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Out-of-hospital Cardiac Arrest across the World: First Report from the International Liaison Committee on Resuscitation (ILCOR)

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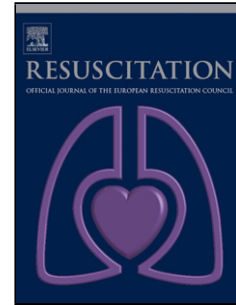
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Out-of-hospital Cardiac Arrest across the World: First Report from the International Liaison Committee on Resuscitation (ILCOR)

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1 **Out-of-hospital Cardiac Arrest across the World: First Report from the International**

2 **Liaison Committee on Resuscitation (ILCOR)**

3

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58

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60

61 **ABSTRACT**

62 **Background:** Since development of the Utstein style recommendations for the uniform reporting
63 of cardiac arrest, increasing numbers of national and regional out-of-hospital cardiac arrest
64 (OHCA) registries have been established worldwide. The International Liaison Committee on
65 Resuscitation (ILCOR) created the Research and Registries Working Group and aimed to
66 systematically report data collected from these registries.

67 **Methods:** We conducted two surveys of voluntarily participating national and regional registries.
68 The first survey aimed to identify which core elements of the current Utstein style for OHCA
69 were collected by each registry. The second survey collected descriptive summary data from
70 each registry. We chose the data collected for the second survey based on the availability of core
71 elements identified by the first survey.

72 **Results:** Seven national and four regional registries were included in the first survey and nine
73 national and seven regional registries in the second survey. The estimated annual incidence of
74 emergency medical services (EMS)-treated OHCA was 30.0 to 97.1 individuals per 100,000
75 population. The combined data showed the median age varied from 64 to 79 years and more than
76 half were male in all 16 registries. The provision of bystander cardiopulmonary resuscitation

77 (CPR) and bystander automated external defibrillator (AED) use was 19.1% to 79.0% in all
78 registries and 2.0% to 37.4% among 11 registries, respectively. Survival to hospital discharge or
79 30-day survival after EMS-treated OHCA was 3.1% to 20.4% across all registries. Favourable
80 neurological outcome at hospital discharge or 30 days after EMS-treated OHCA was 2.8% to
81 18.2%. Survival to hospital discharge or 30-day survival after bystander witnessed shockable
82 OHCA ranged from 11.7% to 47.4% and favourable neurological outcome from 9.9% to 33.3%.

83 **Conclusion:** This report from ILCOR describes data on systems of care and outcomes following
84 OHCA from nine national and seven regional registries across the world. We found variation in
85 reported survival outcomes and other core elements of the current Utstein style recommendations
86 for OHCA across nations and regions.

87

88 Key words

89 Out-of-hospital cardiac arrest, Utstein template, Epidemiology, Resuscitation, Registry

90

91 **MAIN TEXT**92 **Introduction**

93 Out-of-hospital cardiac arrest (OHCA) is a global health issue. The incidence of emergency
94 medical services (EMS)-treated OHCA has been reported as 40.6 per 100,000 person-years in
95 Europe, 47.3 in North America, 45.9 in Asia, and 51.1 in Australia.[1] Patient outcomes after
96 OHCA vary substantially by region but are generally poor, suggesting opportunities for
97 improvement.[2–6]

98 A high-quality registry with a uniform collecting system enables better understanding
99 of the epidemiology of OHCA, facilitates inter-system and intra-system comparisons, identifies
100 knowledge gaps, supports clinical research, and may help to influence performance and improve
101 survival after OHCA.[7] The Utstein style was originally developed to facilitate uniform
102 reporting of terms and to standardise definitions for out-of-hospital resuscitation.[7] The
103 International Liaison Committee on Resuscitation (ILCOR) has revised and updated the Utstein
104 style recommendations for OHCA in 2004 and 2014.[8–11]

105 Along with the development and revisions of the Utstein style recommendations,
106 increasing numbers of OHCA registries have been established in Europe,[2, 12–17] North

107 America,[18–21] Asia,[22, 23] and Oceania[24, 25]. However, to date, there has been a paucity
108 of systematic collection and reporting of data from existing registries.[26] A Research and
109 Registries Working Group was created by ILCOR with the objective of establishing a system to
110 collect descriptive data on systems of care and outcomes following OHCA from registries across
111 the world, which could potentially enable benchmarking and possibly improvement of patient
112 outcomes from cardiac arrest.[27] This article describes the initial findings of the working group.
113

