Abstract:
The most obvious deficiency in the current evaluation of disaster response is the lack of objective, quantifiable measures of performance. This frequently leads to assessments that are highly subjective depending on the evaluator, does not provide those who are planning with targets to achieve, and does not allow for measures that they have improved their preparedness. The goal of this article is to offer recommendations for government agencies at the federal, regional, and local levels, public health departments, and health care institutions to aid in the development of pediatric emergency management performance measures. This will be achieved through the application of traditional quality principles to the assessment of emergency management efforts and to the use of innovative analytic methodologies to develop comprehensive approaches to performance measurement in emergency management.

Keywords:
emergency preparedness; disaster; pediatrics; performance measures; metrics

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Developing Pediatric Emergency Preparedness Performance Measures

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"Are we ready?" This general question frequently serves as a potent stimulus for government, public health, and health care institutions to improve emergency preparedness efforts, despite being hampered by the lack of a specific target or performance measure to assess readiness. Other than the occasional case report of events experienced and a recording of the victims affected and treated, little has been done to establish a rigorous performance assessment of the response to an actual disaster. We are, therefore, left with insufficient objective data on the present performance level of emergency preparedness, making it difficult to direct efforts to improve. This critical deficiency may be especially problematic for pediatric care.

THE NEED FOR PEDIATRIC EMERGENCY MANAGEMENT PERFORMANCE MEASURES

The most obvious deficiency in the current evaluation of disaster response is the lack of objective, quantifiable measures of performance. This frequently leads to assessments that are highly subjective depending on the specific health official involved. Health care organizations are forced to rely on reports from

individual emergency managers based on questions that are difficult to make objective on a case to case basis: "How much equipment or medications do we have?" "How many extra beds can we create?" or, "How many hours of training has staff taken?" are often asked questions that have no clear correlation to achieving preparedness. Indeed, measures such as these may miss key issues of concern such as absent processes, applicability of training, and deficiencies in equipment for actual hazards that may be faced. This is further complicated by the frequent absence of a matching hazard vulnerability analysis, which might determine where the risks are greatest. Without clear performance measures, benchmarking across institutions, communities, and regions is not possible due to a lack of standardized performance metrics.

In the current environment, the risk posed by the absence of performance measures is obvious. Many organizations are now beginning to conduct hazard vulnerability analyses that help to accurately identify risks and areas for focused preparedness efforts. However, institutions remain susceptible to being quickly overwhelmed and possibly incapacitated by large-scale regional events because of the absence of a mechanism to assure effective preparedness for these hazards. The Pandemic and All-Hazards Preparedness Act of December 2006 requires localities to create preparedness initiatives consistent with "measurable, evidence-based benchmarks and objective standards."[1] This is an important step that supports the need for evidence-based preparedness measures. This also parallels current trends in health care toward the use of proven therapies and practices that are targeted to validate performance measures in efforts to maximize health care quality. The hope is that current preparedness efforts will model other health care quality improvement programs and use procedures, training, and processes that are based on validated preparedness strategies and then tested against validated performance measures.

In addition to the Pandemic and All-Hazards Preparedness Act of December 2006, the value of measurement in this area should be self-evident to those in health care and public health. After all, it remains difficult to plan, let alone improve, what one does not measure and for which there is no specific goal or target to be achieved. To best manage our vital yet limited resources, we must analyze our health care institutions' emergency management activities in as rigorous and objective a way as possible. The difficulty is the difference in procedures, measures, and acceptable levels of performance and competency under emergency management conditions versus the normal everyday operations of a hospital or public health department. Because emergency management performance measurements do not exist, one needs to extrapolate from more routine health care quality principles and performance measures and adopt creative approaches to creating such measures for mass casualty events.

