Current practice in the management of new-onset atrial fibrillation in critically ill patients: A UK-wide survey

Chung Shen Chean [1] , Daniel McAuley [2] , Anthony Gordon [3] , Ingeborg Dorothea Welters Corresp. [1, 4]

[1] Intensive Care Unit, Royal Liverpool University Hospital, Liverpool, United Kingdom

[2] School of Medicine, Dentistry and Biomedical Sciences, The Queen's University Belfast, Belfast, United Kingdom

[3] Faculty of Medicine, Department of Surgery & Cancer, Section of Anaesthetics, Pain Medicine and Intensive Care, Imperial College London, London, United Kingdom

[4] Institute of Ageing and Chronic Disease, University of Liverpool, Liverpool, United Kingdom

Corresponding Author: Ingeborg Dorothea Welters
Email address: I.Welters@liverpool.ac.uk

Background: New-onset atrial fibrillation (AF) is the most common arrhythmia in critically ill patients. Although evidence base and expert consensus opinion for management have been summarised in several international guidelines, no specific considerations for critically ill patients have been included. We aimed to establish current practice of management of critically ill patients with new-onset AF. **Methods:** We designed a short user-friendly online questionnaire. All members of the Intensive Care Society were invited via email containing a link to the questionnaire, which comprised 21 questions. The online survey was conducted between November 2016 and December 2016. **Results:** The response rate was 397/3152 (12.6%). The majority of respondents (81.1%) worked in mixed Intensive Care Units and were consultants (71.8%). Most respondents (39.5%) would start intervention on patients with fast new-onset AF and stable blood pressure at a heart rate between 120 and 139 beats/min. However, 34.8% of participants would treat all patients who developed new-onset fast AF. Amiodarone and beta-blockers (80.9% and 11.6% of answers) were the most commonly used anti-arrhythmics. 63.8% of respondents do not regularly anti-coagulate critically ill patients with new-onset fast AF, while 30.8% anti-coagulate within 72 hours. 68.0% of survey respondents do not routinely use stroke risk scores in critically ill patients with new-onset AF. 85.4% of participants would consider taking part in a clinical trial investigating treatment of new-onset fast AF in the critically ill. **Discussion:** Our results suggest a considerable disparity between contemporary practice of management of new-onset AF in critical illness and treatment recommendations for the general patient population suffering from AF, particularly with regard to anti-arrhythmics and anticoagulation used. Amongst intensivists, there is a substantial interest in research for management of new-onset AF in critically ill patients.

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2 **patients: A UK-wide survey**

4 Chean, C.S.[1], McAuley D.F.[2], Gordon, A.C.[3], Welters, I.D.[1,4]

5 [1]Intensive Care Unit, Royal Liverpool University Hospital, Liverpool, United Kingdom.

6 [2]Queens University Belfast, School of Medicine, Dentistry and Biomedical Sciences,
7 Belfast, United Kingdom

8 [3]Faculty of Medicine, Department of Surgery & Cancer, Section of Anaesthetics, Pain
9 Medicine and Intensive Care, Imperial College London, UK

10 [4]Institute of Ageing and Chronic Disease, University of Liverpool, United Kingdom

13 Corresponding author:

14 Ingeborg Welters
15 University of Liverpool,
16 Institute of Ageing and Chronic Disease
17 6 West Derby Street,
18 L7 8TX, Liverpool, United Kingdom
19 I.Welters@liverpool.ac.uk

22 **Abstract:**

24 **Background:**

25 New-onset atrial fibrillation (AF) is the most common arrhythmia in critically ill patients.
26 Although evidence base and expert consensus opinion for management have been
27 summarised in several international guidelines, no specific considerations for critically ill
28 patients have been included. We aimed to establish current practice of management of
29 critically ill patients with new-onset AF.

30 **Methods:**

31 We designed a short user-friendly online questionnaire. All members of the Intensive
32 Care Society were invited via email containing a link to the questionnaire, which
33 comprised 21 questions. The online survey was conducted between November 2016
34 and December 2016.

35 **Results:**

36 The response rate was 397/3152 (12.6%). The majority of respondents (81.1%) worked
37 in mixed Intensive Care Units and were consultants (71.8%). Most respondents (39.5%)
38 would start intervention on patients with fast new-onset AF and stable blood pressure
39 at a heart rate between 120 and 139 beats/min. However, 34.8% of participants would
40 treat all patients who developed new-onset fast AF. Amiodarone and beta-blockers
41 (80.9% and 11.6% of answers) were the most commonly used treatments.

42 63.8% of respondents do not regularly anti-coagulate critically ill patients with new-
43 onset fast AF, while 30.8% anti-coagulate within 72 hours. 68.0% of survey respondents
44 do not routinely use stroke risk scores in critically ill patients with new-onset AF.

45 85.4% of participants would consider taking part in a clinical trial investigating treatment
46 of new-onset fast AF in the critically ill.

47 **Discussion:**

48 Our results suggest a considerable disparity between contemporary practice of
49 management of new-onset AF in critical illness and treatment recommendations for the
50 general patient population suffering from AF, particularly with regard to anti-
51 arrhythmics and anticoagulation used. Amongst intensivists, there is a substantial
52 interest in research for management of new-onset AF in critically ill patients.

53

54 **Strengths and limitations of this study:**

55 Strengths:

56 - A UK-wide survey describing common practice in management of new-onset
57 atrial fibrillation in critically ill patients
58 - Identification of a research interest in practising intensivists to address new onset
59 atrial fibrillation as a common clinical problem in acutely ill patients
60 - Description of disparity in anti-arrhythmic strategies and management of
61 anticoagulation in patients with new-onset atrial fibrillation

62 Limitations:

63 - The low response rate may limit generalisability of findings
64 - The survey was limited to members of the Intensive Care Society and may not
65 reflect non-members' views.
66 - The survey was aimed at general intensivists without specifically addressing
67 management of perioperative or cardiac patients with new-onset atrial
68 fibrillation.

69

70 **Introduction:**

71 Atrial fibrillation (AF) is the most common cardiac arrhythmia in both the general
72 population and the critical care setting (Makrygiannis et al. 2014; Seguin et al. 2004).
73 New-onset fast AF is defined as atrial fibrillation with a rapid ventricular response of
74 more than 100 beats per minute (bpm) in patients without a previous history of atrial
75 fibrillation.

