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Johnston, B. W., Udy, A. A., McAuley, D. F., Mogk, M., Welters, I. D., & Sibley, S. (2024). An international survey of the management of atrial fibrillation in critically unwell patients. *Critical Care Explorations*, *6*(4), Article e1069. https://doi.org/10.1097/CCE.0000000000001069

Published in:
Critical Care Explorations

Document Version:
Publisher's PDF, also known as Version of record

OPEN

An International Survey of the Management of Atrial Fibrillation in Critically Unwell Patients

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OBJECTIVES: To evaluate the current management of new-onset atrial fibrillation and compare differences in practice regionally.

DESIGN: Cross-sectional survey.

SETTING: United States, Canada, United Kingdom, Europe, Australia, and New Zealand.

SUBJECTS: Critical care attending physicians/consultants and fellows.

INTERVENTIONS: None.

MEASUREMENTS AND MAIN RESULTS: A total of 386 surveys were included in our analysis. Rate control was the preferred treatment approach for hemodynamically stable patients (69.1%), and amiodarone was the most used antiarrhythmic medication (70.9%). For hemodynamically unstable patients, a strategy of electrolyte supplementation and antiarrhythmic therapy was most common (54.7%). Physicians responding to the survey distributed by the Society of Critical Care Medicine were more likely to prescribe beta-blockers as a first-line antiarrhythmic medication (38.4%), use more transthoracic echocardiography than respondents from other regions (82.4%), and more likely to refer patients who survive their ICU stay for cardiology follow-up if they had new-onset atrial fibrillation (57.2%). The majority of survey respondents (83.0%) were interested in participating in future studies of atrial fibrillation in critically ill patients.

CONCLUSIONS: Significant variation exists in the management of new-onset atrial fibrillation in critically ill patients, as well as geographic variation. Further research is necessary to inform guidelines in this population and establish if differences in practice impact long-term outcomes.

KEYWORDS: anticoagulation; arrhythmia; atrial fibrillation; long-term follow-up; prophylaxis

Atrial fibrillation (AF) is the most common cardiac arrhythmia encountered in critically ill patients admitted to the ICU. New-onset atrial fibrillation (NOAF) occurs in patients that do not have a known history of chronic or paroxysmal AF and is estimated to complicate between 5% and 15% of all critical care admissions but may be as high as 40% in some cohorts, such as patients admitted with septic shock (1, 2).

The development of NOAF represents a deterioration in the patient's clinical state and is associated with short- and long-term consequences. In the short term, NOAF is associated with acute hemodynamic instability, increased rates of thromboembolic events such as ischemic stroke and pulmonary embolism (3), increased hospital and ICU length of stay (4), and increased mortality (5). In the long-term NOAF has been shown to increase the risk of heart failure, stroke, persistent AF, and mortality at 1 and 5 years (6–8).

Guidelines for the management of AF have been published by several national and international societies (9–15). However, these guidelines tend to focus on

DOI: 10.1097/CCE.0000000000001069

KEY POINTS

Question: We assessed differences in management of new-onset atrial fibrillation in critically ill patients.

Findings: Significant variation exists in the management of new-onset atrial fibrillation within regions, and significant variation between regions with respect to first-line antiarrhythmic therapy, investigations, and follow-up.

Meaning: Further study is needed to inform new-onset atrial fibrillation guidelines specific to a critical care population.

AF developing in the community setting and provide little guidance on the best management of NOAF developing as part of the spectrum of critical illness, mainly due to a lack of evidence informing practice in this population. Furthermore, variation exists between international guidelines, particularly with regards to AF classification, first-line antiarrhythmic agents, recommendations on stroke prophylaxis, and targeting of rate vs. rhythm control (16). A comparison of the clinical guidelines for the management of acute AF is provided in the **Supplementary Appendix (eTable 1**, http://links.lww.com/CCX/B324). Clinicians are forced to extrapolate from studies in populations that vary dramatically from the critically ill in terms of pathophysiology, risk factors, and potential iatrogenic complications from treatment. This leads to a great deal of variation in practice patterns and uncertainty in choosing the most effective antiarrhythmic strategy, whether to target rate or rhythm control, at which heart rate to commence treatment, and whether patients should be anticoagulated following the development of NOAF.

