Treatment and triage recommendations for pediatric emergency mass critical care

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Introduction: This paper will outline the Task Force recommendations regarding treatment during pediatric emergency mass critical care, issues related to the allocation of scarce resources, and current challenges in the development of pediatric triage guidelines.

Methods: In May 2008, the Task Force for Mass Critical Care published guidance on provision of mass critical care to adults. Acknowledging that the critical care needs of children during disasters were unaddressed by this effort, a 17-member Steering Committee, assembled by the Oak Ridge Institute for Science and Education with guidance from members of the American Academy of Pediatrics, convened in April 2009 to determine priority topic areas for pediatric emergency mass critical care recommendations.

Steering Committee members established subcommittees by topic area and performed literature reviews of MEDLINE and Ovid databases. The Steering Committee produced draft outlines through consensus-based study of the literature and convened October 6–7, 2009, in New York, NY, to review and revise each outline. Eight draft documents were subsequently developed from the revised outlines as well as through searches of MEDLINE updated through March 2010.

The Pediatric Emergency Mass Critical Care Task Force, composed of 36 experts from diverse public health, medical, and disaster response fields, convened in Atlanta, GA, on March 29–30, 2010. Feedback on each manuscript was compiled and the Steering Committee revised each document to reflect expert input in addition to the most current medical literature.

Task Force Recommendations: Recommendations are divided into three operational sections. The first section provides pediatric emergency mass critical care recommendations for hospitals that normally provide care to pediatric patients. The second section provides recommendations for pediatric emergency mass critical care at hospitals that do not routinely provide care to pediatric patients. The final section provides a discussion of issues related to developing triage algorithms and protocols and the allocation of scarce resources during pediatric emergency mass critical care. (Pediatr Crit Care Med 2011; 12[Suppl.]:S109–S119)

Key Words: critical illness; emergency mass critical care; medical surge capacity; pediatric; resource allocation; treatment; triage
The Task Force recommendations presented within this paper were developed from peer-reviewed data, literature reviews, similar guidelines first originated by the Adult Task Force on EMCC (1, 3, 6), and from expert opinion. This approach was taken for a number of reasons. First, it was concluded that, to the degree feasible, maintaining consistency between recommendations from the two task forces would facilitate overall preparedness, particularly among those who provide care to both adults and children, and would foster greater confidence among the healthcare community. Further, the Adult Task Force recommendations have to date enjoyed wide distribution and adoption within the healthcare community, forming a working framework and consensus for a standard of care (7). Finally, the Adult EMCC Task Force, which has been working for several years, has already considered many of the same issues that would be addressed in response to large volumes of critically ill pediatric patients in a surge capacity environment (1, 8, 9).

Recommendations are divided into three operational sections. The first section provides PEMCC recommendations for hospitals that normally provide care to pediatric patients. The second section provides recommendations for PEMCC at hospitals that do not routinely provide care to pediatric patients. The final section provides a discussion of issues related to developing triage algorithms and protocols and the allocation of scarce resources during PEMCC.

**PEMCC in pediatric hospitals**

1) Every hospital with a PICU or neonatal intensive care unit (ICU) should plan and prepare to provide PEMCC and should do so in coordination with regional health planning efforts and decisions. This recommendation addresses a number of issues that the Task Force believes to be significant concerns. First, the Task Force strongly believes that all hospitals that provide critical care services to pediatric or neonatal populations have a duty and responsibility to prepare for the delivery of PEMCC in a crisis situation. As outlined in the article, “Pediatric emergency mass critical care: Focus on family-centered care,” children are a particularly vulnerable population during disasters, and there are limitations in the number of facilities that are capable of caring for critically ill children due to the regionalized nature of most pediatric systems (10). Further, evidence from modeling exercises suggests that PEMCC combined with coordinated patient distribution would be the most effective means of decreasing excess mortality in a disaster (11).

The second key aspect of this recommendation is the need for hospitals to undertake their preparedness activities in a coordinated fashion. Regional coordination of the healthcare response to a disaster may occur via formalized systems organized by government bodies, such as a local Department of Public Health, or informal networks, such as regional health coalitions, Emergency Medical Services (EMS), and the role neonatal ICUs can serve as a surge entity in a disaster are presented in detail in the article, “Neonatal and pediatric regionalized systems in pediatric emergency mass critical care”; however, in general, the system should be organized in a hierarchy of tiers as described by Barbera and Macintyre (13), building from the local level up to the national level (Fig. 1).

