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1	ILCOR Consensus Statement
2	Cardiac Arrest and Cardiopulmonary Resuscitation Outcome Reports: Update of the
3	Utstein Resuscitation Registry Template for In-Hospital Cardiac Arrest
4	A Statement for Healthcare Professionals From a Task Force of the International Liaison
5	Committee on Resuscitation (American Heart Association, European Resuscitation Council,
6	Australian and New Zealand Council on Resuscitation, Heart and Stroke Foundation of
7	Canada, InterAmerican Heart Foundation, Resuscitation Council of Southern Africa,
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#### 1 Abstract

2 Utstein-style reporting templates provide a structured framework with which to compare 3 systems of care for cardiac arrest. The 2004 Utstein reporting template encompassed both out-of-hospital and in-hospital cardiac arrest. A 2015 update of the Utstein template focused 4 5 on out-of-hospital cardiac arrest, making this update of the in-hospital template timely. 6 Representatives of the International Liaison Committee on Resuscitation developed an 7 updated in-hospital Utstein reporting template iteratively by meeting face-to-face, by 8 teleconference, and by online surveys between 2013 and 2018. Data elements were grouped 9 by hospital factors, patient variables, pre-event factors, cardiac arrest and postresuscitation 10 processes, and outcomes. Elements were classified as core or supplemental by using a 11 modified Delphi process. Variables were described as core if they were considered essential. 12 Core variables should enable reasonable comparisons between systems and are also 13 considered to be essential for quality improvement programs. Together, with core variables, 14 supplementary variables are considered to be useful for research.

## 1 Introduction

2 The first Utstein-style guideline for the reporting of data from cardiac arrest was published in 3 1991 and represented the output from an international multidisciplinary meeting held at the Utstein Abbey near Stavanger, Norway, in June 1990.<sup>1</sup> This first Utstein reporting guideline 4 5 focused on out-of-hospital cardiac arrest (OHCA) and aimed to standardize definitions and 6 data items, thus enabling comparison of cardiac arrest epidemiology and outcomes between 7 emergency medical services systems. It was anticipated that this would also drive quality 8 improvement, identify knowledge gaps, and facilitate clinical research by standardizing 9 reporting and definitions for use by investigators. The first Utstein reporting guideline for in-10 hospital cardiac arrest (IHCA) was published in 1997 and included 4 categories of variables 11 for documenting in-hospital resuscitation: hospital, patient, arrest, and outcome.<sup>2</sup> Other Utstein reporting guidelines include pediatric advanced life support,<sup>3</sup> laboratory research,<sup>4</sup> 12 education,<sup>5</sup> drowning,<sup>6</sup> postresuscitation care,<sup>7</sup> and emergency medical dispatch.<sup>8</sup> In 2004, the 13 14 Utstein guidelines for reporting cardiac arrest were updated to incorporate definitions and 15 data elements for both OHCA and IHCA, reduce complexity of data collection, and address advances in resuscitation science.<sup>9</sup> The Utstein reporting guidelines for cardiac arrest were 16 17 revised again in 2015, but this update was confined to OHCA because of substantial differences between IHCA and OHCA epidemiology, process of care, and treatments.<sup>10</sup> This 18 article, therefore, is an update to Utstein reporting guidelines for IHCA. 19 Although there are numerous national and regional registries for OHCA,<sup>11-17</sup> there are 20 relatively few for IHCA.<sup>17-20</sup> The American Heart Association Get With The Guidelines -21 22 Resuscitation (GWTG-R) registry has been a particularly valuable source of data on all aspects of IHCA,<sup>21</sup> and more recently, the UK National Cardiac Arrest Audit has also 23

24 reported on the incidence and outcome from cardiac arrest in UK hospitals.<sup>19</sup> The experts

involved in updating these Utstein IHCA reporting guidelines have drawn on the experience
derived from GWTG-R and UK National Cardiac Arrest Audit and, like the recent revision of
the OHCA reporting guideline, the proposals set out in this article aim to balance the desire
for uniform collection of evidence-based factors associated with outcome and the practical
challenges of real-life data collection and validation.

## 6 Methods

7 The Utstein collaborator group met face-to-face on 4 occasions to discuss the revisions to the 8 Utstein IHCA reporting template. The first meeting followed the International Liaison 9 Committee on Resuscitation (ILCOR) meeting in Melbourne, Australia, in April 2013. The 10 second meeting occurred during a 1-day ILCOR meeting in New Orleans, USA, in November 11 2016; the third meeting took place during a 3-day ILCOR meeting in Adelaide, Australia, in 12 May 2017; and the final face-to-face meeting took place during a 3-day ILCOR meeting in Anaheim, California, USA, in November 2017. These face-to-face meetings were 13 14 supplemented by 5 teleconferences that took place during 2016 to 2018. 15 The Utstein collaborator group agreed that, whenever possible, there would be consistency 16 with the definitions and data elements set out in the 2015 OHCA Utstein reporting guideline.<sup>10</sup> Thus, core elements were defined as elements that all registries should aim to 17 18 capture and report and are considered the minimum recommended standard for quality 19 assurance/improvement purposes. A core element is one that is considered both important 20 and reasonably practical to collect and validate. Supplemental elements were defined as 21 elements that were desirable but not essential to capture and report; such elements are more 22 likely to be relevant to research than to quality assurance.

1 After the final face-to-face meeting in 2017, members of the IHCA Utstein Working Group 2 considered core and supplemental data elements under the 6 domains of hospital factors, 3 patient variables, pre-event factors, cardiac arrest and postresuscitation processes, and 4 outcomes. A 2-stage Delphi process was conducted using a web-based survey to achieve 5 consensus for the recommendations for core and supplemental elements. During stage 1, the 6 output from the IHCA Utstein Working Group was presented to the wider collaborator group 7 comprising all members of the ILCOR Advanced Life Support, Basic Life Support, and 8 Pediatric Task Forces. The ILCOR Neonatal Task Force was not included in this 9 collaboration because this Utstein-style guideline does not include neonatal resuscitation, 10 which is distinct from resuscitation of adults and children. Agreement for core and 11 supplemental elements was sought using a 5-point Likert scale, with 1 representing "do not 12 agree" and 5 representing "strongly agree." A score of 4 or 5 was deemed to be "agreement." 13 Participants were also able to submit additional elements for consideration. New elements, or 14 elements for which there was <85% agreement on designation as core or supplemental, were 15 submitted to a second round of voting. There was >85% agreement for designations for all elements by the end of the second round, so further rounds were not required. Data 16 17 definitions were based where possible on 2004 and 2015 Utstein definitions; some were 18 adapted from the GWTG-R registry.

