AHA Medical/Scientific Statement

Special Report

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

Writing Group
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Introduction
Pediatric patients receiving resuscitation have a high mortality and morbidity. To help improve this situation, the American Heart Association and the American Academy of Pediatrics developed guidelines for pediatric resuscitation and an educational program, “Pediatric Advanced Life Support.” Ideally, these guidelines and programs should be based on published, well-controlled research in which objective data were used to evaluate progress in treatment of cardiac arrest, acute respiratory failure, and acute circulatory failure. Unfortunately, because children receive resuscitation infrequently, such data are often lacking, few large studies are available, and the lack of common terminology and methodology makes it impossible to combine smaller studies or compare published results from different centers.

Moreover, clinical pediatric resuscitation research is complicated by the multitude of etiologies producing childhood cardiac arrest or the need for advanced life support (ALS), the impact of underlying diseases in this population, and the lack of explicit definitions. There is a great need for uniform reporting of data in clinical studies involving pediatric resuscitation so that the relevance of these reports can be determined. Explicit definitions of clinical patient information, resuscitation systems and teams, event times and intervals, specific interventions, and outcomes other than death would permit comparisons and meta-analysis among studies and would encourage multi-institutional and international studies.

In 1991 recommended guidelines for the uniform reporting of adult out-of-hospital cardiac arrest data were published internationally with the designation “the Utstein Style.” These guidelines established an important milestone in clinical resuscitation research by spec-
The goal of the task force was to develop uniform guidelines for reporting clinical pediatric ALS research. The task force purposefully broadened its focus to include the very important group of children requiring only airway and ventilation interventions because improvements in outcome are likely to come from prevention of progression of respiratory failure or shock to cardiac arrest. To maximize the usefulness of these guidelines, the task force emphasized simplicity and ease of understanding while assuring that the guidelines would be compatible with recommended data collection in adults. Therefore, the task force borrowed substantially from the definitions detailed in the Utstein Style and in so doing recognizes the Utstein conference participants who established the basis for these deliberations.

In this report, definitions of key terms used to describe ALS research are provided. Measurement of time intervals and the need to collect more comprehensive outcome data are discussed. A template is provided to guide data collection in the prehospital, emergency department, and in-hospital settings. Finally, unresolved issues in reporting pediatric resuscitation research are delineated. The data elements and definitions in this summary are an important first step toward a better system of recording data and describing resuscitation systems for children. It is likely that the pediatric Utstein data elements will require modification based on future input from those involved in pediatric resuscitation.

**Recommended Clinical Data**

**Dictionary of Key Terms**

The first step in developing guidelines for uniform reporting of pediatric resuscitation data is the development of uniform definitions. Clear definitions permit accurate descriptions of different components of emergency medical service (EMS) systems and provide specificity and validity to comparisons of systems and outcomes.

It is recommended that all EMS system data collection forms contain the same core set of data parameters. Data collection forms serve many functions for EMS systems Moreover, it is unrealistic to expect EMS personnel to use separate forms for children and adults. Therefore, data recorded on the EMS form for individual patients should as a minimum contain core data that will allow completion of the clinical portions of the pediatric Utstein template.

**Core data** are those data elements that should always be collected and reported. They are indicated in boldface type and include characteristics of the patient, prehospital EMS system, emergency department or hospital resuscitation system, as well as those elements describing resuscitation outcomes. Core data are essential for comparative analysis of different healthcare systems. Core data are generally easier to collect and in some systems are routinely collected. When possible, core data should be the same as “essential data” recommended for prehospital data recording.

**Supplementary data** are additional, comprehensive, specific facts describing ALS system components that further enhance evaluation of resuscitation outcomes between different healthcare systems and permit more detailed comparisons and more precise analysis of outcomes. However, supplementary data are more difficult to collect and tend to be less precise than core data.

**Resuscitation**, as used in this document, is a global term not limited to therapy of the pulseless, nonbreathing victim; instead, it refers to all basic and advanced life support measures.

**EMS systems** refers to the broad range of emergency care from the prehospital first responder to the intensive care unit setting. It is recommended that all EMS system data collection forms contain the same core set of data parameters. Data collection forms serve many functions for EMS systems Moreover, it is unrealistic to expect EMS personnel to use separate forms for children and adults. Therefore, data recorded on the EMS form for individual patients should as a minimum contain core data that will allow completion of the clinical portions of the pediatric Utstein template.

**Cardiac arrest** is the cessation of cardiac mechanical activity, determined by the inability to palpate a central pulse, unresponsiveness, and apnea. This is a clinical definition; thus, cardiac arrest is present in the child with absent palpable pulses even when organized electric activity is observed with ECG monitoring or when intraarterial pressure monitoring, echocardiography, or some other technique reveals the presence of cardiac contractions generating a pulse pressure or observable cardiac contractions. The latter condition was previously defined as pseudo-electromechanical dissociation, although it should now be called pseudo-pulseless electric activity, based on current AHA terminology. The presence of a cardiac contraction detected by intra-arterial pressure monitoring in adults implies a greater likelihood of response to therapeutic interventions.

**Respiratory arrest** is defined as the absence of respirations (ie, apnea). Both respiratory arrest and isolated respiratory compromise are characterized by cardiac activity detectable as a palpable pulse. Agonal respirations requiring immediate assisted ventilation represent a form of respiratory compromise leading to assisted ventilation (see below), but this condition does not constitute respiratory arrest.

**Respiratory compromise leading to assisted ventilation** is defined as ineffective ventilation from any cause resulting in the clinical decision to provide at least bag-valve-mask or mouth-to-mouth ventilation. This category includes children in respiratory or cardiac arrest as well as children with agonal respirations or other forms of inadequate oxygenation and/or ventilation. The need for assisted ventilation is based on clinical judgment; it is often difficult to determine the requirement for assisted ventilation based on review of medical records. This critical template section was added by the Pediatric Utstein Task Force in the belief that proper treatment of respiratory compromise in children represents the major medical intervention to reduce the number of cardiac arrests (excluding prevention of primary injury and illness) that occur in children. The best measure of quality of resuscitation may, in fact, be derived from evaluating the number of children with isolated respiratory compromise that does not evolve into cardiac or respiratory arrest.

