

AMERICAN JOURNAL OF

DISASTER MEDICINE™

Clinical Research and Practical Application of Mass Casualty Medicine

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Clinical Research and Practical Application of Mass Casualty Medicine

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Results of in-hospital triage in 17 mass casualty trainings: Underestimation of life-threatening injuries and need for re-triage

Christian Kleber, MD; Detlef Cwojdzinski; Markus Strehl; Stefan Poloczek, MD, MPH; Norbert P. Haas, MD

Abstract

Background: In-hospital triage is the key factor for successful management of an overwhelming number of patients in lack of treatment capacity. The main goal of in-hospital triage is to identify casualties with life-threatening injuries and to allocate immediate medical aid. For the first time, we evaluate the quality of in-hospital triage in the German capital Berlin.

Methods: In this prospective observational study of 17 unheralded external mass casualty trainings for Berlin disaster hospitals in 2010/2011, we analyzed the in-hospital triage of 601 rouged casualty actors. Evaluation was performed by structured external survey and interview of the casualty actors after the disaster training. In 93 percent ($n = 558$), complete data were available and suitable for statistical analysis.

Results: The primary triage category was allocated correctly to 61 percent ($n = 338$) of the simulated injury severity. The following measurements were performed: anamnesis in 77 percent, physical examination 71 percent, blood pressure in 68 percent, heart rate in 61 percent, and oxygen saturation in 25 percent. Additive radiological diagnostics were used: 38 percent X-ray, 16 percent computer tomography, and 7 percent ultrasound. On an average, 1.6 ± 1.2 diagnostic tools were used to allocate injury severity to rouged casualties. Of all the rouged casualties, 24 percent overtriage and 16 percent undertriage were observed. Overtriage was significantly infrequent in level I trauma centers ($p = 0.03$). Of the patients with life-threatening injuries, 18 percent was undertriaged. Of the 62 percent with secondary right allocation to triage category, re-triage was only used in 4 percent.

Conclusion: The accuracy of in-hospital triage is low (61 percent). Predominately, the problem of overtriage (24 percent) due to insufficient triage training in contrast to undertriage (16 percent) occurs. The diagnostic triage adjuncts, ultrasound and re-triage, should be routinely used to lower the rate of undetected life threat in mass casualty incidents. Furthermore, a standardized training program and triage algorithm for in-hospital triage should be established.

Key words: disaster, triage, overtriage, undertriage, hospital

Introduction

Triage is the key factor for successful management of an overwhelming number of patients in lack of treatment capacity. Historically, the army of Kaiser Maximilian I in the 16th century in Europe used triage to allocate priorities of medical treatment to wounded soldiers. Today, triage is a fix cornerstone in disaster trauma management. Triage allows the optimization of medical aid in mass casualty incidences and prioritized treatment. The practice of in-hospital disaster triage is beyond daily experience and must be educated and trained. Therefore, experienced and specialized physicians, paramedics, or nurses are needed to perform medical treatment in the context of disaster medicine to handle shortage of personal and equipment without endangered patient with life-threatening injuries. Special courses and triage systems like STaRT, SAVE, triage SIEVE, care flight, SALT, MASS, BASIC, mSTaRT, plus/minus, and SORT, help to reproducibly categorize casualties.¹⁻³ What kind of triage

algorithm should be used and in what kind of scenario, location (prehospital/clinic), or type of profession (paramedic, physician, surgeon), is a controversy and almost no evidence is available. To our experience, the most experienced physician should perform in-hospital triage. In Germany and many other countries, no compulsory regulation for the qualification and method of in-hospital triage exists. This fact may contribute to poor triage results even in well-trained countries like Israel.⁴ Triage decisions are mostly taken on skills like experience and gut feeling, not on physiologic parameters or triage algorithms.⁵ According to the literature and our experience, soft skills like clinical expertise, authority, decisiveness, flexibility, and communication are also important for a successful triage. Triage trainings and education has the capability to improve triage results and accuracy in mass casualty incidence.⁶ Furthermore, staff training can significantly reduce the incidence of overtriage with waste of surge capacity.⁶ Frykberg et al. suggested a linear relationship between overtriage and increased mortality rate for patients with life-threatening injuries, which are up to 15 percent of all the casualties.⁷ Especially for patients with life-threatening injuries, triage mistakes like undertriage pose a direct threat to the health of casualties. The secondary death of casualties is the most important quality parameter in disaster evaluation. Due to undertriage and wrong allocation, the mortality rate may increase, that is, if the triage withheld treatment of patients who need immediate medical aid.

Different types of triages have been invented since the 16th century. The physiologic or anatomic triage and the trauma mechanism-orientated triage. The physiologic triage is divided into primary and secondary triage. The primary triage is located in the prehospital setting, whereas the secondary triage is an in-hospital triage. The main aim of the primary triage is to detect life-threatening injuries and allocate transportation priority or immediate medical aid by paramedics or emergency physicians to severely injured casualties.⁸ In many countries, paramedics perform a sweeping triage to pre-select life-threatening injuries and allocate these patients early to primary triage and then medical aid or transportation. The main goal of in-hospital or secondary triage is to identify casualties with life-threatening

injuries to allocate immediate medical aid to these patients, even in situations with lack of treatment capacity. Mostly priorities are allocated according to physiologic conditions and anatomical injury pattern. Beside detection of life-threatened patients (S1), clinical resource management is a corner stone for successful disaster management. The triage has to detect infectious or contaminated casualties to protect the clinic and staff from contamination and keep the institution operational. In contrast to big scientific efforts in prehospital- or field-triage, the in-hospital triage is neglected.

To our knowledge, we present the first systematic analysis of in-hospital disaster triage. We evaluate the quality of in-hospital triage in the German capital Berlin and tried to answer the following questions:

- Is our in-hospital triage effective?
- How often do we misclassify patients in a mass casualty scenario?
- What kind of misclassification is predominant, undertriage or overtriage?
- What kind of triage method and additional diagnostic tools are used?

Material and methods

In this prospective observational study of 17 unheralded external mass casualty trainings for Berlin disaster hospitals in 2010/2011, we analyzed the in-hospital triage of 601 rouged casualty actors.

Infrastructure and disaster plan in Berlin

As German capital, Berlin sustains 3.5 million inhabitants in an urban area of 892 km² (<http://www.berlin.de>). Law in Berlin regulates hospital mass casualty preparedness. Therefore, of the 100 hospitals, 39 hospitals with 24 hours /365 days emergency department services are part of the contingency plan in Berlin. Six hospitals are level 1 trauma centers. Due to the surge capacity of these hospitals, we distinguish between two different categories of disaster hospitals in Berlin:

Category I: Certified level 1 trauma center in the German Trauma Network DGU

Category II: Other hospitals with emergency departments and lower level of care

Of the 601 rouged actors, 76 percent were triaged in category II hospitals, 24 percent were triaged in category I.

The State Ministry of Health in Berlin provides unannounced external mass casualty trainings for all disaster hospitals on a regular basis. According to the emergency plan of Berlin, the disaster hospitals have to prepare for the treatment of 10 percent of their total amount of hospital beds without emergency treatment irrelevant specialties (eg, psychiatry, geriatrics). The distribution of the different injury severities is dependent on the critical care capacity of the individual hospitals. According to our distribution plan, the disaster hospitals will receive patients with life-threatening injuries up to 25 percent of the capacity of their intensive care unit (ICU).

In-hospital triage in Germany has to be performed by physicians with either surgical, internal medicine, or anesthesiology specialization. No further regulation on qualification or participation in triage course is needed. Furthermore, in Berlin, there is no statutory algorithm for in-hospital triage. The casualties in Germany are allocated to three different categories:

S1 immediate treatment group: severe injury with immediate life-threat

S2 Delayed treatment group: severe injury without immediate life-threat

S3 Minimal treatment group: slightly injured patients, ambulant treatment

The distribution of injury severity of the 601 rouged actors in our study has been 16.6 percent S1 (n = 100), 45.4 percent S2 (n = 273), 37.9 percent S3 (n = 228).

Definitions

Overtriage is defined as overestimation of injury severity, for example, classification of S2 patient as S1. The problem of overtriage is the waste of treatment

capacity to patients with lower priorities. In contrast, undertriage is defined as an underestimation of injury severity, for example, classification of S1 patient as S2, resulting in a misclassification of immediate life threat and withhold of immediate medical aid.

Casualty actors

For realistic disaster hospital trainings, experienced and skilled casualty actors are necessary. The Berlin aid organizations (Red Cross, Arbeiter-Samariter-Bund) have special teams consisting makeup artists and voluntary actors for realistic emergency scenarios.

The evaluation of the accuracy of triage is highly dependent on the action of casualty actors with the need of standardization for scientific reproducibility. All our actors have emergency medicine background and education. Additionally, the actors need to pass special trainings prior to permission to participate in disaster trainings is granted. In courses, 1-2 weeks prior to emergency trainings, the actors were taught in the typical clinical symptoms of medical emergencies and corresponding physiologic parameters (Table 1).

In Berlin, the actors received written acting advices (analogous to simulation cards) including their specific clinical symptoms, vital signs, clinical course, and necessary medical treatment. In the disaster trainings, the actors perform the clinical symptoms (pain, respiration rate, unconscious, tender abdomen) and provide the adjusted vital signs (blood pressure, reperfusion time) to

Table 1. Course contents compulsive for all casualty actors.

Topics	Lessons
Triage training	Purpose, organization, process
Disease simulation	Dyspnoe, unconsciousness, shock, heart attack, stroke
Injury simulation	Fractures, wounds, contusions, burns, amputations, penetrating injuries, tender abdomen
Psychological aspects	Pain, agonal state
Safety	Forbidden diagnostic (X-ray) or invasive medical measures (chest tube), accident prevention, code word for real emergency while training



Figure 1. Examples of roughed injuries.

the physicians and nurses at triage. All kinds of injuries (penetrating/blunt) and body regions are simulated with the help of make-up and artificial blood (Figure 1). The actors are labeled, so that the external observers can sufficiently monitor and evaluate the quality of disaster management. Invasive diagnostics like X-ray were only simulated and the results were provided by the casualty actors or external observers. In total, 601 roughed actors were triaged in our 17 mass casualty trainings.

Evaluation

The triage evaluation was performed by a structured interview of the trained casualty actors and simultaneous documentation of a questionnaire by study observers. Following data was surveyed:

- Hospital category
- Injury severity (S1-S3)

- Triage algorithm and diagnostic tools used (anamnesis, physical examination, measurement blood pressure [BP], heart rate [HR], oxygen saturation [SpO₂], X-ray, ultrasound, computer tomography [CT])
- Allocated area of treatment (emergency department [ED], operation room [OR], intensive care unit [ICU], and ward)

In 93 percent (n = 558) complete data was available and suitable for further analysis.

Statistic

With the help of SPSS 20.0 (IBM) we performed statistical analysis. Group differences of nonparametric samples were tested by Mann-Whitney U test and significant group differences were considered at $p < 0.05$.

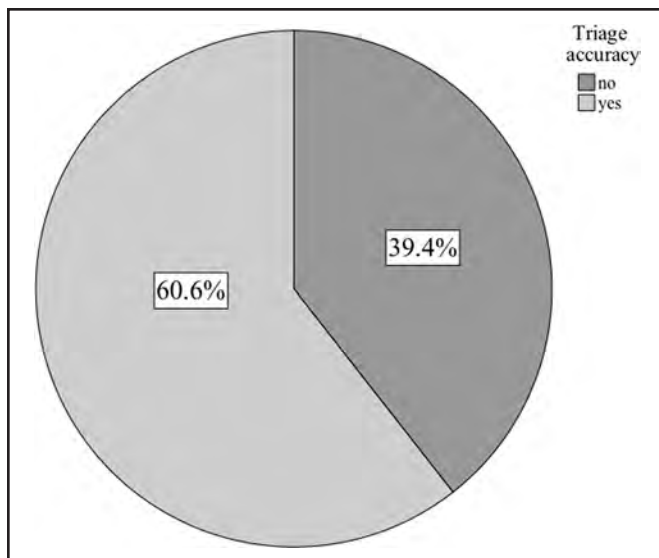


Figure 2. Accuracy of triage: in 61 percent, a correct allocation of injury severity to triage category occurred.

Results

Triage accuracy

In 61 percent ($n = 338$) of the primary triage, the category was allocated correctly to the simulated injury severity (Figure 2). Grouped in the different triage categories 82 percent of the S1, 47 percent of S2, and 73 percent of S3 casualties were classified correctly (Figure 3).

No statistically significant difference was detected comparing the accuracy of triage allocation and hospital category (I/II). The triage was correct in 70 percent of all casualties triaged in category I hospitals and 61 percent in category II hospitals ($p = 0.5$).

Overtriage and undertriage

Of all rouged casualties, overtriage was observed in 23.7 percent ($n = 132$) and undertriage in 15.8 percent ($n = 88$) (Figure 4). In case of overtriage, 27 percent of S2 casualties were allocated to S1, 23 percent of S3 to S2, and 5 percent of S3 to S1. Overtriage appeared significantly more often in category II (26 percent; $p 0.03$) as compared to category I hospitals (13 percent).

