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Cardiac Arrest and Cardiopulmonary Resuscitation Outcome Reports: Update of the Utstein Resuscitation Registry Templates for Out-of-Hospital Cardiac Arrest

A Statement for Healthcare Professionals From a Task Force of the International Liaison Committee on Resuscitation (American Heart Association, European Resuscitation Council, Australian and New Zealand Council on Resuscitation, Heart and Stroke Foundation of Canada, InterAmerican Heart Foundation, Resuscitation Council of Southern Africa, Resuscitation Council of Asia); and the American Heart Association Emergency Cardiovascular Care Committee and the Council on Cardiopulmonary, Critical Care, Perioperative and Resuscitation☆,☆☆

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We dedicate this publication to the late Dr Ian Jacobs, who led ILCOR with passion and vision through to October 19, 2014.

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ABSTRACT

Utstein-style guidelines contribute to improved public health internationally by providing a structured framework with which to compare emergency medical services systems. Advances in resuscitation science, new insights into important predictors of outcome from out-of-hospital cardiac arrest, and lessons learned from methodological research prompted this review and update of the 2004 Utstein guidelines. Representatives of the International Liaison Committee on Resuscitation developed an updated Utstein reporting framework iteratively by meeting face to face, by teleconference, and by Web survey during 2012 through 2014. Herein are recommendations for reporting out-of-hospital cardiac arrest. Data elements were grouped by system factors, dispatch/recognition, patient variables, resuscitation/postresuscitation processes, and outcomes. Elements were classified as core or supplemental using a modified Delphi process primarily based on respondents' assessment of the evidence-based importance of capturing those elements, tempered by the challenges to collect them. New or modified elements reflected consensus on the need to account for emergency medical services system factors, increasing availability of automated external defibrillators, data collection processes, epidemiology trends, increasing use of dispatcher-assisted cardiopulmonary resuscitation, emerging field treatments, postresuscitation care, prognostication tools, and trends in organ recovery. A standard reporting

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template is recommended to promote standardized reporting. This template facilitates reporting of the bystander-witnessed, shockable rhythm as a measure of emergency medical services system efficacy and all emergency medical services system-treated arrests as a measure of system effectiveness. Several additional important subgroups are identified that enable an estimate of the specific contribution of rhythm and bystander actions that are key determinants of outcome.

1. Introduction

The term "Utstein style" is synonymous with consensus reporting guidelines for resuscitation. It originated from an international multidisciplinary meeting held at the Utstein Abbey near Stavanger, Norway, in June 1990.[1] The purpose of this inaugural meeting was to develop, by consensus, uniform terms and definitions for out-of-hospital resuscitation. It was anticipated that this would lead to a better understanding of the epidemiology of cardiac arrest, facilitate intersystem and intrasystem comparisons, enable comparison of the benefits of different system approaches, act as a driver to quality improvement, identify gaps in knowledge, and support clinical research.[2,3] The widespread implementation of these recommendations has encouraged the development of other Utstein-like consensus guidelines addressing pediatric advanced life support,[4] laboratory research,[5] in-hospital resuscitation, [6] education,[7] drowning,[8] postresuscitation care,[9] and emergency medical dispatch.[10]

The original Utstein definitions were revised in 2004 with the aim of reducing complexity and updating data elements based on advances in resuscitation science.[11] The original Utstein recommendations focused efforts to report on patients with a non-emergency medical services (EMS)-witnessed cardiac arrest of presumed cardiac cause, with ventricular fibrillation at the point of first rhythm analysis. The Utstein 2004 revision broadened this focus to include all EMS-treated[12] cardiac arrests irrespective of first monitored rhythm and whether or not the arrests were witnessed. Other major changes in 2004 related to the definition of cardiac arrest (transition from presence/absence of a carotid pulse to signs of circulation), inclusion of defibrillation attempts by bystanders, and extension of the template to include reporting of in-hospital cardiac arrest (IHCA) in both adults and children in the same template.

Since the 2004 update, there has been a substantial increase in the number and scope of resuscitation registries and clinical trial groups, with major national and regional registries established in the United States,[13,14] Europe,[15] Asia,[16] Australia,[17] and Japan.[18] Data from such registries are being used increasingly to compare the epidemiology and outcome of cardiac arrest,[19] explore the relation between key treatments and outcome,[20,21] identify and prioritize gaps in resuscitation science knowledge, and drive quality improvement.[22,23] With this background, in 2013, the International Liaison Committee on Resuscitation (ILCOR) proposed a group form to review and, if necessary, update the Utstein templates for cardiac arrest. This article reports the results of that review with recommendations for further refinement of the Utstein reporting guidelines and reporting templates and a specific focus on out-of-hospital cardiac arrest (OHCA). Because of substantial differences between in-hospital and out-of-hospital epidemiology, process of care, and treatments, a decision was made once more to use separate reporting templates. Thus, this article focuses on OHCA, and a subsequent article will focus on recommendations for IHCA process of care and outcome reporting.

2. Current uses and applications

A review of articles citing the 2004 Utstein manuscript (Scopus, Elsevier, Amsterdam, The Netherlands: March 2014) identified 584 citations. These originated from 50 countries; most citations (493 [84%]) were classified as research articles. One third of the citations focused on epidemiology and outcome (OHCA, n = 126 [22%]; IHCA, n = 41 [7%]) and specialized populations (e.g., drowning, children; n = 43 [7%]). Another third focused on links in the Chain of Survival (early access, including dispatcher, n = 19 [3%]; cardiopulmonary resuscitation [CPR], n = 43 [7%], and defibrillation, n = 31 [5%]; advanced life support, including drugs, n = 19 [3%]; airway, n = 7 [1%]; and postresuscitation care, n = 63 [11%]). The remaining articles examined elements related to outcome and prognostication (n = 76 [13%]); described registries/registry methodology (n = 14 [2%]), quality improvement (n = 33 [6%]), or primary research (n = 44 [8%]); were review articles (n = 22 [4%]); or addressed other factors (n = 3 [0.5%]).

