

Consensus-based Criterion Standard for the Identification of Pediatric Patients Who Need Emergency Medical Services Transport to a Hospital with Higher-level Pediatric Resources

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ABSTRACT

Background: Emergency medical services (EMS) providers must be able to identify the most appropriate destination facility when treating children with potentially severe medical illnesses. Currently, no validated tool exists to assist EMS providers in identifying children who need transport to a hospital with higher-level pediatric care. For such a tool to be developed, a criterion standard needs to be defined that identifies children who received higher-level pediatric medical care.

Objective: The objective was to develop a consensus-based criterion standard for children with a medical complaint who need a hospital with higher-level pediatric resources.

Methods: Eleven local and national experts in EMS, emergency medicine (EM), and pediatric EM were recruited. Initial discussions identified themes for potential criteria. These themes were used to develop specific criteria that were included in a modified Delphi survey, which was electronically delivered. The criteria were refined iteratively based on participant responses. To be included, a criterion required at least 80% agreement among participants. If an item had less than 50% agreement, it was removed. A criterion with 50% to 79% agreement was modified based on participant suggestions and included on the next survey, along with any new suggested criteria. Voting continued until no new criteria were suggested and all criteria received at least 80% agreement.

Results: All 11 recruited experts participated in all seven voting rounds. After the seventh vote, there was agreement on each item and no new criteria were suggested. The recommended criterion standard included 13 items that apply to patients 14 years old or younger. They included IV antibiotics for suspicion of sepsis or a

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seizure treated with two different classes of anticonvulsive medications within 2 hours, airway management, blood product administration, cardiopulmonary resuscitation, electrical therapy, administration of specific IV/IO drugs or respiratory assistance within 4 hours, interventional radiology or surgery within 6 hours, intensive care unit admission, specific comorbid conditions with two or more abnormal vital signs, and technology-assisted children seen for device malfunction.

Conclusion: We developed a 13-item consensus-based criterion standard definition for identifying children with medical complaints who need the resources of a hospital equipped to provide higher-level pediatric services. This criterion standard will allow us to create a tool to improve pediatric patient care by assisting EMS providers in identifying the most appropriate destination facility for ill children.

Prehospital care providers not only deliver lifesaving treatments to their patients, but they also play a role in helping to identify the most appropriate destination facility for their patients. Although hospital destination is often determined by patient or family choice, we cannot underestimate the role prehospital providers can have in helping to guide patients and their families in making this choice. This role is especially important when the patient is a child who may need specialty care. Currently, a triage tool exists for helping providers identify injured patients who are likely to need the resources of a trauma center,¹ but there is no complementary tool for children with medical complaints.

A pediatric prehospital triage tool for use when evaluating children with medical complaints would assist emergency medical services (EMS) providers in making destination decisions. Prehospital identification of ill children who require specialized resources has the potential to improve patient outcomes by ensuring that children have timely access to those resources. While all emergency departments (ED) must be ready to manage children, it has been shown that variability exists in the availability of necessary resources among EDs and low pediatric patient volumes may create a challenge in maintaining competence.²⁻⁶ Further, initial transport to the appropriate destination can decrease the need for interfacility transfer later in a patient's care. Currently, no such tool exists to augment EMS providers' clinical gestalt and guide them in identifying the most appropriate destination for pediatric patients with medical complaints. It is important to note that simply taking all children to hospitals with higher-level pediatric services is likely not necessary and may lead to overcrowding and inefficient use of this valuable resource.^{7,8} Identifying and validating a pediatric destination decision-making tool for ill children has been identified as a prehospital research priority.⁹

Prior to developing a triage tool for pediatric patients with medical complaints for EMS providers, a criterion standard definition needs to be established that defines a child who required higher-level pediatric care. The absence of a defined criterion standard serves as an impediment to the development of a pediatric prehospital triage tool, because without it there is no way to establish the "right" answer when validating the tool. The overall goal of this project was to develop the criterion standard for children with medical complaints who need the resources of a hospital with higher-level pediatric resources so that future work can derive and validate a decision support tool. Therefore, the specific objective for this study was to develop a consensus-based criterion standard for children with a medical complaint who need a hospital with higher-level pediatric resources.

METHODS

This study replicated the methods used in three prior projects that developed criterion standard definitions for various triage tools in the prehospital setting using a modified-Delphi technique.¹⁰⁻¹² This project was conducted by the Charlotte, Houston, and Milwaukee Prehospital (CHaMP) Node of the Pediatric Emergency Care Applied Research Network (PECARN). The institutional review board (IRB) at the Medical College of Wisconsin determined that these types of investigations did not require IRB review or approval.

An expert panel was recruited through PECARN as well as through personal contacts known to the authors. The goal was to recruit a broad range of emergency physicians, some of whom were subspecialists in pediatrics and EMS. We also attempted to recruit physicians from geographically diverse settings. All physicians were contacted by e-mail and invited to participate. Those who participated in the Delphi process were offered the opportunity to also participate as

manuscript authors. No other incentives were offered for participation.