To assess health care emergency preparedness for disasters, terrorism, and public health emergencies and to determine performance measures for public health organizations and health care institutions, both entities must prepare for rarely occurring events while simultaneously attempting to mitigate the likelihood that they will occur at all. Because of the relatively infrequent nature of major disasters, terrorist, and public health emergencies, public health and health care organizations remain ill equipped to systematically evaluate the strengths and weaknesses of their emergency management programs. Health care institutions have always been expected to provide emergency care regardless of the volume and demand. Recent experience indicates that the emergency department (ED) is viewed by the general public as a preferred site for acute care during mass casualty events, regardless of perceived capacity limitations. Recent events demonstrate that the ED becomes a community refuge for the worried well and a source of nursing care, power, nutrition, and medical supplies for those with chronic illness and technology-dependent patients. During the terrorist attacks of September 11, 2001 and the Northeast blackout of 2003, the public flocked to hospitals even when they did not require medical care. During Hurricanes Katrina and Rita (and many other large-scale storms that have occurred in recent years), hospitals were expected to manage through the event and provide care to large volumes of ill and injured patients, as well as the worried well. Emergency departments throughout the United States experienced record patient volumes during May and June 2009 due to the novel H1N1 virus. Finally, the reality that our health care infrastructure could be a potential terrorist target has forced institutions to divert attention and precious resources away from the health care considerations of emergency preparedness to issues of facility security and personnel safety.

In addition to the general discussion of the needs for hospital and public health emergency management performance measures, one must also consider the needs of special populations, in particular children of all ages, when developing these

emergency preparedness performance measures. When considering pediatric needs, one must consider children who are at home, in school and child care, or in transit, as well as children who cannot be reunited with their families. Attention must also be given to children with special health care needs who are particularly vulnerable, especially if their survival relies on specific medical technology. Children are uniquely vulnerable to disasters, terrorism, and public health emergencies because of anatomic, physiologic, and clinical factors as well as developmental and psychological concerns. Although children may respond more rapidly to therapeutic intervention, they are more susceptible to various agents and conditions and are more likely to deteriorate if not carefully monitored.[2] These general principles and an understanding of the unique vulnerabilities and needs of children are essential when evaluating emergency management performance measures for the general (adult) population to assure the presence of measures that are appropriate and specific for children. There could be a multitude of examples of how emergency management performance measures need to be specific to children, but a few examples include the following:

- Proportion of patients affected
- Differences in effects of the event
- Types of resources needed for children
- Impact on performance when children are cared for by adult providers in adult units with adult equipment.

Traditionally, planners have thought that children would be exposed to the effects of disasters, terrorism, and public health emergencies in proportion to their percentage within the population with postevent volumes consistent with normal numbers seen by a hospital. However, natural disasters, such as a weather emergency (ie, tornado and hurricane), may affect pediatric victims out of proportion to their percentage in the population. Reasons for this disproportionate impact include fewer defenses to trauma caused by the event or increased susceptibility to ongoing effects of a disaster. When exposed to equivalent traumatic forces, children with smaller frames and less skeletal protection will often experience greater organ injury than adults do. In addition, although all members of the population may be similarly affected during the actual hurricane, during the subsequent days, children are at greater risk for harm from a lack of supervised activity in a safe environment. Events such as school closures may increase further risk of injury due to hazards in the local environment. This phenomenon has been demonstrated in studies of injury rates in children after natural disasters.

With respect to terrorism, we have, in the past, perceived children to be secondary victims, a consequence of an attack targeted to a facility, institution, or the general population. Recent events suggest that children may indeed be the intended victims, targeted in an effort to cause maximal terror. Recent evidence has shown that targeting children is not just a possibility but an occurrence of high probability, with many accessible targets. The seizure of a school in Beslan, Russia, in 2004 and the subsequent massacre of 186 children is a chilling reminder of this reality. Lastly, with respect to public health emergencies, there are certain events that could cause increased numbers of children as victims. With the recent H1N1 virus pandemic, children have been disproportionately affected compared with adults (and even the older population).

There are developmental, anatomic, and physiologic reasons why children may be disproportionately affected in a terror-related event. As children become dehydrated easily and possess minimal reserve, they are at greater risk than adults when exposed to agents that may cause diarrhea or vomiting. Children also have a unique respiratory physiology. Many of the agents used for chemical and biological attacks are aerosolized (eg, sarin, chlorine, or anthrax). Because children have faster respiratory rates than adults, they are exposed to relatively greater dosages and will suffer the effects of these agents much more rapidly than adults. Children will also potentially absorb more of the substance before it is cleared or diffuses from the respiratory tissues. Many chemical agents, including certain gases such as sarin and chlorine, have a high vapor density and are heavier than air, which means that they "settle" close to the ground, in the air space used by children for breathing. Many biological and chemical agents are absorbed through the skin. Because children have more surface area relative to body mass than adults and because young children, especially those younger than 6 months, have more permeable skin, they receive proportionally higher doses of agents that either affect the skin or are absorbed through it. In addition, because the skin of children is poorly keratinized, vesicants and corrosives result in greater injury to children.

