ORIGINAL RESEARCH

Pediatric Disposition Classification (Reverse Triage) System to Create Surge Capacity

Gabor D. Kelen, MD; Lauren Sauer, MSc; Eben Clattenburg, MD, MPH; Mithya Lewis-Newby, MD, MPH; James Fackler, MD

ABSTRACT

Background: Critically insufficient pediatric hospital capacity may develop during a disaster or surge event. Research is lacking on the creation of pediatric surge capacity. A system of "reverse triage," with early discharge of hospitalized patients, has been developed for adults and shows great potential but is unexplored in pediatrics.

Methods: We conducted an evidence-based modified-Delphi consensus process with 25 expert panelists to derive a disposition classification system for pediatric inpatients on the basis of risk tolerance for a consequential medical event (CME). For potential validation, critical interventions (CIs) were derived and ranked by using a Likert scale to indicate CME risk should the CI be withdrawn or withheld for early disposition.

Results: Panelists unanimously agreed on a 5-category risk-based disposition classification system. The panelists established upper limit (mean) CME risk for each category as <2% (interquartile range [IQR]: 1–2%); 7% (5–10%), 18% (10–20%), 46% (20–65%), and 72% (50–90%), respectively. Panelists identified 25 CIs with varying degrees of CME likelihood if withdrawn or withheld. Of these, 40% were ranked high risk (Likert scale mean ≥7) and 32% were ranked modest risk (≤3).

Conclusions: The classification system has potential for an ethically acceptable risk-based taxonomy for pediatric inpatient reverse triage, including identification of those deemed safe for early discharge during surge events. (*Disaster Med Public Health Preparedness*. 2015;9:283-290)

Key Words: surge capacity, disaster planning, health care rationing, hospital bed capacity, risk assessment

Ensuring sufficient surge capacity is a leading concern in disaster planning and response.[1–8] A considerable body of work has advanced the concept of hospital surge capacity for adult patients and victims.[6,7,9–13] Surge concepts and concerns about capacity during disasters in pediatrics have also been raised, in part, in recognition of a low pediatric hospital bed to pediatric population ratio and the highly regionalized nature of pediatric specialty care.[14–19] Of further concern, children may be more susceptible to mass trauma events and contagious diseases because they are often cohorted at specific sites such as schools and attractions.[15,20,21] However, empirical research is lacking related to effective means to create or ensure adequate pediatric hospital surge capacity.

Several strategies have been advanced to create hospital surge capacity. These include canceling elective admissions, opening unstaffed or unlicensed beds, exploiting unconventional space, and altering standards of care.[6,7,9,10,12,13] Recently, a new concept of *reverse triage*, a risk stratification technique that can be implemented during a disaster as well as during times of severe hospital crowding, has been proposed and explored.[13,22] Reverse triage allows the identification of hospitalized patients deemed safe for discharge and with continued out-of-hospital management for a period of time until the system recovers. The Joint Commission identified that hospitals should be prepared to stand alone for up to 96 hours before outside assistance can be expected during crises.[23] A strong advantage of reverse triage as a surge strategy is the emphasis on conserving rather than increasing overall resource requirements (particularly labor) when demand exceeds routinely available supplies.

A system for reserve triage has been developed for adult inpatients[13] and has been shown to be potentially highly effective.[22] However, reverse triage has not been explored in the pediatric population. Commonly, concepts developed for adult patients are

Copyright © 2015 Society for Disaster Medicine and Public Health, Inc. DOI: 10.1017/dmp.2015.27
https://doi.org/10.1017/dmp.2015.27 Published online by Cambridge University Press

not necessarily applicable to pediatric patients. It is recognized that children have unique medical and psychosocial issues and are considered by the US Department of Health and Human Services as an "at-risk population" during disasters and as a population for whom medical countermeasures during crises may not apply as readily as for adults.[15,20,21] Accordingly, we wished to develop a pediatric-specific risk-based disposition classification system that could form the basis for a pediatric reverse-triage strategy in the event of an overwhelming disaster or severe hospital crowding.

METHODS

We used evidence-based materials, combined with expert panel consensus by use of a modified Delphi technique,[13,24] to derive a pediatric risk-based disposition classification system. The Institutional Review Board on Human Subjects Research approved the study.

Expert Panel Composition

Conference organizers determined the desirable qualifications and subject matter expertise of the panel members, who were thus subsequently identified and invited. All panelists were involved in pediatric health care or disaster planning but represented diverse perspectives, including those of nonclinicians (Table 1). Although some of the panelists were from the lead author's home institution, care was taken to ensure broad national and international experience and to include the perspective of major academic health centers, affiliate teaching centers, dedicated pediatric hospitals, and community hospitals. The training or work experience of the panelists encompassed 11 states from all 4 quadrants of the United States as well as Hawaii and 3 international settings (Israel, United Kingdom, and Canada). Panelists were included only if they could attend the entire event. Written consent to participate was obtained from each of the panelists.

Before convening the panel, the study organizers held 2 rehearsals for the conference[13] to ensure that presentations, discussion, and anonymous electronic voting took place smoothly. An experienced facilitator conducted the proceedings but did not vote.