Clinicians' views on treatment of NOAF have been explored in several surveys in the past (17, 18), covering various geographic areas, including Europe, Australasia, and the United Kingdom. However, little is known about current practice in Canada and the United States. A comparison as to whether there is variation between clinical practice between the United States and other geographical regions is lacking, but could inform the development of international guidelines, future trial designs and outcome research. Our aim was to investigate the preferences and strategies employed by critical care clinicians in the management of NOAF and to highlight geographical similarities and differences.

MATERIALS AND METHODS

Survey Development and Description

The questionnaire used by Chean et al (18) in their 2017 U.K. survey was modified for an international survey. The survey was composed of a consent question, six demographic questions, and 16 AF management questions (18). Modifications included descriptions of types of hospital, titles for level of training, addition of categories of complimentary training (specific to the language used by the regions where the survey would be distributed), and addition of questions regarding electrolyte management and interest in participation in a platform trial. The survey was developed using Qualtrics (Provo, UT). The survey was approved for distribution by the Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board No. 6036668 "CCM-040-22: Current Practice in the management of new-onset atrial fibrillation in critically ill patients—a survey of international intensivists" Approved July 28, 2022), and procedures were followed in accordance with the ethical standards of the responsible institutional committee on human experimentation and with the Helsinki Declaration of 1975. All survey responses were recorded anonymously, and participants were asked to provide consent before accessing the individual survey questions.

NOAF was defined as AF in patients without a known previous history of AF. Questions were designed to obtain respondents views on the management of NOAF in relation hemodynamically stable and unstable patients. We surveyed respondent's views on: 1) rate vs. rhythm control, 2) choice of antiarrhythmic medications, 3) electrical cardioversion, 4) electrolyte supplementation, 5) use of anticoagulation, 6) use of thromboembolic and bleeding risk scores, 7) imaging, and 8) follow-up of patients with a diagnosis of NOAF.

The survey is found in the Supplementary Appendix (**Survey**, http://links.lww.com/CCX/B324).

Survey Distribution

The survey was distributed through professional organizations of critical care physicians. In Canada,

TABLE 1.
Demographic Data of Survey Respondents

Participant Characteristics	Canadian Critical Care Society/ Canadian Critical Care Trials Group	European Society for Intensive Care Medicine	Society for Critical Care Medicine	Intensive Care Society/U.K. Critical Care Research Group	Australia and New Zealand Intensive Care Society Clinical Trials Group
Number of respondents	89	33	139	86	39
Type of hospital					
Community hospital or district general hospital	10	10	56	33	9
Tertiary referral center or university hospital	79	22	81	52	29
Type of ICU					
Mixed ICU	82	27	69	70	33
Predominantly medical	2	2	33	6	2
Predominantly surgical	2	1	26	5	3
Specialist ICU	3	2	10	5	0
Level of practice					
Consultant/attending	68	24	136	54	37
Critical care fellow/registrar	21	8	2	32	1
Years of experience					
< 5 yr	33	9	27	22	0
5–10 yr	18	8	22	18	6
> 10 yr	38	15	89	46	32
Complimentary speciality					
Anesthesia	9	21	33	56	13
Emergency medicine	12	1	9	4	3
Surgery	12	1	37	0	0
Internal medicine	38	3	39	5	11
Respiratory	11	1	12	7	2
Neurology	1	0	1	1	0
Other/none	6	5	7	13	9

the Canadian Critical Care Society (CCCS) and the Canadian Critical Care Trials Group distributed the survey to members via email. The survey was distributed in September 2022 and responses were collected for 2 months until November 2022. In Australia and New Zealand, the survey was distributed by the Australia and New Zealand Intensive Care Society Clinical Trials Group (ANZICS CTG) and was open from October 2022 to January 2023. A link was posted on the European Society for Intensive Care Medicine (ESICM) website and an email was sent out to the ESICM membership. Responses were collected from December 2022 to March 2023. The Society for Critical Care Medicine (SCCM) distributed the survey via email and was open from December 2022 to March 2023. In the United Kingdom, the survey was distributed through the Intensive Care Society and the U.K. Critical Care Research Group via email and was open from December 2022 to March 2023. The survey was promoted on X (formally Twitter).

