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## RESEARCH ARTICLE

# Management of acute atrial fibrillation in the intensive care unit: An international survey

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## Abstract

**Background:** Atrial fibrillation (AF) is common in intensive care unit (ICU) patients and is associated with poor outcomes. Different management strategies exist, but the evidence is limited and derived from non-ICU patients. This international survey of ICU doctors evaluated the preferred management of acute AF in ICU patients.

**Method:** We conducted an international online survey of ICU doctors with 27 questions about the preferred management of acute AF in the ICU, including antiarrhythmic

The AFIB-ICU collaborators are provided in appendix section.

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therapy in hemodynamically stable and unstable patients and use of anticoagulant therapy.

**Results:** A total of 910 respondents from 70 ICUs in 14 countries participated in the survey with 24%–100% of doctors from sites responding. Most ICUs (80%) did not have a local guideline for the management of acute AF. The preferred first-line strategy for the management of hemodynamically stable patients with acute AF was observation (95% of respondents), rhythm control (3%), or rate control (2%). For hemodynamically unstable patients, the preferred strategy was observation (48%), rhythm control (48%), or rate control (4%). Overall, preferred antiarrhythmic interventions included amiodarone, direct current cardioversion, beta-blockers other than sotalol, and magnesium in that order. A total of 67% preferred using anticoagulant therapy in ICU patients with AF, among whom 61% preferred therapeutic dose anticoagulants and 39% prophylactic dose anticoagulants.

**Conclusion:** This international survey indicated considerable practice variation among ICU doctors in the clinical management of acute AF, including the overall management strategies and the use of antiarrhythmic interventions and anticoagulants.

#### KEY WORDS

anticoagulant therapy, atrial fibrillation, intensive care unit, management strategies

#### Editorial Comment

There have been many treatment alternatives for acute or new atrial fibrillation occurring in critically ill patients. Treatment preferences collected by survey from an international group of respondent clinicians are presented in this report. Variation in reported practice may reflect perceptions of varying treatments effects, or also that patients can have quite different underlying conditions and degrees of circulatory adequacy.

## 1 | BACKGROUND

Atrial fibrillation (AF) is the most common cardiac tachyarrhythmia in the intensive care unit (ICU) and in general ward.<sup>1–3</sup> The pathophysiology of AF during critical illness is not completely understood but involves an interaction between an arrhythmogenic substrate and one or more triggers.<sup>4</sup> Several proarrhythmic risk factors are often present in critically ill patients, including vasoactive drugs, electrolyte disturbance, and high disease severity.<sup>2,4–6</sup>

Studies conducted in critical care settings have suggested that acute AF is associated with worse outcomes.<sup>2,7,8</sup> However, the causal role and independent prognostic impact of AF during critical illness are unclear.<sup>2</sup>

In general, goals of the management of acute AF include hemodynamic optimization and prevention of AF-related complications (e.g., heart failure, systemic embolism, and stroke),<sup>9</sup> but the evidence is mainly derived from studies in non-critically ill patients.<sup>2,10</sup> Despite the high incidence and potential clinical importance of acute AF, little is known about the preferred management

strategies among critical care physicians. In this international survey, we assessed the management of acute AF among doctors working in the ICU.

## 2 | METHODS

### 2.1 | Study design and approvals

We conducted an international, online survey using the secure web application Research Electronic Data Capture (REDCap)<sup>11</sup> hosted by the Capital Region of Denmark.

We obtained approval from the Knowledge Centre on Data Protection Compliance (ref. no. P-2021-318). Ethical approval and other approvals were waived due because no patient data were collected and all collected data were anonymized. Participation was voluntary, and no financial support was provided. We considered activation and completion of the survey link as informed consent. The survey was distributed and collected from 3 June 2021 to 9 August

2021. We sent a minimum of two reminders to all participating ICUs before database closure. This manuscript has been prepared according to the Consensus-Based Checklist for Reporting of Survey Studies (CROSS). The checklist is available in the Supplementary Material (SM, Table S1).<sup>12</sup>

## 2.2 | Survey description

Domains of interest were based on different treatments strategies of acute AF in the ICU and the survey was generated by the management group. The survey consisted of 27 questions that assessed characteristics of the participating sites and respondents, and the preferred management strategy in various clinical cases of acute AF in the ICU.

