Atrial Fibrillation and Acute Ischemic Stroke: Evaluation of the Contemporary 2018 National Inpatient Sample Database

Gursukhman D.S. Sidhu, MD, Tarek Ayoub, MD, Abdel Hadi El Hajjar, MD, Aneesh Dhorepatil, MD, Saihariharan Nedunchezian, MD, Lilas Dagher, MD, Keith Ferdinand, MD, and Nassir Marrouche, MD

Tulane Research Innovation for Arrhythmia Discoveries, Tulane University School of Medicine, New Orleans, Louisiana, USA

ABSTRACT

Background: Atrial fibrillation (AF) in acute ischemic stroke (AIS) is considered a binary entity regardless of AF type. We aim to investigate in-hospital morbidity and mortality among patients with non-paroxysmal AF-related AIS.

Methods: Patients hospitalized for AIS with associated paroxysmal or persistent AF were identified from the 2018 national inpatient sample database. We compared in-hospital mortality, stroke-related morbidity, hospital cost, length of stay, and discharge disposition in patients hospitalized with paroxysmal or persistent AF.

Results: A total of 26,470 patients were hospitalized for AIS with paroxysmal or persistent AF. Patient with AIS with persistent AF had a longer hospital length of stay (paroxysmal AF, mean [M] 5.7 days, vs paroxysmal AF pattern on acute AIS hospitalizations and mortality.

The risk of thromboembolism from AF in AIS does not account for the burden or pattern of AF. Major stroke events lead to a significantly disabling quality of life. AIS prevention in AF is centred around anticoagulation, without active discussion regarding reduction of AF burden to reduce AIS-related events in addition to thromboprophylaxis. Further evidence is required to determine the impact of AF pattern on acute AIS-related morbidity and mortality; determining the direction of the impact of AF pattern on AIS morbidity and mortality may assist in this regard.

Therefore, we aimed to evaluate a set of real-world contemporary national inpatient sample (NIS) data from 2018 to study the effect of persistent vs paroxysmal AF pattern on acute AIS hospitalizations and their related morbidity, length of stay, hospital costs, and mortality.

Methods

Study data

We used in-hospital discharge data available from the NIS 2018, from the Healthcare Cost and Utilization Project.
Comorbidities were obtained using the Clinical Classification System (CCS) along with patient demographics, discharge status, length of stay, severity, and comorbidity measures. National estimates of the entire US hospitalized population are calculated using the standardized HCUP sampling and weighting method. All data and materials are publicly available at the HCUP agency website.

Study population

Discharges with a principal admission diagnosis of AIS (ICD-10-CM/PCS code I63) were identified. A principal diagnosis is the diagnosis for admission. The study population was further subdivided into those with paroxysmal AF and those with persistent AF, identified by the presence of listed ICD-10-CM/PCS codes in the secondary diagnosis fields. We also evaluated morbidity and mortality from permanent AF. Comorbidities were obtained using the Clinical Classifications Software Refined for ICD-10-CM diagnoses, which aggregates more than 70,000 ICD-10-CM diagnosis codes into over 530 clinically meaningful categories. Using the logic put forward by the Agency for Healthcare Research and Quality, we identified coexisting medical conditions that were not related to the principal reason for admission and were likely to be conditions that originated before admission. The following comorbid conditions were included in the analysis: hypertension, diabetes mellitus, dyslipidemia, smoking history, coronary artery disease, peripheral arterial disease, obstructive sleep apnea, heart failure, prior cardiac surgery, presence of pacemaker/defibrillator, cognitive decline/dementia, prior stroke, alcohol history, rheumatic valve disease, chronic obstructive lung disease, obesity, iron/nutritional deficiency anemia, cirrhosis, and severe chronic kidney disease (CKD) (stage 4, 5, end-stage renal disease [ESRD]) (Supplemental Table S1). The CHA2DS2-VASc (Congestive Heart Failure, Hypertension, Age [≥ 75 Years] [doubled], Diabetes Mellitus, Stroke [doubled], Vascular Disease, Age [65-74] Years, Sex Category [Female]) score was extrapolated from the above variables.