The IHCA Utstein Working Group, on behalf of collaborators, summarized the output from
this process in a draft of the manuscript that was circulated and approved by the Utstein
IHCA collaborators. The final manuscript was approved by the coauthors and ILCOR.

22 **Results** 

# 23 IHCA Utstein Definitions

The Utstein elements were grouped into 6 domains (Figure). Each domain contained core and
 supplemental elements that are described in the Table.

#### 3 Hospital Factors

4 Core hospital elements are the number of hospital admissions and the number of treated 5 cardiac arrests per year. These data enable calculation of the incidence of cardiac arrest per 6 1000 admissions. There is variation in what constitutes a hospital admission; however, 7 standardization is essential because changing the denominator will have a major impact on 8 cardiac arrest incidence. The consensus definition of hospital admission is admission to an in-9 patient bed; day cases are included while outpatients or visitors are not. Cardiac arrests in the 10 emergency department can be included in the registry, but the IHCA Utstein Working Group 11 recommends that they be excluded for the purposes of calculating incidence of IHCA per 12 1000 admissions. The emergency department cardiac arrest patients who are included in the 13 registry are those who have a cardiac arrest de novo in this location and not those who arrive 14 in cardiac arrest or who rearrest after initial resuscitation from an OHCA. A cardiac arrest is defined as the delivery of chest compressions or defibrillation.<sup>22</sup> In the pediatric population, 15 16 this could include some patients who receive chest compressions for poor perfusion in the setting of severe bradycardia). 17

Supplemental hospital factors are the total number of deaths per year and a description of the number of hospital beds and facilities relevant to cardiac arrest (eg, 24/7 access to a cardiac catheterization laboratory). An estimate of the number of deaths in patients with do-notattempt cardiopulmonary resuscitation (DNACPR) decisions is provided by the difference between the total number of hospital deaths and the number of deaths following a cardiopulmonary resuscitation (CPR) attempt. We accept that there are limitations to this

4 Patient Variables

5 Core patient variables are date of birth and sex. Among the supplemental patient variables, 6 there was consensus for following national guidelines for defining categories of race because 7 there is inevitable international variation in nomenclature. Ideally, baseline neurological 8 status would reflect the status before the index acute illness, but it is was agreed that precardiac arrest Cerebral Performance Category (CPC),<sup>23</sup> Pediatric CPC, <sup>3</sup> or modified Rankin 9 Scale (mRS) score<sup>24</sup> were more likely to be collected at admission. Comorbidities influence 10 11 outcome after IHCA and the following have been previously evaluated for inclusion in the risk-standardization model derived from the GWTG-R registry: heart failure, myocardial 12 13 infarction, or diabetes mellitus; renal, hepatic, or respiratory insufficiency; baseline evidence 14 of motor, cognitive, or functional deficits (CNS depression); acute stroke; acute non-stroke neurologic disorder; pneumonia; hypotension; sepsis; major trauma; metabolic or electrolyte 15 abnormality; and metastatic or hematologic malignancy.<sup>25</sup> There was agreement to include as 16 17 supplemental data the pre-existing conditions that were included in the final GWTG-R registry model: sepsis, hypotension, metastatic or hematological malignancy, hepatic 18 insufficiency, renal insufficiency.<sup>25</sup> The following factors from the GWTG-R pediatric model 19 20 were not included in the Delphi survey: pre-event characteristics (heart failure this admission, 21 heart failure before admission, metabolic or electrolyte abnormality, acute nonstroke central 22 nervous system event, baseline depression in central nervous system function, pneumonia, 23 septicemia, major trauma) and intravenous antiarrhythmics in place at the time of cardiac arrest.26 24

### 1 Pre-event Factors

2 Pre-event core factors are the subject type (eg, outpatient, inpatient) and the illness category 3 (e.g., medical, surgical). It is well recognized that IHCAs are often not sudden unexpected 4 events; they are usually preceded by a period of deterioration evidenced by changes in vital signs.<sup>27,28</sup> It was agreed that the vital signs most proximate to the cardiac arrest would be 5 6 valuable supplementary data but are difficult to collect and standardize; in the future, electronic data capture may make it easier.<sup>29</sup> Of the possible interventions in place at the time 7 8 of cardiac arrest, there was consensus to include as supplementary data continuous infusions 9 of vasopressors/inotropes, invasive ventilation, noninvasive ventilation (including high-flow 10 nasal cannula oxygen), extracorporeal membrane oxygenation, or ventricular assist device.<sup>30</sup>

#### 11 Cardiac Arrest Process Elements

12 Cardiac arrest core process elements include the date and time of cardiac arrest, event

13 location (the predefined locations and the number of options can be determined locally),

14 whether the event was witnessed, and whether the resuscitation team was called.

