

Waterworks, a Full-Scale Chemical Exposure Exercise: Interrogating Pediatric Critical Care Surge Capacity in an Inner-City Tertiary Care Medical Center

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Abbreviations:

ED: emergency department
EMR: electronic medical record
EOC: Emergency Operations Center
HSEEP: Homeland Security Exercise and Evaluation Program
ICU: intensive care unit
KCHC: Kings County Hospital Center
NYIAHP: New York Institute for All Hazards Preparedness
OR: operating room
PACU: post-anesthesia care unit
PED: pediatric emergency department
PICU: pediatric intensive care unit
SICU: surgical intensive care unit

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Abstract

Introduction: Pediatric Intensive Care Unit (PICU) resources are overwhelmed in disaster as the need to accommodate influx of critically-ill children is increased. A full-scale chlorine overexposure exercise was conducted by the New York Institute for All Hazard Preparedness (NYIAHP) to assess the appropriateness of response of Kings County Hospital Center's (KCHC's) PICU surge plan to an influx of critically-ill children. The primary endpoint that was assessed was the ability of the institution to follow the PICU surge plan, while secondary endpoints include the ability to provide appropriate medical management.

Methods: Thirty-six actors/patients (medical students or emergency medicine residents) were educated on presentations and appropriate medical management of patients after a chlorine overexposure, as well as lectures on drill design and expected PICU surge response. Victims presented to the hospital after simulated accidental chlorine overexposure at a public pool. Twenty-two patients with 14 family members needed evaluation; nine of these patients would require PICU admission. Three of nine PICU patients were low-fidelity mannequins. In addition to the 36 actor/patient evaluators, each area had two to four expert evaluators (disaster preparedness experts) to assess appropriateness of global response. Patients were expected to receive standard of care. Appropriateness of medical decisions and treatment was assessed retrospectively with review of electronic medical record.

Results: The initial PICU census was three of seven; two of these patients were transferred to the general ward. Of the nine patients that required Intensive Care Unit (ICU) admission, six actor/patients were admitted to the PICU, one was admitted to the Surgical Intensive Care Unit (SICU), one went to the Operating Room (OR), and one was admitted to a monitored-surge general pediatric bed. The remaining 13 actor/patients were treated and released. Medical, nursing, and respiratory staffing in the PICU and the general ward were increased by two main mechanisms (extension of work hours and in-house recruitment of additional staff). Emergency Department (ED) staffing was artificially increased prior to the drill. With the exception of ocular fluid pH testing in patients with ocular pruritus, all necessary treatments were given; however, an unneeded albuterol treatment was administered to one patient. Chart review showed adequate discharge instructions in four of 13 patients. Nine patients without respiratory complaints in the ED were not instructed to observe for dyspnea. All patients were in the PICU or alternate locations within 90 minutes.

Discussion: The staff was well versed in the major details of KCHC's PICU surge plan, which allowed smooth transition of patient care from the ED to the PICU. The plan provided for a roadmap to achieve adequate medical, nursing, and respiratory therapists. Medical therapy was appropriate in the PICU; however, in the ED, patients with ocular complaints did not receive optimal care. In addition, written discharge instruction and educational material regarding chlorine overexposure to all patients were not consistently provided. The PICU surge plan was immediately accessible through the KCHC intranet; however, not all participants were cognizant of this fact; this decreased the efficiency with which the roadmap was followed. An exaggerated ED staff facilitated evaluation and transfer of patients.

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Conclusion: During disasters, the ability to surge is paramount and each hospital addresses it differently. Hospitals and departments have written surge plans, but there is no literature available which assesses the validity of said plans through a rigorous, structured, simulated disaster drill. This study is the first to assess validity and effectiveness of a hospital's PICU surge plan. Overall, the KCHC PICU surge plan was effective; however, several deficiencies (mainly in communication and patient education in the ED) were identified, and this will improve future response.

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Introduction

In a mass-casualty event, the number of pediatric victims could easily overwhelm existing pediatric intensive care resources. Every hospital must have surge capabilities to address an influx of critically-ill pediatric victims during a mass-casualty event. In the greater New York City area (the five boroughs), there are 239 registered pediatric intensive care beds, with 44 beds located in the borough of Brooklyn.¹ According to the 2010 Census, children under the age of 18 represent over 20% of the population in the United States. Approximately 24.7% (approximately 618,660) of Brooklyn's population is younger than the age of 18, which makes the number of available Pediatric Intensive Care Unit (PICU) beds in the borough less than 7.1 beds per 100,000 children.² Hospitals are required by the Joint Commission to have disaster plans and to test these plans routinely.³ However, only a minority of hospitals have developed pediatric critical care surge plans.