Despite substantial application to a variety of clinical and research projects, a recent evaluation of 13 registries enrolling patients with OHCA in 13 countries noted variation in inclusion criteria, definition, coding, and process-of-care elements.[12] Overall, the registries collected only two thirds of the recommended 2004 core elements. Recommended timed event elements were collected for 43% of events. Thus, the current proposed iteration of the revised Utstein templates attempts to balance (1) the desirability of uniform collection of evidence-based factors associated with outcome and (2) the practical challenges of real-life data collection and validation.

3. What Have We Learned About the Utstein Elements for Cardiac Arrest?

Several core elements have consistently been associated with survival to hospital discharge: witnessed arrest (by a bystander or EMS); bystander CPR; shorter EMS response interval; first shockable rhythm; and return of spontaneous circulation (ROSC) in the field.[24–27] However, it has become evident that the Utstein core elements incompletely explain the variability in OHCA survival across populations,[25–27] even allowing for the declining incidence of ventricular fibrillation in OHCA.[28,29] Since the last iteration of the Utstein style,[11] there has been increased recognition of the importance of additional factors associated with the likelihood of survival after OHCA, such as public access defibrillation, [24,30] dispatcher-assisted CPR,[31] the quality of CPR,[32,33] postresuscitation care,[34–36] variability in "not for resuscitation" order policies and procedures,[37] and accurate prognostication.[38] In addition there have been changing trends in organ recovery and transplantation.[39] Short-term outcomes such as ROSC and survival to hospital discharge (the latter being susceptible to local health system practices) do not take into account patients' health related quality of life.[40,41] Given the advances in understanding of the prognostic

determinants of survival in OHCA, the need to revisit and update the 2004 Utstein guidelines was evident.[11]

4. Methods

The Utstein collaborator group met face to face on 2 occasions to discuss the revisions to the Utstein reporting template. The first meeting was in Vienna, Austria, in October 2012 and was linked to the European Resuscitation Council Scientific Congress. The second meeting followed the ILCOR 2013 Task Force meeting in Melbourne, Australia, in April 2013. During these meetings, the strengths and weaknesses of the previous Utstein consensus articles for cardiac arrest[2,11,42] were reviewed, and opportunities to update and improve them were discussed.

Consensus was reached for several overarching principles. After repeated attempts to address key issues related to OHCA and IHCA in the same template, it became apparent that separate reporting templates would facilitate end-user acceptance and use of updated reporting templates. Consistency was sought in data elements and definitions between IHCA and OHCA unless there was a strong rationale for deviation. Core elements were defined as elements that all registries should aim to capture and report. The decision to assign an element as core was based on the evidence-based importance of capturing that element, tempered by the practical challenges of real-life data collection and validation. Collection and verification of core elements was considered the minimum recommended standard for quality assurance/improvement purposes. Supplemental elements were defined as elements that were desirable but not essential to capture and report, including elements more relevant to research than quality assurance.

Breakout groups considered core and supplemental data elements under the domains of system factors, dispatch/recognition, patient variables, resuscitation and postresuscitation processes, and outcomes. After the Melbourne meeting, a 2-stage Delphi process was conducted to refine the recommendations for core and supplemental elements. During stage 1, the output from the breakout groups was presented to the wider collaborator group. Agreement for core and supplemental element designations was sought using a 5-point Likert scale. Participants were also able to submit additional elements for consideration. New elements, or elements for which there was <85% agreement on designation as core or supplemental, were submitted to a second round of voting. There was greater than 85% agreement for designations for all elements by the end of the second round, so further rounds were not required.

Data definitions were based where possible on current 2004 Utstein definitions. New element definitions were proposed by the writing group and circulated to the collaborator group for vetting.

The writing group, on behalf of collaborators, summarized the output from this process in a draft of the manuscript that was circulated and discussed electronically with the Utstein collaborators. This led to further development of the Utstein reporting template and classification of pathogenesis. The final manuscript was approved by the coauthors and ILCOR.

5. Results

5.1. OHCA Utstein Definitions

The Utstein elements were grouped into 5 domains (Fig. 1). Each domain contained core and supplemental elements that are described in Table 1.