2) Hospitals with ICUs should plan and prepare to provide PEMCC each day of the response for a total critically ill patient census at least double the PICU bed capacity and at least triple the usual ICU capability. This recommendation was adopted primarily to maintain consistency with the Adult Task Force guidelines. As with the recommendation for adult EMCC, little evidence is available to guide selection of the specific target numbers that should be used to maintain surge preparedness. The United States National Planning Scenarios (14) outline several possible disaster scenarios that would create hundreds to thousands of critically ill adults and children over broad geographical regions. If an event of such magnitude were to occur, critical care surge capability of at least triple the usual PICU capability would be required, even with the institution of PEMCC. Day to day, very little surge capacity exists within the current pediatric critical care system, since most PICUs operate at nearly their total capacity. As discussed in the article, “Supplies and equipment for pediatric emergency mass critical care.”
Mechanical ventilation

There are far fewer pediatric than adult critical care beds. The potential surge required may be even higher than that required for adult critical care beds. However, the Task Force recognizes that even the stated recommendation of tripling PICU capability will be a significant stretch for many hospitals. Therefore, at this time, asking hospitals to consider planning beyond this level does not seem feasible. Given that pediatric hospitals face many of the same limitations regarding “staff, stuff, and space” that adult hospitals confront (5, 15, 16), it is reasonable to expect that they too would strive for the same target objectives as adult hospitals. Although each hospital is ultimately responsible for ensuring that adequate preparations have been made for surge management, this does not mean they alone must bear the burden for stockpiling. Hospitals and governments within a region may collaborate on planning and stockpiles.

3) Hospitals should prepare to deliver PEMCC for at least 10 days without sufficient external assistance. When preparing to deliver PEMCC, it is important to recognize that even if external assistance is available, it will likely take several days for external teams and resources to be mobilized. Although a number of disaster response teams exist, such as Disaster Medical Assistance Teams (17, 18), they are predominately geared toward providing primary care and some acute care medical management. The teams do not have the capacity to provide sustained critical care for either adult or pediatric populations (8, 19). To provide support for PEMCC, personnel would have to be mobilized from other pediatric critical care centers, a process that takes substantially longer than deployment of Disaster Medical Assistance Team-type rapid response and may be delayed by logistic issues, such as credentialing. An additional consideration relates to maintaining facility continuity of operations if it experiences infrastructure failure during the disaster, as was experienced during Hurricane Katrina (20, 21). Further, in a pandemic-type scenario where all hospitals in a broad geographic region are impacted, there may be little or no ability to mobilize external resources. PEMCC should include, when applicable, the following:

- Mechanical ventilation
- Intravenous fluid resuscitation
- Vasopressor administration
- Antidote or antimicrobial administration for specific disease
- Sedation and analgesia
- Select practices to reduce adverse consequences of critical illness and critical care delivery
- Other optimal therapeutics and interventions, such as enteral nutrition and renal replacement therapy
- Reducing cold stress
- Age-specific and family-centered care
- Chaplaincy and palliative care

The treatments listed above form the essential components of individual critical care management, although during periods when resources (staff, stuff, and space) are abundant, the care provided to critically ill patients is very complex and involves therapies that go far beyond these basic modalities. During periods of resource scarcity, it is crucial to focus on the core treatments, since this approach guarantees the best opportunity for survival for the majority of patients. The Task Force’s decision to focus on these essential treatments is both practical and pragmatic. In a practical sense, only a limited amount of an organization’s resources can be directed toward preparedness activities. These activities, in particular stockpiling, carry with them prohibitive costs in terms of the upfront financial burden of acquiring material, storage, and maintenance for stock, as well as the opportunity cost associated with choosing preparedness over an alternative priority. Thus, one must focus on the essential elements of providing critical care. An even more important consideration in the Task Force’s deliberations as to what should be included in PEMCC was the pragmatic consideration of what is operationally feasible during a crisis. Given the limitations imposed by staffing resources in critical care, PEMCC will require clinicians who do not typically work in critical care to assist. With the constraints driven by the limited skill level of those providing care, combined with the limited supply (stuff) and time constraints, it will only be feasible to provide the most essential therapies.

Specific details about the supplies required for providing PEMCC are discussed in the article, “Supplies and equipment for pediatric emergency mass critical care.”