The New York Institute for All Hazards Preparedness (NYIAHP) conducted a full-scale disaster drill titled "Waterworks." The primary goal of the exercise was to interrogate the Kings County Hospital Center's (KCHC's) PICU surge plan, which was developed in conjunction with the Pediatric Disaster Coalition, a member of New York City Department of Health. The two primary objectives were to evaluate the effectiveness of the institution's surge response to a sudden influx of critically-ill pediatric patients and to evaluate their medical management.

Methods

Study Design

This was a prospective, single-center, simulated disaster drill that was based on Homeland Security Exercise and Evaluation Program (HSEEP) terms for a full-scale exercise. The NYIAHP designed the exercise to assess the management of pediatric patients presenting to an emergency department (ED) after a chemical exposure, with a primary focus on PICU surge capacity. Prior to the initiation of the exercise, a working group was tasked with creating 30 simulated patients, nine of whom would require eventual PICU management. After the creation of simulated patients, another group of senior medical professionals (ED physicians, intensive care unit (ICU) attendants, and pulmonologists) were tasked with creating a list of appropriate medical interventions required to manage the patients. This checklist was given to the participants and evaluators, and was cross-checked to assess for completeness. In addition, all order sets were reviewed retrospectively.

Study Setting

The simulation took place at KCHC, an urban, tertiary care, level 1 trauma center. The Center is a 626-bed academic teaching hospital that receives approximately 160,000 adult and pediatric

ED visits annually, of which approximately 32,000 are children. The ED is divided into an adult area and a separate pediatric area. The adult ED has 57 beds, and the Pediatric Emergency Department (PED) has 13 beds, with a separate area designed to treat eight asthma patients. The in-patient pediatric ward has 40 beds and the PICU has seven beds with two isolation rooms, all capable of handling patients who are ventilated. There are four beds that provide continuous monitoring on the general pediatric ward. These monitored beds can handle four ventilated patients, and represent the excess surge capacity of the PICU.

Study Protocol

The scenario involved a chlorine overexposure at a public swimming pool with 80 children and 50 adult patrons on a Wednesday morning in July 2011. Children began experiencing symptoms at 6:10 AM. The chlorine level at 7:10 AM was four times the normal limit. Emergency Medical Services arrived at the event site, and decontamination ensued. Twenty-two patients required transport to KCHC for further medical treatment. The chief complaints included respiratory complaints, ocular complaints, and traumatic injuries.⁴⁻⁹ Nine of 22 patients required intensive care placement.

Actors/Victims

Actors were medical students or emergency medicine residents. They played the roles of 19 pediatric patients and 14 family members. They were trained on chemical exposures, the drill outline, and the role of evaluators 24 hours before the initiation of the drill. The actors were given a patient profile card to carry during the drill, which included their chief complaint, physical exam findings with expected medical interventions, and final disposition. The NYIAHP also used three low-fidelity simulation mannequins as patients.

Hospital Staffing

The staffing for the hospital was typical for a Wednesday morning in early summer, except for the two Emergency Medicine attendings and 10 Emergency Medicine residents brought in the day of the drill to treat the simulated patients in the ED and the PED. The intent of the study was primarily to investigate the PICU surge plan and not the ED. As such, the authors did not believe the increased staffing would affect the results. Importance was also placed on sufficient staffing, including clerks, nurses, physicians, respiratory therapists, transporters and Emergency Operations Center (EOC) staff following the Incident Command Structure.

Expectations

It was expected that patients would be provided standard treatment for chlorine overexposure and other simulated medical problems.

For respiratory symptoms, this included treatment with albuterol and corticosteroids, and with tracheal intubation in cases of severe distress. For ocular complaints, patients should receive pH testing and ocular irrigation. Trauma was to be managed per usual hospital protocols. Furthermore, physicians were to communicate the risks of chlorine overexposure as well as any treatments given to patients and their guardians. Each patient needed to have an appropriate disposition based on a final diagnosis, which was predetermined by the drill designers. The PICU was expected to increase staffing and bed availability. It was expected that the above be completed in a timely fashion. All treatments, orders, discharge instructions, and time-based criteria (eg, time to admission, time to discharge, initiation of medical therapy, and medical and surgical consults) were objectively assessed by retrospectively interrogating KCHC emergency medical records (EMRs).

