ELSEVIER

Resuscitation 63 (2004) 233–249

RESUSCITATION

www.elsevier.com/locate/resuscitation

Cardiac arrest and cardiopulmonary resuscitation outcome reports: update and simplification of the Utstein templates for resuscitation registries. A statement for healthcare professionals from a task force of the international liaison committee on resuscitation (American Heart Association, European Resuscitation Council, Australian Resuscitation Council, New Zealand Resuscitation Council, Heart and Stroke Foundation of Canada, InterAmerican Heart Foundation, Resuscitation Council of Southern Africa)☆

Ian Jacobs, Vinay Nadkarni*, Jan Bahr, Robert A. Berg, John E. Billi, Leo Bossaert, Pascal Cassan, Ashraf Coovadia, Kate D'Este, Judith Finn, Henry Halperin, Anthony Handley, Johan Herlitz, Robert Hickey, Ahamed Idris, Walter Kloeck, Gregory Luke Larkin, Mary Elizabeth Mancini, Pip Mason, Gregory Mears, Koenraad Monsieurs, William Montgomery, Peter Morley, Graham Nichol, Jerry Nolan, Kazuo Okada, Jeffrey Perlman, Michael Shuster, Petter Andreas Steen, Fritz Sterz, James Tibballs, Sergio Timerman, Tanya Truitt, David Zideman

Pediatric Critical Care Fellowship, Children's Hospital of Philadelphia, Department of Anesthesia and Critical Care, 34th St. and Civic Center Blvd. Sixth Floor, Room 6120C, Philadelphia, PA 19104-4309, USA

Received 27 September 2004; accepted 27 September 2004

Abstract

Outcome following cardiac arrest and cardiopulmonary resuscitation is dependent on critical interventions, particularly early defibrillation, effective chest compressions, and advanced life support. Utstein-style definitions and reporting templates have been used extensively in published studies of cardiac arrest, which has led to greater understanding of the elements of resuscitation practice and progress toward international consensus on science and resuscitation guidelines. Despite the development of Utstein templates to standardize research reports of cardiac arrest, international registries have yet to be developed. In April 2002 a task force of ILCOR met in Melbourne, Australia, to review worldwide experience with the Utstein definitions and reporting templates. The task force revised the core reporting template and definitions by consensus. Care was taken to build on previous definitions, changing data elements and operational definitions only on the basis of published data and experience derived from those registries that have used Utstein-style reporting. Attention was focused on decreasing the complexity of the existing templates and addressing logistical difficulties in collecting specific core and supplementary (i.e., essential and desirable) data elements recommended by previous Utstein consensus conference. Inconsistencies in terminology between in-hospital and out-of-hospital Utstein templates were also addressed. The task force produced a reporting tool for essential data that can be used for both quality improvement

☆ This statement has been copublished in *Circulation.*

* Corresponding author. Tel.: +1 215 590 1868; fax: +1 215 590 4327.
E-mail address: nadkarni@email.chop.edu (V. Nadkarni).

0300-9572/$ – see front matter © 2004 Published by Elsevier Ireland Ltd.
doi:10.1016/j.resuscitation.2004.09.008

(registries) and research reports and that should be applicable to both adults and children. The revised and simplified template includes practical and succinct operational definitions. It is anticipated that the revised template will enable better and more accurate completion of all reports of cardiac arrest and resuscitation attempts. Problems with data definition, collection, linkage, confidentiality, management, and registry implementation are acknowledged and potential solutions offered. Uniform collection and tracking of registry data should enable better continuous quality improvement within every hospital, EMS system, and community.

Keywords: Cardiac arrest; Cardiopulmonary resuscitation; Utstein templates

Resumo

O prognóstico após paragem cardíaca e reanimação cardio-pulmonar está dependente de intervenções críticas, particularmente a desfibrilhação precoce, as compressões torácicas eficazes e o suporte avançado de vida. As definições do estilo Utstein e as folhas de registo têm sido amplamente utilizados em estudos publicados de paragem cardíaca, o que levou a uma grande compreensão dos elementos da prática de reanimação e a progressos para consensos internacionais sobre ciência e guidelines de reanimação. Apesar de estarem desenvolvidos registos Utstein para standartizar a investigação sobre as paragens cardíacas, é ainda necessário o desenvolvimento de registos internacionais. Em Abril de 2002 houve uma reunião em Melbourne, do comité internacional ILCOR, para rever a experiência mundial com as definições Utstein e os registos realizados. Este grupo reviu quer a folha de registo, quer as definições de consenso. O estudo foi baseado em definições prévias; os dados e as definições operacionais foram realizados com base nos dados publicados e na experiência derivada dos registos que utilizaram o estilo Utstein. A atenção foi dirigida para diminuir a complexidade dos registos existentes e enunciar as dificuldades logísticas em recolher dados relativos a questões centrais e suplementares (i.e. essenciais e desejáveis) recomendados por prévias conferências de consenso sobre o estilo Utstein. Foi também equacionada a questão de existir inconsistência na terminologia utilizada, entre os registos Utstein intra e extra-hospitalares. Este grupo produziu uma ferramenta de trabalho para registo de dados essenciais que pode ser utilizada quer para melhoria da qualidade (registos) e para investigação e que pode ser aplicável quer a adultos quer a crianças. Os registos revistos e simplificados incluem definições práticas e sucintas. É de antecipar que os registos revistos e simplificados permitam um melhor e mais preciso registo de todas as paragens cardíacas e das tentativas de reanimação. Foram revistos os problemas com a definição dos dados, registo, confidencialidade, abordagem e implementação dos registos bem como sugeridas potenciais soluções. Uma forma de recolha e registo mais uniforme deve permitir uma melhoria contínua da qualidade dentro do hospital, no sistema SEM e na comunidade.

Palavras chave: Paragem cardíaca; Reanimação cardio-pulmonar; Registos Utstein

Resumen

El resultado del paro cardiaco y la resucitación cardiopulmonar es dependiente de intervenciones criticas, particularmente de la desfibrilación precoz, las compresiones torácicas efectivas, y la ventilación asistida. Las definiciones y templados de reporte han sido usados en forma extensiva en estudios publicados acerca de paro cardiorrespiratorio, lo que ha llevado a una mayor comprensión de los elementos de la práctica de la resucitación y progreso hacia el consenso internacional en ciencia y guías internacionales de resucitación [7]. Pese al desarrollo de los templados de Utstein para estandarizar los reportes de investigación en paro cardiaco, aun deben desarrollarse los registros internacionales. En Abril de 2002 un grupo de trabajo de ILCOR se reunió en Melbourne, Australia, para revisar la experiencia con las definiciones y templados de Utstein a lo largo del mundo. El grupo de trabajo revisó los principales templados de reporte y las definiciones solo sobre la base de los datos publicados y de la experiencia derivada de esos registros que han usado el estilo Utstein de reporte. Se ha enfocado la atención en disminuir la complejidad de los templados existentes y enfrentar las dificultades logísticas en recoger los elementos de datos específicos fundamentales y suplementarios (por ejemplo los esenciales y los deseables) recomendados en previas conferencias de consenso de Utstein. También se han abordado algunas inconsistencias entre los templados intra y extrahospitalario. El grupo de trabajo produjo una herramienta para el reporte de datos esenciales que puede ser usada tanto para mejoría en calidad (registros) y reportes de investigación y que deberían ser aplicables tanto a adultos como a niños. Los templados revisados y simplificados incluyen definiciones prácticas y sucintas. Se anticipa que el templado revisado permitirá completar en forma mejor y más precisa todos los reportes de paro cardiaco y de intentos de resucitación. Se abordan problemas con definición, recolección, confidencialidad, manejo e implementación de registro de datos y se ofrecen potenciales soluciones. La recolección y seguimiento uniforme de datos de registro debería permitir una mejoría continua en calidad dentro de cada hospital, sistema de servicios de emergencias médicas(EMS), y comunidad.