114 **Methods**

115 The ILCOR Research and Registries Working Group conducted three face-to-face meetings and
116 five teleconferences between January 2016 and September 2017, and a consensus was reached
117 for a strategy to collect data from participating registries. Participation in this project by
118 registries was voluntary. We conducted two surveys of the participating national and regional
119 registries (**Table 1**): the first survey aimed to describe which of the Utstein elements were
120 collected by each registry and the second survey aimed to report summary data from each
121 registry to describe characteristics of OHCA in the nation or region. The first survey assessed
122 which core elements of the latest Utstein style recommendation for OHCA in 2014 were
123 collected by each registry,[10, 11] and identified any discrepancies in the data collection process.
124 Based on the availability of the data elements in each registry in the first survey, we chose the
125 elements for the second survey and descriptively reported the 2015 summary data from each
126 registry. If 2015 data were not available, the most recently available data were reported. The data
127 from the Rescu Epistry in Toronto, Canada were extracted from a published paper.[28] We
128 included population-based registries which covered all EMS resuscitation attempted OHCA in
129 each area. We defined a national registry as one that collected data from the whole nation or

130 multiple regions within one nation designated to be representative of the whole nation; other
131 registries were designated as regional registries. We calculated the estimated annual incidence of
132 EMS-treated OHCA at each registry, using the annual number of EMS-treated OHCA as the
133 numerator and the total population of covered area as the denominator. When a registry collected
134 type of bystander cardiopulmonary resuscitation (CPR), i.e., conventional CPR with rescue
135 breathing or chest compression-only CPR, we presented proportion of patients who received
136 each type of bystander CPR among EMS resuscitation attempted OHCAs in the registry.
137 Similarly, when a registry collected data on the application of an AED and shock delivery by a
138 bystander, we presented the proportion of those who had an AED applied and a shock delivered.
139 When we calculated the proportion of those who received bystander CPR, had an AED applied,
140 and received an AED shock, we excluded EMS-witnessed OHCA from the denominators
141 because those with EMS-witnessed OHCA did not have the opportunity to have these bystander
142 interventions. Survival outcomes were reported for both all EMS-treated OHCAs and
143 bystander-witnessed shockable OHCAs. Favourable neurological outcome was defined as
144 Cerebral Performance Category (CPC) 1 or 2, or modified Rankin Scale ≤ 3 following the Utstein
145 recommendation.[10, 11] We used a secure electronic database, Research Electronic Data

146 Capture (RED Cap) for data collection for both surveys and data management.[29]

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148 **Results**

149 Eighteen registries were invited to participate in the first survey. Seven national and 4 regional
150 OHCA registries responded and are included in the first survey results. Thirty-seven registries
151 were invited to participate in the second survey, 14 did not respond to the invitation, and 7 were
152 not population-based registries. As a result, 9 national and 7 regional registries are included in
153 the second survey results. (**Table 1**) Based on the differences between the elements measured by
154 each registry and the core elements of Utstein 2014 OHCA style recommendations, we excluded
155 the following elements from the secondary survey: dispatcher-identified cardiac arrest,
156 resuscitation not attempted (because of a written *do not attempt cardiopulmonary resuscitation*
157 order or obvious death), targeted temperature management (TTM) indication, vasopressin use,
158 reperfusion (e.g. percutaneous coronary intervention, PCI) attempted, and type and timing of
159 reperfusion. (**Supplemental Table**)

160 We report the results of the second survey, summary data of core elements of the Utstein
161 template from each participating registry in 2015 in **Tables 2-5, and Figure 1**. All registries were
162 population-based and national registries included between 25.0% to 100% of the national
163 population. (**Table 2**) The estimated annual incidence of EMS-treated OHCA ranged from 30.0

164 to 97.1 individuals per 100,000 population. Seven registries recorded dispatcher CPR
165 instructions, which ranged from 1.6% to 54.7% of EMS-treated OHCA across registries.
166 Median age varied from 64 to 79 years and more than half of patients were male in all registries.
167 **(Table 3)** All registries reported witness status and 37.0% to 69.8% of OHCA were witnessed
168 by a bystander. Fourteen registries recorded the location of OHCA and 51.6% to 85.3% occurred
169 at home. All registries reported bystander CPR and 11 registries reported bystander AED use
170 **(Figure 1 and Table 3)**. The provision of bystander CPR ranged from 19.1% to 79.0% in all
171 registries **(Figure 1)**. Six registries recorded types of bystander CPR. Chest compression-only
172 bystander CPR was provided for 15.4% to 46.9% of OHCA. Bystander AED use varied from
173 2.0% to 37.4% and shock delivered from 0.5% to 7.2% **(Table 3)**. Fourteen registries recorded
174 the cause of cardiac arrests, and the proportion of documented as medical cause ranged from
175 52.0% to 95.2%. Thirteen registries recorded EMS response time, the interval from incoming call
176 to the time that the first emergency response vehicle stopped at the scene, with median intervals
177 ranging from 5 to 11 minutes **(Table 4)**.