The surge plan for the PICU is a tiered response, activated in stages as justified by acuity of disaster. An outline of the plan is available as supplementary material online. Briefly, in the event the KCHC PICU is required to increase its census, the PICU attending, as the PICU Incident Commander, will activate the surge plan. The hospital EOC will also be activated. The PICU attending will inventory all admitted and potential PICU patients, and rank each according to acuity and likely resource utilization. The patients who have the lowest acuity, and will likely require the least resource utilization, will be admitted to the surge space located on the general pediatric ward. This space has four monitored beds located contiguously in two rooms, and is capable of handling ventilated patients. Once the surge space is utilized for PICU patients, one PICU nurse and a junior resident will be assigned to the surge space. The surge space, as well as the PICU, will be under the medical direction of the PICU attending. In addition, all medical and nursing staff will be instructed to work 12-hour shifts for surge response.

Evaluations

The effectiveness of the institution's surge response and medical management were assessed subjectively and objectively. Prior to initiation of the exercise, evaluators were instructed as to what the optimal response of the institution to a mass-casualty event would be. In addition, they received a written copy of the KCHC surge plan. At the end of the exercise, all evaluators were interviewed and asked to rate subjectively how closely the entire institution followed the response. To objectively assess how each department responded to the surge plan, each evaluator was given a set of actionable items that needed to be completed by each department. Because appropriate medical management was the ultimate endpoint, objective criteria were used to assess outcome. In the PICU and the general in-patient ward, admission and discharge of patient, as well as timely transfer of patients to monitored beds for the general in-patient, was investigated. In addition, by using EMRs, the appropriateness of medical management was assessed. Proper augmentation of staff was monitored. Secondary measures included investigation of non-medical resource utilization, such as equipment, patient tracking, and communication with patients and their families. Kings County Hospital Center had changed over to EMRs in the year 2000, but EMR has not been validated during disasters. As such, the authors sought specifically to look at the EMR efficiency during disasters. Lastly, with all simulated disaster events, the effectiveness of the hospital EOC was assessed.

Each zone (Triage, ED, PED and PICU, and EOC) had two to four evaluators monitoring the area, and each evaluator

completed a specific evaluation form for that zone. Each form was designed to assess the appropriateness of response for a particular area. In the in-patient arena (PICU and in-patient general ward) all 19 actor patients, 14 actor family members, and three simulation teams also completed evaluations of their care and treatment. All patient participants were educated on clinical manifestation of chlorine overexposure prior to the exercise, and expected subsequent management. In addition, all participants also received more detailed instructions on their particular case scenario. For example, for the child that would eventually require tracheal intubation, the simulation team was given an inventory of all the appropriate steps that were required to be performed prior to intubation. These instructions were given on the day prior to the exercise.

As for the evaluators, they were selected from various agencies typically involved when disasters occur (eg, the Fire Department of New York, the Department of Health of New York City, the Pediatric Disaster Coalition (PDC), Emergency Medical Services, and Cohen's Children's Hospital). The evaluator from the PDC was an intensivist who specializes in disaster management and systems, and is one of the founding members of the PDC. The evaluators involved in mannequin simulation were all mature ED attendings who take care of children. The group from the Fire Department of New York and the Department of Health assessed functioning of the EOC. They have participated in evaluations during previous exercises.

A copy of the evaluation is provided as supplementary material online.

Data Analysis

Data from the evaluation forms were reviewed, and discrepancies were resolved through subsequent discussion with evaluators and participants as well as a review of video record. Review of the EMR also was performed. The members of the drill design team determined jointly whether the above criteria were appropriately met.

Results

Staffing

At the start of the drill, the PICU was staffed by three nurses. The staffing was increased by three additional nurses in response to the drill. In addition to the two regularly-assigned respiratory therapists for the pediatric and neonatal units, an additional therapist was "floated" in response to the exercise. The PICU was covered by one senior resident and two junior residents. The post-call junior resident who was scheduled to be off-duty at 8:00 AM was requested to stay, as an actual disaster would have negated any 405 state or federal regulations (regulations on duty hours). A junior pediatric floor resident was reassigned to staff the monitored beds on the general inpatient area. The chief pediatric resident assisted with some patients. There are three Pediatric Attending Intensivists employed by KCHC. One attending intensivist was deployed to the PED to facilitate critically ill patient care and transfer to the PICU. This was not part of the surge response. One attending intensivist was a trusted agent for the drill, and was designated to handle any real-world patient care problems that may have arisen during the drill. The third attending intensivist cared for the PICU patients, both actual and drill.