**Cardiopulmonary resuscitation (CPR)** is a broad term meaning an attempt to restore spontaneous, effective ventilation and circulation. CPR is subclassified as basic or advanced (see below), and CPR outcomes may be classified as successful or unsuccessful.
Basic CPR is an attempt to restore effective ventilation, using expired air inflation of the lungs, and circulation, using external compressions of the chest wall. Basic CPR airway maneuvers include noninvasive methods of opening the airway and application of cricoid pressure. Rescuers may provide ventilation with airway adjuncts, such as mouth-to-mask ventilation and face shields appropriate for use by the lay public. This definition excludes the use of bag-valve-mask devices as well as invasive airway maneuvers. The type of closed chest compression techniques, including either standard, interposed abdominal compression-ventilation CPR,

sustained patient from the site of arrest to the emergency department for out-of-hospital arrest or the intensive care unit for acute myocardial infarction or pneumonia, may be recorded as a separate event. The occurrence of ROSC or termination of efforts evaluating the chest compressions. If mechanical circulatory support is subsequently received, it will be considered a new cardiac arrest episode.

Return of spontaneous ventilation (ROSV) refers to the return of spontaneous respiratory effort in a previously apneic child, excluding agonal or gasping respirations. Although the task force recognizes that this time point may be influenced by therapeutic interventions, such as the use of neuromuscular blockade, it may represent an important prognostic indicator.

Time Points and Time Intervals

Interval, not time, refers to the period between two events. Improper and inconsistent use of these terms has produced much confusion and misunderstanding in the cardiac arrest literature. The definition of intervals should be clear and should not rely on EMS jargon. The format for expression of intervals should be event-to-event interval, with an explicit statement of the two anchor events. Some authors recommend other jargon for these intervals, but the advantage of these neologisms remains unclear.

In adults a powerful determinant of ROSC is the interval between collapse to initiation of resuscitative efforts. Consequently, this interval is a major determinant of ultimate survival. Moreover, evaluation of system performance depends on accurate information about when specific events occurred (ie, time points) and the intervals between these events. Different clocks may be used to describe the intervals of cardiac arrest (Fig 1). For example, the patient clock begins with onset of respiratory or cardiac arrest and runs until ventilation and circulation are restored. The ambulance clock starts when the response vehicle begins to move and ends when the patient arrives at the hospital. Finally, the hospital clock begins with the patient’s arrival at the hospital and ends when the patient is discharged from the hospital or dies during hospitalization. For evaluation of patient outcome, the patient clock is most important. Examples of core intervals include the following:

Call-response interval is the period of time from receipt of a call by EMS system dispatchers to the moment that the emergency response vehicle stops at the resuscitation scene. This interval includes the time required to process the call, dispatch emergency personnel, move personnel from their quarters to the emergency vehicle, start the vehicle in motion, and travel to the scene.

Start-stop CPR interval is the time from initiation of basic CPR by healthcare providers to either onset of sustained ROSC or termination of efforts. Evaluating the duration of CPR efforts may provide valuable information about how long efforts in pediatric CPR should be continued. Recent data on adult resuscitation suggest that CPR start-stop intervals greater than 25 minutes in out-of-hospital cardiac arrests may be a useful guideline to discontinuation of prehospital resuscitation efforts. Similar data in pediatric near-drowning in non-icy waters suggest that failure to respond to 25 minutes of prehospital ALS predicts death or severe neurological impairment. For patients receiving chest compressions intermittently (ie, intermittent ROSC), total duration of chest compressions may be recorded as a separate interval.

Return of spontaneous circulation (ROSC) refers to the time from initiation of resuscitative efforts in an official capacity as part of an organized, specifically trained response team. By this definition, nurses, physicians, and paramedics who witness a cardiac arrest in a public setting and initiate CPR but do not respond as part of an organized team are not emergency personnel.

Return of spontaneous circulation (ROSC) is the time from initiation of resuscitative efforts in a cardiac arrest patient, regardless of their duration. A palpable pulse is detectable by manual palpation of a major artery, usually the carotid artery in older children and the brachial or femoral artery in infants and young children. While ROSC is less clinically important than eventual hospital discharge, it may be a useful outcome in clinical trials and other intervention studies, particularly in prehospital resuscitation. The occurrence of ROSC does not mean that chest compressions should always be discontinued; they may still be necessary if the child has bradycardia/poor perfusion and is receiving basic CPR.

ROSC may be further classified as intermittent or sustained. Some patients have brief (up to 20 minutes) ROSC after an intervention such as administration of a bolus of epinephrine but never achieve a sustained stable rhythm and palpable pulse that would permit prolonged termination of chest compressions. To facilitate standardization and uniform reporting, sustained ROSC is defined as return of spontaneous circulation for 20 minutes or longer. Although arbitrarily defined, this duration should be sufficient to permit transfer of the patient from the site of arrest to the emergency department for out-of-hospital arrest or the intensive care unit (ICU) or operating room without the need for ongoing
Fig 1. Different clocks used to describe event time periods and intervals during resuscitation. Reproduced from Cummins et al.5

A list of specific event times for the prehospital, emergency department, and in-hospital settings is displayed in Table 1. A number of intervals may be calculated from these time points. The task force noted that many pediatric emergency patients enter the EMS system by private vehicle delivery to the emergency department rather than by a prehospital EMS system. Inherent differences exist between these two patient groups in clinical status, frequency and effectiveness of prehospital CPR provided, documentation and timing of interventions, and clinical response. These differences make comparisons difficult. Therefore, these patients should either be analyzed separately or included in the population of emergency department arrests rather than prehospital EMS system arrests because their outcome is not attributable to the care provided by the prehospital system.