Conference Proceedings

The proceeding occurred in 2013 at a conference center distant from the host institution but in the same city. The proceeding was not associated with any society or organization's conference. The objectives and methodology essentially mirrored that used for a previous exercise focused on reverse triage for adults.[13] The objectives of the expert panel were to (1) develop an evidence-based Pediatric Risk-Based Disposition Classification (Reverse Triage) System, based on tolerance of risk of a consequential medical event (CME) as defined by the need for a critical intervention (CI) during the ensuing 96 hours after discharge or transfer to a lower level of care (vide infra), and (2) assess the risk of a CME occurrence for each particular CI in a list should the intervention be withdrawn or not initiated. The concept of CME and CI are discussed below.

TABLE 1

Expertise of Panel[a]	
Physicians	14
Pediatricians	7
Pediatric Intensivists	4
Pediatric Surgeon	3
Pediatric, other MD	3
Other MD	1
Nurses	8
Pediatric RN	6
PICU RN	1
Pediatric Nurse Manager	2
Other RN	4
Other	12
Discharge/Bed Planner	4
Supply Chain Specialist	1
Pediatric Department Administration	2
Public Health Expert	3
Ethicist	2
Pharmacist	2
Total Distinct Expert Panelists[b]	25

[a]Abbreviation: PICU, pediatric intensive care unit.
[b]There were 25 panelists. Many had dual expertise and thus were counted twice.

Before the convening of the panel, each panelist received a detailed manual containing background information on goals, objectives, literature, planned methodology, and expectations of the expert panel. The panel convened over 2 days. There were several presentations by experts, including on surge capacity, reverse triage, risk assessment and concepts of risk tolerance, and ethics as specifically related to disaster and the pediatric patient population.[17,25–27] Evidence-based information was presented on decision-making protocols based on risk[28] (eg, Pneumonia Patient Outcomes Research Team [PORT][29] and APGAR,[30] Bacterial Meningitis Score in Children,[31] PRISM,[32] Westley Croup Score[33]), peer-reviewed publications,[34] and data on adverse events, readmission rates of discharged pediatric patients, and iatrogenic events related to being in the hospital. Open time for discussion was planned as part of these presentations.

Actual proceedings were conducted as follows. Items related to consensus definition, assumptions, or list inclusion were displayed on a screen by the facilitator and an open discussion would follow. When the facilitator felt consensus was reached, an anonymous electronic vote was taken to confirm. For items requiring a vote such as risk tolerance levels or ranking CI importance, the issue or item was displayed and an initial vote was taken prior to any discussion (aside from

https://doi.org/10.1017/dmp.2015.27 Published online by Cambridge University Press

FIGURE 1

Assumptions Made in the Derivation of the Pediatric Risk-Based Disposition Classification System.

- The hospital is in crisis mode (overwhelmed by patients)
- The hospital will remain functional
- Disaster Plans will exist
- Health-care system will recover with 4 days (96 hrs)
- Government and other disaster response will occur (<96 hrs)
- Liability protection exists or is not an issue
- In-patient beds could be redistributed across services
- Quality of care is not compromised
- Basic (nonprofessional) care available after early discharge
- "Discharge" for any level of classification implies only one level lower
- Transportation of patients will not be considered a limitation

clarifying questions). The results of the vote were immediately displayed and a moderated discussion ensued. Following conclusion of the discussion, a final vote was taken. During all discussion, to protect against reticence to speak out, panelists could send anonymous comments via SMS text, which would be displayed without attribution during the discussion.

Discussions were also held on the first day on items such as assumptions, age range to be considered, and expected medical sophistication of early discharge destinations, particularly for low-risk groups. The uniform consensus on assumptions is shown in Figure 1. The age range agreement was full term (37 weeks) to 18 years of age (the limit for many pediatric hospitals). Panelists decided after considerable discussion that there should be no stratification of age groups for differential consideration, because the basic principles of reverse triage and CME related to CI importance cut across all age groups relatively equally as defined here. Also, the panelists concluded that age group divisions added unnecessary complexity and that adult criteria would be applied to most children falling into older age groups. Discharge destination for patients eligible for early discharge was assumed to be for non-medically-sophisticated destinations such as a family home or equivalent.

On the second day, addressing objective 1, the panelists were asked to reach consensus on the definition of each stratified level of risk tolerance. For example, for the lowest risk tier, the panelists discussed whether the definition should comprise 1 of 3 possibilities: no risk at all, risk no higher than baseline for routine discharge, or minimal if unlikely incremental risk. Then by using the modified Delphi technique a blinded computer-assisted vote was taken for the upper level of risk tolerance for each of 5 tiers, starting with the lowest risk level. The vote pertained to the upper limit of acceptable risk (in terms of percent) of a CME occurring as the result of early discharge over a 96-hour period. The software used (Turning Point Polling Software 4.5.1.224; Turning Technologies, Youngstown, OH) allowed for immediate display of the vote distribution. Using the software, panelists electronically submitted their upper limit of acceptable risk (in terms of a percentage) of a CME occurring specifically due to early discharge over a 96-hour period. Following an initial nonbinding electronic vote taken for each tier, there was a general discussion with a focus on outlier opinions. Subsequently, a final binding vote was taken. Each tier was discussed before proceeding to consideration of the next.