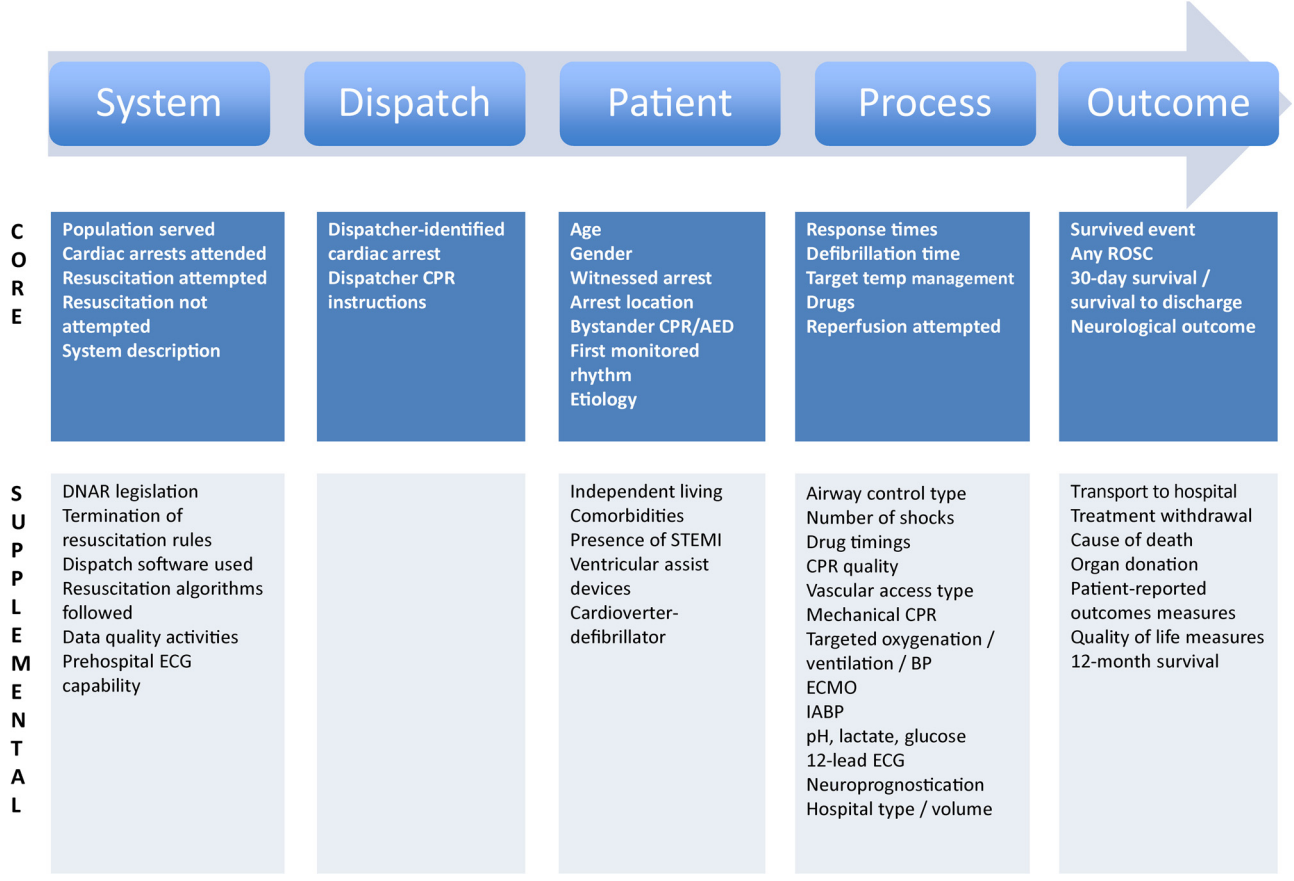

Fig. 1. Data element domains. Core and supplemental elements are shown for each of the 5 domains. AED indicates automated external defibrillator; BP, blood pressure; CPR, cardiopulmonary resuscitation; DNAR, do not attempt resuscitation; ECMO, extracorporeal membrane oxygenation; IABP, intra-aortic balloon pump; ROSC, return of spontaneous circulation; STEMI, ST-segment–elevation myocardial infarction; and temp, temperature.

Table 1
Utstein Data Definitions.

Utstein OHCA Elements	Consensus Definition 2014	Data Options
System Core		
Population served*	Total population of service area of EMS system	Number of cases
Number of cardiac arrests attended*	Number of cardiac arrests attended (arrests defined by absence of signs of circulation)	Number of cases
Resuscitation attempted	When EMS personnel perform chest compressions or attempt defibrillation, it is recorded as a resuscitation attempt by EMS personnel	Number of cases
Resuscitation not attempted	Total number of cardiac arrests in which resuscitation was not attempted and the number of those arrests not attempted because a written DNACPR order was present or victim was obviously dead or signs of circulation were present	Total number of cases, number with DNACPR, number considered futile, number with signs of circulation, number unknown
System description*	A description of the organizational structure of the EMS being provided. This should encompass the levels of service delivery, annual case numbers, and size of geographic region covered.	Number and type of EMS tier; providers' skill set; number of EMS calls, excluding interfacility transfers; population served based on census data; footprint served in square kilometers or square miles
System Supplemental		
System description (supplemental)*	System information: Free text description defining (A) the presence or existence of legislation that mandates no resuscitation should be started by EMS or health services in specific circumstances or clinical cohorts of patients; (B) systems for limiting/terminating prehospital resuscitation; (C) termination of resuscitation rules; (D) whether dispatch software is used (and type, version); (E) resuscitation algorithms followed (eg, AHA, ERC, any local variations, CPR or shock first, compression-only CPR initially/compressions and ventilations). (F) Describe any formalized data quality activities in place. (G) Describe prehospital ECG capability, that is, whether or not EMS system has ability to perform and interpret (or have interpreted via telemetry) 12-lead ECGs in the field.	Free text
Dispatcher Core		
Dispatcher identified presence of cardiac arrest*	Did the dispatcher identify the presence of cardiac arrest before arrival of EMS?	Yes/no/unknown/not recorded
Dispatcher provided CPR instructions*	Did the dispatcher provide telephone CPR instructions to the caller?	Yes/no/unknown/not recorded
Core Patient		
Age	If the victim's date of birth is known, it should be recorded in an acceptable format. If the date of birth is not known but the victim's age is known, age should be recorded. If the victim's age is not known, age should be estimated and recorded.	3 Digits (state units: years, months, or days) Indicate whether estimated/unknown/not recorded. Specify whether reported average ages include or exclude estimated ages.
Gender	Sex	Male/female/unknown/not recorded
Witnessed arrest	A cardiac arrest that is seen or heard by another person or is monitored. EMS personnel respond to a medical emergency in an official capacity as part of an organized medical response team. Bystanders are all other groups. By this definition, physicians, nurses, or paramedics who witness a cardiac arrest and initiate CPR but are not part of the organized rescue team are characterized as bystanders, and the arrest is not described as EMS witnessed.	Bystander witnessed/EMS witnessed/unwitnessed/unknown/not recorded
Arrest location	The specific location where the event occurred or the patient was found. Knowledge of where cardiac arrests occur may help a community to determine how it can optimize its resources to reduce response intervals. A basic list of predefined locations will facilitate comparisons. Local factors may make creation of subcategories useful.	Home/residence; industrial/workplace; sports/recreation event; street/highway; public building; assisted living/nursing home; educational institution; other; unknown/not recorded
Bystander response	Bystander CPR is CPR performed by a person who is not responding as part of an organized emergency response system to a cardiac arrest. Physicians, nurses, and paramedics may be described as performing bystander CPR if they are not part of the emergency response system involved in the victim's resuscitation. Bystander CPR may be compression only or compression with ventilations (the act of inflating the patient's lungs by rescue breathing with or without a bag-mask device or any other mechanical device).	Bystander CPR (subset: compression only, compression and ventilations)/no bystander CPR/unknown/not recorded
	Bystander AED use	AED used, shock delivered/AED used, no shock delivered/AED not used/Unknown/not recorded
First monitored rhythm	The first cardiac rhythm present when the monitor or defibrillator is attached to the patient after a cardiac arrest.	VF/pulseless VT/PEA/asystole/bradycardia/AED nonshockable/AED shockable/unknown/not recorded