Although children may be seen in larger than expected proportions in a mass casualty event and may also be affected differently than adults, it is also important to recognize that children frequently need unique resources. As such, the presence of

these resources and competency in their use would have to be included in emergency management performance measures. Examples can be as simple as the availability of medicines in preparations that can be administered to children, and, for medications that do not come in such formulations (eg, liquids), knowledge of how to convert these to pediatric acceptable forms, and the presence of competent personnel. Another important example is the presence of pediatric-specific medical devices, such as intraosseous needles and vascular catheters (and other equipment) in sizes appropriate for children of all ages. There may also be related resource needs such as pediatric-specific nutrition (ie, formula and baby food), child safe environments for minor injured children or children accompanying injured and ill adults, and providers for supervision of children not requiring medical care but without a guardian. Lastly, unique systems may be needed such as those for identification, tracking, and timely reunification of unaccompanied children with their families.

Finally, when addressing pediatric performance measures, one must account for changes in performance across all domains when due to a surge of pediatric victims, we are forced to care for children in adult-patient–oriented facilities, with adult equipment and by providers who are not trained in pediatrics. This scenario will likely affect performance, and perhaps outcomes, because of to the poor efficacy of adult-patient–designed equipment and supplies and the lack of experience and lower competency level of the health care providers in this role. Modification of equipment for the use in patient age groups and/or sizes for which it was not designed may be possible, but this will inevitably affect performance. One must account for all these modifications when addressing pediatric-specific emergency management performance measures.

At the core of designing performance measures is the goal to improve care. In emergency management situations, there may be an additional goal, to increase the capacity one can handle. In 1999, the Institute of Medicine's seminal report, “To Err is Human: Building a Safer Health System,” outlined a comprehensive strategy “by which government, health care providers, industry, and consumers could improve overall health care quality by noting that poor quality is caused by faulty systems, processes, and conditions that lead people to make mistakes or fail to prevent them.”[3] The approaches discussed in this and other reports on improving health care performance and patient safety include the development of specific performance measures that allow benchmarking and validation of measures to reach these performance measures. Despite the significant growth in the use of performance measures as a strategy to assess and improve quality in health care institutions and in the public health arena, no similar strategy seems to exist for these same organizations relating to assessing and/or improving emergency preparedness capabilities.

There is not a complete absence of emergency management metrics, but those that exist are often limited and nonvalidated and, in most cases, do not address the unique needs of children. Existing metrics such as the Health Resources and Services Administration's critical benchmarks and sentinel indicators for its Bioterrorism Hospital Preparedness Program have not been fully validated and are not evidence based.[4] The recent focus of The Joint Commission on revamping its emergency management standards and moving them to a unique section from their previous location as part of the standards related to environment of care provides hospitals motivation to strengthen their emergency management performance measures; however, there is a lack of specific guidance.[5] In addition to the efforts of Health Resources and Services Administration through their funding program, the Centers for Disease Control and Prevention has developed 23 performance measures related to its cooperative agreement with public health departments and supplemental pandemic influenza guidance. Although helpful, these are not validated and, in many cases, not even tested performance measures. Therefore, more emphasis on standardizing best practices and measures that relate to health care emergency management performance measures is required.

Investigators studying the effects of preparedness efforts have noted that, “the lack of well-accepted, standardized measures and metrics makes it difficult to satisfy the demands for accountability, or gauge the level of preparedness.”[6] Even more troubling is that years after 9/11, Hurricane Katrina, and the early concerns regarding an influenza pandemic, there are still few defined performance standards for state and local emergency public health preparedness programs. In addition to this deficiency, investigations with regard to health care institutions' lack of emergency management performance measures echo these ideas, pointing out that, “A major problem affecting the outcome of disaster health care is the lack of internationally accepted standards of performance for disaster health management and response.”[7] Most striking is an

article by Nelson et al,[8] who argue that, "the situation is not because of a shortage of measures of preparedness, given that numerous entities have crafted definitions of preparedness, but that the only consistency across them is inconsistency." Lastly, to assure that the unique needs of children are met in all-hazard emergency preparedness, one must have validated and consistent pediatric-appropriate and specific public health and health care emergency management performance measures. This is necessary to demonstrate convincingly the lack of pediatric preparedness and then to document the benefits of interventions and programs designed to improve pediatric emergency preparedness.