Using a similar process to address objective 2, panelists were given the definition of a CI (see below) and shown a list of CIs to be considered. The initial list developed by study investigators was based on those previously published for adults.[13,22] The list was further vetted by 5 pediatricians. The panel discussion allowed modification of the list including deletion, addition, and collapse of procedure categories. The modified Delphi technique was again used to rate each intervention on the final list by using a Likert scale of 1 to 10 for level of potential harm, corresponding to a sense of risk of a CME.[13] A score of 10 indicated virtual certainty of a CME; a 1 indicated a high unlikelihood of a CME. Panelists were asked to refrain from voting on interventions or procedures if they were not familiar with associated indications and risk profile. For purposes of analyses, any CI with a mean ranking of 7 or higher was considered high-risk for CMEs, a mean ranking between 4 and 6 indicated moderate risk, and a mean ranking of 3 or less modest risk.

Concept of Critical Interventions and Consequential Medical Events

The concept of CMEs and relation to CIs are discussed in detail elsewhere.[13] Briefly, a CI is any procedure or intervention that if withdrawn or withheld could reasonably be foreseen to result in preventable medical deterioration or untoward effect (ie, a CME). The adopted consensus operational definition of a CME was unexpected death, irreversible impairment, or reduction of function occurring within 96 hours of withdrawing or failing to initiate one or more in-hospital interventions (CIs) aimed at stabilizing, ameliorating, or alerting the presence of the medical condition for which it would be normally be applied. Thus, failure to initiate or continue a CI risked a CME within a 96-hour period.

Data Analysis

Data were electronically recorded and displayed in real time by using the Turning Point Polling Software. These data were permanently stored in a secure database. Only the final votes

https://doi.org/10.1017/dmp.2015.27 Published online by Cambridge University Press

were used for analyses. Means and interquartile ranges were calculated as appropriate. Because the exercises protected anonymity in recording participant responses, subgroup analyses by medical discipline were not possible.

RESULTS

Panelists unanimously assented that a 5-category disposition classification system was optimal (Table 2). Consensus was reached on the wording and connotation of each of the tiers.

The panelists judged that risk assumption for category 1 should be equivalent to that following routine discharge. Category 2 was judged to include patients who might warrant discharge if surge capacity were required in a constrained resource environment or if remaining hospitalized during a disaster posed unique incremental risks. Examples of these patients might include those requiring observation for trauma without obvious evident injury, partially treated asthma, and admission for control of nausea related to chemotherapy. Category 3 patients were generally judged inappropriate for early discharge except in highly unusual circumstances where risk of remaining in a hospital setting presented a risk of morbidity or mortality as may occur during a biothreat or emerging infectious agent spreading within the facility itself. Examples of patients in this category may include those on general surgical wards in the immediate period following non-life-threatening orthopedic surgery, where oral intake, voiding, and other functions are not yet a surety to ensure safe discharge. Patients in category 4 have a high likelihood of a CME if discharged early, even if moved to a lower level of care. Examples of such patients include those requiring emergency surgery, vasoactive infusions, continuous respiratory support, or special medications. Finally, category 5 patients were considered too unstable for discharge or transfer to a lower level of care. These would include a sizeable proportion of the intensive care unit (ICU) patient population. The upper limit of 72% (rather than 100%) reflects the opinion that a small proportion of patients being moved for upwards of 96 hours to a lower level of care would not result in mortality or permanent morbidity, and that for those patients who experience mortality or permanent disability, moving posed no actual incremental risk (ie, the CME was highly likely even without transfer).

The tolerance for placing children into the lowest tier (category 1) for risk of a CME caused by early discharge was under 2%. An example of those in this lowest risk category might include children receiving intravenous antibiotics where transition to oral antibiotics is not optimal but is acceptable. The next risk categories had upper risk tolerance limits of 7%, 18%, 46%, and 72% of a CME, respectively.

Table 3 shows the consensus ratings for the list of 25 CIs that if not initiated or withdrawn would result in a CME. Less than one-half of the CIs were considered as high risk (Likert scale score of 7 or greater), about one-quarter as modest risk (Likert scale score of 4 to 6), and about one-third as modest risk (Likert scale score of 3 or less).

DISCUSSION

Hospital surge capacity is a major concern in developed countries. In fact, the need to plan and develop methods to increase hospital capacity during times of high-consequent disasters or times of severe hospital crowding are standard recommendations of the Joint Commission and the American College of Emergency Physicians.[35,36] There has been considerable work during the last decade in defining concepts and general approaches to creating hospital surge capacity,[9–11,19,37] but there is scant work specific to pediatric populations, even though this population is identified as a particularly vulnerable group.

