could occur, which would introduce bias to our results. Second, among patients with persistent AF, we did not further characterize which of them had long-standing persistent AF. This information might be of interest in terms of providing additional insight on the prognostic significance of patients with this advanced form of persistent AF. Third, our study outcomes were determined by linkage with health administrative databases, making it prone to bias related to diagnostic misclassification and/or inaccuracy because the specificity and sensitivity of *ICD-10* codes are not 100%. However, these sources of bias should not preferentially affect one exposure group over another. This limitation is universal in all studies that use population-based administrative databases to ascertain outcomes. Given the use of administrative codes, we could not provide further information on several pertinent aspects, such as details of the type of AF-related admissions or ER visits that occurred (eg, tachycardia related to AF, cardioversion for AF, or heart failure attributable to a primary diagnosis of AF), types of AF ablation strategy used, periprocedural/intraprocedural anticoagulation regimen, information on AF duration before and after ablation, and causes of death. Finally, this study only assessed 1-year outcomes. A longer time horizon may have shown an even greater reduction in HCU, as suggested by previous studies.[19]

CONCLUSIONS

Patients with persistent AF undergoing catheter-based AF ablation experienced higher rates of adverse outcomes

and greater HCU relative to those with paroxysmal AF. Regardless of AF type, ablation importantly reduced the rate of AF-related hospitalizations or ER visits in the year after ablation when compared with the year before.

ARTICLE INFORMATION

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Affiliations

From the Department of Medicine, University of Toronto, Ontario, Canada (A.C.H., H.C.W., K.A., P.A., E.C., A.V.); Peter Munk Cardiac Centre, Toronto General Hospital, University Health Network, Toronto, Ontario, Canada (A.C.H.); Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada (H.C.W., E.C.); ICES, Toronto, Ontario, Canada (H.C.W., F.Q., K.H.); St. Michael's Hospital, Unity Health Toronto, Toronto, Ontario, Canada (K.A., P.A.); University of Ottawa Heart Institute, Ottawa, Ontario, Canada (D.H.B., P.B.N.); Trillium Health Partners, Mississauga, Ontario, Canada (A.H.H.); Department of Medicine, Hamilton Health Sciences, Population Health Research Institute, McMaster University, Hamilton, Ontario, Canada (J.S.H.); Division of Cardiology, Western University, London Health Sciences Centre, London, Ontario, Canada (P.L.-S., A.C.S.); Scarborough Health Network, Toronto, Ontario, Canada (B.M.); Division of Cardiology, Kingston General Hospital, Queen's University, Kingston, Ontario, Canada (D.P.R.); and Southlake Regional Health Centre, Newmarket, Ontario, Canada (A.V.).

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Supplementary Material

Tables S1–S6
Figure S1

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SUPPLEMENTAL MATERIAL

Table S1. Administrative Codes Employed in the Identification of Periprocedural Complications.