No statistically significant differences were detected for the incidence of undertriage referring the

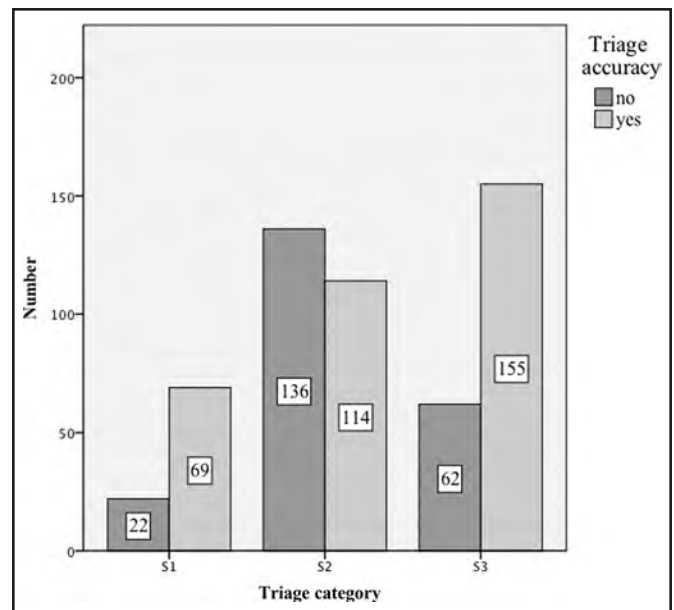


Figure 3. Distribution of incorrect triage to injury severity (S1-3). Twenty-two (S1), 136 (S2), and 62 (S3) patients were not correctly allocated to the corresponding triage category.

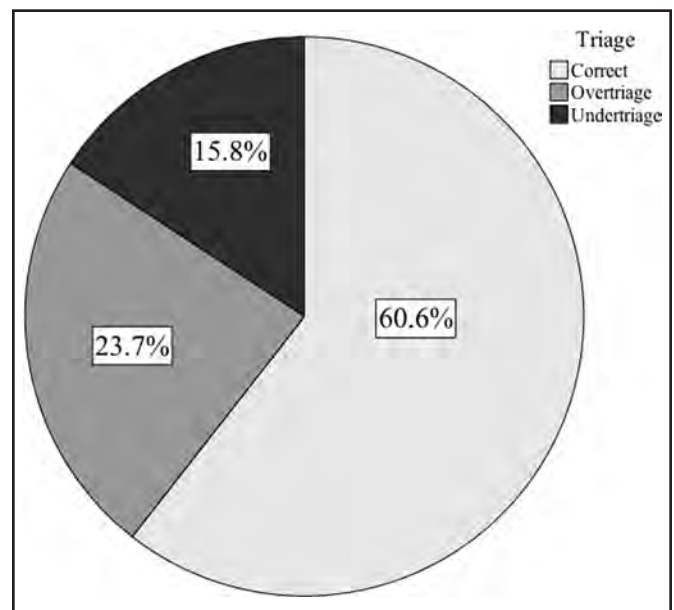


Figure 4. Distribution of triage mistakes: In 23.7 percent overtriage and 15.8 percent undertriage were observed.

category of hospital ($p 0.3$). Undertriage was performed by allocating 26 percent of S2 casualties to S3, 17 percent S1 to S2, and 1 percent S1 to S3 triage category.

Re-triage

Repeated triage (re-triage) at the different treatment areas according to their triage category (S1-S3) within the hospital were performed in only 3.8 percent ($n = 21$). In 62 percent of the re-triaged casualties with initial misclassification, a secondary correct allocation of the injury severity to the correct triage category was observed.

Diagnostic tools

The following measurements were performed: anamnesis in 77 percent, physical examination 71 percent, BP in 68 percent, HR in 61 percent, and oxygen saturation in 25 percent. Additive radiological diagnostics were used: 38 percent X-ray, 16 percent CT, and 7 percent ultrasound. On an average, 1.6 ± 1.2 diagnostic tools were used to allocate injury severity to rouged casualties. No statistical significant association was detected for the use of diagnostic tools and correct allocation to triage categories, overtriage and undertriage.

Allocated area of treatment

After triage, 37 percent of rouged casualties were treated in the ED, 27 percent on ward, 15 percent in OR, and 11 percent on ICU. In 10 percent, no mapping was possible.

Discussion

For the first time, we present a systematic analysis of triage results in 17 unheralded external hospital disaster trainings in Berlin. Limitation of all disaster triage trainings is the dependency of triage results and realistic representation of injury severity by casualty actors. Our casualty actors have medical background and passed special courses prior participation in disaster trainings is granted. Furthermore, analogous to simulation cards, written instructions were provided to the actors to secure reproducibility and adequate simulation of physiologic injury severity. We reason that our triage results are realistic and reproducible.

We detected an accuracy of 61 percent in correct allocation of injury severity to triage category. To our opinion, the rate of incorrect classification of injury

severity to triage category for in-hospital-triage is not acceptable. In 18 percent, life-threatening injuries were not identified. We analyzed the inconsequently performed physical examination and anamnesis to be only used in less than 80 percent, as major contributors to this triage result. Furthermore, diagnostic tools were insufficiently used (average 1.6), capable to ease decision process for in-hospital triage. Especially, patients with blunt abdominal trauma benefit from focused abdominal ultrasound in the triage area. Ultrasound is a quick, noninvasive, reproducible, and repeatable diagnostic tool precious to detect free abdominal fluid and allocate patients with free fluid to S1 triage category. Additionally, the use of physiologic parameters is irreplaceable. It can help discriminate patients with or without life threat.

We observed 18 percent of undertriage for patients with immediate life threat (S1). Compared to previously published data with up to 47 percent of S1 patients not detected, it is a quite low rate, but still for us it is intolerable.⁴ From the literature it is known that patients with internal abdominal bleedings are endangered of undertriage. In the clinical routine, we would perform an ultrasound or CT scan to verify potential abdominal bleeding. In our study the easy, noninvasive, mobile, and quick available tool ultrasound was used in only 7 percent of all triaged casualties, whereas the time-consuming and expensive CT scan was used in 16 percent. Therefore, we recommend the regular use of ultrasound for patients with abdominal injury at in-hospital triage in order to discriminate S1 from S2 patient. Furthermore, the effect of overtriage due to abdominal trauma can simultaneously be lowered. CT scan in disaster scenarios should only be performed for severe traumatic brain injuries with potential indication for emergency craniotomy.

On our opinion, regular re-evaluation of physiologic condition of patients in the different treatment areas is also an easy and feasible tool to raise the accuracy of triage. Re-triage can lead to either escalation of triage category or step down after successful medical treatment, creating new treatment capacities. Re-triage in our collective was used in less than 4 percent, but when used, more than 60 percent of initially misclassified casualties could be allocated to the correct

triage category. To conclude, re-triage should be routinely used and can lower the rate of incorrect triage.

The problem of overtriage (24 percent) was predominating as compared to undertriage (16 percent). Because of the phenomenon of overtriage, with consumption of treatment capacity, can be lowered by training; this indicates the insecurity of the triage physician and fear to underestimate the injury severity and endanger the patient's life.⁶ The fact that overtriage occurred significantly more often in category II hospitals, normally not used to admit polytraumatized patients, underscores this effect. Knowing that overtriage contributes to the mortality rate of life-threatening injuries due to senseless consumption of treatment capacity, we recommend an obligatory education for all physicians and nurses involved in disaster management and in-hospital triage. Furthermore, a uniform triage algorithm for all hospitals and education program should be established.

The allocation of patients to the treatment areas reflects the common distribution of injury severity. Mostly, the patients were treated in the emergency department and on ward. Only 26 percent of all casualties were treated in ICU or OR.

Conclusion

The accuracy of in-hospital triage is low (61 percent). Predominately, the problem of overtriage (24 percent) due to insufficient triage training in contrast to undertriage (16 percent) occurs. The diagnostic triage adjuncts, ultrasound and re-triage, should be routinely use to lower the rate of undetected life threat in mass casualty incidence. Furthermore, a standardized training program and triage algorithm for in-hospital triage should be established.

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References

1. Paul AO, Kay MV, Hornburger P, et al.: Mass casualty incident management by mSTaRT. *MMW Fortschr Med.* 2008; 150(19): 40-41.
2. Benson M, Koenig KL, Schultz CH: Disaster triage: START, then SAVE—A new method of dynamic triage for victims of a catastrophic earthquake. *Prehosp Disaster Med.* 1996; 11(2): 117-124.
3. Cone DC, Serra J, Kurland L: Comparison of the SALT and Smart triage systems using a virtual reality simulator with paramedic students. *Eur J Emerg Med.* 2011; 18(6): 314-321.
4. Ashkenazi I, Kessel B, Khashan T, et al.: Precision of in-hospital triage in mass-casualty incidents after terror attacks. *Prehosp Disaster Med.* 2006; 21(1): 20-23.
5. Arbon P, Zeitz K, Ranse J, et al.: The reality of multiple casualty triage: Putting triage theory into practice at the scene of multiple casualty vehicular accidents. *Emerg Med J.* 2008; 25(4): 230-234.
6. Pelaccia T, Delplancq H, Tribby E, et al.: Can teaching methods based on pattern recognition skill development optimise triage in mass-casualty incidents? *Emerg Med J.* 2009; 26(12): 899-902.
7. Hirshberg A, Holcomb JB, Mattox KL: Hospital trauma care in multiple-casualty incidents: A critical view. *Ann Emerg Med.* 2001; 37(6): 647-652.
8. Jenkins JL, McCarthy ML, Sauer LM, et al.: Mass-casualty triage: Time for an evidence-based approach. *Prehosp Disaster Med.* 2008; 23(1): 3-8.

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A pan-European study of capabilities to manage mass casualties from the release of chemical agents: The MASH project

David J. Baker, FRCA; Virginia S. G. Murray, FRCP; Pierre A. Carli, MD

Abstract

The European Union (EU) Mass Casualties and Health (MASH) project that ran between 2008 and 2010 was designed to study the management of mass casualties from chemical and radiological releases and associated health implications. One area of study for this project concerned arrangements within EU Member States for the management of mass casualties following a chemical release. This was undertaken via a confidential online questionnaire that was sent to selected points of contact throughout the EU. Responses were obtained from 18 states from respondents holding senior positions in chemical planning and incident response. Information gathered shows a lack of uniformity within the EU about the organization of responses to chemical releases and the provision of medical care. This article presents the overall findings of the study demonstrating differences between countries on planning and organization, decontamination, prehospital emergency medical responses, clinical diagnoses, and therapy and aftercare. Although there may be an understandable reluctance from national respondents to share information on security and other grounds, the findings, nevertheless, revealed substantial differences between current planning and operational responses within the EU states for the management of mass chemical casualties. The existing international networks for response to radiation incidents are not yet matched by equivalent networks for chemical responses yet sufficient information was available from the study to identify potential deficiencies, identify common casualty management pathways,

and to make recommendations for future operations within the EU. Improvements in awareness and training and the application of modern information and communications will help to remedy this situation. Specialized advanced life support and other medical care for chemical casualties appear lacking in some countries. A program of specialized training and action are required to apply the findings revealed by the MASH study into a unified cross-border emergency medical response.

Key words: MASH, European, mass, chemical, casualty, management

Introduction

Across Europe and other parts of the world, individual poisoning and its management is a common occurrence in emergency medical practice.¹ This situation rarely causes risk to the attending emergency teams due to onward transmission of the hazard. However, in the case of exposure to a chemical agent, the situation is quite different. Accidental or deliberate releases of domestic or industrial chemicals can present as an emergency not only to the individuals who may have been exposed but also to those who may be in contact with them and become secondarily contaminated. This potential transmission of a health risk is one of the essential differences between an individual poisoning and a chemical incident.²

Chemical incidents may be on a small or large scale, but both can have potentially wide health problems. Such releases may be accidental or deliberate as a result of terrorist action and may give rise to a

number of primary and secondary chemical casualties.³ The number of casualties following a release will depend on the location and type of incident. In a crowded urban setting, mass casualties are to be expected as was seen following the release of methyl isocyanate in Bhopal, India, in 1984, which caused more than 5,000 early fatalities and more than 50,000 long-term casualties.⁴

Much of the world has become familiar with mass casualties as a result of trauma from explosive devices, and major disaster plans have been elaborated to manage casualties. However, plans for the management of conventional trauma may not always be directly applicable to releases of chemical agents, not least because the number of actual casualties may be difficult to determine. This is because many chemical agents do not act immediately but signs and symptoms develop after a certain time, known as the latency period.⁵

The management of any chemical agent release must follow two parallel lines of action, which are: (i) management of the incident site to minimize spread of contamination and (ii) management of the injured. Both these lines have the following inherent problems:

- The injury is toxic in nature and may appear with variable latency
- There is a requirement for early detection, identification, and monitoring of the released chemical agent
- If the agent is persistent, the release must be contained and controlled
- Persistency enforces the need for protection for responders and decontamination of casualties
- The decontamination of casualties causes a potential delay in bringing them to definitive medical care
- Provision of essential early life support and antidote therapy by protected personnel inside a contaminated zone will be

necessary for casualties with life-threatening respiratory failure

The European Union (EU) THREAT program⁶ has shown that neither hospitals nor physicians are well prepared to deal with mass chemical casualties. Equally, details about organizational, operational, and emergency medical responses in the EU have not previously been coordinated.