TABLE 2

Consensus Pediatric Risk-Based Disposition Classification and Tolerance for Consequential Medical Event[a]

Risk of Consequential Medical Event	Basis	Mean Upper Limit of Tolerance for Consequential Medical Events (IQR)
I (Minimal)	No anticipated medical consequential events over next 96 h	1.7% (1–2%)
II (Possible)	Calculated risk of nonfatal adverse event possible, but risk of premature discharge during crisis is relatively low and potential for continued similar therapy in next designated disposition setting is essentially assured.	6.6% (5–10%)
III (Probable)	Some risk is assumed. Patient discharge to home not advisable unless Critical Event itself posses a clear risk of morbidity or death remaining an inpatient (eg, risk of BT transmission, effects of resource constraints).	17.7% (10–20%)
IV (Likely)	Patient care cannot be interrupted without virtually ensured morbidity or mortality. Patient requires ongoing highly skilled care.	45.6% (20–65%)
V (Definite)	Patient generally requires intensive care and is considered unstable for lower level of care.	72.1% (50–90%)

[a]Abbreviations: BT, biothreat; EMTALA, Emergency Medical Treatment and Active Labor Act; IQR, interquartile range.

https://doi.org/10.1017/dmp.2015.27 Published online by Cambridge University Press

TABLE 3

Critical Interventions and Expert Panel Consensus of Likelihood of Consequential Medical Event if Procedure or Treatment Modality is Withdrawn[a]

Critical Intervention	No. of Votes	Median (IQR)
High Risk		
CPR	21	10 (10–10)
Interventional Cardiac Catheterization	19	9 (8–9)
Acute Renal Replacement Therapy (eg, dialysis)	21	9 (9–9)
ECMO	18	9 (9–10)
Continuous Cardiorespiratory Monitoring	20	8 (7–9)
Invasive Positive Pressure Ventilation	21	8 (8–9)
Continuous IV or Aerosolized Medication	21	8 (8–9)
Emergency and Essential Surgeries in OR setting	21	8 (8–9)
Interventional Endoscopy	20	8 (7–8)
Emergent/Essential Bedside Procedures (eg, LP, thoracentesis, paracentesis)	20	7 (5–8)
Moderate Risk		
Blood Products	20	6 (5–7)
Noninvasive Positive Pressure Ventilation	21	6 (5–7)
Non-Obstructing Airway Foreign Body Removal[b]	21	5 (4–6)
Plasmapheresis	21	5 (5–6)
IV fluids	21	4 (3.5–5)
Intermittent IV Medication	19	4 (3–5)
Supplemental Oxygen	21	4 (4–5)
Modest Risk		
Central Vascular Access Requirement	21	3 (2–3.5)
Intracranial Monitoring and Drainage	21	3 (3–4.5)
Psychiatric Monitoring[c]	21	3 (2–3.5)
Arterial Line Requirement[d]	21	2 (1–2)
Parenteral Pain Medication	21	2 (2–2)
Wound Care (Major)[e]	21	2 (1–2)
Assistance with Activities of Daily Living	21	1 (1–1)
Parenteral Nutrition	20	1 (1–2)

[a]Abbreviations: CPR, cardiopulmonary resuscitation; ECMO, extracorporeal membrane oxygenation; IV, intravenous; OR, operating room; LP, lumbar puncture.
[b]Other foreign body removal falls under Wound Care, Interventional Endoscopy, or Essential Bedside Procedure.
[c]Includes suicide watch and lock down for self-protection or protection of others.
[d]Added by panelists; original items removed by panelists were dextrose IV, intermittent aerosolized medication, and interventional radiology.
[e]Packing change, dressing change, burn care, incision and drainage, wound FBR.

We derived a system whereby pediatric inpatients can be tiered for consideration of early discharge (reverse triage) to allow the creation of surge capacity while conserving hospital-based resources. A similar consensus and modified Delphi technique was used to derive pediatric standards to be applied during disasters.[24] The proposed system is based on acceptable assumed risk of a preventable untoward outcome or medical event, given a certain patient surge scenario. The system seeks to balance the needs of those who may be at a higher risk for a CME if denied a resource (eg, disaster victims) compared with those who currently have benefit from the resources but are at lower risk of a CME without the provision. In creating the system, the panelists relied on ethical precepts related to children, which differ in some respects from precepts related to adults owing to vulnerabilities in this population.[26,38]

Such a disposition classification system had been developed for adult patient populations[13] and this line of work is being further developed and gaining adherents,[39–44] including in pediatric practice[45] and among US[46] and foreign government agencies.[47] Whereas a similar methodology was used for the previous work that addressed adult inpatients,[13,22] the resulting pediatric classification system differs in some respects. The previous work assumed risk related to outright discharge back to the previous nonhospital setting of a given patient regardless of level of care in the hospital. The pediatric consensus panelists wished to assume that disposition was not discharge in all cases, but rather to one level of care lower than currently being resourced. Generally, this applies to ICU patients who may be transferred to a stepdown unit or general hospital ward to free up resources for disaster patients in greater need of the ICU-specific resources. All other pediatric patients were presumed discharged back to the community.