<table>
<thead>
<tr>
<th>Table 1. Event Times*</th>
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<tbody>
<tr>
<td><strong>EMS Event Times</strong></td>
</tr>
<tr>
<td>Time of event onset</td>
</tr>
<tr>
<td>Time incident reported</td>
</tr>
<tr>
<td>Time dispatch notified</td>
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<tr>
<td>Time EMS unit notified</td>
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<tr>
<td>Time unit responding</td>
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<tr>
<td>Time of arrival at scene</td>
</tr>
<tr>
<td>Time of arrival at patient’s side</td>
</tr>
<tr>
<td>Time bystander CPR started</td>
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<tr>
<td>Time bystander CPR stopped</td>
</tr>
<tr>
<td>Time CPR begun by EMS</td>
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<tr>
<td>Time CPR stopped by EMS</td>
</tr>
<tr>
<td>Time unit left scene</td>
</tr>
<tr>
<td>Time of arrival at destination</td>
</tr>
<tr>
<td>Time of sustained return of spontaneous circulation</td>
</tr>
<tr>
<td>Time of return of spontaneous ventilation</td>
</tr>
<tr>
<td>Time of assisted ventilation by EMS provider</td>
</tr>
<tr>
<td>Time of ALS procedures (specify procedure)</td>
</tr>
<tr>
<td>Time of ALS medications (specify medication)</td>
</tr>
</tbody>
</table>

*Core event times are indicated in boldface type.
EMS indicates emergency medical services; CPR, cardiopulmonary resuscitation; ALS, advanced life support; ED, emergency department.
Clinical Outcomes

Clinical outcomes following attempted resuscitation constitute core information required for system evaluation, inter-system comparisons, and clinical trials. The chief goal of cardiocerebral resuscitation is to return the child to his or her preevent level of neurologic function. Therefore, resuscitative efforts cannot be evaluated without assessment of neurologic outcome in two dimensions: quality and duration. Researchers need these data to show that resuscitative efforts have a net positive benefit for patients, their families, and society.

Traditional EMS system assessments include measurement of the structure and process of emergency care delivery. The traditionally reported outcome is death, which is a limited measure of outcome. To determine whether the EMS system has a positive influence on other patient outcomes, clinical studies must examine additional factors. These outcomes should answer the question of whether the system is “doing the right things” (its effectiveness), as well as whether it is “doing things right” (process and structure of the EMS system).

Studies should also consider not only the effectiveness of the EMS system but its efficiency. What are the costs of EMS personnel, time, training, equipment, and medical care for the patient? What are the hospital costs per patient? What are the hospital costs per child resuscitated?

Cerebral and Overall Performance Outcome Categories

The Glasgow-Pittsburgh Outcome Categories are the most widely used approach to evaluate quality of life after successful resuscitation in adults. The categories are divided into cerebral performance and overall performance. The cerebral performance categories evaluate cerebral capabilities, whereas the overall performance categories reflect cerebral and noncerebral status. Overall outcome categories are reliable and easy to obtain, often requiring only a telephone call to family members. An alternative simple outcome is to record the time of awakening or return to consciousness. The value of this outcome parameter in children has not been examined.

When reporting outcomes in children, the task force strongly recommends using a measurement system that is age-appropriate and has been validated in children. Currently the only method for quantifying functional outcomes meeting these criteria in children is a pediatric modification of the Pittsburgh Outcome Categories. The major modification was the addition of a sixth level of outcome, mild disability (Tables 2 and 3). The Pediatric Overall Performance Category may be determined premorbidly and after discharge by a follow-up call to the family. In a multi-institutional study the change (defined as the Delta score) in the Pediatric Overall and
Cerebral Performance Categories between premorbid state and condition at hospital discharge correlated with length of stay in the pediatric intensive care unit (ICU) and Pediatric Risk of Mortality (PRISM) score at admission. Examining the change in performance category may help determine the effects of the index illness leading to ALS compared with underlying, premorbid problems.

Failure to consider the child's premorbid state may lead to inappropriate conclusions about the effect of the ALS event. For example, some premorbid conditions may affect outcome more than the episode leading to ALS interventions. To more accurately define the cause of deterioration following ALS intervention, the task force recommends categorizing a deterioration in functional outcome as (1) secondary to the index illness or injury that caused the need for ALS; (2) secondary to direct complications of the index event (eg, aspiration pneumonia or seizures specifically related to the event or its resuscitation); or (3) deterioration caused by a problem unrelated to the index illness leading to ALS. An example of the first type is an infant with infantile spinal muscular atrophy who presents with respiratory failure that easily responds to ALS interventions but who subsequently dies within the 1-year follow-up period secondary to the preexistent condition. An example of the third type is a child with multiple trauma who dies during the third week of ICU stay secondary to catheter-related fungal sepsis.

The Pediatric Outcome Categories were recently used in a cardiac arrest population showing deterioration in the cerebral performance category in 50% of survivors when compared with their premorbid state. The Pediatric Outcome Categories should be used to record prearrest status, status at time of discharge, and status after 1 year. Because prearrest status is determined retrospectively, care should be taken to minimize potential bias when calculating the Delta score.

A supplemental outcome measurement is used to record specific impairments and disabilities. Impairments are disturbances at an organ level caused by the underlying pathology of a condition, detected by clinicians during physical examination or laboratory tests. Impairments may or may not result in disabilities (ie, limitations in daily functioning). Disabilities reflect the quality of the patient's life but may be influenced by factors other than the underlying pathology and must be based on deficiencies in age-appropriate activities.

Pediatric Utstein Style Template for Reporting Advanced Life Support Data

How to Use the Template

The template (Fig 2) represents a guide for reporting ALS data in children. Note that completion of every section of the template is not required. Template sections may be completed based on the research question, quality improvement assessment needs, or system analysis question asked.