76 In the past decades there has been increased attention to new-onset AF in patients in
77 critical care, because it is associated with a worse prognosis (Chen et al. 2015; Shaver et
78 al. 2015). Evidence is growing that new-onset AF is associated with longer Intensive Care
79 Unit (ICU) stay and higher mortality (Reinelt 2001; Tseng et al. 2016; Yoshida et al.
80 2015). Observational studies suggested that the prevalence of AF in non-cardiac medical
81 ICUs ranges from 5 to 26% (Carrera et al. 2016; Chen et al. 2015), and affects up to 10%
82 of patients in surgical ICUs (Knotzer et al. 2000; Seguin et al. 2004).

83 However, despite the relatively high incidence of new-onset AF among critically ill
84 patients, there is paucity of evidence for its management in the critical care setting. In
85 particular, little is known about new-onset AF in comparison to pre-existing AF in this
86 subset of patients. Previous studies have mainly investigated the epidemiology, risk

87 factors and outcomes of new-onset atrial fibrillation in critical care, while little evidence,
88 which is mainly based on small single-centre studies is available for treatment (Yoshida
89 et al. 2015).

90 As a result, guidance on management of AF is based on the evidence obtained in the
91 general population and does not include patients in intensive care. We performed an
92 online survey amongst practising intensivists in the United Kingdom to establish current
93 practice regarding the management of critically ill patients developing new-onset AF.
94 We also aimed to identify areas in which adherence to current guidance is low and
95 further research is needed to clarify uncertainties in the treatment of these patients.

96

97 **Methods**

98 We designed a short user-friendly online questionnaire using Qualtrics® (Provo, Utah,
99 USA) to assess the knowledge and to explore the current practice of British critical care
100 physicians in managing new-onset atrial fibrillation. The questionnaire was pilot-tested
101 and revised based on the question value. Where clinically relevant, more than one
102 answer could be given.

103 *Selection sample*

104 The survey population consisted of 3152 medical members of Intensive Care Society
105 (ICS), who are practicing intensive care doctors in the UK and for whom email contacts
106 were available. We excluded critical care doctors who did not practise or were retired.

107 The participants received an email containing the link to the questionnaire, which was a
108 web-based survey comprising of 21 questions and developed using the open source
109 survey application Qualtrics®. The online survey was conducted from November 2016 to
110 December 2016.

111 *Questionnaire*

112 The survey was anonymous and included a consent form at the beginning of the survey
113 and in the email circulated to all participants. The consent form explained the purpose
114 of the study, the risks and benefits and data management. The survey consisted of 21
115 questions, which were divided into two domains. The first domain comprised 7
116 questions, which mainly recorded the background and demographic data of the
117 responding physicians and their critical care unit. The second domain had 14 questions
118 that aimed to identify current treatment strategies for critically ill patients with new-
119 onset fast atrial fibrillation. The survey took no more than 10 minutes to complete.

120 Demographic variables included type of practice hospitals (district general, tertiary
121 referral centre or university hospital), the number of patients admitted to the unit per
122 year, the number of staffed beds in the department, the case mix of the unit
123 department (predominantly surgical, medical, mixed or specialist ICU) as well as the
124 level of training, years of experience and any secondary specialty of the survey
125 participants.

126 To identify and explore the current practice in managing critically ill patients with new-
127 onset AF, participants were asked to state a threshold heart rate at which they
128 intervene in patients with fast AF and stable blood pressure, whether they favour
129 rhythm or rate control as the primary treatment goal, the most commonly used anti-
130 arrhythmic drugs and the reasons for their choice. Survey participants were also asked
131 about their treatment strategy in an example of a critically ill patient with chest sepsis
132 who developed new-onset AF with a heart rate of 140-160 beats per minute. In this
133 survey question, participants were given options of different treatment strategies,
134 including electrolyte supplementation, Direct Current (DC) cardioversion and anti-
135 arrhythmic drugs. Survey participants were requested to state their target serum
136 potassium and serum magnesium level among critical care patients with new-onset AF.

137 Finally, participants were also asked about their anti-coagulation practice including
138 duration and medication used and their views on stroke risk assessments in critically ill
139 patients with new-onset AF. A further question explored the use of trans-oesophageal
140 or transthoracic echocardiography to guide treatment. At the end of the survey, their
141 views on conducting a clinical trial investigating treatment of new-onset AF in this
142 subgroup of patients were obtained. This included the anti-arrhythmic medications at
143 highest priority for investigation and acceptability of a placebo arm in a research study
144 investigating the effectiveness of anti-arrhythmics in critically ill patients with new-onset
145 AF.

146 The full content of the survey is available as a supplementary file.

147 ***Data analysis***

148 A survey data report was auto-generated by Qualtrics® to aid data analysis. Descriptive
149 statistics were carried out by providing absolute numbers and percentages of
150 background and demographic variables and for all questions relating to knowledge and
151 current practice. Where applicable, contingency tables were produced and analysed
152 using Fisher's exact test. To measure of association between two nominal variables,
153 Cramer V was used and interpreted as follows: 0.1 – 0.29 weak association, 0.3 – 0.5
154 moderate association, > 0.5 strong association.

155

Results

Demographics of survey participants

158 Questionnaires were sent to 3152 members of the Intensive Care Society (ICS) who had
159 updated email addresses available. We received 427 responses. Survey links that had
160 been opened without provision of replies were excluded from the study. 397 complete
161 survey responses were obtained (12.6%). We excluded 30 surveys with incomplete
162 answers on the management of new-onset AF in critically ill patients from the analysis.
163 Four lacked information on background and demographics and were also excluded.

164 46.6% of respondents were from District General Hospitals; a smaller proportion
165 (38.5%) worked in University Hospitals or Tertiary referral centres. The admission rate
166 ranged between 500 and 2000 patients/year in most centres, 81.1% of units were mixed
167 ICUs admitting medical and surgical patients (Table 1).

168 Most respondents (47.2%) worked on units with 11-20 staffed beds (level 2 and level 3).
169 Our results indicate that mainly senior medical staff responded to the survey invitation,
170 with Consultants representing 71.8% of respondents; 53.9% had more than 10 years of
171 experience in Critical Care. Anaesthesia was the most common secondary specialty
172 stated (83.9%) (Table 2).