178 All registries recorded survival to hospital discharge or 30-day survival and 11 registries
179 recorded favourable neurological outcome at hospital discharge or 30 days after EMS-treated

180 OHCA (**Table 5**). Survival to hospital discharge or 30-day survival after EMS-treated OHCA
181 varied from 3.1% to 20.4% across all registries. Favourable neurological outcome at hospital
182 discharge or 30 days after EMS-treated OHCA varied from 2.8% to 18.2%. Survival to hospital
183 discharge or 30-day survival after bystander witnessed shockable OHCA ranged 11.7% to 47.4%
184 and favourable neurological outcome was from 9.9% to 33.3%.
185

186 **Discussion**

187 This ILCOR report presents a descriptive summary of OHCA systems of care and outcome data
188 from 16 national and regional OHCA registries across the world. The data show that most
189 registries are collecting and reporting core elements of the Utstein data set.[10, 11] There is a
190 6.6-fold difference in survival to hospital discharge or 30-day survival (3.1% to 20.4%) and a
191 6.5-fold difference in favourable neurological outcome at hospital discharge or at 30 days (2.8%
192 to 18.2%) after EMS-treated OHCA across the registries. Importantly, direct comparison of the
193 outcomes between registries is not appropriate because of multiple confounders: system, dispatch,
194 patient, and process that are measured and unmeasured in the latest Utstein style templates. For
195 example, core elements of the latest Utstein templates do not include the following data points
196 which contribute to the denominator for population-based EMS-treated cases, although some of
197 these factors are listed as supplemental elements of system in the Utstein template; (1) criteria to
198 dispatch EMS providers, (2) how prehospital advance directives are handled by dispatcher, (3)
199 legislation prescribing who is mandated to receive resuscitation, (4) determination of futility
200 before starting resuscitation, and (5) determination of who should be transported with continued
201 treatment and who should have their resuscitative efforts terminated at the scene.[10, 11] Each

202 one of these factors at system-level contributes to the determination of who receives an EMS
203 response and if EMS initiates resuscitative effort through a standardized endpoint. The difference
204 in these factors across registries could also explain the observed large variation in the estimated
205 incidence of EMS-treated OHCA in our report. Prior work from the Resuscitation Outcomes
206 Consortium, a multicentre research network in the United States and Canada showed that there
207 was a variability (23.9% to 100%) in the proportion of patients where resuscitation was initiated
208 by EMS in EMS-assessed OHCA across 129 EMS agencies in North America.[30] Future efforts
209 are warranted to capture these known factors that contribute to the denominator for
210 population-based EMS-treated cases across registries. Furthermore, a recent analysis of data
211 from 12 OHCA registries showed that Utstein factors could explain only about half of the
212 variation in OHCA survival between settings.[26]

213 We also reported a 4.1-fold difference in survival to hospital discharge or 30-day survival
214 (11.7% to 47.4%) and a 3.4-fold difference in favourable neurological outcome at hospital
215 discharge or at 30 days (9.9% to 33.3%) for patients with bystander witnessed shockable OHCA.
216 This population can be considered to represent a less heterogeneous group than all EMS-treated
217 OHCA and is a better comparator of system efficacy as recommended in the Utstein style.[10,

218 11] The potential mechanisms of the variation in outcomes after bystander-witnessed shockable
219 OHCA across registries include differences in each Utstein OHCA element: system, dispatch,
220 patient, and process. Importantly, we observed a 4.1-fold difference in the provision of bystander
221 CPR (19.1% to 79.0%) and a 18.7-fold difference in bystander AED use (2.0% to 37.4%). As
222 these interventions are linked closely with favourable outcomes[23, 31–37] and modifiable, it is
223 important to recognize these differences by regions and optimize the provision of bystander CPR
224 and AED use in all communities. This might include widespread training in CPR and AED
225 use[14, 38], media campaigns[39], dispatcher CPR instructions[40–42], and new technologies
226 using a mobile phone to direct nearby registered lay rescuers to the scene.[43–45]