Results

At total, 26,470 patients have been hospitalized for an AIS ischémique aigu accompagné d’une FA paroxystique ou persistante. Le séjour à l’hôpital était plus long pour les patients atteints d’un AIS ischémique aigu accompagné d’une FA persistante (FA paroxystique, moyenne [M] de 5,7 jours, écart-type [ET] ±6,8 jours; FA persistante, M de 7,4 jours, ET ±11,9 jours, p < 0,001) et les coûts d’hospitalisation ont été plus élevés dans ce groupe de patients (FA paroxystique, M de 15 449 $, ET ±18 320 $; FA persistante, M de 19 834 $, ET ±23 312 $, p < 0,001). La mortalité à l’hôpital était plus élevée chez les patients atteints d’un AIS ischémique aigu accompagné d’une FA persistante (FA paroxystique, 4,6 % vs FA persistante, 6,2 %, p < 0,001). Des marqueurs indirects d’incapacité liée à l’AIS, comme une hémorragie intracrânienne (rapport des cotes [RC] : 1,9, intervalle de confiance [IC] à 95 % : 1,6-2,2), la nécessité d’une gastrostomie (RC : 2,1, IC à 95 % : 1,8-2,4) ou d’une trachéostomie (RC : 3,1, IC à 95 % : 2,1-4,4) ont été davantage associés à l’AIS ischémique aigu découlant d’une FA persistante.

Conclusions

La FA persistante est associée à une issue défavorable liée à l’AIS chez les patients hospitalisés, possiblement en raison d’un phénomène thrombo-embolique aggravé. La forme de la FA peut être annonciatrice d’une plus grande morbidité liée à l’AIS.

Study endpoints

The primary endpoint of the study was in-hospital mortality, stroke-related morbidity (intracerebral hemorrhage, sepsis), and indirect measure of functional outcome (discharge to facility [non-home discharges], in-hospital tracheostomy, and percutaneous gastrostomy tube placement). Secondary endpoints were cost of hospitalization, length of stay, and All Patient Refined Diagnosis Related Groups (APR-DRGs) payment-related severity of illness class. Admissions with a higher class (eg, major or extreme) are more likely to consume more significant healthcare resources in hospitals than patients with a lower class in the same DRG.

Statistical analysis

The analysis was done according to the Methodological Standards in Research Using the NIS. The data are presented using survey-specific discharge weights in the NIS to provide the national estimates. Descriptive statistics are presented as frequencies, with percentages for categorical variables. Mean with standard deviation are reported for continuous measures. Baseline characteristics were compared using the χ² test for categorical variables, and the Student t test for continuous variables. A multivariate survey-specific logistic regression model was created to determine the odds of AF pattern with the risk of death, brain hemorrhage, sepsis, tracheostomy, gastrostomy, and non-home discharges. The model was adjusted for the following covariates: age, sex, race, insurance, hospital region, hypertension, diabetes mellitus,
Table 1. Baseline characteristics

| Characteristic                  | Paroxysmal AF | Persistent AF | P     |
|--------------------------------|---------------|--------------|-------|
| Total number of hospital admissions | 24,240        | 2230         | < 0.001 |
| Age, y                         |               |              |       |
| < 65                           | 15.1          | 13.0         |       |
| 65–75                          | 23.6          | 20.6         |       |
| > 75                           | 61.3          | 66.4         |       |
| Female                         | 52.6          | 52.7         | 0.9   |
| Race                           |               |              | 0.06  |
| White                          | 77.2          | 74.1         |       |
| Black                          | 10.5          | 11.1         |       |
| Hispanic                       | 6.6           | 9.3          |       |
| Others                         | 5.7           | 5.5          |       |
| Comorbidities                  |               |              |       |
| Hypertension                   | 89.5          | 86.8         | 0.001 |
| Diabetes                       | 37.8          | 33.4         | 0.001 |
| Dyslipidemia                   | 63.9          | 55.6         | < 0.001 |
| Smoker                         | 10.3          | 8.7          | 0.02  |
| Coronary artery disease        | 39.5          | 38.1         | 0.2   |
| Peripheral arterial disease    | 10.9          | 8.5          | 0.001 |
| Obstructive sleep apnea        | 8.9           | 9.6          | 0.3   |
| Heart failure                  | 29.7          | 40.6         | < 0.001 |
| Prior cardiac surgery          | 13.1          | 10.1         | < 0.001 |
| Pacemaker/defibrillator        | 9.8           | 8.7          | 0.1   |
| Dementia                       | 19.2          | 18.8         | 0.7   |
| Prior stroke                   | 17.7          | 14.3         | < 0.001 |
| Alcohol use                    | 2.7           | 2.7          | 0.9   |
| Rheumatic valvular disease     | 5.7           | 8.3          | < 0.001 |
| Chronic obstructive lung disease | 16.2      | 13.9         | 0.005 |
| Obesity                        | 14.3          | 12.6         | 0.02  |
| Iron/nutritional deficiency anemia | 4.8       | 2.5          | < 0.001 |
| Cirrhosis                      | 1.6           | 3.8          | < 0.001 |
| CKD (stage 4, 5; ESRD)         | 5.6           | 3.6          | < 0.001 |
| Primary payer                  |               |              | 0.3   |
| Medicare                       | 81.2          | 80.5         |       |
| Private                        | 11.8          | 11.9         |       |
| Medicaid/self-pay/other        | 7.0           | 7.6          |       |
| Hospital characteristics       |               |              |       |
| Teaching hospital              | 69.7          | 74.0         | < 0.001 |
| Rural location                 | 8.5           | 6.7          | < 0.001 |
| Bed size: large                | 49.8          | 55.4         | < 0.001 |
| Stroke-related procedures      |               |              |       |
| Tissue plasminogen activator   | 6.4           | 7.3          | 0.1   |
| Thrombectomy use               | 3.4           | 5            | < 0.001 |