The template begins with a description of the demographics of the EMS system of interest, definition of the event etiology, a description of the patient's source and mode of transport, as appropriate, and location of the event. The first numerical input is a determination of the number of children in the broad category Respiratory Compromise Leading to Assisted Ventilation. The number of patients in that section then provides the denominator for subsequent calculation of incidence rates. The specific number of patients entered at subsequent levels in the template permits researchers to calculate multiple rates.

Investigators can calculate a large variety of outcome rates from the reporting template because of the multiple combinations of denominators and numerators possible. Reported outcome(s) should be presented as rates or percentages; for example, rate of admissions per total number of resuscitations attempted. The appropriate outcome rate to report may differ among various systems and locations. As a minimum, the task force recommends that all studies report the denominator of cardiac arrests and the numerator of number discharged alive (ie, the outcome would be the cardiac arrest survival to hospital discharge rate). However, it is recognized that the number of survivors will be a small percentage of total cardiac arrests in children. Therefore, collection of additional outcome rates is strongly encouraged. For example, the task force recommends enumerating the number of children with sustained ROSC and survival for more than 7 days as additional core outcome data.

Because some template sections will contain only a small number of patients, calculation of all possible rates or percentages may fail to adequately express the potential clinical variability that exists. Reporting confidence intervals (CIs) can improve interpretation of study data by indicating the degree of uncertainty about an observation. Confidence intervals give a range of values based on observed data; the greater the number of patients, the narrower the CI. A range of clinically acceptable CIs may be calculated; usually a CI of at least 80% is used. A recent analysis illustrates the advantage of reporting CIs. A study of out-of-hospital arrest outcome in New York City included over 3000 patients; the Utstein Style was combined with CIs to express outcome data. If ventricular fibrillation onset was witnessed, mean survival was 5.3% (99% CI, 2.9% to 8.8%). Despite the large total number of patients, the threefold variation in possible mean survival should be noted in this subgroup analysis. The CI more accurately reflects the potential variability of the observation of interest if the study is repeated with a similar number of patients.

Depending on the research question asked, patients who subsequently experience one or more additional arrests during hospitalization may be considered as one person for analysis, whether or not they are successfully resuscitated following subsequent arrests. Alternatively, they may be analyzed separately to determine the impact of multiple arrests on outcome.

Template Terms

The following data elements are contained in the Pediatric Utstein Style Template for reporting ALS data (Fig 2). Core data are described below in boldface type; supplementary data are described in italic type. Some data elements apply only to one site of resuscitation, ie, out-of-hospital, emergency department, or hospital settings; these are so indicated. Terms previously defined in the section "Dictionary of Key Terms" are not defined here. This section is included for reference to the template. To maintain simplicity of the template, some data elements requiring detailed information based on the
Figure 2. Pediatric Utstein Style template for recording advanced life support (ALS) data. Specific components of the template are delineated in the text. For ease of use, additional data elements are described in the text but are not specifically included in the template. These additional elements are underlined in the text. EMS indicates emergency medical services; N, number to insert in a template section; CPR, cardiopulmonary resuscitation; ROSC, return of spontaneous circulation; ROSV, return of spontaneous ventilation; DNAR, do not attempt resuscitation order.
location or type of event are described below in underlined type but are not displayed on the template. The explanation provided with these terms should make it obvious when and how they are used. It should also be noted that many of the data elements refer to either patients with cardiac arrest or patients with a pulse but compromised ventilation. Therefore, some data element choices, such as describing patient status on hospital admission, are specific for the patient's condition for which ALS is provided. Finally, template elements listed as bulleted elements require additional detailed input, depending on the nature of the event. These required data elements are described in further detail below in boxed text corresponding to the bulleted template terms.

**Demographics**

Because the template is designed to meet the needs of researchers evaluating in-hospital, emergency department, and out-of-hospital pediatric ALS, information about each system component should be recorded to better define the population at risk. The methodology section of any manuscript or report on out-of-hospital cardiac arrest or ALS outcome should report the population served by the EMS system and the percentage of the population younger than 21 years. The latter permits calculation of the incidence of pediatric ALS in the at-risk population. The total population of a community is a useful figure only when the entire population resides within the specific EMS system service area. Supplementary community data for out-of-hospital ALS interventions includes the total population served by the EMS system and the geographic area served (in square km).

There is no consistency regarding the upper age of a child, but an adolescent is usually considered 13 years of age or older. Therefore, supplementary data may include reporting the number of patients in each of the following age strata: 0 to 12 months, 1 to 4 years (preschool), 5 to 12 years (child), and 13 to 21 years (adolescent). An investigator may wish to include additional subgroups, such as infants less than 1 month of age to allow separate examination of neonatal resuscitation. The task force noted that the upper age definition of a “pediatric patient” varies in different EMS systems; if a different age limit is used, it should be specifically stated. Additional supplementary data may include the child's gender, educational level, and socioeconomic status, as well as the total number of annual deaths in the community and the number of deaths in the various age strata.

Similarly, recording the total number of patients seen in the emergency department and the number who are younger than 21 years permits calculation of the percentage of the emergency department population in the pediatric age group as well as the incidence of ALS interventions in children seen in the emergency department.

When the event location is the hospital, additional at-risk populations to report as a denominator include the number of children admitted to the hospital and the number of days of care provided to hospitalized children. Unless specifically included in the study, these numbers should not include newborns or infants admitted to a neonatal intensive care unit. The latter is preferred because hospitals admitting high-acuity patients may admit fewer patients with longer lengths of stay. Simply reporting the incidence of cardiac arrest per 1000 admissions may overstate the incidence.