Statistics

Surveys that did not contain information on the treatment of AF were excluded (e.g., refused consent or only provided demographic data). An explorative analysis was performed to generate percentages and frequencies. Where applicable, Fisher exact test was performed to investigate differences in distribution of responses. Responses from SCCM served as reference group and were compared with all other professional organizations. Where multiple comparisons were performed to determine differences between responses Bonferroni-Holm correction was used for each question to adjust the significance level.

RESULTS

Demographics

There were a total of 489 responses. We excluded 103 surveys from further analysis due to lack of responses beyond demographic data. Where surveys were partially answered, responses to individual questions were included if possible. A total of 386 surveys were included in our analysis. The demographic data of respondents is presented in **Table 1**. Specialist ICUs included trauma, neurosurgical, and cardiac/cardiac surgery ICUs. Other complimentary specialities included cardiology, nephrology, family medicine, and infectious diseases.

Prophylaxis

Over half of respondents (60.0%) indicated they used parenteral magnesium supplementation to achieve high-normal serum magnesium levels in patients at risk for atrial arrhythmias (**Fig. 1**).

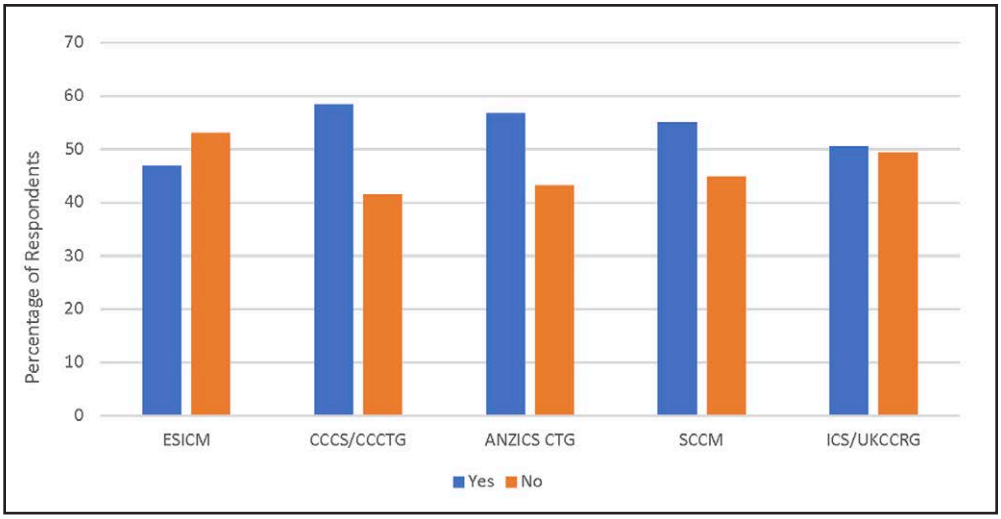

Figure 1. Parenteral magnesium supplementation for patients at risk of atrial arrhythmias. ANZICS CTG = Australia and New Zealand Intensive Care Society Clinical Trials Group, CCCS = Canadian Critical Care Society, CCCTG = Canadian Critical Care Trials Group, ESICM = European Society for Intensive Care Medicine, ICS = Intensive Care Society, SCCM = Society for Critical Care Medicine, UKCCRG = U.K. Critical Care Research Group.

Treatment

The majority of respondents stated they would treat patients with NOAF with a rapid ventricular response and a stable blood pressure at a heart rate of 120–139 beats/min. Clinicians consistently aimed for serum potassium levels greater than 4.0 mmol/L and serum magnesium levels greater than 1.0 mmol/L. Rate control was the most common primary treatment goal, and amiodarone was the most used antiarrhythmic agent for NOAF (**Table 2**).

TABLE 2.