AF, atrial fibrillation; CKD, chronic kidney disease; ESRD, end-stage renal disease.

Values are percentage (%) of the total number in the groups, unless otherwise indicated.

Discussion

Our survey analysis of the inpatient hospitalization 2018 NIS data demonstrates a considerable difference in stroke and AF pattern of persistent, vs paroxysmal, AF. The paroxysmal AF phenotype was more prevalent in patients with vascular risk factors, such as diabetes, and a prior history of stroke and dyslipidemia. Persistent AF had a higher prevalence of comorbid heart failure. The overall CHA2DS2-VASc score was equivalent among both AF-related patterns with AIS. The
persistent AF group had prolonged in-hospital stay, high inpatient cost, a significantly greater number of tests and procedures, and worse APR-DRG-related severity of illness charted during their stay. On multivariate analysis, AIS stroke patients admitted with persistent AF had worse stroke-related morbidity and functional outcome. This finding was present despite a similar rate of tissue plasminogen activator use in paroxysmal vs persistent AF patients.

AF increases the hospital cost of AIS substantially, which may reflect severity of stroke, or the added costs of diagnosis and treatment of previously undiagnosed AF. Wang et al. demonstrated that the presence of AF adds 26% to the

Figure 1. Prevalence of Congestive Heart Failure, Hypertension, Age (≥ 75 Years) (doubled), Diabetes Mellitus, Stroke (doubled), Vascular Disease, Age (65-74) Years, Sex Category (Female) (CHA2DS2-VASc) score in paroxysmal vs persistent atrial fibrillation (AF).

Figure 2. Risk-adjusted odds of morbidity and mortality in persistent atrial fibrillation (AF) with paroxysmal AF as a reference standard. Morbidity defined intracranial hemorrhage, sepsis, and functional class by need for tracheostomy, gastrostomy tube placement, and non-home discharges. The model is adjusted for: age, sex, race, insurance, hospital region, hypertension, diabetes mellitus, dyslipidemia, smoking history, coronary artery disease, peripheral arterial disease, obstructive sleep apnea, heart failure, prior cardiac surgery, presence of pacemaker/defibrillator, cognitive decline/dementia, prior stroke, alcohol history, rheumatic valve disease, chronic obstructive lung disease, obesity, iron/nutritional deficiency anemia, cirrhosis, and chronic kidney disease (stage 4, 5, end-stage renal disease).
inpatient cost of stroke.\textsuperscript{22} We further found that length of stay, cost of hospitalization, and payer-related severity were higher in AIS in the presence of persistent, compared with paroxysmal, AF. This issue was not evaluated in previous trials and could account for the contrasting high cost of AIS with AF. This information may be valuable to guide decision-making for resource allocation, especially for those investigating strategies to mitigate cost in patients with stroke.\textsuperscript{23}

