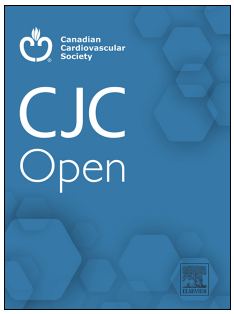
Journal Pre-proof



Validation of the use of discharge diagnostic codes for the verification of secondary atrial fibrillation in administrative databases

Erika Nakajima, BSc, Bisan ShweikiAlrefaee, MD, Peter C. Austin, PhD, Dennis T. Ko, MD-MSc, Husam Abdel-Qadir, MD PhD

PII: S2589-790X(23)00122-1

DOI: https://doi.org/10.1016/j.cjco.2023.05.007

Reference: CJCO 675

To appear in: *CJC Open*

Received Date: 22 March 2023

Revised Date: 8 May 2023

Accepted Date: 14 May 2023

Please cite this article as: E. Nakajima, B. ShweikiAlrefaee, P.C. Austin, D.T. Ko, H. Abdel-Qadir, Validation of the use of discharge diagnostic codes for the verification of secondary atrial fibrillation in administrative databases, *CJC Open* (2023), doi: https://doi.org/10.1016/j.cjco.2023.05.007.

Validation of the use of discharge diagnostic codes for the verification of secondary atrial fibrillation in administrative databases

Short title: Validation study of secondary atrial fibrillation

Erika Nakajima BSc[a, b]*, Bisan ShweikiAlrefaee MD[b]*, Peter C. Austin PhD[c,d], Dennis T. Ko MD-MSc[b-e] Husam Abdel-Qadir MD PhD[a-d, f]
* Co-first authors

Affiliations

a. Women's College Hospital
b. Department of Medicine, University of Toronto
c. ICES (formerly known as the Institute for Clinical Evaluative Sciences)
d. University of Toronto, Institute of Health Policy, Management, and Evaluation
e. Schulich Heart Centre, Sunnybrook Health Sciences Center
f. University Health Network

All the above from Toronto, Ontario, Canada

Word count: 3344 words

Address for correspondence:
Husam Abdel-Qadir MD, PhD, FRCPC
Women's College Hospital, Room 6452
76 Grenville Street, Toronto, Ontario, Canada M5S1B2
E-mail: h.abdel.qadir@utoronto.ca
Phone: +1-416-323-7723
Fax: +1 800 953 0138

Abstract (246 words)

Background: "Secondary atrial fibrillation" (AF) denotes AF precipitated by short-term triggers and which may be reversible. There is interest in using administrative data to study secondary AF but their ability to verify secondary AF has not been studied.

Methods: We conducted a cross-sectional analysis of 1000 randomly selected hospitalizations of patients discharged alive between January 1st, 2016 and March 31st, 2020 with AF coded as the most responsible diagnosis (Type 1), post-admit Comorbidity (Type 2), or secondary diagnosis (Type 3). We compared diagnosis types to AF category (secondary or not) as determined by a physician blinded to the discharge diagnosis type. We calculated the positive predictive value (PPV) of the designation of secondary AF in comparison to physician determination.

Results: A total of 421 hospitalizations had AF documented as a Type 2 diagnosis; this had a PPV of 94.8% for physician determination of secondary AF. After excluding hospitalizations with pre-existing AF and those for whom AF type could not be determined by the physician, the PPV of a Type 2 diagnosis (N=391) for secondary AF was 99.7%. Type 3 diagnoses of AF (N=222) mostly captured hospitalizations with pre-existing AF (87.8% of Type 3 diagnoses).

Conclusions: A Type 2 diagnosis can be used to verify secondary AF in people who were first diagnosed with AF while hospitalized for other causes. This facilitates cohort studies and clinical trial recruitment of people with this AF subtype, although it should not be used to determine prevalence/ incidence of secondary AF.