Treatment of New Onset Atrial Fibrillation Preferences of Survey Respondents

Treatment	Canadian Critical Care Society/ Canadian Critical Care Trials Group	European Society for Intensive Care Medicine	Society for Critical Care Medicine	Intensive Care Society/U.K. Critical Care Research Group	Australia and New Zealand Intensive Care Society Clinical Trials Group	Total
Heart rate to trigger intervention, *n*/*n* total (%)						
100–119 beats/min	11/89 (12.4)	2/32 (6.3)	17/138 (12.3)	4/85 (4.7)	2/38 (5.3)	36/382 (9.4)
120–139 beats/min	48/89 (53.9)	10/32 (31.3)	71/138 (51.4)	34/85 (40.0)	19/38 (50.0)	182/382 (47.6)
140–159 beats/min	16/89 (18.0)	3/32 (9.4)	23/138 (16.7)	25/85 (29.4)	5/38 (13.2)	72/382 (18.8)
> 160 beats/min	1/89 (1.1)	1/32 (3.1)	1/138 (0.7)	4/85 (4.7)	0/38 (0.0)	7/382 (1.8)
Independent of their heart rate	13/89 (14.6)	16/32 (50.0)	26/138 (18.8)	18/85 (21.2)	12/38 (31.6)	85/382 (22.3)
Primary treatment goal, *n*/*n* total (%)						
Rate	14/89 (15.7)	17/32 (53.1)	31/138 (22.5)	27/86 (31.4)	18/37 (48.6)	107/382 (28.0)
Rhythm	72/89 (80.9)	14/32 (43.8)	106/138 (76.8)	54/86 (62.8)	18/37 (48.6)	264/382 (69.1)
No primary treatment goal	3/89 (3.4)	1/32 (3.1)	1/138 (0.7)	5/86 (5.8)	1/37 (2.7)	11/382 (2.9)
Most commonly used antiarrhythmic drug for NOAF, *n*/*n* total (%)						
Amiodarone	68/89 (76.4)	26/32 (81.3)	74/138 (53.6)	68/86 (79.1)	35/37 (94.6)	271/382 (70.9)
Beta-blocker	17/89 (19.1)	5/32 (15.6)	53/138 (38.4)	16/86 (18.6)	2/37 (5.4)	93/382 (24.3)
Procainamide	0/89 (0.0)	0/32 (0.0)	9/138 (6.5)	0/86 (0.0)	0/37 (0.0)	9/382 (2.4)
Calcium channel blocker	1/89 (1.1)	0/32 (0.0)	2/138 (1.4)	1/86 (1.2)	0/37 (0.0)	4/382 (1.0)
Digoxin	1/89 (1.1)	1/32 (3.1)	0/138 (0.0)	1/86 (1.2)	0/37 (0.0)	3/382 (0.7)
Other	2/89 (2.2)	0/32 (0.0)	0/138 (0.0)	0/86 (0.0)	0/37 (0.0)	2/382 (0.5)
Target serum potassium level for patients with NOAF, *n*/*n* total (%)						
> 3.5mmol/L	11/89 (12.4)	3/32 (9.4)	7/138 (5.1)	4/86 (4.7)	2/37 (5.4)	27/382 (7.1)
> 4 mmol/L	69/89 (77.5)	13/32 (40.6)	104/138 (75.4)	33/86 (38.4)	19/37 (51.4)	238/382 (62.3)
> 4.5 mmol/L	4/89 (4.5)	13/32 (40.6)	23/138 (16.7)	47/86 (54.7)	16/37 (43.2)	103/382 (27.0)
> 5 mmol/L	0/89 (0.0)	0/32 (0.0)	0/138 (0.0)	1/86 (1.2)	0/37 (0.0)	1/382 (0.2)
I do not aim for a specific serum potassium level	5/89 (5.6)	3/32 (9.4)	4/138 (2.9)	1/86 (1.2)	0/37 (0.0)	13/382 (3.4)

(*Continued*)

TABLE 2. (*Continued*)
Treatment of New Onset Atrial Fibrillation Preferences of Survey Respondents