We defined acute AF as a first-time diagnosis or a newly developed episode of AF in a patient without a history of persistent or permanent AF. Moreover, hemodynamic instability was defined as hypotension, elevated lactate, increased vasopressor dose, or signs of hypoperfusion. We surveyed (1) the preferred management strategies (i.e., rhythm or rate control), (2) the preferred antiarrhythmic therapy, and (3) the use of anticoagulant therapy. We included branching logic functions in the survey to describe different treatment aspects of acute AF in more detail based on the respondent's previous answers. The survey was pilot-tested and revised by the ICU doctors and researchers working at the coordinating site before data collection. The survey is available in the SM, Table S2.

## 2.3 | Survey distribution

We recruited countries from an international network of ICUs participating in the ongoing AFIB-ICU cohort study.<sup>13</sup> Each country had a national investigator who invited other local ICUs to participate in the survey. The coordinating site distributed an online link with direct access to the survey to all site investigators, who distributed the link to the doctors working in their ICU, and completed a short questionnaire with specific details about their local ICU. All types of ICUs were invited to participate (medical, surgical, and mixed ICUs), and invited doctors included both specialists and non-specialists.

## 2.4 | Statistics

We presented data descriptively with continuous variables as medians with interquartile ranges (IQRs), and categorical variables as numbers and percentages.

The proportion of missing data was reported, and all analyses were conducted as complete-case analyses. All statistical analyses were performed using R (version 4.0.2). As we used a convenience sample, no sample size estimation was performed.

## 3 | RESULTS

A total of 910 respondents from 70 ICUs in 14 countries participated in the survey (Figure 1 and SM, Table S3). The participating ICUs were primarily mixed ICUs (90%), followed by medical (5%) and surgical ICUs (5%). The median response rate among doctors at sites was 56% (IQR 43–80) (SM, Table S4). Overall there were few missing data (SM, Table S5–S6). Most respondents were ICU specialists (74%) with a median of 10 years (5–17) in the specialty. At the site level, 20% reported having a local guideline for the management of acute AF (Table 1).

### 3.1 | Management of acute AF in a hemodynamically stable patient

Nearly all respondents preferred observation and correction of reversible causes as the first-line management strategy (95%); for second-line strategy, 56% preferred rhythm control and 41% rate control (Table 2 and SM, Table S5).

In a hemodynamically stable patient, 47% of the respondents would initiate an active antiarrhythmic therapy within the first 6 h, whereas 20% would not initiate treatment at any given time point regardless of the AF duration. Among those intervening against acute AF in hemodynamically stable patients, 45% would use amiodarone, 23% beta-blockers other than sotalol, and 11% magnesium (Figure 2). We observed similar findings when assessing the preferred interventions according to country (SM, Table S8–S21).

If the patient had a known history of heart failure, 39% OSV. Most respondents would use amiodarone (39%), digoxin (31%), or other beta-blockers than sotalol (12%) (SM, Table S5).

### 3.2 | Management of acute AF in a hemodynamically unstable patient

In a hemodynamically unstable patient, 48% of respondents would observe or correct reversible causes as first-line management strategy, whereas 48% preferred rhythm control. Among the different rhythm controlling strategies, 34% would use DC cardioversion and 14% antiarrhythmic agents (Table 3 and SM, Table S6). Less than 5% would use the rate control strategy as the primary management strategy (Table 3).

Among those intervening against acute AF in hemodynamically unstable patients, 51% would use DC cardioversion, 42% amiodarone, and 3% digoxin (Figure 2) (SM, Table S8–S21). Most respondents (75%) would not change the intervention strategy depending on an underlying pathophysiological condition (e.g., postoperative care, heart failure, or sepsis). For the respondents who would change the management strategy based on a specific pathophysiological condition, the most preferred interventions included DC cardioversion, amiodarone, and digoxin in all the subpopulations with hemodynamic instability (Table 3 and SM, Table S6).