Table 1 (*Continued*)

Utstein OHCA Elements	Consensus Definition 2014	Data Options
Pathogenesis	The most likely primary cause of the cardiac arrest. Medical: Includes cases in which the cause of the cardiac arrest is presumed to be cardiac, other medical cause (eg, anaphylaxis, asthma, GI bleed), and in which there is no obvious cause of the cardiac arrest Traumatic: Cardiac arrest directly caused by blunt, penetrating, or burn injury Drug overdose: Evidence that the cardiac arrest was caused by deliberate or accidental overdose of prescribed medications, recreational drugs, or ethanol Drowning: Victim is found submersed in water without an alternative causation Electrocution Asphyxial: External causes of asphyxia, such as foreign-body airway obstruction, hanging, or strangulation	Medical: traumatic cause/drug overdose/drowning/electrocution/ asphyxial/not recorded. (Note this variable does not include the unknown option as unknown causes should be assigned as medical causes.)
Supplemental Patient		
Independent living*	Before the cardiac arrest, the patient was able to perform all activities of daily living without the assistance of caregivers.	Yes/no/unknown/not recorded
Comorbidities*	The patient has a documented history of other disease conditions that existed before the cardiac arrest.	Yes/no/unknown/not recorded
VAD	The patient is supported by any form of VAD to augment cardiac output and coronary perfusion.	Yes/no/unknown/not recorded
Cardioverter-defibrillator*	The patient has an internal or external cardioverter-defibrillator.	Internal/external/no/unknown/not recorded
Presence of STEMI*	At the time of the first 12-lead ECG performed after ROSC, the presence of STEMI is observed.	Yes/no/unknown/not recorded
Core OHCA Process		
Response times	The time interval from incoming call to the time the first emergency response vehicle stops at a point closest to the patient's location. The time of the incoming call is when it is first registered at the center answering emergency calls, regardless of when the call is answered.	mm:ss/unknown/not recorded
Defibrillation time	The time interval from incoming call to the time the first shock is delivered	mm:ss/unknown/not recorded
TTM*	The time and setting where TTM was initiated	Intra-arrest/post-ROSC prehospital/post-ROSC in-hospital,/TTM indicated but not performed/TTM not indicated/unknown/not recorded Supplemental: If TTM used, what was target temperature (data options: temperature [in degrees Celsius]/unknown/not recorded)?
Drugs given	The term drugs refers to delivery of any medication (by IV cannula, IO needle, or tracheal tube) during the resuscitation event.	Adrenaline/amiodarone/vasopressin/none given/unknown/not recorded
Supplemental OHCA Process		
Airway control (type)	Prehospital airway control: During the resuscitation, what was the main airway device used?	None used/oropharyngeal airway/supraglottic airway/endotracheal tube/surgical airway/multiple/unknown/not recorded
CPR quality*	During the resuscitation, were there mechanisms or processes in place to measure the quality of CPR being delivered?	Yes/no/unknown/not recorded
Number of shocks	The number of shocks delivered (including shocks delivered by public access defibrillators)	Number/unknown/not recorded
Drug timings	The time interval from incoming call to the time vascular access is obtained and the first drug is given	mm:ss/unknown/not recorded
Vascular access (type)*	The main route through which drugs were administered during the arrest	Central line/peripheral IV/IO/endotracheal/unknown/not recorded
Mechanical CPR*	At any time during the resuscitation, was a mechanical CPR device deployed?	Mechanical compression-decompression device/load-distributing band/other mechanical device/unknown/Not recorded
Targeted oxygenation/ventilation*	After ROSC, was targeted ventilation applied?	O_2 and CO_2/O_2 only/CO_2 only/not used/unknown/not recorded. If this variable is reported, include details of specific targets in system description.

Table 1 (*Continued*)

Utstein OHCA Elements	Consensus Definition 2014	Data Options
Core Post Resuscitation Process		
Reperfusion attempted*	Was coronary reperfusion attempted?	Type: Angiography only/PCI/thrombolysis/none/unknown/ not recorded Timing: Intra-arrest/within 24 h of ROSC/>24 h but before discharge/unknown/not recorded
Supplemental Post Resuscitation Process		
ECLS*	When was ECLS used?	Before ROSC/after ROSC/not used/unknown/not recorded
IABP*	Was an IABP used?	Yes/no/unknown/not recorded
pH*	What was the first pH recorded after ROSC?	pH value/unknown/not recorded
Lactate*	What was the first lactate recorded after ROSC?	Lactate value (mmol/L)/unknown/not recorded
Glucose*	After ROSC, was glucose titrated to a specific target?	Yes/no/unknown/not recorded
Number and type of neuroprognostic tests*	Number and type of neuroprognostic tests used	SSEP—Yes/no/unknown/not recorded NSE—Yes/no/unknown/not recorded EEG—Yes/no/unknown/not recorded CT of brain—Yes/no/unknown/not recorded MRI of brain—Yes/no/unknown/not recorded Clinical examination—Yes/no/unknown/not recorded Other (define)—Yes/no/unknown/not recorded Indicate timing of test and whether test led to discontinuation of treatment
Hospital type*	Was the patient's primary transfer to a specialist healthcare facility (able to perform all forms of periarrest and postarrest care and allocated this role by the area of administration) or nonspecialist center?	Specialist center/nonspecialist center/unknown/not recorded
Hospital volume*	How many cases of OHCA does the hospital treat each year?	Number of cases/y
12-Lead ECG*	Was a 12-lead ECG performed after ROSC?	Yes/no/unknown/not recorded
Targeted blood pressure management*	What target blood pressure was used?	mm Hg/no target set/unknown/not recorded
Core outcomes		
Survived event	ROSC sustained until arrival at the emergency department and transfer of care to medical staff at the receiving hospital	Yes/no/unknown/not recorded
Any ROSC	Did the patient achieve ROSC at any point during the resuscitation attempt?	Yes/no/unknown/not recorded
30-d survival or survival to discharge	Was the patient alive at the point of hospital discharge/30 d?	Yes/no/unknown/not recorded
Neurological outcome at hospital discharge	Record CPC and/or mRS or pediatric equivalent at hospital discharge. Include a definition of how it was measured (face to face, extracted from notes, combination).	CPC score (1-5)/unknown/not recorded mRS (0-6)/unknown/not recorded
Supplemental outcomes		
Survival status	The patient is alive at 12 mo after cardiac arrest.	Yes/no/unknown/not recorded
Transported to hospital*	Was the patient transported to the hospital?	Yes/no/unknown/not recorded
Treatment withdrawn (including timing)*	A decision to withdraw active treatment was made. Record the time that this occurred after ROSC.	Yes/no/unknown/not recorded Days/hours
Cause of death*	Cause of death as officially recorded in the patient's medical records or death certificate	
Organ donation*	The number of patients who had >1 solid organs donated for transplantation	Number of cases/unknown/not recorded
Patient-reported outcome measures (outcomes selected by patients as being important)*	Patient-focused health outcomes were assessed	Free text
Quality-of-life measurements (standardized questionnaires, eg, EQ-5D, SF-12)*	A validated quality-of-life measure was used to assess health quality of life.	Yes/no/unknown List quality-of-life instrument(s) used and outcomes/scores.