The panelists' toleration of risk for pediatric patients was relatively conservative compared to a similar previously held exercise for adult patients that followed the same methodology, including the same objectives, preparatory work, and Delphi technique.[13] The panelists' consensus determined that the lowest risk tolerance category should be no higher than

https://doi.org/10.1017/dmp.2015.27 Published online by Cambridge University Press

that expected for a planned discharge. A previous study of acceptable assumed risk of early discharge among adults in this lowest category (3.8%)[22] is more than twice that determined by pediatric panel. This ratio of double accepted risks held for the second and third tiers as well (11.7% and 33.1%, respectively, in the adult study), and was still significantly lower in the fourth tier (61% in the adult study). Interestingly, the highest risk category had a lower tolerance of 72% (versus 92% for adults), reflecting the 2 precepts noted above.

To some extent, a direct comparison of the adult criteria to those derived here for pediatrics presents difficulties. The definitions for each tier are not perfectly aligned. For example, in the adult study the lowest tier was defined to include "minimum to no" risk, whereas in the current study the consensus definition was "no anticipated" risk. The differences in definitions for the 4th and 5th tiers between the 2 studies were inconsequential and yet the differences in risk tolerance are striking. Although not explored explicitly with the panelists, several reasons for these differences are postulated. First, typical pediatric mortality rates are dramatically lower than for adults, likely because of lower societal tolerance for an untoward event and an implicit bias for greater protection of children from preventable harms than adults. Also, children have many life years left and a CME may have a greater impact on those years. Finally, children are dependent on capable adults for all basic care.

The CIs for the pediatric population were derived to inform a currently ongoing study that can estimate potential surge capacity for a given ward, entire hospital, or even regional system given sufficient patient data that can associate risk of early discharge for individual patients. Given that the derivation of the CIs was based on previous work in adults, it is not too surprising that all 25 pediatric CIs had an equivalent in the published work on adults, although only 18 of these CIs were essentially identical. The pediatric panel wished that some CIs were subsumed under a more general rubric and that others were specifically considered as independent items. For example, extracorporal membrane oxygenation was identified as a specific CI, whereas in the adult work it was subsumed under "major surgical procedure," although both were assigned the exact same risk score (9) in the 2 studies, respectively. One important differentiation involved intravenous (IV) medications and fluids. Whereas the original adult work had just one category (IV fluids, medications, pressors), the pediatric panel wished to distinguish risk on the basis of whether IV medication was continuous versus intermittent administration, and further separated IV fluids from medication. There were only 2 major differences in risk assignments between the current pediatric work and the previous adult work. Continuous cardiorespiratory monitoring as a CI was ranked an 8 in importance but only a 3 in adults. This reflects a difference of clinical practice, as many adult patients are routinely placed on monitors despite evidence that this has low bearing on outcomes, whereas the panelists felt that children are not routinely placed on such monitoring unless they actually need it. The other disparate procedure was intracranial monitoring and drainage, which received a low-risk score of 3 in the current report but a high-risk score of 8 in the previous work. The difference between the adult work and the current pediatric derivations raises the issue as to whether 2 scoring systems are really required for the targeted population. Although this was not explored, we believe the pediatric work represents some subtle advances in thought. For example, differentiating intermittent from continuous IV medication administration may represent a risk differentiation in adults, as was perceived in children by the current panel.

The convention of using CIs as a proxy to determine the need for continued inpatient stay has been previously detailed.[13,22] Briefly, because it would be unethical to conduct a randomized controlled trial to measure CME risk by withholding or withdrawing treatment, the concept of CIs as a proxy was developed. The failure to implement (or prematurely withdraw) some CIs, such as intubation, is associated with a high likelihood of a CME. Other CIs such as arterial line placement are associated with a relatively low risk of CME if not implemented or withdrawn. In this model, failure to implement (or withdrawal of) an indicated CI at any time during a 96-hour window from the time that early discharge is contemplated is presumed to be associated with some risk of a CME.

The ultimate goal of this line of work is to establish a scoring system predictive of the risk categories for use during crowding or disasters to allow early discharge. This type of risk "scoring" system would be similar to those noted earlier.[28–34] We currently are engaged in investigation to derive a scoring system that would predict risk of early discharge based on clinical condition and patient characteristics. Until such time, application of this pediatric reverse triage is conceptual, but during a disaster or other state of crisis, the risk associated with withdrawal or withholding of a CI can be used as a guide to determine which patients have the lowest likely risk profile. For example, one would seek early discharge from the lowest risk tier, ie, those essentially suitable for discharge, and not require a CI (that cannot be maintained in the community). However, where some risk is tolerable or required to address the surge demand at hand, one would seek early discharge among the 2nd risk tier, which would only apply to those with CIs in the "modest" risk (lowest) category for a CME if withdrawn.