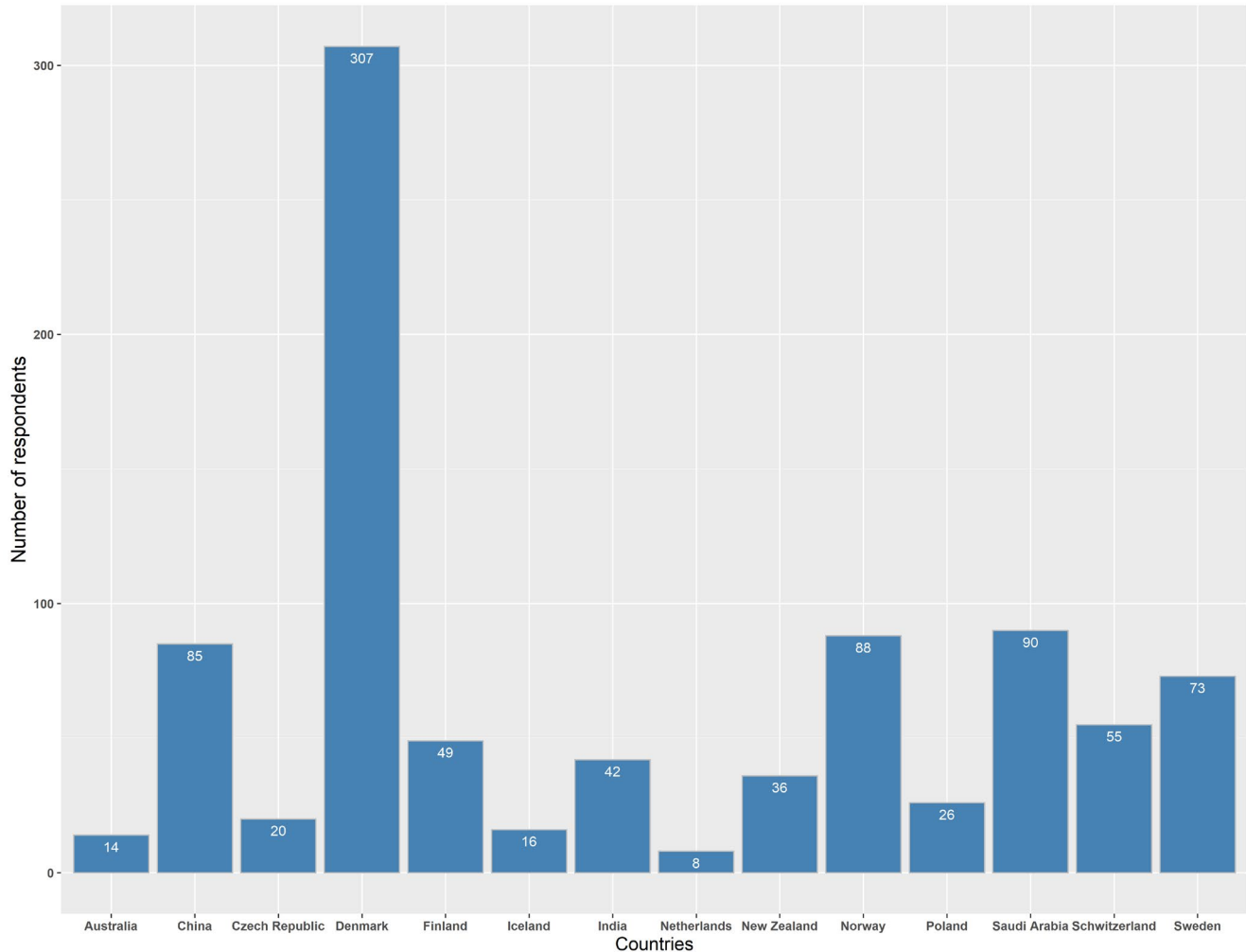


FIGURE 1 Number of respondents per country

### 3.3 | Anticoagulant therapy

Approximately half of the respondents reported that they would use a risk score to assess the risk of stroke in a patient with acute AF in the ICU (Table 4). Most respondents (67%) would initiate anticoagulant therapy, and 61% and 39% would administer anticoagulant agents in therapeutic and prophylactic doses, respectively (Table 4).

The most frequently used anticoagulant agents reported were low molecular weight heparin (82%) and unfractionated heparin (15%). Sixty percent would schedule routine follow-up by a cardiologist after ICU discharge in patients with a detected episode of AF in the ICU (Table 4).

### 3.4 | Preferences for future clinical trials

Eighty-six percent of the respondents would be willing to participate in a future randomized clinical trial on the management of acute AF in the ICU (SM, Table S6). The preferred interventions in a future trial

included amiodarone (76%), beta-blockers other than sotalol (58%) and DC cardioversion (57%) and magnesium (54%) (SM, Table S7). In addition, most respondents were willing to include a placebo group (83%).