A large-scale incident, although rare, may stretch the resources of a single country so that expert help may be requested from neighboring nations, or the release may affect several countries. Within the context of the EU, the ultimate goal for mass casualty management is the ability to respond effectively and efficiently to a major chemical incident in a variety of situations, with a coordinated, compatible response.

The MASH Project

The EU project to examine Mass Casualties and Health (MASH) following the release of chemical and radiological agents,⁷ which took place between 2008 and 2010 involved partners from several European states with expertise in both chemical and radiological incident management together with biotechnology and information and communications technology. The project, funded by the EC Health Directorate (DG SANCO) and coordinated and managed by the European CBRN centre, Umea, Sweden, included regular meetings of the participating partners face-to-face around Europe, by teleconference or at a number of workshops. Teams from nine different European organizations included the CBRNe centre in Umea, Umea University, Karolinska Institute, FOI (all in Sweden), the Bundeswehr Institute of Radiobiology and the University of Ulm in Germany, SAMU de Paris in France, CEIT in Spain, and the United Kingdom Health Protection Agency (HPA) in the United Kingdom.

This article concerns only the management, responses, and analysis of the chemical questionnaire that was conducted by the SAMU de Paris (Paris Emergency Medical Service) and the UK Health Protection Authority. Both these organizations have

direct responsibility for planning and responses for the management of chemical casualties in their respective states within the EU. Other aspects of the MASH study and the recommendations made are considered elsewhere.⁸

Methods

The main objective of the chemical section of MASH was to gather information from specialist respondents in Member States concerning their readiness to manage casualties from chemical releases and the wider health implications these present. Information gathering was done online using a questionnaire accessed through a secure Web site.

The MASH chemical questionnaire was designed to:

- Determine awareness of the problem.
- Gather information about management of the chemical incident.
- Gather information about management of the casualties.

Target points for information gathering

At the start of the project, the European Commission confirmed that there was no central register of persons in Member States who have special responsibility for the management of casualties following chemical releases. However, information was available about the emergency response departments responsible for chemical casualties within Member States. These were contacted by e-mail and requests for information were made to persons at a Director or senior administrator level to ensure that the information provided was as authoritative as possible.

Questionnaire

The information-gathering activity from the chemical questionnaire had the following overall objectives:

- Establishing recognized points of contact for expert response teams in chemical accident management across a wide range of national agencies

- Assessment of the awareness of the problems of the management of mass chemical casualties by the hospital services of health and other organizations that can provide expert advice
- Gathering information about the presence and operation of trained special emergency medical teams.

The chemical questionnaire used to gather direct information from national sources was available from a MASH Web site. Each respondent provided information through a coded access and password system on the understanding that the replies received would be treated as confidential. Respondents were asked to fill in the answers to the questions to the best of their ability and to provide blank responses where there were uncertainties. The subjects covered by the questionnaire are shown in Box 1.

Processing information

On receipt of the completed questionnaires, data were gathered as relative and absolute frequencies. The information received was then analyzed and discussed at a series of workshops involving the project partners, which culminated in the publication of a number of recommendations to the European Commission to provide solutions to the problems identified.

Results

Response to requests for information

Requests for information were sent to contact addresses by e-mail to all the 27 EU Member States.

Box 1. Subjects covered by the MASH chemical response questionnaire

1. Planning and organization
2. Decontamination
3. Managing chemical incidents: prehospital triage, detection, identification, and monitoring
4. Approaches to clinical diagnosis
5. Therapy and aftercare
6. Further comments and points of contact for further communication

Completed questionnaires were received from 18 of these. Overall, there was input from 20 respondents who all held senior administrative or medical advisory posts at ministerial level or equivalent within their respective states.

The breakdown of the expert responses was as follows:

- Thirteen were directors or held senior posts in governmental departments responsible for disaster management, including chemical release
- Five were senior consultant clinicians with special responsibility for chemical casualty management and advice
- Fourteen of the respondents were medically qualified at a postgraduate level
- Six of the respondents were scientifically qualified at doctoral level.

Findings from the chemical questionnaire

Tables 1-5 present a synopsis of the analyzed responses for organization, prehospital response, decontamination arrangements and capability, clinical diagnosis, and therapy and aftercare. Data are expressed as percentages of overall yes or no responses. In several cases, replies to questions were either unknown or left blank. Total percentages of less than 100 reflect this.

Planning and organization

1. About two-thirds of the organizations replying to the questionnaire are tasked to assume control in a chemical incident (Table 1).
2. All responding organizations were available on a 24-hour basis to respond to chemical incidents.
3. Overall, police, emergency medical services, and army are aware of the chemical incident response arrangements in

place. The fire, police, and ambulance services are involved but military usually are not.

4. Hospital awareness of the organizational structure for dealing with chemical releases was moderate.

5. Expert advice is not widely available at the point of release. Expert chemical medical response teams are not widely available in the EU.

6. Half of the respondents indicated a rapid response time for chemical releases indicating that a rapid response to mass casualty chemical incidents is not widespread within the EU.

7. The tasks of expert onsite teams, including sampling, decontamination, monitoring, and the provision of early medical care, were provided.

8. There was agreement that the provision of specialized teams for chemical incidents is essential.

9. There was unanimous support from respondents for an EU program of cooperation in management of chemical casualties.

10. Most respondents made information about their network structures and planning available to MASH. Some of this information is available through the open literature, as in the case of France.⁹ Other countries adopt a more closed approach.

Decontamination arrangements

1. The figures returned for overall national decontamination capacity varied widely depending on the size and facilities available (Table 2).

Table 1. Organizational structures		
Question	Yes	No
1. Is your organization tasked to assume control following a chemical release?	12/18 (67 percent)	6/18 (33 percent)
2. 24-hour availability?	18/18 (100 percent)	0
3. Are responding emergency services aware of the 24-hour availability of your service		
Police	14/18 (78 percent)	3/18 (17 percent)
Fire	15/18 (83 percent)	2/18 (12 percent)
EMS	17/18 (94 percent)	0/18 (0 percent)
Military	12/18 (67 percent)	4/18 (22 percent)
4. Are hospitals aware availability of expert advice?	10/18 \geq 80 percent awareness	
5. Does your organization provide an expert team for the management of chemical casualties?	10/18 (56 percent)	7/18 (41 percent)
6. What is the response time?	7/18 < 2 – 4 h	
7. What are the tasks of the expert team?	Decontamination, sampling, monitoring	
	Provision of emergency medical care	
8. Do you think that the presence of an expert team is essential in chemical incidents?	10/18 (56 percent)	0/18 (0 percent)
9. Are you interested in an EU program for training such teams?	18/18 (100 percent)	0
10. Can you provide details of the network structure for managing chemical incidents in your country?	15/18 (83 percent)	1/18 (6 percent)
EMS, Emergency Medical Services.		

Table 2. Decontamination		
Question	Yes	No
1. What is the decontamination capacity in your state using all available resources?	(responses range from 5 to 1,700/h)	
2. How long would it take to set up this capacity?	7/18 < 10 h	
	3/18 >10 h	
3. Which organization provides this service?		
Fire	13/18 (72 percent)	5/18 (28 percent)
EMS	10/18 (56 percent)	8/18 (44 percent)
Military	7/18 (39 percent)	11/18 (61 percent)
Others	2/18 (11 percent)	16/18 (89 percent)
EMS, Emergency Medical Services.		

Table 3. Prehospital triage and diagnosis

Question	Yes	No
1. Is there a training scheme to allow early recognition of accidental or deliberate chemical release?	6/18 (38 percent)	10/18 (56 percent)
2. Is there a scheme for prehospital examination and triage?	12/18 (71 percent)	5/18 (28 percent)
3. Is there special triage and chemical injury management training for physicians?	7/18 (47 percent)	8/18 (44 percent)
4. Is there a standard documentation sheet for prehospital chemical diagnosis? ³	5/18 (28 percent)	10/18 (56 percent)
5. Is there special training for paramedic and ambulance personnel dealing with chemical incidents?	6/18 (33 percent)	8/18 (44 percent)

Table 4. Clinical diagnosis: toxidromes

Question	Yes	No
1. Is there a standard set of toxidromes available in your state to aid diagnosis?	7/18 (39 percent)	8/18 (44 percent)
2. Is there standard documentation to record signs and symptoms following chemical release? ¹	6/18 (33 percent)	8/18 (44 percent)

2. Less than half the responding states were able to set up the decontamination capability in less than 10 hours. In others, there were substantial delays of up to 48 hours.

3. Decontamination services are provided by fire and rescue services, EMS, and the military in that order.

Prehospital medical responses

1. Most respondents did not report a standardized training scheme for early recognition of accidental or deliberate chemical release (Table 3).

2. The majority of respondents reported arrangements for prehospital examination and triage.

3. About half the respondents reported a special training scheme for physicians in the triage of chemical injuries.

4. There was a lack of standardized documentation sheets for chemical casualties in the majority of states and a lack of standardized reporting procedures and documentation for chemical casualties.

5. Less than half the respondents reported special chemical training schemes for paramedical or other ambulance personnel.

Clinical diagnosis

1. Toxidromes following exposure to chemical agents are not widely used to assess prognosis (Table 4).

Table 5. Therapy and aftercare

Question	Yes	No
1. Are there hospitals specialized in the treatment of chemical casualties in your State	8/18 (44 percent)	8/18 (44 percent)
2. Are the available quantities of stockpiled antidotes known?	12/18 (67 percent)	4/18 (22 percent)
3. Is there an emergency plan for the provision of antidotes	7/18 (39 percent)	8/18 (44 percent)
Are details of the antidotes available?	11/18 (61 percent)	4/18 (22 percent)
Can you specify the antidotes?	9/18 (50 percent)	9/18 (50 percent)
4. Are the emergency services able to provide early life support for chemical casualties?	8/18 (44 percent)	8/18 (44 percent)
5. Is there provision for psychological support following a chemical incident?	3/18 (17 percent)	12/18 (67 percent)
6. Are you interested in an EU medical cooperation program for the management of victims of accidental chemical release?	16/18 (89 percent)	0/18 (0 percent)

2. Standardized documentation sheets for clinical management are available in less than half of the responding states.

6. There was a strong interest in an EU cooperation program for chemical casualty management.

Therapy and aftercare of chemical casualties

1. Less than half of responding states have hospital facilities specialized in treatment of chemical casualties (Table 5).

2. The majority of respondents know the quantities of antidotes available nationally, but detailed information was limited due to problems of national confidentiality.

3. Less than half of the respondents have an emergency plan for the provision of antidotes.

4. Only half the respondents reported provision of early life support care by EMS in chemical incidents and knew the equipment used.

5. The majority of responding states did not provide standard psychological aftercare for victims of a chemical release.

Antidotes

As noted in Table 2, a certain amount of information was provided about antidotes to chemical agents. The following points are noted:

- Of the nine states responding, two noted that they did not have any civil stockpiles of antidotes.
- Of the remaining seven, all reported stocking atropine; three held stocks of hydroxocobalamin; and two held only other cyanide antidotes with the exclusion of hydroxocobalamin.
- One state reported that information about antidotes was classified. None of the responding states provided information about the stocks held in the civil sector.

Discussion

Although chemical incidents occur on an almost daily basis within the EU 27 mass chemical incidents of

the scale seen in Bhopal⁴ or Tokyo¹⁰ have been rare. Thus most experience in managing chemical casualties comes from smaller scale incidents in the civil sector or from military experience with chemical warfare. Experience in managing mass chemical casualties comes largely from the First World War and later actions such as the Iran-Iraq war. Writings from the First World War^{11,12} still provide a useful insight into the problems of managing chemical injury, particularly in the large number of wounded compared with fatalities and the problems of pathology developing some time after exposure due to the inherent latency of many of the agents used, such as mustard gas. It should be noted, however, that military and civilian organizations for the management of mass casualties are different.

It is clear from analysis of previous chemical incidents producing mass casualties in a civil setting³ that there is heavy burden placed on hospital services due to the requirement to manage respiratory problems. Thus, emergency departments and intensive care are likely to be overstretched in the case of most urban chemical agent releases. Many chemical agents cause fatality due to a final action on the respiratory system. Antidote therapy remains a mainstay in the management of chemical casualties but does not replace the need for emergency medical care in the form of early advanced life support.

Europe, along with other parts of the world, is vulnerable to the effects of chemical release, both accidental and deliberate which may produce mass casualties. Although such incidents are by no means inevitable, it is essential that proper planning and incident response are in place. Civilians remain more vulnerable than trained military formations to chemical exposure, and it was the purpose of the chemical agent casualty section of the MASH project to try to discover national attitudes to mass chemical casualty management within the Member States, what preparations and capabilities exist, and the possibility for cooperation within the EU in the event of future chemical incidents.

From the results of the MASH chemical questionnaire, the following observations and comments may be made:

1. Is the response received representative of current European practice?

Despite information being available from only 18 of the 27 Member States, the answers received may be taken as being broadly representative of the EU grouping as six responders represent states joining at the last expansion of the Union to its present size, two represent Scandinavian states, and 12 are from the original 15 Member State grouping.