Grouping	ICD-10 or CCI code or OHIP billing code
Bleeding complications	**D78.02; D78.22; E36.02; E89.811; G97.32; G97.52; H59.121; H59.122; H59.123; H59.129; H59.321; H59.322; H59.323; H59.329; H95.22; H95.42; I97.410; I97.411; I97.418; I97.42; I97.610; I97.611; I97.618; I97.620; J95.62; J95.831; K91.62; K91.841; L76.02; L76.22; M96.811; M96.831; N99.62; N99.821; D78.12; E36.12; G97.49; H59.229; H95.32; I97.51; I97.52; J95.72; K91.72; L76.12; M96.821; N99.72; T88.8XXA; K66.1** **I60; I61; I62.0; I62.1; I62.9; K92.0; K92.1; K92.2; I85.0; I98.20; I98.3; K22.10; K22.12; K22.14; K22.16; K25.0; K25.2; K25.4; K25.6; K26.0; K26.2; K26.4; K26.6; K27.0; K27.2; K27.4; K27.6; K28.0; K28.2; K28.4; K28.6; K29.0; K63.80; K31.80; K55.20; K62.5; K92.2; K66.1; R04.0; R04.1; R04.2; R04.8; R04.9; H35.6; H43.1; H45.0; M25.0; M79.81; I32.0; N02.0; N02.1; N02.2; N02.3; N02.4; N02.5; N02.6; N02.7; N02.8; N02.9; R31.0; R31.1; R31.9; N93.8; N93.9; N95.0; R58; D68.3**
Transfusion	**1.LZ.19.^^**
Vascular complications	**T81.718A; T81.72XA; T80.1XXA; S09.0XXS; S15.9XXS; S45.909S; S55.909S; S65.909S; S75.909S; S85.909S; S95.909S; S25.90XS; S35.90XS; T88.9XXS; I77.0; I77.2; S15.009A; S15.309A; S15.209A; S09.0XXA; S15.8XXA; S15.9XXA; S25.00XA; S25.109A; S25.20XA; S25.309A; S25.409A; S25.509A; S25.90XA; S45.809A; S45.009A; S45.109A; S45.209A; S55.109A; S65.109A; S55.009A; S65.009A; S65.209A; S65.309A; S65.409A; S65.509A; S45.809A; S75.009A; S75.209A; S85.309A; S85.409A; S85.009A; S85.509A; S85.009A; S85.509A; S85.109A; S85.139A; S85.809A; S85.169A; S95.109A; S75.809A; S95.809A; 1.IA.80; 1.IB.80; 1.IC.80; 1.ID.80; 1.IJ.80; 1.IK.80; 1.IM.80; 1.IN.80; 1.IS.80; 1.JE.80; 1.JJ.80; 1.JK.80; 1.JL.80; 1.JM.80; 1.JQ.80; 1.JT.80; 1.JU.80; 1.JW.80; 1.JX.80; 1.JY.80; 1.KG.80; 1.KR.80; 1.KT.80; 1.KV.80; 1.KX.80; 1.KY.80; 1.KZ.80**
Vascular complications involving the lower extremities	**S75.909S; S85.909S; S95.909S; S75.009A; S75.209A; S85.309A; S85.409A; S85.009A; S85.509A; S85.009A; S85.509A; S85.109A; S85.139A; S85.809A; S85.169A; S95.109A; S75.809A; S95.809A**

Respiratory complications	**J95.851; J95.89; J95.859; J95.88; J95.89; J95.811; J90; J94.2; J94.8; 1.GV.52.^^**
Cardiac complications	**I97.710; I97.790; I97.88; I97.89; I31.2; I31.4; T82.519A; T82.529A; T82.539A; T82.599A; T82.528A; T82.538A; T82.598A; 1.HA.52; I21.x; I22.x; I25.2; I50.x; 1.HM.80; 1.HM.78; 1.HP.80; 1.HP.78; 1.HZ.80**
Neurologic complications	**I97.811; I97.821; I60.0; I60.1; I60.2; I60.3; I60.4; I60.5; I60.6; I60.7; I60.9; I61.x; I63.0; I63.1; I63.2; I63.4; I63.5; I63.8; I63.9; I64.x; H34.1; G45.0; G45.1; G45.2; G45.3; G45.8; G45.9; I63; I65; I66; G97.32; G97.52; G97.49**
Genitourinary complications	**N99.89**
Complications involving interventional/surgical therapy	**Z341; E650; E682; M134; M137; Z401; R790; R795; R862; R781; R708; R783; R784; R785; R855; R856; R808; R873; R864; R825; R826; R818; R819; R820; Z226; 1.VZ.70; 1.IA.80; 1.IB.80; 1.IC.80; 1.ID.80; 1.IJ.80; 1.IK.80; 1.IM.80; 1.IN.80; 1.IS.80; 1.JE.80; 1.JJ.80; 1.JK.80; 1.JL.80; 1.JM.80; 1.JQ.80; 1.JT.80; 1.JU.80; 1.JW.80; 1.JX.80; 1.JY.80; 1.KG.80; 1.KR.80; 1.KT.80; 1.KV.80; 1.KX.80; 1.KY.80; 1.KZ.80; 1.HA.52; 1.HM.80; 1.HM.78; 1.HP.80; 1.HP.78; 1.HZ.80; 1.GV.52.^^**

CCI indicated Canadian Classification of Health Interventions; OHIP, Ontario Health Insurance Plan; ICD-10 = International Statistical Classification of Diseases and Related Health Problems, 10th revision.

Codes to define peri-procedural complications were derived from a compendium of diagnostic codes from ICD-10, procedure codes from CCI, and physician billing codes from OHIP.