Data definitions have been categorized as core and supplemental. Data definitions have mostly been updated. Registries and researchers may wish to check against their current definitions. The unknown category should be assigned when the variable is recorded as unknown. This differs from the not recorded category, which is reserved for where data are missing or the system does not collect those data.

AED indicates automated external defibrillator; AHA, American Heart Association; CPC, Cerebral Performance Category; CPR, cardiopulmonary resuscitation; CT, computed tomography; DNACPR, do not attempt cardiopulmonary resuscitation; ECLS, extracorporeal life support; EEG, electroencephalogram; EMS, emergency medical services; ERC, European Resuscitation Council; GI, gastrointestinal; IABP, intra-aortic balloon pump; IO, intraosseous; IV, intravenous; mm:ss, minutes and seconds; MRI, magnetic resonance imaging; mRS, modified Rankin Scale; NSE, neuron-specific enolase; OHCA, out-of-hospital cardiac arrest; PCI, percutaneous coronary intervention; PEA, pulseless electrical activity; ROSC, return of spontaneous circulation; SF-12, 12-Item Short Form Health Survey; SSEP, somatosensory evoked potentials; STEMI, ST-segment–elevation myocardial infarction; TTM, targeted temperature management; VAD, ventricular assist device; VF, ventricular fibrillation; and VT, ventricular tachycardia.

* New variables.

5.1.1. System Description

The system description defines the characteristics of the population served and the structure of the EMS response. It includes the number of cases of cardiac arrest attended by EMS (cardiac arrest is defined by the absence of signs of circulation irrespective of whether the assessment was made by EMS or bystander), the number of cases for which resuscitation was attempted by EMS, and the reasons why resuscitation was not attempted. A

resuscitation attempt is defined as the act of trying to maintain or restore life by establishing and/or maintaining breathing and circulation through CPR, defibrillation, and other related emergency care. A structured system description has been added to improve consistency when describing the components of the healthcare system responsible for responding to OHCA.

5.1.2. Dispatch

Dispatcher-identified cardiac arrest and dispatcher-assisted CPR have been included as core elements to reflect the impact these processes can have on patient outcome.[43,44] The system description provides the opportunity to describe operation of the local EMS dispatch. Researchers and clinical service directors who wish to record additional information (e.g., dispatcher diagnostic code, bystander response) are directed to a consensus paper on dispatcher assistance for OHCA.[45]

5.1.3. Patient Variables

Patient variables include patient demographics, comorbidities, pathogenesis, initial presentation, and bystander response. The location of the arrest and whether it was witnessed should be recorded.

The designation of pathogenesis was one of the most contentious areas discussed during this revision. The Utstein process has for decades tried to separate cardiac (or presumed cardiac) from noncardiac (or presumed noncardiac) causes. The original intention was to create case equivalency; however, separation into cardiac and noncardiac causes has proved to be subjective,[46,47] with some communities reporting the percentage of noncardiac causes of all arrests as several percent and others up to 40%.[48,49]

Given this variation, we suggest that the primary reporting by systems should state the outcomes of all EMS-treated cardiac arrests (which measures system effectiveness) and those that are bystander witnessed and for which the first monitored rhythm is shockable (which measures system efficacy). Registries and researchers should continue to record the pathogenesis of cardiac arrest and report it as part of the overall description of EMS-treated cardiac arrests. Pathogenesis should be categorized under the following headings, which also recognize the importance of backward compatibility with existing definitions: medical (presumed cardiac or unknown, other medical causes); traumatic cause; drug overdose; drowning; electrocution; or asphyxial (external). Where >1 cause is possible (eg, ventricular fibrillation arrest leading to a fall from a height), the most likely primary cause should be cited (in this example, presumed cardiac). Table 1 provides further information about classification into different pathogenic categories.

The first monitored rhythm is the rhythm recorded at the time of first analysis of the monitor or defibrillator after a cardiac arrest. If the automated external defibrillator (AED) does not have a rhythm display, it may be possible to determine the first monitored rhythm from a data storage card, hard drive, or other device used by the AED to record data. If the AED has no data-recording device, the first monitored rhythm should be classified simply as shockable or nonshockable. This data point can be updated at a later time if the AED has data download capability. Bradycardia has been retained as an option to enable appropriate reporting when chest compressions are provided for severe bradycardia with pulses and poor perfusion (most commonly in children). When CPR is started because of the absence of signs of circulation despite electrocardiographic evidence of electrical activity (i.e., pulseless electrical activity), it should be recorded as pulseless electrical activity even if the electrocardiographic rhythm is slow. Asystole is defined by a period of at least 6 seconds without any electrical activity of >0.2 mV (which could represent atrial complexes).