Palabras clave: Paro cardiaco; Resucitacion cardiopulmonar; Utstein templados

1. Introduction

The outcome of cardiac arrest and cardiopulmonary resuscitation (CPR) is dependent on critical interventions, particularly early defibrillation, effective chest compressions, and assisted ventilation. Despite considerable efforts to improve the treatment of cardiac arrest, most reported survival outcome figures are poor. If patient outcomes are to improve, evaluation of the contribution of all potential risk factors and interventions is essential. Such evaluation has been hindered

by the lack of accurate data on structure, process, and outcome of care, in part due to the lack of uniformity in defining and reporting results.

To improve this situation, international resuscitation council task forces, now known as the International Liaison Committee on Resuscitation (ILCOR), published a series of guidelines for uniform reporting of adult out-of-hospital, pediatric, and adult in-hospital resuscitation and resuscitation education and animal research [1–4]. Utstein-style guidelines and templates were also prepared for reporting resuscitation outcomes following trauma and drowning [5,6].

The Utstein-style definitions and reporting templates have been used extensively in published outcome studies of cardiac arrest. The use of these tools has contributed to greater understanding of the elements of resuscitation practice and has facilitated progress toward an international consensus on science and resuscitation guidelines.

Although the Utstein-style reporting template has many benefits, it also has several limitations. Herlitz and coworkers [7] recently reviewed published studies of outcome following cardiac arrest that reported the use of Utstein-style templates. Many of these studies identified the complexity of the existing templates and logistical difficulties in collecting some of the recommended core and supplementary data elements. For example, it is difficult for rescuers to estimate and record specific intervals accurately during the resuscitation event. It is often not possible to ascertain elements such as time of collapse for unwitnessed arrests and outcomes in terms of survival at 6 months or 1 year after hospital discharge. Furthermore, inconsistencies in terminology between in-hospital and out-of-hospital Utstein templates prevent adequate integration and comparison of individual research studies. In addition, the most recent international guidelines for resuscitation recommended important changes in the practice of resuscitation, some of which affect the validity of the existing Utstein definitions. Two examples of changes in practice that necessitate revision of the Utstein templates are the removal of the pulse check by non–healthcare providers as a criterion for defining cardiac arrest and the provision for attempted defibrillation by bystanders [8].

In April 2002 an ILCOR task force met in Melbourne, Australia, to review and revise the Utstein definitions and reporting templates. To identify potential changes to data elements, the task force reviewed published data and experience from cardiac arrest registries that have used Utstein-style reporting templates. The task force used a modified Delphi methodology established by prior Utstein-style conferences to review data and achieve consensus on the following elements:

- data registries;
- Utstein templates;
- operational definitions;
- time issues;
- report elements and format;
- data linkage;
- data access, management, and confidentiality issues;
- registry implementation issues.

Data on cardiac arrest outcomes are generally collected and reported in two different formats: a *registry*, which is used for quality improvement, and a *research report*, which examines specific interventions and outcomes. The objective of the task force was to develop a single, simple, and practical template for uniform collection and reporting of data on cardiac arrest. Uniform collection and tracking of data facilitates better continuous quality improvement within hospitals, emergency medical services (EMS) systems, and communities. It also enables comparisons across systems for clinical benchmarking to identify opportunities for improvement. The revised template includes practical and succinct operational definitions that synthesize what has been learned from the previous Utstein reporting guidelines and existing cardiac arrest registries. The revised template should lead to better and more accurate reporting of cardiac arrests and resuscitation attempts. The revised template will be suitable for recording resuscitation attempts in both adults and children.

2. Utstein definitions

The authors of the 1991 Utstein publication wrote that "the nomenclature of cardiac arrest presents a classic problem in semantics," and added that "the Utstein definitions and recommendations attempt to solve this problem by presenting consensus definitions [1]." The task force reviewed the current definitions and updated them when appropriate to address challenges encountered with the use of these definitions and to conform with the recommendations of the *Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care: An International Consensus on Science* [8]. Those definitions that were satisfactory and consistent with current practice were not changed. Following are definitions of the 29 core data elements as agreed on by consensus.

2.1. Arrest, witnessed

A witnessed cardiac arrest is one that is seen or heard by another person or an arrest that is monitored.

2.2. Assisted ventilation

Assisted ventilation is the act of inflating the patient's lungs by rescue breathing with or without a bag-mask device or any other mechanical device.

2.3. Attempted defibrillation

Defibrillation can be attempted by means of an automated external defibrillator (AED), a semi-automated external defibrillator, an implantable cardioverter-defibrillator (ICD), or

a manual defibrillator. The type of device used is not considered a core data element.

2.4. Bystander CPR

Bystander CPR is cardiopulmonary resuscitation 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.

2.5. Cardiac arrest

Cardiac arrest is the cessation of cardiac mechanical activity as confirmed by the absence of signs of circulation. If an EMS provider or physician did not witness the cardiac arrest, he/she may be uncertain as to whether a cardiac arrest actually occurred.

2.6. Cause of arrest/aetiology

An arrest is presumed to be of cardiac aetiology unless it is known or likely to have been caused by trauma, submersion, drug overdose, asphyxia, exsanguination, or any other noncardiac cause as best determined by rescuers.

2.7. Chest compressions

Chest compressions are performed by an individual or a mechanical device during CPR in an attempt to restore spontaneous circulation.

2.8. CPR

Cardiopulmonary resuscitation is an attempt to restore spontaneous circulation by performing chest compressions with or without ventilations.

2.9. Date of arrest

The date of arrest is the date the event was known to occur or the date on which the victim was found. Date of arrest should be recorded in a conventional format that is consistent for the region (e.g., YYYY,MM,DD or DD,MM,YYYY or MM,DD,YYYY).

2.10. Date of birth/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.

2.11. Date of discharge or death

The date of discharge or death is the date on which the patient was discharged from the acute hospital or was certified dead. It should be recorded in an acceptable format.

2.12. Defibrillation attempt before EMS arrival

When a bystander attempts defibrillation, e.g., public access or lay rescuer defibrillation, it is recorded as a defibrillation attempt before EMS arrival. AEDs are increasingly being made available for access by the general public. In patients with an ICD, a shockable rhythm is likely to have triggered at least one shock by the device before the arrival of EMS personnel. This can be confirmed by analyzing the ICD memory. After extensive discussion, the task force agreed that defibrillation attempts by ICDs are important but difficult for EMS to track. Thus, ICD documentation is optional.

2.13. Drugs

The term "drugs" refers to delivery of any medication (by intravenous cannula, intraosseous needle, or tracheal tube) during the resuscitation event.