METHODS OF DETERMINING PEDIATRIC EMERGENCY PREPAREDNESS PERFORMANCE MEASURES

When one discusses performance measures, it is important to remember that these are metrics we use to improve the quality of care. With regard to emergency management, performance measures are used to increase capacity and efficiency. A classic approach to health care performance measures is to discuss them with regard to the domains of structure, process, and outcome.[9] Recently, in addition to these domains, volume has also become an important predictor of clinical outcomes. Although we believe that these domains can be applied to emergency management functions and the development of performance measures for disasters, there are some fundamental differences when compared with their use in development and categorization of traditional health care metrics.

Volume Measures

When one uses volume as a metric, it is based on the principle that increased frequency of a task or procedure improves quality. If one were not to believe this to be true, then volume could not serve as a metric. The current commonly held belief is that volume cannot be the only measure of quality because it is possible to have high volume without good quality. Most experts believe that a hospital that never handles children will likely perform poorly if suddenly tasked to care for a severely ill or injured child. In addition, if an institution regularly provides care for just a handful of children, one might also predict that such a facility would be challenged if tasked to treat a large number of sick or injured children in a disaster. Conversely, simply because a hospital regularly treats a large volume of children does not mean that the performance is good, or that they are prepared to treat significantly larger numbers of sick and injured children in a disaster. However, we do presume that these larger volume hospitals will be more likely to perform better in a pediatric mass casualty event than a hospital that treats children rarely. As such, volume is one metric that is often used for emergency preparedness.

Volume is a performance metric that has been used previously in health care; an example would be procedural areas such as surgery or procedure credentialing. The challenge with this metric is that, fortunately, in hospital emergency management, the number of actual events is extremely low, and this diminishes the value of volume of disaster events handled as a significant performance metric. However, this does not preclude using other volume metrics. Some have used the frequency of staff training, drills, and exercises as reasonable proxies, but even when conducted often, annual volumes rarely exceed single digits.

Despite the difficulty of using either true disaster experiences or drills as the volume metric, there may be surrogate metrics that hospitals can analyze (eg, pediatric visits, pediatric beds and/or pediatric critical care beds, ED visits for major trauma, patients brought in via ambulance, and pediatric staff). When evaluating these proxy metrics on an institutional basis, low pediatric volume may not be correctable. For instance, how does an institution increase its volume of ambulance visits or care for pediatric patients without changing its operational paradigm or referral patterns? In addition to pediatric exposure, how does a hospital increase the numbers of major trauma patients without trauma center designation? Moreover, how does one choose threshold values for any volume metric? Traditional health care volume standards are usually empiric. It is only recently that actual data relating to volume and outcomes have become available in nondisaster health care performance measures.

As has been previously discussed, because the criterion standard for emergency management is performance during a disaster, rigorous data relating nondisaster volume performance proxies to outcomes during disaster does not exist. Nevertheless, it seems reasonable to suggest that facilities without significant volume in areas such as patients arriving via ambulance or trauma cases would not be able to respond to a large-mass casualty incident as well as a trauma center or busy ED might

perform. In addition to trauma center status and large volumes, with regard to pediatric performance, one would need to use routine ED and hospital pediatric volume as a surrogate. In general, one could reasonably assume that routine nondisaster care competency and performance would increase with increased pediatric volumes, and this general level of pediatric performance, although not disaster focused, could be used as a general surrogate for pediatric disaster performance. This might be due to a variety of factors, including increased levels of pediatric experience and competency of clinical staff, or the greater likelihood of stocking pediatric equipment or supplies with larger day-to-day pediatric volumes.

There may be partial solutions. For example, a small, rural hospital ED with very small pediatric volumes could collaborate with a larger hospital or a children's hospital with significant pediatric resources to rotate personnel, thereby increasing the breadth of experience for each, or a facility could simply increase the frequency of staff training in pediatric care and drills involving children. Sites also can examine institutional choke points (eg, which resource categories, such as physicians or nurses, limit expansion of pediatric surge capacity).