227 We found discrepancies between measured elements in each registry and core elements
228 of the latest Utstein style recommendations for OHCA (e.g., 6/11 registries measured
229 “resuscitation not attempted [because of a written *do not attempt cardiopulmonary resuscitation*
230 decision or obvious death]”, 6/11 “dispatcher identified cardiac arrest”, 3/11 “targeted
231 temperature management indication”, 7/11 “reperfusion attempted”), which is consistent with a
232 previous report.[46] Most of these infrequently measured core elements of the Utstein style
233 recommendations are variables that were newly adopted in 2014, implying that the updated

234 Utstein templates have yet to be widely implemented. As new post cardiac arrest treatments have
235 been developed [47, 48], many of the recently adopted core and supplemental elements include
236 in-hospital post-resuscitation interventions, which implies the need for a comprehensive data
237 collecting system to link prehospital and in-hospital elements. This will necessitate collaboration
238 between EMS systems and medical institutions. The Utstein elements predict survival but
239 account for only a modest portion of regional variation in patient outcome after OHCA,
240 suggesting that there are other unmeasured factors that are contributing to the outcome
241 variability.[5, 49, 50] To capture these important yet to be measured factors, future research
242 should identify these factors and subsequent revision of the Utstein style recommendation is
243 required.

244 The data generated by this global registry report help with understanding the current
245 epidemiology of OHCA and inform quality improvement. We plan to increase the number of
246 participating registries to enable more comprehensive reporting of systems of care and outcomes
247 following OHCA throughout the world. Continuity is also important to assess secular trends of
248 outcomes and evaluate effectiveness of various interventions. We also plan to conduct a similar

249 project for in-hospital cardiac arrest following the Utstein style recommendations for in-hospital
250 cardiac arrests.[51–54]

251 This report has several limitations. First, denominators may not have been standardized
252 across all elements. We intended to include all EMS-resuscitated OHCAs in the denominators,
253 but the failure to include all of these OHCAs in the denominators may account at least partially
254 for the large variation in outcomes such as survival, bystander CPR, and AED use across
255 registries. Second, we were not able to include all core and supplemental elements of the latest
256 Utstein style recommendation for OHCA in 2014 because these data were not available in all
257 registries. Third, although most registries provided data for 2015, the year of data collection was
258 different in two of the registries. Fourth, most of the registries which participated in this survey
259 are from high income nations/regions, so our results may not be applicable to low income
260 nations/regions.

261

262 **Conclusion**

263 Based on the Utstein style recommendations for OHCA reporting, we described the data
264 collected on systems of care and outcomes following OHCA from 9 national and 7 regional
265 registries across the world. We found variation in patient outcomes and in other core elements of
266 the latest Utstein style recommendations for OHCA across nations and regions, suggesting
267 opportunities for improvements in data definitions and reporting system.

268

269

270

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275

276 **Conflict of interest**

277 JPN is Editor-in-Chief, GDP and JS are Editors of Resuscitation.

278 The rest of authors report no conflicts of interest related specifically to this manuscript.

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281 The authors have no financial relationships relevant to this manuscript to disclose.

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449

450 **Figure legend**

451 Figure. Proportion of provision of bystander cardiopulmonary resuscitation among patients with

452 emergency medical services resuscitation attempted out-of-hospital cardiac arrest*

453 * We excluded EMS-witnessed out-of-hospital cardiac arrest

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Table 1. Participating registries

Name of registry	Country	Response to the first survey	Response to the second survey
National/International Registries*			
Cardiac Arrest Registry to Enhance Survival (CARES)	United States	✓	✓
Danish Cardiac Arrest Registry	Denmark		✓
Norwegian Cardiac Arrest Registry	Norway	✓	✓
Swedish Cardiac Arrest Registry	Sweden	✓	
Out-of-hospital Cardiac Arrest Outcomes (OHCAO)	United Kingdom	✓	✓
Australian Resuscitation Outcomes Consortium (Aus-ROC)	Australia		✓
Australian Resuscitation Outcomes Consortium (Aus-ROC)	New Zealand		✓
Pan-Asian Resuscitation Outcomes Study (PAROS)	Singapore	✓	✓
Pan-Asian Resuscitation Outcomes Study (PAROS)	South Korea	✓	✓
Utstein Japan	Japan	✓	✓
Regional Registries			
Saving Hearts in Arizona Registry & Education (SHARE)	United States	✓	✓
Rescu Epistry	Canada		✓
Helsinki Cardiac Arrest Registry	Finland	✓	✓
Pavia Cardiac Arrest Registry (Pavia CARE)	Italy	✓	✓
Ticino Registry of Cardiac Arrest	Switzerland		✓
Pan-Asian Resuscitation Outcomes Study (PAROS)	Tainan City, Taiwan	✓	✓
Sudden Death Expertise Center registry (SDEC)	Paris		✓

*We defined a national registry as one aiming for nationwide coverage and an international registry as one including more than one country.