Introduction

Atrial fibrillation (AF) is the most common sustained cardiac arrythmia [1], which portends substantially increased risks of death, heart failure, and stroke [2-4]. While AF is mostly a chronic disease, it can also be precipitated in-hospital by short-term triggers such as surgery, infection, electrolyte disturbances, pneumonia, and chronic obstructive pulmonary disorder (COPD) exacerbations [5-8]. AF that is triggered by a short-term precipitant often appears to resolve after its reversal. Such temporary cases of AF have been designated as "secondary AF", in contrast to "primary AF" that develops without acute provocation and that is expected to be longer-lasting[9, 10]. Secondary AF comprises a large portion of new-onset AF that is diagnosed in-hospital[5, 6]. Despite this, there are limited data on management patterns or the prognosis of secondary AF. This has resulted in minimal guidance about secondary AF in clinical practice guidelines [8, 11-14].

The knowledge gaps about the management patterns and outcomes of people with secondary AF can be informed using population-based studies leveraging administrative datasets, as they can be used to create highly inclusive cohorts with long-term follow-up. Administrative datasets can also be used to verify diagnosis of secondary AF in people who may be candidates for clinical trials investigating management approaches. In theory, this can be accomplished by leveraging administrative datasets to verify first-ever AF diagnoses of secondary AF in people who were hospitalized for a different diagnosis. Since these data are collected primarily for administrative purposes, it is important to determine their validity before using them for clinical research. Accordingly, the goal of this study was to study the performance of an algorithm for verification of secondary AF in people who were first documented with AF during an acute hospitalization where the AF was not the primary reason for hospitalization. Our hypothesis was

that AF that was first diagnosed in-hospital under such circumstances would have a high positive predictive value (PPV) for secondary AF.

Material and methods

All medical diagnoses made in hospitalized patients in Canada are recorded in the Canadian Institute for Health Information's Discharge Abstract Database (CIHI-DAD). The diagnoses are classified into diagnosis types based on the impact the condition had on the patient's in-hospital care[15]. Diagnosis type M (most responsible diagnosis) refers to a condition that is the most responsible for a patient's stay in hospital. If a patient is hospitalized for more than one condition, the one responsible for the greatest portion of the stay is selected as the most responsible. Diagnosis type 1 (pre-admit comorbidity) refers to a condition that existed prior to the patient's stay in hospital. Diagnosis type 2 (post-admit comorbidity) refers to a condition that arises after the patient is admitted to the hospital. Both diagnoses type 1 and 2 are comorbid diagnoses and require fulfillment of at least one of the following criteria of significance: requires treatment beyond maintenance of the pre-existing condition, increases length of stay by at least 24 hours, and/or significantly affects the treatment received. Diagnosis type 3 refers to a secondary diagnosis for which a patient may or may not receive treatment. A diagnosis type 3 cannot meet any of the criteria of significance listed above[15].

We conducted a cross-sectional analysis using electronic medical record data, which was approved by the University Health Network research ethics board. The hospital's data services department provided us with a randomly selected sample of 1000 hospitalizations of patients who were discharged alive between January 1st, 2016 and March 31st, 2020 from Toronto General Hospital (TGH), Toronto Western Hospital (TWH), or Princess Margaret Cancer Centre (PMCC) with a Type M, Type 2, or Type 3 diagnosis of AF. These three hospitals together

comprise the University Health Network in Toronto. Patients who were coded to have a Type 1 diagnosis of AF were not included since our objective was to study AF that was first recognized in-hospital (rather than a pre-admit comorbidity).