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Table S2. Administrative Codes with their Associated Definitions Employed in the Identification of Periprocedural Complications.

Grouping	ICD-10, CCI, or OHIP code	Description
Bleeding complications	**D78.02**	Intraoperative hemorrhage and hematoma of the spleen complicating other procedure
	D78.22	Postprocedural hemorrhage of the spleen following other procedure
	E36.02	Intraoperative hemorrhage and hematoma of an endocrine system organ or structure complicating other procedure
	E89.811	Postprocedural hemorrhage of an endocrine system organ or structure following other procedure
	G97.32	Intraoperative hemorrhage and hematoma of a nervous system organ or structure complicating other procedure
	G97.52	Postprocedural hemorrhage of a nervous system organ or structure following other procedure
	H59.121	Intraoperative hemorrhage and hematoma of right eye and adnexa complicating other procedure
	H59.122	Intraoperative hemorrhage and hematoma of left eye and adnexa complicating other procedure
	H59.123	Intraoperative hemorrhage and hematoma of eye and adnexa complicating other procedure, bilateral
	H59.129	Intraoperative hemorrhage and hematoma of unspecified eye and adnexa complicating other procedure
	H59.321	Postprocedural hemorrhage of right eye and adnexa following other procedure
	H59.322	Postprocedural hemorrhage of left eye and adnexa following other procedure
	H59.323	Postprocedural hemorrhage of eye and adnexa following other procedure, bilateral
	H59.329	Postprocedural hemorrhage of unspecified eye and adnexa following other procedure
	H95.22	Intraoperative hemorrhage and hematoma of ear and mastoid process complicating other procedure
	H95.42	Postprocedural hemorrhage of ear and mastoid process following other procedure
	I97.410	Intraoperative hemorrhage and hematoma of a circulatory system organ or structure complicating a cardiac catheterization
	I97.411	Intraoperative hemorrhage and hematoma of a circulatory system organ or structure complicating a cardiac bypass

	I97.418	Intraoperative hemorrhage and hematoma of a circulatory system organ or structure complicating other circulatory system procedure
	I97.42	Intraoperative hemorrhage and hematoma of a circulatory system organ or structure complicating other procedure
	I97.610	Postprocedural hemorrhage of a circulatory system organ or structure following a cardiac catheterization
	I97.611	Postprocedural hemorrhage of a circulatory system organ or structure following cardiac bypass
	I97.618	Postprocedural hemorrhage of a circulatory system organ or structure following other circulatory system procedure
	I97.620	Postprocedural hemorrhage of a circulatory system organ or structure following other procedure
	J95.62	Intraoperative hemorrhage and hematoma of a respiratory system organ or structure complicating other procedure
	J95.831	Postprocedural hemorrhage of a respiratory system organ or structure following other procedure
	K91.62	Intraoperative hemorrhage and hematoma of a digestive system organ or structure complicating other procedure
	K91.841	Postprocedural hemorrhage of a digestive system organ or structure following other procedure
	L76.02	Intraoperative hemorrhage and hematoma of skin and subcutaneous tissue complicating other procedure
	L76.22	Postprocedural hemorrhage of skin and subcutaneous tissue following other procedure
	M96.811	Intraoperative hemorrhage and hematoma of a musculoskeletal structure complicating other procedure
	M96.831	Postprocedural hemorrhage of a musculoskeletal structure following other procedure
	N99.62	Intraoperative hemorrhage and hematoma of a genitourinary system organ or structure complicating other procedure
	N99.821	Postprocedural hemorrhage of a genitourinary system organ or structure following other procedure
	D78.12	Accidental puncture and laceration of the spleen during other procedure
	E36.12	Accidental puncture and laceration of an endocrine system organ or structure during other procedure
	G97.49	Accidental puncture and laceration of other nervous system organ or structure during other procedure
	H59.229	Accidental puncture and laceration of unspecified eye and adnexa during other procedure
	H95.32	Accidental puncture and laceration of the ear and mastoid process during other procedure