2. Is the information gathered authoritative?

Response for information was received from senior managers or from directors of responsible agencies at a ministerial level. There is, therefore, every reason to believe that the information provided represents genuine national positions in the response to mass civilian casualties following chemical release.

No central EU registry of competent state organizations for chemical casualty management was available for use in the study. Thus, approaches for information were made largely on a "cold" basis by e-mail and Internet. The reluctance of some Member States to participate in providing information may lie in the sensitivity of the subject of chemical agent release and particularly of deliberate chemical release and its association with terrorism. E-mail may not be the most suitable cold contact technique for a project like MASH. Information gathered could be supplemented by direct personal contact and interview, but this was not possible within the scope of the MASH project.

3. Identified gaps in European mass chemical casualty management

The study has identified a number of gaps in the current European chemical incident response capability. These are:

- There have been a number of EU initiatives such as the Eurotox exercise¹³ and the HAESCUAEP project¹⁴ to assess

collaboration between Member States in the management of chemical casualties. However, there remains little evidence of a coordinated EU approach at present. This contrasts with other programs concerning safety measures in the manufacture and transport of chemicals such as the REACH program.¹⁵ The present study indicates, however, an awareness by the respondents of the importance of management of mass chemical casualties and a uniform desire to be involved in future EU training programs.

- Although some States have advanced and integrated plans for chemical casualty management linking both prehospital, hospital care and all the emergency services, this is by no means a pan-European movement. Such differences in approach may reflect differences in emergency medical systems. However, this may not always be the case. The United Kingdom and France, which are quite different in their approaches to prehospital medical care,^{16,17} as the UK system is paramedical while that in France is medically based, nevertheless, they have common themes in the management of chemical casualties.

- Chemical response training for emergency medical responders appears variable within the EU. There is a lack of training and prehospital capability for the provision of emergency medical care was reported by only 60 percent of responding Member States. There are exceptions to this. In France, the SAMU medical teams have been trained in this area for a number of years and planning has been regularly updated to take account of changes in hazards and threats.¹⁹ In the United Kingdom, there has been an initiative over the past 4 years to provide specialist hazardous area response teams, which are able to provide paramedical care within contaminated zones.¹⁷

- Chemical incidents involving persistent agents require decontamination of casualties. Responses showed that decontamination services are present but highly variable in Member States. The provision of decontamination services is a key stage in casualty management as it is at this stage that potentially life-threatening delays can occur. While some chemical agents are persistent, particularly those like mustard gas, most chemicals are not and this may be a mitigating factor in the provision of emergency care. However, it is by no means clear from this study that this fact is widely understood.

- Antidote therapy has been the mainstay of emergency responses to mass chemical releases for many years and the doctrine derives essentially from the military response to chemical warfare agents. Results from this study shows that a wide spectrum of conventional antidotes is deployed within the EU, but detailed data about stocks and deployment procedures are lacking and in some cases are classified. It is not possible from the data currently available to establish whether there could be significant cross border cooperation in the transfer of antidote stocks between Member States.

- In addition to antidotes provision, it is established that advanced life support will be required for some casualties within a contaminated zone who are in risk of dying from primary respiratory failure.¹⁸ The responses received have indicated that the provision of such life support within the EU is highly variable. Only half the responders indicated that EMS is able to provide medical care within a contaminated zone. By the same token, documentation of the management of patients and medical training programs are also lacking.

- There are few hospital facilities dedicated to the management of chemical casualties within Europe. Equally, there is very limited training for physicians to manage chemical casualties. Psychologic aftercare of exposed patients is also limited. In diagnosis, toxidromes are not widely used or taught, and there is no standardized European clinical management or notification documentation.
- On a positive note, the study has shown that, perhaps in recognition of the planning and operation deficiencies that exist regarding the management of mass chemical casualties within the EU, there is widespread interest in cross-border collaboration to improve this situation and particularly in the provision of special training programs for emergency medical response personnel.
- The MASH chemical mass casualties study has a number of limitations which should be noted here. Although information was received about national position from a majority of Member States, there are considerable gaps. Given the general political sensitivity surrounding deliberate chemical agent release, it is possible that they may not be filled at all. The information received, together with that available in the open literature, does give some indication of preparations and planning within the EU. More details are required to clarify the position.

The study has also revealed that several European states have developed detailed plans for response to chemical incidents, which apply to different EMS systems. These could provide a model for an integrated European response. France in particular has had detailed planning in place for a number of years, which integrates chemical incident response with responses for other types of disaster, including radiation casualties.¹⁹ This approach highlights the need for planning

and training of emergency personnel, which adopts an all-hazards approach to disaster management rather than concentrating only on specific hazards such as chemical and radiological agent release.

It is useful to compare information gathered about chemical casualty management with that for radiation releases. There is a relatively advanced degree of preparation and cross-border collaboration within Europe for radiation incidents compared with chemical.²⁰ The reasons for this may lie in the fact that very few radiation incidents have occurred in the past and those have (eg, the Chernobyl incident) involved a large number of nations and the need for collaboration was evident from the outset. Conversely, chemical incidents although frequent, are usually small in nature and are managed by national responses that so far have not been integrated into an international network.

There are considerable differences between chemical and radiological releases and the casualties they produce. The relative ease of detection and identification of radiation hazards due to the inherent transmitted signal of emitted radiation from isotopes is markedly different from chemical hazards that reveal their nature only by nonspecific physical qualities such as color and smell and by the toxidromes they produced in victims.

Conclusion

The MASH study has revealed substantial differences between current planning and operational responses within the EU states for the management of mass chemical casualties. The existing international networks for response to radiation incidents are not yet matched by equivalent networks for chemical responses. Improvements in awareness and training and the application of modern information and communications will help to remedy this situation. Specialized advanced life support and other medical care for chemical casualties is lacking. A program of specialized training is required and would be welcomed within Europe. The risk of large-scale chemical release, either accidental or deliberate, producing mass casualties remains substantial. Action is required to apply the findings revealed by the MASH study into a unified cross-border emergency medical response.

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References

1. Schaper A, Desel H, Wyke S, et al.: Countering health threats by chemicals with a potential terrorist background—Creating a rapid alert system for Europe. *Eur J Intern Med.* 2012;23(2): e63-e66.
2. Murray VSG, Baker DJ: Chemical incidents. In Greaves I, Porter K, Smith S (eds.): *Practical Prehospital Care: The Principles of Immediate Care*. Churchill Livingstone, London: Elsevier, 2011: 503-513.
3. Baker DJ: Civilian exposure to toxic agents: the emergency medical response. *Prehosp Disast Med.* 2004; 19(2): 157-161.
4. Anon: Calamity at Bhopal. *Lancet.* 1984; 137: 1378-1379.
5. Baker DJ: The anesthesiologist and chemical and biological weapons. In Miller R (ed.): *A Textbook of Anesthesia*, 7th ed. St Louis, MI: Elsevier, 2008: Chapter 72.
6. Council of the European Union: Conclusions on preparedness and response in the event of a CBRN attack, 2010. Available at www.consilium.europa.eu/uedocs/cms_data/docs/.../117556.pdf. Accessed August 2, 2011.
7. Baker D, Watson S, Holmes S, et al.: Mass Casualties and Health following the release of toxic chemicals and radioactive material (MASH). Available at www.hpa.org.uk/Publications/Radiation/.../rad006miscpubMASH/. Accessed February 5, 2013.
8. UK Health Protection Agency: Mass Casualties from chemical and radiological agent release: Foresight into needs, possibilities and information requirements for the future. Available at www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1296682119753. Accessed October 6, 2011.
9. Anon: Circulaire 700 SGDN/PSE/PPS (November 7, 2008). Relative a la doctrine nationale d'emploi des moyens et de soins face a une action terroriste mettant en œuvre des matieres chimiques (in French). Available at www.sante.gouv.fr/un-plan-pour-les-risques-nrbc.html. Accessed December 28, 2011.
10. Okumura T, Nomura T, Suzuki T, et al.: The dark morning: The experiences and lessons learned from the Tokyo Subway Sarin attack. In Marrs T, Maynard R, Sidell F (eds.): *Chemical Warfare Agents: Toxicology and Treatment*, 2nd ed, Chapter 13. Chichester, UK: John Wiley and Sons, Ltd, 2007: 277-286.
11. Maynard R: Opinions of chemical warfare. In Marrs T, Maynard R, Sidell F (eds.): *Chemical Warfare Agents: Toxicology and Treatment*, 2nd ed, Chapter 1. Chichester, UK: John Wiley and Sons, Ltd, 2007: 1-20.
12. Prentiss A: *Chemicals in War*. New York, NY: McGraw Hill Inc., 1937.
13. EU, 2002: Protection of citizens in the event of a terrorist attack: Commission announces large-scale European simulation exercise (EURATOX 2002). Available at <http://europa.eu/rapid/pressReleasesAction.do?reference=IP/02/1498&form=HTML&aged=1&language=EN&guiLanguage=fr>. Accessed November 9, 2011.
14. Council of the European Union: EU project HESCUAEP. Available at <http://www.hesculaep.org>. Accessed August 2, 2011.
15. Council of the European Union: EU REACH project/. Available at <http://www.intertek.com/reach>. Accessed August 2, 2011.
16. Baker DJ, Telion C, Carli P: Multiple casualty incidents: The pre-hospital role of the anesthesiologist in Europe. *Anesthesiol Clin.* 2007; 25(1): 179-188.
17. Anon: The UK HART system. Available at <http://www.ambulancehart.org.uk>. Accessed August 2, 2011.
18. Baker DJ: Management of respiratory failure in toxic disasters. *Resuscitation.* 1999; 42(2): 125-131.
19. Anon: Plan Biotox—An introduction (in French). Available at <http://www.sante.gouv.fr/htm/dossiers/biotox.into.htm>. Accessed December 28, 2011.
20. Rojas-Palma C, Liland A, Næss Jerstad A, et al. (eds.): *TMT Handbook, Triage, Monitoring and Treatment of People Exposed to Ionizing Radiation Following a Malevolent Act*. Didcot, UK: NRPA, 2009.

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A decision process for determining whether to conduct responder health research following large disasters

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Abstract

Disasters often set the stage for scientific inquiry within the field of occupational safety and health. This is especially true when the long-term consequences of exposures associated with a particular disaster are unclear. However, a responder research study can be costly and difficult to design, and researchers must consider whether the proposed study will produce useful, reliable results and is a prudent public health investment.

The decision process can be segregated into various components, including scientific rationale that should be formally recognized as critical to efficiently and effectively determine whether a research study is warranted. The scientific rationale includes certain controlling or "gatekeeper" factors that should be present to proceed with research.

Key words: disaster research, responder research, postdisaster research, surveillance, health monitoring

Introduction

Disasters often set the stage for scientific inquiry that could help mitigate potential short- and long-term health effects among responders, as well as improve capabilities for responding to future events. However, the disaster environment presents many challenges for the conduct of research, including the immediate emphasis on critical response activities, limited access to incident leadership, inability to engage response personnel in scientific research activities not

immediately pertinent to the event response, marshaling of necessary resources in an expeditious manner, and timely recognition of important occupational safety and health events during the response or recovery operation. The disaster environment is typically dynamic and often hazardous, chaotic, and highly charged with conflicting scientific opinions, political pressures, and disparities in knowledge or the capability to safely perform the required work.¹

Emergency response workers (responders) and others involved in response, remediation, and recovery efforts often perform nonroutine activities in uncharacterized, potentially hazardous environments and may encounter novel exposures or experience unexpected health effects. Thus, there is frequently a pressing public health need to answer critical questions regarding the health impact of these exposures and/or determine the factors responsible for any adverse health effects experienced, whether immediate or delayed. Issues related to conducting research during and following disasters have gained increasing attention following the World Trade Center disaster in 2001 and, more recently, the Deepwater Horizon disaster.^{2,3} For example, the National Biodefense Safety Board (NBSB), an advisory committee within the US Department of Health and Human Services, recently explored the inclusion of scientific investigations as a component of disaster planning.⁴ However, a responder research study can be costly and difficult to design; therefore, one must carefully consider whether a proposed or requested study

will be able to produce useful, reliable results and is a prudent public health investment.

Providing the foundation for disaster-related responder health research and subsequently determining the need to pursue a study requires careful consideration and planning before an event occurs. The ability to conduct such research also rests on how successfully responder exposures, and injuries and illnesses are documented in near-real time during and following an event. These data are of greater benefit if baseline health and fitness information are available for comparison (ie, before responders are deployed to a disaster).⁵ Research studies should address clearly articulated, important questions or hypotheses, and be appropriately designed to maximize the likelihood of producing a meaningful study. Unless the potential for such a study is anticipated, the ability to collect critical baseline data can be lost. However, the factors and decision-making processes relevant to determining whether to conduct responder health research, or how to perform such research best, have been relatively unexplored.