Treatment	Canadian Critical Care Society/ Canadian Critical Care Trials Group	European Society for Intensive Care Medicine	Society for Critical Care Medicine	Intensive Care Society/U.K. Critical Care Research Group	Australia and New Zealand Intensive Care Society Clinical Trials Group	Total
Target serum magnesium level for patients with NOAF, *n*/*n* total (%)						
0.75–1 mmol/L	12/89 (13.5)	4/32 (12.5)	1/138 (0.7)	9/86 (10.5)	3/37 (8.1)	29/382 (7.6)
1.0–1.2 mmol/L	65/89 (73.0)	13/32 (40.6)	30/138 (21.7)	49/86 (57.0)	21/37 (56.8)	178/382 (46.6)
> 1.2 mmol/L	1/89 (1.1)	5/32 (15.6)	100/138 (72.5)	13/86 (15.1)	8/37 (21.6)	127/382 (33.2)
I do not aim for a specific serum magnesium level	11/89 (12.4)	10/32 (31.3)	7/138 (5.1)	15/86 (17.4)	5/37 (13.5)	48/382 (12.6)

NOAF = new-onset atrial fibrillation.

Respondents to the SCCM survey reported a higher use of beta-blockers as a first-line agent than any other geographic region (**Fig. 2**; $p < 0.001$).

For patients with NOAF and hypotension requiring vasopressors, the majority of respondents indicated they would choose a strategy of electrolyte supplementation and antiarrhythmic therapy (54.7%) with consideration of direct current cardioversion (DCCV) only if electrolyte and antiarrhythmic therapy failed.

Anticoagulation

Respondents to the SCCM, ANZICS CTG, and ESICM surveys were likely to start anticoagulant therapy within 72 hours (SCCM 65.9%, ANZICS CTG 54.6%, ESICM 50%), while respondents of the Canadian and U.K. surveys were less likely to anticoagulate patients routinely (CCCS 62.9%, United Kingdom 75.6%) (**Fig. 3**; $p < 0.001$). Most respondents (43.8%) reported they did not use stroke or bleeding risk scores such as Congestive Heart Failure, Hyptertension, Age, Diabetes mellitus, Stroke (CHADS2), Congestive Heart Failure, Hypertension, Age > 75, Diabetes mellitus, Stroke, Vascular disease history, Age 65 to 74, Sex category (CHA2DS2-VASc), Hypertension, Abnormal renal/liver function, Stroke, Bleeding history or predisposition, Labile International Normalized Ratio, Elderly, Drugs/alcohol (HAS-BLED), or Outcomes Registry for Better Informed Treatment of Atrial Fibrillation (ORBIT) in critically ill patients with NOAF, and 49% agreed that modified risk scores should be developed for critically ill patients. Subcutaneous therapeutic dose low-molecular-weight heparin (52.6%) and IV high-molecular-weight heparin (45.9%) were considered the most appropriate anticoagulants in the critical care setting.

Testing and Follow-Up

While transthoracic echocardiography was commonly ordered in critically ill patients with NOAF (64.5%), 26.4% of respondents do not routinely perform echocardiography to guide treatment of NOAF, and 9.6% only ordered echocardiography in patients with a cardiac history. Responders to the SCCM survey reported a higher use of echocardiography (82.7%) than any other survey group. A regional difference also exists in follow-up of patients, with respondents to the SCCM survey reporting more frequent referral to a cardiology

