

RESUSCITATION AFTER CARDIAC SURGERY AWARENESS, AN EGYPTIAN MULTICENTRE SURVEY

Authors and Institutions

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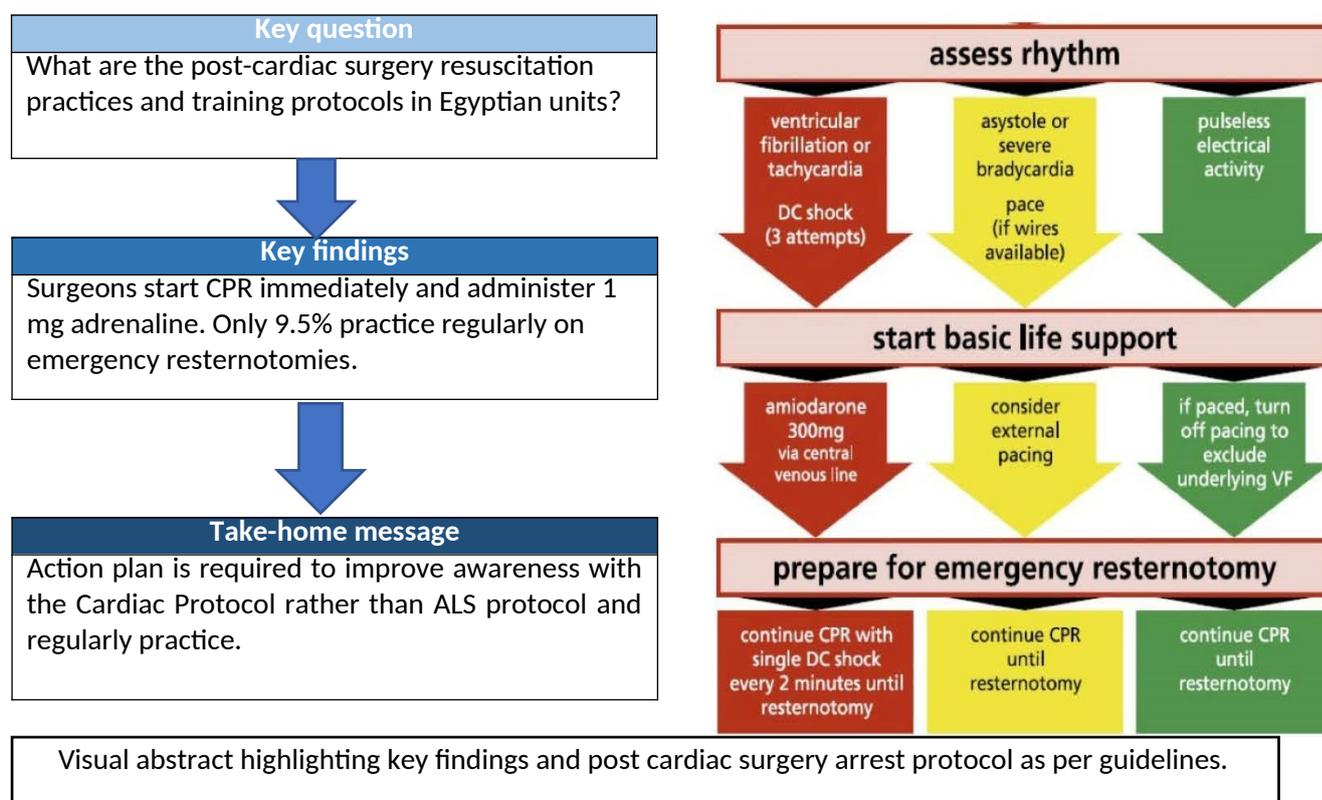
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Abstract

Cardiac surgery patients have different resuscitative needs than other patients who experience in-hospital cardiac arrest, this was addressed in the guidelines. However, it is unknown how widely the guidelines are practiced, or a training protocol is followed in different cardiac surgery units in Egypt.