**Description of Prehospital EMS Systems**

In adult resuscitation, numerous studies have demonstrated that the organization of the EMS system has a beneficial effect on cardiac arrest outcome. However, this observation is based principally on studies of early defibrillation of adults with ventricular fibrillation arrest. Most (80% to 90%) nontraumatic cardiac arrests in adults are caused by coronary artery disease with sudden onset of ventricular fibrillation. Therefore, a system that is organized to get defibrillators to patients as quickly as possible achieves higher survival rates. However, researchers have not yet determined the effect of EMS system components and structure on outcome of pediatric arrest, primarily because of methodological complexities. Because many causes of pediatric arrest are without a dominant etiology (ie, ventricular fibrillation), as seen in adults, the effects of EMS organization on the outcomes of such a wide range of causes is difficult to detect. Data from one cause of pediatric arrest, near-drowning, suggest that the speed with which an EMS system provides early ALS (ie, airway management) is associated with improved outcomes.

Differences in outcomes between EMS systems could be due to differences in clinical factors, treatment skills, or EMS systems. Because the many variations in structure and processes of EMS systems could affect outcomes, all future studies of pediatric out-of-hospital cardiopulmonary emergencies must precisely describe the EMS system. The initial report on the Utstein Style contained a detailed list of descriptors that should be used to describe the EMS system. In general the EMS system should be described in terms of who arrives (level of training), what arrives (therapeutic interventions), when they arrive (response intervals), and how they provide care after arrival (therapeutic protocols). Following is a review of those aspects of EMS care that should be described in publications examining out-of-hospital pediatric cardiopulmonary emergencies.

**Who Arrives (Level of Training)**

In the United States most EMS systems comprise two tiers; in European EMS systems three tiers may be present. The first tier consists of the first personnel to arrive at an emergency. These personnel are usually called emergency medical technicians (EMTs) or first responders. In the United States first-tier personnel receive 80 to 120 hours of training. Paramedics usually make up the second tier. They may be highly trained, receiving up to 1500 hours or more of training and supervision. In Europe and some EMS programs in large US cities the third tier may consist of physicians who are present on ambulances or other special response vehicles.

**What Arrives (Therapeutic Interventions)**

Basic EMT skills and training are limited to basic CPR, use of noninvasive airway devices with oxygen, and automated external defibrillation. Since automated external defibrillators are programmed to deliver shocks of 200 J or more, EMS protocols seldom permit first-tier personnel to perform defibrillation in children. Paramedic personnel provide the same interventions as
EMTs, plus advanced interventions such as endotracheal intubation, placement of intravenous lines, administration of medications, and defibrillation and cardioversion. Physicians arriving on the scene of a prehospital emergency can provide the full range of advanced prehospital skills and make decisions regarding transport of the patient directly to an operating room or termination of care.

When They Arrive (Response Intervals)

Multiple studies in adults have confirmed that the interval between collapse and definitive treatment provides the best prediction of outcome. Therefore, information on response intervals is considered core in all studies of out-of-hospital resuscitation. The median (not mean) and range of the call response interval for the various tiers of the response system should be described. The median interval should be reported because mean intervals are inappropriately distorted by long response time in individual patients.

How They Provide Care After Arrival (Therapeutic Protocols)

The general resuscitation protocols used by EMS providers should be stated, including whether the protocols adhere to those recommended by a consensus group such as the American Heart Association or the European Resuscitation Council. The description of field protocols should mention how the protocols differ from the consensus recommendations, whether protocols for pediatric patients can be initiated rapidly, whether personnel must wait for radio or telephone permission to proceed, how much base station control is imposed, and criteria for transportation or cessation of efforts.

The Community “Chain of Survival”

The “chain of survival” metaphor has provided a useful conceptual model for describing the organization of an EMS system for cardiopulmonary emergencies. The four links in the chain of survival have been modified for pediatric resuscitation and consist of injury prevention, early CPR, early access, and early advanced life support. Each link should be briefly described, with comments on how well-established it is in the community.

Emergency Department Demographics

Hospital Descriptions

Less is known about factors in emergency departments that affect outcome. An emergency department should be described in terms of the level of training of its providers, therapeutic intervention capabilities, and treatment protocols. Emergency departments are subject to population biases based on location, referral patterns, policies, and community. Therefore, it is important to report measurable descriptors of the emergency department and the hospital in which it is located. To permit comparison among different emergency departments, the following core questions should be answered:

1. Is the emergency department located in a children’s hospital or a general hospital?
2. How large is the hospital in which the emergency department is located? How many total beds and how many non-neonatal pediatric beds does the hospital have?
3. How is the hospital classified? Is it part of a teaching/university hospital or a nonteaching hospital?
4. Is the emergency department a dedicated pediatric center (or dedicated section of an adult unit), or are children seen within a general adult emergency department?
5. What is the emergency department trauma level?
6. What are the total number of emergency department patients seen on a yearly basis and what are the number of children in each age group seen each year?
7. Describe the community served by the emergency department. Include a classification such as urban, suburban, or rural, and the payer mix of the population served (eg, percent Medicaid, self-pay, private insurance, National Health Service, etc).
8. Provide an estimate of the acuity level of patients seen. This may consist of the percentage of patients classified as needing resuscitation, having an emergency or urgent condition, or requiring nonurgent care determined by a standardized classification system. Alternatively, the ratio of patients admitted to the hospital from the emergency department divided by the number of emergency department patients seen may serve as a proxy of patient acuity.

Who (Level of Training)

Describe the physician staffing of the emergency department. This should include notation of whether the emergency department has 24-hour coverage by board certified (or other accreditation, as appropriate) emergency medicine physicians. Are the physicians certified in pediatric emergency medicine? Do pediatric or emergency medicine residents cover the emergency department? Are all emergency department resuscitations managed by personnel in the department, or is a resuscitation team activated for all/some codes? If a resuscitation team is activated, under what circumstances are they called? What is the composition of the resuscitation team? Are there different teams for adults and children? What is the training level of team members (eg, pediatric advanced life support or advanced pediatric life support [APLS])?