In addition to patient volumes across multiple categories, there are other volumes that one could use as a performance metric. Examples of other volumes that can be used as performance measures include the following:

- Hours of training an individual has received in areas of emergency management
- Hours of training in pediatric care and/or pediatric disaster management
- Numbers of staff trained in emergency management
- Numbers of staff trained in pediatrics and/or pediatric disaster management.

In addition, there are certain elements that must be measured as volumes to gauge minimal capacity for emergency preparedness. An extreme example of this principle would be that if a facility had no generators (zero volume), then it could never operate in a power-out emergency. As such, certain volumes of items are essential, but it is also difficult to determine the absolute number needed. One can often determine the volume needed per number of patients, but in the case of pediatric-specific measures, one would still have to project the total numbers of children expected and also alter the numbers if adult equipment, adult providers, or adult units are to be used. The types of items one would measure under this type of volume metric include but are not limited to the following:

- Beds available (this would include subcategories for pediatric beds, critical care beds, etc)
- Numbers of pediatric providers and total number of providers
- Doses of key medications
- Numbers of ventilators and other equipment
- Patient nutrition (eg, formula)
- Numbers of personal protective equipment for staff

Structure Measures

Structure measures in health care quality are binary metrics relating to the presence or absence of specific items. These are often found in regulatory or certification guidelines. Typical items for which there are structural metrics are facilities, plans, and procedures. With the recent emphasis on emergency preparedness, changes in Joint Commission Emergency Management Standards, and various preparedness grants, many binary structural performance metrics have been created for hospitals and public health agencies. In fact, a significant percentage of existing health care emergency management performance metrics are of the structure category (eg, whether a site has a dedicated staff position serving as the emergency management coordinator and whether it has a decontamination facility). Also of note is the fact that although structural metrics are often the most easily addressed, they frequently have little evidence-based rationale for improved emergency management performance. While recognizing this potential limitation, wherever there exists a binary structural emergency management performance metric, the metric should be evaluated to determine whether it addresses pediatric needs and, if not, whether modification or an additional metric is needed for children. A good example might be the question as to whether a facility has a decontamination shower. Although this is an appropriate metric for emergency management with respect to all populations including pediatrics, the additional metrics related to children that would need to be present might include presence of a mixing valve to allow heated water, presence of a regulator to down-regulate water pressure to levels safe for children, and the ability to decontaminate families as a single unit and nonambulatory children. Other examples of a structural metric would be the existence of an emergency management plan and whether disaster

drills have been conducted. For the former metric to best address children, one would add the following: "Does the emergency management plan include pediatric considerations?" and "Were pediatric experts involved with plan development." For the latter metric to address children, one might add the following: "Do all disaster drills include children as victims" and "Has the institution conducted a drill in which all of the victims were children or a drill involving a volume of children out of proportion to normal numbers seen." As is true for the general binary structural metrics, although these do provide a target for emergency management performance, they do not provide an ongoing target to achieve, do not allow precise measurement of performance, are difficult to use for benchmarking purposes with other institutions and agencies, and do not necessarily reflect quality (eg, there may be a disaster plan, but it is a bad plan). Despite these stated limitations, this category of performance measures is still important to assure that certain key structural elements are in place.

Therefore, using only a binary structural metric to assess performance may have limited value. To apply these elements to emergency management performance, a combination of binary and scaled metrics must be developed that encompass the all-hazards approach used in emergency management efforts nationwide. For example, if a site has a decontamination facility (ie, it responds yes to the binary question), scaled metrics (eg, the number of patients it can handle simultaneously, or the number of victims that can be decontaminated during a period of time) can provide additional detail as to the capabilities and capacity of the site. Because validated numeric thresholds or absolute number targets for these scaled metrics do not currently exist, one will have to use creative approaches to develop them. This might include performing a hazard vulnerability analysis to help determine what the performance level should be. For example, if there is a neighboring chemical plant with 100 to 150 workers, one might state that the facility would need the ability to decontaminate 100 to 150 workers in the time it would take to prevent toxic effects from the agents available in that factory. This exercise would help create site-specific scaled metrics but would not necessarily develop scaled metrics that would apply across institutions or regions as hazard risks, and population needs may vary. However, instead of the absolute number threshold being what would be standardized across institutions, one could standardize the methodology used to develop these scaled metrics. As was discussed regarding binary structural metrics, each scaled metric should be evaluated to determine if it addresses pediatric concerns and, if not, whether modification or additional scaled metrics are necessary to address the unique needs of children.