Supplies/Space

Necessary and appropriate pediatric-sized supplies were available throughout the ED, PED and PICU. The only exception was

Expected Intervention	Expected to Receive Intervention n	Expected to Receive Intervention and Received Intervention n (%)
Albuterol	11	11 (100%)
Steroids	11	11 (100%)
Intubation	3	3 (100%)
Ocular pH testing	0	5 (0%)
Ocular irrigation	5	5 (100%)
Explanation of effects of chlorine	22	4 (18%)
Explanation of treatments	22	15 (68%)

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Table 1. Compliance with Medical Intervention

that gurney restocking in the ED triage area was delayed. The PICU was able to make sufficient beds available by utilizing surge space according to the surge plan. The PICU first transferred existing, stable floor patients to the general pediatric ward. Second, four monitored beds on the general pediatric ward were placed under the purview of the PICU. A ward junior resident, the PICU intensivist, and a PICU certified nurse took responsibility for the patients on the monitored beds.

Interventions

Appropriateness—For patients with respiratory complaints, all (11/11) were appropriately treated with albuterol and steroids and all (three of three) requiring mechanical ventilation were intubated. Patients with ocular complaints (five of five) received irrigation; however, the ocular pH was not checked on any of the patients. The physicians caring for patients with ocular complaints requested litmus paper, but there was a delay and it did not arrive in the PED before the termination of the drill. All five patients received an ophthalmology consult. All key treatments for other conditions, such as pain control in vaso-occlusive crisis, depakote loading for traumatic seizure, and splinting of lower extremity fracture, were performed. One patient without a respiratory complaint was given an unnecessary albuterol treatment. Appropriateness of treatment was measured both in the ED and the PICU. In the PICU, the EMR was used to assess appropriateness of treatment in all patients except one, whose paper chart was examined. Table 1 summarizes the appropriateness of medical intervention.

Timeliness—All interventions were timely. Specifically, the first albuterol treatment was given in <25 minutes; steroids were given in <45 minutes; intubation was performed in <15 minutes; and ocular irrigation was initiated in <30 minutes for all patients requiring these treatments. One patient with wheeze was discharged before appropriate reassessment (17 minutes after the second Albuterol treatment).

Patient Education—Of the 22 patients, 15 were given an explanation of treatments received (explanations were given either to them or to their parents), but only four received an explanation of the effects of chlorine overexposure. All 13 discharged

patients received discharge instructions specific to their presenting complaints. Nine patients who did not complain of respiratory symptoms did not receive information regarding the possibility of delayed respiratory symptoms for which they were at risk.

Specialty Service Consultations—All five patients with ophthalmologic complaints received an ophthalmology consult within one hour of their arrival at the ED. Neurosurgery was consulted for an intracranial bleed and arrived within 10 minutes. Hematology was consulted for the patient with the vaso-occlusive crisis. Obstetrics/gynecology was consulted for the 13-year-old pregnant female but did not respond. Social work was consulted for the 13-year-old unaccompanied minor.

Disposition/PICU Surge—At the initiation of the drill, three of seven PICU beds were filled by real-world patients. Nine of the simulation patients required ICU placement. The ED physicians decided to send two of the simulated patients to alternative intensive care settings. A 16-year-old male with an intracranial bleed went to the surgical ICU and a 17-year-old female with angioedema went to the post-anesthesia care unit (PACU) with an ultimate disposition to the medical ICU. The PICU prepared for a surge response according to KCHC's Emergency Operations Plan. They transferred two of the preexisting patients to the general pediatric ward and overflowed a 17-year-old patient actor with wheezing to a monitored floor bed. The remaining six actor patients were admitted to the PICU. The staff further discussed what they would use for additional surge space, specifically noting the PACU. The PICU Director and a senior PICU resident came to the ED to facilitate the admission process from the PED to the PICU. All ICU patients were either in the PICU or leaving the ED for an alternative ICU in <90 minutes.

Electronic Medical Record—The proprietary EMR for KCHC is the Quadramed System. It was used for patient documentation during the drill. This was the first time an EMR was used during a drill at KCHC. Upon review, it was found that providers were able to register all patients and record medications, laboratory and imaging orders in the ED, as well as record admission orders in the PICU. These orders

were not documented as completed for the purposes of the drill. There was some delay during initial registration of drill patients in the ED because the EOC previously had instructed staff to go with a paper system in the time of mass casualty or disaster.