Reverse triage as a technique has been found to offer significant potential for creating surge capacity,[22] with the added advantage of not having to increase resources. A study assessing the potential contribution of reverse triage in several different types of hospitals showed reverse triage as the largest contributing strategy to create adult surge capacity.[22] Several studies have offered validation related to the expected scope of such a strategy on capacity creation.[48,49]

A preliminary pilot survey sampling pediatric patients on general wards indicates that reverse triage, using the need for CIs as the measure, may contribute significantly less

https://doi.org/10.1017/dmp.2015.27 Published online by Cambridge University Press

incremental capacity than for adults, freeing only 5% to 10% of capacity by use of a very conservative risk-tolerance protocol.[50] However, as Kanter and Moran suggest, alteration in standards of care that includes liberalizing discharge criteria can assist in creating modest pediatric surge capacity[18] and would be necessary in a mass casualty event.[18,51] Thus, restricting pediatric reverse triage to the lowest category would not likely create significantly needed capacity. Another uncontrolled study that attempted to apply reverse triage concepts to a recent influenza-related spike in pediatric patient volume noted limited success because there was no method of application or central authority to guide the process.[41] Reverse triage as a strategy would not be particularly effective if it were not woven into crisis response plans with clear means of application.

Limitations

We cannot be certain that the panel truly represented a national consensus. However, we made efforts to ensure diversity and the relatively conservative result indicates a cautious rather than liberal result. Further, we did not consider lay or patient perspectives, although an understanding of untoward outcomes and proxy measures may prove difficult to explain to a medically unsophisticated audience. The Delphi method does not ensure the "right" answer, but it is a well-accepted method for creating objective criteria. The CI list was derived without questioning whether the intervention was actually needed in the immediate designated time frame.[22] Although it was assumed that basic care of the child was available after discharge (Figure 1), the panel noted that safe discharge may be more challenging for pediatric patients than adult patients for several reasons: specialty facilities such as skilled nursing facilities and hospice are scarce for pediatric patients, home nursing is less available, and, owing to the centralized nature of pediatric centers, home may be a considerable distance from access to pediatric resources should acute needs arise. Finally, although we included ethics experts on the panel, and we believe an ethical perspective informed the outcomes derived, institutional ethics committees ultimately have fiat over medical decisions. However, each institution should consider the implications of reverse triage as part of preparedness planning, because uninformed actions are open to error in the heat of the moment.

CONCLUSIONS

The disposition classification system allows an ethical risk-based taxonomy for pediatric inpatient reverse triage that includes identification of those deemed safe for early discharge during surges in demand. We believe this study represents an important step in the development of an ethically acceptable approach to the allocation of pediatric inpatient resources during surge events. To initiate needed empirical validation of this approach, we are currently undertaking a large-scale study with rigorous methodology to assess the impact of the derived classification system on pediatric surge capacity creation. Derivation of clinical prediction rules awaits such investigations.

About the Authors

The Department of Emergency Medicine (Dr Kelen, Ms Sauer, Mr Clattenburg)and the Department of Pediatrics (Dr Fackler), The Johns Hopkins University School of Medicine, Baltimore, Maryland; the Department of Pediatrics, University of Washington School of Medicine, Seattle, Washington (Dr Lewis-Newby); the Johns Hopkins Office of Critical Event Preparedness and Response, Johns Hopkins Institutions, Baltimore, Maryland (Dr Kelen and Ms Sauer), and the National Center for the Study of Preparedness and Catastrophic Event Response, The Johns Hopkins University, Baltimore, Maryland (Dr Kelen, Ms Sauer, Mr Clattenburg).

Correspondence and reprint requests to G.D. Kelen, MD, FRCP(C), FACEP, Director, National Center for the Study of Preparedness and Catastrophic Event Response, 5801 Smith Ave, Suite 3220, Davis Bldg, Baltimore, MD 21209 (e-mail: gkelen@jhmi.edu).

Support

This work was supported in part by the US Department of Homeland Security through a grant (N00014-06-1-0991) awarded to the National Center for the Study of Preparedness and Critical Event Response (PACER) at the Johns Hopkins University. Any opinions, finding, conclusions, or recommendations expressed in this publication are those of the authors and do not represent the policy or position of the Department of Homeland Security. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the article. None of the authors received an honorarium to write this article.

Acknowledgments

Preliminary data from this manuscript were presented in abstract form at the Society for Academic Emergency Medicine's 2013 annual meeting.

Published online: March 27, 2015.

REFERENCES

1. Committee on the Future of Emergency Care in the United States. *Hospital Based Emergency Care at the Breaking Point*. Future of Emergency Care Series. Washington, DC: National Academies Press; 2006.
2. Surge Hospitals: Providing safe care in emergencies. 2006. The Joint Commission on Accreditation of Healthcare Organizations. http://www.jointcommission.org/assets/1/18/surge_hospital.pdf. Accessed March 3, 2014.
3. Homeland Security Presidential Directive/HSPD-21. Public Health and Medical Preparedness. October 2007. http://www.dhs.gov/xabout/laws/gc_1219263961449.shtm≠1. Accessed March 3, 2014.
4. FEMA 577, Design guide for improving hospital safety in earthquakes, floods, and high winds: providing protection to people and buildings. 2007. http://www.fema.gov/media-library/assets/documents/10672?id=2739 and www.fema.gov/.../20130726-1610-20490-3588/577_ch1.pdf Accessed January 18, 2014.
5. DeLia D. Dwindling supply of empty beds: implications for hospital surge capacity. *Health Affairs*. 2008;27:1688-1694.
6. Kelen GD, McCarthy ML. The science of surge. *Acad Emerg Med*. 2006;3:1089-1094.
7. Kaji AH, Koenig KL, Lewis RJ. Current hospital disaster preparedness. *JAMA*. 2007;298:2188-2190.
8. Peleg K, Kellermann AL. Enhancing hospital surge capacity for mass casualty events. *JAMA*. 2009;302:565-567.
9. Hick JL, Hanfling D, Burstein JL, et al. Health care facility and community strategies for patient care surge capacity. *Ann Emerg Med*. 2004;44:253-261.