Anti-arrhythmic treatment of new-onset AF

174 39.5% of respondents would start intervention on patients with fast new-onset AF and
175 stable blood pressure at a heart rate between 120 and 139 beats/min. However, a
176 similar proportion of respondents (34.8%) would treat all patients who developed new-
177 onset fast AF, independent of their heart rate, even if the blood pressure remained
178 stable. 54.7% of respondents stated that the primary treatment goal of new-onset AF
179 among ICU patients with stable BP without a known cardiac history was rate control,
180 while 40.3% of respondents aimed for rhythm control. We analysed whether the
181 choosing rate control versus rhythm control as primary treatment goal influenced
182 physicians' views on heart rate at which they would intervene (Table 2). Although a
183 significantly higher percentage (p<0.001) of physicians who stated "Rhythm control" as
184 their primary treatment goal would intervene at any heart rate, the overall association
185 between primary treatment goal and heart rate requiring intervention was only
186 moderate (Cramer's V =0.316).

187 Amiodarone was by far the most commonly used anti-arrhythmic for treatment of new-
188 onset AF in critically ill patients (80.9% of answers), followed by beta-blockade (11.6%)
189 (Figure 1).

190 We wanted to explore the primary treatment strategy for a typical critically ill patient
191 using a case vignette of a patient with chest sepsis, who develops fast new-onset AF
192 with a heart rate of 140-160 bpm. The patient had no cardiac history, a blood pressure
193 of 100/60 mmHg and received 0.25 mcg/kg/min noradrenaline. Most survey
194 respondents opted for electrolyte supplementation to high normal level and additional
195 anti-arrhythmics (53.6%). 23.8% of respondents advocated electrolyte supplementation
196 to a high normal level only, and 14.9% opted for DC cardioversion when anti-
197 arrhythmics and electrolyte replacement fail to achieve rate and/or rhythm control. No
198 one chose to perform DC cardioversion only (Figure 2). In critically ill patients with new-
199 onset AF 74.3% of survey respondents aimed for serum Potassium level of >4.5 mmol/l
200 and 59.7% of survey respondents aimed for serum Magnesium level of 1.0-1.2 mmol/l
201 (Figure 3). Pharmacodynamics properties and adverse effect profile were leading factors
202 for choosing anti-arrhythmic treatment for new-onset AF in critically ill patients (Figure
203 4).

204 **Anticoagulation in patients with new-onset fast AF:**

205 63.8% of respondents stated that they would not regularly anti-coagulate critically ill
206 patients with new-onset fast AF, while 30.8% would anti-coagulate within 72 hours
207 (Table 3a). 53.3% of all survey respondents thought that subcutaneous low molecular
208 weight heparin in therapeutic dose is appropriate for anti-coagulation and 26,8%
209 considered intravenous high molecular weight heparin as appropriate, provided that no
210 contra- indications for either substance were known (Table 3b). Sub-analysis excluding
211 respondents who gave "I do not regularly anti-coagulate critically ill patients with new
212 onset fast AF" as the only answer (136/362 respondents), revealed that either low or
213 high molecular weight heparin was considered appropriate for anti-coagulation by more
214 than 98% of physicians.

215 68.0% of survey respondents did not use stroke risk scores routinely in critically ill
216 patients with new-onset AF to assess the need for anticoagulation. 30.9% of survey
217 respondents thought that stroke risk scores inaccurately reflect the risk of embolic
218 events in critically ill patients with new-onset atrial fibrillation due to prothrombotic
219 changes associated with critical illness. 47.0% of respondents thought that modified risk
220 scores should be developed for critically ill patients with new-onset atrial fibrillation
221 (Table 4).

222 Approximately half of the respondents (52.2%) would request an echocardiogram in
223 patients with new-onset AF. Only a small minority (3.3%) would use transoesophageal
224 echocardiography, while a large proportion (48.9%) would request a transthoracic
225 echocardiography. 39.2% of survey respondents did not routinely perform
226 echocardiography to guide treatment.

227 ***Research interest amongst intensivists who treat patients with new-onset AF***

228 85.4% of survey respondents would consider taking part in a clinical trial investigating
229 treatment of new-onset fast AF in the critically ill. In the setting of a research study on
230 general ICU patients, amiodarone (74.0%) and beta-blockers (55.8%) were the two most
231 frequently mentioned pharmaceutical treatments to be investigated for critically ill
232 patients with new-onset fast AF. There was a divided opinion regarding the use of a
233 placebo arm (i.e. not treating new-onset AF with anti-arrhythmics or rate-limiting
234 agents, when BP and cardiac output are stable). In the setting of a research study
235 investigating the effectiveness of anti-arrhythmic or rate-limiting agents in critically ill
236 patients with new-onset fast AF, 50.3% of respondents would not accept a placebo arm.

237

238 **Discussion**

239 New-onset AF is the most commonly observed arrhythmia in critically ill patients
240 (Artucio & Pereira 1990). It is associated with a worse prognosis (Champion et al. 2014;
241 Chen et al. 2015; Shaver et al. 2015) and longer ICU stays (Duby et al. 2017; Reinelt
242 2001), particularly in patients with sepsis (Klein Klouwenberg et al. 2017). Despite the
243 large number of patients affected and potential long-term consequences (Walkey et al.
244 2014), thorough research on treatment of new-onset AF is lacking (Walkey et al. 2015).
245 Our survey revealed two areas with substantial research need: Anti-arrhythmic
246 treatment of new-onset AF and anticoagulant therapy.

247 Prolonged periods of elevated heart rate are associated with a higher risk of cardiac
248 complications (Sander et al. 2005). A retrospective study in non-cardiac ICU patients
249 found that 37% of patients with new-onset AF suffered from hemodynamic instability
250 related to the development of AF (Kanji et al. 2012). Intensivists are concerned about
251 complications such as hypotension, myocardial ischemia and reduced organ perfusion,
252 all of which are known to be associated with new-onset AF with a high conduction rate.
253 In our survey, one third of intensivists would treat all patients with new-onset fast AF,
254 independent of their heart rate, even if the blood pressure remained stable, presumably
255 in an attempt to prevent these potentially harmful events. However, a slightly higher
256 proportion (39.5%) would set a heart rate of more than 120 bpm as a treatment
257 threshold in haemodynamically stable patients.