5) All communities should develop a graded response plan for events across the spectrum, from multiple casualty incidents to catastrophic critical care events. These plans should clearly delineate what levels of modification of critical care practices are appropriate for the different disaster-specific surge requirements. Use of PEMCC should be restricted to mass critical care events. Surges in demand for pediatric critical care services exist on a continuum that ranges from minor day-to-day peaks in demand, due to routine epidemiologic fluctuations from events such as operating room demand (day of the week), seasonal events, such as traumas or respiratory syncytial virus, to overwhelming mass illness events caused by pandemics. Hicks et al (4) has described this continuum in terms of conventional care, contingency care, and crisis care. Hospitals must have plans in place to deal with all magnitudes of surges. However, to be executed effectively and efficiently in a disaster, it is important to recognize that hospitals cannot stop at the planning phase, but also need to undertake other activities within the preparedness phase, such as staff training and required disaster exercises (22). PEMCC represents a major alteration of the standards of care and should be restricted to catastrophic mass casualty events (crisis care) where surge capacity efforts have either failed or will not be sufficient to meet the system demands (either observed or expected). In these instances, strategies such as PEMCC can be deployed to maximize the provision of critical care services as well as to optimize resource utilization. Despite the potential benefits of using PEMCC in such circumstances, it is important to recognize any potential harms associated with the decision to implement PEMCC. It should be put into action only when necessary and always with the appropriate checks and balances in place to minimize any risk to the population (1, 6, 7).

6) PEMCC requires one mechanical ventilator per patient concurrently receiving sustained ventilatory support. The Task Force does not feel a suitable substitute for mechanical ventilators exists that would allow appropriate PEMCC to be implemented. Alternative methods for providing ventilation, such as via bag-valve mask, are an essential part of PEMCC in that they serve as a bridge while resources are being mobilized and mechanical ventilators are made available. Manual ventilation has been used successfully via tracheostomy tubes for days in patients with neuromuscular respiratory failure (polio) (23), but this is a
unique situation that cannot readily be extrapolated to settings with other causes of respiratory failure. In these situations, manual ventilation has been used temporarily for hours via endotracheal tubes in the setting of a power failure (24) and weather-related emergencies (25–28). In the patient transport setting, manual ventilation provides similar gas exchange compared to standard mechanical ventilation (29–31). However, evidence generally suggests that manual ventilation with bag-valve masks for prolonged periods is not feasible and carries a higher risk of harm than mechanical ventilation managed by skilled physicians (32).

The specifications for PEMCC mechanical ventilators are discussed in the “Supplies and equipment for pediatric emergency mass critical care” article. Given the expense of mechanical ventilators, individual institutions may not be able to afford to stockpile a sufficient quantity of ventilators to fulfill the stated target of tripling their normal capability. In these circumstances, hospitals should work within their local health coalitions at the regional and/or state levels to develop strategies and stockpiles to meet this target. Further, hospitals should develop and maintain up-to-date inventories of their ventilators so that resources can be efficiently and effectively deployed in the event of a disaster. Beyond the mechanical ventilator itself, a number of consumable supplies are also required to provide mechanical ventilation (e.g., ventilator circuits, endotracheal tubes, suction catheters). Again, further details about these supplies can be found elsewhere in this issue.

7) To optimize medication availability and safe administration, the Task Force recommends that modified processes of care should be considered before an event, such as the following:

- Rules for medication substitutions
- Rules for safe dose or drug frequency reduction
- Rules for conversion from parenteral administration to oral/enteral when possible
- Rules for medication restriction (e.g., oseltamivir if in short supply during an influenza pandemic)
- Guidelines for medication shelf-life extension
- Length-based weight estimates, which should be used if access to scales is limited

During a disaster, particularly a prolonged and/or geographically extensive event, key medications, such as antibiotics and analgesics, may become limited. It is important to establish plans and processes in advance to extend these resources. Substituting an alternative medication from the same class that will provide a similar outcome increases potential options but also facilitates stockpiling by focusing on developing stores of a manageable number of key medications. Converting from parenteral to enteral medications reduces the need for intravenous access, which may present a challenge during PEMCC when noncritical care staffs are required to assist in the provision of care. Shelf-life extensions may become necessary if shortages occur or in the event of supply-chain disruption. However, as with the other recommendations herein, appropriate data, expertise, and evidence are required to safely make these decisions, emphasizing the need for advanced planning. Experts, such as pharmacists, infectious diseases specialists, and pharmacologists, should be consulted when developing such plans. Ideally this consultation will occur at the federal level within agencies, such as the Centers for Disease Control and Prevention and the Food and Drug Administration to provide the appropriate guidance. Finally, during a disaster when time and equipment are limited, the Task Force recommends that length-based weight estimates for drug dosing may allow more efficient patient management.