2.14. Emergency medical services

EMS personnel respond to a medical emergency in an official capacity as part of an organized medical response team. 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 not part of the EMS system.

2.15. End of event

A resuscitation event is deemed to have ended when death is declared or spontaneous circulation is restored and sustained for 20 min or longer. If extracorporeal life support is being provided, the end of event is 20 min after establishment of extracorporeal circulation.

2.16. First monitored rhythm

The first monitored rhythm is the first cardiac rhythm present when the monitor or defibrillator is attached to the patient after a cardiac arrest. If the 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.

2.17. Location of arrest

Location of arrest is 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. For example:

- *Place of residence*: e.g., home, apartment, back yard of a home.
- *Public place*: e.g., the street, city park, shopping center, sports stadium, entertainment center, airport, railway station, church, beach, office building.
- *Other*: hotel room, private office, long-term care nursing facility.

2.18. Neurological outcome at discharge from hospital

Documentation of the patient's neurological status at many specific points is desirable (e.g., on discharge from the hospital, at 6 months, at 1 year); however, recording neurological outcome after discharge has been difficult. Survival without higher neurological function is suboptimal; therefore, it is important to attempt to assess neurological outcome at discharge. A simple validated neurological score such as cerebral performance category (CPC) should be recorded if available [9].

2.19. Patient identifier

A patient identifier is a unique numeric or alpha-numeric sequence that identifies a specific patient and cardiac arrest event. Ideally the patient identifier should follow the patient from the resuscitation event to hospital discharge (recovery or death). Unfortunately, few systems have the ability to link individual patient care records for the out-of-hospital, in-hospital, and post-discharge phases of the event.

2.20. Resuscitation

A resuscitation attempt is defined as the act of attempting to maintain or restore life by establishing and/or maintaining airway, breathing, and circulation through CPR, defibrillation, and other related emergency care.

2.21. Resuscitation attempt by EMS personnel

When EMS personnel perform CPR or attempt defibrillation, it is recorded as a resuscitation attempt by EMS personnel.

2.22. Resuscitation not attempted by EMS personnel

EMS personnel may not attempt resuscitation when a do-not-attempt-resuscitation (DNAR) order exists, a resuscitation attempt is considered futile, or resuscitation is not required (e.g., the patient has signs of circulation).

2.23. Return of spontaneous circulation (ROSC)

Signs of return of spontaneous circulation include breathing (more than an occasional gasp), coughing, or movement. For healthcare personnel, signs of ROSC may also include evidence of a palpable pulse or a measurable blood pressure. For the purposes of the Utstein registry template, "successful resuscitation," or ROSC, is defined for all rhythms as the restoration of a spontaneous perfusing rhythm that results in more than an occasional gasp, fleeting palpated pulse, or arterial waveform. Assisted circulation (e.g., extracorporeal support such as extracorporeal membrane oxygenation or biventricular assist device) should not be considered ROSC until "patient-generated" (i.e., spontaneous) circulation is established. Previous reports focused on outcomes from ventricular fibrillation have variably defined "successful defibrillation" as the termination of fibrillation to any rhythm (including asystole) and the termination of fibrillation to an organized electrical rhythm at 5 s after defibrillation (including pulseless electrical activity, PEA). Neither of these definitions of "successful defibrillation" would qualify as ROSC unless accompanied by evidence of restoration of circulation. By consensus, the term "any ROSC" is intended to represent a brief (approximately >30 s) restoration of spontaneous circulation that provides evidence of more than an occasional gasp, occasional fleeting palpable pulse, or arterial waveform. The time that ROSC is achieved is a core data element.

2.24. Sex

Sex (male or female) may be an important risk factor for cardiac arrest and resuscitation interventions.

2.25. Shockable/nonshockable rhythm

This element refers to the first monitored rhythm, which, when analyzed by the person interpreting the monitor/defibrillator or an AED, was found to be treatable by attempted defibrillation (i.e., shockable or nonshockable). In general, shockable cardiac arrest rhythms are further divided into ventricular fibrillation and pulseless ventricular tachycardia. Nonshockable cardiac arrest rhythms can be categorized as either asystole or PEA. Although a very specific definition of asystole is desirable, no consensus agreement was reached on either a specific duration (e.g., 30 s) or heart rate (e.g., <5 beats per minute) to define asystole versus bradycardia/PEA. In future iterations of the registry document, further consideration and additional research resources may need to be devoted to addressing the importance and abil-

ity of providers to differentiate between these initial cardiac rhythms.

2.26. Successful CPR before EMS arrival

Occasionally when a bystander witnesses a cardiac arrest and starts CPR, the victim will regain signs of circulation by the time EMS personnel arrive. If the bystander verifies that the victim had no signs of circulation and that CPR was performed, a registry record should be initiated. EMS personnel do not need to verify that a cardiac arrest occurred for this case to be included in the registry.

2.27. Survived event

For the out-of-hospital setting:	Sustained ROSC with spontaneous circulation until admission and transfer of care to medical staff at the receiving hospital.
For the in-hospital setting:	Sustained ROSC for >20 min (or return of circulation if extracorporeal circulatory support is applied).

2.28. Survival to hospital discharge

Survival to hospital discharge is the point at which the patient is discharged from the hospital acute care unit regardless of neurological status, outcome, or destination. Ideally this should indicate survival to discharge from acute hospital care, including a possible rehabilitation period in a local hospital before long-term care, home care, or death.

2.29. Sustained return of spontaneous circulation

Sustained ROSC is deemed to have occurred when chest compressions are not required for 20 consecutive minutes and signs of circulation persist (or sustained ROC if extracorporeal circulatory support is applied). Thus, after resuscitation from in-hospital cardiac arrest, sustained ROSC and survived event have the same definition.

3. Utstein reporting templates

The 1991 out-of-hospital and the 1997 in-hospital Utstein templates were comprehensive documents targeted mainly to the research community [1,2]. The definitions in these documents have helped to standardize resuscitation terminology, although capture of many data items is difficult for many individuals and institutions.

The task force discussed problems with collection of resuscitation data extensively and assessed the usefulness of collecting data elements that were deemed important because of their potential impact on outcome but were difficult to collect or had questionable accuracy (e.g., time of collapse). Of equal concern were some data items that were deemed to have relatively little direct impact on outcome and yet were reliable and easy to collect (e.g., time EMS vehicle stopped).

The previous adult Utstein templates focused on witnessed ventricular fibrillation (VF) arrests. One reason to focus on witnessed VF was to provide a suitable comparator for comparing success of systems nationally and internationally. However, a large and growing proportion of out-of-hospital arrests and the majority of in-hospital arrests present with a non-VF rhythm [10,11]. The Utstein experts agreed that the revised template should include all initial cardiac arrest rhythms but retain the ability to analyze the witnessed VF subgroup for comparisons of systems. The 1991 Utstein document divided data into core and supplementary items, whereas the 1997 templates used slightly different terminology: essential and desirable. The revised Utstein template emphasizes only “core” data elements for registry use (Fig. 1). The changes between earlier and revised Utstein templates are summarized in the Table 1.