## 4 | DISCUSSION

In this international survey, we found considerable variation in the preferences for the clinical management of acute AF in ICU patients. Most ICUs reported that they did not have a local guideline to manage AF. In hemodynamically stable patients, most respondents preferred observation and correction of reversible causes as a first-line strategy, whereas rhythm control using DC cardioversion or amiodarone was the most preferred management strategy in patients with hemodynamic instability. Notably, we observed variation in the preferences for use of risk scores, anticoagulant therapy, and follow-up by a cardiologist.

Observational studies have suggested that AF is associated with worse outcomes, but the causal role is debated due to conflicting

TABLE 1 Baseline characteristics of participating sites and respondents

Variable	No. of observations <sup>a</sup>
Hospital type	70
Tertiary care	37 (53%)
Secondary care	33 (47%)
Types of ICU	70
Mixed ICU	62 (90%)
Medical ICU	4 (5%)
Surgical ICU	4 (5%)
Number of beds, median (IQR)	13 (10–24)
Local protocol or guideline for the management of AF	70
No	55 (79%)
Yes	15 (21%)
Level of training	910
Specialist	673 (74%)
Non-specialist	237 (26%)
Number of years in the speciality, median (IQR)	10 (5–17)
Diagnostic method used to detect AF	908
Continuous ECG monitoring confirmed by 12-lead ECG	723 (80%)
Continuous ECG monitoring	185 (20%)
Consider acute AF as an independent factor leading to a worsening in the overall prognosis	906
No	205 (23%)
Yes	701 (77%)

Abbreviations: AF, atrial fibrillation; ECG, electrocardiogram; ICU, intensive care unit; IQR, interquartile range; No., number.

<sup>a</sup>Values are numbers (percentages) unless stated otherwise.

results and methodological flaws in the studies including small sample sizes, short follow-up periods, and risk of confounding.<sup>2,7,8,14–17</sup>

AF may reduce ventricular diastolic volume and stroke volume leading to hemodynamic collapse.<sup>18,19</sup> Moreover, sustained acute AF during critical illness might increase the risk of more persistent forms of AF due to proarrhythmic changes in the cardiac tissue and electrophysiological system.<sup>4,20</sup> Unresolved AF increases the risk of tachycardia-induced heart failure, stroke, and death.<sup>21–23</sup> Early initiation of treatment seems reasonable and beneficial to improve the hemodynamics and prevent potential complications. We found that nearly half of the respondents would initiate treatment within the first 6 h in hemodynamically stable patients.

The European Society of Cardiology recommends rate control using beta-blockers or calcium channel blockers as first-line therapy in hemodynamically stable patients with normal left ventricular systolic function.<sup>9</sup> Our survey showed no clear preference for rate- or rhythm control for hemodynamically stable patients without cardiovascular comorbidity. In contrast to the guideline, amiodarone was the most favored pharmacological agent to treat acute AF in

the present survey. Some guidelines also recommend amiodarone as a useful intervention in patients with critical illness.<sup>9,24</sup> However, the evidence is mainly derived from non-critically ill, hospitalized patients, or outpatient settings focusing on chronic forms of AF.<sup>2,10,25</sup> Newer systematic reviews have concluded that the overall quantity and quality of studies in critically ill patients are too limited to firmly support one management strategy over another.<sup>2,10,25</sup> The wide spectrum of available interventions combined with the sparse evidence in ICU settings likely explains the observed practice variation.

Patients in the ICU differ from other patient populations in various aspects, due to multiorgan failure, complex pathophysiology, and the need for advanced life support, making ICU patients more vulnerable to adverse effects.<sup>4</sup> This is an important consideration due to known serious cardiac and non-cardiac side effects of antiarrhythmic agents.<sup>26–28</sup> Acute AF may not necessarily need to be treated since spontaneous conversion is common within the first 24 h.<sup>29,30</sup>

This survey highlight important differences in the preferences regarding the use of anticoagulant therapy, including use of prophylactic or therapeutic dosing. Firm evidence has demonstrated a beneficial effect of anticoagulants in stable outpatients.<sup>31</sup> However, the timing and dosing of anticoagulant therapy is a challenge during critical illness due to dynamic changes in coagulation status and the potential concurrent need for invasive procedures and surgery.<sup>4</sup> Observational studies conducted in critically ill patients with sepsis or admitted to mixed ICUs have not demonstrated any clear benefit of therapeutic versus prophylactic anticoagulant dosing.<sup>32–35</sup>