8) PEMCC ideally should occur in hospitals or similarly designed and equipped structures with experience in providing critical care to pediatric patients (e.g., mobile medical facility designed for critical care delivery or outpatient surgical procedure center). After ICUs, postanesthesia care units, and emergency departments reach capacity, hospital locations for PEMCC should be prioritized in the following order: 1) intermediate care units, step-down units, and large procedure suites; 2) telemetry units; and 3) hospital wards.

When it becomes necessary to obtain more space for providing critical care, the Task Force recommends that the first areas to convert to additional PICUs should be environments that currently provide care to the highest acuity patients outside of the ICU. This includes functional areas, such as intermediate care units, step-down units, postanesthetic care units, and procedural suites that typically have physical layouts and equipment that can readily allow for conversion to a critical care area. Specifically, they usually have the necessary key infrastructure, such as oxygen, medical gas, and suction. Figures 2 and 3 illustrate the recommended manner in which to expand critical care areas. Unless there has been a disruption of hospital infrastructure, alternative care facilities should be reserved for the lowest...
Delegation of duties that usually lie
Assignments should be based on staff
Strategies to achieve and maintain ade-
should include the following:
patients.
patients within a hospital where these
most appropriate to manage critically ill
radiology, which will not be available at
terventions, such as surgery and
quires various consultative services or in-
agement of critically ill patients often re-
provide critical care is available, the man-
ary facilities for more than brief periods.
Even if the infrastructure necessary to
provide critical care is available, the man-
agement of critically ill patients often re-
quires various consultative services or in-
terventions, such as surgery and radiology, which will not be available at
the alternate care site. Therefore, it is
most appropriate to manage critically ill
patients within a hospital where these
services are close at hand and use alter-
native care sites to manage less acute
patients.

9) Principles for staffing models
should include the following:
- Strategies to achieve and maintain ade-
quate staffing levels should be developed.
- Patient care assignments for units
should be managed by the most expe-
rrienced clinician available.
- Assignments should be based on staff
abilities and experience.
- Delegation of duties that usually lie
within the scope of some workers’
practice to different healthcare workers
may be necessary and appropriate un-
der surge conditions.
- Systematic efforts to reduce care vari-
ability, procedure complications, and
errors of omission must be used when possible.

To expand critical care capacity during PEMCC, the model of care provision
must be modified (3, 8). Because critical
care human resources are limited (33–
35), it will be necessary to employ staff
who typically work outside of critical care
in the provision of PEMCC. The funda-
mental principle underlying this recom-
dendation is that it is important to focus
on skills rather than job titles. By focusing
on the skills that are required to
perform PEMCC and matching that with
the skills various healthcare workers pos-
sess, it is much easier to identify which
staff can be redeployed to assist with PEMCC.

One approach to maintain safe prac-
tice yet still allow staff expansion through
the integration of noncritical care work-
ers is the use of care teams. In the care
team model, experienced critical care
providers work in partnership with pro-
viders who possess certain skills to per-
form aspects of PEMCC but who do not
routinely work in PICUs. For example,
instead of the typical 2:1 or 1:1 critical
care nurse-to-patient ratio, in PEMCC
two critical care nurses may work with
three nurses from other areas, such as
postanesthesia care or step-down units,
for a total of six or seven patient coverage
by a care team. The critical care nurses
can supervise the noncritical care pa-
tients and perform tasks that lie outside
the skill set of the other nurses. This
model is not all that dissimilar from how
residents, fellows, and staff work in teach-
ing hospitals. Project XTREME (Cross-
Training Respiratory Extenders for Med-
ical Emergencies) provides an example of
how this type of approach can be applied
to respiratory therapy needs in disaster
response by training healthcare providers
to function as “respiratory therapy ex-
tenders” capable of managing mechanical
ventilators under supervision (36).

**PEMCC in nonpediatric hospitals**

1) All hospitals must plan for the care of some children:
- Hospitals with neonatal ICUs will need
to manage pediatric patients beyond
their typical age limits.
- Adult hospitals should provide stabili-
ization of critically ill pediatric patients
pending transfer.
- Adult hospitals should plan to provide
care for noncritically ill pediatric pa-
tients other than infants (children with
special needs may be an exception).
- Adult ICUs, during a mass casualty
event, should keep adolescent patients
without consultation and patients
older than 5–8 yrs following consulta-
tion with pediatrics.