Methods

A 21-question survey is created and included: Participants demographics, Prevalence of cardiac arrest, Cardiac arrest protocol, Emergency re sternotomy technique, Training protocols. Survey was disseminated through social media messaging platforms during the period between November 2020 and January 2021.

Results

95 responses were from 11 centres across Egypt. 68.5% of the respondents were surgeons, 76.8% of participants were junior surgeons.

For patients who go into VF after cardiac surgery, respondents would attempt a median of 3 shocks with only 24.2% commencing defibrillation shocks before external cardiac massage, while the

34 majority initiating CPR immediately and performing emergency re sternotomy in a median time of 10
35 mins. 56.8% would give 1 mg of adrenaline as soon the cardiac arrest was established.
36 If a surgeon was not available, only 36.8% of respondents would allow any trained personnel to
37 perform the emergency re sternotomy. Only 9.5% practice regularly on emergency sternotomies.
38 75% think tailored training is important and staff should be oriented about it in the future.

39 **Conclusion**

40 An action plan is required to improve the awareness of the junior surgeons with the Cardiac
41 Advanced Life Support Protocol.

42

43 Keywords: Cardiac surgery, Resuscitation, Training, Education

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45

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52 **Abbreviations and acronyms**

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| | |
|-------|--|
| ACLS | Advanced Cardiac Life Support |
| AHA | American Heart Association |
| ALS | Advanced Life Support |
| CPR | Cardiopulmonary Resuscitation |
| EACTS | European association of cardiothoracic surgery |
| ECM | External cardiac massage |
| ERC | European resuscitation council |
| ICU | Intensive care unit |
| ROSC | Return of spontaneous circulation |
| PEA | Pulseless electrical activity |
| STS | Society of Thoracic Surgeons |
| VF | Ventricular fibrillation |
| VT | pulseless Ventricular tachycardia |

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56 **Introduction**

57 Every year, over 250,000 patients have cardiac surgery in some 450 centres in Europe [1] and more

58 than 400,000 patients undergo cardiac surgery in the United States at approximately 1,200 medical

59 centres [2-4]. During the past decade, there has been an increasing recognition that cardiac surgery

60 patients have different resuscitative needs than other medical and surgical patients who experience

61 in-hospital cardiac arrest. The special resuscitative needs of cardiac surgery patients were addressed

62 in the 2010 European Resuscitation Council (ERC) Guidelines for Resuscitation in the section

63 reviewing cardiac arrest in special circumstances and the 2010 American Heart Association (AHA)

64 Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care in Special
65 Situations. [5-6]. However, it's unknown how widely the guidelines are practiced, or a training
66 protocol is followed in different units in Egypt. This national survey aims to identify the views and
67 common practice of Egyptian cardiac surgery teams regarding resuscitation after cardiac surgery.

68 **Methods and Materials.**

69 A 21-question survey is created (Table 1) based on the original survey used by the European
70 Association of Cardiothoracic Surgery (EACTS) guidelines committee.[7] Questions included the
71 following topics: Participants demographics, Prevalence of cardiac arrest in the intensive care unit,
72 Cardiac arrest with ventricular fibrillation or non-shockable rhythm, Emergency resternotomy
73 technique, Training and arrest protocols. Survey dissemination was through social media platforms
74 and mobile messaging applications and emails during the time period between November 2020 and
75 January 2021. Ethics approval and informed consent have been waived by the institutional review
76 board.

77 **Demographics**

78 The first eight questions were used to obtain demographic data on the expertise of the respondent,
79 the size of the unit and the prevalence of cardiac arrest and emergency resternotomy in the unit
80 where the respondent worked.

81 **Data cleaning**

82 Prior to analysis the data from all respondents were analysed independently and excluded if the
83 multiple choice, numerical or text responses indicated that the survey had been incorrectly
84 completed or if multiple respondents came from the same email address. Respondents were
85 excluded if there were no responses to over 50% of the questions or if the numerical data responses
86 were impossible (i.e., more arrests than operations performed in that unit).
87

88 **Statistical analysis**

89 Continuous data are presented as median, mean, standard deviation and range, or only as median if
90 the data was significantly skewed using the Kolmogorov—Smirnov test. Categorical data was

91 presented as percentages. Data was presented and analysed using SPSS 13.0 (Statistical Package for
92 the Social Sciences, SPSS Inc Chicago, USA).