A second-year Internal Medicine resident (BS) reviewed the discharge summary associated with each hospitalization. The reviewer was blinded to the diagnosis type that had been recorded by the hospital's medical records department. The description of the clinical course and any available ECGs were used to verify the diagnosis of AF. The physician reviewer was asked to determine whether the AF was more aptly characterized as primary or secondary AF based on whether the AF was felt to be the primary cause of hospitalization or a secondary issue that arose during hospitalization. The reviewer also determined if the AF was newly diagnosed or documented in the patient's past medical history. She also collected patient age, sex, hospital (TGH, TWH, or PMH) and calendar year of discharge. The presence of sinus rhythm at time of discharge was also recorded if that could be determined from the discharge summary. No personal health information (e.g., date of birth) was collected. The AF category and prior AF status were classified as undetermined for hospitalizations where the discharge summary could not be accessed.

Statistical analysis

Baseline characteristics were summarized using the median, with 25^{th}-75^{th} percentiles (Q1-Q3) for continuous variables, while counts with percentages were used for categorical variables. The physician reviewer's determination of AF category (primary vs. secondary) was treated as the reference standard for the purposes of this analysis. This was compared against the categorization of AF as per the discharge diagnosis type assigned in the hospital discharge record. If AF was coded as the most responsible diagnosis in the hospital discharge record (i.e.,

diagnosis type M), it was categorized as primary. Our main approach to the determination of secondary AF was if it was documented as a Post-Admit Comorbidity (diagnosis type 2). We also explored the performance of AF as a Secondary Diagnosis (diagnosis Type 3) for determination of secondary AF.

We calculated the positive predictive value (PPV) of the designation of secondary or primary AF in the hospital discharge record, in comparison to the reference standard (physician determination). The primary analysis included all hospitalizations, including those where the AF category could not be determined after chart review, and hospitalizations of patients with pre-existing AF. We conducted sensitivity analyses after excluding people documented in the discharge summary as having pre-existing AF, and charts in which the AF diagnosis type could not be determined by the reviewer (i.e., a complete case analysis). As a secondary analysis, Kappa statistics were calculated to determine the agreement between the physician determination of AF diagnosis type versus discharge summaries [16]. We also conducted a *post hoc* analysis to determine the distribution of AF diagnosis types and the PPV at each of the 3 hospitals in the University Health Network. All statistical analyses were conducted using SPSS[17].

Results

Patient Characteristics

Of the 1000 hospital discharges provided, 14 charts could not be accessed, while 3 were duplicates of patients that were already included. The characteristics of the 983 included patients are summarized in Table 1. Most patients were male (60.9%), and the median age at hospital admission was 70 years (Q1-Q3 62-78 years).

Of the 1000 hospitalizations with AF diagnoses, most (78.2%) were discharges from Toronto General Hospital (TGH). With regards to AF diagnosis type, 357 (35.7%) were

classified in the hospital discharge record as having diagnosis type M, 421 (42.1%) as diagnosis type 2, and 222 (22.2%) as diagnosis type 3. Based on physician chart review, 442 (44.2%) of hospitalizations involved patients documented as having a diagnosis of AF prior to their hospital admission.

Validation of Diagnostic Codes

We included all 1000 hospitalizations with a type M, 2, or 3 AF diagnosis in the primary analysis. A breakdown of the 1000 hospitalizations according to the hospital discharge record and whether they were determined to be primary or secondary AF according to physician review is presented in Table 2. The PPV of a Type 2 diagnosis of AF in the hospital discharge record for classifying AF as secondary was 94.8%, while the PPV of a Type 3 diagnosis was 87.4%. The PPV of a Type M diagnosis for classifying AF as primary was 86.0%. The overall kappa score was 0.55. The analysis stratified by each specific hospital revealed significant differences in the distribution of AF diagnosis, as summarized in Table 3 ($p< 0.001$). Nonetheless, the PPV of a Type 2 diagnosis for predicting secondary AF was above 90% in all three hospital sites (97.1% at TGH, 90.4% at TWH, 100% at PMH).