	I97.51	Accidental puncture and laceration of a circulatory system organ or structure during a circulatory system procedure
	I97.52	Accidental puncture and laceration of a circulatory system organ or structure during other procedure
	J95.72	Accidental puncture and laceration of a respiratory system organ or structure during other procedure
	K91.72	Accidental puncture and laceration of a digestive system organ or structure during other procedure
	L76.12	Accidental puncture and laceration of skin and subcutaneous tissue during other procedure
	M96.821	Accidental puncture and laceration of a musculoskeletal structure during other procedure
	N99.72	Accidental puncture and laceration of a genitourinary system organ or structure during other procedure
	T88.8XXA	Other specified complications of surgical and medical care, not elsewhere classified, initial encounter
	K66.1	Hemoperitoneum
Transfusion	**1.LZ.19.**^^	Transfusion
Vascular complications	**T81.718A**	Complication of other artery following a procedure, not elsewhere classified, initial encounter
	T81.72XA	Complication of vein following a procedure, not elsewhere classified, initial encounter
	T80.1XXA	Vascular complications following infusion, transfusion and therapeutic injection, initial encounter
	S09.0XXS	Injury of blood vessels of head, not elsewhere classified, sequela
	S15.9XXS	Injury of unspecified blood vessel at neck level, sequela
	S45.909S	Unspecified injury of unspecified blood vessel at shoulder and upper arm level, unspecified arm, sequela
	S55.909S	Unspecified injury of unspecified blood vessel at forearm level, unspecified arm, sequela
	S65.909S	Unspecified injury of unspecified blood vessel at wrist and hand level of unspecified arm, sequela
	S75.909S	Unspecified injury of unspecified blood vessel at hip and thigh level, unspecified leg, sequela
	S85.909S	Unspecified injury of unspecified blood vessel at lower leg level, unspecified leg, sequela
	S95.909S	Unspecified injury of unspecified blood vessel at ankle and foot level, unspecified leg, sequela
	S25.90XS	Unspecified injury of unspecified blood vessel of thorax, sequela
	S35.90XS	Unspecified injury of unspecified blood vessel at abdomen, lower back and pelvis level, sequela

	T88.9XXS	Complication of surgical and medical care, unspecified, sequela
	I77.0	Arteriovenous fistula, acquired
	I77.2	Rupture of artery
	S15.009A	Unspecified injury of unspecified carotid artery, initial encounter
	S15.309A	Unspecified injury of unspecified internal jugular vein, initial encounter
	S15.209A	Unspecified injury of unspecified external jugular vein, initial encounter
	S09.0XXA	Injury of blood vessels of head, not elsewhere classified, initial encounter
	15.8XXA	Injury of other specified blood vessels at neck level, initial encounter
	S15.9XXA	Injury of unspecified blood vessel at neck level, initial encounter
	S25.00XA	Unspecified injury of thoracic aorta, initial encounter
	S25.109A	Unspecified injury of unspecified innominate or subclavian artery, initial encounter
	S25.20XA	Unspecified injury of superior vena cava, initial encounter
	25.309A	Unspecified injury of unspecified innominate or subclavian vein, initial encounter
	S25.409A	Unspecified injury of unspecified pulmonary blood vessels, initial encounter
	S25.509A	Unspecified injury of intercostal blood vessels, unspecified side, initial encounter
	S25.90XA	Unspecified injury of unspecified blood vessel of thorax, initial encounter
	S45.809A	Unspecified injury of other specified blood vessels at shoulder and upper arm level, unspecified arm, initial encounter
	S45.009A	Unspecified injury of axillary artery, unspecified side, initial encounter
	S45.109A	Unspecified injury of brachial artery, unspecified side, initial encounter
	S45.209A	Unspecified injury of axillary or brachial vein, unspecified side, initial encounter
	S55.109A	Unspecified injury of radial artery at forearm level, unspecified arm, initial encounter
	S65.109A	Unspecified injury of radial artery at wrist and hand level of unspecified arm, initial encounter
	S55.009A	Unspecified injury of ulnar artery at forearm level, unspecified arm, initial encounter
	S65.009A	Unspecified injury of ulnar artery at wrist and hand level of unspecified arm, initial encounter
	S65.209A	Unspecified injury of superficial palmar arch of unspecified hand, initial encounter
	S65.309A	Unspecified injury of deep palmar arch of unspecified hand, initial encounter
	S65.409A	Unspecified injury of blood vessel of unspecified thumb, initial encounter
	S65.509A	Unspecified injury of blood vessel of unspecified finger, initial encounter
	S45.809A	Unspecified injury of other specified blood vessels at shoulder and upper arm level, unspecified arm, initial encounter
	S75.009A	Unspecified injury of femoral artery, unspecified leg, initial encounter