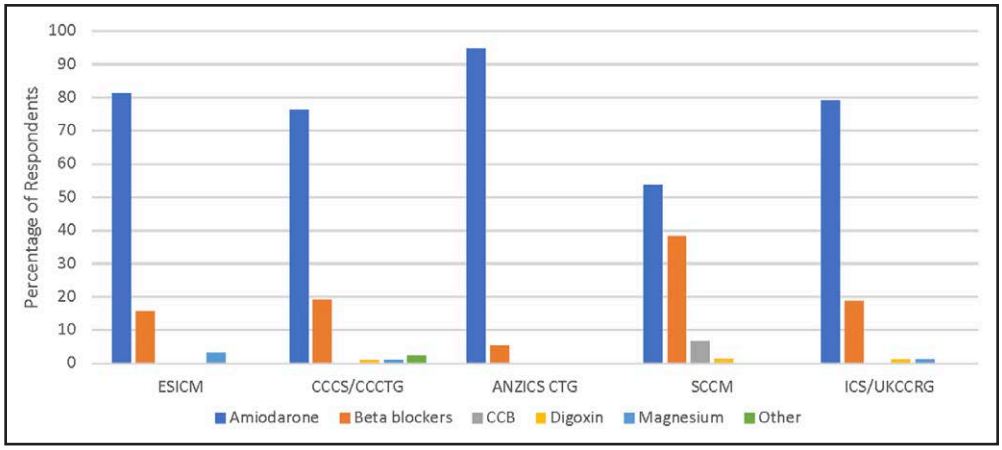

Figure 2. First-line antiarrhythmic agent for patients with new-onset atrial fibrillation. ANZICS CTG = Australia and New Zealand Intensive Care Society Clinical Trials Group, CCB = calcium channel blockers, CCCS = Canadian Critical Care Society, CCCTG = Canadian Critical Care Trials Group, ESICM = European Society for Intensive Care Medicine, ICS = Intensive Care Society, SCCM = Society for Critical Care Medicine, UKCCRG = U.K. Critical Care Research Group.

arrhythmia clinic or an ICU follow-up clinic than CCCS, ANZICS, and U.K. respondents (**Fig. 4**; $p < 0.001$).

Future Study

When asked about a platform trial investigating prophylaxis, treatment, anticoagulation, and long-term follow-up of NOAF in critically ill patients, 83.0% of respondents stated they would be interested in participating in such a study, with 75.1% willing to enroll in a treatment arm, 60.1% willing to enroll in an anticoagulation arm, and 59.1% interested in a prophylaxis arm.

DISCUSSION

Considerable variation exists in the prophylaxis, treatment, anticoagulation, and follow-up of critically ill patients with NOAF. This survey demonstrates geographic variability in practice, specifically with respect to first-line antiarrhythmic agents, investigations, and follow-up of patients, where respondents to the SCCM survey reported greater use of beta-blockers, more frequent use of echocardiography, and a higher referral rate to cardiology or ICU follow-up clinics.

The findings of variation in practice are in keeping with the 2017 survey by Chean et al (18), a U.K. wide survey that demonstrated disparity between the treatment of NOAF in critically ill patients and the recommendations for a general patient population with AF. Despite the passing of 6 years, responses regarding treatment and anticoagulation use remain largely unchanged, but with equal enthusiasm for further research on these topics.

Similarly, a recent survey by Wetterslev et al (17), conducted with intensivists in Scandinavia, Europe, the Middle and Far East, and Australia and New Zealand, also showed substantial variation in practice. While our survey showed that respondents are most likely to initiate treatment at a heart rate greater than 120 beats per minute, Wetterslev et al (17) found 48% of respondents would initiate treatment within 6 hours in a hemodynamically stable patient. Both studies found amiodarone to be the most commonly used antiarrhythmic in both hemodynamically stable and unstable patients, and the survey by Wetterslev et al (17) also demonstrated there were geographic variations in the choice of the first-line antiarrhythmic for a hemodynamically stable patient, with a higher percentage of respondents in Australia, Finland, Iceland, The Netherlands, and Saudi Arabia choosing a beta-blocker as the first-line agent, and respondents in Sweden electing to use magnesium for stable critically ill patients. For hemodynamically unstable patients, 48% of respondents preferred rhythm control, with 34% choosing DC cardioversion as a first-line therapy, despite evidence from Kanji et al (19) that DC cardioversion has limited success in critically ill patients with NOAF and those who are converted often revert back to AF.

Geographic differences noted in the treatment of NOAF may be due to system and patient level differences, where private and for-profit healthcare systems such as those found in the United States and some countries in Europe have more ICU beds per capita, greater rates of mechanical ventilation (20), and increased use of diagnostic tests (21), for example, echocardiography. In publicly funded systems such as those in Canada, Australia, New Zealand, and United Kingdom, ICU beds are a limited resource reserved for patients with high severity of illness.