Among 357 hospitalizations with a type M diagnosis, 237 (66.4%) were documented in the medical record to have AF prior to hospital admission. Similarly, of 222 hospitalizations with a type 3 diagnosis of AF, 195 (87.8%) were documented found to have AF pre-admission. In contrast, only 10 (2.4%) of the 421 hospitalizations with a type 2 diagnosis had AF pre-admission. The results of the analyses after excluding the 442 hospitalizations with pre-existing AF and 18 hospitalizations whose prior AF status was unknown are presented in Table 4. For hospitalizations where the AF was newly recognized, the PPV of a Type 2 diagnosis for classifying AF as provoked was 96.8%, while the PPV of a type M diagnosis for classifying AF

as primary was 84.2%. Conversely, the PPV for classifying AF as provoked was only 52.2% for a Type 3 AF diagnosis in hospitalizations with newly recognized AF in-hospital. However, for 10 of these hospitalizations with a Type 3 diagnosis (43.5%), the reviewing physician could not classify the AF as primary versus provoked. The overall kappa score for this subset of the study sample was 0.79.

After excluding hospitalizations with prior AF and those with undetermined AF category, we were left with 517 hospitalizations with newly recognized AF and whose AF diagnosis type could be characterized. A breakdown of diagnosis types is presented in Table 5. The PPV of a Type 2 diagnosis for determining provoked AF was 99.7%, while the PPV of a Type 3 diagnosis for determining provoked AF was 92.3%. The PPV of a Type M diagnosis for classifying AF as primary AF was 85.0%. The overall kappa score for this subset of the cohort was 0.83.

Discussion

In this cross-sectional validation study, we demonstrated that appropriate utilization of discharge diagnosis types in the CIHI-DAD can be used to categorize patients as likely having primary or secondary AF. The PPV was high when compared to physician determination of AF type after chart review. In particular, a discharge diagnosis of AF as a Type 2 diagnosis had a PPV of >90% for detecting AF that was not the primary reason for hospitalization and that was not recognized before hospital admission. When we further excluded people who had been documented to have pre-existing AF, the PPV of a Type 2 diagnosis for determining secondary AF rose to >95%. We would like to highlight to readers that the PPV in the sensitivity analyses excluding people with undetermined AF status and pre-existing AF are likely overestimated. A Type M diagnosis also performed well for verifying primary AF, with a PPV of 86%. Type 3 diagnoses of AF mostly captured people with pre-existing AF, which constituted 87.8% of such

diagnoses, indicating that they should not be used for the study of people with secondary AF in administrative data.

Overall, our analysis suggests that a Type 2 discharge diagnosis of AF can be used to leverage administrative datasets for the study of people whose AF was first recognized in-hospital during an admission for another cause. The PPVs of the discharge diagnostic type 2 in verifying patients with secondary AF were higher than 90% in all our analyses. This suggests that Type 2 diagnoses can be used to verify patients with a high likelihood of having secondary AF. The reliability of this approach can be increased further if the lookback period in administrative datasets is used to exclude any diagnoses of AF that were made before hospital admission.

There is a paucity of data regarding the management of patients with secondary AF, especially in those admitted for non-cardiac and non-surgical reasons. This is particularly relevant for stroke prophylaxis with anticoagulants which balances the risk of stroke with that of bleeding [18]. The risk of stroke in patients with secondary AF is less established than people with primary AF, and patients with secondary AF are also more likely to have multiple comorbidities than similarly aged patients with primary AF [5, 19]. Lubitz *et al.* performed a longitudinal observational study following participants from the Framingham Heart Study with AF first detected between 1949 and 2012. The results of the study demonstrated that risk of recurrent AF was high whether the AF was primary or secondary, and that long-term risks of stroke and mortality were similar between participants with primary and secondary AF. The authors called for future studies that could help determine whether increased AF surveillance and adherence to primary AF management principles is warranted in patients with secondary AF [6]. Another study led by Siontis *et* al utilized administrative data from Minnesota to demonstrate

that patients with secondary AF after noncardiac surgery was associated with a lower risk of recurrence but similar stroke risk as patients with primary AF that was unrelated to surgery[20]. However, it is unclear if patients with secondary AF would benefit from receiving anticoagulation at the same thresholds as people with primary AF. Quon *et al.* conducted a retrospective cohort study using Quebec administrative data to assess the risk of ischemic stroke and hemorrhage in patients with secondary AF. The authors found that there was no association between anticoagulation and lower risk of ischemic stroke in patients with secondary AF, thus concluding that there is limited benefit in using anticoagulants in some patients with secondary AF.