3.1. Consensus recommendation

Data should be classified as core or supplementary. *Core data* are the absolute minimum data required for continual quality improvement. These data form the data set for CPR registries at local, state/provincial, national, and international levels. They should be relatively easy to collect and reliable and include patient, event (process), and outcome data. Collection of these data elements should be sufficient to enable comparisons of process and outcomes among different institutions and countries. *Supplementary* data are required for resuscitation research. The standardized definitions enable comparative analysis between resuscitation studies. The task force agreed that a single data collection form should be used for both out-of-hospital and in-hospital cardiac arrest; an example is given in Fig. 2.

4. Dates, time points, and intervals

The two most important intervals affecting patient survival are the collapse-to-first CPR attempt interval and collapse-to-first defibrillatory shock interval [12-18]. In the original Utstein document, many other time points and intervals were recommended as core items for research and quality assurance purposes. Several of these time elements were included because of their known association with outcomes; others were included because they are relatively easy to document accurately and may be useful for quality assurance. These other times include when the emergency vehicle stops at the scene, the resuscitation team arrives at the patient’s side, IV access is obtained, medications are given, and sustained ROSC is first attained.

The use of these clearly defined resuscitation intervals has improved resuscitation research as well as hospital and EMS quality assurance programs; however, few epidemiological

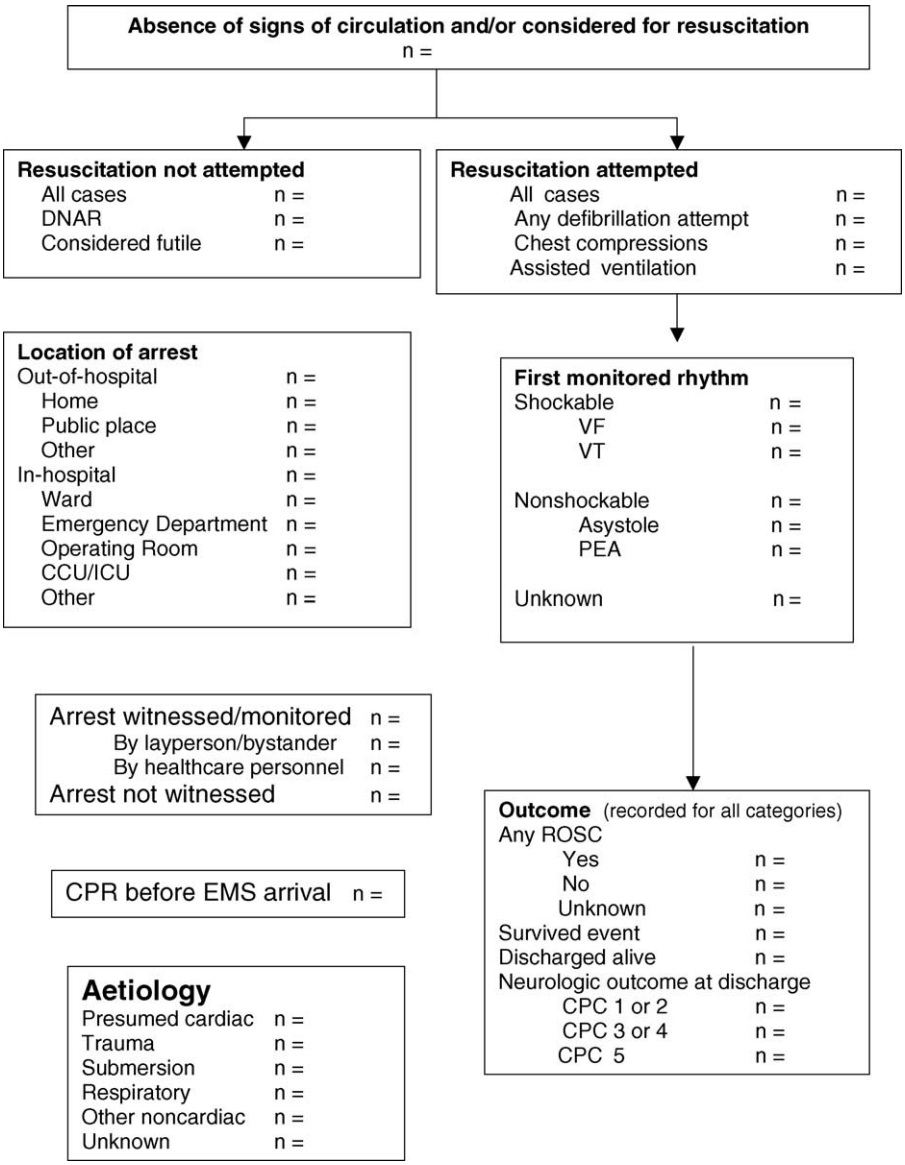

Fig. 1. Utstein reporting template for core data elements. ED, emergency department; OR, operating room; CCU/ICU, critical care unit/intensive care unit; and PEA, pulseless electrical activity.

studies and even fewer EMS and hospital systems have included the entire recommended list of core time elements. The supplementary list is used rarely. Time points such as estimated time of collapse when the arrest was not witnessed are impossible to obtain, and others are inherently unclear, such as when the hospital resuscitation team arrives (members arrive at different times).

Clock inaccuracy and lack of clock synchronization continue to be a problem. To minimize timing errors, the task force recommends that one clock (or one synchronized to the initial clock) be used to determine all times throughout the resuscitation attempt. It is more important to record intervals rather than specific times accurately.

The goal of the task force was to distinguish the time points and intervals that constitute core elements from those representing supplementary data elements. Comparison of these elements enables comparison among research investigations and quality assurance programs. The following are the recommended time point/intervals to be collected and should be recorded in an acceptable format (HH:MM or similar).

4.1. Recommended core time events to be recorded

4.1.1. Date of death

The date of death should be recorded in a conventional format.

4.1.2. Time of witnessed/monitored arrest

An arrest is witnessed if the collapse was seen (or heard) by an identifiable witness and monitored if a medical professional or electronic monitoring device detects and documents apparent cardiac arrest or the potential need for resuscitation.

Table 1
Utstein data templates: summary of changes

1991 Name	2004 Name	2004 Definition	1991 Status	2004 Status
1. Population served by EMS system	Removed	Total population of service area of EMS system	Core	Supplementary
2. Confirmed cardiac arrests considered for resuscitation	Absence of signs of circulation and/or considered for resuscitation	Number of cardiac arrests defined by absence of signs of circulation	Core	Core
3. Resuscitations not attempted	Unchanged	Total number of cardiac arrests in which resuscitation was not attempted and number of these arrests not attempted because	Core (total not attempted)	Core
		A DNAR order was present	None (DNAR and futile status)	
		Attempt was considered futile (or meaningless)		
		Signs of circulation were present		
4. Resuscitations attempted	Unchanged	Total number of resuscitations attempted and number of these resuscitations that included	Core (total attempted)	Core
		Any defibrillation attempt		
		Chest compressions	None (defibrilla-tion, chest compres-sions, and ventila-tions)	
		Ventilations		
5. Cardiac aetiology	Aetiology	Number of resuscitations in which etiology of arrest was	Core	Core
		Presumed cardiac		
		Trauma		
		Submersion		
		Respiratory		
		Other		
		Unknown		
6. Noncardiac aetiology	Merged with aetiology	See aetiology	Core	See aetiology
	Arrest witnessed/monitored	Total number of resuscitation attempts and number of arrests witnessed by	None	Core
		Laypersons		
		Healthcare providers		
7. Arrest witnessed by bystanders	See arrest witnessed/monitored	Number of resuscitation attempts in which arrest was witnessed by laypersons	Core	Core
8. Arrest not witnessed	See arrest witnessed/monitored	Number of resuscitation attempts in which arrest was not witnessed by anyone	Core	Core
9. Arrest witnessed by EMS personnel	See arrest witnessed/monitored	Number of resuscitation attempts in which arrest was witnessed by healthcare personnel	Core	Core
	First monitored rhythm shockable	Total number of resuscitation attempts in which first monitored rhythm was shockable and identified as:	None	Core
		VF		
		VT		
		Unknown AED shockable rhythm		
10. Initial rhythm VF	See monitored rhythm shockable	Number of resuscitation attempts in which first monitored rhythm after arrest was VF	Core	Core
11. Initial rhythm VT	See monitored rhythm shockable	Number of resuscitation attempts in which first monitored rhythm after arrest was VT	Core	Core