93 (Table 1. depicting survey questions.)

| | |
|----|---|
| 94 | Demographics |
| 95 | 1- What's your speciality? |
| 97 | (a) Cardiothoracic surgeon |
| 98 | (b) Cardiac surgery Anesthesiologist |
| | (c) Cardiac surgery intensive care specialist |
| | 2- What's your degree of expertise? |
| | a) Consultant grade |
| | b) Non consultant/Middle grade/specialist/ in training |
| | 3- What's the name of your hospital? |
| | Prevalence of cardiac arrest in the intensive care unit |
| | 4- How many cardiac surgical procedures did your unit perform in the past 12 months? |
| | 5- How many patients in the past 12 months do you estimate required closed chest compressions for cardiac arrest in your cardiac intensive care following cardiac surgery? |
| | 6- How many patients in the past 12 months who suffered a cardiac arrest on your cardiac intensive care unit required emergency re sternotomy as part of the resuscitation? |
| | 7- How many patients in the past 12 months who required an emergency re sternotomy also required a return onto cardiopulmonary bypass? |
| | 8- Of all patients who arrested, what percentage of these do you estimate survived to hospital discharge? |
| | Cardiac arrest with ventricular fibrillation |
| | 9- Regarding patients who go into ventricular fibrillation or pulseless ventricular tachycardia on your cardiac intensive care have you ever experienced successful return to a spontaneous circulation with a precordial thump? |
| | (a) I have witnessed one or more successful occasions |
| | (b) I have never witnessed this, but I have heard of success in cardiac surgical patients |
| | (c) I have never witnessed or heard of success, but I would have a go if I thought it was appropriate |
| | (d) I have never witnessed or heard of success and I think that it is benign but of little use |
| | (e) I think that this is a potentially harmful manoeuvre and would not condone its use |
| | 10- If a patient goes into ventricular fibrillation or pulseless ventricular tachycardia on your cardiac intensive care after cardiac surgery do you think that they should: |
| | (a) Receive immediate external chest compressions followed by defibrillation as soon as available |
| | (b) Have defibrillation as soon as possible and only commence external chest compression after 1—3 attempts at defibrillation have failed |
| | 11- on your unit if a patient goes into ventricular fibrillation or pulseless ventricular tachycardia what is your preferred sequence of defibrillation attempts? |
| | (a) I would perform three attempts at defibrillation in a row, then commence chest compressions for 2 min with a single shock after each 2-min cycle |
| | (b) I would perform single attempts at defibrillation with external chest compressions for 1 min between attempts |
| | (c) I would perform single attempts at defibrillation with external chest compressions for 2 min between attempts |
| | (d) I would perform three attempts at defibrillation in a row, with external chest compressions till re sternotomy |
| | 12- For patients in established cardiac arrest when do you think that administration of epinephrine (adrenaline) is warranted? |
| | (a) As soon as possible |
| | (b) after 2 min of external massage |
| | (c) After 3—5 min of external massage |
| | (d) After 5—10 min of external massage |
| | (e) Only after continued cardiac arrest despite emergency re sternotomy |
| | (f) Only in exceptional circumstances and should not be part of routine cardiac arrest management after cardiac surgery |
| | 13- If you had to name a number of defibrillation attempts or a rough time at which you felt that a patient less than 24 h after cardiac surgery in ventricular fibrillation should have emergency re sternotomy what would it be? (number of attempts and number of minutes) |
| | 14- If you had to name a number of defibrillation attempts or a rough time at which you felt that a patient MORE than 24 h after cardiac surgery in ventricular fibrillation should have emergency re sternotomy what would it be? (number of attempts and number of minutes) |
| | Cardiac arrest where the rhythm is not VF or pulseless VT. |