We found that nearly half of the respondents used a scoring system (e.g., CHADS2 or CHA2DS2-VASc) to assess the risk of ICU patients with acute AF. However, there is only sparse evidence available evaluating the accuracy of these scoring systems for the risk of stroke during critical illness.<sup>34–38</sup> Taken together, the quantity and quality of available studies are still too limited to evaluate the benefit-risk ratio for anticoagulant therapy in ICU patients developing acute AF.<sup>39</sup> Also the reported use of structured follow-up by a cardiologist varied considerably. Large-scale observational studies indicate that newly detected episodes of AF may have a long-term impact and increase the risk of stroke, heart failure, and death beyond the ICU stay.<sup>20–22</sup>

The strengths of this international survey include a large number of participating ICUs and respondents, with resulting high external validity. Furthermore, we pilot-tested the survey among physicians before it was distributed. Finally, we achieved acceptable response rates for most of the participating sites and had limited missing data.

The survey also comes with limitations. First, despite its international format, the survey may not reflect the preferred clinical practice in North America and other parts of Europe not participating in the survey. Moreover, there was substantial variation in the number of respondents from each country. One-third of the respondents came from Denmark, and the Nordic countries represented over 50% of the total population. Consequently, the external validity in the Nordic countries is high, whether it is lower in other parts of the world. Second, there was a great variation in the participating sites'

TABLE 2 Management strategies in a hemodynamically stable ICU patient with AF

Variable	No. of observations <sup>a</sup>
Preferred potassium level for ICU patients with acute AF	908
3.0 to <3.5 mmol/L	5 (<1%)
3.5 to <4.0 mmol/L	65 (7%)
4.0 to <4.5 mmol/L	554 (61%)
4.5 to 5.5 mmol/L	205 (23%)
>5.5 mmol/L	1 (<1%)
I would not aim for any specific levels	78 (9%)
HR trigger to initiate treatment	907
Not initiating treatment regardless of the HR	59 (7%)
I would initiate treatment regardless of the HR	140 (15%)
Heart rate ≥ 110 bpm	212 (23%)
Heart rate ≥ 120 bpm	225 (25%)
Heart rate ≥ 130 bpm	139 (15%)
Heart rate ≥ 140 bpm	76 (8%)
Heart rate ≥ 150 bpm	56 (6%)
Timing of intervention	907
Within 1 h	151 (17%)
Between 1–6 h	273 (30%)
Between 6–12 h	82 (9%)
Between 12–24 h	79 (9%)
Between 24–48 h	72 (8%)
>48 h	25 (3%)
I would not initiate treatment in this type of patient with AF	225 (25%)
First-line therapy	905
Observation	859 (95%)
Rhythm control strategy using one or more pharmacological agents	22 (2%)
Rate control strategy using one or more pharmacological agents	18 (2%)
Rhythm control using direct current cardioversion	6 (<1%)
Second-line therapy	903
Rhythm control strategy using one or more pharmacological agents	462 (51%)
Rate control strategy using one or more pharmacological agents	368 (41%)
Rhythm control using direct current cardioversion	47 (5%)
Observation	26 (3%)
Third-line therapy	902
Rhythm control strategy using one or more pharmacological agents	367 (41%)
Rate control strategy using one or more pharmacological agents	287 (32%)
Rhythm control using direct current cardioversion	238 (26%)
Observation	10 (1%)
Fourth-line therapy	902
Rhythm control using direct current cardioversion	611 (68%)
Rate control strategy using one or more pharmacological agents	229 (25%)
Rhythm control strategy using one or more pharmacological agents	52 (6%)
Observation	10 (1%)
The three preferred interventions in a hemodynamically stable patient with acute AF	906
Amiodarone	409 (45%)

TABLE 2 (Continued)

Variable	No. of observations <sup>a</sup>
Beta blockers other than sotalol	209 (23%)
Magnesium	96 (11%)
Change of the preferred intervention strategy to manage acute AF in ICU patients with sepsis, heart failure or postoperative admission	906
No	494 (55%)
Yes	412 (46%)
Known heart failure	309 (75%)
Sepsis	157 (38%)
Postoperative patient without suspicion of sepsis	88 (21%)

Abbreviations: AF, atrial fibrillation; bpm, beats per minute; DC, direct current; HR, heart rate; ICU, intensive care unit; mmol/L, milimoles per litre; No., number.