Table 1 (*Continued*)

1991 Name	2004 Name	2004 Definition	1991 Status	2004 Status
	First monitored rhythm nonshockable	Total number of resuscitation attempts in which first monitored rhythm was nonshockable and rhythm was identified as Asystole PEA Bradycardia Other Unknown AED nonshockable rhythm	None	Core
12. Initial rhythm asystole	See first monitored rhythm nonshockable	Number of resuscitation attempts in which first monitored rhythm after arrest was asystole	Core	Core
13. Other initial rhythms	See first monitored rhythm nonshockable	Number of resuscitation attempts in which first monitored rhythm after arrest was unshockable	Core	Core
14. Determine presence of bystander CPR: yes or no for each subset	CPR before EMS	Number of resuscitation attempts in which CPR (chest compression) was performed before EMS arrival	Core	Core
	Rhythm analysis or defibrillation before EMS	Number of resuscitation attempts in which either AED rhythm analysis or defibrillation was performed before EMS arrival	None	Core
15. Any ROSC	Any ROSC	Number of resuscitation attempts in which any ROSC was present Yes No Unknown	Core	Core
16. Never achieved ROSC	See any ROSC	See any ROSC	Core	See Any ROSC
17a. Efforts stopped: patient died en route to hospital	Removed	Number of resuscitation attempts in which all resuscitative efforts were discontinued and patient died before arriving at hospital	Core	Supplementary
17b. Efforts stopped: patient died in ED	Removed	Number of resuscitation attempts in which all resuscitative efforts were discontinued and patient died in ED	Core	Supplementary
18. Admitted to ICU/ward	Survived event to ED/ICU	Number of resuscitation attempts in which patient regained signs of circulation and was admitted to ED or ICU	Core	Core
19a. Died in-hospital total	Removed	Number of resuscitation attempts in which patient regained signs of circulation and was admitted to ED/ICU but died in hospital	Core	Supplementary
19b. Died in hospital within 24 hours	Removed	Number of resuscitation attempts in which patient regained signs of circulation and was admitted to ED/ICU but died in hospital within 24 h	Core	Supplementary
20. Discharged alive	Unchanged	Number of resuscitation attempts in which patient regained signs of circulation, was admitted to ED/ICU, and was discharged from hospital alive	Core	Core
21. Died within 1 year of hospital discharge	Removed	Number of resuscitation attempts in which patient regained signs of circulation, was discharged alive from hospital but died within 1 year from hospital discharge	Core	Supplementary

Table 1 (*Continued*).

1991 Name	2004 Name	2004 Definition	1991 Status	2004 Status
22. Alive at 1 year	Removed	Number of resuscitation attempts in which patient regained signs of circulation, was discharged alive from hospital, and was/is alive at 1 year from hospital discharge	Core	Supplementary
	Neurological outcome at discharge	Number of resuscitation attempts in which patient regained signs of circulation, was discharged alive from hospital, and had a CPC score of 1 or 2 3 or 4 or unknown	None	Core
	Location of arrest: out-of-hospital	Total number of resuscitations that took place out-of-hospital and number of resuscitation attempts that took place within Home/residence Industrial/workplace Sport/recreation event Street/highway Public building Assisted living/nursing home Educational institution Other Unspecified/unknown	None	Core (EMS only)
	Location of arrest: in-hospital	Total number of resuscitation attempts that took place in-hospital and number of resuscitation attempts that took place within Ward ED Operating room ICU Other Unknown	None	Core (hospital only)

4.1.3. Time call received

The time the first EMS operator was contacted should be listed as the time the call was received. In the hospital the comparable time is when the resuscitation team is called after initial determination of the potential need for resuscitation. In some hospital settings (e.g., intensive care unit, emergency department, operating room), this time may be when the bedside practitioner notes an arrest or the potential need for resuscitation and shouts for help. In other hospital settings, it may be when a nurse, ward clerk, or physician calls the operator to notify the cardiac arrest team. If a resuscitation team is called to evaluate a critically ill patient before an arrest or the need for resuscitation and the patient has an arrest in the presence of the team, the time of call receipt is the same as the time of witnessed collapse/arrest.

4.1.4. Time of first rhythm analysis/assessment of need for CPR

This time is defined as (1) when cardiac rhythm is analyzed for a shockable rhythm or (2) when a provider clinically assesses the need for CPR (e.g., no signs of circulation in the setting of a respiratory arrest or drowning). In most circumstances this is the time when an AED or other defibrillator is attached to the patient and turned on. For in-hospital patients undergoing continuous electrocardiographic (ECG) monitoring, this is the time when a provider attempts to interpret the ECG for evidence of a shockable rhythm.

There are several reasons for adding this element to the previous core element of time to defibrillation. Evidence is accumulating that for prolonged VF, rhythm analysis and CPR before defibrillation may be preferable to immediate defibrillation [19,20]. Moreover, many patients in cardiac arrest or in need of CPR are not in VF. In both circumstances, time of first rhythm analysis/assessment of CPR need is more meaningful than time to defibrillation.

4.1.5. Time of first CPR attempts

The time of first CPR attempts (specifically, chest compressions or defibrillation attempts) should be recorded both for bystander-initiated CPR and CPR initiated by EMS personnel/healthcare providers.

Cardiac Arrest Data Collection Form

Date of arrest YYYY/MM/DD

Patient identifier (first name, last name, or ID number)

Sex

Age years (estimated) **OR** Date of birth YYYY/MM/DD

Cardiac arrest determined by

Cause of arrest

Treatment before EMS arrival

Bystander CPR

Defibrillation by bystander ☐ or implanted defibrillator ☐

Resuscitation attempted by EMS yes

Location of arrest out of hospital in hospital

Witnessed If witnessed, time of arrest HH:MM

Initial rhythm

Chest compressions

Defibrillation attempt

Ventilation Drugs

Time of collapse HH:MM (estimated)

Time of call receipt HH:MM

Time vehicle stopped HH:MM

Time of first rhythm analysis HH:MM

Spontaneous circulation on arrival in ED

Hospital admission

Hospital discharge

Date of hospital discharge (or death) YYYY/MM/DD

Neurological status at discharge (CPC)

Fig. 2. Revised Utstein cardiac arrest data collection form.