258 More than half of the intensivists who participated in our survey aimed for rate control
259 as the primary treatment goal, while about 40% prioritized rhythm control. A recent
260 single-center, retrospective, cohort study described a higher mortality in septic patients
261 with new-onset AF who failed to convert into sinus rhythm (Liu et al. 2016). Rhythm
262 control and rate control have both been used as outcome measures in the few
263 therapeutic studies available in the literature, although there is no clear guidance
264 whether rate or rhythm control is preferable to influence overall outcome of critical
265 illness (Liu et al. 2016).

266 In fact, a recent systematic review on new-onset AF in non-cardiac critically ill patients
267 identified only five studies, which compared different treatment strategies for new-
268 onset AF in critically ill patients (Yoshida et al. 2015). However, only one of the studies
269 was a randomised controlled trial. Therapies studied to date include beta-blockers
270 (Balser et al. 1998; Meierhenrich et al. 2010), Vernakalant (Arrigo et al. 2014), Diltiazem
271 (Balser et al. 1998), DC cardioversion (Arrigo et al. 2015; Kanji et al. 2012; Mayr et al.
272 2003; Meierhenrich et al. 2010; Seguin et al. 2006), Amiodarone (Balser et al. 1998;
273 Kanji et al. 2012; Meierhenrich et al. 2010; Seguin et al. 2006; Sleeswijk et al. 2008),
274 Sotalol (Kanji et al. 2008) and digitalis glycosides (Meierhenrich et al. 2010; Seguin et al.
275 2006). The need to perform research on treatment of new-onset AF in critically ill
276 patients is reflected by the high percentage (85%) of intensivists who declared an
277 interest in participating in such research.

278 In our survey, amiodarone was the preferred pharmaceutical treatment for more than
279 80% of intensivists who participated, potentially because it is associated with fewer
280 haemodynamic effects compared to beta-blockers and calcium channel blockers (Delle
281 Karth et al. 2001). Unfortunately, evidence supporting its use in critically ill patients is
282 limited to small single-centre studies only (Delle Karth et al. 2001; Shibata et al. 2016).

283 NICE guidelines recommend either a standard beta-blocker or a rate-limiting
284 calcium-channel blocker as initial monotherapy for patients with new-onset AF (Jones et
285 al. 2014) or, for patients who are sedentary, digoxin monotherapy. These guidelines
286 have been developed for patients with AF in the general population, but may not be
287 transferable to the intensive care setting due to different predisposing factors for AF in
288 critically ill patients. In particular, new-onset AF has been associated with inflammation
289 and occurs in up to 46% of patients with septic shock (11). Patients with septic shock
290 who developed new-onset AF showed a continuous, significant increase in CRP plasma
291 levels before occurrence of AF (Meierhenrich et al. 2010). Further risk factors for new-
292 onset AF in the critically ill include inotropic support (Seguin et al. 2006), advanced age
293 and high scores of severity of disease (Yoshida et al. 2015). In the United Stated, where

294 diltiazem is available for intravenous administration, calcium-channel blockers were the
295 most frequently used drugs to treat new-onset AF during sepsis (Walkey et al. 2016),
296 although the use of beta-blockers was associated with improved mortality in a
297 propensity analysis.

298 About a quarter of respondents would choose electrolyte supplementation to a high
299 normal level only, while more than half (53.6%) would add anti-arrhythmics or rate-
300 limiting agents as a primary treatment strategy. The use of intravenous magnesium
301 sulphate bolus application followed by continuous infusion achieved conversion to sinus
302 rhythm or decrease in heart rate <110 bpm in 16 of 29 patients (55%) in a small
303 prospective study (Sleeswijk et al. 2008), while magnesium-amiodarone step-up therapy
304 achieved a conversion rate of more than 90% within 24 h in a cohort of mixed critically
305 ill patients. Although these findings suggest that amiodarone, magnesium sulphate, or
306 the combination thereof might be effective to prevent or treat new-onset AF, more
307 studies are needed to evaluate the efficiency and safety profile of these drugs in the
308 general critically ill population.

309 Haemodynamic stability during and immediately after the onset of AF and long-term
310 stroke risk are often dependent on underlying left ventricular systolic and diastolic
311 function. Echocardiography provides useful information on right and left ventricular
312 function as well as size of both atria to determine optimal treatment in patients with
313 acute haemodynamic deterioration. Although nearly half of the respondents would
314 request a transthoracic echo, a large proportion (39%) does not routinely use
315 echocardiography to guide management in this patient cohort.

316

317 NICE/ACC/AHA/ESC practice guidelines recommend routine anti-coagulation of patients
318 with new-onset AF depending on their individual risk of thromboembolic events using
319 established scores such as CHADS2 and CHA2DS2-VASc (Jones et al. 2014). However, the
320 risk of stroke and thromboembolic events in critically ill patients who develop new-
321 onset AF has been evaluated in only very few studies. A recent prospective
322 observational study revealed that both CHADS2 and CHA2DS2-VASc are predictive of
323 thromboembolic events in the critical care setting (Champion et al. 2014), with a
324 CHADS2 score of 4 or higher being the most accurate threshold. In a large retrospective
325 study on more than 49 000 patients with sepsis Walkey et al (Walkey et al. 2011)
326 described that new-onset AF during severe sepsis was associated with a nearly four-fold
327 increased risk of in-hospital ischemic stroke, with threefold greater in-hospital stroke
328 rates compared with patients without AF during sepsis. Despite this adverse risk profile,
329 63.8% of intensivists participating in our survey stated that they would not regularly

330   anti-coagulate critically ill patients with new-onset fast AF, while 30.8% of respondents
331   would anti-coagulate within 72h. Intensivists may be reluctant to commence
332   therapeutic anticoagulation in critically ill patients with new-onset AF because the
333   risk/benefit ratio of anticoagulation during acute critical illness is often unclear. Critically
334   ill patients may be at substantially increased risks of severe bleeding due to
335   thrombocytopenia, renal failure, liver failure, invasive devices, and unscheduled
336   procedures (Walkey et al. 2015), and bleeding complications such as gastrointestinal
337   haemorrhage or intracerebral bleeds are common (Darwish et al. 2013). Currently
338   recommended scores for stratification of thromboembolic risk, such as the CHADS2 and
339   CHA2DS2VASc scores, and the scores for hemorrhagic risk, like the HAS-BLED score have
340   limitations when applied in critically ill patients (Ferreira et al. 2015). Hence scores
341   developed to assess the stroke risk in the general population with AF, are not routinely
342   used by more than two thirds of intensivists who participated in our survey. 30.9% of
343   survey respondents felt that the currently recommended stroke risk scores inaccurately
344   reflect the risk of embolic events in critically ill patients with new-onset AF due to
345   prothrombotic changes associated with critical illness. Nearly half of the respondents
346   (47.0%) thought that modified risk scores should be developed for critically ill patients
347   with new-onset atrial fibrillation to take into account such alterations in the coagulation
348   system in critically ill patients. In an attempt to address this, a multi-centre
349   observational study has been set up to further identify clinical and echocardiographic
350   risk factors for thromboembolic events in critically ill patients with new-onset AF (Labbe
351   et al. 2015).