Outcome Measures

Outcome measures are often referred to as the ultimate goal in health care performance metrics. The traditional health care outcome measures that have been used are morbidity and mortality. Recently, outcome measures have been expanded to include additional indicators such as quality of life and functional outcomes. In addition to these other outcome measures, many health care institutions also use interval measures of outcome. An example of an interval measure might be return of spontaneous circulation after cardiac arrest, with neurologic function being the ultimate outcome. Using patient outcomes during disaster situations poses significant challenges including lack of frequency, differences in type and scale of disaster events, effects of intervening factors such as triage, and care provided before arrival to the hospital. In addition, variability of event type and scale make it difficult to compare one event to another and, as such, poses a problem for longitudinal assessments and benchmarking comparison data.

Despite these challenges, we should strive to develop outcome measures for emergency preparedness. Although it may be difficult to compare events based on type and scale, we should still track mortality and morbidity. When considering outcome measures for children, it is important to prospectively establish data elements and collection mechanisms that will assist the analysis of pediatric performance. Most governmental data collection following disasters groups all mortality and morbidity are in one category, for both adults and children. Even if children are segregated, they are often counted as a single population children. Pediatric experts understand that all children are not the same, and to truly analyze pediatric performance one must differentiate, neonates, infants, preschool–aged children, school-aged children, and adolescents. In addition, to allow for benchmarking and comparison of performance across events, which is essential because disaster events are rare, one must also collect event data. The purpose of event data is to allow the conversion of morbidity and mortality data from absolute numbers to rates that would allow longitudinal assessment, event to event comparison, and long-term benchmarking. As an example, if the incident was a mass trauma event caused by an explosion, one would likely want to

know the total number injured and also the total number affected. One could then determine mortality rates per 100 injured patients and mortality rates per 100 victims present in the blast zone. These data would allow comparison against future events to determine if performance had improved, even if the event magnitude was different. Challenges will exist for comparisons across different event types, but morbidity and mortality rates may allow benchmarking of certain outcomes across events, such as mortality of ventilated patients per 100 people exposed. Lastly, one can also define interval outcome measures in emergency preparedness. Such measures might include the following:

- Mortality and morbidity before hospital arrival
- Mortality and morbidity before triage
- Mortality and morbidity in first-week postevent
- Mortality and morbidity by triage category (method to evaluate triage)
- For biologic events or public health emergencies, infectivity rates among exposed and infectivity rates among those not primarily exposed

Process Measures

Process measures are a way of assessing component processes toward a desired outcome goal that pertain to activities for which there is solid evidence indicating that they will improve outcomes (eg, the administration of corticosteroids for those with asthma, antibiotics for pneumonia, and asthma care plans for chromic asthmatics). In emergency preparedness, process measures are those that people most often think they are using. As can be seen from this article, what many may consider performance measures are actually structural measures because they determine the presence or absence of a structure and do evaluate and provide a metric related to a process. Examples of the types of process performance metrics that can be used in emergency preparedness include but are not limited to the following:

- Time to triage
- Numbers of victims triaged per unit time
- ED length of stay and throughput numbers
- ED arrival to operating room time
- Time from arrival to decontamination
- Number of patients receiving prophylaxis
- Time to provide in-time training to critical staff or by functional role
- Numbers of providers receiving in-time training or by functional role.

Although many, if not most, of these process performance measures can be applied toward developing pediatric performance measures, the key is to assure that the children are separately measured. This helps to not only assess the care of children but also determine if there are deficiencies in care related to children. In addition, one can use comparative process measures to determine if different processes or additional resources will be needed for pediatric care. An example would be time for decontamination measures. If one were to see significant differences in pediatric versus adult decontamination, then we would know that we need additional resources and perhaps improved processes for pediatric decontamination to achieve times at least on par with adult decontamination.