https://doi.org/10.1017/dmp.2015.27 Published online by Cambridge University Press

10. Hick JL, Barbera JA, Kelen GD. Refining surge capacity: conventional, contingency, and crisis capacity. *Disaster Med Public Health Prep*. 2009;3: S59-S67.
11. Barbisch DF, Koenig KL. Understanding surge capacity: essential elements. *Acad Emerg Med*. 2006;13(11):1098-1102.
12. Kaji A, Koenig KL, Bey T. Surge capacity for health care systems: a conceptual framework. *Acad Emerg Med*. 2006;13:1157-1159.
13. Kelen GD, Kraus CK, McCarthy ML, et al. Inpatient disposition classification for the creation of hospital surge capacity: a multiphase study. *Lancet*. 2006;368:1984-1990.
14. National Academies Institute of Medicine, Committee on the Future of Emergency Care in the United States Health System. *Emergency Care for Children: Growing Pains*. National Academies Press, 2007. http://books.nap.edu/openbook.php?record_id=11655. Accessed March 3, 2014.
15. Allen GM, Parrillo SJ, Will J, Mohr JA. Principles of disaster planning for the pediatric population. *Prehosp Disaster Med*. 2007;22(6): 537-540.
16. National Commission on Children and Disasters. *2010 Report to the President and Congress*. AHRQ Publication no. 10-M037. Rockville, MD: Agency for Healthcare Research and Quality; October 2010.
17. Antommaria AHM, Powll T, Miller JE, Christian MD; for the Task Force for Pediatric Emergency Mass Critical Care. Ethical issues in pediatric emergency mass critical care. *Pediatr Crit Care Med*. 2011; 12(Suppl):S163-S168.
18. Kanter RK, Moran JR. Pediatric hospital and intensive care unit capacity in regional disasters: expanding capacity by altering standards of care. *Pediatrics*. 2007;119:94-100.
19. Kanter RK. Strategies to improve pediatric disaster surge response: potential mortality reduction and tradeoffs. *Crit Care Med*. 2007; 35(12):2837-2842. PMID 17901842.
20. Vetter S, Dulaev I, Mueller M, et al. Impact of resilience enhancing programs on youth surviving the Beslan school siege. *Child Adolesc Psychiatry Ment Health*. 2010;22:4-11.
21. Dyb G, Jensen TK, Nygaard E, et al. Post-traumatic stress reactions in survivors of the 2011 massacre of Utoya Island, Norway. *Br J Psychiatry*. 2014;204:361-367. 10.1192/bjp.bp.113.133157.
22. Kelen GD, McCarthy ML, Kraus CK, et al. Creation of surge capacity by early discharge of hospitalized patients at low risk for untoward events. *Disaster Med Public Health Prep*. 2009;3:S1-S7.
23. The Joint Commission. Emergency Management. The Joint Commission edition. July 2012. http://www.uhnj.org/mdstfweb/The_Joint_Commission/Emergency%20Management.pdf. Last accessed March 3, 2014.
24. Kanter RK, Andrake JS, Boeing NM, et al. Developing consensus on appropriate standards of disaster care for children. *Disaster Med Public Health Prep*. 2009;3(1):27-32. PMID 19293741.
25. Kraus CK, Levy FL, Kelen GD. Lifeboat ethics: considerations in the discharge of inpatients for the creation of hospital surge capacity. *Disaster Med Public Health Prep*. 2007;1(1):51-56.
26. Antommaria AHM, Sweney J, Poss B. Critical appraisal of: triaging pediatric critical care resources during a pandemic: ethical and medical considerations. *Pediatr Crit Care Med*. 2010;11:396-400.
27. Kissoon N; for the Task Force for Pediatric Emergency Mass Critical Care. Deliberations and recommendations of pediatric emergency mass critical care task force: executive summary. *Pediatr Crit Care Med*. 2011;12(Suppl):S103-S108.
28. Laupacis A, Sekar N, Stiell IG. Clinical prediction rules: a review and suggested modifications of methodological standards. *JAMA*. 1997; 277(6):488-494.
29. Fine MJ, Auble TE, Yealy DM, et al. A prediction rule to identify low risk patients with community-acquired pneumonia. *N Engl J Med*. 1997;336:243-250.
30. Apgar V. A proposal for a new method of evaluation of the newborn infant. *Current Res Anesth Analg*. 1953;32:260-267.
31. Nigrovic LE, Kuppermann N, Maciac CG, et al. Clinical prediction rule for identifying children with cerebrospinal fluid pleocytosis at very low risk of bacterial meningitis. *JAMA*. 2007;297:52-60.
32. Pollac MM, Ruttimann UE, Getson PR. Pediatric risk of mortality (PRISM) score. *Crit Care Med*. 1988;16:1110-1116.