100 **Results**

101

102 Of 126 responses, 95 were suitable for inclusion. 31 responses were deleted due to duplication or
103 incorrect completion. We have responses from over 11 centres across Egypt, 54.7% of respondents
104 were from one centre, the rest were from other different centres. 68.5% of the respondents were
105 surgeons while cardiac anaesthetists and intensivists formed 12.6% and 18.9% respectively. The
106 majority of participants were non-consultants/middle-grade doctors comprising 76.8%, consultant
107 participation was 23.2%.

108

109 The median number of cases performed in the units of respondents was 480 and this ranged from 10
110 to 3000. The average percentage of cardiac arrests in these units was 7% and the average
111 percentage of emergency re-sternotomy after cardiac arrest was 2.4%. Respondents reported that
112 the median survival to hospital discharge of all arrests was 33%.

113

114 Concerning a precordial thump
115 in ventricular fibrillation (VF) or
116 pulseless ventricular tachycardia
117 (VT), 37.9% of respondents had
118 seen this work at least once. In
119 addition, 15.8% had heard of its

10- If a patient goes into ventricular fibrillation or pulseless ventricular tachycardia on your cardiac intensive care after cardiac surgery do you think that they should:
95 responses



DC shocks in a VF arrest situation.

120 successful use and an additional 14.7% would have a go even though they have never heard of a
121 success. Only 12.6% felt that this might be harmful & 18.9% think it's of little use.

122 In patients who arrest with VF or VT, only 24.2% of respondents would commence 1-3 defibrillation
123 shocks then perform external cardiac massage (ECM), with the majority initiating CPR immediately
124 (Figure 1).

125

126 Regarding the sequence of
127 defibrillation attempts
128 interspersed with ECM, 50.5% of
129 respondents would perform
130 three attempts at defibrillation

12- For patients in established cardiac arrest when do you think that administration of epinephrine (adrenaline) is warranted?
95 responses

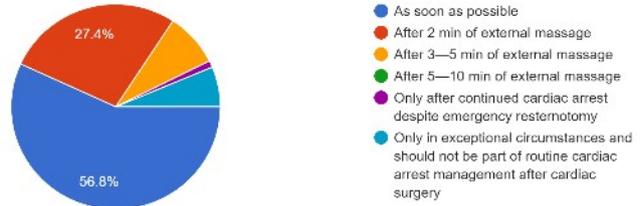


Figure 2 Adrenaline administration patterns after cardiac arrest.

131 without intervening ECM, and 35.8% of these respondents would then perform two minutes of ECM
132 before further attempts. 49.4% would perform single defibrillation attempts interspersed with ECM
133 at 1- or 2-minute intervals, and 56.8% of respondents would give 1 mg of adrenaline as soon the
134 cardiac arrest was established. Only 6.3% of respondents thought that it should be given rarely or
135 not at all. (Figure 2).

136

137 For patients who go into VF in less than 24 hours after cardiac surgery, respondents would attempt a
138 mean of 3 shocks prior to emergency resternotomy, and would hope to do this in a median time of
139 10 mins. They would also perform an emergency resternotomy within 15 min if the rhythm was not
140 VF. While for patients who suffer cardiac arrest more than 24 hours after the surgery results were, a
141 median of 5.6 attempts of defibrillation and a median of 17.6 minutes to perform emergency
142 resternotomy. (Table 2).