Communication—Various means of communication were available during the drill, including landline phones, hospital supplied cellular phones, KCHC owned Nextel phones, walkie-talkies, and overhead announcements, all of which were used. The study was not designed to assess the superiority of one modality versus another; however, evaluators' comments suggest that because there were several options for communication, interpersonal communication was facilitated. Several evaluators commented that hospital administration needed to more effectively communicate with the greater hospital community so all individuals would be cognizant of the disaster and its ramification to patients and staff.

Command and Control between Clinical Care Providers and EOC Staff—While evaluators agreed there were individuals who took charge in each zone within the ED and PED in the first 10 minutes, there was no agreement on who took charge, since numerous individuals were shouting instructions but no single individual commanded the scene. This was due to poor utilization of the Incident Command System, specifically, the use of identification vests. The vests in the ED were distributed after 20 minutes. Emergency department staff further noted that prior to patients' arrival, there was not sufficient debriefing of the nature of the incident or incident action planning. In the PICU, vests were not used and there was again lack of agreement from evaluators about who was in charge. The PICU did not conduct an Incident Planning meeting or devise a written plan of response. In the EOC, the Incident Commander was not identified formally, but it was noted that all seemed to know who was in charge and there were name tags at the desks. There was no incident planning meeting or written plan in the EOC.

Command and Control between EOC and Patient Care Zones—The EOC continually communicated with hospital departments. Emergency Operations Center personnel requested regular updates from the ED; however, the updates were not always accurate and timely. The EOC communicated with other departments to assess the availability of additional nurses and space to accommodate the surge of pediatric patients. The EOC discussed emotional counseling for patients and their families. Dietary needs were reviewed, and entertainment for the pediatric patients in the ED was discussed. Communication from the EOC to the PICU regarding admissions was delayed, with the initial notification for three admissions occurring after patients were already in the PICU. The PICU frequently updated the EOC with the unit's status.

Command and Control to Outside Agencies—Various outside agencies were contacted. The ED called New York City Poison Control, although not until an hour after the start of the drill. Emergency Operations Center personnel called two nearby hospitals for bed availability and supplies, including patient

monitors. They also called nearby churches for clothing. Neither the Fire Department of New York/Emergency Medical Services nor the New York City Department of Health and Mental Hygiene were called to inquire about the specifics of the chlorine exposure, such as the specific level of chlorine at the site where the event happened.

Discussion

PICU/Surge

The primary objective of this drill was to test the newly-developed KCHC PICU surge plan. Overall, the plan was successful and the authors believe there were multiple factors responsible for this. Throughout the drill, it was evident that the staff was well informed about the plan, and followed it appropriately. The EOP, and specifically the KCHC PICU surge plan, were able to provide efficient guidelines to adequately increase staffing, including nursing, respiratory therapists, and other ancillary staff, for the PICU. Patients who were able to be "downgraded" with respect to acuity were transferred to the general ward quickly. Additionally, when the disaster drill was initiated, one of the attending intensivists went to the PED. This facilitated the admission process for all patients. This was not part of the initial plan, but facilitated transfer of patient care. The intensivists and ED attendants further discussed additional possibilities for overflow, which would have proved important if additional patients had presented to KCHC in need of intensive care. Ultimately, the PICU, ED, and KCHC EOC were able to provide appropriate and timely dispositions for all patients. Nine patients who required PICU/ICU admission were admitted to higher level of care within 90 minutes of presentation. This is likely due to the increase in resident and attending staff in the ED. In real-world events, this extremely generous ED staffing would not likely occur instantaneously. In an actual disaster, the admission process would be delayed; however, when patients were admitted to the PICU, the time from order entry to "pick-up" by nursing staff was appropriate. Although many participants admitted that they were familiar with the plan, most were not able to easily access it on the intranet. Fortunately, the Head Nurse had a paper copy. It would have been beneficial if the EOC, through the information technology department, had the disaster plan of each unit and the hospital displayed on the intranet. Additionally, phone communication between EOC and PICU attendants was often delayed and was not real time. Efficient communication would have helped with the transfer and care of patients. Lastly, it would have benefited all areas to have just-in-time training regarding management and adverse outcomes in chlorine overexposure.