Stroke-related morbidity leads to significant loss of quality of life and hastens mortality.\textsuperscript{24} Deguchi et al.\textsuperscript{25} in a retrospective analysis in Japan, reported that patients admitted with persistent AF and AIS had significantly worse National Institutes of Health Stroke Scale (NIHSS) scores compared to those with paroxysmal AF ($P < 0.001$). At a 90-day follow-up, the persistent AF group also had poor neurologic recovery ($P < 0.001$). Another study, by Inaba et al.\textsuperscript{26} attributed this difference to a larger stroke burden in those with persistent AF. In their study, nonparoxysmal AF and stroke patients had a significantly larger infarct brain volume, as assessed by computed tomography or magnetic resonance imaging, compared with patients with paroxysmal AF and stroke (paroxysmal AF, median: 4.4 [interquartile range: 1.1-32] mL; persistent AF median: 64 [interquartile range: 6.9-170] mL; $P < 0.0001$). We report a higher incidence of invasive procedures in AIS patients hospitalized with persistent AF, specifically, thrombectomy, gastrostomy, and tracheostomy. The use of gastrostomy and tracheostomy in AIS patients is an indicator of poor functional recovery.\textsuperscript{22} Additionally, patients with AIS and persistent AF had a higher likelihood of being discharged to skilled nursing facilities, hinting at poor neurologic recovery despite an increase in interventions.

The CHA\textsubscript{2}-DS\textsubscript{2}-VASc score predicts the risk of AIS in patients with AF with accurate predictability.\textsuperscript{28} However, the score has poor validity in predicting the severity of stroke.\textsuperscript{25,29} Persistent AF reflects a multifactorial pathognomonic process of atrial remodeling, coagulopathy, and impending cardiac dysfunction. It signifies a higher burden of AF in patients who are not monitored with devices.\textsuperscript{31} The milieu may cause rapid progression and enlargement of thrombogenic foci in the cerebral circulation. This possibility is corroborated by our finding of worse morbidity and functional outcome in AIS patients admitted to the hospital with persistent AF. Catheter ablation reduces AF electrical burden and delays progression of AF pattern. The early rhythm control strategy for AF used in the Early Aggressive Invasive Intervention for Atrial Fibrillation (EARLY-AF) trial has demonstrated a reduction in future stroke incidence in addition to use of anticoagulation therapy.\textsuperscript{32} Aggressive identification and multidisciplinary management of adverse AF patterns has the potential to reduce morbidity and mortality.

**Limitations**

Our study has inherent limitations. First, the NIS is an administrative billing database with an inherent risk of mis-coding errors. The use of a contemporary 2018 database using the ICD-10-CM/PCS ameliorates this discrepancy, to a limit, given its very high sensitivity and positive predictive value in external validation studies.\textsuperscript{33,34} Second, evaluation of the burden of AF was not possible, especially in patients with paroxysmal AF, given that some patients may have had silent AF episodes for a long duration. Also, we cannot account for the variability and consistency of coding for AF pattern at different centres. However, this issue does not impact our study finding of a poor morbidity outcome in nonparoxysmal AF patients. Third, improved AF detection techniques may have led to the inclusion of healthier subjects, but this would be limited to outpatients and less likely to impact AF detection in hospitalized patients with AIS.

**Figure 3.** Mean number (no.) of procedures, length of stay, and in-hospital costs among patients admitted to the hospital with acute ischemic stroke with different patterns of atrial fibrillation (AF).
Furthermore, the CHA2DS2-VASc score in our study was evenly distributed among the 3 groups. Fourth, there is a lack of clinical, laboratory, and imaging data to validate our findings. There is an absence of information on anticoagulation initiation, timing, and implantable AF monitoring devices. We have used surrogates of stroke severity used in multiple prior administrative database studies.35,36 Fifth, we were unable to exclude other etiologies of AIS, such as large vessel atherosclerosis or small vessel lacunar strokes, which may have impacted our findings. Finally, the bias of unmeasured confounders may have affected the outcome of our study.

**Summary and Conclusions**

AIS secondary to a nonparoxysmal AF pattern may contribute to increased length of stay, hospital costs, stroke severity, and mortality. Our study attempts to fill a knowledge gap by attributing the severity of AF burden to severity of stroke. Our findings may help determine a future research focus on the examination of the clinical and economic burden of AIS and allow us to determine the cost effectiveness of interventions for AF in AIS control and prevention.

**Funding Sources**

Funding was provided by Tulane Research Innovation for Arrhythmia Discoveries, Tulane University School of Medicine, New Orleans, LA.