This is likely the most novel and most
important recommendation that the Task
Force has made. During the review of the
current data and during its deliberations,
the Task Force recognized that, given the
organizational system for pediatric care
and the limitations in capacity discussed
earlier, the only way to effectively save
children’s lives would be to draw upon
the proportionally larger pool of re-
sources within nonpediatric hospitals.
The implications of the regionalized
model for the delivery of pediatric care
and the ethical issues related to the allo-
ration of resources between adults and
children during a disaster are both dis-
cussed in detail elsewhere in this publi-
cation. The current discussion will focus
on the recommendations for providing
PEMCC in nonpediatric hospitals.

When considering how to safely en-
gage nonpediatric hospitals in the care of
children during a disaster, the fundamen-
tal principle used to guide the Task
Force’s recommendations is that the
most complex and most acutely ill chil-
dren should be managed at pediatric hos-

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**Figure 3.** Recommended manner in which to expand critical care areas: progressive step during sustained conditions. Reprinted with permission from Rubinson et al (3).
pitals that have the most experience in treating such patients. Thus, nonpediatric hospitals should only be asked to manage less acutely ill children or critically ill children that are the least physiologically different from adult patients (i.e., adolescents). Nonpediatric hospitals should include a pediatrician or pediatric medical liaison in those committees responsible for disaster planning, appeals, and determining when crisis standards of care should be implemented. New York State has published guidance for nonpediatric hospitals to manage pediatric patients during a disaster (http://www.omh.state.ny.us/omhweb/disaster_resources/pandemic_influenza/hospitals/bhpp_focus_ped_toolkit.html).

An equally important rationale prompting the Task Force to make this recommendation is evidence indicating that the majority of victims will self-extricate from the site of the disaster and present to any hospital, often the closest, but not necessarily the hospital that authorities direct patients to use (37). As a result, many nonpediatric hospitals may be faced with critically ill pediatric patients presenting at their doors, particularly if entire families are affected as a unit. Under normal circumstances, most nonpediatric hospitals have plans and processes to provide initial resuscitation or stabilization of pediatric patients in the emergency departments but then proceed with very early transfer of the pediatric patient to a pediatric facility. In the event of a large-scale disaster, rapid transfer may not be feasible. First, given their resource limitations, pediatric hospitals will likely be overwhelmed very quickly and therefore may not be able to accept transfers. Additionally, transportation may not be available depending on the nature of the disaster. In many circumstances, emergency medical services resources will be fully committed to the on-scene response, negating any interfacility transfers. Finally, the transport of critically ill patients is very staff intensive and takes nurses, respiratory therapists and physicians away from areas of need (5).

2) During a disaster, it may be more efficient to transfer skilled pediatric critical care teams to nonpediatric centers to support those facilities in providing care to critically ill pediatric patients. However, if healthcare workers are going to be moved between institutions, then hospitals and government authorities must be prepared to credential incoming teams expeditiously. When it is not feasible or efficient to transfer individual pediatric patients for management at a pediatric facility, an alternative consideration would be to dispatch teams of pediatric providers to nonpediatric facilities to support them in managing pediatric patients there. Not only does this approach relieve the pressure on the pediatric sites, it also likely provides for safer care of pediatric patients in nonpediatric centers and provides a “force-multiplier” effect similar to the care team model discussed above. Finally, the transportation of the pediatric teams to the nonpediatric hospital does not require a vehicle fitted for patient transport. Other modes of emergency or nonemergency transportation can be used. This is particularly effective if the nonpediatric hospital already has a store of the necessary pediatric equipment on site. Equipment recommendations for nonpediatric hospitals are presented in the New York State guidance mentioned earlier (http://www.omh.state.ny.us/omhweb/disaster_resources/pandemic_influenza/hospitals/bhpp_focus_ped_toolkit.html). If nonpediatric hospitals do not have the pediatric equipment needed to sustain critically ill patients, pediatric critical care teams may need to take their own equipment.

A significant limitation of this approach, and a problem frequently faced in disaster response, is the difficulty associated with credentialing (9, 38, 39). For such an approach to work, a system for rapid credentialing or advanced credentialing would be required. Government bodies and professional colleges can prepare for disasters by developing programs to credential healthcare workers in advance, such as the Emergency System for Advance Registration of Volunteer Health Professionals and Medical Reserve Corps/National Disaster Medical System (http://www.medicalreservecorps.gov/File/ESAR_VHP/ESAR-VHPMRCIntegrationFactSheet.pdf). One possible alternative to avoid these difficulties is to use telemedicine technologies to provide pediatric support to nonpediatric hospitals (See the article, “Pediatric emergency mass critical care: The role of community preparedness in conserving critical care resources”).