	S75.209A	Unspecified injury of greater saphenous vein at hip and thigh level, unspecified leg, initial encounter
	S85.309A	Unspecified injury of greater saphenous vein at lower leg level, unspecified leg, initial encounter
	S85.409A	Unspecified injury of lesser saphenous vein at lower leg level, unspecified leg, initial encounter
	S85.009A	Unspecified injury of popliteal artery, unspecified leg, initial encounter
	S85.509A	Unspecified injury of popliteal vein, unspecified leg, initial encounter
	S85.009A	Unspecified injury of popliteal artery, unspecified leg, initial encounter
	S85.509A	Unspecified injury of popliteal vein, unspecified leg, initial encounter
	S85.109A	Unspecified injury of unspecified tibial artery, unspecified leg, initial encounter
	S85.139A	Unspecified injury of anterior tibial artery, unspecified leg, initial encounter
	S85.809A	Unspecified injury of other blood vessels at lower leg level, unspecified leg, initial encounter
	S85.169A	Unspecified injury of posterior tibial artery, unspecified leg, initial encounter
	S95.109A	Unspecified injury of plantar artery of unspecified foot, initial encounter
	S75.809A	Unspecified injury of other blood vessels at hip and thigh level, unspecified leg, initial encounter
	S95.809A	Unspecified injury of other blood vessels at ankle and foot level, unspecified leg, initial encounter
	1.IA.80	Ascending aorta repair
	1.IB.80	Aortic arch repair
	1.IC.80	Descending aorta repair
	1.ID.80	Aortic NEC repair
	1.IJ.80	Coronary artery repair
	1.IK.80	Coronary vein repair
	1.IM.80	Pulmonary artery repair
	1.IN.80	Pulmonary vein repair
	1.IS.80	Vena caval repair
	1.JE.80	Carotid artery repair
	1.JJ.80	Brachiocephalic artery repair
	1.JK.80	Subclavian artery repair
	1.JL.80	Internal mammary artery repair
	1.JM.80	Arteries of arm NEC repair

	1.JQ.80	Jugular vein repair
	1.JT.80	Subclavian vein repair
	1.JU.80	Veins of arm NEC repair
	1.JW.80	Intracranial vessel repair
	1.JX.80	Other vessels of head, neck, or spine NEC, repair
	1.JY.80	Thoracic vessels NEC, repair
	1.KG.80	Arteries of the leg NEC, repair
	1.KR.80	Vein of leg NEC, repair
	1.KT.80	Vessels of the pelvis, perineum and gluteal region repair
	1.KV.80	Artery NEC, repair
	1.KX.80	Vein NEC, repair
	1.KY.80	Artery with vein, repair
	1.KZ.80	Blood vessels NEC, repair
	I60; I61; I62.0; I62.1; I62.9; K92.0; K92.1; K92.2; I85.0; I98.20; I98.3; K22.10; K22.12; K22.14; K22.16; K25.0; K25.2; K25.4; K25.6; K26.0; K26.2; K26.4; K26.6; K27.0; K27.2; K27.4; K27.6; K28.0; K28.2; K28.4; K28.6; K29.0; K63.80; K31.80;	Bleeding

	K55.20; K62.5; K92.2; K66.1; R04.0; R04.1; R04.2; R04.8; R04.9; H35.6; H43.1; H45.0; M25.0; M79.81; I32.0; N02.0; N02.1; N02.2; N02.3; N02.4; N02.5; N02.6; N02.7; N02.8; N02.9; R31.0; R31.1; R31.9; N93.8; N93.9; N95.0; R58; D68.3	
Vascular complications involving the lower extremities	**S75.909S**	Unspecified injury of unspecified blood vessel at hip and thigh level, unspecified leg, sequela
	S85.909S	Unspecified injury of unspecified blood vessel at lower leg level, unspecified leg, sequela
	S95.909S	Unspecified injury of unspecified blood vessel at ankle and foot level, unspecified leg, sequela
	S75.009A	Unspecified injury of femoral artery, unspecified leg, initial encounter
	S75.209A	Unspecified injury of greater saphenous vein at hip and thigh level, unspecified leg, initial encounter
	S85.309A	Unspecified injury of greater saphenous vein at lower leg level, unspecified leg, initial encounter
	S85.409A	Unspecified injury of lesser saphenous vein at lower leg level, unspecified leg, initial encounter
	S85.009A	Unspecified injury of popliteal artery, unspecified leg, initial encounter