A specific point of debate is the need for anticoagulation of secondary AF in the setting of cardiac surgery. Oraii *et al* reported that new-onset post-operative AF following coronary artery bypass graft (CABG) surgery was associated with increased risk of overall mortality and stroke midway through their 49-month follow-up time but did not portend longer-term mortality risk if people who had early stroke were censored [21]. In a systematic review of 9 observational studies, Wang *et al* reported that anticoagulation of people with secondary AF following cardiac surgery was associated with minimally lower risk of arterial thromboembolism (2 less events per 1000 person-years), but increased risk of bleeding (42 more events per 1000 person-years) [22].

Most prior studies on secondary AF have focused on stroke risk and the need for anticoagulation. It is less appreciated that people discharged from hospital with AF have a high risk of death,[19] and that stroke only contributes to a negligible proportion of the mortality risk associated with AF [23, 24]. This highlights the importance for people with secondary AF to receive close follow-up after their discharge geared at addressing their overall health status. Indeed, the American College of Cardiology (ACC)/American Heart Association (AHA)/Heart

Rhythm Society (HRS) guidelines recommend "careful follow-up" for patients with newly diagnosed secondary AF. For cardiovascular diseases other than AF, there are ample data demonstrating that early follow-up is associated with improved outcomes for patients after discharge from hospital or the emergency department (ED), particularly if patient care is shared between cardiologists and generalists [25-28].

When it comes to AF, there are less data on physician follow-up and its association with patient outcomes. Most available data are specific to patients with primary AF discharged from the ED. In a study of 14,907 patients discharged from Ontario ED's with a new primary diagnosis of AF between 2007 and 2012, only half the patients had follow-up within a week, and 18.0% had still not obtained follow-up care at 30 days [29]. Another study of 2902 propensity score-matched pairs of individuals with newly diagnosed primary AF in the ED demonstrated that cardiologist care within a year of diagnosis was associated with lower mortality (5.3% vs 7.7%) [30]. Data from Ontario indicated that less than half the patients who are diagnosed with primary AF in the ED are started on anticoagulation after discharge despite being eligible for it based on their age [31]. We suspect similar or larger gaps in care for hospitalized patients with newly diagnosed secondary AF. These are important questions about secondary AF that can be addressed using administrative data by applying the approach tested in this study."

The Ontario administrative datasets potentially offer a valuable resource for investigating patients with secondary AF, their management, and their prognosis following discharge. Tu *et al.* demonstrated that Ontario administrative database diagnostic codes used to identify patients with AF had a specificity of over 95% [32]. Validating the accuracy of diagnostic codes for determining primary versus secondary AF, however, is crucial before conducting further studies using administrative data. The Minnesota study led by Siontis *et al* identified patients with

229 secondary AF using ICD-9 diagnostic codes, and each diagnosis had to be validated by trained
230 nurse abstractors [20]. In contrast, the study by Quon *et al* utilized ICD-10 diagnostic codes to
231 identify and diagnose patients with secondary AF without reviewing the accuracy of these codes
232 and that was highlighted as a limitation of the study [7]. Collectively. these studies highlight that
233 administrative data can be useful to study secondary AF but require validation of the
234 appropriateness of using diagnostic codes in verifying secondary AF.