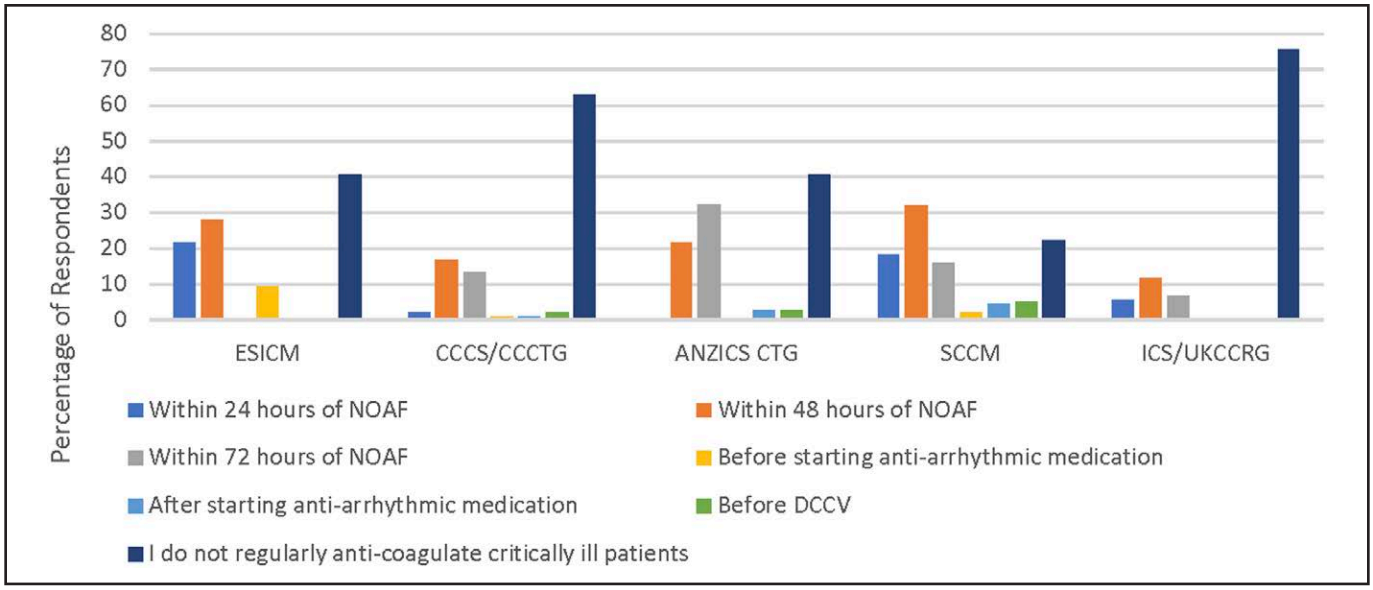

Figure 3. Timing of anticoagulation therapy. ANZICS CTG = Australia and New Zealand Intensive Care Society Clinical Trials Group, CCCS = Canadian Critical Care Society, CCCTG = Canadian Critical Care Trials Group, DCCV = direct current cardioversion, ESICM = European Society for Intensive Care Medicine, ICS = Intensive Care Society, NOAF = new-onset atrial fibrillation, SCCM = Society for Critical Care Medicine, UKCCRG = U.K. Critical Care Research Group.