143 Table 2.

144

| | Number of responses | Median | Range |
|---|---------------------|-----------|--------------------|
| Number of defibrillations attempts before resternotomy in VF/VT | | | |
| Cardiac arrest <24 h | 95 | 3 shocks | 14 (min 1, max 15) |
| Cardiac arrest > 24 h | 95 | 5 shocks | 19 (min 1, max 20) |
| Time to resternotomy where initial rhythm is VF/VT | | | |
| Cardiac arrest <24 h | 95 | 10 mins | 29 (min 1, max 30) |
| Cardiac arrest > 24 h | 95 | 17.6 mins | 58 (min 2, max 60) |
| Time to resternotomy where initial rhythm is asystole/PEA | | | |
| Cardiac arrest <24 h | 95 | 15 mins | 44 (min 1, max 45) |
| Cardiac arrest > 24 h | 95 | 17.6 mins | 44 (min 1, max 45) |

145

146 A series of questions were asked on the conduct of an emergency resternotomy in patients who
147 have suffered a cardiac arrest (Table 3). If a surgeon was not immediately available 36.8% of

148 respondents would be happy for a suitably trained non-surgeon to perform the emergency
149 resternotomy while 58.9% of respondents would not be happy for anyone except a surgeon to
150 perform the resternotomy. Of respondents who would allow a non-surgeon to perform an
151 emergency resternotomy, 33.7% would allow anyone trained for the procedure to do it, 14.4%
152 would allow an anaesthesiologist, 17.9% would allow intensive care doctor, and 12.6% would allow a
153 junior grade doctor to perform an emergency resternotomy. Only 9.5% and 3.2% would allow a
154 theatre scrub nurse and a senior intensive care nurse respectively to do this.

155

156 49.4% of the participants have never practised any local training to perform an emergency
157 sternotomy however 34.7% believe it is a must-have. 41% of the respondents state they occasionally
158 practice or talk with the staff about guidance in the event of a cardiac arrest. Only 9.5% practice
159 regularly on emergency sternotomies.

160 25% assume current training is sufficient and does not need modification or additional patient
161 tailoring, while 75% think tailored training is important and staff should be oriented about it in the
162 future.

163 70.5% of all respondents advocate the current guidelines for resuscitation published by the ERC,
164 EACTS, and the AHA for use on their patients, however, 5% disagree with the guidelines and have
165 their own local protocol. Meanwhile, 24.2% have not read the guidelines.

166 **Discussion**

167 The incidence of cardiac arrest after cardiac surgery is around 0.7–7% [8-16] and has reduced in
168 recent years. The most remarkable statistic regarding these patients is the relatively good outcome
169 with 17–79% of patients suffering a cardiac arrest surviving to hospital discharge, a far higher
170 proportion than can be hoped for when cardiac arrest occurs in other settings. The reason for this
171 superior survival is the high incidence of reversible causes for the arrest. Ventricular fibrillation (VF)
172 accounts for 25–50% of cases and, in the intensive care unit (ICU) setting, this is immediately

173 identified and treated. Also, tamponade and major bleeding account for many arrests and both
174 conditions may be quickly relieved by prompt resuscitation and emergency resternotomy where
175 appropriate.

176 Prompt recognition and treatment by ICU staff trained in the recognition and management of these
177 arrests improved survival. Practicing protocol-based arrest management has been shown to reduce
178 by 50% the time to chest reopening and reduce complications resulting from the resternotomy after
179 cardiac surgery [17-22].

180
181 EACTS endorsed resuscitation guidelines for this special group, this is further followed by the
182 European Resuscitation Council and American Heart Association in 2010 and finally endorsed in the
183 STS expert consensus in 2017. Our survey gives an insight into current practices in the Egyptian
184 cardiac surgery centres and the degree of orientation and adoption of guidelines.

185 In our study, 68.5% of the respondents were cardiac surgeons, of which are 76.8% middle grade/
186 resident/ junior doctors. This is representative of first responders to cardiac arrest call in a routine
187 practice thus it's crucial to identify knowledge and practices to evaluate the quality and safety of
188 patient care.

189
190 Our respondents will act in a VT/VF cardiac arrest situation as follows, 75% will start CPR, 57% will
191 give adrenaline immediately, almost 50% will perform single attempts of defibrillation between
192 external cardiac massage either at 1- or 2-minute intervals. They will undertake a median of 3 shocks
193 or 10 minutes to perform an emergency resternotomy if within 24 hours of the surgery. These
194 figures increased if the surgery was more than 24 hours ago, with a median of 5 shocks and 17.5
195 minutes to emergency resternotomy. All of which are more in line with Advanced Life Support (ALS)
196 or Advanced Cardiac Life Support (ACLS) protocols and not the protocol dedicated for cardiac
197 surgery and advocated by current guidelines.