<sup>a</sup>Values are numbers (percentages).

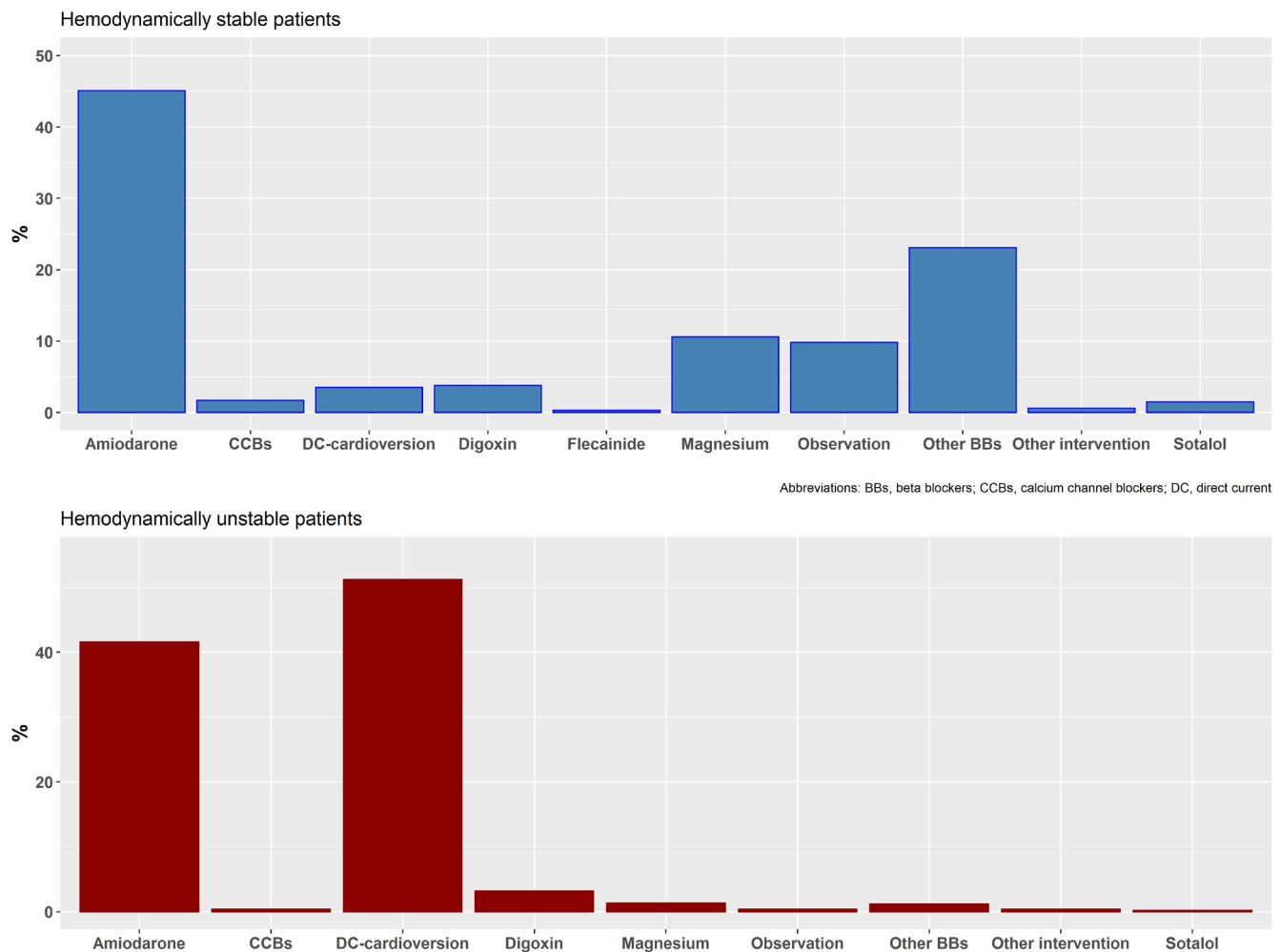


FIGURE 2 Preferred interventions against acute AF in hemodynamically stable and unstable ICU patients

response rates, thereby increasing the risk of selection bias. Third, the overall aim was to describe the preferred management of acute AF in a structured and understandable manner. As a consequence,

some of the proposed clinical scenarios may have been more simple than those occurring in daily clinical practice. Fourth, the administered treatment may be based on locally applied hemodynamic