Table 2. Summary data in Utstein core elements (system and dispatch)

Name of registries	Country	Total population of covered area of the registry	Proportion of population in covered area of the registry among the country's population, %	Population-based	Annual number of attempted resuscitation in 2015	Estimated Incidence of EMS treated OHCA per 100,000 population	Annual number of dispatcher CPR instruction, n (%)
National/International Registries							
Cardiac Arrest Registry to Enhance Survival (CARES)	United States	85,000,000	25.0%	Yes	52,902	62.2	N/A
Danish Cardiac Arrest Registry*	Denmark	5,627,235	100.0%	Yes	4,053	72.0	N/A
Norwegian Cardiac Arrest Registry	Norway	4,793,741	93.0%	Yes	2,298	47.9	N/A
Out-of-hospital Cardiac Arrest Outcomes (OHCAO)	United Kingdom	54,646,932	83.9%	Yes	28,914	52.9	N/A
Australian Resuscitation Outcomes Consortium (Aus-ROC)	Australia	15,215,358	64.0%	Yes	7,120	46.8	N/A
Australian Resuscitation Outcomes Consortium (Aus-ROC)	New Zealand	4,595,720	100.0%	Yes	2305	50.2	N/A
Pan-Asian Resuscitation Outcomes Study (PAROS)	Singapore	5,535,000	100.0%	Yes	2,322	42.0	1,250 (53.8)
Pan-Asian Resuscitation Outcomes Study (PAROS)	South Korea	51,069,375	97.0%	Yes	27,656	54.2	10,432 (37.7)
Utstein Japan	Japan	127,094,745	100.0%	Yes	123,421	97.1	67,488 (54.7)
Regional Registries							
Saving Hearts in Arizona Registry & Education (SHARE)	United States	6,931,071	2.2%	No	4,467	64.4	71 (1.6)
Rescu Epistry [†]	Canada	6,600,000	19.0%	Yes	3,610	54.7	N/A
Helsinki Cardiac Arrest Registry	Finland	639,222	12.0%	Yes	225	35.2	120 (53.3)
Pavia Cardiac Arrest Registry (Pavia CARE)	Italy	547,435	1.0%	Yes	490	89.5	50 (10.2)
Ticino Registry of Cardiac Arrest	Switzerland	350,363	10.0%	Yes	247	70.5	N/A
Pan-Asian Resuscitation Outcomes Study (PAROS)	Tainan City, Taiwan	1,885,390	8.0%	Yes	1,599	84.8	261 (16.3)
Sudden Death Expertise Center registry (SDEC)	Paris	6,800,000	10.0%	Yes	2,040	30.0	N/A

*Data in 2014

[†]Data in 2013

CPR denote cardiopulmonary resuscitation.

Table 3. Summary data for all EMS treated OHCA in Utstein core elements (patient)