198
199 The current guidelines advocate, once cardiac arrest is identified, to assess the rhythm first and not
200 to commence chest compressions as in ALS protocol, reason being the possibility of presence of
201 shockable rhythm such as VF or pulseless VT in 25 - 50% of cases [22]. If a shockable rhythm is
202 identified, chest compressions could be delayed for up to 1 minute to deliver 3 shocks as this might
203 spare the traumatic chest compressions to a fresh sternotomy wound and avoid complications of
204 cardiac/graft injury.

205
206 In the cardiac surgical patient, the efficacy of defibrillation reduces by 10% for every minute delay, in
207 addition, success rates for immediate sequential shocks for VF or pVT decline from 78% with the first
208 shock to 14% with the third, therefore immediate defibrillation with three sequential attempts at
209 150 Joules is advised.[24] While in sever bradycardia or asystole, it is advisable before starting chest
210 compressions to turn the pacing to emergency setting or DDD mode, 90 beats, maximum amplitude.

211
212 No study concluded benefit or harm of administering adrenaline during resuscitation of the
213 postoperative cardiac surgical patient however, the risk of administering adrenaline in conventional
214 doses is with profound hypertension, bleeding, or tearing of vessel anastomoses on return of
215 spontaneous circulation (ROSC), which can precipitate catastrophic harm or further cardiac arrest.
216 [25] Therefore the recommendation to administer adrenaline is to be delayed until reversible causes
217 of arrest are excluded and directed by a senior clinician experienced in their use. Adrenaline remains
218 a useful drug in peri-arrest situations in smaller doses.

219
220 Of concern, almost 60% would not prefer anyone but the surgeon to perform a resternotomy, not
221 junior surgical trainees or non-surgeon colleagues even if trained for it. Nonetheless, 40% would
222 allow anyone trained for emergency sternotomy to perform it in case of cardiac arrest, of note the
223 highest percentage is 17.9% for the intensive care doctors. This could be due to the fact that junior
224 surgeons in the majority of cardiac units in Egypt are the ones actually managing cardiac intensive

225 care, thus being familiar with surgical problems and have enough skills to perform an emergency
226 sternotomy. Senior intensive care or theatre nurses whether were accepted to perform emergency
227 resternotomy by only 13% of the respondents, we believe the reason being the lack of training or
228 fear of medicolegal pursuits and claims.

229 Despite 70.5% of respondents advocate the current guidelines for resuscitation, only 50% of answers
230 indicate there is either occasional discussion with the team on a cardiac arrest protocol (41.1%) or
231 regular training (9.5%). The remaining 49.4% of the respondents concur there is no training available
232 however, 75% believe in its importance and would endorse it in their units.

233
234 An immediate postcardiac arrest care algorithm can offer structured guidance to facilitate the
235 identification and treatment of the potential causes of the arrest, prevention of arrest recurrence,
236 optimization of cardiac output and oxygen delivery during the arrest, and implementation of
237 neuroprotective strategies after the return of spontaneous circulation. Thus, the need to raise the
238 awareness and training of the junior surgical doctors and intensive care staff with current guidance
239 and emergency sternotomy protocols is paramount.

240
241 The core message for our trainees and fellows; external chest compressions is ineffective in
242 tamponade, tension pneumothorax and extreme hypovolemia. Brain damage will occur in 5 minutes,
243 the only way to save those patients is to perform a rapid smooth emergency resternotomy.

244

245 **Limitations**

246 Our study has several limitations. Dissemination through social media is dependent on personal
247 efforts to reach our target audience, which explains the small number of respondents and the
248 reason 60% of the responses are from one centre. However, this was the best available alternative
249 as there is no structured method in Egypt for data collection from multiple centres.