235 Our study has several limitations. First, all patients in our cohort received care from three
236 hospitals (TGH, TWH, PMH), but they all fall within one healthcare system (University Health
237 Network) in one urban centre (Toronto). Therefore, the results of this study might not be
238 generalizable to a wider population outside of this health system. Another limitation is that we
239 did not verify all diagnoses of AF with electrocardiograms. Thus, for most patients, we relied on
240 the description of the clinical course within the discharge summary. Additionally, we relied on
241 discharge summaries for identification of pre-existing AF, and this may have not been sensitive
242 enough to identify all previously recognized AF. We also did not collect data on whether the AF
243 was diagnosed before or after admission to hospital. Our approach was limited to reviewing AF
244 diagnoses made within the specific hospitalization, and we did not determine if AF was
245 provoked by an event preceding the admission to hospital (including previous hospitalizations).
246 Another limitation of our study was the use of only one physician chart reviewer. There were
247 several cases where the physician was not able to determine whether AF was primary or
248 secondary, and this may have been improved with the use of a second chart reviewer. Finally,
249 our sample was defined by people having been documented with AF as one of the discharge
250 diagnoses. This means that we did not include patients who would have had AF that was not
251 documented in the discharge diagnoses. Accordingly, we could only verify true and false

positives, i.e., we could not determine sensitivity and negative predictive value as we could not distinguish true from false negatives. This means Type 2 diagnoses of AF should not be used to interrogate administrative datasets to report on the population-wide incidence and/ or prevalence of secondary AF. Rather, their use should be limited to determining the characteristics and outcomes of a subset of people who have a high likelihood of secondary AF.

Conclusions

A Type 2 diagnosis can be used to verify secondary AF in people hospitalized for other causes, particularly if pre-existing diagnoses of AF are excluded. This strategy can leverage administrative datasets to study the management and outcomes of hospitalized patients with secondary AF while allowing for comprehensive long-term follow-up. The high PPV can also be useful to verify people with secondary AF for recruitment into pragmatic clinical trials leveraging administrative datasets. However, this approach should not be used to determine prevalence or incidence of secondary AF given its undetermined sensitivity.

Funding Sources: This study was funded by the Canadian cardiovascular Society Atrial Fibrillation Research Award (to DTK and HAQ). Dr. Ko is supported by the Jack Tu Chair in Cardiovascular Outcomes Research. Dr. Abdel-Qadir is supported by a National New Investigator Award from the Heart and Stroke Foundation of Canada. The funding sources had no role in the conduct of the study, the decision to publish or the preparation of the manuscript

Disclosures: No relevant conflicts of interest declared.