	S85.509A	Unspecified injury of popliteal vein, unspecified leg, initial encounter
	S85.009A	Unspecified injury of popliteal artery, unspecified leg, initial encounter
	S85.509A	Unspecified injury of popliteal vein, unspecified leg, initial encounter
	S85.109A	Unspecified injury of unspecified tibial artery, unspecified leg, initial encounter
	S85.139A	Unspecified injury of anterior tibial artery, unspecified leg, initial encounter
	S85.809A	Unspecified injury of other blood vessels at lower leg level, unspecified leg, initial encounter
	S85.169A	Unspecified injury of posterior tibial artery, unspecified leg, initial encounter
	S95.109A	Unspecified injury of plantar artery of unspecified foot, initial encounter
	S75.809A	Unspecified injury of other blood vessels at hip and thigh level, unspecified leg, initial encounter
	S95.809A	Unspecified injury of other blood vessels at ankle and foot level, unspecified leg, initial encounter
Respiratory complications	**J95.851**	Ventilator associated pneumonia
	J95.89	Other postprocedural complications and disorders of respiratory system, not elsewhere classified
	J95.859	Other complication of respirator [ventilator]
	J95.88	Other intraoperative complications of respiratory system, not elsewhere classified
	J95.89	Other postprocedural complications and disorders of respiratory system, not elsewhere classified
	J95.811	Postprocedural pneumothorax
	J90	Pleural effusion, not elsewhere classified
	J94.2	Hemothorax
	J94.8	Other specified pleural conditions
	1.GV.52.^^	Chest tube insertion
Cardiac complications	**I97.710**	Intraoperative cardiac arrest during cardiac surgery
	I97.790	Other intraoperative cardiac functional disturbances during cardiac surgery
	I97.88	Other intraoperative complications of the circulatory system, not elsewhere classified
	I97.89	Other postprocedural complications and disorders of the circulatory system, not elsewhere classified

	I31.2	Hemopericardium, not elsewhere classified
	I31.4	Cardiac tamponade
	T82.519A	Breakdown (mechanical) of unspecified cardiac and vascular devices and implants, initial encounter
	T82.529A	Displacement of unspecified cardiac and vascular devices and implants, initial encounter
	T82.539A	Leakage of unspecified cardiac and vascular devices and implants, initial encounter
	T82.599A	Other mechanical complication of unspecified cardiac and vascular devices and implants, initial encounter
	T82.528A	Displacement of other cardiac and vascular devices and implants, initial encounter
	T82.538A	Leakage of other cardiac and vascular devices and implants, initial encounter
	T82.598A	Other mechanical complication of other cardiac and vascular devices and implants, initial encounter
	1.HA.52	Drainage of the pericardium
	1.HM.80;1.HM.78	Repair of atrium
	1.HP.80; 1.HP.78	Repair of ventricle
	1.HZ.80	Repair of heart NEC
	I21.x; I22.x; I25.2	Myocardial infarction
	I50.x	Heart failure
Genitourinary complications	**N99.89**	Other postprocedural complications and disorders of genitourinary system
Neurologic complications	**I97.811**	Intraoperative cerebrovascular infarction during other surgery
	I97.821	Postoperative cerebrovascular infarction during other surgery
	G97.32	Intraoperative hemorrhage and hematoma of a nervous system organ or structure complicating other procedure
	G97.52	Postprocedural hemorrhage of a nervous system organ or structure following other procedure
	G97.49	Accidental puncture and laceration of other nervous system organ or structure during other procedure
	I60.0; I60.1;	Stroke, TIA, or intracranial bleeding