**TABLE 3** Management strategies in a hemodynamically unstable ICU patient with AF

Variable	Total no. of observations <sup>a</sup>
First-line therapy	904
Observation	433 (48%)
Rhythm control using direct current cardioversion	309 (34%)
Rhythm control strategy using one or more pharmacological agents	124 (14%)
Rate control strategy using one or more pharmacological agents	38 (4%)
Second-line therapy	904
Rhythm control strategy using one or more pharmacological agents	351 (39%)
Rhythm control using direct current cardioversion	275 (30%)
Observation	155 (17%)
Rate control strategy using one or more pharmacological agents	123 (14%)
Third-line therapy	901
Rhythm control strategy using one or more pharmacological agents	311 (35%)
Rate control strategy using one or more pharmacological agents	283 (31%)
Rhythm control using direct current cardioversion	190 (21%)
Observation	117 (13%)
Fourth-line therapy	901
Rate control strategy using one or more pharmacological agents	458 (51%)
Observation	196 (22%)
Rhythm control using direct current cardioversion	131 (15%)
Rhythm control strategy using one or more pharmacological agents	116 (13%)
The three most preferred interventions in a hemodynamically unstable patient with acute AF	907
DC cardioversion	464 (51%)
Amiodarone	377 (42%)
Digoxin	29 (3%)
Change of the preferred intervention strategy to manage acute AF in ICU patients with sepsis, heart failure or postoperative admission	907
No	696 (77%)
Yes	211 (23%)
Known heart failure	129 (61%)
Sepsis	112 (53%)
Postoperative patient without suspicion of sepsis	68 (32%)

Abbreviations: AF, atrial fibrillation; DC, direct current; HR, ICU, intensive care unit; No., number.

<sup>a</sup>Values are numbers (percentages).

**TABLE 4** Anticoagulant therapy in ICU patients with acute atrial fibrillation

Variable	No. of observations <sup>a</sup>
Continue anticoagulant therapy (known history of AF)	905
No	159 (18%)
Yes	476 (82%)
Initiation of anticoagulant therapy in patients with acute AF	906
No	297 (33%)
Yes	609 (67%)
Timing of anticoagulant therapy	608
Within 24 h	378 (62%)
Within 48 h	163 (27%)
>48 h	67 (11%)
Preferred agent for anticoagulant or antiplatelet therapy	608
Low molecular weight heparin	485 (80%)
Unfractionated heparin	103 (17%)
Direct oral anti-coagulants	12 (2%)
Antiplatelet agents	6 (1%)
Vitamin K antagonist	2 (<1%)
Preferred dosing strategy for anticoagulant including low molecular weight heparin, unfractionated heparin and DOAK	608
Prophylactic dose	232 (39%)
Therapeutic dose	368 (61%)
Use of scoring systems to assess the risk of stroke in ICU patients with acute AF	907
No	471 (52%)
Yes	436 (48%)
Follow-up by cardiologist	907
No	548 (60%)
Yes	359 (40%)

Abbreviations: AF, atrial fibrillation; DC, direct current; DOAK, direct oral anticoagulants; ICU, intensive care unit; No., number.

<sup>a</sup>Values are numbers (percentages).

monitoring which was not included in the questions. For example, echocardiography may be used by some. In addition, the responses regarding anticoagulants may have been affected by local strategies on thromboprophylaxis to all ICU patients and not exclusively patients with acute AF.

The aim main was to describe various management aspects of NOAF in a broad population of ICU patients, why we also included, for example, cardio-thoracic ICU patients where the incidence of NOAF may be higher than in general ICU patients.

In conclusion, we found considerable practice variation among ICU doctors in the preferred clinical management of acute AF, including the overall management strategies, use of interventions, and anticoagulants.

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## CONFLICT OF INTERESTS

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## AUTHOR CONTRIBUTION

MW, AG, NH, CH, MHM and AP contributed to the study design. MW drafted the manuscript. MW, MHM, AG, CH, NH, TA, JS, PY, AA, JH, MS, MC, EL, SH, YA, WS, MS, MB, FK and AP critically revised the manuscript and approved the final manuscript. The AFIB-ICU collaborators contributed to recruitment of study sites, study participants and data collection.

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#### SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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## APPENDIX

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