Background

For the purposes of this article, health studies conducted in conjunction with the response to emergency events are divided into the following four basic types: 1) nonresearch activities involving routine or baseline health monitoring, health surveillance, industrial hygiene or environmental assessments, responder interviews/focus groups, and roster/registry activities,* optimally planned in a generic way before an event (termed *baseline activities*); 2) those that investigate and respond to immediate health problems and exposures and are designed to expeditiously provide useful and actionable information that directly affects the health and safety of current responders (termed *public health investigations*) during the course of the response[†]; 3) those that are exploratory or preliminary in their approach, often to determine the need for, feasibility, or design of a more

comprehensive research study (termed *pilot investigations*); and 4) those that entail a systematic and rigorous investigation, typically require detailed, peer-reviewed protocols, usually extend well beyond the duration of the emergency, and are designed to develop or contribute to generalizable scientific knowledge (termed *responder health research*). Federal regulations regarding human subject research generally do not consider public health activities implemented to prevent or control disease or injury and improve health, or to improve a public health program, as research.⁶ Although the implementation of health activities may not be research, the monitoring and reporting of the effectiveness of these programs can be considered research, and detailed investigation and reporting of events among responders is important.

Methods

Review of the response activities related to the 2010 Deepwater Horizon oil release in the Gulf of Mexico indicated a need for a systematic decision-making process to determine if postdisaster responder health research should be initiated. In response, National Institute for Occupational Safety and Health (NIOSH) convened a work group consisting of senior NIOSH scientists experienced with disaster response and representing the disciplines of epidemiology, occupational medicine and psychiatry, and industrial hygiene, as well as former directors of the NIOSH emergency preparedness and response program, medical staff involved in the World Trade Center Health Program, and epidemiologists involved in industry-wide studies. Drawing on direct experience in multiple large emergency/disaster responses, including the terrorist attacks of September 11, 2001, anthrax events, severe acute respiratory syndrome, Hurricane Katrina, and the Deepwater Horizon oil release, the work group developed a comprehensive rationale for determining when to conduct responder health research studies.

An extensive literature search[‡] using a variety of search terms[§] yielded numerous studies that investigated

*A "roster" is a list with contact information for all responders scheduled to perform a duty; a "registry" collects, stores, and manages information about affected population at risk of exposure or who have developed a specific disease.

†Because of the time elements inherent in these studies, they primarily address acute effects, conditions, or concerns and are not designed to detect delayed or chronic effects.

‡Databases searched included MEDLINE®, EMBASE®, Cumulative Index to Nursing and Allied Health Literature (CINAHL®), Health and Safety Science Abstracts, and NIOSHTIC.

§Searched terms included "emergency responder, disaster worker, emergency worker, and first responder" and "long-term study, postdisaster study, surveillance, and health monitoring."

the health status of emergency response workers in various response scenarios; however, none of these studies addressed the thought processes or criteria involved in the decision to conduct such a study, and no general treatments of this issue were identified. However, the Agency for Toxic Substances and Disease Registry (ATSDR) has developed guidance for determining if an environmental assessment should be conducted in a nonemergency situation.⁷ The NBSB recently released a report discussing the need for disaster research and the significant barriers to conducting such research, but this report does not specifically address the decision process on whether to proceed with research.⁴

After defining the types of responder health studies and activities pertinent to a disaster response, the work group considered previous emergency response studies as well as current trends in emergency response research methodologies. While assessing potential criteria related to determining the need for a study, it became clear that a focused hypothesis (or hypotheses) based on varying pre-existing information is a critical component of an effective decision-making process. The work group then discussed factors that should be evaluated to determine whether pursuing a study was warranted, including issues such as feasibility and research significance. Using these considerations, the group conducted a tabletop exercise (briefly described later in the article) to test the validity of the proposed decision-making process.

This article summarizes the work group's recommendations for determining when a responder health research study should be initiated, including the critical factors that need to be considered when making the decision to perform research.

Results

Hypothesis development for responder research

As described above, a responder health research study is designed to address a specified scientific query, generally articulated as a hypothesis or set of hypotheses, although sometimes expressed or operationalized in varying ways in different scientific disciplines. Hypotheses may arise from the results of recently

concluded or ongoing public health investigations begun during or just after an emergency response. Hypotheses may also derive from data produced by health surveillance, individual worker health monitoring efforts, pilot studies, or previous research. As in any research endeavor, a hypothesis should be precise in its construction; make specific, unambiguous, and testable predictions; and clearly define the intent of the research study. Contemplated studies should be designed to address potential confounders and have sufficient statistical power to detect a meaningful effect. More detailed discussions on hypothesis development and research project design are available elsewhere.⁸⁻¹⁰

Improperly formulated hypotheses or inappropriately applied theory can be detrimental. For example, when broad concerns are voiced about potential health effects in a disaster, researchers may transform the question into one more readily investigated with available resources. Although the transformation often narrows and simplifies the focus to something manageable and potentially resolvable, researchers must be vigilant to ensure that the hypothesis is constructed so that it remains able to evaluate the original health concerns. If the research can address only a narrow aspect of the original health concern, or if it can address only a tangential issue, then serious consideration about whether it is prudent to proceed is necessary. Alternatively, researchers may try to study an overly expansive or complex hypothesis in an attempt to satisfy the original broad health concerns, leading to research that is unfocused, inefficient, subject to constant ad hoc modification, and that yields scientifically ambiguous results.

Factors to consider for a responder health research study

The factors to consider when determining whether a responder health research study should be conducted are presented below (Table 1). These factors can be broadly organized into six categories related to 1) exposures, 2) observed adverse health events, 3) public health significance and scientific importance, 4) societal considerations, 5) feasibility, and 6) level of research interest. Several of these factors were adapted to an occupational context from the previously referenced ATSDR guidance document.⁷

Table 1. Factors to consider for a responder health research study

Exposure-related factors	<ul style="list-style-type: none"> • Presence of exposures to hazardous substances, conditions, trauma, etc • Existence of unique, novel, or unusual exposures • Presence of complex environments or combined exposures • Potential implications of exposures on worker health • Types of science/research methodologies necessary to address/answer exposure questions
Adverse health event-related factors	<ul style="list-style-type: none"> • Observance or anticipation of unique, novel, particularly serious, or unusual adverse health events • Occurrence of unexpected or unforeseen occupational health issues during or following an event • Presence of higher than expected numbers or rates of a specific adverse health event—or of overall events • Occurrence of adverse health problems associated with exposures below applicable occupational limits
Public health significance and scientific importance	<ul style="list-style-type: none"> • Ability to provide new knowledge or information about an exposure-outcome relationship • Ability to evaluate specific exposures or outcomes that have not been adequately studied • Ability to generalize to other situations or populations • Ability to confirm or refute a preliminary or pre-existing hypothesis or theory • Ability to answer questions that need to be answered and cannot be answered in any other way • Ability to contribute to or directly improve the public health response to disasters • Magnitude of event, for example, a large number of workers exposed or considered at risk
Societal factors	<ul style="list-style-type: none"> • High-profile or traumatic event • Beliefs about harm or resource disparities, particularly among high-risk groups • Unique vulnerability of the worker population • Socioeconomic, legal, political, and psychological implications of the event
Feasibility factors	<ul style="list-style-type: none"> • Access to the work site(s) • Ability to quickly collect reliable data, particularly if data could be lost if not collected immediately • Ability to document or validate human health outcomes • Ability to assign workers into exposure categories to permit exposure-response assessment • Adequate study size and statistical power • Ability to identify and locate subjects and records • Availability of an appropriate control or comparison population • Ability to address potential confounding factors • Ability to measure and disentangle the relevant environmental, behavioral, or other factors • Ability to reasonably estimate or document individual exposure • Adequacy of resources to support, conduct, and complete the study • Adequacy of support from employers and unions or other relevant stakeholders (eg, other federal agencies, state or local agencies or components, trade groups, etc) • Ability to provide participants with necessary confidentiality • Ability to address potential ethical issues and obtain expeditious Institutional Review Board (IRB) approval for time-sensitive research • For federal agencies, ability to obtain timely emergency clearance from the Office of Management and Budget (OMB) for survey instruments that fall under the jurisdiction of the Paperwork Reduction Act • Adequacy of preliminary or baseline data to support the study (this is implied in some of the above bullets)
Level of research interest	<ul style="list-style-type: none"> • Research arising from academic/research areas of interest • Contribution to established institutional program goals, such as emergency response research priority areas

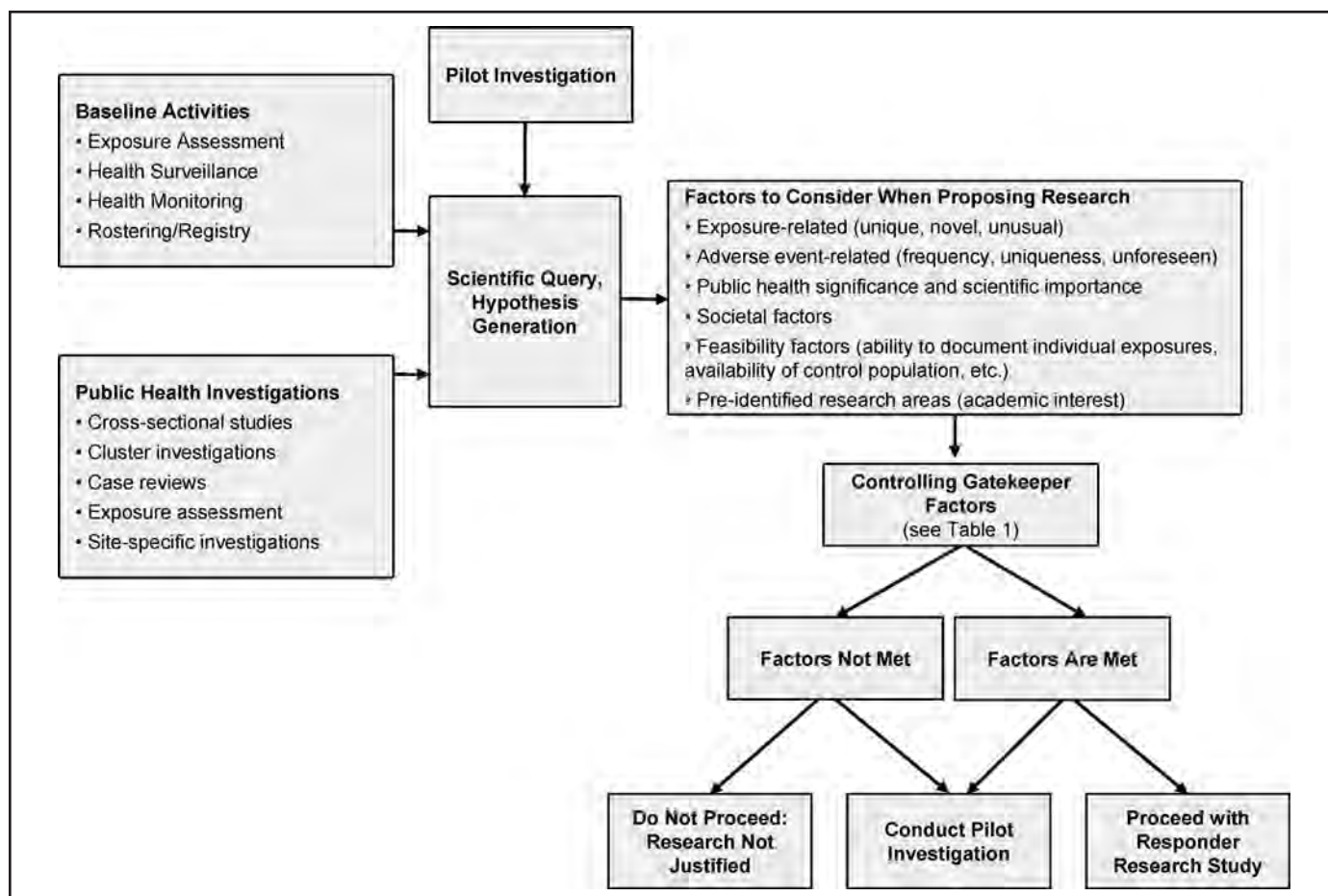


Figure 1. Process for determining whether to conduct responder research utilizing expert opinion.

The work group conducted a tabletop exercise to test and refine the above factors and to assess their utility in deciding whether to conduct a responder health research study. The group used as an example the response to the damage at the Fukushima Daiichi nuclear power facility, sustained in the March 2011 earthquake/tsunami, and focused on the release of radioactive contamination into the surrounding environment and the potential for radiation exposures to response workers. This exercise indicated that these factors/questions were useful in determining priority public health research questions and helped to elucidate various information, exposure, and resource needs. The exercise thus suggested that research could readily be justified, but the group did not have access to information that would have allowed it to consider other factors, such as feasibility. The exercise further illuminated the need for preplanning to provide

a timely science response to a large-scale disaster, focusing on predictable logistical needs, resource identification, interagency coordination, mechanisms for the systematic collection of data, etc for a variety of possible disaster scenarios. Waiting to address these issues until postevent can result in significant delays, inefficiency, and affect the likelihood of a successful study.