	I60.2; I60.3; I60.4; I60.5; I60.6; I60.7; I60.9; I61.x; I63.0; I63.1; I63.2; I63.4; I63.5; I63.8; I63.9; I64.x; H34.1; G45.0; G45.1; G45.2; G45.3; G45.8; G45.9; I63; I65; I66	
Non-CNS thromboembolic complications	**I74; K55.0; N28.0; G95.1; I23.6; I51.3**	Non-CNS thromboembolic events
Complications involving interventional/surgical therapy	**Z341**	Closed drainage effusion or pneumothorax
	E650; E682	Cardiac pump bypass
	M134; M137	Thoracotomy
	Z401	Aspiration of pericardium
	R790	Suture of lacerated major artery
	R795	Repair of lacerated major artery or microscopic repair of digital artery
	R862	Repair of lacerated major artery or microscopic repair of digital artery by bypass or interposition graft
	R781	Ligation of artery
	R708	Ligation of internal iliac artery
	R783; R784; R785	Aorto-iliac repair
	R855	Common femoral/profunda femoris repair - as sole procedure

	R856	Extended profundoplasty
	R808	Femoral aneurysm - reconstruction or excision with graft
	R873	Thrombin injection of femoral artery pseudoaneurysm
	R864	Repair of false aneurysm at groin anastomosis
	R825	Resection of AV aneurysm or fistula with major graft
	R826	Resection of AV aneurysm or fistula with minor graft
	R818; R819; R820	Repair of a lacerated major vein
	Z226	Soft tissue incision and drainage (surgical)
	1.VZ.70	Leg incision, Not other specified
	1.IA.80	Ascending aorta repair
	1.IB.80	Aortic arch repair
	1.IC.80	Descending aorta repair
	1.ID.80	Aortic NEC repair
	1.IJ.80	Coronary artery repair
	1.IK.80	Coronary vein repair
	1.IM.80	Pulmonary artery repair
	1.IN.80	Pulmonary vein repair
	1.IS.80	Vena caval repair
	1.JE.80	Carotid artery repair
	1.JJ.80	Brachiocephalic artery repair
	1.JK.80	Subclavian artery repair
	1.JL.80	Internal mammary artery repair
	1.JM.80	Arteries of arm NEC repair
	1.JQ.80	Jugular vein repair
	1.JT.80	Subclavian vein repair
	1.JU.80	Veins of arm NEC repair
	1.JW.80	Intracranial vessel repair
	1.JX.80	Other vessels of head, neck, or spine NEC, repair
	1.JY.80	Thoracic vessels NEC, repair

	1.KG.80	Arteries of the leg NEC, repair
	1.KR.80	Vein of leg NEC, repair
	1.KT.80	Vessels of the pelvis, perineum and gluteal region repair
	1.KV.80	Artery NEC, repair
	1.KX.80	Vein NEC, repair
	1.KY.80	Artery with vein, repair
	1.KZ.80	Blood vessels NEC, repair
	1.HA.52	Drainage of the pericardium
	1.HM.80; 1.HM.78	Repair of atrium
	1.HP.80; 1.HP.78	Repair of ventricle
	1.HZ.80	Repair of heart NEC
	1.GV.52.^^	Chest tube insertion

CCI indicated Canadian Classification of Health Interventions; OHIP, Ontario Health Insurance Plan; ICD-10 = International Statistical Classification of Diseases and Related Health Problems, 10th revision.

Codes to define peri-procedural complications were derived from a compendium of diagnostic codes from ICD-10, procedure codes from CCI, and physician billing codes from OHIP.

Canadian Classification of Health Interventions, 4th edition, Canadian Institute of Health Information (2015). https://www.cihi.ca/sites/default/files/cci_volume_four_2015_en_0.pdf. Accessed April 25 2018.

Schedule of benefits. Physician services under the Health Insurance Act. Ministry of health and Long Term Care, Ontario (2015). http://www.health.gov.on.ca/en/pro/programs/ohip/sob/physserv/sob_master11062015.pdf. Accessed April 25 2018.

Table S3. Oral anticoagulation use after AF ablation for Ontario patients who were >65 years old (2012-16).

	Percentage of patients who filled a prescription for the same oral anticoagulant at 300-365 days after discharge from ablation (%)
Apixaban prescribed within 90 days from ablation (n=134)	78.3%
Dabigatran prescribed within 90 days from ablation (n=274)	66.4%
Rivaroxaban prescribed within 90 days from ablation (n=294)	69.7%
Warfarin prescribed within 90 days from ablation (n=245)	66.1%

Table S4. Multivariable Analysis of Factors Associated with All-Cause Mortality after AF Ablation.