3) A referral network for pediatrics consultation or transfers should be established to support hospitals that do not normally receive pediatric patients. With adult hospitals providing care for some pediatric patients during a disaster, consultation and pediatrician support will be required for these facilities. While most adult centers see children in their emergency departments and thus have some experience with transferring such patients to a pediatric referral center, such transfer arrangements are often of an informal, ad hoc nature; therefore, it is prudent to provide adult hospitals with a plan for referral and consultation in advance of a disaster. When developing this referral network, it is important to consider all pediatric resources within a region and not academic centers only. There may in fact be nonacademic centers near the affected hospital that can quite capably provide advice and/or management.

4) Nonpediatric hospitals should pre-identify hospital staff (physicians, nurses, nurse practitioners, physicians assistants) with experience in care of pediatric patients (may include emergency medicine, anesthesia, otolaryngology, trauma surgery, general surgery, and certain medical specialties or nurses with past experience in pediatrics), create key positions in which these individuals would serve (including job action sheets), and integrate them into the hospital’s plan to manage pediatric patients. It is important to re-member that, even in an adult hospital, there may be staff who have experience working with pediatric patients. These staff members can form a cadre from which to draw in the event of a disaster involving many critically ill children.

Triage

For centuries, many have struggled with the issue of how to manage situations where healthcare resources (supplies) do not meet the demands. Although present to some degree in many healthcare systems on a daily basis, resource allocation decisions often become most apparent and pressing during acute surges in demands, such as disasters. When faced with a shortfall of resources, a number of potential options exist for allocating the available resources. The default option would be to do nothing and just continue practice as normal on a first-come, first-serve basis until all the available resources are used. Although this approach requires the least deviation from normal practice, excess mortality is the likely result, and the public and healthcare professionals tend to consider it an unacceptable response to crisis situations. Further, this approach may exacerbate preexisting discrepancies in access to healthcare based on economic, social status, or other factors. As an al-
ternative, one may consider a lottery approach for the allocation of scarce resources (40). If conducted properly, this approach to triage would overcome the issues of perpetuating various discriminations in access, but it is not feasible because of logistic issues, the most significant being that it is impossible to know in advance who is going to be injured or fall ill and require a medical resource.

Faced with similar challenges during the 1700s, the Surgeon General of Napoleon’s army issued the first rules of triage (French for “to sort”) whereby he directed that the wounded should be treated in priority of their injuries rather than their rank or status. From this point onward, triage has become the primary method for allocating scarce resources and has evolved to have two functional components: the first to sort or prioritize patients, and the second to ration resources to optimize their availability so they may be directed to the patients who are most likely to benefit from them. This concept of triage is based on utilitarian principles and is the most common, but it is not the only approach that can be taken. Alternative perspectives, such as that of egalitarianism whereby resources would be directed to those most in need, could also be taken. The ethics of triage have been extensively discussed elsewhere (40–43).

Regardless of the particular goals used to guide the development of triage, the process of triage is an iterative one that occurs at multiple points along the continuum of care: primary triage (prehospital decisions concerning priority for referral to health facilities, such as hospitals or alternate care sites); secondary triage (emergency department decisions concerning initial priority for primary treatment); and tertiary triage (decisions regarding priority for definitive management and critical care). Critical elements of triage at any level, when using a utilitarian approach, are knowledge of the demand on the system, knowledge of the supply of resources, and the ability to predict which patients will or will not benefit from the resources. Systems-level triage also occurs at command and control levels concerned with how resources will be distributed at the macro level via the health emergency operations center (44).

In addition to the variability in the possible goals of tertiary triage (e.g., utilitarian vs. egalitarian principles), the process of undertaking tertiary triage also varies greatly. Traditionally, primary and secondary triage has been conducted by a sole triage officer (or multiple, independently functioning triage officers) based on either protocols (typical for primary and secondary triage) (45–48) or expert experience and judgment (tertiary triage in trauma settings). Although protocols have been developed for primary and secondary triage, virtually none of these are evidence based or have validated outcomes of their performance in real-time disasters (49). However, with the development of proposed adult tertiary triage protocols (6, 50, 51), some groups (52) have suggested the use of a triage panel or committee. While this may be beneficial in diffusing responsibility and the pressure of decision making from any one individual, committee-based decision making is cumbersome under the best of circumstances and unlikely to be feasible or efficient in the midst of a disaster, particularly for time-sensitive decision-making. The Adult EMCC Task Force has considered these issues in detail (6).