Surrogate Measures From Routine Health Care Operations

Although many of the previous sections have described the challenges faced in developing performance measures that would apply purely during a natural disaster, terrorism event, or public health emergency, there are relatively frequent occurrences in hospitals and public health departments that although not true disasters, approach the level of systems disruption, increased patient volume, decision making, and/or resource demand that are seen with catastrophic events, such as the recent H1N1 surge. If hospitals and public health departments would apply emergency management principles to these more routine problems that disrupt normal operations or put significant burdens on the institution or agency, it would have several benefits. It would serve as a rehearsal or quasi-drill of various aspects of an institution's emergency management plan. Second, performance during these events can be used as a surrogate assessment of the institution's emergency management performance. Examples of these opportunities include the following:

- ED peak census periods
- Hospital over census and lack of bed availability
- Periods of critical staffing shortage
- Laboratory or computer downtimes
- Fires and/or other internal emergencies such as floods.

Traditionally, these occurrences are viewed as unusual events but are not placed within an

emergency management approach with activation of incident command, data collection, and evaluation of performance (including after action reports) and are often ignored or aggregated along with routine data. A specific focus on these events is warranted because they may most closely replicate disaster situations and thus could be used as a means for evaluating disaster preparedness.

Another approach to surrogate measures is to modify existing performance measures to disaster situations and assumptions. An example of this approach was described by Kanter et al[10] in a recent publication on developing standards for emergency preparedness. This approach described that "building on interventions for pediatric hospital disaster care was based on the following assumptions: A surge of 500 patients per million population needing hospital inpatient care has been used as a basis for federal disaster planning. Previous analysis in 1 metropolitan area indicated that a surge of 500 children per million usually would exceed existing resources. One strategy to accommodate 500 children per million would involve altering standards of care sufficiently that 4 times the usual number of hospital patients could be served." Then using this assumption of alterations in operation for disaster, they applied this. The Therapeutic Intervention Scoring System is a validated system that describes relative staff time and resource utilization necessary to carry out standard clinical interventions in an intensive care unit. Using this validated tool and modifying it to be consistent with disaster operations, they were able to determine which interventions would not be possible in a disaster and to develop excepted performance measures for these interventions. This is one example of how one can use existing validated hospital performance measures as surrogates for emergency preparedness simply by altering them to the assumptions that would be in place in a disaster, terrorism event, or public health emergency. While providing this one example, this approach could be applied to a multitude of existing validated performance measures.

One has to recognize that performance targets and metric definitions may be different during a disaster as compared with periods of normal operations, but that does not mean they still do not serve as important performance measures. Although at first when we attempt to use these as preparedness metrics, it may not be possible to always establish the ideal absolute values, we can use the best available information to provide a starting point. Then one can use changes in these metrics to assess the hospital longitudinally as a performance metric and one could compare this data with local, regional, and even national peers for benchmarking. For example, although wait times may be lengthened during these periods, they can nonetheless prove useful when sequentially compared or benchmarked against other institutions during the same times of system stress. What is important is that performance standards can be established for both normal and disaster operations to ensure uniformity across institutions, systems, and regions. With regard to pediatric-specific surrogate performance measures, one can use those presented in this section and other typical hospital performance measures so long as children are segregated when the data are collected. In addition, one can use pediatric-specific performance measures but apply them to disaster events that affect hospital systems and operations, with the methodology described above of using best available information to establish baseline and then measuring change over time.

DETERMINING SPECIFIC METRICS AND ABSOLUTE TARGETS

As described above, it is important to use all the metric categories (structure, process, and outcomes) enhanced by the incorporation of volume as an additional metric category, with the inclusion of surrogate measures in the creation of pediatric emergency preparedness performance measures. Even so, key questions remain. First, what would be defined as a disaster, terrorism event, or public health emergency where these measures would be applied? Should we measure from an all-hazards perspective or from a hazard-specific view? These are but a few of the issues that also need to be answered. Central to the ability to effectively use performance measures is the need to specifically and rigorously define each metric. In addition, there exists the need to define specific values for all these metrics (this is generally less of a problem for binary metrics with a yes/no response). Lastly, data sources, indicators of compliance, and inclusion and exclusion criteria must be explicitly delineated as data definitions. In these areas, unique disaster definitions must be developed to ensure applicability across the varied disaster, terrorism, and public health emergencies events that may occur. A key factor for the ability to benchmark across hospitals and agencies and advocate for pediatric preparedness is that the pediatric preparedness community develops consensus on these definitions so that they can be universally applied.