15 Documentation of whether monitoring was in place at the time of cardiac arrest is also core 16 data; this would typically be electrocardiographic monitoring, but it could also include pulse 17 oximetry. The first documented rhythm, application of an automated external defibrillator or 18 manual defibrillator, and whether shocks or chest compressions were given are also core data. 19 The final core item is use of extracorporeal cardiopulmonary resuscitation (ECPR). It was 20 agreed that the IHCA Utstein definition of ECPR should align with that proposed by the Extracorporeal Life Support Organization<sup>31</sup>: "ECPR is the application of rapid-deployment 21 22 venoarterial extracorporeal membrane oxygenation, usually by peripheral cannulation, to 23 provide circulatory support in patients in whom conventional CPR is unsuccessful in

1 achieving sustained ROSC. Sustained ROSC is deemed to have occurred when chest 2 compressions are not required for 20 consecutive minutes and signs of circulation persist. 3 ECPR implies the application of [extracorporeal life support] during conventional CPR. Use 4 of [extracorporeal life support] initiated for low cardiac output after sustained ROSC is considered venoarterial [extracorporeal membrane oxygenation]." 5 Nine supplemental cardiac arrest process elements are included. There was discussion on 6 7 whether the airway intervention element should include the specific type of supraglottic 8 airway used, but it was agreed that this would be left as a generic supraglottic airway. Ideally, 9 the timing of these interventions (eg, drugs, airway) should be documented because they are 10 more likely to occur the longer the resuscitation attempt continues. The duration of 11 resuscitation is strongly associated with worse outcome. In observational studies, this will 12 bias the results toward a harmful effect of the intervention-an effect that has been termed resuscitation time bias.<sup>32</sup> The CPR quality element should include an indication of whether 13 14 data are being used for real-time feedback or for quality assurance review. In keeping with 15 Extracorporeal Life Support Organization nomenclature, ECPR start is defined as initiation of extracorporeal flow after cannulation and circuit connection to the patient.<sup>31</sup> 16 Because quality of CPR is the most important determinant of myocardial and cerebral blood 17 flow during CPR and resultant outcomes,<sup>33</sup> IHCA reports would optimally provide CPR 18 hemodynamic data (e.g., arterial diastolic blood pressure during CPR), potential proxies of 19 20 CPR hemodynamics (e.g., end-tidal carbon dioxide), or CPR mechanical data (e.g., chest compression depth and rate, chest compression fraction).<sup>33</sup> However, practical issues relegate 21 22 the consideration of these important data to future updates of this template.

23 Postresuscitation Process

1 Targeted temperature management is defined as an active therapy to achieve and maintain a 2 specific target temperature for a defined duration and is 1 of 4 core postresuscitation process 3 elements. The other core elements are avoidance of pyrexia, coronary angiography (divided 4 into urgent [within 2 hours after cardiac arrest] and delayed), and attempted coronary 5 reperfusion (percutaneous coronary intervention or thrombolysis). There are 11 supplemental 6 postresuscitation process elements. After considerable discussion, post-cardiac arrest pyrexia 7 was defined as a temperature  $\geq 38^{\circ}$ C within 72 hours after cardiac arrest. Documentation of 8 vasopressor and inotrope infusions within the first 72 hours after ROSC is a supplemental 9 element. Although the documentation of sedation and neuromuscular blocker use was also 10 proposed, there was no consensus from the Delphi survey to include these items. The IHCA 11 Utstein Working Group discussed this at length because sedation is thought to be an important factor in delayed awakening after cardiac arrest.<sup>34-36</sup> Although we have been 12 13 faithful to the Delphi process and excluded sedation and neuromuscular blockers as 14 supplemental items, the IHCA Utstein Working Group is supportive of local decisions to 15 collect these data. Documentation of neuroprognostic tests should include both the types of tests and their timing. 16

## 17 *Outcome*

Where possible, recommendations on the documentation of survival are consistent with those included in the 2015 OHCA Utstein update.<sup>10</sup> There are 7 core elements. It was agreed that the definition of "Date and time CPR stopped" would be that used by the GWTG-R registry: "Date and time sustained ROSC (lasting >20 min) began or resuscitation efforts were terminated." For the core item "Reason CPR stopped," there was considerable discussion on the use of the term *futility*, but it was eventually agreed not to include this. Survived event is defined as sustained ROSC or return of circulation supported by ECPR. The other option for

1 "Reason CPR stopped" is that the patient died (unable to achieve sustained ROSC). A 2 DNACPR decision before the resuscitation attempt has also been added to the data options 3 for this element. The working group noted that a previous American Heart Association 4 consensus statement recommended that those resuscitation attempts that occur after a 5 DNACPR decision has been made should not be counted in IHCA incidence or outcome measures.<sup>22</sup> Knowledge of the number of patients with a DNACPR decision who 6 inadvertently receive CPR when they have an IHCA is a useful quality measure for local 7 8 systems of care.

9 Any ROSC is a core outcome element and is defined by return of circulation in the absence 10 of ongoing chest compressions (return of adequate pulse/heart rate by palpation, auscultation, 11 Doppler, arterial blood pressure waveform, or documented blood pressure >50 mm Hg systolic). There was considerable discussion about the evidence for using systolic blood 12 13 pressure >50 mm Hg as one of the criteria for any ROSC. The IHCA Utstein Working Group 14 agreed that it was preferable to make a statement on this topic rather than stay silent because 15 many patients with IHCA have invasive arterial blood pressure monitoring. Systolic blood 16 pressure >50 mm Hg is recommended by others to discriminate hypotension from a pulseless 17 electrical activity cardiac arrest, and there are limited data indicating that a pulse is often not palpable once the blood pressure is <60 mm Hg.<sup>37-40</sup> Ultimately, it was agreed that this was, 18 19 at best, "expert opinion" and is a knowledge gap. Neurological outcome at 30 days or 20 hospital discharge is recorded as either CPC/Pediatric CPC or mRS score and can be measured by face-to-face or telephone interview, extraction from the medical record, or a 21 22 combination of the two. The CPC is a 5-point scale ranging from 1 (good cerebral performance) to 5 (dead), and the Pediatric CPC is a 6-point scale ranging from 1 (good 23 cerebral performance) to 6 (dead). The mRS is a 7-point scale ranging from 0 (no symptoms) 24