Hospital Demographics

When reporting an in-hospital resuscitation, the following core questions should be answered: How large is the hospital in terms of the total number of beds, the number of non-neonatal pediatric beds, and the number of pediatric ICU beds? Is it a teaching or nonteaching hospital? Is it a free-standing children’s hospital or part of a community or university hospital? What is the annual number of total admissions and pediatric admissions to the hospital (excluding newborn and neonatal admissions unless this age group is included in the study)?

Who (Level of Training)

Is there a pediatric residency training program, and is there a pediatric intensive care fellowship training program? Is there a dedicated pediatric ICU? If not, how many beds in the general ICU unit are for critically ill children? Are patients in the ICU cared for by a full-time pediatric ICU service, adult intensivists, or others?
The Utstein Style for adults recommend a simple dichotomous arrest etiology of "cardiac" or "noncardiac." This approach works well in adults because the vast majority (more than 85%) of adult arrests are of cardiac etiology. It does not work in children because pediatric arrests have a wide variety of causes.

Accurate classification of the cause of arrest or need for ALS is complicated by difficulty in clearly identifying the proximate disease process causing the event. For example, should a child with head trauma producing respiratory arrest be classified as a trauma etiology, primary CNS etiology, or respiratory etiology? In view of this ambiguity, the task force recommends classifying all events as the result of one of the following primary physiological indications for ALS intervention: respiratory compromise, circulatory compromise, or cardiorespiratory failure. The latter refers to simultaneous collapse of both systems.

Classifying the primary physiological disturbance requiring ALS intervention is the minimum information required; the task force recommends providing additional data on the disease process leading to the primary physiological disturbance. Various classification schemes for cause of arrest have been used, but they all suffer from difficulty classifying complex patients and lack of uniform acceptance of terminology. Therefore, the task force recommends using a standardized method of coding patient diseases, such as the International Classification of Diseases (ICD)-9-CM coding system.

The task force recognizes that some patients may not be correctly classified until well after the need for ALS intervention. When possible, information from the patient's hospital medical record or postmortem exam, as appropriate, should be used to determine event etiology. The task force also recognizes that although ICD-9-CM codes are often used to classify patients, they have a number of limitations. The ICD-9-CM codes consist of diagnoses, pathological processes, symptoms, physical findings, test findings, and severity indicators. Thus, the "correct" coding may vary among providers, institutions, or regions. Furthermore, the common practice of recording codes to maximize reimbursement limits the validity of diagnostic data. When possible, ICD-9-CM coding should not be obtained from discharge billing documents but instead should be coded to reflect the patient's clinical diagnosis specifically leading to the physiological derangement requiring ALS intervention. External cause of injury (E codes) should also be recorded as appropriate.

As a third layer of event etiology data, the task force recommends recording the presence of preexistent conditions that may affect patient outcome. These conditions should also be classified with standard diagnostic terminology such as ICD-9-CM coding. Recording this information helps determine the effect of the event on the patient's ultimate outcome. For further discussion, see the outcomes section.
arthral monitoring. Although in-hospital monitoring is most common, many technology-dependent children are now monitored at home.

**Resuscitation not attempted:** This section indicates the number of children for whom ALS is indicated but is not attempted because of obvious patient death or preexistent orders limiting resuscitation. This section will most often be used to describe prehospital EMS responses.

**Clinical status of patient when first EMS provider arrives:** Breathing (yes/no), spontaneous palpable central pulse (yes/no), bystander CPR (yes/no), bystander ventilation (yes/no) (see below for further details). In the case of bystander CPR or bystander ventilation, indicate the person who performed the procedure using the list in the "Witnessed event" section (ie, parent, friend, bystander, etc).

**Pulse and initial rhythm**

The initial rhythm should be recorded for all children who receive ALS or BLS intervention. The rhythm choices are ventricular fibrillation, ventricular tachycardia, asystole, bradycardia, supraventricular tachycardia, sinus tachycardia, normal sinus rhythm, or other. Organized electric activity without a detectable pulse is defined as pulseless electric activity (PEA). One subset of PEA is electromechanical dissociation (EMD), defined as PEA with a narrow, more organized complex. Supraventricular tachycardia requires a regular, normal complex ventricular rate greater than 200 beats per minute (bpm) in a child. The diagnosis of supraventricular tachycardia can be difficult because some children with sinus tachycardia may have heart rates greater than 200 bpm, and a minority of patients may have aberrant conduction leading to a wide ventricular complex. Characteristics of supraventricular tachycardia include a consistent rate with no spontaneous variation as seen in sinus tachycardia, and a response (at least temporarily) to the usual treatment of supraventricular tachycardia. Bradycardia is defined as a ventricular heart rate less than 60 bpm in a child and 50 bpm in an adolescent. The rhythm is often not determined immediately on initiating resuscitative efforts. Thus, resuscitative maneuvers performed before rhythm identification should be recorded.

**Bystander CPR**

The terms bystander CPR, lay responder CPR, and citizen CPR are synonymous; the preferred term is bystander CPR, which is basic CPR performed by someone who is not part of an organized emergency response team. In general this would be a person who witnessed the arrest and may be a professional (ie, professional first-responder CPR). Although improved outcome in CPR is associated with early bystander-initiated CPR effort in adults,10,20 it is not clear whether bystander CPR changes outcome in children.9,27 Documentation of the effectiveness of bystander CPR has public health implications in terms of educating the lay public to perform basic CPR. The term bystander CPR applies only to out-of-hospital locations. Within the hospital basic CPR is typically performed by a healthcare professional (usually a nurse or physician) within a minute of recognition of arrest, even if CPR is initially begun by a parent or other layperson. Thus, there is little advantage in distinguishing between initial in-hospital CPR performed by a layperson or professional. Bystander ventilation may be administered to patients with respiratory arrest or respiratory compromise with a palpable pulse leading to assisted ventilation.

**Bystander ventilation**

Refers to provision of rescue breathing only, including mouth-to-mouth, pocket mask, or other means of providing ventilation, by someone who is not part of an organized emergency response team.