Bystander responses are critical to patient outcomes. All systems should capture the number of cases in which bystander resuscitation is started (chest compressions or standard CPR), whether or not an AED is deployed, and whether or not it delivered a shock.

Supplemental information includes whether a patient was living independently before the arrest, comorbidities, and new treatments (cardioverter-defibrillators, ventricular assist devices).

5.1.4. Process Elements

Core process elements include the EMS response time, time to first shock, whether targeted temperature management was used before or after ROSC, and whether coronary reperfusion was attempted. Twelve supplemental elements are included (6 elements related to treatments initiated out of the hospital and 6 elements related to treatments initiated in the hospital).

5.1.5. Outcome

Recommendations regarding the documentation of survival outcomes remain largely unchanged from the 2004 Utstein style. The core reporting outcome for initial survival is “survived event” (which is defined ROSC sustained until arrival at the emergency department and transfer of care to medical staff at the receiving hospital). To ensure compatibility with historical data sets, any ROSC remains a core outcome. ROSC is defined according to a clinical assessment that shows signs of life comprising a palpable pulse or generating a blood pressure. Assisted circulation (e.g., extracorporeal life support, ventricular assist devices, or mechanical CPR) should not be considered ROSC until patient-generated circulation is established. For nonsurvivors, a supplemental element may be recorded to show whether any solid organs were recovered for transplantation.

Long-term survival can be reported as either survival to 30 days or survival to hospital discharge according to the ease of collecting this information within each healthcare system. Survival at 12 months should be reported when possible but is considered supplemental information because of the challenge of such longterm follow-up. Neurological outcome may be reported using the Cerebral Performance Category (CPC),[50] modified Rankin Scale (mRS),[51] or equivalent pediatric tools.[4] The CPC is a 5-point scale ranging from 1 (good cerebral performance) to 5 (dead). The mRS is a 7-point scale ranging from 0 (no symptoms) to 6 (dead). We define survival with favorable neurological outcome as a CPC 1 or 2 or mRS 0 to 3 or no change in CPC or mRS from the patient’s baseline status. Patient-reported outcomes and health-related quality of life are included to reflect the importance of the quality of recovery beyond simply survival.

5.2. Time Points and Intervals

Survival from cardiac arrest is related inversely to the interval from collapse to definitive care.[52,53] In this revised Utstein template, we have limited the core time point/interval elements to response time and time to first defibrillation (Table 1). The time of drug administration remains as a supplemental element. The previous Utstein documents recommended several additional core and supplemental time points or intervals. Certain time points are impossible to estimate (e.g., time of collapse in an unwitnessed arrest), many are not routinely collected (e.g., in OHCA, arrival at the patient’s side), and others are unlikely to be recorded accurately (e.g., time of first compression, time vascular access was achieved, time of ROSC). It is recognized that additional time points or intervals may be collected routinely by some agencies; this revised template is not intended to suggest that such data points are redundant. Moreover, the collection of additional elements may be required for specific research studies.[54]

The problem of lack of synchronization of clocks and other time-recording devices persists[55–57] and can result in intervals being