1	to 6 (dead). In keeping with the 2015 OHCA Utstein update, survival with favorable
2	neurologic outcome is defined as a CPC 1/2 or mRS 0-3 or no change in CPC or mRS from
3	the patient's baseline status. <sup>10</sup> The Core Outcome Set for Cardiac Arrest Collaborators
4	recommend the mRS over the CPC because the latter lacks discrimination between scores
5	and has the potential for ceiling effects and overestimation of function. <sup>41</sup>
6	The core outcome of organ donation includes documentation of either donation after brain
7	death or donation after circulatory death. Date and time of death if before hospital discharge
8	is the final core outcome; in some healthcare systems, date of death can be relatively easily
9	tracked after hospital discharge. This should be included if possible.
10	There are 4 supplemental outcome elements. The cause of death can be obtained from the
11	medical records and death certificates. However, death certificates are generally considered
12	to be an unreliable source for cause of death. <sup>42-44</sup> Investigators have recently proposed 5
13	categories for cause of death after cardiac arrest: sudden cardiac death, refractory
14	hemodynamic shock, respiratory failure, neurological withdrawal of life-sustaining treatment,
15	and comorbid withdrawal of life-sustaining treatment. <sup>45</sup> The IHCA Utstein Working Group
16	agreed that these should be included as data options. Health-related quality of life
17	measurements are a supplemental outcome. The Core Outcome Set for Cardiac Arrest
18	Collaborators suggested that health-related quality of life could be assessed at 180 days or 1
19	year, or both; however, they recognized that the longer duration of follow-up is likely to be
20	logistically more challenging. <sup>41</sup> The consensus among the IHCA Utstein collaborators was
21	that health-related quality of life measurements are ideally measured at 12 months.

# 22 Implementation

1 Implementation of the IHCA Utstein reporting guideline will facilitate comparison between 2 IHCA registries throughout the world. Use of standardized definitions will enable consistent 3 recording and reporting of IHCA data and will allow reliable documentation of trends in 4 interventions and outcomes. Reliable documentation of the incidence of cardiac arrest is an 5 important performance indicator because this can be reduced by (a) early detection of the deteriorating patient and instigating treatments to prevent cardiac arrest<sup>28</sup> and (b) 6 implementation of DNACPR decisions when appropriate.<sup>46</sup> Thus, the incidence of cardiac 7 8 arrest is a key performance indicator that can be used to track the effectiveness of rapid 9 response systems in preventing cardiac arrest and implementation of DNACPR decisions to 10 ensure that CPR is attempted only when appropriate. There are challenges in using the 11 incidence of cardiac arrest per 1000 hospital admissions to compare performance among 12 hospitals because this will be influenced significantly by external factors such as the proportion of elective admissions versus emergency admissions and type of hospital, as well 13 14 as by the variability in proportion of patients at each hospital with advanced directives. This 15 can be mitigated to some extent by risk-adjusting for hospital characteristics when comparing hospitals.47 16

17 As for the OHCA Utstein reporting guideline, there are substantial challenges in striking a balance between including as core data those factors that are deemed essential for quality 18 19 assurance purposes while including only those data that can be collected relatively easily and 20 reliably in different healthcare systems globally. If too many items are deemed core or if they 21 require considerable resources to enable reliable collection, only a few hospitals will comply 22 with the IHCA Utstein reporting guideline, which will limit participation in a national registry. If only a small proportion of hospitals participate in the registry, the generalizability 23 24 of the findings is limited. This, in turn, reduces the value of international comparisons.

1 Although supplemental items are not deemed essential, the IHCA Utstein Working Group

2 recognizes the importance of research in guiding and validating quality assurance/

3 improvement and encourages collection of supplemental items when practicable.

# 4 Conclusion

Utstein-style guidelines standardize reporting of the process of care and outcomes for patients
with cardiac arrest. This update of the IHCA Utstein reporting guideline includes 6 domains:
hospital factors, patient variables, pre-event factors, cardiac arrest and postresuscitation
processes, and outcomes. This consensus IHCA reporting template adopts the style of the
recently updated OHCA version.

## 10 Legends

11 Figure. Data element domains. Core and supplemental elements are shown for each of the 6 12 domains. AED indicates automated external defibrillator; BP, blood pressure; CPC, Cerebral Performance Category; CPR, cardiopulmonary resuscitation; ECG, electrocardiogram; 13 14 ECMO, extracorporeal membrane oxygenation; ECPR, extracorporeal cardiopulmonary 15 resuscitation; HR, heart rate; IABP, intra-aortic balloon pump; ICU, intensive care unit; 16 LVAD, left ventricular assist device; mRS, modified Rankin Scale; NIV, noninvasive 17 ventilation; OHCA, out-of-hospital cardiac arrest; PCPC, Pediatric Cerebral Performance 18 Category; ROSC, return of spontaneous circulation; RR, respiratory rate; SBP, systolic blood 19 pressure; temp, temperature; TTM, targeted temperature management; VAD, ventricular 20 assist device; and WLST, withdrawal of life-sustaining treatment. 21 Table. Utstein Data Definitions for In-hospital Cardiac Arrest. Data definitions have been

categorized as core and supplemental. AED indicates automated external defibrillator; BP,

1	blood pressure; CPC, Cerebral Performance Category; CPR, cardiopulmonary resuscitation;
2	DNACPR, do not attempt cardiopulmonary resuscitation; ECG, electrocardiogram; ECMO,
3	extracorporeal membrane oxygenation; ECPR, extracorporeal cardiopulmonary resuscitation;
4	EEG, electroencephalogram; ETCO <sub>2</sub> , end-tidal carbon dioxide; HR, heart rate; HFNC, high-
5	flow nasal cannula; IABP, intra-aortic balloon pump; ICU, intensive care unit; LBBB, left
6	bundle branch block; LVAD, left ventricular assist device; MRI, magnetic resonance
7	imaging; mRS, modified Rankin Scale; NIV, noninvasive ventilation; NSE, neuron specific
8	enolase; OHCA, out-of-hospital cardiac arrest; PCI, percutaneous coronary intervention;
9	PCPC, Pediatric Cerebral Performance Category; ROSC, return of spontaneous circulation;
10	RR, respiratory rate; SBP, systolic blood pressure; SSEP, somatosensory evoked potentials;
11	temp, temperature; TTM, targeted temperature management; VAD, ventricular assist device;
12	VF, ventricular fibrillation; VT, ventricular tachycardia; VV ECMO, venovenous
13	extracorporeal membrane oxygenation; and WLST, withdrawal of life-sustaining treatment.
14	Contributions
15	JPN ran the Delphi surveys and prepared the first draft of the manuscript under the oversight
16	of RAB, JS, and GDP. The draft manuscript was revised after input from a core writing group
17	initially (JN, RAB, LWA, FB, PSC, MWD, SWL, MHMM, VMN, MS, GDP, PTM, JS).
18	These outputs were then circulated and discussed in detail with coauthors who added
19	important intellectual content to the manuscript's refinement. The final manuscript was
20	approved by all authors and collaborators.