**Confirmed cardiac or respiratory arrest:** Yes or no. These data will reveal the frequency of cardiac or respiratory arrests not confirmed by healthcare providers (ie, either false-positive arrests or children who responded to bystander CPR with ROSC or ROSV).

**Treatments**

**BLS treatment:** Record the type of respiratory support provided (eg, mouth-to-mask or pocket mask ventilation) and the method of mechanical circulatory support (eg, standard CPR, interposed-abdominal compression CPR, or active compression-decompression CPR).

**ALS treatment:** The specific protocols used by a system should be listed when the EMS system is described. Within the emergency department or hospital, specific comment is required regarding compliance with the AHA guidelines,3 the European Resuscitation Council guidelines,48 or other resuscitation guidelines. Record whether intubation was accomplished; type, route, and doses of medications and fluids administered; and use of pacing, cardioversion, defibrillation (including number and dose of shocks given), and use of other advanced techniques such as extracorporeal membrane oxygenation.

**ROSC never achieved:** This template section represents the number of children in a specific event location (ie, prehospital, emergency department, or hospital) who never achieved ROSC despite resuscitative efforts. Failure to respond to prehospital ALS measures with ROSC is unlikely to result in a good outcome unless the patient was hypothermic or had some other reversible cause of cardiac arrest, such as drug intoxication that was corrected after arrival at the hospital. The start-stop CPR interval should be recorded in this section as the median time interval plus range. For prehospital events, investigators should report the number of patients in whom prehospital resuscitative efforts are discontinued (ie, efforts ceased in the field).

**Any ROSC:** This term is defined as the return of spontaneous central palpable pulses of any duration. The presence of sustained or intermittent ROSC should be recorded. The start-stop CPR interval should also be recorded in this section.

**ROSV and no ROSV, control of ventilation:** Return of spontaneous ventilation (ROSV) may be a useful prognostic measurement of outcome. Unfortunately, in some patients ROSV may be unrecognized due to administration of neuromuscular blocking drugs, anesthesics, or sedatives. Children receiving total ventilatory support may have a different outcome than those with some return of ventilatory efforts.

**Patient status**

Determination of patient status depends on location of the event. Final status at the scene refers to the condition of the patient when transport begins. The recom-
mended categories are ROSC (sustained or intermittent), continuing CPR, or death (include time when CPR efforts ceased).

**Status on arrival at the emergency department:** For an out-of-hospital event, this information documents a change in status during transport. The recommended categories are ROSV, the presence of sustained or intermittent ROSC, continuing CPR, or death. If sustained ROSC occurs in any location, patient information should include blood pressure, respiratory rate, and some assessment of the level of neurological function. The Glasgow Coma Scale or modifications for children are often used; however, the latter have not been validated. The task force recommends as a minimum using a simple assessment of level of patient response to stimulation, abbreviated as AVPU, or Alert and responsive, responsive only to verbal stimulation, responsive only to painful stimulation, and unresponsive. The patient's core temperature should be recorded to determine if unresponsiveness is secondary to hypothermia.

Status on arrival at the emergency department also characterizes the type of event (respiratory compromise, circulatory compromise, or cardiopulmonary failure) and whether event onset occurred before or after the patient's arrival in the emergency department. In addition, prehospital interventions, such as endotracheal intubation or vascular access should be noted.

**Status after treatment in the emergency department:** The recommended categories for cardiac arrest victims are as follows: never achieved sustained ROSC, ROSC with subsequent death in the emergency department, ROSC and admitted to the hospital (including the operating room), or transferred to another hospital. The latter group may either have sustained ROSC or need ongoing CPR. The eventual outcome of transferred patients may be difficult to document, but an attempt should be made to determine patient survival. Additional categories are ROSV or need for ongoing ventilatory support.

**Died in the emergency department:** This number comprises patients who never achieved ROSC and patients who responded briefly but were never sufficiently stable to be admitted to the hospital (ie, intermittent ROSC).

**Status on admission to the hospital unit:** Record at least the AVPU score as an index of the level of consciousness, blood pressure, rate of spontaneous respirations (if any), and presence of brain stem reflexes. The latter may include pupillary light response, corneal reflex, oculocephalic reflex, and oculovestibular (ie, cold water caloric) testing. These reflexes are recommended because they may provide useful prognostic data if followed over time. The use of paralytic agents or sedatives should be noted because they affect the neurological evaluation. To stratify patients by severity of illness, a method such as the Pediatric Risk of Mortality (PRISM) score may be recorded using data collected during the first 24 hours in the ICU.

**Status on discharge:** For surviving patients, record the patient's overall status using an appropriate method for children, such as the Pediatric Overall and Cerebral Performance Categories.

Patient disposition

A number of possibilities exist, depending on the location and type of event. For out-of-hospital and emergency department events, note the number of children admitted to an intensive care unit/ward. This population represents those children in whom ROSC was sustained for a sufficient duration to permit admission (ie, sustained ROSC). This category requires the presence of spontaneous circulation and a measurable blood pressure, with or without vasopressor support. Children admitted to the ICU in continued cardiac arrest who receive ongoing chest compression should not be included in this section and are more appropriately considered to have died in the emergency department or out of hospital. Although uncommon in pediatric patients, the use of artificial circulatory devices such as emergency cardiopulmonary bypass and intra-aortic balloon pumps imply that spontaneous circulation is present (albeit mechanically maintained), and such patients should be included in this category. There is no duration requirement for successful admission to the hospital.

**Patient died in the hospital:** A. Total deaths B. Within first 24 hours C. Between 1 and 7 days. Researchers should tabulate the number of patients who died in the hospital, noting patients who died during the first 24 hours of admission and those who died between 1 and 7 days. It is expected that many in the latter group will have brain death established, E. DNAR (do not attempt resuscitation) orders written, F. withdrawal of support; and/or G. organ donation obtained. Note that support is withdrawn only in non-brain-dead patients. The purpose of tracking whether a DNAR order was written is to document a change in selection criteria and the use of DNAR orders in children over time. Patients with DNAR orders may still receive full support and survive. Thus, it may be worthwhile to record when support is withdrawn. Clearly, duration of survival will differ between medical centers combining DNAR and withdrawal of support versus DNAR alone. Organ donation may be obtained from cadaveric donors as well as brain-dead donors with a beating heart. When practical, the donor type should be recorded to reflect the successful harvest of living organs from postarrest patients.

