ILCOR Consensus Statement

Cardiac Arrest and Cardiopulmonary Resuscitation Outcome Reports: Update of the Utstein Resuscitation Registry Template for In-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)

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Abstract

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

Introduction

The first Utstein-style guideline for the reporting of data from cardiac arrest was published in 1991 and represented the output from an international multidisciplinary meeting held at the Utstein Abbey near Stavanger, Norway, in June 1990.[1] This first Utstein reporting guideline focused on out-of-hospital cardiac arrest (OHCA) and aimed to standardize definitions and data items, thus enabling comparison of cardiac arrest epidemiology and outcomes between emergency medical services systems. It was anticipated that this would also drive quality improvement, identify knowledge gaps, and facilitate clinical research by standardizing reporting and definitions for use by investigators. The first Utstein reporting guideline for in-hospital cardiac arrest (IHCA) was published in 1997 and included 4 categories of variables for documenting in-hospital resuscitation: hospital, patient, arrest, and outcome.[2] Other Utstein reporting guidelines include pediatric advanced life support,[3] laboratory research,[4] education,[5] drowning,[6] postresuscitation care,[7] and emergency medical dispatch.[8] In 2004, the Utstein guidelines for reporting cardiac arrest were updated to incorporate definitions and data elements for both OHCA and IHCA, reduce complexity of data collection, and address advances in resuscitation science.[9] The Utstein reporting guidelines for cardiac arrest were 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.[10] This article, therefore, is an update to Utstein reporting guidelines for IHCA.

Although there are numerous national and regional registries for OHCA,[11-17] there are relatively few for IHCA.[17-20] The American Heart Association Get With The Guidelines – Resuscitation (GWTG-R) registry has been a particularly valuable source of data on all aspects of IHCA,[21] and more recently, the UK National Cardiac Arrest Audit has also reported on the incidence and outcome from cardiac arrest in UK hospitals.[19] 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.

Methods

The Utstein collaborator group met face-to-face on 4 occasions to discuss the revisions to the Utstein IHCA reporting template. The first meeting followed the International Liaison Committee on Resuscitation (ILCOR) meeting in Melbourne, Australia, in April 2013. The second meeting occurred during a 1-day ILCOR meeting in New Orleans, USA, in November 2016; the third meeting took place during a 3-day ILCOR meeting in Adelaide, Australia, in 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 supplemented by 5 teleconferences that took place during 2016 to 2018.

The Utstein collaborator group agreed that, whenever possible, there would be consistency with the definitions and data elements set out in the 2015 OHCA Utstein reporting guideline.[10] Thus, core elements were defined as elements that all registries should aim to capture and report and are considered the minimum recommended standard for quality assurance/improvement purposes. A core element is one that is considered both important and reasonably practical to collect and validate. Supplemental elements were defined as elements that were desirable but not essential to capture and report; such elements are more likely to be relevant to research than to quality assurance.

After the final face-to-face meeting in 2017, members of the IHCA Utstein Working Group considered core and supplemental data elements under the 6 domains of hospital factors, patient variables, pre-event factors, cardiac arrest and postresuscitation processes, and outcomes. A 2-stage Delphi process was conducted using a web-based survey to achieve consensus for the recommendations for core and supplemental elements. During stage 1, the output from the IHCA Utstein Working Group was presented to the wider collaborator group comprising all members of the ILCOR Advanced Life Support, Basic Life Support, and Pediatric Task Forces. The ILCOR Neonatal Task Force was not included in this collaboration because this Utstein-style guideline does not include neonatal resuscitation, which is distinct from resuscitation of adults and children. Agreement for core and supplemental elements was sought using a 5-point Likert scale, with 1 representing "do not agree" and 5 representing "strongly agree." A score of 4 or 5 was deemed to be "agreement." 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 >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 2004 and 2015 Utstein definitions; some were 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.

Results

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.

Hospital Factors

Core hospital elements are the number of hospital admissions and the number of treated cardiac arrests per year. These data enable calculation of the incidence of cardiac arrest per 1000 admissions. There is variation in what constitutes a hospital admission; however, standardization is essential because changing the denominator will have a major impact on cardiac arrest incidence. The consensus definition of hospital admission is admission to an in-patient bed; day cases are included while outpatients or visitors are not. Cardiac arrests in the emergency department can be included in the registry, but the IHCA Utstein Working Group recommends that they be excluded for the purposes of calculating incidence of IHCA per 1000 admissions. The emergency department cardiac arrest patients who are included in the registry are those who have a cardiac arrest de novo in this location and not those who arrive 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.[22] In the pediatric population, this could include some patients who receive chest compressions for poor perfusion in the setting of severe bradycardia).

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-not-attempt 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

method for estimating the number of DNACPR decisions—not least because of double counting; for example, a patient may have a cardiac arrest with return of spontaneous circulation (ROSC) and then die with a subsequent DNACPR decision.