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1

#### 1 **References**

2 1. Cummins RO, Chamberlain DA, Abramson NS, Allen M, Baskett PJ, Becker L, 3 Bossaert L, Delooz HH, Dick WF, Eisenberg MS, Evans TR, Holmberg S, Kerber R, Mullie 4 A, Ornato JP, Sandoe E, Skulberg A, Tunstall-Pedoe H, Swanson R, Thies WH. 5 Recommended guidelines for uniform reporting of data from out-of-hospital cardiac arrest: 6 the Utstein Style: a statement for health professionals from a task force of the American 7 Heart Association, the European Resuscitation Council, the Heart and Stroke Foundation of Canada, and the Australian Resuscitation Council. Circulation. 1991;84:960–975. 8 9 2. Cummins RO, Chamberlain D, Hazinski MF, Nadkarni V, Kloeck W, Kramer E, 10 Becker L, Robertson C, Koster R, Zaritsky A, Bossaert L, Ornato JP, Callanan V, Allen M, 11 Steen P, Connolly B, Sanders A, Idris A, Cobbe S. Recommended guidelines for reviewing, reporting, and conducting research on in-hospital resuscitation: the in-hospital 'Utstein style': 12 13 a statement for healthcare professionals from the American Heart Association, the European 14 Resuscitation Council, the Heart and Stroke Foundation of Canada, the Australian Resuscitation Council, and the Resuscitation Councils of Southern Africa. Resuscitation. 15 16 1997;34:151-183. 3. 17 Zaritsky A, Nadkarni V, Hazinski MF, Foltin G, Quan L, Wright J, Fiser D, Zideman 18 D, O'Malley P, Chameides L. Recommended guidelines for uniform reporting of pediatric advanced life support: the Pediatric Utstein Style: a statement for healthcare professionals 19 20 from a task force of the American Academy of Pediatrics, the American Heart Association, 21 and the European Resuscitation Council. Resuscitation. 1995;30:95–115.

Idris AH, Becker LB, Ornato JP, Hedges JR, Bircher NG, Chandra NC, Cummins
 RO, Dick W, Ebmeyer U, Halperin HR, Hazinski MF, Kerber RE, Kern KB, Safar P, Steen

PA, Swindle MM, Tsitlik JE, von Planta I, von Planta M, Wears RL, Weil MH. Utstein-style
guidelines for uniform reporting of laboratory CPR research: a statement for healthcare
professionals from a task force of the American Heart Association, the American College of
Emergency Physicians, the American College of Cardiology, the European Resuscitation
Council, the Heart and Stroke Foundation of Canada, the Institute of Critical Care Medicine,
the Safar Center for Resuscitation Research, and the Society for Academic Emergency
Medicine. *Resuscitation*. 1996;33:69–84.

5. Chamberlain DA, Hazinski MF; on behalf of the European Resuscitation Council, the
American Heart Association, the Heart and Stroke Foundation of Canada, the Australia and
New Zealand Resuscitation Council, the Resuscitation Council of Southern Africa, the
Consejo Latino-Americano de Resuscitación. Education in resuscitation. *Resuscitation*.
2003;59:11–43.

Idris AH, Berg RA, Bierens J, Bossaert L, Branche CM, Gabrielli A, Graves SA,
 Handley AJ, Hoelle R, Morley PT, Papa L, Pepe PE, Quan L, Szpilman D, Wigginton JG,
 Modell JH. Recommended guidelines for uniform reporting of data from drowning: the
 "Utstein style". *Resuscitation*. 2003;59:45–57.

17 7. Langhelle A, Nolan J, Herlitz J, Castrén M, Wenzel V, Søreide E, Engdahl J, Steen
18 PA; on behalf of the participants at the 2003 Utstein Consensus Symposium. Recommended
19 guidelines for reviewing, reporting, and conducting research on post-resuscitation care: the
20 Utstein style. *Resuscitation*. 2005;66:271–283.

8. Castrén M, Karlsten R, Lippert F, Christensen EF, Bovim E, Kvam AM, Robertson Steel I, Overton J, Kraft T, Engerstrom L, Garcia-Castrill Riego L; and the Emergency
 Medical Dispatch expert group at the Utstein Consensus Symposium 2005. Recommended

2 emergency medicine: the Utstein style. *Resuscitation*. 2008;79:193–197. doi:

3 10.1016/j.resuscitation.2008.07.007

4 9. Jacobs I, Nadkarni V, Bahr J, Berg RA, Billi JE, Bossaert L, Cassan P, Coovadia A, 5 D'Este K, Finn J, Halperin H, Handley A, Herlitz J, Hickey R, Idris A, Kloeck W, Larkin GL, Mancini ME, Mason P, Mears G, Monsieurs K, Montgomery W, Morley P, Nichol G, Nolan 6 7 J, Okada K, Perlman J, Shuster M, Steen PA, Sterz F, Tibballs J, Timerman S, Truitt T, 8 Zideman D. Cardiac arrest and cardiopulmonary resuscitation outcome reports: update and 9 simplification of the Utstein templates for resuscitation registries: a statement for healthcare 10 professionals from a task force of the International Liaison Committee on Resuscitation 11 (American Heart Association, European Resuscitation Council, Australian Resuscitation Council, New Zealand Resuscitation Council, Heart and Stroke Foundation of Canada, 12 13 InterAmerican Heart Foundation, Resuscitation Council of Southern Africa). Resuscitation. 14 2004;63:233-249. doi: 10.1016/j.resuscitation.2004.09.008 15 10. Perkins GD, Jacobs IG, Nadkarni VM, Berg RA, Bhanji F, Biarent D, Bossaert LL, 16 Brett SJ, Chamberlain D, de Caen AR, Deakin CD, Finn JC, Gräsner JT, Hazinski MF, 17 Iwami T, Koster RW, Lim SH, Ma MH, McNally BF, Morley PT, Morrison LJ, Monsieurs KG, Montgomery W, Nichol G, Okada K, Ong ME, Travers AH, Nolan JP; for the Utstein 18 Collaborators. Cardiac arrest and cardiopulmonary resuscitation outcome reports: update of 19 20 the Utstein Resuscitation Registry templates for out-of-hospital cardiac arrest: a statement for 21 healthcare professionals from a task force of the International Liaison Committee on 22 Resuscitation (American Heart Association, European Resuscitation Council, Australian and New Zealand Council on Resuscitation, Heart and Stroke Foundation of Canada, 23 24 InterAmerican Heart Foundation, Resuscitation Council of Southern Africa, Resuscitation

1	Council of Asia); and the American Heart Association Emergency Cardiovascular Care
2	Committee and the Council on Cardiopulmonary, Critical Care, Perioperative and
3	Resuscitation. Resuscitation. 2015;96:328–340. doi: 10.1016/j.resuscitation.2014.11.002
4	11. Morrison LJ, Nichol G, Rea TD, Christenson J, Callaway CW, Stephens S, Pirrallo
5	RG, Atkins DL, Davis DP, Idris AH, Newgard C; and the ROC Investigators. Rationale,
6	development and implementation of the Resuscitation Outcomes Consortium Epistry-Cardiac
7	Arrest. Resuscitation. 2008;78:161–169. doi: 10.1016/j.resuscitation.2008.02.020
8	12. McNally B, Stokes A, Crouch A, Kellermann AL; CARES Surveillance Group.
9	CARES: Cardiac Arrest Registry to Enhance Survival. Ann Emerg Med. 2009;54;674.e2-
10	683.e2. doi: 10.1016/j.annemergmed.2009.03.018
11	13. Gräsner JT, Lefering R, Koster RW, Masterson S, Böttiger BW, Herlitz J, Wnent J,
12	Tjelmeland IB, Ortiz FR, Maurer H, Baubin M, Mols P, Hadžibegović I, Ioannides M, Škulec
13	R, Wissenberg M, Salo A, Hubert H, Nikolaou NI, Lóczi G, Svavarsdóttir H, Semeraro F,
14	Wright PJ, Clarens C, Pijls R, Cebula G, Correia VG, Cimpoesu D, Raffay V, Trenkler S,
15	Markota A, Strömsöe A, Burkart R, Perkins GD, Bossaert LL; the EuReCa ONE
16	Collaborators, National Ambulance Service of the Health Service Executive Dublin Fire
17	Brigade, the Swedish Association of Local Authorities and Regions, and the Federazione
18	Cantonale Ticinese Servizi Ambulanze. EuReCa ONE-27 Nations, ONE Europe, ONE
19	Registry: a prospective one month analysis of out-of-hospital cardiac arrest outcomes in 27
20	countries in Europe. Resuscitation. 2016;105:188-195. doi:
21	10.1016/j.resuscitation.2016.06.004
22	14. Ong ME, Shin SD, Tanaka H, Ma MH, Khruekarnchana P, Hisamuddin N, Atilla R,

23 Middleton P, Kajino K, Leong BS, Khan MN. Pan-Asian Resuscitation Outcomes Study

1	(PAROS): rationale, methodology, and implementation. <i>Acad Emerg Med.</i> 2011;18:890–897.
2	doi: 10.1111/j.1553-2712.2011.01132.x

3	15. Beck B, Bray J, Cameron P, Smith K, Walker T, Grantham H, Hein C, Thorrowgood
4	M, Smith A, Inoue M, Smith T, Dicker B, Swain A, Bosley E, Pemberton K, McKay M,
5	Johnston-Leek M, Perkins GD, Nichol G, Finn J; on behalf of the Aus-ROC Steering
6	Committee. Regional variation in the characteristics, incidence and outcomes of out-of-
7	hospital cardiac arrest in Australia and New Zealand: results from the Aus-ROC Epistry.
8	Resuscitation. 2018;126:49-57. doi: 10.1016/j.resuscitation.2018.02.029
9	16. Kitamura T, Iwami T, Kawamura T, Nagao K, Tanaka H, Hiraide A; on behalf the
10	All-Japan Utstein Registry of the Fire and Disaster Management Agency. Nationwide public-
11	access defibrillation in Japan. N Engl J Med. 2010;362:994–1004. doi: 362/11/994 [pii]
12	10.1056/NEJMoa0906644 [doi]
13	17. Booth A, Moylan A, Hodgson J, Wright K, Langworthy K, Shimizu N, Maconochie I.
14	Resuscitation registers: how many active registers are there and how many collect data on
15	paediatric cardiac arrests? Resuscitation. 2018;129:70-75. doi:
16	10.1016/j.resuscitation.2018.03.029
17	18. Peberdy MA, Kaye W, Ornato JP, Larkin GL, Nadkarni V, Mancini ME, Berg RA,
18	Nichol G, Lane-Trultt T; on behalf of the NRCPR Investigators. Cardiopulmonary
19	resuscitation of adults in the hospital: a report of 14 720 cardiac arrests from the National
20	Registry of Cardiopulmonary Resuscitation. Resuscitation. 2003;58:297-308.