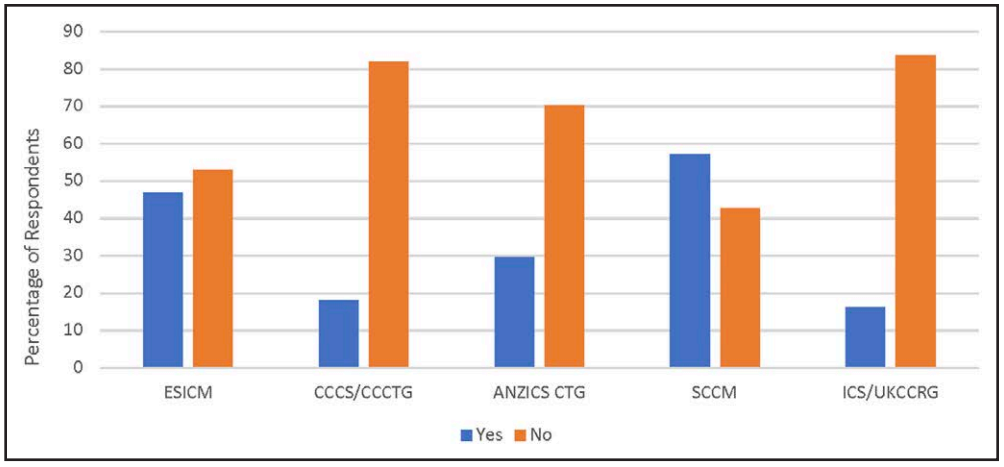

Figure 4. Referral for follow-up to cardiology arrhythmia clinic or ICU follow-up clinic for patients with new-onset atrial fibrillation. ANZICS CTG = Australia and New Zealand Intensive Care Society Clinical Trials Group, CCCS = Canadian Critical Care Society, CCCTG = Canadian Critical Care Trials Group, ESICM = European Society for Intensive Care Medicine, ICS = Intensive Care Society, SCCM = Society for Critical Care Medicine, UKCCRG = U.K. Critical Care Research Group.

In these countries, critically ill patients with NOAF may reflect a group of more hemodynamically unstable patients requiring vasopressor and inotrope support, which may account for reluctance in use of beta-blockers for management of NOAF. Access to primary care physicians and cardiology or follow-up clinics may also differ between countries and healthcare systems, accounting for the increased referral rates found from respondents to the SCCM survey. There are no studies of long-term outcomes of NOAF in critical illness to determine if these geographic differences in treatment have an impact on patient outcomes.

The findings of this survey have important implications. The variation in practice internationally and within regions indicates that current guidelines may not adequately address the management of this arrhythmia in critically ill patients and further efforts are needed to establish evidence to inform practice in this population. Where guidelines do exist, such as a recommendation in the Canadian guidelines (10) for follow-up for patients who develop NOAF and survive to ICU discharge given their increased risk for AF recurrence (22), stroke, heart failure, and death (6), knowledge translation efforts must be improved to ensure critical care clinicians are adhering to best practices. Finally, respondents to this survey, Chean et al (18) and Wetterslev et al (17), overwhelmingly expressed an interest in further research on NOAF in critically

ill patients. Current research in critically ill patients is sparse and may focus on outcomes that are not in keeping with clinical practice, such as outcomes of rhythm control (23) when clinicians are treating with a preference for rate control. Future research needs established definitions of NOAF, a core outcome set that is important to clinicians and patients and should focus on improving our understanding of the pathophysiology of this common arrhythmia, as well as treatment, anticoagulation, and long-term outcomes.

Strengths of this study include involvement of clinicians from the United States and Canada who have not been included in previous surveys, and the first comparison of treatment by geographic location to highlight regional differences. Limitations include a lack of response rate due to the distribution methods used; however, the similarities between previous surveys suggest we have sampled a representative proportion of intensivists. Similarly, it is possible that respondents could have received the survey more than once if they were members of more than one professional society.

CONCLUSIONS

There continues to be significant variation in the treatment of NOAF in critically ill patients. Future studies are needed to inform management in this challenging population with consideration of differences in hemodynamic stability, pathophysiology, resource availability, and long-term outcomes.

ACKNOWLEDGMENTS

We thank the Society of Critical Care Medicine, the European Society of Intensive Care Medicine, the Canadian Critical Care Society, the Canadian Critical Care Trials Group, the Australia and New Zealand Intensive Care Society Clinical Trials Group, the Intensive Care Society, and the U.K. Critical Care Research Group for distribution and promotion of the survey.

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Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's website (http://journals.lww.com/ccejournal).

Drs. McAuley and Welters have grant funding for an atrial fibrillation trial unrelated to the submitted work: (National Instiute for Health and Care Research Health Technology Assessment programme 2022–2026): A randomized controlled trial to investigate clinical and cost effectiveness of Amiodarone vs Beta Blockade for new-onset atrial fibRillation in icU–a Pragmatic sTudy (ABBRUPT). The remaining authors have disclosed that they do not have any potential conflicts of interest.

Drs. Welters and Sibley are joint senior authors.

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