4.1.6. Time of first defibrillation attempt if shockable rhythm

This time should be recorded in real time when the first shock is delivered. The best way to obtain this information is through an AED or conventional defibrillator with automated event documentation. These devices provide precise details about initial rhythm, times, and responses of heart rhythm to therapy. In the hospital the time interval from collapse/arrest to first defibrillation attempt may be the most important process indicator of effective response when VF is the initial cardiac arrest rhythm.

4.1.7. Recommended supplementary time events to be recorded

These time points are useful for internal quality assurance or research but are not deemed core time elements. They are either not considered as important in assessing process or outcome or there are problems with their accuracy and reproducibility.

4.1.8. Time first emergency response vehicle is mobile

This is the time when the emergency response vehicle begins to move. The interval between the time the call was

received and the time the vehicle began to move is usually documented precisely and is important for quality assurance (e.g., prolonged intervals may be due to prolonged call processing or slowness of ambulance personnel).

4.1.9. Time vehicle stops

This is the time when the emergency response vehicle stops moving at a location as close as possible to the patient. This time is documented precisely and is an important quality assurance measure.

4.1.10. Time of return of spontaneous circulation.

This time marks the return of any palpable pulse in the absence of ongoing chest compressions. If invasive intra-arterial blood pressure is being monitored, systolic blood pressure >60 mmHg can be used as a surrogate of a palpable pulse.

4.1.11. Time vascular access achieved and time medications given

The value of intravascular or tracheal medications used in cardiac resuscitation has yet to be determined [15,21]; nevertheless, their effectiveness may be time dependent. For this reason, the time of medication administration may be useful.

4.1.12. Time CPR stopped/death

Numerous psychological and situational factors influence the time at which CPR is stopped, and this time point is often imprecise. Nevertheless, this information may be useful (e.g., for developing guidelines on when to stop CPR). Duration of CPR is an important quality assurance issue (e.g., provision of CPR for 1–2 h may be inappropriate) and is a supplementary data item.

4.2. Previously recommended time points that are no longer recommended

4.2.1. Departure from scene and arrival at the emergency department

This time point was deleted because it differs greatly among EMS systems, especially when distances from the scene to the emergency department vary greatly.

4.2.2. Time tracheal intubation achieved

The importance of this time is unclear, especially in light of increasing evidence that effective airway control and adequate ventilation of the lungs are more important than the specific intervention of tracheal intubation.

4.2.3. Time arrest confirmed, time of end of ROSC, and time of awakening

These time points were deleted because of their imprecise definitions and practical difficulties encountered in documenting the times accurately.

4.2.4. Time of arrival at the patient's side

This time point was also deleted because of imprecise definition and practical difficulties documenting this time accurately, especially in hospitals, because team members arrive at different times.

5. Potential problems and solutions for reporting times

Accurate recording of resuscitation times is difficult because of the psychological stress and intensive work generated during resuscitation attempts and because clock accuracy is unreliable. Despite this, quality assurance and medicolegal requirements make such documentation a high priority. Well-constructed forms for reporting cardiac arrest and CPR can and should facilitate good recordkeeping.

5.1. Postresuscitation phase

The original Utstein reporting templates for both out-of-hospital and in-hospital cardiac arrest include factors up until ROSC and thereafter jump to outcome measurements (i.e., died in the hospital, was discharged alive, functional outcome, etc.) without designating specific postresuscitation factors during the in-hospital phase following ROSC. At the time this was logical because information on postresuscitation factors that affect outcome was very limited.

It is now known that several postresuscitation variables influence outcome dramatically. Two randomized controlled studies of adults with out-of-hospital VF cardiac arrest report a significant improvement in outcome when hypothermia was induced after ROSC [22,23]. Two other studies reported significant differences between hospitals in survival of patients admitted after prehospital cardiac arrest. These differences were not explained by prehospital factors [24,25]. In addition to body temperature, there was a negative association between survival and high blood glucose levels, seizure activity, and low pH [24]. These observational studies do not prove that treatment of these factors improves outcome, but they should provoke further research. Cardiovascular and respiratory dysfunction are also present to a variable degree during the first 24 h after resuscitation, and interhospital variations in monitoring and treatment are likely to influence outcome. Importantly, regional and local differences in approaches to limitation and withdrawal of technological support can dramatically influence length of stay and survival [25].

In many communities, the difficulty of linking prehospital and hospital data is insurmountable. As a minimum, the experts agree that whether or not hypothermia was induced should be included in reports as a core element. Additional desirable postresuscitation factors such as body temperature (both hyperthermia and hypothermia), blood glucose values, seizure activity, and some hemodynamic and ventilatory/blood gas variables may be important supplementary elements for specific research reports.

6. Data access and management

The collection and collation of sudden cardiac arrest registry data poses several challenges for EMS providers and researchers. First, a person who experiences a sudden out-of-hospital cardiac arrest is often treated by lay rescuers, public safety responders, or EMS responders, as well as a range of healthcare providers in the Emergency Department, coronary care or intensive care unit, and general ward. Information about the structure, process, and outcome associated with each of these settings may be collected sequentially by a single individual or multiple individuals representing each setting. If the latter occurs, then it may be difficult to track the care provided for each patient.

Collation of cardiac arrest data for entry into a registry may be done locally, regionally, nationally, or internationally. A significant advantage of collating data in a regional or larger database is that doing so enables individual clinicians or EMS systems to compare their own patient populations, interventions, and outcomes with those of other systems. This then enables clinicians and EMS providers to identify opportunities to improve quality of care and ascertain if resuscitation is being provided according to evidence-based guidelines.

The task force was aware that some are reluctant to contribute data to a central registry. Their reasons include concerns about ownership, data security, confidentiality, and resources. These concerns can be resolved by collaboration and the open exchange of ideas. The application of new computer technology can now ensure data security through use of firewalls, encrypted passwords, and de-identifying individual patient records. The concern of data ownership and intellectual/academic recognition could be addressed through written understandings with each of the key stakeholders.

In most jurisdictions, local privacy laws and provisions will govern the collection of cardiac arrest data for a registry. The task force recommends that sites participating in a registry seek review and approval from their institutional review board or ethics committee to ensure compliance with local standards for health data registries and informed consent.

The task force also considered data accuracy defined by the ability of a measurement to match the true value of the quantity being measured. This is a particular challenge with sudden cardiac arrest data for several reasons: intervals are often underestimated or reported in convenient numbers, such as even numbers or multiples of 5; patient factors are difficult to verify because most patients are not available for interview after the event; care processes are difficult to verify; and long-term outcomes, such as post-discharge status, are often difficult to obtain. Where resources are available, data should be reabstracted at each site to enable assessment of the quality of the registry data.

As with data accuracy, the reliability or similarity of results between different observations, experiments, or trials also presents a challenge for registries. Cardiac arrest data elements tend to be underreported and incomplete [26]. Every effort should be made to ensure completeness of data. Restricting data elements to the recommended core items listed in this report will facilitate this.

7. Data linkage

Data linkage involves the collation of records for an individual from various sources into one cumulative file [27]. Increasing globalization, conversion from a paper-based to an electronic-based health record system, and development of increasingly user-friendly linkage software, have strengthened opportunities for data linkage and global data integration.