- 21 19. Nolan JP, Soar J, Smith GB, Gwinnutt C, Parrott F, Power S, Harrison DA, Nixon E,
- 22 Rowan K; on behalf of the National Cardiac Arrest Audit. Incidence and outcome of in-

1	nospital cardiac arrest in the Officer Kingdoni National Cardiac Arrest Audit. Resuscitation.
2	2014;85:987-992. doi: 10.1016/j.resuscitation.2014.04.002
3	20. Radeschi G, Mina A, Berta G, Fassiola A, Roasio A, Urso F, Penso R, Zummo U,
4	Berchialla P, Ristagno G, Sandroni C; Piedmont IHCA Registry Initiative. Incidence and
5	outcome of in-hospital cardiac arrest in Italy: a multicentre observational study in the
6	Piedmont Region. Resuscitation. 2017;119:48-55. doi: 10.1016/j.resuscitation.2017.06.020
7	21. American Heart Association. Get With The Guidelines <sup>®</sup> -Resuscitation.
8	https://www.heart.org/en/professional/quality-improvement/get-with-the-guidelines/get-with-
9	the-guidelines-resuscitation. Accessed February 16, 2019.
10	22. Morrison LJ, Neumar RW, Zimmerman JL, Link MS, Newby LK, McMullan PW Jr,
11	Hoek TV, Halverson CC, Doering L, Peberdy MA, Edelson DP; on behalf of the American
12	Heart Association Emergency Cardiovascular Care Committee; Council on
13	Cardiopulmonary, Critical Care, Perioperative and Resuscitation; Council on Cardiovascular
14	and Stroke Nursing; Council on Clinical Cardiology; and Council on Peripheral Vascular
15	Disease. Strategies for improving survival after in-hospital cardiac arrest in the United States:
16	2013 consensus recommendations: a consensus statement from the American Heart
17	Association. Circulation. 2013;127:1538–1563. doi: 10.1161/CIR.0b013e31828b2770
18	23. Jennett B, Bond M. Assessment of outcome after severe brain damage. <i>Lancet</i> .
19	1975;1:480–484.
20	24. van Swieten JC, Koudstaal PJ, Visser MC, Schouten HJ, van Gijn J. Interobserver
21	agreement for the assessment of handicap in stroke patients. Stroke. 1988;19:604-607.
22	25. Chan PS, Berg RA, Spertus JA, Schwamm LH, Bhatt DL, Fonarow GC, Heidenreich
23	PA, Nallamothu BK, Tang F, Merchant RM; on behalf of the AHA GWTG-Resuscitation

1 hospital cardiac arrest in the United Kingdom National Cardiac Arrest Audit. *Resuscitation*.

1	Investigators. Risk-standardizing survival for in-hospital cardiac arrest to facilitate hospital
2	comparisons. J Am Coll Cardiol. 2013;62:601-609. doi: 10.1016/j.jacc.2013.05.051
3	26. Holmberg MJ, Moskowitz A, Raymond TT, Berg RA, Nadkarni VM, Topjian AA,
4	Grossestreuer AV, Donnino MW, Andersen LW, American Heart Association's Get With
5	The Guidelines-Resuscitation I. Derivation and Internal Validation of a Mortality Prediction
6	Tool for Initial Survivors of Pediatric In-Hospital Cardiac Arrest. Pediatr Crit Care Med.
7	2018;19:186-195. doi: 10.1097/PCC.000000000001416
8	27. Andersen LW, Kim WY, Chase M, Berg KM, Mortensen SJ, Moskowitz A, Novack
9	V, Cocchi MN, Donnino MW; on behalf of the American Heart Association's Get With the
10	Guidelines®-Resuscitation Investigators. The prevalence and significance of abnormal vital
11	signs prior to in-hospital cardiac arrest. Resuscitation. 2016;98:112–117. doi:
12	10.1016/j.resuscitation.2015.08.016
13	28. Lyons PG, Edelson DP, Churpek MM. Rapid response systems. <i>Resuscitation</i> .
14	2018;128:191-197. doi: 10.1016/j.resuscitation.2018.05.013
15	29. Schmidt PE, Meredith P, Prytherch DR, Watson D, Watson V, Killen RM,
16	Greengross P, Mohammed MA, Smith GB. Impact of introducing an electronic physiological
17	surveillance system on hospital mortality. BMJ Qual Saf. 2015;24:10-20. doi:
18	10.1136/bmjqs-2014-003073
19	30. Peberdy MA, Gluck JA, Ornato JP, Bermudez CA, Griffin RE, Kasirajan V, Kerber
20	RE, Lewis EF, Link MS, Miller C, Teuteberg JJ, Thiagarajan R, Weiss RM, O'Neil B; on
21	behalf of the American Heart Association Emergency Cardiovascular Care Committee;
22	Council on Cardiopulmonary, Critical Care, Perioperative, and Resuscitation; Council on

23 Cardiovascular Diseases in the Young; Council on Cardiovascular Surgery and Anesthesia;

1	Council on Cardiovascular and Stroke Nursing; and Council on Clinical Cardiology.
2	Cardiopulmonary resuscitation in adults and children with mechanical circulatory support: a
3	scientific statement from the American Heart Association. Circulation. 2017;135:e1115-
4	e1134. doi: 10.1161/CIR.0000000000000504
5	31. Conrad SA, Broman LM, Taccone FS, Lorusso R, Malfertheiner MV, Pappalardo F,
6	Nardo MD, Belliato M, Grazioli L, Barbaro RP, McMullan DM, Pellegrino V, Brodie D,
7	Bembea MM, Fan E, Mendonca M, Diaz R, Bartlett RH. The Extracorporeal Life Support
8	Organization Maastricht Treaty for Nomenclature in Extracorporeal Life Support: a position
9	paper of the Extracorporeal Life Support Organization. Am J Respir Crit Care Med.
10	2018;198:447-451. doi: 10.1164/rccm.201710-2130CP
11	32. Andersen LW, Grossestreuer AV, Donnino MW. "Resuscitation time bias": a unique
12	challenge for observational cardiac arrest research. Resuscitation. 2018;125:79-82. doi:
13	10.1016/j.resuscitation.2018.02.006
14	33. Meaney PA, Bobrow BJ, Mancini ME, Christenson J, de Caen AR, Bhanji F, Abella
15	BS, Kleinman ME, Edelson DP, Berg RA, Aufderheide TP, Menon V, Leary M; on behalf of
16	the CPR Quality Summit Investigators, the American Heart Association Emergency
17	Cardiovascular Care Committee, and the Council on Cardiopulmonary, Critical Care,
18	Perioperative and Resuscitation. Cardiopulmonary resuscitation quality: improving cardiac
19	resuscitation outcomes both inside and outside the hospital: a consensus statement from the
20	American Heart Association. Circulation. 2013;128:417-435. doi:
21	10.1161/CIR.0b013e31829d8654
22	34. Paul M, Bougouin W, Dumas F, Geri G, Champigneulle B, Guillemet L, Ben Hadj
23	Salem O, Legriel S, Chiche JD, Charpentier J, Mira JP, Sandroni C, Cariou A. Comparison of