In addition, one often develops the quantitative nature of metrics from previous data or from other

institutions' validated numbers. In the case of emergency preparedness, this is a challenge due to the relative infrequency of events. That said, one can still analyze disaster events that have occurred to at least give initial quantitative values to these developed performance metrics, which in the future can be further refined. In many cases, these quantitative values will be defined by expert opinion and consensus because of the absence of historical data. This should not be a barrier to establishing metrics but rather serve as a starting point. Although not validated, these numbers do provide a target. They also provide a reference to show improvement over time and an opportunity to compare with other facilities. If we were to start with empiric or "best guess" values, we could at least begin to collect data in these metrics over the coming years. These historical data could then serve as the foundation for the development of validated quantitative values for performance metrics.

PRIORITY AREAS FOR PERFORMANCE MEASURES

The priority areas to target for the initial pediatric preparedness performance measures and the methodology by which these pediatric emergency preparedness performance measures are developed can be established. Although not ideal, general emergency preparedness performance measures currently exist. As has been described, many of these are structural and binary in nature (eg, is there a disaster plan, is there a hospital disaster coordinator, is there a decontamination facility). In addition to these structure measures, there do exist certain volume measures, though these are often vague and, in many cases, are empiric without validation (eg, ability to handle a 500-patient surge per million population). At a minimum, there must exist parallel pediatric performance measures for all of these structural and volume performance measures. For the structural performance measure examples noted above, the following pediatric measures would apply: "Does the disaster plan specifically address the unique needs of children?" "Do you have a disaster coordinator with specific knowledge of pediatric emergency preparedness?" and "Does your decontamination equipment address the unique challenges of decontaminating children?" Likewise for the volume measure example noted, one would also ask the following: "Could your organization handle a uniquely pediatric surge of 500 patients per million population?"

After assuring pediatric equivalency in existing emergency preparedness performance measures, one then must move to develop those performance measures that address the unique needs of children and assure that there is both capacity and competency to address the needs of children. Examples of these include the following:

Volume
- Pediatric providers available for emergency preparedness
- Pediatric providers trained in emergency preparedness
- Number of nonpediatric staff trained in pediatric aspects of emergency preparedness

Structure
- Specific numbers of pediatric patients who can be decontaminated
- Specific numbers of pediatric patients who can be treated with existing pharmaceuticals and prophylactic agents
- At least one but preferably more pediatric-specific event drill conducted per year
- All disaster drills include pediatric patients at a minimum in proportion to their numbers in the population served

Outcome
- Pediatric morbidity and mortality segregated by age ranges from mass trauma events
- Pediatric morbidity and mortality segregated by age ranges occurring in the weeks and months after events during the recovery period

Process
- Number of children that the triage providers can triage per hour
- Time for emergency care and either discharge from hospital or admission under disaster conditions

Surrogate
- Application of existing validated pediatric staffing performance measures modified for disaster operation assumptions
- ED time to triage and time to disposition during peak census periods

SUMMARY

Recent disaster events, such as September 11th and Hurricanes Katrina and Rita, combined with current concerns for public health emergencies such as pandemic influenza, have led to a continued focus on emergency preparedness. As has been discussed in this article, to optimally prepare for children and advocate for their needs, pediatric-specific performance measures need to be

recognized and developed. It is also important that performance measures that address the unique needs of children are not just developed but that they are universally accepted to allow for benchmarking. To develop these measures one must use existing validated approaches to developing performance measures by focusing on the domains of volume, structure, process, and outcome. This can then be supplemented through the use of surrogate measures to overcome the problem caused by the infrequency of disaster events and the benefit of adopting existing validated health care performance measures. In the short term, out of necessity, we will need to use existing volume and structural measures that are currently in use in emergency preparedness but assure that they are adapted to contain pediatric-specific components. We then need to develop unique pediatric specific emergency preparedness performance measures that will be based on empiric quantitative measures. This will allow us in the long term to have the data to develop validated pediatric emergency preparedness performance measures that are based on collected data.

The approach, quantitative methodology and consensus development process described in the article, when applied, will significantly advance pediatric preparedness. Ultimately, these pediatric-specific measures must exist and be used to assess current levels of performance and guide resource allocation and targeted improvement efforts.

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