352   Importantly, decisions to anti-coagulate patients with new-onset AF during critical
353   illness may influence the stroke risk beyond their critical care admission. More than half
354   of patients with new-onset AF have a later recurrence of AF (Walkey et al. 2014).
355   Patients with new-onset AF during acute illness also have elevated long-term risksof
356   stroke. A proposed approach to long-term management of patients who develop
357   periods of AF during critical illness includes re-assessment for rhythm and heart rate
358   surveillance, cardiovascular comorbidities, thyroid function, stroke risk and should
359   include echocardiography and patients' preferences (Walkey et al. 2015) to manage
360   stroke and cardiovascular risk after ICU discharge. However, data are lacking to estimate
361   rates of severe bleeding versus stroke risk with use of systemic anticoagulation during
362   critical illness. Due to this uncertainty, a recent review concluded that routine
363   anticoagulation for new-onset AF among critically ill patients with elevated bleeding risk
364   cannot be recommended as a treatment where benefits outweigh risks (Walkey et al.
365   2015).

366   Our survey has several limitations. We only approached members of the Intensive Care
367   Society (ICS), due the necessity of an accessible and up-to-date email distribution list.
368   Approximately two thirds of practising intensivists in the UK are members of the ICS,
369   indicating that a significant proportion of intensivists were not given the opportunity to
370   express their views. Given the low overall response rate, non-response bias may also
371   have influenced our results. However, acute care physicians are a professional group
372   with reportedly low survey response rates (Champion & Deye 2017), likely due to time
373   constraints and high workload. This short online survey consisted of a limited number of
374   general questions only to allow rapid completion. Hence, we could not thoroughly
375   explore background knowledge and experience of the respondents in in this complex
376   field. In particular, treatment strategies in relation to cardiac function and combination
377   of therapies such as cardioversion in addition to anti-arrhythmic substances could not
378   be evaluated.

379   Our survey focused on general management of new-onset atrial fibrillation in critical
380   care; specific subgroups of patients including those after cardiothoracic surgery or with
381   primary cardiac diagnoses were not specifically addressed. These patient cohorts may
382   require separate investigations because of different pathomechanisms and treatment
383   requirements.

384   **Conclusions:**

385   We identified a high variation in the use of anti-arrhythmic treatment in critically ill
386   patients with new-onset AF, which can be explained by the lack of both high-quality
387   studies and evidence to guide the management of new-onset AF in the critical care
388   setting. Intensivists expressed a substantial interest in research in this area, making it a
389   priority for future clinical trials. Interventional and observational studies will have to
390   address the benefits of pharmacotherapy for new-onset AF in critically ill patients and
391   the effect of individual drug choices on patient short and long-term outcomes. Further
392   work is also required to describe and assess the risk/benefit ratio of thromboembolic
393   prophylaxis in critically ill patients with new-onset AF.

394

395

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400   invitation.

401

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502   onset atrial fibrillation in critically ill: a systematic review. *J Intensive Care* 3:19. 10.1186/s40560-
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507 **Legends to Figures and Tables**

508

509 Tables:

510 Table 1: Intensive Care Unit (ICU) characteristics and level of Level of training of survey
511 respondents. SAS = Specialty and associate specialist (Doctors not in training with at
512 least four years postgraduate experience).

513 Table 2: Survey responses regarding heart rate at which doctors would intervene
514 depending on their primary treatment goal (rate versus rhythm control).

515 Table 3: Survey responses regarding initiation of anticoagulation treatment in atrial
516 fibrillation and choice of appropriate anticoagulants.

517 Table 4: Survey responses regarding stroke risk assessment in critically ill patients with
518 new-onset atrial fibrillation

519

520 Figures:

521 Figure 1: Medications used for treatment of new-onset atrial fibrillation

522 Figure 2: Case vignette to assess treatment of new-onset atrial fibrillation with fast
523 ventricular rate.

524 Figure 3: Electrolytes level targets in the management of atrial fibrillation

525 Figure 4: Rationale for choosing anti-arrhythmic treatment for new-onset AF in critically
526 ill patients. Other reasons given included "Effectiveness", "Chance of cardioversion",
527 "Amiodarone works"

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Intensive Care Unit (ICU) characteristics

1 Table 1
2

Please state your level of training:	Response	%
Consultant	285	71.79%
Trainee	94	23.68%
SAS	18	4.53%
Total	397	100.00%

a)

0%

5%

Tertiary Referral Centre or University Hospital	153	38.54%
Total	397	100.00%

How many years of experience do you have in Critical Care?	Response	%
<1 year	4	1.01%
1-3 years	42	10.58%
3-5 years	44	11.08%
5-10 years	93	23.43%
More than 10 years	214	53.90%
Total	397	100.00%

b)

c)

d)

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e)

3% f)

5%

9%

>2000	49	12.34%
I do not know	35	8.82%

Please state your complimentary specialty:	Response	%
Intensive Care Medicine only	37	9.32%
Anaesthesia	333	83.88%
Acute medicine	18	4.53%
Emergency Medicine	6	1.51%
Paediatrics	0	0.00%
Surgery	3	0.76%
Total	397	100.00%

%

%

%

%

%

Total	397	100.00%

Level of training of survey respondents

1   Table 2:

			Rate control	Rhythm control	Total
At which heart rate would you intervene in patients with fast AF and stable blood pressure?	>160/beats per min	Count	3	0	3
		Percentage	1.5%	0.0%	0.9%
	100-119/beats per min	Count	30	17	47
		Percentage	15.2%	11.5%	13.6%
	120-139/beats per min	Count	93	48	141
		Percentage	47.0%	32.4%	40.8%
	140-159/beats per min	Count	30	9	39
		Percentage	15.2%	6.1%	11.3%
	Independent of their heart rate I treat all patients who have developed new onset fast AF. even if the blood pressure remains stable	Count	42	74	116
		Percentage	21.2%	50.0%	33.5%
Total		Count	198	148	346
		Percentage	100.0%	100.0%	100.0%

Survey responses regarding initiation of anticoagulation treatment in atrial fibrillation.