References

1. Medical Advisory, S., *Ablation for atrial fibrillation: an evidence-based analysis.* Ont Health Technol Assess Ser, 2006. **6**(7): p. 1-63.
2. Benjamin, E.J., et al., *Impact of atrial fibrillation on the risk of death: the Framingham Heart Study.* Circulation, 1998. **98**(10): p. 946-52.
3. Chugh, S.S., et al., *Epidemiology and natural history of atrial fibrillation: clinical implications.* J Am Coll Cardiol, 2001. **37**(2): p. 371-8.
4. Patel, N.J., et al., *Contemporary trends of hospitalization for atrial fibrillation in the United States, 2000 through 2010: implications for healthcare planning.* Circulation, 2014. **129**(23): p. 2371-9.
5. Gundlund, A., et al., *Comparative thromboembolic risk in atrial fibrillation with and without a secondary precipitant-Danish nationwide cohort study.* BMJ Open, 2019. **9**(9): p. e028468.
6. Lubitz, S.A., et al., *Long-term outcomes of secondary atrial fibrillation in the community: the Framingham Heart Study.* Circulation, 2015. **131**(19): p. 1648-55.
7. Quon, M.J., H. Behlouli, and L. Pilote, *Anticoagulant Use and Risk of Ischemic Stroke and Bleeding in Patients With Secondary Atrial Fibrillation Associated With Acute Coronary Syndromes, Acute Pulmonary Disease, or Sepsis.* JACC Clin Electrophysiol, 2018. **4**(3): p. 386-393.
8. Verma, A., *Does "Secondary" Atrial Fibrillation Really Exist?* JACC Clin Electrophysiol, 2018. **4**(3): p. 394-396.
9. Cheung, C.C. and J.G. Andrade, *Reversible or Provoked Atrial Fibrillation?: The Devil in the Details.* JACC Clin Electrophysiol, 2018. **4**(4): p. 563-564.
10. Verma, A., *Does "Secondary" Atrial Fibrillation Really Exist?* JACC: Clinical Electrophysiology, 2018. **4**(3): p. 394-396.
11. Andrade, J.G., et al., *2018 Focused Update of the Canadian Cardiovascular Society Guidelines for the Management of Atrial Fibrillation.* Can J Cardiol, 2018. **34**(11): p. 1371-1392.
12. January, C.T., et al., *2014 AHA/ACC/HRS guideline for the management of patients with atrial fibrillation: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines and the Heart Rhythm Society.* J Am Coll Cardiol, 2014. **64**(21): p. e1-76.
13. January, C.T., et al., *2019 AHA/ACC/HRS Focused Update of the 2014 AHA/ACC/HRS Guideline for the Management of Patients With Atrial Fibrillation: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Rhythm Society.* J Am Coll Cardiol, 2019. **74**(1): p. 104-132.
14. Kirchhof, P., et al., *2016 ESC Guidelines for the management of atrial fibrillation developed in collaboration with EACTS.* Eur Heart J, 2016. **37**(38): p. 2893-2962.
15. Canadian Institute for Health Information, *Canadian Coding Standards for Version 2022 ICD-10-CA and CCI*. 2022, CIHI: Ottawa, ON.
16. Landis, J.R. and G.G. Koch, *The measurement of observer agreement for categorical data.* Biometrics, 1977. **33**(1): p. 159-74.

17. IBM Corp., *IBM SPSS Statistics for Windows, Version 28.0. Released 2021. Armonk, NY: IBM Corp.*
18. Eckman, M.H., et al., *Moving the tipping point: the decision to anticoagulate patients with atrial fibrillation.* Circ Cardiovasc Qual Outcomes, 2011. **4**(1): p. 14-21.
19. Abdel-Qadir, H., et al., *Importance of Considering Competing Risks in Time-to-Event Analyses: Application to Stroke Risk in a Retrospective Cohort Study of Elderly Patients With Atrial Fibrillation.* Circ Cardiovasc Qual Outcomes, 2018. **11**(7): p. e004580.
20. Siontis, K.C., et al., *Associations of Atrial Fibrillation After Noncardiac Surgery With Stroke, Subsequent Arrhythmia, and Death : A Cohort Study.* Ann Intern Med, 2022. **175**(8): p. 1065-1072.
21. Oraii, A., et al., *Effect of postoperative atrial fibrillation on early and mid-term outcomes of coronary artery bypass graft surgery.* Eur J Cardiothorac Surg, 2022. **62**(3).
22. Wang, M.K., et al., *Use of Anticoagulation Therapy in Patients With Perioperative Atrial Fibrillation After Cardiac Surgery: A Systematic Review and Meta-analysis.* CJC Open, 2022. **4**(10): p. 840-847.
23. Healey, J.S., et al., *Occurrence of death and stroke in patients in 47 countries 1 year after presenting with atrial fibrillation: a cohort study.* Lancet, 2016. **388**(10050): p. 1161-9.
24. Gomez-Outes, A., et al., *Causes of Death in Anticoagulated Patients With Atrial Fibrillation.* J Am Coll Cardiol, 2016. **68**(23): p. 2508-2521.
25. Ayanian, J.Z., et al., *Specialty of ambulatory care physicians and mortality among elderly patients after myocardial infarction.* N Engl J Med, 2002. **347**(21): p. 1678-86.
26. Ezekowitz, J.A., et al., *Impact of specialist follow-up in outpatients with congestive heart failure.* Cmaj, 2005. **172**(2): p. 189-94.
27. Czarnecki, A., et al., *Association between physician follow-up and outcomes of care after chest pain assessment in high-risk patients.* Circulation, 2013. **127**(13): p. 1386-94.
28. Atzema, C.L. and S.M. Singh, *Acute Management of Atrial Fibrillation: From Emergency Department to Cardiac Care Unit.* Cardiol Clin, 2018. **36**(1): p. 141-159.
29. Atzema, C.L., et al., *Incident atrial fibrillation in the emergency department in Ontario: a population-based retrospective cohort study of follow-up care.* CMAJ Open, 2015. **3**(2): p. E182-91.
30. Singh, S.M., et al., *The Relationship Between Cardiologist Care and Clinical Outcomes in Patients With New-Onset Atrial Fibrillation.* Can J Cardiol, 2017. **33**(12): p. 1693-1700.
31. Atzema, C.L., et al., *Association of Follow-Up Care With Long-Term Death and Subsequent Hospitalization in Patients With Atrial Fibrillation Who Receive Emergency Care in the Province of Ontario.* Circ Arrhythm Electrophysiol, 2019. **12**(12): p. e006498.
32. Tu, K., et al., *Identifying Patients With Atrial Fibrillation in Administrative Data.* Can J Cardiol, 2016. **32**(12): p. 1561-1565.