Name of registries	Country	Age		Male, n (%)	Witnessed arrest, n (%)			Location, n (%)					AED use by bystander, n (%) [‡]		First monitored rhythm, n (%)	Pathogenesis, n (%)						
		Median (IQR)	Mean (SD)		Bystander witnessed	EMS witnessed	Home/residence	Industrial/workplace	Sports/recreation event	Public building	Educational institution	Assisted living/nursing home	AED use	Shock delivered		Shockable	Medical	Trauma	Drug overdose	Drowning	Electrocution	Asphyxial
National/International Registries																						
Cardiac Arrest Registry to Enhance Survival (CARES)	United States	64 (52, 77)	62.5 (19.4)	32,255 (61.0)	19,558 (37.0)	6,346 (12.0)	36,733 (69.4)	N/A	880 (1.7)	3,780 (7.1)	N/A	5,679 (10.7)	2866 (6.2)	893 (1.9)	10,594 (20.0)	45,243 (85.5)	N/A	N/A	367 (0.7)	36 (0.1)	4,620 (8.7)	
Danish Cardiac Arrest Registry*	Denmark	72 (61, 82)	N/A	2,535 (62.6)	1,808 (44.9)	472 (11.7)	2,866 (72.0)	N/A	N/A	N/A	N/A	N/A	N/A	119 (3.6)	724 (18.7)	N/A	N/A	N/A	N/A	N/A	N/A	
Norwegian Cardiac Arrest Registry	Norway	N/A	66 (18.9)	1,532 (66.7)	1,183 (51.5)	292 (12.7)	1,402 (61.0)	62 (2.7)	34 (1.5)	N/A	N/A	253 (11.0)	256 (12.8)	N/A	575 (25.0)	1,659 (72.2)	85 (3.7)	138 (6.0)	37 (1.6)	N/A	368 (16.0)	
Out-of-hospital Cardiac Arrest Outcomes (OHCAO)	United Kingdom	72.6 (58.2, 82.7)	68.6 (19.2)	17,626 (63.3)	10,742 (46.6)	3,512 (15.2)	N/A	N/A	N/A	N/A	N/A	N/A	443 (2.5)	N/A	5,762 (21.3)	18,831 (92.3)	714 (3.5)	268 (1.3)	55 (0.3)	N/A	524 (2.6)	
Australian Resuscitation Outcomes Consortium (Aus-ROC)	Australia	65 (48, 78)	61.5 (21.2)	4,863 (68.3)	2,687 (38.0)	1,081 (15.2)	4,741 (66.6)	N/A	N/A	N/A	N/A	504 (7.1)	N/A	N/A	1,757 (25.1)	5,058 (71.0)	N/A	N/A	N/A	N/A	N/A	
Australian Resuscitation Outcomes Consortium (Aus-ROC)	New Zealand	66 (52, 77)	61.7 (20.6)	1,540 (66.8)	1,179 (51.1)	678 (29.4)	1,554 (67.4)	N/A	N/A	N/A	N/A	62 (2.7)	N/A	N/A	834 (36.5)	1,790 (77.7)	104 (4.5)	34 (1.5)	25 (1.1)	0	219 (9.5)	
Pan-Asian Resuscitation Outcomes Study (PAROS)	Singapore	67 (56, 77)	65.7 (18.0)	1,512 (65.1)	1,253 (54.0)	212 (9.1)	1,649 (71.0)	N/A	36 (1.6)	204 (8.8)	N/A	83 (3.6)	90 (4.3)	34 (1.6)	377 (16.2)	2,211 (95.2)	96 (4.1)	N/A	14 (0.6)	1 (0.0004)	N/A	
Pan-Asian Resuscitation Outcomes Study (PAROS)	South Korea	69 (54, 79)	65.0 (19.0)	17,884 (64.7)	10,472 (37.9)	1,911 (6.9)	16,089 (58.2)	N/A	397 (1.4)	296 (1.1)	N/A	1,793 (6.5)	518 (2.0)	117 (0.5)	3,591 (13.0)	20,309 (73.4)	3,719 (13.4)	458 (1.7)	381 (1.4)	N/A	2056 (7.4)	
Utstein Japan	Japan	79 (67, 86)	75 (17.0)	70,421 (57.1)	51,125 (41.4)	9,862 (8.0)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1815 (1.6)	8,039 (6.5)	92,107 (74.6)	7,803 (6.3)	402 (0.3)	4,058 (3.3)	N/A	N/A	
Regional Registries																						
Saving Hearts in Arizona Registry & Education (SHARE)	United States	64 (51, 76)	61 (20.9)	2,869 (64.2)	1,754 (39.3)	438 (9.8)	2,701 (60.5)	41 (0.9)	68 (1.5)	334 (7.5)	19 (0.4)	523 (11.7)	151 (3.7)	56 (1.4)	909 (20.3)	3,887 (87.0)	129 (2.9)	125 (2.8)	55 (1.2)	0 (0)	49 (1.1)	
Rescu Epistry [†]	Canada	N/A	70.6 (16.1)	2,310 (64.0)	1,639 (45.4)	469 (13.0)	3,079 (85.3)	N/A	N/A	N/A	N/A	N/A	97 (3.1)	40 (1.3)	751 (20.8)	21,089 (88.3)	1,167 (4.9)	140 (0.6)	140 (0.6)	12 (0.05)	99 (0.4)	
Helsinki Cardiac Arrest Registry	Finland	66 (57, 76)	67 (15.0)	161 (71.6)	157 (69.8)	29 (12.9)	116 (51.6)	3 (1.3)	N/A	31 (13.8)	N/A	18 (8.0)	13 (6.6)	9 (4.6)	85 (37.8)	117 (52.0)	6 (2.7)	6 (2.7)	3 (1.3)	0 (0)	7 (3.1)	
Pavia Cardiac Arrest Registry (Pavia CARE)	Italy	79 (66, 85)	75 (15.0)	297 (60.6)	276 (56.3)	79 (16.1)	393 (80.2)	9 (1.8)	1 (0.2)	44 (9.0)	0	42 (8.6)	9 (2.2)	4 (1.0)	84 (17.1)	461 (94.1)	18 (3.7)	0 (0)	1 (0.2)	1 (0.2)	9 (1.8)	
Ticino Registry of Cardiac Arrest	Switzerland	74 (62, 83)	70 (17.0)	159 (64.4)	131 (53.0)	25 (10.1)	167 (67.6)	4 (1.6)	8 (3.2)	53 (21.5)	0	15 (6.1)	83 (37.4)	16 (7.2)	45 (18.2)	198 (80.2)	12 (4.9)	5 (2.0)	4 (1.6)	0 (0)	24 (9.7)	
Pan-Asian Resuscitation Outcomes Study (PAROS)	Tainan City, Taiwan	70 (54, 81)	66.1 (18.9)	1,018 (63.7)	913 (57.1)	89 (5.6)	1,164 (72.8)	52 (3.3)	8 (0.5)	18 (1.1)	9 (0.6)	71 (4.4)	N/A	N/A	127 (7.9)	1,370 (85.7)	229 (14.3)	4 (0.3)	4 (0.3)	0 (0)	20 (1.3)	
Sudden Death Expertise Center registry (SDEC)	Paris	66 (54, 78)	65 (16.0)	1,344 (65.9)	1,274 (62.5)	251 (12.3)	1,511 (74.1)	N/A	N/A	N/A	N/A	N/A	35 (2.0)	N/A	552 (27.1)	N/A	N/A	N/A	N/A	N/A	N/A	