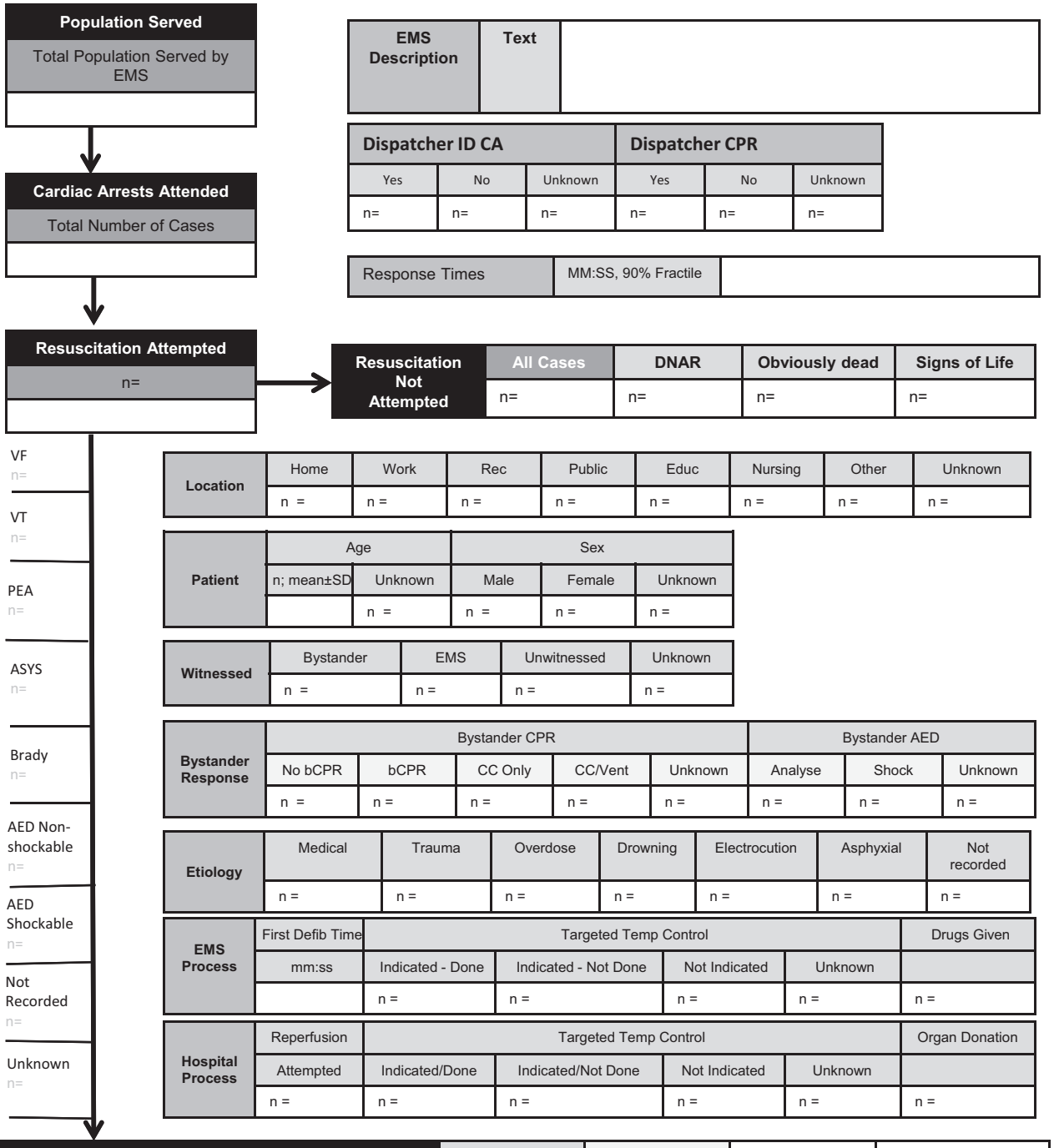

Fig. 2. Utstein standardized template for reporting outcomes from out-of-hospital cardiac arrest. AED indicates automated external defibrillator; ASYS, asystole; bCPR, bystander cardiopulmonary resuscitation; Brady, bradycardia; CC, chest compressions; CPC, Cerebral Performance Category; CPR, cardiopulmonary resuscitation; DC; discharge; Defib, defibrillation; DNAR; do not attempt resuscitation; Educ, educational institution; EMS; emergency medical services; Fav, favorable; ID, identified; mRS, modified Rankin Scale; PEA, pulseless electrical activity; Rec, sports/recreation event; ROSC, return of spontaneous circulation; Temp, temperature; Vent, ventilations; VF, ventricular fibrillation; and VT, ventricular tachycardia. *Utstein comparator group (system efficacy).

reported inaccurately. The recommendation remains that one clock (or synchronization to a single clock) be used to determine all times throughout the resuscitation attempt.

5.3. Utstein Reporting Template

The purpose of the revised Utstein template is to provide a framework that combines the core elements of resuscitation performance for OHCA, including the community response, EMS treatments, and hospital systems of care. In previous iterations of the Utstein template, the target user was primarily a resuscitation research scientist. In the 2014 Utstein template (Fig. 2 also available as Online Data Supplement 2), the authors recognized the need to widen the scope of the reporting template to encompass the needs of those involved in research, program evaluation, and continuous quality improvement. The goal in 2014 is to make the template intuitive to complete and effective in mapping the patient's journey through the local resuscitation system, as well as to enable knowledge sharing between resuscitation networks. To this end, the template has been reengineered in the following ways: First, the template follows the natural flow of the patient through community, out of-hospital, and in-hospital systems of care. It is expected that this format will facilitate data collection. Second, the template encompasses the core system structure, process, and outcome of care, as well as performance measures similar to those used in other systems of models of care (eg, ST-segment–elevation myocardial infarction, stroke, trauma).[58] Third, the various data dictionary and data formats are embedded within the template, which enables easier data entry by the user. Outcomes are defined at 4 levels: any ROSC, survived event, survived to discharge, and favorable neurological outcome at discharge if known. Registries may report survival to 30 days as an alternative to survival to discharge. The 2014 template allows reporting of the bystander witnessed cardiac arrest who had a first recorded rhythm that was shockable. This is recommended as the Utstein comparator of system efficacy. All EMS-treated cardiac arrests are recommended for system effectiveness comparisons. Outcomes of several important subgroups are identified that allow an estimate of the specific contribution of rhythm and bystander actions that are key determinants of outcome. This is particularly important for improving bystander CPR and outcome of the increasingly prevalent nonshockable rhythms. Only with knowledge of these specific outcomes can differences between systems and improvement over time be understood. The template includes the capability to add other user-defined outcomes for specific purposes.

5.4. Scope for Improving Utstein-Style Reporting

Previous Utstein templates do not characterize the nature of the organized EMS response. EMS systems are commonly grouped as either 1- or 2-tier systems, depending on the number and skill of providers who respond. In some settings, multiple EMS agencies cover a region in a patchwork fashion, with variable geographic and administrative overlap. Some municipal EMS systems use a private EMS agency for nonurgent transportation. Other agencies occasionally dispatch a paramedic supervisor to the scene. Most experts would not classify either of these as 3-tier services. Additional details about how services are provided may yield additional insight into regional differences in process and outcome.

Some, but not all, cardiac arrest registries monitor routinely for completeness of case capture. A comparison of patients not enrolled versus those enrolled in a registry designed to capture consecutive patients with acute coronary syndrome found that 30% of eligible patients were missing.[59] The missing patients were at higher risk, received poorer quality of care, and had a higher mortality rate than those who were included.[59] A similar analysis of the Swedish Cardiac Arrest Register reported that 25% of eligible cases were missing.[60] These missing case subjects tended to be older and less likely to receive bystander CPR but had significantly higher survival rates. Such selection bias limits the ability of registries to reliably assess epidemiology and the effectiveness of quality improvement initiatives or other interventions. [61] Each EMS agency participating in the Resuscitation Outcomes Consortium (ROC) Epistry[62] uses routine monitoring and necessary corrections for completeness of case capture. By consistently applying such monitoring, the estimated incidence of EMS-treated OHCA in participating North American ROC sites has increased by >20% since the inception of the ROC Epistry.[63,64] Organizers of cardiac arrest registries should

Table 2
Utstein Checklist for Standardized Reporting.