Patient Variables

Core patient variables are date of birth and sex. Among the supplemental patient variables, there was consensus for following national guidelines for defining categories of race because there is inevitable international variation in nomenclature. Ideally, baseline neurological status would reflect the status before the index acute illness, but it is was agreed that pre–cardiac arrest Cerebral Performance Category (CPC),[23] Pediatric CPC, [3] or modified Rankin Scale (mRS) score[24] were more likely to be collected at admission. Comorbidities influence 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 infarction, or diabetes mellitus; renal, hepatic, or respiratory insufficiency; baseline evidence of motor, cognitive, or functional deficits (CNS depression); acute stroke; acute non-stroke neurologic disorder; pneumonia; hypotension; sepsis; major trauma; metabolic or electrolyte abnormality; and metastatic or hematologic malignancy.[25] There was agreement to include as supplemental data the pre-existing conditions that were included in the final GWTG-R registry model: sepsis, hypotension, metastatic or hematological malignancy, hepatic insufficiency, renal insufficiency.[25] The following factors from the GWTG-R pediatric model were not included in the Delphi survey: pre-event characteristics (heart failure this admission, heart failure before admission, metabolic or electrolyte abnormality, acute nonstroke central nervous system event, baseline depression in central nervous system function, pneumonia, septicemia, major trauma) and intravenous antiarrhythmics in place at the time of cardiac arrest.[26]

Pre-event Factors

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

Cardiac Arrest Process Elements

Cardiac arrest core process elements include the date and time of cardiac arrest, event location (the predefined locations and the number of options can be determined locally), whether the event was witnessed, and whether the resuscitation team was called. Documentation of whether monitoring was in place at the time of cardiac arrest is also core data; this would typically be electrocardiographic monitoring, but it could also include pulse oximetry. The first documented rhythm, application of an automated external defibrillator or manual defibrillator, and whether shocks or chest compressions were given are also core data. The final core item is use of extracorporeal cardiopulmonary resuscitation (ECPR). It was agreed that the IHCA Utstein definition of ECPR should align with that proposed by the Extracorporeal Life Support Organization[31]: “ECPR is the application of rapid-deployment venoarterial extracorporeal membrane oxygenation, usually by peripheral cannulation, to provide circulatory support in patients in whom conventional CPR is unsuccessful in

achieving sustained ROSC. Sustained ROSC is deemed to have occurred when chest compressions are not required for 20 consecutive minutes and signs of circulation persist. ECPR implies the application of [extracorporeal life support] during conventional CPR. Use of [extracorporeal life support] initiated for low cardiac output after sustained ROSC is considered venoarterial [extracorporeal membrane oxygenation]."

Nine supplemental cardiac arrest process elements are included. There was discussion on whether the airway intervention element should include the specific type of supraglottic airway used, but it was agreed that this would be left as a generic supraglottic airway. Ideally, the timing of these interventions (eg, drugs, airway) should be documented because they are more likely to occur the longer the resuscitation attempt continues. The duration of resuscitation is strongly associated with worse outcome. In observational studies, this will bias the results toward a harmful effect of the intervention—an effect that has been termed *resuscitation time bias*.[32] The CPR quality element should include an indication of whether data are being used for real-time feedback or for quality assurance review. In keeping with Extracorporeal Life Support Organization nomenclature, ECPR start is defined as initiation of extracorporeal flow after cannulation and circuit connection to the patient.[31]

Because quality of CPR is the most important determinant of myocardial and cerebral blood flow during CPR and resultant outcomes,[33] IHCA reports would optimally provide CPR hemodynamic data (e.g., arterial diastolic blood pressure during CPR), potential proxies of CPR hemodynamics (e.g., end-tidal carbon dioxide), or CPR mechanical data (e.g., chest compression depth and rate, chest compression fraction).[33] However, practical issues relegate the consideration of these important data to future updates of this template.

Postresuscitation Process

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

Outcome

Where possible, recommendations on the documentation of survival are consistent with those included in the 2015 OHCA Utstein update.[10] 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

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

Any ROSC is a core outcome element and is defined by return of circulation in the absence of ongoing chest compressions (return of adequate pulse/heart rate by palpation, auscultation, Doppler, arterial blood pressure waveform, or documented blood pressure >50 mm Hg systolic). There was considerable discussion about the evidence for using systolic blood pressure >50 mm Hg as one of the criteria for any ROSC. The IHCA Utstein Working Group agreed that it was preferable to make a statement on this topic rather than stay silent because many patients with IHCA have invasive arterial blood pressure monitoring. Systolic blood pressure >50 mm Hg is recommended by others to discriminate hypotension from a pulseless 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.[37-40] Ultimately, it was agreed that this was, at best, "expert opinion" and is a knowledge gap. Neurological outcome at 30 days or 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 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 cerebral performance) to 6 (dead). The mRS is a 7-point scale ranging from 0 (no symptoms)

to 6 (dead). In keeping with the 2015 OHCA Utstein update, survival with favorable neurologic outcome is defined as a CPC 1/2 or mRS 0–3 or no change in CPC or mRS from the patient's baseline status.[10] The Core Outcome Set for Cardiac Arrest Collaborators recommend the mRS over the CPC because the latter lacks discrimination between scores and has the potential for ceiling effects and overestimation of function.[41]

The core outcome of organ donation includes documentation of either donation after brain death or donation after circulatory death. Date and time of death if before hospital discharge is the final core outcome; in some healthcare systems, date of death can be relatively easily tracked after hospital discharge. This should be included if possible.