*Data in 2014

†Data in 2013

[‡]We excluded EMS-witnessed OHCA from the denominators.

IQR denote interquartile range; SD: standard deviation; EMS: Emergency medical services; AED: automated external defibrillator.

Table 4. Summary data for all EMS treated OHCA in Utstein core elements (process)

Name of registries	Country	Median Time from call to EMS arrival on, minute, median (IQR)	Median Time from call to shock by EMS, minute, median (IQR)	The time interval from incoming call to initiation of EMS CPR [§] , minute, median (IQR)	The time interval from incoming call to hospital arrival [§] , minute, median (IQR)	TTM, n (%)		Drugs given, n (%)	
						Prehospital TTM	TTM (total)	Adrenaline	Amiodarone
National/International Registries									
Cardiac Arrest Registry to Enhance Survival (CARES)	United States	7.1 (5.1, 10.0)	N/A	N/A	40.0 (31.4, 51.0)	5,224 (9.9)	10,174 (19.2)	38,617 (73.0)	4,843 (9.2)
Danish Cardiac Arrest Registry*	Denmark	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Norwegian Cardiac Arrest Registry	Norway	9 (6.0, 14.0)	N/A	N/A	N/A	0 (0)	N/A	1,402 (61.0)	299 (13.0)
Out-of-hospital Cardiac Arrest Outcomes (OHCAO)	United Kingdom	6.1 (3.8, 9.3)	N/A	N/A	N/A	N/A	N/A	17,125 (78.5)	2,116 (9.7)
Australian Resuscitation Outcomes Consortium (Aus-ROC)	Australia	8.0 (6.0, 11.0)	N/A	N/A	65.0 (49, 88)	N/A	N/A	N/A	N/A
Australian Resuscitation Outcomes Consortium (Aus-ROC)	New Zealand	9.0 (7.0, 13.0)	N/A	N/A	58.0 (43, 79)	N/A	N/A	N/A	N/A
Pan-Asian Resuscitation Outcomes Study (PAROS)	Singapore	9.0 (7.1, 11.5)	16.6 (12.7, 23.9)	12.3 (10.1, 15.5)	37.7 (33.0, 42.8)	N/A	133 (5.7)	1,866 (80.4)	27 (1.2)
Pan-Asian Resuscitation Outcomes Study (PAROS)	South Korea	7 (5.0, 10.0)	10 (9, 14)	9 (6, 12)	26 (21, 33)	N/A	627 (2.3)	N/A	N/A
Utstein Japan	Japan	7 (6.0, 9.0)	12 (9, 20)	9 (7, 12)	32 (26, 40)	N/A	N/A	21,712 (17.6)	N/A
Regional Registries									
Saving Hearts in Arizona Registry & Education (SHARE)	United States	5 (4, 7)	12 (8, 19)	9 (6, 11)	28 (23, 34)	33 (0.7)	454 (10.2)	3,570 (79.9)	277 (6.2)
Rescu Epistry [†]	Canada	6.5 (2.8) [‡]	N/A	N/A	N/A	N/A	2,101 (58.2)	N/A	N/A
Helsinki Cardiac Arrest Registry	Finland	8.5 (7.0, 10.0)	9.5 (8.0, 11.1)	8.5 (7.0, 10.0)	N/A	11 (4.9)	26 (11.6)	136 (60.4)	35 (15.6)
Pavia Cardiac Arrest Registry (Pavia CARE)	Italy	11 (8.0, 14.0)	15 (11, 26)	13 (10, 21)	66 (51, 87)	N/A	N/A	223 (45.5)	43 (8.8)
Ticino Registry of Cardiac Arrest	Switzerland	9 (6.0, 12.0)	11 (9, 15)	N/A	66(49, 79)	N/A	N/A	205 (83.0)	36 (14.6)
Pan-Asian Resuscitation Outcomes Study (PAROS)	Tainan City, Taiwan	6 (4.6, 8.1)	N/A	N/A	23 (19, 29)	N/A	N/A	60 (3.8)	0 (0)
Sudden Death Expertise Center registry (SDEC)	Paris	N/A	N/A	N/A	N/A	N/A	271 (13.3)	1,522 (74.6)	241 (16.7)