Proposed process for determining when to conduct a responder health research study

The process for determining whether to conduct a research study is informed by multiple inputs and considerations, as illustrated in Figure 1, but should begin with the development of a scientific query, expressed as a hypothesis (or hypotheses). Public health investigations that evaluate exposures and health outcomes among responders during the event

Table 2. Critical gatekeeper factors for determining if postdisaster research should be conducted

Critical gatekeeper factors	
Scientific query	Scientific queries must be based on sound theoretical foundations—the hypothesis (or set of hypotheses) must be testable and precise in construction, makes specific and unambiguous predictions, and clearly defines the research questions that the study will address.
Exposure-related	Actual exposures must be present, as well as a mechanism to characterize and document exposures. Without exposure, or exposure data, the research has a low probability of providing useful public health information.
	The proposed research should result in information about an exposure-outcome relationship.
Study design	Critical questions cannot be answered through any other less-costly or simpler way than through a responder research study.
	The research has sufficient scientific validity and the ability to answer questions that need to be answered. Confounders can be successfully addressed.
Feasibility factors	Identification and location of subjects and records are possible.
	Funding, other resources, and available expertise are sufficient to conduct the study through to its conclusion.
	Data-related logistic hurdles, including those related to study size, statistical power, and availability of exposure-outcome data, can be overcome.
	Regulatory-related clearances can be expeditiously obtained (ie, OMB approval for federal agencies and IRB clearance).

or health monitoring and surveillance efforts that document the health status of the responders may suggest one or more hypotheses worthy of further study. Pilot investigations that are exploratory in nature can also be hypothesis-generating. After hypotheses development, logical and transparent evaluation is important to determine if they truly merit the time and investment required for a research study.

The hypotheses will be informed by the “factors to consider” described in the preceding section. This is a complex process entailing considerable expert scientific judgment and should be conducted by a science planning team (described later). The process should be thorough, deliberative, systematic, and transparent, considering as many of the factors as possible based on available information.

Although consideration of the factors generally occurs after hypothesis generation, it may be necessary to evaluate some or all at earlier stages, and many can be evaluated in parallel. For example, exposures

measured or inferred during the event or observed adverse outcomes (eg, a cluster of cases) may identify significant knowledge gaps, question current understanding, and inform the need for a responder research study. Feasibility issues, such as access, support from workers and agencies, etc, are other examples of factors that can be considered before committing resources for more extensive studies.

While there are no predetermined thresholds for these factors, such as a particular level of increased incidence of adverse outcomes or degree of excessive exposure that necessarily trigger a decision for or against conducting a research study, there are several controlling (or “gatekeeper”) factors that must be satisfied for postdisaster responder research to proceed (Table 2). If any of these gatekeeper factors are not adequately satisfied, a responder research study should not proceed, or at a minimum, the research should be seriously reconsidered. It will often be advisable for the initial activities to be limited to baseline

activities or a pilot investigation to evaluate study feasibility or help determine whether health concerns justify a full-scale study. Even if the gatekeeper factors are met, prudence dictates that pilot investigations should be considered before the initiation of large, expensive responder health research projects.

As the ability to identify and locate subjects and records is a critical gatekeeper factor that crucially affects the feasibility of responder research following a large-scale disaster, development of a responder roster or registry can be particularly important, especially when the proposed research involves large numbers of responders. The absence of a registry or roster makes research studies difficult to conduct and possibly less accurate because identifying the universe of response and remediation workers postresponse can be very difficult, if not impossible. If only a subset of workers is identified and recruited as participants, they may not be representative of the entire workforce, and the study results will likely be skewed.

Discussion

Because of the many complexities associated with both the decision to conduct responder research and the actual conduct of responder research, analyzing in advance a prioritized set of potential disaster scenarios could help identify research opportunities. For example, it could be useful to evaluate research questions and knowledge gaps likely to arise and be amenable to study during a variety of incident types, including those foreseen in Federal Emergency Management Agency (FEMA) National Planning Scenarios.¹¹ Careful analysis in the planning stages enables the appropriate application of multidisciplinary expertise to identify scientific gaps, formulate well-defined hypotheses, and design potential studies within the life cycle of a disaster and the requisite phases of emergency management. Planning includes preidentification of subject matter experts in a variety of scientific disciplines and predetermination of data needs and systems for obtaining the necessary data (eg, exposure assessment and worker rosters).

To facilitate the decision process, the organization or agency contemplating research should, as part of its preplanning efforts, create a science planning team of

experienced subject matter experts from diverse scientific disciplines (eg, occupational medicine, industrial hygiene, toxicology, epidemiology, psychology, and emergency response). The team should be substantially separate from those primarily responsible for coordinating the immediate response. Once a disaster commences, the science planning team should rapidly convene to review, refine, and prioritize any previously developed generic plans to identify event-specific potential research needs, including a statement of rationale and importance. Scope of the effort (including approximate numbers of staff and potential costs) should also be estimated. This information should be reviewed and a determination made as to whether the research should be pursued. In some cases, the level of research interest may inform these determinations and may be reflected in an agency or institution's research agenda.¹²

The science planning team, supplemented by specific subject matter experts as appropriate, should be able to evaluate the information available and reach consensus on whether there are valid, testable, and relevant hypotheses or appropriate theoretical foundations, and whether a responder research study can be feasibly and productively conducted. The team should also be required to periodically reassess the need for conducting responder research because of the rapidly evolving nature of disasters and worker exposures.

Disaster response, especially for events where responder health research is anticipated, should routinely include collection of a core set of baseline data, such as exposure data, rosters of exposed individuals, and baseline health status.⁵ Failure to begin collecting critical data as early as possible can result in data that are unavailable, lost, or cannot be reconstructed, which can significantly affect study feasibility. Research plans as described above should include provisions for anticipatory data collection, including standard instruments for emergency or generic OMB clearance (in the case of federally sponsored research) and advance preparations for IRB approval, even if it is ultimately decided not to move forward with a research study.

As part of planning efforts for research initiatives, strong interagency communication and cooperation will be needed among federal, state, and local

governmental agencies (eg, health departments, workers compensation bureaus, labor departments, and FEMA) in the jurisdiction of the disaster. These discussions may be expedited before an event through discussions with relevant umbrella organizations, such as the Council of State and Territorial Epidemiologists, Association of State and Territorial Health Officials, and National Association of County and City Health Officials.

Finally, discussions with other public safety, public service, and nongovernmental organizations, including labor unions and educational institutions, are necessary to establish expectations, roles, and responsibilities related to research that may be considered during or following a disaster. In order for research projects—especially those requiring data collection from a large number of people—to go forward efficiently, it is imperative that workers and other participants understand the importance of the work, trust that it is being performed for their or for society's benefit (and not solely to fulfill institutional needs), and understand that the results will be shared with them when the data are collected and analyzed. Moreover, the affected workers themselves will be an asset, supplying specific knowledge and skills, including appropriate language and cultural sensitivities, which can strengthen data collection efforts.

Conclusions

The decision process on whether to proceed with a responder health research study can be segregated into various components that should be formally recognized as critical to determining whether a research study of responder health is warranted. The decision process should be formalized to ensure the best possible judgment and recommendation and may benefit from advanced planning in anticipation of possible events. Critical gatekeeper factors should be initially assessed and must be satisfied if a research study is to be initiated. A determination to conduct a study without sufficient information to develop the exposure-outcome relationship or without an initial hypothesis is not generally recommended and may be subject to ethical concerns. In the current austere fiscal environment, the recommended framework should ensure

that research that is most needed and justified will be identified and prioritized.

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References

1. Jackson BA, Baker JC, Ridgely MS, et al.: Protecting emergency responders: Safety management in disaster and terrorism response. DHHS (NIOSH) Publication No. 2004-144, Rand Publication No. MG-170. 2004. Available at <http://www.cdc.gov/niosh/docs/2004-144/pdfs/2004-144.pdf>. Accessed January 22, 2013.
2. Government Accountability Office: September 11: HHS needs to develop a plan that incorporates lessons from the responder health programs. GAO-08-610, May 2008. Available at <http://www.gao.gov/new.items/d08610.pdf>. Accessed January 23, 2013.

3. Kitt MM, Decker JA, Delaney L, et al.: Protecting workers in large-scale emergency responses. *JOEM*. 2011; 53(7): 711-715.
4. Department of Health and Human Services, Office of the Assistant Secretary for Preparedness and Response, National Biodefense Safety Board: Call to Action: Include Scientific Investigations as an Integral Component of Disaster Planning and Response. Available at <http://www.phe.gov/Preparedness/legal/boards/nbsb/Documents/nbsbrec14.pdf>. Accessed January 22, 2013.
5. National Response Team: Emergency Responder Health Monitoring and Surveillance Document, January 26, 2012. Available at <http://nrt.sraprod.com/ERHMS/>. Accessed January 23, 2013.
6. Protection of Human Subjects, 45 Code of Federal Regulations, part 46.
7. Agency for Toxic Substances and Disease Registry: *Guidance for ATSDR Health Studies*. April 1996, Available from the Division of Health Studies, Agency for Toxic Substances and Disease Registry, 4770 Buford Highway, Mailstop F-57, Atlanta, GA 30341-3717.
8. Popper K: *The Logic of Scientific Discovery*. New York: Basic Books, Inc., 1959.
9. Singleton RA, Straits BC: *Approaches to Social Research*. 3rd ed. New York: Oxford University Press, 1999.
10. Rothman KJ, Greenland S: *Modern Epidemiology*. 2nd ed. Philadelphia: Lippincott-Raven, 1998.
11. Department of Homeland Security: Office for Domestic Preparedness, National Preparedness Guidelines, 2007. Available at http://www.fema.gov/pdf/emergency/nrf/National_Preparedness_Guidelines.pdf. Accessed January 23, 2013.
12. NIOSH Emergency Preparedness Program Goals: Available at <http://www.cdc.gov/niosh/programs/epr/goals.html>. Accessed January 23, 2013.



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Emergency preparedness in a sample of persons with disabilities

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Abstract

Objective: The objective of this study was to characterize emergency preparedness in this vulnerable population, and to ascertain the role of the personal assistant (PA) and the potential impact of prior emergency experience on preparedness efforts.

Design: Cross-sectional Internet-based survey conducted in 2011.

Setting: Convenience sample.

Participants: Two-hundred fifty-three community residents with cognitive and/or physical disabilities, all receiving personal assistance services.

Main outcome variables: Emergency preparedness, operationalized as responses to a seven-item scale.

Results: The mean score for the emergency preparedness scale was 2.32 (SD = 2.74), range 0-7. Even though 62.8 percent ($n = 159$) of the participants had previously experienced one or more large-scale emergencies, only 47.4 percent ($n = 120$) of the entire sample and 55.3 percent ($n = 88$) of those with actual emergency experience reported preparing an emergency plan. Sixty-three percent ($n = 76$) of those reporting a plan had involved their PA in its development. Participants who reported such involvement were significantly more likely to have higher scores on the emergency preparedness scale ($p < 0.001$). Participants who had experienced a prior emergency were also more likely to score higher on the emergency preparedness scale ($p < 0.001$). In general, participants reported limited attention to other basic preparedness recommendations: only 28 percent ($n = 70$) had prepared a "go-bag" with necessary supplies, 29 percent ($n = 74$) had developed a strategy for

communicating with their PA during emergencies, and 32 percent ($n = 81$) had stockpiled emergency supplies. Of particular importance, only 26 percent ($n = 66$) had made alternative back-up plans for personal assistance.

Conclusions: Involving the PA in the planning process and experiencing an emergency were both significantly associated with higher emergency preparedness scores in this sample of people living with disabilities. However, critical deficiencies in preparedness were noted, such as lack of back-up plans for replacing their PA. Despite a concerted national effort to improve preparedness in the population of people living with disabilities, important preparedness gaps remain. These findings highlight the need for additional study on emergency preparedness barriers in people living with disabilities so that effective strategies to reduce vulnerabilities can be identified.

Key words: disabled, disaster preparedness, personal assistant

Introduction

Past emergency events, such as Hurricane Katrina in 2005, the 2010 Haiti earthquake, the 2001 World Trade Center disaster, and many other natural and man-made disasters, underscore the vulnerability of certain segments of the population.¹⁻⁴ People with disabilities and those with chronic health conditions may be at increased risk of morbidity and mortality because of difficulties in responding rapidly or taking necessary protective actions during emergency situations.⁴⁻⁷ In a study by Chou et al.,⁶ persons with moderate physical disabilities had a significantly

greater risk of mortality than persons without such disabilities (OR = 1.7, 95% CI = 1.2-2.3). Similarly, in a case-control study by Osaki et al.⁷ that examined the risk factors associated with mortality during the 1995 Hashin-Awaji earthquake in Japan, persons with physical disabilities were much more likely (OR = 5.6, 95% CI = 1.61-19.78) to have died compared to controls matched on sex and age.