1   Table 3a)

When would you normally anti-coagulate critically ill patients with new-onset atrial fibrillation, if no contra-indications for anti-coagulation are known?	Bar	Response	%
New onset AF within 24 hours		26	7.18%
New onset AF within 48 hours		54	14.92%
New onset AF within 72 hours		35	9.67%
Before starting anti-arrhythmic medication		4	1.10%
After starting anti-arrhythmic medication		3	0.83%
Before DC cardioversion		9	2.49%
I do not regularly anti-coagulate critically ill patients with new-onset fast AF		231	63.81%
Total		362	100.00%

4   b)

In critically ill patients with new-onset fast atrial fibrillation which of the following do you consider appropriate for anticoagulation provided that no contra-indications are known? Please tick all answers that reflect your views.	Bar	Response	%
Intravenous High Molecular Weight heparin in therapeutic dose		97	26.80%
Subcutaneous Low Molecular Weight heparin in therapeutic dose		193	53.31%
Use of novel oral anti-coagulants (NOACs)		17	4.70%
Use of warfarin		20	5.52%
I do not regularly anti-coagulate critically ill patients with new onset fast AF		190	52.49%
Total		517	100.00%

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7

Survey responses regarding stroke risk assessment in critically ill patients with new-onset atrial fibrillation

1   Table 4:
2

Please tick all answers that reflect your views on stroke risk assessment in critically ill patients with new-onset atrial fibrillation:	Bar	Response	%
I do not use stroke risk scores routinely in critically ill patients with new onset AF to assess the need for anticoagulation		246	67.96%
I regularly calculate a risk score (e. g. CHAD2, CHA2DS2-VASc) to assess the need for anti-coagulation		39	10.77%
Stroke risk scores inaccurately reflect the risk of embolic events in critically ill patients with new-onset atrial fibrillation due to prothrombotic changes associated with critical illness		112	30.94%
Stroke risk scores favour anti-coagulation despite a higher risk of bleeding in critical illness		73	20.17%
Modified risk scores should be developed for critically ill patients with new-onset atrial fibrillation		170	46.96%
Total		640	100.00%

Figure 1

Medications used for treatment of new-onset atrial fibrillation

a)

Which is the most commonly used anti-arrhythmic drug for new onset fast atrial fibrillation in your ICU?	Response	%
Amiodarone	293	80.94%
ß-blocker	42	11.60%
Flecainide	1	0.28%
Diltiazem	0	0.00%
Digoxin	12	3.31%
Other anti-arrhythmics (e. g. Verapamil, sotalol)	14	3.87%
Total	362	100.00%

b)

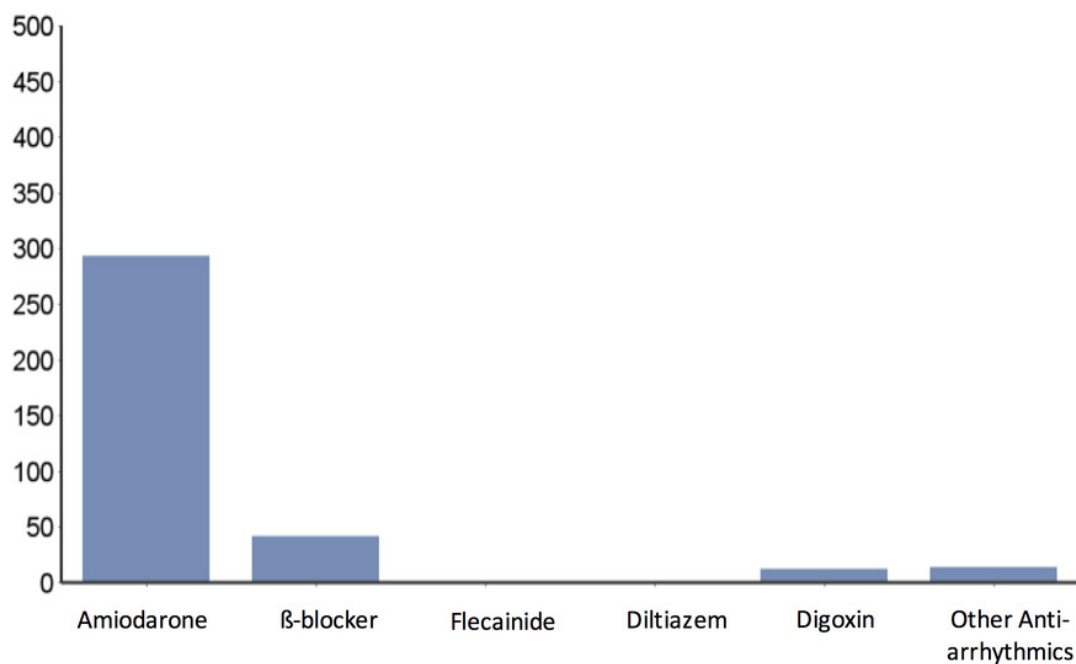
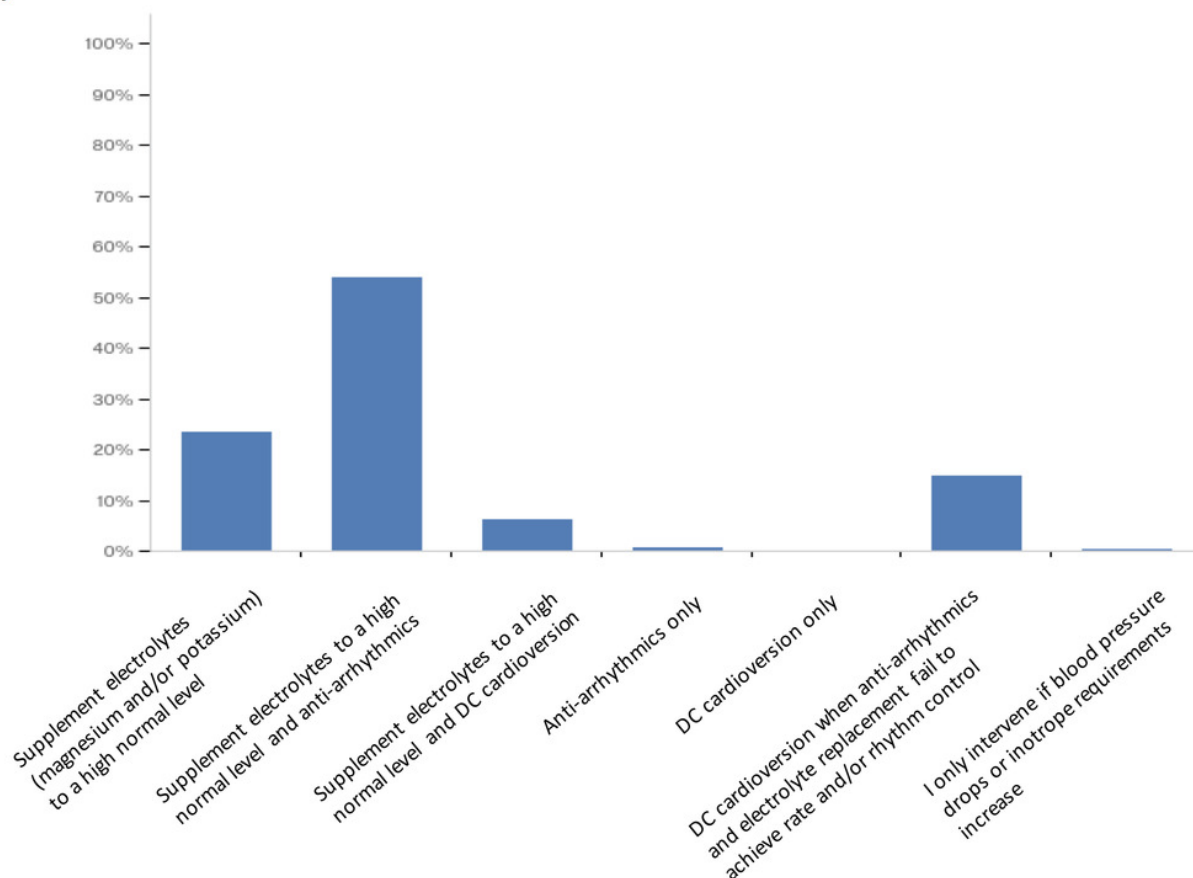