**Disclosures**

N.M. reports consulting fees from Abbott, Biotronik, Wavelet Health, Cardiac Design, Medtronic, Preventice, Vytronus, Biosense Webster, Marrek Inc., and Boston Scientific; research funding from Abbott, Boston Scientific, GE Healthcare, Siemens, Biotronik, Vytronus, and Biosense Webster; ownership interest in Marrek Inc. and Cardiac Designs; contracted research with Biosense Webster, Medtronic, St. Jude Medical, and Boston Scientific; and consulting fees from Biotronik and Preventice. The other authors have no conflicts of interest to disclose.

**References**

1. Kimura K, Minematsu K, Yamaguchi T. Japan Multicenter Stroke Investigators’ Collaboration (J-MUSIC). Atrial fibrillation as a predictive factor for severe stroke and early death in 15,831 patients with acute ischaemic stroke. J Neurol Neurosurg Psychiatry 2005;76:679-83.
2. Lee E, Choi EK, Han KD, et al. Mortality and causes of death in patients with atrial fibrillation: a nationwide population-based study. PLoS One 2018;13:e0209687.
3. Wolf PA, Mitchell JB, Baker CS, Kannel WB, D’Agostino RB. Impact of atrial fibrillation on mortality, stroke, and medical costs. Arch Intern Med 1998;158:229-34.
4. Benjamin EJ, Wolf PA, D’Agostino RB, et al. Impact of atrial fibrillation on the risk of death: the Framingham Heart Study. Circulation 1998;98:946-52.
5. Zafrir B, Lund LH, Laroche C, et al. Prognostic implications of atrial fibrillation in heart failure with reduced, mid-range, and preserved ejection fraction: a report from 14 964 patients in the European Society of Cardiology Heart Failure Long-Term Registry. Eur Heart J 2018;39:4277-84.
6. Mehta RH, Dabbous OH, Granger CB, et al. Comparison of outcomes of patients with acute coronary syndromes with and without atrial fibrillation. Am J Cardiol 2003;92:1031-6.
7. Mathew JP, Parks R, Savino JS, et al. Atrial fibrillation following coronary artery bypass graft surgery—predictors, outcomes, and resource utilization. JAMA 1996;276:300-6.
8. Chen XY, Lin ML, Wang W. The progression in atrial fibrillation patients with COPD: a systematic review and meta-analysis. Oncotarget 2017;8:102420-7.
9. Gallagher MM, Camm J. Classification of atrial fibrillation. Am J Cardiol 1998;82:18n-27n.
10. Staerk L, Sherer JA, Ko D, Benjamin EJ, Helm RH. Atrial fibrillation epidemiology, pathophysiology, and clinical outcomes. Circ Res 2017;120:1501-17.
11. Habibi M, Lima JAC, Khurram IM, et al. Association of left atrial function and left atrial enhancement in patients with atrial fibrillation: cardiac magnetic resonance study. Circ-Cardiовasc Imaging 2015;8:e002769.
12. Jadić AS, Duncan E, Miyazaki S, et al. Functional nature of electrogram fractionation demonstrated by left atrial high-density mapping. Circ Arrhythm Electrophysiol 2012;5:32-42.
13. Lip GY, Nieuwlaat R, Pisters R, Lane DA, Crijns HJ. Refining clinical risk stratification for predicting stroke and thromboembolism in atrial fibrillation using a novel risk factor-based approach: the euro heart survey on atrial fibrillation. Chest 2010;137:263-72.
14. Dabrowska-Bender M, Milewska M, Golabek A, Duda-Zalewska A, Staniszevska A. The impact of ischemic cerebral stroke on the quality of life of patients based on clinical, social, and psychoemotional factors. J Stroke Cerebrovasc Dis 2017;26:101-7.
15. Steinberg BA, Hellkamp AS, Lokhnygina Y, et al. Higher risk of death and stroke in patients with persistent vs. paroxysmal atrial fibrillation: results from the ROCKET-AF Trial. Eur Heart J 2015;36:288-96.
16. Agency for Healthcare Research and Quality. Overview of the national (nationwide) inpatient sample (NIS). Available at: https://www.hcup-us.ahrq.gov/nisoverview.jsp. Accessed April 7, 2021.
17. Agency for Healthcare Research and Quality. NIS description of data elements. Available at: https://www.hcup-us.ahrq.gov/db/nation/nis/nisde.jsp. Accessed April 7, 2021.
18. Agency for Healthcare Research and Quality. HCP methods series. Available at: https://www.hcup-us.ahrq.gov/reports/methods/methods.jsp. Accessed April 7, 2021.
19. Agency for Healthcare Research and Quality. Healthcare Cost and Utilization Project national inpatient sample. Available at: https://www.hcup-us.ahrq.gov/databases.jsp. Accessed April 7, 2021.
20. Agency for Healthcare Research and Quality. Clinical classifications software refined. Available at: https://www.hcup-us.ahrq.gov/toolssoftware/ccsr/ccs_redefined.jsp. Accessed April 7, 2021.
21. Khera R, Angraal S, Couch T, et al. Adherence to methodological standards in research using the national inpatient sample. JAMA 2017;318:2011-8.
22. Wang G, Joo H, Tong X, George MG. Hospital costs associated with atrial fibrillation for patients with ischemic stroke aged 18-64 years in the United States. Stroke 2015;46:1314-20.
23. Bassand JP, Accetta G, Al Mahmeed W, et al. Risk factors for death, stroke, and bleeding in 28,628 patients from the GARFIELD-AF registry: rationale for comprehensive management of atrial fibrillation. PLoS One 2018;13:e0191592.
24. Virani SS, Alonso A, Aparicio HJ, et al. Heart disease and stroke statistics—2021 update: a report from the American Heart Association. Circulation 2021;143:e254-743.