Some disaster researchers suggest that this increased risk is due not only to physical vulnerabilities but also to the compounding effects of social vulnerabilities, such as poverty. Data indicate that persons with disabilities have an increased likelihood of lower educational levels, higher unemployment rates, lower income, and fewer social supports compared to persons without disabilities.^{8,9} In the aftermath of disasters, people with disabilities also have an increased risk of other adverse outcomes, such as loss of permanent housing, loss of possessions, and increased financial hardship compared to people without disabilities.¹⁰⁻¹²

In an effort to improve disaster-related outcomes and to support community and individual-level resiliency, the US federal government has invested several billion dollars to improve preparedness.^{13,14} Although there is recent evidence that this approach has led to improvements on specific elements of preparedness, most community-level studies continue to indicate that a sizable proportion of the population is still unprepared on even the most basic planning elements.¹⁵ For example, a 2010 Zogby survey found that only 46 percent of the general public had an emergency plan.¹⁶ Similarly, a 2011 Marist survey found that while 49 percent had a plan, 30 percent of those with a plan lacked key plan elements, such as emergency supplies of food and water.¹⁷ Some emergency experts contend that the economically disadvantaged and the elderly are especially likely to be unprepared.^{15,18} Others suggest that women and non-English speakers,^{19,20} and individuals with disabilities should also be included in this group, and in fact, recent studies generally indicate that people living with disabilities are more likely to report subpar levels of preparedness compared to those without disabilities.^{21,22} In a large study of respondents to the

2006-2007 Behavioral Risk Factor Surveillance System, Smith et al.²² noted that only 25.8 percent (n = 1,740) of the participants reporting a disability believed they were “very prepared” for an emergency, with 53.3 percent (n = 3,616) indicating that they were “somewhat prepared” and 20.7 percent (n = 1,397) reporting that they were “not at all prepared.” In addition, only 33.5 percent (n = 2,277) of the participants with a disability reported having an evacuation plan.²² In another study, comparing the preparedness of people with a functional-based disability (in this case, transportation-related special need) to the general population, although special needs households were more likely to have located a shelter, arranged a meeting place, and packed a go-bag, they were no more likely to have created a plan for evacuation or to have purchased food and other supplies.²³ Other research, focused on preparedness at the home health and personal care agency-level, showed that disaster planning and response capabilities were very limited, with most agencies reporting that they expected the clients’ families and local emergency responders to assist clients when necessary.²⁴ At the caregiver level, preparedness and response is problematic as well. In a 2010 survey that Gershon and colleagues conducted on pandemic preparedness among New York City home-care aides (N = 374), 57 percent of aides responded that they would be unwilling to report to duty at their recipient’s home during a disaster and 62 percent had secondary competing obligations that would limit their ability to do so.²⁵ Taken together, these findings suggest that preparedness at multiple levels may be suboptimal for persons with disabilities living in the community. While improvements in preparedness appear to have been made in the general population, the disabled population appears to be lagging behind, despite nearly a decade of increased activities to improve this by Federal Emergency Management Agency (FEMA), the Centers for Disease Control and Prevention (CDC), the National Organization on Disability, the National Institute for Disability and Rehabilitation Research, Disabled World Towards Tomorrow, American Red Cross, American Public Health Association, disAbility Preparedness, and many other governmental and nongovernmental agencies.^{8,9,18,26-36}

Studying the preparedness of people with disabilities is important because they represent a large proportion of the population. In the United States, there are an estimated 56.7 million people (nearly one in five people) with at least one disability.³⁷ A large proportion of these, approximately 30 million, report difficulty with ambulatory activities,³⁷ and more than 15 million American adults have some form of cognitive disability.³⁷ More than one in five people with a disability require assistance with one or more activities of daily living (ADLs) or instrumental activities of daily living (IADLs).³⁷ For people living with a disability and receiving some form of personal assistance, it would seem that involving the personal assistant (PA) in the preparation of emergency plans would be central to personal disaster planning. However, information on disaster planning among people living with a disability is very limited, and even more so with respect to the level of engagement of the PA in the planning process. Similarly, as experiencing a prior emergency should provide strong motivation for developing an emergency preparedness plan,^{11,38} we were particularly interested to determine if that same pattern would be replicated in a sample of people living with disabilities.

The objective of this study was to characterize emergency preparedness in this vulnerable population and to ascertain the role of the PA and the potential impact of prior emergency experience on preparedness efforts.

Methods

Study design and participants

This cross-sectional study was conducted in 2011. Over a 6-week period, a self-administered survey was made available on the Internet using a Web-based tool,³⁹ with participants recruited through public requests on multiple disability list serves (Centers for Personal Assistance Services [PAS] based at the University of California, San Francisco; coalition of People of Disabilities; National Council on Independent Living; etc). The survey was developed with input from experts in personal emergency preparedness planning efforts for people with disabilities and expertise on the issues

associated with the independent living needs of those requiring personal assistance services. Survey data were transferred to a statistical software program for analysis.

Eligibility criteria included: 1) disability status and 2) receipt of personal assistance services. The first two questions of the online survey reiterated the requirements for participant eligibility and individuals who did not meet these eligibility criteria were not able to further complete the survey. In some cases (2 percent, $n = 5$), the survey was completed by the parent of a child with a disability. All study procedures had human subjects protection approval of the Public Health Institute's Institutional Review Board.

Questionnaire development and design

A 37-item study questionnaire included several contingency questions, such as "if you had made a plan for communicating with your PA, how would you do so?" The questionnaire was written in English and prepared at a 6th grade reading level using the Flesch-Kincaid Grade Level Readability Test.⁴⁰ The final draft was reviewed by disaster preparedness and disability experts for content validity. The questionnaire included items that addressed four major domains: demographics; disability and personal caregiver status; emergency preparedness planning; prior emergency experience, including the level of engagement of the caregiver during that event and lessons learned from that experience. Most items had categorical or dichotomous response formats although there were several open-ended questions.

Study measures

Demographics. The four items addressed were age, gender, race, and ethnicity.

Disability and personal assistance status. With items derived from the American Community Survey of the US Census Bureau,⁴¹ respondents were asked to indicate if they had hearing, visual, cognitive, and/or mobility disabilities, and if they needed assistance in bathing and dressing. They were also asked if they needed help performing errands or chores. With respect to their PA, respondents were asked how many

hours per week they used paid or unpaid assistants and the source of their assistant (eg, governmental agency, private agency, consumer-directed model, or other).

Emergency preparedness planning. Seven items addressed preparedness planning; respondents were queried as to whether or not they had prepared the following: 1) a personal emergency plan; 2) an evacuation plan; 3) an easy-to-carry go-bag with critical items, such as cell phone, medications, flashlight, etc; 4) emergency supplies on hand, such as extra food, batteries, supplies, and equipment; 5) a communications plan for contacting their PA; 6) an emergency contacts list; and 7) a back-up plan for assistance in the event their PA could not reach them during an emergency. Additional items determined whether or not the respondent had tested their plan, if they had shared their plan with some or all of their assistants, followed by one open-ended question on reasons for not sharing their plan with their PA.

Prior emergency experience. Several items collected information on the type of emergency event respondents had experienced, the length of warning that they had before the event, the personal assistance they received during and immediately after the event, whether or not they evacuated to a shelter, and whether or not their assistant accompanied them to the shelter. Respondents were asked if they had found any aspects of their preparedness plans in place at the time of their last emergency experience particularly helpful to them and, if so, to explain how these were helpful. There was also an open-ended question on any lessons learned from that experience, including changes that the participants made to their emergency planning and advice they might want to share with other people with disabilities.

Statistical analysis

After data cleaning and editing procedures, frequency distributions and descriptive summary statistics and other analyses were performed. The level of significance was set at an alpha level of 0.05, two-tailed. Pearson's χ^2 analysis was used to assess relations between categorical items and the outcome

variable (preparedness). To determine the association between emergency preparedness and both the PA involvement in the planning and prior emergency experience, the emergency preparedness scale was dichotomized (1 = score of 0-2; 2 = score of 3-7) and then odds ratios and their 95% confidence intervals (CI) were estimated. All analyses were conducted using SPSS 21.0.⁴²

Results

Demographics

The majority of the sample was white (67 percent, $n = 169$). Twelve percent ($n = 31$) of the sample self-identified as Hispanic. Forty-nine percent ($n = 124$) of the sample reported that they were female, 39.1 percent ($n = 99$) reported that they were male, with 30 individuals declining to answer this question. The mean age was 47.8 (SD = 14.55), mode = 55, median = 50 and ranged from 8 to 87 years.

Disability and personal assistance status

Mobility disabilities were most commonly reported, with 69 percent ($n = 175$) of the sample reporting this type of disability. Many participants also reported difficulties with activities of daily living; 58.5 percent ($n = 148$) reported serious difficulties with dressing or bathing and 53.4 percent ($n = 135$) required assistance with doing chores or doing errands. Twenty-one percent ($n = 53$) of the participants reported serious difficulties with concentrating, remembering, or making decisions; 13.8 percent ($n = 35$) reported serious difficulty seeing (even when wearing glasses); and 5.5 percent ($n = 14$) reported serious problems with their hearing.

Participants received varying hours of paid help per week: 20.2 percent ($n = 51$) received over 40 hours per week, 21.3 percent ($n = 54$) received 25-40 hours per week, 17.8 percent ($n = 45$) received 9-24 hours per week, 24 percent ($n = 60$) received 8 hours or less a week, and the remainder (17 percent, $n = 43$) did not indicate any paid assistance and presumably they had unpaid assistance. A sizeable proportion (39.5 percent, $n = 83$) of those reporting paid assistance ($n = 210$) hired their own help, 26.7 percent ($n = 56$) reported

that the PA was provided to them through a government agency, 14.2 percent (n = 30) said their assistant came from a private agency, 6.2 percent (n = 13) indicated that they had used an “other” resource for obtaining assistance (Center for Independent Living, family member, etc), and the remainder (13.3 percent, n = 28) did not indicate the source of their assistant.

Emergency preparedness planning

The seven-item emergency preparedness scale had a mean scale score of 2.32 (SD = 2.74), mode = 0, median = 0, and a range of 0-7 (each item was assigned 1 point, if the respondent did not indicate having *any* of the seven items, they were assigned a score of 0; more than 50 percent of respondents had a score of 0 and thus the median is zero). The Cronbach alpha was .93 (95% CI = 0.916-0.942), indicating a good internal consistency for this scale. Nearly half of the sample (n = 120, 47.4 percent) reported that they had an emergency plan, and of these, 63.3 percent (n = 76) indicated that they had involved their PA in its development. Fifteen percent (n = 18) of those with a plan (n = 120) indicated that they shared their plan with all of their PAs, 8.3 percent (n = 10) indicated that they shared their plan with only some of their PAs, 10 percent (n = 12) reported that they did not share their plan with any of their PAs, and 66.7 percent (n = 80) declined to respond to this question. Of the individuals (36.7 percent, n = 44) who reported having a plan yet not involving their PAs in its development, the common reasons given for not sharing their plan with PAs included: “My PA will be busy tending to the needs of their own family members,” “The PA is just not that dependable,” “Experience tells me I can’t count on them,” “I have a new PA and they did not help me develop the plan,” “She is not family,” and “I might not be with my PA when an emergency occurs.” Of those reporting a plan, 57.5 percent (n = 69) reported that they had actually tested their ability to implement the plan. Involvement of the PAs in the emergency plan was strongly associated with emergency preparedness; 90 percent of the respondents that had involved the PA in the planning had an emergency preparedness scale score of 3 or greater (OR = 41.66, 95% CI = 18.18 - 90.91). Because of the different

size n’s for those that involved and those that did not involve the PAs, and the small n in one of the cells of the crosstabs, the odds ratios are unstable and should be interpreted with caution.

Responses to specific preparedness planning elements for the entire sample of 253 respondents were as follows: 34.8 percent (n = 88) of the participants reported having an evacuation plan, 27.7 percent (n = 70) had a go-bag ready, 32.0 percent (n = 81) had emergency supplies available, and 29.2 percent (n = 74) had a way to communicate with their PA in case of an emergency. Of the 74 people who indicated that they did have a way to communicate, the following means of communication included one or more of the following: cellphones (94.6 percent, n = 70), landlines (60.8 percent, n = 45), text messages (43.2 percent, n = 32), e-mails (43.2 percent, n = 32), online social networks (10.8 percent, n = 8), two-way radio (2.7 percent, n = 2), ham radio (1.4 percent, n = 1), and pager (1.4 percent, n = 1). In terms of having an emergency contacts list, 34.8 percent (n = 88) of the respondents indicated that they did have such a list. For the item that asked if they had emergency items on hand, such as medications, 30.4 percent (n = 77) of the participants indicated that they did have these items readily available at all times. Regarding the planning for an alternative source of personal assistance in case their regular PA would not be available to assist them during an emergency, only 26.1 percent (n = 66) of participants reported that they had made alternative back-up plans. For those participants indicating an alternative back-up plan, respondents reported that they would rely on one or more of the following: family members, friends, neighbors, roommate, church members, coworkers, and local nursing home. A very small proportion, 4 percent (n = 10) reported that they intended to hire another PA “on the spot.” A modest proportion of all respondents, 20.2 percent (n = 51), reported that the agency providing for their care would allow their PA to accompany them to continue to provide services if they were evacuated to another area (such as a shelter or a hotel).

Communications during an emergency was problematic. Only 20.6 percent (n = 52) of participants reported that there was an emergency warning alert

system in their community, with 14.2 percent ($n = 36$) unsure if such a service was available in their community. Participants were generally not involved in preparedness planning within their community; only one (0.4 percent) participant reported being involved in community emergency drills.