The original intent of the Task Force Steering Committee was to propose a protocol for allocating scarce pediatric critical care resources (tertiary triage) during a disaster. Currently, the Task Force is unable to identify a pediatric prognostic scoring system, a critical factor required for the development of a tertiary triage protocol that would be appropriate for use. Although several pediatric prognostic scores are used for research purposes (Table 1), their performance characteristics limit their utility in directing resource allocation. The proposed adult tertiary triage protocols use prognostic scoring systems to identify patients who have an excessively high mortality despite critical care therapy, thereby allowing resources to be directed to patients who are most likely to benefit (6, 43, 50). The current pediatric scoring systems fail to sufficiently discriminate between those who are likely to survive and those who are not. The Pediatric Risk of Mortality II score, for example, has been used extensively since it was introduced in 1988, but has had waning reliability in predicting mortality over the past decade, and has never performed well among populations with particular conditions and from selected locations outside of North America. Its successor, the Pediatric Risk of Mortality III, has improved discrimination and is continually being refined with newer and larger patient datasets, but to date remains proprietary. Studies (53–61) describing the Pediatric Index of Mortality II score have documented good discrimination between PICU survivors and nonsurvivors, but the score has been tested primarily in Australia, New Zealand, and the United Kingdom, and its performance in broader populations remains uncertain. Additional to these considerations, given the physiologic resiliency that children possess, mortality rates even in the most critically ill children are still very low compared to the adult ICU population. Thus, pediatric triage algorithms driven solely by tools that predict a high risk of mortality are unlikely to have a significant impact on the allocation of PICU resources, since only a very small proportion of children are likely to reach the probability-of-mortality threshold at which resources will be withheld or withdrawn.

Recently, several pediatric protocols have been proposed that use exclusion criteria based on preexisting conditions for the use of life support in pediatric patients during a catastrophic event. Unfortunately, the Task Force concluded that it could not endorse these protocols. Although the Task Force did not outright reject the principle of exclusion criteria, the primary difficulty with the proposed exclusion criteria is that they would exclude so few patients that no significant impact on resource availability is likely to be appreciated. The inability of the Task Force to recommend a tertiary triage protocol unfortunately does not negate the potential need for resource allocation decisions to be made if a major disaster were to occur. While the necessary development activities are undertaken to create the components for a pediatric tertiary triage protocol, the Task Force offers the following considerations in the event that resource scarcities occur. The approaches are divided into considerations for sudden-impact disasters and sustained-impact disasters (1).

**Sudden-Impact Disasters.** Sudden-impact disasters are unexpected and involve trauma from either natural or man-made kinetic events. In such cases, the existing primary and secondary triage protocols are most relevant and should be used. Effective use of primary and secondary triage may mitigate the need for tertiary triage by limiting overtriage (59) and ensuring the most efficient use of available critical care resources. In the event that efforts at surge management,
would be a mixed group comprising pa-
impact disaster, patients for critical care
the surge event itself, in a sustained-
ity of the patients would be the result of
den event disasters where the vast major-
tained-impact disasters occur over a pro-
work of an incident management system
and should be conducted within the frame-
any triage circumstance, the degree of ra-
is the current standard of practice. As with
know that the score has no better predictive power than chance alone; the greater the area under the ROC, the better the discriminatory power.

PICU, pediatric intensive care unit; PRISM, Pediatric Risk of Mortality; PIM, Pediatric Index of Mortality.

“Performance of a prediction score is commonly measured by “discrimination” (the ability of the score to distinguish subjects regarding a dichotomized outcome, such as life versus death) and “calibration” (the score’s ability to predict outcome in a population independent of the one used to develop the score). Discrimination is usually quantified by measuring the area under the receiver operating curve (ROC), where area under the ROC = 0.5 indicates that the score has no better predictive power than chance alone; the greater the area under the ROC, the better the discriminatory power.

including PEMCC, are insufficient to meet the demand, tertiary triage should be conducted by experienced trauma sur-
geons and/or intensivists (pediatric or adult) using their best medical judgment as is the current standard of practice. As with any triage circumstance, the degree of rationing should be proportional to the expected or realized shortfall in resources, and should be conducted within the framework of an incident management system under the command and control of a regional health authority to ensure all possible resources are mobilized.

**Sustained-Impact Disasters.** Sustained-impact disasters occur over a pro-
longed period of time and/or large geo-
graphic area and are most likely to result from bioevent disasters, such as a pan-
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<td>PRISM II (53)</td>
<td>1988</td>
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<td>Each organ is scored 0, 1, 10, or 20, depending on degree of dysfunction, rendering the score noncontinuous.</td>
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<td>Front-end predictor of mortality</td>
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Table 1. Pediatric prognostic scores

PICU, pediatric intensive care unit; PRISM, Pediatric Risk of Mortality; PIM, Pediatric Index of Mortality.