As part of another project, an informal group used an e-mail process to develop a list of criteria that warranted transport to a hospital with higher-level pediatric resources. This list was used to develop the initial Delphi survey for this project (Table 1). The panelists were instructed to vote on whether each of the criteria identified a child whom they believed needed the resources of a hospital with higher level of pediatric resources. They were also instructed to suggest a time frame in which the service had to occur for it to be considered to have met the criterion. At the end of the survey, panelists were asked to suggest additional criteria that should be considered for inclusion. The surveys were distributed to each panelist using Survey Monkey and panelists provided their name on each survey so that response rates could be tracked and any clarifications to answers could be requested.

Two authors (JRS and EBL) reviewed the responses to each survey, but they did not participate in the voting. The methods described below for assessing consensus were determined a priori by the two authors responsible for reviewing each survey, following methodologies set forth in prior studies conducted in the prehospital setting.^{10–12} If an individual criterion received fewer than 50% of the panelists' votes during a voting round, it was removed from consideration in subsequent voting rounds. If a criterion received at least 80% of the panelists' votes for inclusion, it was considered to have achieved consensus and no further voting was required on that criterion. If a criterion received between 50 and 80% of the panelists' votes

for inclusion, it was revised based on the comments of the panelists and was included in the next voting round. A new survey was then created with the modified criteria and any newly suggested criteria. Criteria that had been approved were listed at the end of each survey for each panelists' reference.

This process was repeated for each subsequent voting round, but in later rounds participants were asked to provide a reason for their vote. These reasons were compiled and provided in an anonymous pros and cons format in the survey to assist panelists in reaching consensus. Voting rounds were conducted until consensus was achieved as indicated by all remaining criteria receiving at least 80% approval and no new criteria being suggested by panelists.

RESULTS

A total of 11 panelists were recruited to participate in the project (Table 2). There were a total of seven voting rounds. All panelists participated in all voting rounds. After the fourth voting round, no new items were added to the list of criteria for consideration, although the opportunity to suggest new criteria was offered in all voting rounds. During the survey process, it was suggested by several participants that the age of the patients to whom these criteria apply needed to be reconsidered. This question was added to the fourth-round survey and, after clarification in the fifth-round survey, consensus was reached that the criteria being developed applied to pediatric patients 14 years old or younger. The final list of criteria included 13 items (Table 3).

DISCUSSION

This study defined a criterion standard for children with a medical illness who would have needed the resources of a hospital with higher-level pediatric resources. This criterion standard can now be used to develop tools that predict which children with a medical illness need the services of a hospital with higher-level pediatric resources because it will allow investigators to determine the accuracy of any developed prediction tools. It is important to note that these criteria are not for use at the time of prehospital decision making since most of them will not occur until after the prehospital phase of care is completed.

The development of any clinical decision tool requires a criterion standard against which to judge

Table 1
Initial List of Criteria to Seed the Consensus-building Process

Airway management or respiratory assistance in the ED
≥40 ml/kg IV fluid bolus(es) given within 2 hours of arrival
Cardiopulmonary resuscitation in the ED
Pacing, cardioversion, or defibrillation in the ED
Three or more treatments or continuous treatment of an inhaled medication in the ED
IV drug administration in the ED (excluding analgesics, antiemetics, antacids)
Nontraumatic blood product administration in the ED
Surgery within 4 hours of ED arrival
Seizures treated with two different classes of anticonvulsant medications
Two or more abnormal age-adjusted vital signs upon ED in a child with immunocompromise, history of marrow or solid organ transplant, or prior cardiac surgery

Table 2

Expert Panel Participants: All Panelist Voted in All Seven Rounds of the Survey

Name	Specialty	Institution	Location
David C. Brousseau, MD, MS	Pediatric emergency medicine	Medical College of Wisconsin	Milwaukee, WI
Jeremy T. Cushman, MD, MS, EMT-P	Emergency Medicine, EMS	University of Rochester	Rochester, NY
Peter S. Dayan, MD, MSc	Pediatric emergency medicine	Columbia University	New York, NY
Patrick C. Drayna, MD	Pediatric emergency medicine	Medical College of Wisconsin	Milwaukee, WI
Amy L. Drendel, DO, MS	Pediatric emergency medicine	Medical College of Wisconsin	Milwaukee, WI
Matthew P. Gray, MD, MS	Pediatric emergency medicine	Medical College of Wisconsin	Milwaukee, WI
Christopher Kahn, MD, MPH	Emergency medicine, EMS	University of California at San Diego	San Diego, CA
Michael T. Meyer, MD	Pediatric critical care	Medical College of Wisconsin	Milwaukee, WI
Manish I. Shah, MD, MS	Pediatric emergency medicine	Baylor College of Medicine	Houston, TX
Manish N. Shah, MD, MPH	Emergency medicine, EMS	University of Wisconsin–Madison	Madison, WI
Rachel M. Stanley, MD, MHSA	Pediatric emergency medicine	Nationwide Children's Hospital	Columbus, OH

Table 3

Consensus-based Criterion Standard for Children Who Need the Resources of Hospital Equipped to Provide Higher-level Pediatric Resources