250 Data regarding the number of procedures, closed chest compressions, re-sternotomy, and going back
251 on bypass rates are mere speculations of the respondents and may not represent the actual figures
252 and numbers as 77% of the respondents are middle-grade doctors and might not always be oriented
253 with the numbers, also it is not feasible to access these institutional numbers easily. Moreover,
254 COVID 19 pandemic has significantly impacted the number of procedures performed and could be a
255 valid reason for the heterogeneity of data from respondents from the same centre.

256

257 **Conclusion**

258 Resuscitation after cardiac surgery has a high survival rate due to the high incidence of reversible
259 causes. A structured protocol and a well-trained staff are advocated by the current resuscitation
260 guidelines. An action plan is required to improve the awareness of the junior surgeons with the
261 Cardiac Advanced Life Support Protocol. Proper training of the intensive care staff to implement the
262 protocol in a timely organised manner is needed. Emergency re-sternotomy under 5 minutes is the
263 only effective way to save patients with tamponade and extreme hypovolemia.

264 **Conflict of interest Statement**

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269 **Author contribution statement**

270 Author 1 contributed to conception, design, analysis, interpretation and writing of the work.

271 Author 2, 3 and 4 contributed to data acquisition and revising the manuscript.

272 **Supplementary tables**

273 **Table 3**

274

| | Responses | percentages |
|---|-----------|-------------|
| (6) Precordial thump (total) | 95 | |
| (a) Witnessed | 36 | 37.9% |
| (b) Heard of success | 15 | 15.8% |
| (c) Have a go | 14 | 14.7% |
| (d) Of little use | 18 | 18.9% |
| (e) Potentially harmful | 12 | 12.6% |
| (7) Defibrillation or ECM for VF | 95 | |
| (a) Immediate ECM | 72 | 75.8% |
| (b) Immediate defibrillation | 23 | 24.2% |
| (8) Sequence of shocks for VF | 95 | |
| (a) Three attempts, 2 min ECM then single shocks | 34 | 35.8% |
| (b) Single attempts with 1 min ECM | 12 | 12.6% |
| (c) Single attempts with 2 min ECM | 35 | 36.8% |
| (d) Three attempts, ECM till resternotomy | 14 | 14.7% |
| (9) When is adrenaline warranted | 95 | |
| (a) As soon as possible | 54 | 56.8% |
| (b) After 2 min of ECM | 26 | 27.4% |
| (c) After 3–5 min after ECM | 8 | 8.4% |
| (d) Only after emergency resternotomy | 1 | 1.1% |
| (e) Only in exceptional circumstances | 6 | 6.3% |
| (15) Emergency resternotomy | 95 | |
| (a) A surgeon should always do this | 56 | 58.9% |
| (b) A trained non-surgeon could do this | 35 | 36.8% |
| (c) Any non-surgeons could do this | 4 | 4.2% |
| (17) Do you train for emergency resternotomy | 95 | |
| (a) We never practise, not necessary | 14 | 14.7% |
| (b) We never practise might be good idea | 33 | 34.7% |
| (c) Informal talks and experience | 11 | 11.6% |
| (d) We have occasionally practised | 28 | 29.5% |
| (e) We regularly practise | 9 | 9.5% |
| (18) Current guidelines for the ICU | 95 | |
| (a) I advocate the ERC/AHA 2005 guidelines | 67 | 70.5% |
| (b) I do not agree with these, we have our own protocol | 1 | 1.1% |
| (c) I do not agree with these, we have no protocol | 4 | 4.2% |
| (d) I have not read the ERC/AHA guidelines | 23 | 24.2% |
| (19) Current training | 95 | |
| (a) It is adequate currently but not tailored | 17 | 17.9% |
| (b) We give additional training | 7 | 7.4% |
| (c) Tailored training might be useful | 18 | 18.9% |
| (d) Tailored training is important and should be given | 53 | 55.8% |

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294 **References**

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