**Discharged alive:** If the patient died in the hospital, record the date and time of death and length of survival after ROSC or ROSV. Intermediate survival durations (ie, death within 24 hours or 1 to 7 days) are potentially important because they document patients in whom cardiac function was restored but death occurred later, usually due to brain death.

**Discharge destination**

If the patient is discharged, researchers may record the discharge destination: home (or preevent residence), rehabilitation facility, extended care facility (nursing home), other acute care hospital, or other. Although discharge destination is often used as a surrogate for neurological outcome, researchers should record the need for home nursing care because discharge to home may not necessarily represent a good outcome.

**Alive at 1 year:** In patients surviving to hospital discharge, follow-up should determine if the patient died within the first year after discharge. The number of
children who are discharged alive but subsequently died within 1 year of discharge may be calculated. When practical, the best functional outcome and cause(s) of death should be determined.

**Status at 1 year**

Same as status at hospital discharge, although researchers may want to record the best ever outcome achieved. Deterioration in cerebral and overall performance should be attributed to the initial insult causing the need for ALS, a preexistent condition, or a new condition, as detailed in the section “Cerebral and Overall Performance Outcome Categories.”

**Unresolved Issues**

In its deliberations, the task force identified a number of unresolved problems in reporting pediatric ALS data. These include defining the etiology of an event, identifying comorbidities and preexistent conditions, and evaluating neurological function and functional outcome. One of the most difficult problems is how to identify the cause of an event requiring ALS intervention. As noted, the imprecision of the ICD-9-CM coding system can result in a variety of codes for one patient. Various arrest etiology classifications were discussed by the task force, but all were imprecise in their definitions. The task force also recognized the need to identify preexistent conditions that could influence outcome, but no standardized methodology could be recommended. How should a patient’s outcome be objectively attributed to the index event compared with a preexistent condition or the effects of hypoxia-ischemia that occurred during the event? This dilemma may not have a simple resolution, because all of these factors may contribute to eventual outcome.

The task force also considered creating separate templates for out-of-hospital, emergency department, and in-hospital arrests. This would have resulted in a very complex document. Therefore, the task force simplified the approach, recognizing that investigators will use only portions of the generic template. Data should be linked from the out-of-hospital to the inpatient setting.

Because patients may experience multiple arrests, the task force decided to limit the reporting of arrest rates to the index episode. This may not adequately reflect the impact of the patient on the EMS system and the effects of multiple arrests on patient outcome. Moreover, each event may represent an important hospital quality-improvement episode. The best method of considering repeated arrest episodes is uncertain. It is not known if sustained versus intermittent ROSC represents useful outcomes. Furthermore, should circulatory support provided by extracorporeal membrane oxygenation or cardiopulmonary bypass be considered sustained ROSC? It is also not known which intervals should be recorded. Is the interval from event time to time of bystander or EMS CPR an important outcome predictor? What about the interval from event time to sustained ROSC or the interval from the time CPR began to sustained ROSC?

Because the task force wanted to describe outcome following various ALS interventions in children, it would be desirable to include children receiving intervention(s) to support circulatory failure. Unfortunately it is not clear how to capture this population. Does every child receiving a fluid bolus merit inclusion as having received an ALS intervention? How is “shock requiring ALS intervention” defined? Should a child with paroxysmal atrial tachycardia who receives cardioversion but is not in clinical shock be included because an ALS intervention was used?

Similarly, the task force attempted to quantify the success of airway and breathing interventions by noting the return of spontaneous ventilation. Is ROSV an important event to monitor? Does ROSV mean that the returned respiratory effort was effective? Indeed, how is the effectiveness of ventilation defined or quantified, whether spontaneous or supported? The definition will likely vary, depending on the child’s underlying condition.

What is the best way to quantify the extent of cerebral function early after an arrest? Should a modified Glasgow Coma Scale be obtained in all patients? Is the AVPU system an adequate tool? Which brain stem reflexes or other components of the neurological exam are important to monitor after an arrest? What other parameters should be monitored shortly after an arrest? Are blood pressure, pulse pressure, heart rate, and temperature important? Is a glucose measurement, lactate level, or other metabolic measurement valuable in predicting outcome?

Finally, how should the age range of the pediatric population be defined? Does it matter if the event is the result of trauma versus a medical illness? Many trauma centers define a child as younger than 14 or 16 years. Is this appropriate for reporting outcome data? What is the ideal way to stratify patient age groups?

**Summary**

This consensus document is an attempt to provide an organized method of reporting pediatric ALS data in out-of-hospital, emergency department, and in-hospital settings. For this methodology to gain wide acceptance, the task force encourages development of a common data set for both adult and pediatric ALS interventions. In addition, every effort should be made to ensure that consistent definitions are used in all age groups. As health care changes, we will all be challenged to document the effectiveness of what we currently do and show how new interventions or methods of treatment improve outcome and/or reduce cost. Only through collaborative research will we obtain the necessary data.

For these reasons, and to improve the quality of care and patient outcomes, it is the hope of the task force that clinical researchers will follow the recommendations in this document. It is recognized that further refinements of this statement will be needed; these recommendations will improve only when researchers, clinicians, and EMS personnel use them, work with them, and modify them. Suggestions, emendations, and other comments aimed at improving the reporting of pediatric resuscitation should be sent to Arno Zaritsky, MD, Eastern Virginia Medical School, Children’s Hospital of The King’s Daughter, Division of Critical Care Medicine, 601 Children’s Lane, Norfolk, VA 23507.

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