25. Deguchi I, Fukuoka T, Hayashi T, et al. Clinical outcomes of persistent and paroxysmal atrial fibrillation in patients with stroke. J Stroke Cerebrovasc Dis 2014;23:2840-4.

26. Inaba O, Yamauchi Y, Sekigawa M, et al. Atrial fibrillation type matters: greater infarct volume and worse neurological defects seen in acute cardiogenic cerebral embolism due to persistent or permanent rather than paroxysmal atrial fibrillation. Europace 2018;20:1591-7.

27. Roth EJ, Lovell L, Harvey RL, Bode RK, Heinemann AW. Stroke rehabilitation: indwelling urinary catheters, enteral feeding tubes, and tracheostomies are associated with resource use and functional outcomes. Stroke 2002;33:1845-50.

28. Friberg L, Rosenqvist M, Lip GY. Evaluation of risk stratification schemes for ischaemic stroke and bleeding in 182 678 patients with atrial fibrillation: the Swedish Atrial Fibrillation cohort study. Eur Heart J 2012;33:1500-10.

29. Zhao Y, Ji L, Liu J, et al. Intensity of left atrial spontaneous echo contrast as a correlate for stroke risk stratification in patients with nonvalvular atrial fibrillation. Sci Rep 2016;6:27050.

30. Huang J, Wu SL, Xue YM, et al. Association of CHADS2 and CHA2DS2-VASc scores with left atrial thrombus with nonvalvular atrial fibrillation: a single center based retrospective study in a cohort of 2695 Chinese subjects. Biomed Res Int 2017;2017:6839589.

31. Jahan S, Fazel J, Liles J, et al. Biomarkers of inflammation, thrombogenesis, and collagen turnover in patients with atrial fibrillation. Clin Appl Thromb Hemost 2018;24:718-23.

32. Kirchhof P, Camm AJ, Goette A, et al. Early rhythm-control therapy in patients with atrial fibrillation. N Engl J Med 2020;383:1305-16.

33. Alhajji M, Kawsara A, Alkhouli M. Validation of acute ischemic stroke codes using the International Classification of Diseases tenth revision. Am J Cardiol 2020;125:1135.

34. Agency for Healthcare Research and Quality. Introduction to the HCUP National Inpatient Sample (NIS), 2018. Available at: https://www.hcup-us.ahrq.gov/db/nation/nis/NIS_Introduction_2018.jsp. Accessed April 7, 2021.

35. Alkhouli M, Alqahtani F, Aljohani S, Alvi M, Holmes DR. Burden of atrial fibrillation-associated ischemic stroke in the United States. JACC Clin Electrophysiol 2018;4:618-25.

36. Elbadawi A, Elgendy IY, Ha LD, et al. In-hospital cerebrovascular outcomes of patients with atrial fibrillation and cancer (from the National Inpatient Sample Database). Am J Cardiol 2018;121:590-5.

Supplementary Material

To access the supplementary material accompanying this article, visit CJC Open at https://www.cjcopen.ca/ and at https://doi.org/10.1016/j.cjco.2022.01.010.