Criteria	Time Frame
Received IV antibiotics for suspicion of sepsis within 2 hours of ED arrival	Within 2 hours of ED arrival
First-time or unknown prior seizure treated with two different classes of anticonvulsive medications (e.g., benzodiazepine and levetiracetam) or if known to have seizure disorder, treated with two different classes of anticonvulsive medications in addition to usually prescribed treatment, within 2 hours of ED arrival	
Non-trauma-related blood product administration within 4 hours of ED arrival	Within 4 hours of ED arrival
Airway management of any type (e.g., endotracheal, oral, supraglottic device), prior to or within 4 hours of ED arrival	Prior to or within 4 hours of ED arrival
Respiratory assistance (i.e., bag-valve mask, continuous positive airway pressure, high-flow nasal cannula)—excluding oxygen therapy, prior to or within 4 hours of ED arrival	
Electrical therapy (i.e., pacing or cardioversion), prior to or within 4 hours of ED arrival	
Use of one of the following IV/IO medications listed in the 2015 version of the Pediatric Advanced Life Support resuscitation guidelines: adenosine, albumin, amiodarone, atropine, calcium, dopamine, dobutamine, epinephrine, IV lidocaine, norepinephrine, procainamide, prostaglandin E, sodium bicarbonate, or terbutaline; prior to or within 4 hours of ED arrival	
Any surgery within 6 hours of ED arrival	Within 6 hours of ED arrival
Utilized interventional radiology within 6 hours of ED arrival	
Patients who receive prehospital or in-hospital CPR, excluding patients who had resuscitation terminated upon arrival at the ED, prior to or within 6 hours of ED arrival	Prior to or within 6 hours of ED arrival
Intensive care unit admission from the ED	None
Two or more abnormal vital signs for age on arrival at the ED (i.e., first vital signs taken in the ED) in a child who has history of immunocompromise, marrow or solid organ transplant, or cardiac surgery	
Technology-assisted children whose chief complaint involves a malfunction of their technology, excluding those with gastrostomy tubes	

the tool. This has also been referred to as a gold standard but is now more commonly referred to as a criterion standard, since there are very few standards that do not have the potential for some error. However, it is important that the criterion standard be as accurate as possible, since any tool that is developed can only be as good as the criterion standard to which it is compared.

While we have focused on using the developed criterion standard to validate a tool developed for EMS

providers to use in pediatric destination decision making, it may also have implications for quality improvement in EMS. If pediatric patients with medical conditions that need a hospital with higher-level pediatric resources can be identified, it may also inform who requires special prearrival notifications to be made, who requires rapid transport, or who may benefit from other specialty care, in addition it may also help to define which patients should be interfacility transferred. Communities could use the defined

criterion standard to identify those cases that should be more carefully reviewed or have their outcomes monitored. Assuring that these children arrive at the most appropriate hospital is the first step in evaluating the overall process of care and its impact on outcome.

For a criterion standard to be usable either in a research or in a clinical context, the presence or absence of the criteria must be easily assessed. The criteria identified in Table 3 can all be determined through a hospital-based medical record review. The criteria defined by our experts largely included treatments rather than specific diagnoses or patient presentations. This makes obtaining these data from a patient's medical record less complicated and likely more reliable, but these definitions will need to be operationalized and identified through a medical record review to ensure its usability. This process has been used previously for the study of field triage and mass casualty triage guidelines.^{10–12} Those guidelines have since been operationalized and used in real world analyses.^{13–16}

Of the 13 identified criteria, only three were not treatment interventions: admission to the intensive care unit (ICU), specific comorbid conditions with two or more abnormal vital signs, and technology-assisted child with a malfunction. Of these three criteria, all are likely to be documented and easily identified by chart review. However, many of these criteria may be difficult to abstract through an electronic database query and likely will require an actual record review. It does seem likely that a trained research assistant could abstract this information from a patient's chart with physician oversight. Studies that use this technique will need to make the assumption that because an intervention was provided to a patient it was "needed," and this could be a limitation for those studies. For example, admission to an ICU could be a subjective decision that is based on factors other than patient needed such as hospital protocol, bed availability, or physician preference.

LIMITATIONS

There are several limitations to this study. While every effort was made to recruit a wide variety of clinicians from diverse geographic locations, the panel was mostly composed of physicians who work in or near hospitals equipped to provide higher-level pediatric resources. Panel selection is a common limitation of the modified Delphi process, but we attempted to mitigate this bias as much as possible through our expert selection methodology. A broad range of specialty expertise was

obtained, although geographic diversity was not as high as anticipated. This may have introduced some bias into the results, but no more so than one would expect to find in a qualitative consensus-building process. As this criterion standard is applied for research and other practical applications, feedback from other diverse practice settings will be needed to best refine these criteria. The defined criteria have also not yet been collected for use in research or quality improvement and, while these data seem to be easily identifiable in the patient record, that assumption requires further testing.

CONCLUSION

We developed a 13-item consensus-based criterion standard definition for identifying children with medical complaints who need the resources of a hospital equipped to provide higher-level pediatric resources. This criterion standard will allow us to create a tool to improve pediatric patient care by assisting prehospital providers in identifying the most appropriate destination facility for ill children.

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