33. Westley CR, Cotton EK, Brooks JG. Nebulized racemic epinephrine by IPPB for the treatment of croup. *Am J Dis Child*. 1978;132:484-487.
34. Maguire JL, Kulik DM, Laupacis A, et al. Clinical Prediction Rules for children: a systematic review. *Pediatrics*. 2001;128:e666. http://pediatrics.aappublications.org/content/128/3/e666.full.pdf. Accessed January 10, 2014.
35. Joint Commission on Accreditation of Healthcare Organizations. Health care at the crossroads: strategies for creating and sustaining community-wide emergency preparedness systems. http://www.jointcommission.org/assets/1/18/emergency_preparedness.pdf. Accessed January 10, 2014.
36. ACEP Policy Statement. Health care system surge capacity recognition, preparedness, and response. *Ann Emerg Med*. 2005;45:239.
37. Soremukun OA, Zane RD, Walls A, et al. Cancellation of scheduled procedures as a mechanism to generate hospital bed surge capacity—A pilot study. *Prehosp Disaster Med*. 2011;26(3):224-229.
38. Antommaria AH, Powel T, Miller JE, Christian MD; Task Force for Pediatric Emergency Mass Critical Care. Ethical issues in pediatric emergency mass critical care. *Pediatr Crit Care Med*. 2011;12:S163-S168. doi: 0.1097/PCC.0b013e318234a88b.
39. Satterthwaite PS, Atkinson CJ. Using 'reverse triage' to create hospital surge capacity: Royal Darwin hospital's response to the Ashmore Reef disaster. *Emerg Med J*. 2012;29:160-162.
40. Moskop JC, Sklar DP, Geiderman JM, et al. Emergency department crowding, Part 2—Barriers to reform and strategies to overcome them. *Ann Emerg Med*. 2009;612-617.
41. Van Cleve WC, Hagan P, Lozano P, Mangione-Smith R. Investigating a pediatric hospital's response to an inpatient census surge during the 2009 H1N1 influenza pandemic. *Jt Comm J Qual Saf*. 2011;37: 376-382.
42. Christian MD, Joynt GM, Colvn J, et al. Critical care triage In Sprung CL, Cohen R, Adini B, eds. Recommendations and standard operating procedures for intensive care unit and hospital preparations for an influenza epidemic or mass disaster. Summary report of the European Society of Intensive Care Medicine's Task Force for intensive care unit triage during an influenza epidemic or mass disaster. *Intensive Care Med*. 2010;36: S55-S64.
43. Sprung CL, Danis M, Iapichino G, et al. Triage of intensive care patients: identifying agreement and controversy. *Intensive Care Med*. 2013;39(11):1916-1924.
44. Ranse J, Zeitz K. Disaster triage. In: Powers R, Daily E, eds. *International Disaster Nursing*. New York, NY: Cambridge University Press; 2010.
45. Griffiths JL, Estipona A, Waterson JA. A framework for physician activity during disasters and surge events. *Am J Disaster Med*. 2011;6:39-46.
46. Timbie JW, Ringel JS, Fox DS, et al. Evidence Report/Technology Assessment, Number 207. Allocation of scarce resources during mass casualty events. AHRQ publication no. 12-E006-EF. Rockville, MD: Agency for Healthcare Research and Quality; 2012. http://www.phe.gov/coi/Documents/Allocation%20of%20Scarce%20Resources%20During%20Mass%20Casualty%20Events.pdf. Accessed January 10, 2014.
47. Pandemic Influenza: Surge Capacity and Prioritisation [sic] in health services. Part 12. Admission to, utilization of and discharge from services. The Scottish Government Publications October 2008. http://spoxy5.insipio.com/generator/sc/www.scotland.gov.uk/Publications/2008/10/28141252/12. Last accessed January 10, 2014.
48. Davis DP, Poste JC, Hicks T, et al. Hospital bed surge capacity in the event of a mass-casualty incident. *Prehosp Disaster Med*. 2005;20: 169-176.
49. Challen K, Walter D. Accelerated discharge of patients in the event of a major incident: observational study of a teaching hospital. *BMC Public Health*. 2006;6:108.
50. Clattenburg E, Sauer L, Kelen G. Reverse triage in pediatrics. A new method to increase in-hospital surge capacity. *Acad Emerg Med*. 2013;20:S59-S60.
51. Health Systems Research, Inc. *Altered Standards of Care in Mass Casualty Events*. Rockville, MD: Agency for Healthcare Research and Quality; 2005. AHRQ publication 05– 0043.

https://doi.org/10.1017/dmp.2015.27 Published online by Cambridge University Press