Table 1. Characteristics of patients included in the validation study (N=983)

Median Age (Q1-Q3)	70 (62-78)
Sex	
Male, N (%)	609 (60.9)
Female, N (%)	374 (37.4)
Hospital	
Toronto General Hospital, N (%)	781 (79.4)
Toronto Western Hospital, N (%)	183 (18.6)
Princess Margaret Hospital, N (%)	17 (1.7)
Not documented, N (%)	2 (0.2%)
Year of Discharge	
2016, N (%)	182 (18.5)
2017, N (%)	240 (24.4)
2018, N (%)	257 (26.1)
2019, N (%)	247 (25.1)
2020, N (%)	57 (5.8)
AF Prior to Hospital Admission	
Yes, N (%)	441 (44.9)
No, N (%)	540 (54.9)
Unknown, N (%)	2 (0.2)
Sinus Rhythm at Discharge	
Yes, N (%)	313 (31.8)
No, N (%)	29 (3.0)
Unknown, N (%)	641 (65.2)

Table 2. A comparison of the AF discharge diagnosis type against AF category as determined by physician review for all hospitalizations (N=1000)

	Primary	Secondary	Undetermined	Total
Type M	307	42	8	357
Type 2	1	399	21	421
Type 3	11	194	17	222
Total	319	635	46	1000

Table 3. A comparison of the AF discharge diagnosis type against hospital location (N=1000)

	TGH	TWH	PMH	Unknown	Total
Type M, N (% of hospital)	294 (37.6)	56 (30.6)	0 (0.0)	7 (38.9)	357
Type 2, N (% of hospital)	347 (44.4)	52 (28.4)	15 (88.2)	7 (38.9)	421
Type 3, N (% of hospital)	141 (18.0)	75 (41.0)	2 (11.8)	4 (22.2)	222
Total	782	183	17	18	1000

Table 4. A comparison of the AF discharge diagnosis type against AF category as determined by physician review after excluding hospitalizations with prior AF (N=540)

	Primary	Secondary	Undetermined	Total
Type M	96	17	1	114
Type 2	1	390	12	403
Type 3	1	12	10	23
Total	98	419	23	540

Table 5. A comparison of the AF discharge diagnosis type against AF category as determined by physician review after excluding patients with prior AF and/or unknown AF type according to physician review (N=517)

	Primary	Secondary	Total
Type M	96	17	113
Type 2	1	390	391
Type 3	1	12	13
Total	98	419	517