Figure 2

Case vignette to assess treatment of new-onset atrial fibrillation with fast ventricular rate.

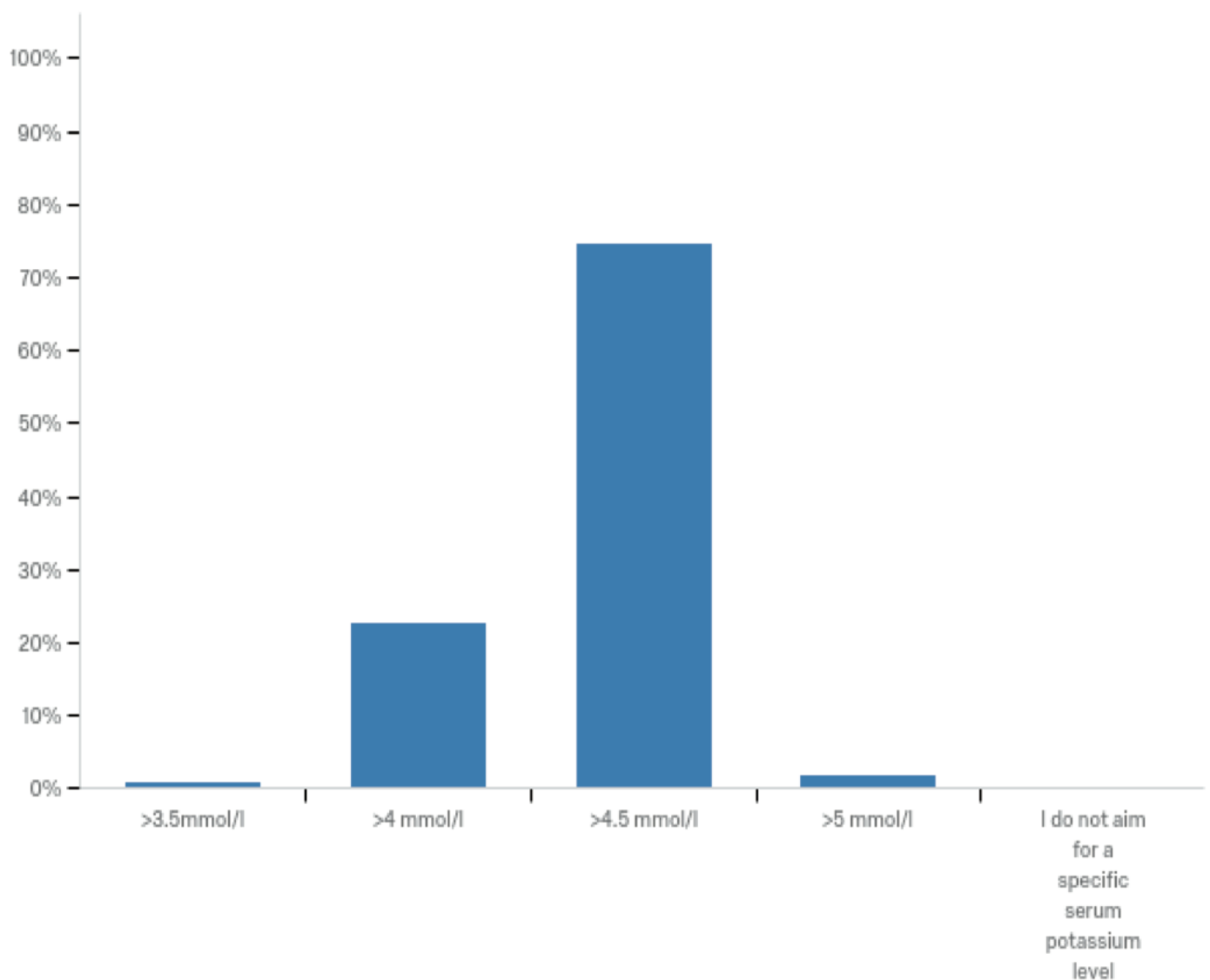
a)