Record linkage is a vital component of local, regional, national, and even international data and health information management [28,29]. Through linkage it becomes possible to track fragmented health information, input missing or inconsistent data, and measure short- and long-term health outcomes while adjusting for covariate risk, demographics, and potentially confounding variables in health service evaluation and research. Linkage can help tie together structure, process, and outcome variables within large registries, which will facilitate benchmarking of cardiac resuscitation activities. For example, dispatch, prehospital, first responder, ambulance, defibrillator device, hospital, and death registry data could be incorporated into a single database. Linked registry data can support continual quality improvement within hospitals, communities, health networks, and countries. By virtue of its population-based approach, data linkage helps avoid selection bias. Because data are collected without any known purpose or outcome a priori, reporting and recall biases are minimized.

Concerns about privacy, confidentiality, and information security have led many countries to enact strict legislation to protect data (e.g., in the United States, the Health Insurance Portability and Accountability Act). This sort of legislation has constrained the ability to link large registries across and within national boundaries [29]. Conflict between the rights of the individual to protect information about himself/herself and the responsibility of health services to improve healthcare delivery makes record linkage difficult.

8. Implementation

Global information sharing is difficult to implement. There is a need to address state/provincial, regional, and national regulations that limit sharing of data related to individual patient outcomes after resuscitation. Barriers exist between:

- Prehospital and in-hospital systems to determine specific patient outcomes at hospital discharge.
- Data repositories to determine specific patient outcomes at 30 days, 6 months, and 1 year.

Table 2
Conflicts of interset

Writing group member name	Research grant	Speakers Bureau/Honoraria	Stock ownership	Consultant/Advisory Board	Other
Dr. Ian Jacobs	National Health & Medical Research Council; Commonwealth Department of Health-Australia; Department of Health-Western Australia; Laerdal Foundation	None	None	None	None
Dr. Vinay Nadkarni	National Institutes of Child Health and Development Ross/Abbott Laboratories Drager Medical	None	None	Laerdal Medical Medical Education Technologies Inc.	None
Dr. Jan Bahr	None	None	None	None	None
Dr. Robert Berg	Medtronic Physiocontrol	None	None	None	None
Dr. John Billi	None	None	None	None	None
Dr. Leo Bossaert	None	None	None	None	None
Dr. Pascal Cassan	None	None	None	None	None
Dr. Ashraf Coovadia	None	None	None	None	None
Dr. Catherine D'Este	None	None	None	None	None
Dr. Judith Finn	National Health & Medical Research Council (Aust); National Institute of Clinical Studies (Aust)	None	None	None	None
Dr. Henry Halperin	Revivant, Inc.	None	None	Revivant, Inc. Medtronic Philips	None
Dr. Anthony J. Handley	None	None	None	Laerdal	None
Dr. Johan Herlitz	Laerdal Foundation	None	None	None	None
Dr. Robert Hickey	None	None	None	None	None
Dr. Ahamed Idris	Medtronic Laerdal NIH NASA/Department of Defense	None	None	Philips	None
Dr. Walter Kloeck	None	None	None	None	None
Dr. Gregory Luke Larkin	None	None	None	None	None
Dr. Mary Mancini	None	None	None	None	None
Dr. Pip Mason	None	None	None	None	None
Dr. Greg Mears	American Heart Association (fundation for the National EMS Information System Project)	None	None	None	None
Dr. Koenraad Monsieurs	None	None	None	None	None
Dr. William H. Montgomery	None	None	None	American Heart Association	None
Dr. Peter Morley	None	None	None	American Heart Association	None

Table 2 (*Continued*)

Writing Group Member Name	Research Grant	Speakers Bureau/Honoraria	Stock Ownership	Consultant/Advisory Board	Other
Dr. Graham Nichol	CIHR; Medtronic; AHA, NHLBI and industry for assessment of public access defibrillation; AHRQ, CIHR and Medtronic for assessment of cardiac resynchronization therapy; NHLBI for Resuscitation Outcomes Consortium; Cardiac Science, Medtronic ERS, Philips Inc. Zoll Inc. for cardiac arrest registry	None	None		Sponsor, Wearable Cardioverter defibrillator trial (Lifecor)
Dr. Jerry Nolan	None	None	None	None	None
Dr. Kazuo Okada	None	None	None	None	None
Dr. Jeffrey Perlman	None	None	None	None	None
Dr. Michael Shuster	None	None	None	None	None
Dr. Petter Andreas Steen	None	None	None	Cardiodigital	Laerdal Medical board member
Dr. Fritz Sterz	MedCool Laerdal European Commission, Directorate General XII, Science, Research and Development - Joint Research Centre, BIOMED 2 Programme Ministry of Science, Research and Art -Austra Jubilee Funds of the Austrian National Bank Medical Scientific Foundation by the Mayor of Vienna Austrian Science Foundation GALIEO Contact Point Austria/Austrian Space Agency European Resuscrtation Council KCI Medical Products	None	None	None	None
Dr. James Tibballs	None	None	None	None	None
Dr. Sergio Timerman	None	None	None	None	None
Tanya Truitt	None	None	None	Digital Innovations NRCPR Database Company	None
Dr. David Zideman	None	None	None	None	None

This table represents the relationships reported by writing group members that may be perceived as a real or potential conflict of interest. All members of the writing group are required to complete and submit Disclosure Questionnaire showing all such relationships that might be perceived as real or potential conflicts of interest.

- Registries to enable sharing of minimally identified data into an international resuscitation database.

The reports generated from existing registries should conform to the Utstein template, enabling communication and comparison between registries.

The importance of collecting and sharing resuscitation data must be made clear to the public and to relevant regulators. Protection of patient confidentiality is paramount, but with appropriate safeguards, it should still be possible for key organizations to share data. Examples include public health databases and population-specific registries such as those established for cancer. Cardiac arrest registries should be no different. Patient advocates, national resuscitation organizations, and ILCOR should actively engage the appropriate legislative and regulatory bodies to facilitate the development and sharing of registry information.

9. Summary

Outcome following cardiac arrest and cardiopulmonary resuscitation is dependent on critical interventions, particularly early defibrillation, effective chest compressions, and advanced life support. Utstein-style definitions and reporting templates have been used extensively in published studies of cardiac arrest, which has led to greater understanding of the elements of resuscitation practice and progress toward international consensus on science and resuscitation guidelines [7]. Despite the development of Utstein templates to standardize research reports of cardiac arrest, international registries have yet to be developed.

In April 2002 a task force of ILCOR met in Melbourne, Australia, to review worldwide experience with the Utstein definitions and reporting templates. The task force revised the core reporting template and definitions by consensus. Care was taken to build on previous definitions, changing data elements and operational definitions only on the basis of published data and experience derived from those registries that have used Utstein-style reporting. Attention was focused on decreasing the complexity of the existing templates and addressing logistical difficulties in collecting specific core and supplementary (i.e., essential and desirable) data elements recommended by previous Utstein consensus conferences. Inconsistencies in terminology between in-hospital and out-of-hospital Utstein templates were also addressed.