Interventions

Except for pH testing of the ocular fluid in patients with ocular complaints, all other necessary treatments were given in a timely fashion. The accelerated treatment and discharge of the patient with asthma was likely an artificiality of the drill. Though an unneeded albuterol treatment was given to one patient, this was unlikely to cause any harm. Patient education was somewhat lacking in explanation of treatments and significantly lacking in the explanation of the effects of chlorine overexposure. This may have been due to a focus on the desire to quickly process the drill patients, a lack of knowledge of the effects of chlorine, or artificialities of the drill. Most importantly, for patients who did not have respiratory symptoms, the discharge instructions did not

Successes of Exercise	Room For Improvement
Effective treatment of critically-ill children in ED	Discharge instructions in the ED were not always adequate
Effective transfer of critically-ill children from ED to PICU	Ocular medical management was suboptimal
Effective transfer of children from PICU to General Ward	Communications between EOC and PICU and between EOC and ED were not always timely
Efficient response from consult service	Identification of Incident Commanders in the PICU and ED were delayed
Adherence to PICU surge plan	Lack of efficient access of PICU Surge Plan by all employees
Medical management of patients in PICU and alternate care sites	EMR not consistently used between ED and PICU
Effective increase in PICU Attending, Resident, Nurse, and Ancillary staffing	EOC did not effectively communicate with Greater Hospital Community

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Table 2. Effectiveness of Exercise

Abbreviations: ED, Emergency Department; EMR, emergency medical record; EOC, emergency operations center; PICU, pediatric intensive care unit.

mention the possibility of delayed respiratory symptoms or instruct patients to return for respiratory complaints. This could lead to a delay in seeking care and to a poor outcome. Utilization of prewritten discharge instructions may have been helpful. In the ED, PED, PICU, and EOC, there was no clear incident action meeting or incident action plan. Further, neither the guidelines for treatment of chlorine, nor information on the specifics of the exposure were obtained until an hour into the drill. This is likely the cause of many drill players feeling uninformed and unclear about the specific treatments and plan. Had a well-informed incident action plan been developed and discussed, treatments and discharge instructions may have been more thorough to include ocular pH testing and instructions to return for delayed respiratory symptoms.

Limitations

There were several limitations to this study. The simulated patient participants received two separate educational instructions on chlorine overexposure and their individual patient scenarios; however, none were tested post instruction to quantify degree of retention. This was also true for the evaluators, although this likely did not affect their evaluations, as a majority of participants had been evaluators in previous disaster scenarios. In addition, most were assigned to areas where they were experts. For example, the evaluators from the PDC were assigned to evaluate the PICU, while members from NYIAHP were assigned to the EOC, as they had evaluated them previously. This probably contributed to some minor variance in response, but likely did not contribute substantially to results as no one evaluator was given superiority and discrepancies were cleared after post-study interviews. Lastly, the ED was staffed much more abundantly than would have been expected for time of day and work day. This was done intentionally to assure that existing patients would receive optimal care. This may have biased flow, but as the primary goal was to assess PICU surge capacity, the authors allowed for this artificiality. Ideally, this scenario would have been conducted with normal staffing; however, patient safety was the first priority. Table 2 summarizes the overall effectiveness of the exercise.

Conclusion

Ultimately, the KCHC PICU surge plan was successful in adequately accepting critical care patients to the PICU in a timely manner during this mass-casualty drill. Patients were admitted to the PICU from the ED efficiently in <90 minutes, and transfer of the more stable existing patients in the PICU occurred in a timely manner. Save one, all orders sent were entered into the EMR and picked up by nursing staff. In the one instance where orders were not placed into the EMR, the resident staff placed them on the paper chart. Of the nine simulated patients who required ICU admission, six were admitted to the PICU while the remainder were admitted to other areas of the hospital. One of the nine patients was admitted directly to the surge unit located on the general ward, while the other two patients were admitted to alternate ICU care settings in the hospital. A few deficiencies in the departmental surge plan were identified. Although the administrators were efficient in accessing the plan, it was not clear whether the nurses, residents, and respiratory and attending staff were able to reference the plan. The hospital and departmental plans should be easily accessible to all health care providers and team members, especially when a disaster is in progress. As large-scale disasters are infrequent phenomena, it is impossible to be expert on all presentations and management; however, it is not unreasonable for a few members of the health care team (both in-patient and ED) to become proficient with regards to management of rare phenomena. These individuals can become hospital-wide resources and aid in management issues in various arenas. In addition, prepared educational documents may be helpful for thorough patient education, particularly in less common presentations, such as chlorine overexposure. Further studies of actual events will provide additional knowledge regarding the critical care planning needs for pediatric mass-casualty incidents. Additional areas for research may lead to development of acceptable suboptimal care plans which will be needed in serious mass-casualty events.

Supplementary material

To view supplementary material for this article, please visit <http://dx.doi.org/10.1017/S1049023X13009096>

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