In a patient with chest sepsis (no cardiac history, blood pressure 100/60 mmHg, receiving 15 ml/min (0.25 mcg/kg/min) noradrenaline), who develops fast new onset AF with a heart rate of 140-160 bpm, your primary treatment strategy consists of:	Response	%
Supplement electrolytes (magnesium and/or potassium) to a high normal level	86	23.76%
Supplement electrolytes to a high normal level and anti-arrhythmics	194	53.59%
Supplement electrolytes to a high normal level and DC cardioversion	23	6.35%
Anti-arrhythmics only	3	0.83%
DC cardioversion only	0	0.00%
DC cardioversion when anti-arrhythmics and electrolyte replacement fail to achieve rate and/or rhythm control	54	14.92%
I only intervene if blood pressure drops or inotrope requirements increase	2	0.55%
Total	362	100.00%

b)

Electrolytes level targets in the management of atrial fibrillation

a)

In critically ill patients with new onset fast AF, which Serum Potassium level would you aim for?	Response	%
>3.5mmol/l	3	0.83%
>4 mmol/l	82	22.65%
>4.5 mmol/l	269	74.31%
>5 mmol/l	7	1.93%
I do not aim for a specific serum potassium level	1	0.28%
Total	362	100.00%

b)

In critically ill patients with new onset fast AF, which Serum Magnesium level would you aim for?	Response	%
0.75-1 mmol/l	30	8.29%
1.0-1.2 mmol/l	216	59.67%
>1.2 mmol/l	71	19.61%
I do not aim for a specific serum magnesium level	45	12.43%
Total	362	100.00%

d)

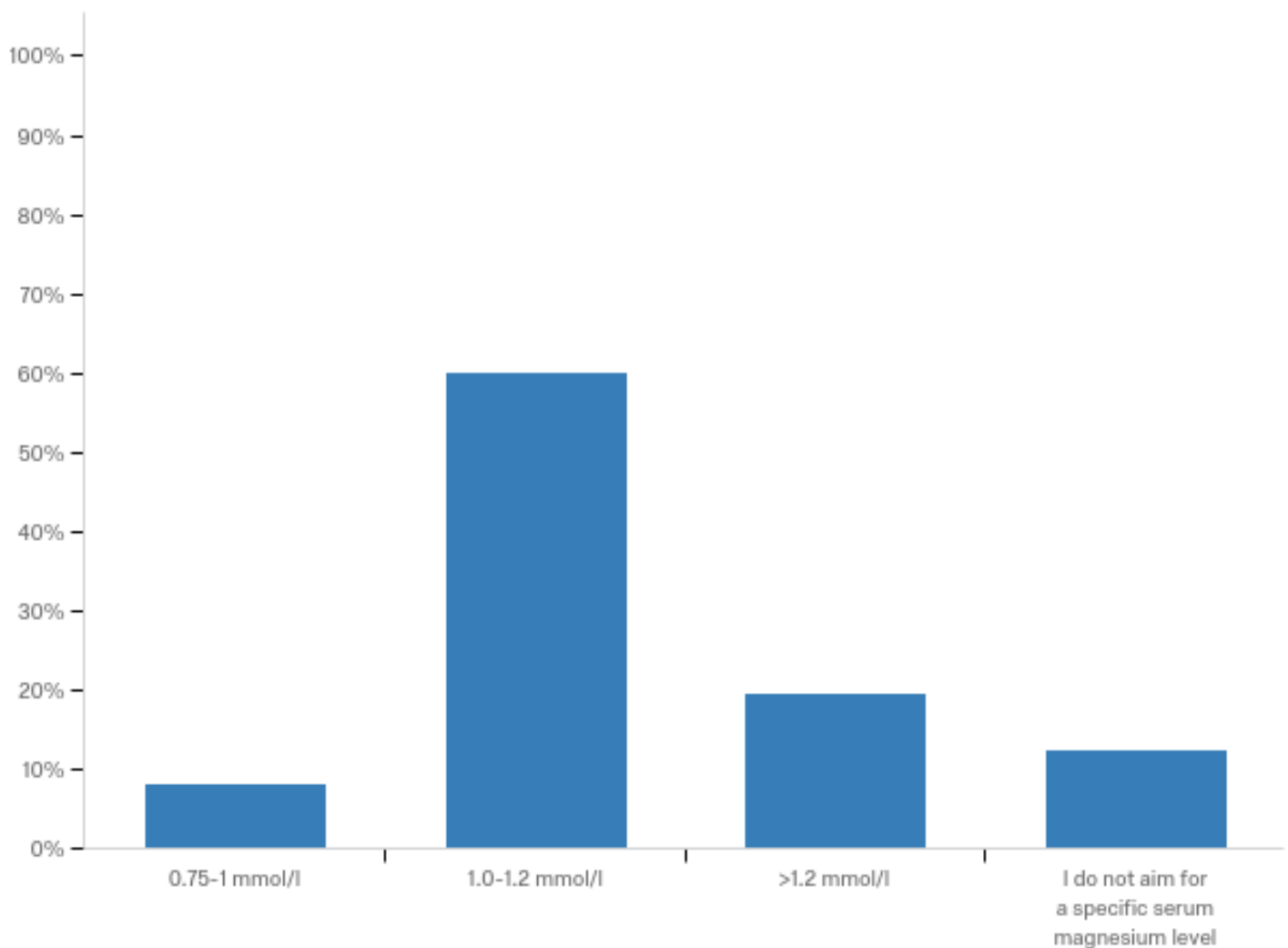



Figure 4

Rationale for choosing anti-arrhythmic treatment for new-onset AF in critically ill patients. Other reasons given included "Effectiveness", "Chance of cardioversion", "Amiodarone works".

a)

Rationale for choosing anti-arrhythmic treatment for new-onset AF in critically ill patients.	Response	%
Availability from hospital pharmacy	53	8.40%
ICU drug policy	109	17.27%
Cost	12	1.90%
Pharmacokinetic advantages	109	17.27%
Pharmacodynamic properties	176	27.89%
Adverse effect profile	123	19.49%
Other, please specify:	49	7.77%
Total	631	100%

b)