The task force produced a reporting tool for essential data that can be used for both quality improvement (registries) and research reports and that should be applicable to both adults and children. The revised and simplified template includes practical and succinct operational definitions. It is anticipated that the revised template will enable better and more accurate completion of all reports of cardiac arrest and resuscitation attempts. Problems with data definition, collection, linkage, confidentiality, management, and registry implementation are acknowledged and potential solutions offered. Uniform collection and tracking of registry data should enable better continuous quality improvement within every hospital, EMS system, and community.

Conflicts of interest

See Table 2.

Acknowledgments

In 1991 the authors of the original Utstein uniform reporting guidelines wrote that “certain features of the Utstein guidelines will need to be revised and supplemented.” The recommendations in this document emanate directly from work published in prior Utstein consensus conferences and ILCOR advisory statements. Specific recognition is due Richard Cummins, Douglas Chamberlain, and Peter Safar, who led the world to cooperate in order to understand the pathophysiology of cardiac arrest and resuscitation. We dedicate this update to their efforts and to the many scientists who strive to make their dream a reality.

References

[1] Cummins RO, Chamberlain DA, Abramson NS, et al. Recommended guidelines for uniform reporting of data from out-of-hospital cardiac arrest: the Utstein style. A statement for health professionals from a task force of the American Heart Association, the European Resuscitation Council, the Heart and Stroke Foundation of Canada, and the Australian Resuscitation Council. Resuscitation 1991;22:1–26.

[2] Cummins RO, Chamberlain D, Hazinski MF, et al. Recommended guidelines for reviewing, reporting, and conducting research on in-hospital resuscitation: the in-hospital ’Utstein style’. American Heart Association. Resuscitation 1997;34:151–83.

[3] Zaritsky A, Nadkarni V, Hazinski MF, et al. Recommended guidelines for uniform reporting of pediatric advanced life support: the Pediatric Utstein Style. A statement for healthcare professionals from a task force of the American Academy of Pediatrics, the American Heart Association, and the European Resuscitation Council. Resuscitation 1995;30:95–115.

[4] Chamberlain DA, Hazinski MF. Education in resuscitation. Resuscitation 2003;59:11–43.

[5] Idris AH, Berg RA, Bierens J, et al. Recommended guidelines for uniform reporting of data from drowning: the “Utstein style”. Resuscitation 2003;59:45–57.

[6] Dick WF, Baskett PJ. Recommendations for uniform reporting of data following major trauma—the Utstein style. A report of a working party of the International Trauma Anaesthesia and Critical Care Society (ITACCS). Resuscitation 1999;42:81–100.

[7] Fredriksson M, Herlitz J, Nichol G. Variation in outcome in studies of out-of-hospital cardiac arrest: a review of studies conforming to the Utstein guidelines. Am J Emerg Med 2003;21:276–81.

[8] The American Heart Association in collaboration with the International Liaison Committee on Resuscitation (ILCOR). Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care—An International Consensus on Science. Resuscitation 2000;46:1–446.

[9] A randomized clinical trial of calcium entry blocker administration to comatose survivors of cardiac arrest. Design, methods, and patient characteristics. The Brain Resuscitation Clinical Trial II Study Group. Control Clin Trials. 1991;12:525–545.
[10] Stratton SJ, Niemann JT. Outcome from out-of-hospital cardiac arrest caused by nonventricular arrhythmias: contribution of successful resuscitation to overall survivorship supports the current practice of initiating out-of-hospital ACLS. Ann Emerg Med 1998;32:448–53.
[11] Peberdy MA, Kaye W, Ornato JP, et al. Cardiopulmonary resuscitation of adults in the hospital: a report of 14720 cardiac arrests from the National Registry of Cardiopulmonary Resuscitation. Resuscitation 2003;58:297–308.
[12] Eisenberg MS, Horwood BT, Cummins RO, et al. Cardiac arrest and resuscitation: a tale of 29 cities. Ann Emerg Med 1990;19:179–86.
[13] Larsen MP, Eisenberg MS, Cummins RO, et al. Predicting survival from out-of-hospital cardiac arrest: a graphic model. Ann Emerg Med 1993;22:1652–8.
[14] Valenzuela TD, Roe DJ, Cretin S, et al. Estimating effectiveness of cardiac arrest interventions: a logistic regression survival model. Circulation 1997;96:3308–13.
[15] Spearpoint KG, McLean CP, Zideman DA. Early defibrillation and the chain of survival in 'in-hospital' adult cardiac arrest; minutes count. Resuscitation 2000;44:165–9.
[16] Stiell IG, Wells GA, DeMaio VJ, et al. Modifiable factors associated with improved cardiac arrest survival in a multicenter basic life support/defibrillation system: OPALS study phase I results. Ontario prehospital advanced life support. Ann Emerg Med 1999:44–50.
[17] Stiell I, Nichol G, Wells G, et al. Health-related quality of life is better for cardiac arrest survivors who received citizen cardiopulmonary resuscitation. Circulation 2003:1939–44.
[18] De Maio VJ, Stiell IG, Wells GA, et al. Optimal defibrillation response intervals for maximum out-of-hospital cardiac arrest survival rates 2003.
[19] Niemann JT, Cairns CB, Sharma J, et al. Treatment of prolonged ventricular fibrillation. Immediate countershock versus high-dose epinephrine and CPR preceding countershock. Circulation 1992;85:281–7.
[20] Cobb LA, Fahrenbruch CE, Walsh TR, et al. Influence of cardiopulmonary resuscitation prior to defibrillation in patients with out-of-hospital ventricular fibrillation. JAMA 1999;281:1182–8.
[21] American Heart Association. Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care: International Consensus on Science, Part 6: advanced cardiovascular life support: Section 6: Pharmacology II: agents to optimize cardiac output and blood pressure. Circulation. 2000;102(Suppl. I):I129–I135.
[22] Bernard SA, Gray TW, Buist MD, et al. Treatment of comatose survivors of out-of-hospital cardiac arrest with induced hypothermia. N Engl J Med 2002;346:557–63.
[23] Mild therapeutic hypothermia to improve the neurologic outcome after cardiac arrest. Hypothermia after Cardiac Arrest Study Group. N Engl J Med. 2002;346:549–556.
[24] Langhelle A, Tyvold SS, Lexow K, et al. In-hospital factors associated with improved outcome after out-of-hospital cardiac arrest. A comparison between four regions in Norway. Resuscitation 2003;56:247–63.
[25] Engdahl J, Abrahamsson P, Bang A, et al. Is hospital care of major importance for outcome after out-of-hospital cardiac arrest? Experience acquired from patients with out-of-hospital cardiac arrest resuscitated by the same emergency medical service and admitted to one of two hospitals over a 16-year period in the municipality of Goteborg. Resuscitation 2000;43:201–11.
[26] Tunstall-Pedoe H, Bailey L, Chamberlain DA, et al. Survey of 3765 cardiopulmonary resuscitations in British hospitals (the BRESUS Study): methods and overall results. BMJ 1992;304:1347–51.
[27] Newcombe HB, Kennedy JM, Axford SJ, et al. Automatic linkage of vital records. Science 1959;130:954–9.
[28] Gill L, Goldacre M, Simmons H, et al. Computerised linking of medical records: methodological guidelines. J Epidemiol Community Health 1993;47:316–9.
[29] Jaro MA. Probabilistic linkage of large public health data files. Stat Med 1995;14:491–8.