1	two sedation regimens during targeted temperature management after cardiac arrest.
2	Resuscitation. 2018:204-210. doi: 10.1016/j.resuscitation.2018.03.025
3	35. Samaniego EA, Mlynash M, Caulfield AF, Eyngorn I, Wijman CA. Sedation
4	confounds outcome prediction in cardiac arrest survivors treated with hypothermia. Neurocrit
5	Care. 2011;15:113-119. doi: 10.1007/s12028-010-9412-8
6	36. Paul M, Bougouin W, Geri G, Dumas F, Champigneulle B, Legriel S, Charpentier J,
7	Mira JP, Sandroni C, Cariou A. Delayed awakening after cardiac arrest: prevalence and risk
8	factors in the Parisian registry. Intensive Care Med. 2016;42:1128–1136. doi:
9	10.1007/s00134-016-4349-9
10	37. Paradis NA, Martin GB, Goetting MG, Rivers EP, Feingold M, Nowak RM. Aortic
11	pressure during human cardiac arrest: identification of pseudo-electromechanical
12	dissociation. Chest. 1992;101:123-128.
13	38. Deakin CD, Low JL. Accuracy of the advanced trauma life support guidelines for
14	predicting systolic blood pressure using carotid, femoral, and radial pulses: observational
15	study. BMJ. 2000;321:673-674.
16	39. Paradis NA, Halperin HR, Zviman M, Barash D, Quan W, Freeman G. Coronary
17	perfusion pressure during external chest compression in pseudo-EMD, comparison of systolic
18	versus diastolic synchronization. Resuscitation. 2012;83:1287-1291. doi:
19	10.1016/j.resuscitation.2012.02.016
20	40. Myerburg RJ, Halperin H, Egan DA, Boineau R, Chugh SS, Gillis AM, Goldhaber JI,
21	Lathrop DA, Liu P, Niemann JT, Ornato JP, Sopko G, Van Eyk JE, Walcott GP, Weisfeldt
22	ML, Wright JD, Zipes DP. Pulseless electric activity: definition, causes, mechanisms,
23	management, and research priorities for the next decade: report from a National Heart, Lung,

1 and Blood Institute workshop. *Circulation*. 2013;128:2532–2541. doi:

# 2 10.1161/CIRCULATIONAHA.113.004490

3	41. Haywood K, Whitehead L, Nadkarni VM, Achana F, Beesems S, Böttiger BW,
4	Brooks A, Castrén M, Ong MEH, Hazinski MF, Koster RW, Lilja G, Long J, Monsieurs KG,
5	Morley PT, Morrison L, Nichol G, Oriolo V, Saposnik G, Smyth M, Spearpoint K, Williams
6	B, Perkins GD; on behalf of the COSCA Collaborators. COSCA (Core Outcome Set for
7	Cardiac Arrest) in adults: an advisory statement from the International Liaison Committee on
8	Resuscitation. Resuscitation. 2018;127:147–163. doi: 10.1016/j.resuscitation.2018.03.022
9	42. Chugh SS, Jui J, Gunson K, Stecker EC, John BT, Thompson B, Ilias N, Vickers C,
10	Dogra V, Daya M, Kron J, Zheng ZJ, Mensah G, McAnulty J. Current burden of sudden
11	cardiac death: multiple source surveillance versus retrospective death certificate-based review
12	in a large U.S. community. J Am Coll Cardiol. 2004;44:1268–1275.
13	43. Ravakhah K. Death certificates are not reliable: revivification of the autopsy. <i>South</i>
14	Med J. 2006;99:728–733. doi: 10.1097/01.smj.0000224337.77074.57
15	44. Tseng ZH, Olgin JE, Vittinghoff E, Ursell PC, Kim AS, Sporer K, Yeh C, Colburn B,
16	Clark NM, Khan R, Hart AP, Moffatt E. Prospective countywide surveillance and autopsy
17	characterization of sudden cardiac death: POST SCD Study. Circulation. 2018;137:2689-
18	2700. doi: 10.1161/CIRCULATIONAHA.117.033427
19	45. Witten L, Gardner R, Holmberg MJ, Wiberg S, Moskowitz A, Mehta S, Grossestreuer
20	AV, Yankama T, Donnino MW, Berg KM. Reasons for death in patients successfully
21	resuscitated from out-of-hospital and in-hospital cardiac arrest. Resuscitation. 2019;136:93-

22 99. doi: 10.1016/j.resuscitation.2019.01.031

1	46. Jones DA, Bagshaw SM, Barrett J, Bellomo R, Bhatia G, Bucknall TK, Casamento
2	AJ, Duke GJ, Gibney N, Hart GK, Hillman KM, Jäderling G, Parmar A, Parr MJ. The role of
3	the medical emergency team in end-of-life care: a multicenter, prospective, observational
4	study. Crit Care Med. 2012;40:98-103. doi: 10.1097/CCM.0b013e31822e9d50
5	47. Chen LM, Nallamothu BK, Spertus JA, Li Y, Chan PS; on behalf of the American
6	Heart Association's Get With the Guidelines-Resuscitation Investigators. Association
7	between a hospital's rate of cardiac arrest incidence and cardiac arrest survival. JAMA Intern
8	Med. 2013;173:1186–1195. doi: 10.1001/jamainternmed.2013.1026

9