Covariate	Hazard ratio	95% Confidence interval	P-value
Persistent AF (vs. paroxysmal AF)	1.74	1.15-2.63	0.01
Age (per year increase)	1.03	1.00-1.06	0.046
Charlson score (per point increase)	1.40	1.20-1.64	<0.001
CHA_2DS_2-VaSc score (per point increase)	1.12	0.87-1.46	0.38
Income quintile			
1 (lowest)	Referent	-	-
2	0.50	0.24-1.05	0.07
3	0.84	0.44-1.60	0.60
4	0.85	0.45-1.61	0.62
5 (highest)	0.51	0.27-0.98	0.04
Female	0.69	0.41-1.17	0.17
Rural residence	1.19	0.73-1.95	0.49
Diabetes	1.45	0.85-2.48	0.17
Hypertension	1.21	0.65-2.23	0.55
COPD	1.72	1.08-2.74	0.02
Stroke/TIA/Non-CNS thromboembolism	1.08	0.40-2.93	0.87
MI	1.40	0.60-3.27	0.44
PCI or CABG	0.86	0.36-2.06	0.73
LVEF			
≥50%	Referent	-	-
35-49%	1.42	0.68-2.93	0.35
<35%	0.60	0.18-2.05	0.42
Not reported	0.94	0.60-1.48	0.80

Table S5. Multivariable Analysis of Factors Associated with AF-Related Hospitalization or ER Visit.

Covariate	Hazard ratio	95% Confidence interval	P-value
Persistent AF (vs. paroxysmal AF)	1.21	1.09-1.34	<0.001
Age (per year increase)	1.00	0.99-1.01	0.67
Charlson score (per point increase)	1.03	0.96-1.10	0.48
CHA_2DS_2-VaSc score (per point increase)	1.08	1.01-1.16	0.02
Income quintile			
1 (lowest)	Referent	-	
2	0.92	0.77-1.01	0.36
3	0.91	0.76-1.08	0.26
4	0.88	0.74-1.04	0.14
5 (highest)	1.00	0.85-1.17	0.96
Female	1.03	0.91-1.16	0.68
Rural residence	1.00	0.88-1.14	0.97
Diabetes	0.81	0.70-0.95	0.007
Hypertension	0.98	0.86-1.11	0.75
COPD	1.09	0.96-1.25	0.20
Stroke/TIA/Non-CNS thromboembolism	0.71	0.50-1.01	0.06
MI	0.99	0.74-1.34	0.96
PCI or CABG	0.78	0.56-1.05	0.11
LVEF			
≥50%	Referent	-	
35-49%	1.00	0.81-1.23	0.99
<35%	0.78	0.56-1.09	0.15
Not reported	1.03	0.93-1.14	0.53

Table S6. Multivariable Analysis of Factors Associated with Peri-Procedural Complications within 30 Days of Ablation.

Covariate	Odds ratio	95% Confidence interval	P-value
Persistent AF (vs. paroxysmal AF)	1.34	1.02-1.75	0.04
Age (per year increase)	1.00	0.98-1.02	0.99
Charlson score (per point increase)	1.05	0.96-1.24	0.53
CHA_2DS_2-VaSc score (per point increase)	1.31	1.05-1.63	0.02
Income quintile			
1 (lowest)	1.66	1.11-2.48	0.03
2	1.35	0.92-1.98	0.42
3	1.06	0.73-1.54	0.31
4	1.10	0.77-1.57	0.44
5 (highest)	Referent	-	-
Female	1.18	0.84-1.67	0.34
Rural residence	0.80	0.56-1.14	0.22
Diabetes	1.67	0.45-1.00	0.05
Hypertension	1.08	0.74-1.58	0.68
COPD	0.90	0.63-1.28	0.55
Stroke/TIA/Non-CNS thromboembolism	0.63	0.33-1.20	0.16
MI	1.36	0.68-2.70	0.38
PCI or CABG	1.59	0.72-3.52	0.25
LVEF			
≥50%	1.05	0.80-1.38	0.35
35-49%	1.35	0.82-2.22	0.49
<35%	1.37	0.68-2.77	0.56
Not reported	Referent	-	

Figure S1. Flow Diagram of Patients Included in the Study.