There are 4 supplemental outcome elements. The cause of death can be obtained from the medical records and death certificates. However, death certificates are generally considered to be an unreliable source for cause of death.[42-44] Investigators have recently proposed 5 categories for cause of death after cardiac arrest: sudden cardiac death, refractory hemodynamic shock, respiratory failure, neurological withdrawal of life-sustaining treatment, and comorbid withdrawal of life-sustaining treatment.[45] The IHCA Utstein Working Group agreed that these should be included as data options. Health-related quality of life measurements are a supplemental outcome. The Core Outcome Set for Cardiac Arrest Collaborators suggested that health-related quality of life could be assessed at 180 days or 1 year, or both; however, they recognized that the longer duration of follow-up is likely to be logistically more challenging.[41] The consensus among the IHCA Utstein collaborators was that health-related quality of life measurements are ideally measured at 12 months.

Implementation

Implementation of the IHCA Utstein reporting guideline will facilitate comparison between IHCA registries throughout the world. Use of standardized definitions will enable consistent recording and reporting of IHCA data and will allow reliable documentation of trends in interventions and outcomes. Reliable documentation of the incidence of cardiac arrest is an important performance indicator because this can be reduced by (a) early detection of the deteriorating patient and instigating treatments to prevent cardiac arrest[28] and (b) implementation of DNACPR decisions when appropriate.[46] Thus, the incidence of cardiac arrest is a key performance indicator that can be used to track the effectiveness of rapid response systems in preventing cardiac arrest and implementation of DNACPR decisions to ensure that CPR is attempted only when appropriate. There are challenges in using the incidence of cardiac arrest per 1000 hospital admissions to compare performance among 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 as by the variability in proportion of patients at each hospital with advanced directives. This can be mitigated to some extent by risk-adjusting for hospital characteristics when comparing hospitals.[47]

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 assurance purposes while including only those data that can be collected relatively easily and reliably in different healthcare systems globally. If too many items are deemed core or if they require considerable resources to enable reliable collection, only a few hospitals will comply 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 of the findings is limited. This, in turn, reduces the value of international comparisons.

Although supplemental items are not deemed essential, the IHCA Utstein Working Group recognizes the importance of research in guiding and validating quality assurance/ improvement and encourages collection of supplemental items when practicable.

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.

Legends

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

Table. Utstein Data Definitions for In-hospital Cardiac Arrest. Data definitions have been categorized as core and supplemental. AED indicates automated external defibrillator; BP,

blood pressure; CPC, Cerebral Performance Category; CPR, cardiopulmonary resuscitation; DNACPR, do not attempt cardiopulmonary resuscitation; ECG, electrocardiogram; ECMO, extracorporeal membrane oxygenation; ECPR, extracorporeal cardiopulmonary resuscitation; EEG, electroencephalogram; $ETCO_2$, end-tidal carbon dioxide; HR, heart rate; HFNC, high-flow nasal cannula; IABP, intra-aortic balloon pump; ICU, intensive care unit; LBBB, left bundle branch block; LVAD, left ventricular assist device; MRI, magnetic resonance imaging; mRS, modified Rankin Scale; NIV, noninvasive ventilation; NSE, neuron specific enolase; OHCA, out-of-hospital cardiac arrest; PCI, percutaneous coronary intervention; PCPC, Pediatric Cerebral Performance Category; ROSC, return of spontaneous circulation; RR, respiratory rate; SBP, systolic blood pressure; SSEP, somatosensory evoked potentials; temp, temperature; TTM, targeted temperature management; VAD, ventricular assist device; VF, ventricular fibrillation; VT, ventricular tachycardia; VV ECMO, venovenous extracorporeal membrane oxygenation; and WLST, withdrawal of life-sustaining treatment.

Contributions

JPN ran the Delphi surveys and prepared the first draft of the manuscript under the oversight of RAB, JS, and GDP. The draft manuscript was revised after input from a core writing group initially (JN, RAB, LWA, FB, PSC, MWD, SWL, MHMM, VMN, MS, GDP, PTM, JS). These outputs were then circulated and discussed in detail with coauthors who added important intellectual content to the manuscript's refinement. The final manuscript was approved by all authors and collaborators.

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