Section	Checklist Item	Yes/No Page Reported
Abstract	Abstract includes the term "Utstein"	
Methods	System description	
	Setting and location where data were collected	
	Methods used to identify cases, including any quality assurance processes for completeness of measuring case ascertainment	
	Population of patients being reported (eg, Utstein comparator, EMS-treated arrests, or other population)	
	Systems used to obtain timed data, including any synchronization between clocks	
	Definitions used for core and supplemental elements are in concordance with Utstein 2014 style (or alternative definitions are identified)	
	Data source (eg, registry) and whether complete or partial data were used	
	Appropriate EQUATOR tool used to support study reporting (http://www.equator-network.org/reporting-guidelines/)	
Statistical analysis	Analytical methods used to handle missing data (eg, complete case analysis, multiple imputation)	
Results	Time period from which data were collected	
	Utstein comparator population results	
	EMS-treated population results	
	Proportion of missing data	
Discussion	Limitations, addresses sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	
	External validity of findings Interpretation consistent with results, balancing benefits and harms and considering other relevant evidence	

EMS indicates emergency medical services; and EQUATOR, Enhancing the Quality and Transparency of Health Research.
Available as online-only Data Supplement 3.

implement monitoring and remediation for completeness of case capture.

There is variation in the magnitude and coding of missing data between registries. Missing data arise in most clinical studies and can bias inferences if data are not missing completely at random.[65] In addition, some registries combine "not done" and "unknown" into a single response. Organizers of registries should work to reduce unknown and missing data.

5.5. Implementation

Since 1990, implementation, update, and simplification of ILCOR Utstein templates for cardiac arrest resuscitation audit, registry, and research have improved transparency and comparability of reports. Challenges lie ahead for future implementation, particularly in the balance of feasibility versus desirability of data elements. Challenges with adherence to "not-for-resuscitation" rules, capture of actual measured quality of CPR parameters (e.g., depth, rate, chest compression fraction, ventilation rate, perishock pause intervals), and linkage of out-of-hospital and inhospital interventions and outcomes persist. We have continued to identify a few core elements that we think every system of care should collect and report, as well as many supplemental elements that we think may be applicable to research-oriented systems, special resuscitation circumstances or processes, or EMS systems with advanced capability to routinely capture information on CPR quality. Recognition and focus on a core outcome comparator (i.e., bystander-witnessed, shockable cardiac arrest) may offer a universal comparator for all systems, as a tracer methodology for efficacy in all systems. Increased implementation of these updated consensus definitions and reporting templates will inform and improve future formulas for survival[66] and enable meta-analysis and inclusion of larger numbers of patients in studies of cardiac arrest where appropriate.

Just as the Consolidated Standards of Reporting Trials (CONSORT) Statement[67] is designed to assist in reporting research by use of a checklist and flow diagram (http://www.consort-statement.org/consort-2010), the application of the Utstein template is intended to improve transparency and consistency of reports of cardiac arrest process of care and outcomes (Table 2). In addition to reporting Utstein elements, researchers should ensure that appropriate reporting guidelines relevant to the specific study design are followed (eg, CONSORT Statement for clinical trials; Strengthening the Reporting of Observational Studies in Epidemiology [STROBE] statement for observational studies [http://www.equator-network.org]).

6. Conclusions

Utstein-style guidelines standardize reporting of the process of care and outcomes for patients with cardiac arrest. With use of the ILCOR infrastructure, face-to-face meetings, and an Internet-based modified Delphi approach, the 2004 OHCA Utstein reporting definitions and templates were updated for the 5 domains: system factors, dispatch/recognition, patient variables, process variables, and outcomes. New or modified elements reflect consensus on the need to account for EMS system factors, increasing availability of AEDs, variability in the data collection process, trends in epidemiology, increasing use of dispatcher-assisted CPR, emerging field treatments, postresuscitation care, prognostication tools, and trends in organ recovery and transplantation.[39] The consensus reporting template, which resembles a CONSORT diagram, facilitates reporting of bystander-witnessed, shockable rhythm as a measure of EMS system efficacy and all EMS-treated arrests as a measure of system effectiveness. Several important subgroups are identified that allow an estimate of the specific contribution of rhythm and bystander actions that are key determinants of outcome.

Contributions

The detailed contributions are summarized in the online-only Data Supplement 1. In brief, Dr Perkins ran the Delphi surveys and prepared the first draft of the manuscript under the oversight of Drs Jacobs and Nadkarni. Drs Travers and Koster developed and refined the reporting template. The draft manuscript and templates were revised after input from a core writing group initially (Drs Nadkarni, Berg, Finn, Gräsner, Nichol, Morley, Travers, and Nolan). These outputs were then circulated and discussed in detail with coauthors and collaborators, who added important intellectual content to the manuscript's refinement. The final manuscript was approved by all authors and collaborators.

Conflict of interest statement

The American Heart Association makes every effort to avoid any actual or potential conflicts of interest that may arise as a result of an outside relationship or a personal, professional, or business interest of a member of the writing panel. Specifically, all members of the writing group are required to complete and submit a Disclosure Questionnaire showing all such relationships that might be perceived as real or potential conflicts of interest.

Disclosures

Writing Group Disclosures.

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/ Honoraria	Expert Witness	Ownership Interest	Consultant/ Advisory Board	Other
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Dominique Biarent	Hopital Universitaire des Enfants Reine Fabiola	None	None	None	None	None	None	None
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Allan R. de Caen	University of Alberta and Stollery Children's Hospital	None	None	None	None	None	None	None

(*Continued*)

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Jan-Thorsten Grasner	Kiel University	None	None	None	None	None	None	None
Mary Fran Hazinski	Vanderbilt University	None	None	None	None	None	American Heart Association[†]	None
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Jerry P. Nolan	Royal United Hospital, Bath	None	None	None	None	None	None	None
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This table represents the relationships of writing group members that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all members of the writing group are required to complete and submit. A relationship is considered to be "significant" if (a) the person receives $10 000 or more during any 12-month period, or 5% or more of the person's gross income; or (b) the person owns 5% or more of the voting stock or share of the entity, or owns $10 000 or more of the fair market value of the entity. A relationship is considered to be "modest" if it is less than "significant" under the preceding definition.

[*] Modest.

[†] Significant.

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Richard Lyon	University of Edinburgh	Resuscitation Council (UK) Research Grant[†]	None	None	None	None	Physio Control[*]; Zoll Medical[*]	None
Thomas Rea	University of Washington; Public Health-Seattle and King County, Emergency Medical Services Division	None	None	None	None	None	None	None
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[*] Modest.

[†] Significant.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.resuscitation.2014.11.002.

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