“Performance of a prediction score is commonly measured by “discrimination” (the ability of the score to distinguish subjects regarding a dichotomized outcome, such as life versus death) and “calibration” (the score’s ability to predict outcome in a population independent of the one used to develop the score). Discrimination is usually quantified by measuring the area under the receiver operating curve (ROC), where area under the ROC = 0.5 indicates that the score has no better predictive power than chance alone; the greater the area under the ROC, the better the discriminatory power.

including PEMCC, are insufficient to meet the demand, tertiary triage should be conducted by experienced trauma surgeons and/or intensivists (pediatric or adult) using their best medical judgment as is the current standard of practice. As with any triage circumstance, the degree of rationing should be proportional to the expected or realized shortfall in resources, and should be conducted within the framework of an incident management system under the command and control of a regional health authority to ensure all possible resources are mobilized.

**Sustained-Impact Disasters.** Sustained-impact disasters occur over a pro-
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able to offer any specific recommenda-

S116 Pediatr Crit Care Med 2011 Vol. 12, No. 6 (Suppl.)
ations regarding duration for appropriate time trials or markers of response. These issues would fall simply to expert opinion. In the event that there are multiple patients for a single-resource hospital, physicians must decide between using a first-come, first-serve approach or an expert-based (nonprotocolized, nonevidence-based) triage opinion from an experienced physician. Neither situation is ideal and both are fraught with pitfalls. At this juncture, the Task Force cannot recommend one option above the other.

Despite the current inability to propose a tertiary triage protocol for use in pediatric populations, the Task Force continues to support the need for such a protocol to be developed and recommends that researchers work to develop an appropriate scoring system for use in tertiary triage. This effort is likely best coordinated by a collaboration of professional societies (particularly pediatric critical care) supported by government agencies that hold responsibility for emergency management.

The Task Force recommends that a tertiary triage score for use in pediatrics take a different approach than what has been applied in the adult critical care field. Since a PICU allocation algorithm based exclusively on predicting a high likelihood of mortality is unlikely to have a significant impact on resources, ideally a pediatric triage protocol would identify both those patients who are unlikely to survive, regardless of whether they receive critical care, as well as those children likely to require an extended duration of critical care to achieve survival. Using a combination of these outcomes and cumulative incidence, restricting critical care from patients who are unlikely to survive, or who will require a prolonged ICU course, would allow physicians to optimize resource utilization. To have a significant impact on resources, a pediatric triage protocol would have to identify both those children with high predicted mortality (e.g., 80%, as suggested for the adult protocol) and additionally predict excessive resource utilization (e.g., mechanical ventilator utilization) among those with lesser mortality. The thresholds for diverting critical care resources from critically ill children would be fluid, depending on the relative scarcity of those resources. To date, no scoring system, either adult or pediatric, has been developed to perform in this manner.

The Task Force recognizes that critical care is but one element in a health system that is attempting to provide the best opportunity for survival to all those who might benefit. Discipline-directed triage management protocols will only be as important as the manner in which these tertiary level algorithms can be integrated into a larger, system-wide triage scheme that begins at the primary triage care level and ends with whatever additional resources a regional support system can mobilize. Many “uncomfortable but real” decisions that have not, to date, been operationalized at the local level will, out of necessity, be made. Triage management requires an infrastructure, such as health emergency operations centers (as outlined in the article, “Pediatric emergency mass critical care: The role of community preparedness in conserving critical care resources”), central triage committees, data collection/analysis, and triage officer education. Although attempts to provide independent hospital-centric plans are noble, they do not solve what ultimately requires an integrated, population-based, system-wide solution.

CONCLUSION

Disasters producing overwhelming numbers of critically ill children are rare. However, rather than diminishing the importance of planning and preparation, this fact serves to increase the importance of having preparations in place to respond when they do occur, since clinicians have no routine experience in responding to them. This paper presents recommendations for the provision of critical care to large numbers of children and considerations for resource allocation.

ACKNOWLEDGMENTS

The Pediatric Emergency Mass Critical Care Task Force thanks the American Academy of Pediatrics and its Disaster Preparedness Advisory Council for their review and contributions to the issue.

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59. Frykberg ER: Medical management of disasters and mass casualties from terrorist bombings: How can we cope? J Trauma 2002; 53:201–212

APPENDIX

Task force members in alphabetical order

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