*Data in 2014

†Data in 2013

‡Reported mean (SD)

§Not in Utstein core element

IQR denote interquartile range; SD: standard deviation; EMS: Emergency medical services; AED: automated external defibrillator;

Table 5. Summary data in Utstein core elements (Outcome)

Name of registries	Country	All EMS treated OHCA including EMS witnessed, n (%)		Shockable bystander witnessed (EMS witnessed excluded), n (%)	
		Either discharged alive or 30 day survival	Good neurological outcome at hospital discharge or 30 days	Either discharged alive or 30 day survival	Good neurological outcome at hospital discharge or 30 days
National/International Registries					
Cardiac Arrest Registry to Enhance Survival (CARES)	United States	5,562 (10.5)	4,467 (8.4)	2,096 (33.4)	1,877 (29.9)
Danish Cardiac Arrest Registry * ‡	Denmark	515 (12.7)	N/A	233 (47.4)	N/A
Norwegian Cardiac Arrest Registry ‡	Norway	360 (15.7)	N/A	157 (43.6)	N/A
Out-of-hospital Cardiac Arrest Outcomes (OHCAO)	United Kingdom	1,962 (7.8)	N/A	761 (21.6)	N/A
Australian Resuscitation Outcomes Consortium (Aus-ROC)	Australia	531 (11.0)	N/A	220 (31.0)	N/A
Australian Resuscitation Outcomes Consortium (Aus-ROC)	New Zealand	316 (13.8)	N/A	175 (31.0)	N/A
Pan-Asian Resuscitation Outcomes Study (PAROS)	Singapore	121 (5.2)	3.2	53 (20.5)	37 (14.3)
Pan-Asian Resuscitation Outcomes Study (PAROS)	South Korea	1,875 (6.8)	3.9	833 (34.4)	659 (27.3)
Utstein Japan ‡	Japan	7,802 (6.3)	4,400 (4.6)	1,721 (33.8)	1,213 (23.8)
Regional Registries					
Saving Hearts in Arizona Registry & Education (SHARE)	United States	524 (12.0)	279 (6.2)	168 (31.0)	129 (23.8)
Rescu Epistry †	Canada	339 (9.4)	307 (8.5)	1,123 (31.1)	N/A
Helsinki Cardiac Arrest Registry	Finland	46 (20.4)	41 (18.2)	22 (34.9)	21 (33.3)
Pavia Cardiac Arrest Registry (Pavia CARE)	Italy	37 (7.6)	28 (5.7)	17 (29.8)	12 (21.1)
Ticino Registry of Cardiac Arrest	Switzerland	21 (8.5)	20 (8.1)	10 (24.4)	10 (24.4)
Pan-Asian Resuscitation Outcomes Study (PAROS)	Tainan City, Taiwan	50 (3.1)	44 (2.8)	13 (11.7)	11 (9.9)
Sudden Death Expertise Center registry (SDEC) ‡	Paris	144 (7.1)	140 (6.9)	92 (20.9)	88 (20.0)

*Data in 2014

†Data in 2013

‡Reported 30 day survival.

IQR denote interquartile range; SD: standard deviation; OHCA; out-of-hospital cardiac arrest; EMS: emergency medical services.