Prior emergency experience

A large proportion of the sample reported prior emergency experiences (62.8 percent, $n = 159$). The types of previous emergencies that the participants had experienced were varied and included one or more the following: a) weather-related natural disaster: storms (28.3 percent, $n = 45$), hurricanes (19.5 percent, $n = 31$), earthquakes (10.7 percent, $n = 17$), heat waves (9.4 percent, $n = 15$), tornadoes (8.2 percent, $n = 13$), tsunamis (3.8 percent, $n = 6$), and cold waves (4.4 percent, $n = 7$); b) fires (10.7 percent, $n = 17$); and c) terrorist attacks (1.3 percent, $n = 2$). Most participants who had experienced a prior emergency and who also provided information on the type of warning they had received prior to the event either reported no warning (37.6 percent, $n = 60$), or one of a very short duration (less than one day, 29.4 percent, $n = 47$). However, a sizable number did report receiving longer advance notice (at least a day's notice) (32.9 percent, $n = 52$). During or immediately after the event, 61.6 percent ($n = 98$) of participants reported that their PA was with them, and, of these, a large proportion (85.7 percent, $n = 84$) said that their PA stayed with them. If the PA was not with the participant at the start of the event, 27.7 percent ($n = 41$) reported that their PA did manage to get to them at a later point, although the time it took to reach them ranged from several hours to several days. Therefore, during or soon after the event, 87.4 percent ($n = 139$) of the participants had the assistance of their PA and 12.6 percent ($n = 20$) did not. Those without their PA's immediate help were provided with assistance by family members (including young children), friends, neighbors, coworkers, building managers, other source (FEMA, National Guard, fire department, state school for the blind, etc), or no one. Many participants (61 percent, $n = 97$) reported that they were able to stay in their home during the event

because of their preplanning, others stated that they were forced to stay in their home because of the lack of preplanning. A small proportion (5.7 percent, $n = 9$) was evacuated to shelters, others (28.3 percent, $n = 45$) were evacuated to another location (including hotels, family members, friend's home that was wheelchair accessible, fire station, military base, and PA's home, etc), and eight (5 percent) individuals declined to answer this question. Prior emergency experience was significantly associated with higher scores on the emergency preparedness scale ($OR = 4.42$, 95% $CI = 2.45-7.99$).

The things that participants found helpful during an emergency included: a) having emergency items, such as medications, phone, etc, immediately available to them (71.7 percent, $n = 114$), b) having stores of emergency supplies at home such as food, blankets, and batteries (48.4 percent, $n = 77$), c) having a go-bag (39 percent, $n = 62$), and d) having an evacuation plan (39 percent, $n = 62$). Of those people ($n = 120$) who had a plan prior to the emergency event, 41.5 percent ($n = 66$) said they had changed aspects of their plan after their most recent emergency. As shown in Table 1, the aspects of the plan that were changed relate to: a) revised items to be carried/included in the go-bag; b) having made a relocation plan; and c) changes made to safely stay at home.

After having experienced a disaster, specific advice that participants would give to other people with disabilities, included: a) having all essential information and contacts' information readily available and a plan for maintaining communication with these contacts; b) anticipating the need for alternate care providers, planning for back-up power for assistive devices, having back-up supplies of medications and other supplies readily available; c) preparing a specific plan, practicing and updating it, and being ready to fully implement it; and d) making preparations for evacuating on short notice. These tasks are detailed in Table 2.

Discussion

Having a plan and engaging the PA in the plan was clearly associated with higher emergency preparedness scores. However, serious deficiencies in emergency

Table 1. Changes made to existing emergency plan after experiencing an emergency (n = 69)

Revised items to be carried/included in go-bag:

- Added a list of all medications that I routinely take.
- Added money to the easy-to-carry go bag.
- Put actual supplies in the grab bag.
- Started carrying all of my grab bag items in case I am out of the home during the emergency.
- Now I carry 3 days of medications with me at all times.
- Added more supplies to grab bag, including pillow and blankets to help me be more comfortable.
- Added more flashlights, solar lights, batteries, and nonperishable food to grab bag.
- I packed my grab bag to last me a month instead of a week.
- Now I keep copies of important documents in more than one place.

Made a relocation plan:

- Made an off-site evacuation plan.
- Added my name to a special needs shelter.
- Found an alternate living situation that is completely accessible.
- Moved to a more accessible area.
- Added myself to the evacuation list at the Department of Health.
- I found a list of evacuation shelters in my area.
- Planned for who would take care of my pet.
- Changed agencies as my agency would not let my PA take me to the hospital.
- I started advocating better for people with disabilities and for our inclusion in any community planning.

Made changes to remain safely at home and maintain in contact:

- Prepared an emergency contacts list and shared this list with my providers and family members.
- Developed a communications plan.
- Bought a home generator.
- Added a back-up PA to my plan.
- Added a landline phone.
- Now keep my call button within better reach.

Table 2. Preparedness advice for persons with disabilities, from persons with disabilities with actual emergency experience

Have essential information readily available

- Have an updated contacts list.
- Let your PA know who has your Power of Attorney.
- Have an updated list of your medications and care needs.

Anticipate alternative care providers, access to devices, medication, other key resources

- Remember that your PAs may be restricted in traveling for several days after a bad storm.
- Stay with your caregiver no matter what.
- If possible, hire a live-in attendant.
- Always have a back-up PA in case yours cannot come.
- Train others on some of your special needs (eg, feeding tube, so that they can help you in case you need extra help).
- Talk to plenty of other people besides your PA about your plan and get a commitment from them that they will provide help.
- Have several back-up contacts; network with everyone you know.
- Make sure the local fire department knows that you may need help.
- Know the manual operations for your medical equipment.
- Always keep your cell phone charged.
- Keep extra cash to pay your PAs in case they cannot get paid through their regular mechanisms.
- Get a home generator if you rely on electricity for your care.
- Have a battery operated radio in your home; have batteries handy.
- Keep your medications in a water proof tub along with a list of the medications.
- Always keep large plastic bags available to fit over controls and wiring of wheelchair if you use one.
- Keep water purification tablets handy—it was hard to reach the large water tankers that came around my neighborhood and I could not carry the bottles.

Develop an emergency preparedness plan

- Do not procrastinate about making a plan.
- Write out your plan and update it.
- Always communicate your plan with your PAs.
- Be prepared and practice your plan.
- Drill through your plans several times.

Table 2. Preparedness advice for persons with disabilities, from persons with disabilities with actual emergency experience (continued)

- Talk with others who have been through an emergency.
- Understand your local community's emergency plans.
- Prepare for all types of different emergencies.
- Prepare a contract between you and the PAs regarding their responsibility to you during an emergency.
- Hire PAs that agree with your plan.
- Make sure your PA is in agreement with staying with you if you have to shelter in place.
- Share your plan with the agency and make sure they agree to it.

Preparations for an emergency evacuation

- Know where the public safety centers are located (fire stations, police departments, etc).
- Have a plan to access various shelters—you do not want to start looking for them in an emergency.
- Make a very specific list of things for your PA to pack for you in case you are evacuated.
- Do not rely on your shelter for all of your needs; bring bedpans, catheters, med supplies, and anything else you may need with you.
- Check the expiration date periodically on your medications designated for your evacuation.
- Have at least two transportation options.
- Heed the weather advisories and do not wait until the last minute.
- Set up a meeting place for all family members.

Other advice

- Stay calm.
- Have patience.

preparedness remained, even for those who had involved their PA in their planning effort. Of particular note was the lack of sharing the plan with all of their PAs for those with multiple PAs. Also of concern was the absence of planning for back-up assistance in the event that the PA was unavailable to provide help. For the proportion reporting that they were without personal assistance from any source during an actual emergency, it is not known to what extent their assistance needs were adequately met and what impact this may have had on their health and well being. Identifying back-up care providers and sharing the

plans with all PAs are critical preparedness strategies for people with disabilities. For some participants, distrust in the PA's reliability seems to be a barrier to sharing the plan, and this requires further investigation to understand the roots of this lack of trust. There was also evidence of a lack of preparedness on other basic elements of a plan, such as having an emergency contacts list or back-up sources of necessary supplies and medications. This could be a problem if relocation is needed, as many shelters will most likely not be able to quickly supply these essential items. FEMA²⁸ provides sample lists of durable medical equipment and

consumable medical supplies to assist emergency managers in their planning and preparation to meet the needs of individuals with disabilities, but the extent to which these items are actually available at shelters is not well known. An example of one of the many preparedness tip sheets for people with disabilities is provided by the American Public Health Association. Their “Get Ready”³³⁻³⁶ tip sheets advise people with disabilities to conduct a personal assessment of the items that are needed on a daily basis, while emphasizing the need to know the types of disasters most likely to occur in their community. Importantly, people living with disabilities are advised to consider how a disaster might affect critical medical equipment, such as powered medical equipment and assistive devices, and how emergency back-up power will be provided. This guidance echoes many of the recommendations that the study participants offered, following their own experience with a disaster (see Table 2).

Besides the lack of involvement with the PA, including sharing the plan with them, study participants rarely reported that they had planned for communicating with their PA during an emergency. Almost one-third of the participants experiencing an emergency reported that their PA was not with them, and that, in some cases, there was an extended delay before the PA could finally reach them. Having a communication plan in place might have helped them to stay in contact with either their PA or back-up providers. Multiple sources of communication should be considered in case land lines are not in operation or if cell phone towers are inoperable or overloaded. Engagement with community disaster planners is encouraged for all community members, and especially for people living with a disability, as this may be an excellent source of information on various options available for obtaining back-up power, or obtaining help with transportation. Participation in community drills would inform people with disabilities about the steps their own community has taken in terms of community-level preparedness. Our findings also underscore the need for determining if the PA will be able to accompany the client to a relocation site. The need for the PA’s assistance in performing activities of daily living may be needed wherever the individual relocates.

Our results are similar to those of other fairly recent studies exploring preparedness of people with disabilities. For instance, Smith et al.,²² in a much larger sample, found similarly low levels of preparedness in this population. Ballantyne et al.⁴³ observed that perceiving external agencies and authorities as responsible for one’s personal safety can reduce an individual taking action to lessen his/her risk of harm.⁴³ The reliance on PAs for assistance may have a similar impact on preparedness planning for persons with disabilities and it may explain the deficiencies in preparedness reported in this sample.

We found that there was a fourfold increased likelihood of preparedness given a prior emergency experience. Other studies have also found that prior disaster experience correlates with some improvements in emergency planning at the individual level.^{38,44,45} Research is mixed, however, on the extent of changes in planning that are sometimes made following disaster experience, with simpler changes, and those that are perceived to be more controllable, most likely to be made.^{46,47} The changes that the participants made in improving their preparedness after they had experienced an event focused on the gaps that became evident during the experience. Some of the changes that were made as a result of actually experiencing a disaster were quite simple, such as adding cash to their go-bag, but other changes required much more complex action and resources, such as moving to a more accessible location and buying a home generator. The specific advice that the participants provided for other people living with disabilities similarly covered a range of planning activities, from sharing the plan with the agency, to hiring a live-in attendant. Some of the advice was very heartfelt, such as “have patience” and “be calm,” while other advice was very practical, such as heeding weather advisories. All of the advice was based on the “lived experience” of the participant, thereby making it very valuable.

Recommendations

Based on these findings, a number of recommendations are made. The most important of these is to involve the PA in the development of the emergency preparedness plan. Steps needed to ensure back-up assistance, power, and to safely evacuate to another

location should be discussed and agreed upon. People living with disabilities should be encouraged to prepare a list of their current necessary medications, supplies, equipment, etc, that they are dependent upon. Back-up plans for communicating with their PA, members of their support team, family members, their healthcare providers, or any other key contacts, such as the power company, should be made and included in the emergency plan. Guidance on preparedness is now available from multiple sources, and the responsibility for ensuring that the plans are in place and that guidelines are followed should be shared between the individual and the leadership at the agency overseeing or providing personal assistance. Leadership at agencies representing the traditional agency model (formal provider) or the newer consumer-directed model should ensure that their clients are informed of the agencies' emergency planning. This will allow individuals to tailor their own plans with the full knowledge of the capabilities of the agency, if, in fact, they receive services through an agency. This will also be beneficial in terms of identifying other needed resources (eg, transportation to a shelter).⁴⁸ It would be helpful to have the agency provide the necessary linkages to local resources; in the absence of this, clients need to take the initiative in identifying these resources (power companies, local shelters, etc). Plans should include the role and responsibility of the PA in ensuring that the client has adequate transportation prearranged. It is the responsibility of the agency to conduct organizational preplanning, such as identifying alternate transportation and surge capacity to reduce the barriers care providers might have in reaching their clients during an emergency. Agencies are also responsible for emergency preparedness training programs for their care providers, and these programs should stress the importance of communication planning as well as the agencies guidelines and policies on the caregivers responsibilities. These policies should be shared with the client as well to help clarify the capabilities and expectations of both parties and to help build a climate of trust.

Limitations

Because this study used a cross-sectional design, causality cannot be ascertained. Further, since the

participants self-reported, it is possible that participants provided socially desirable responses, although the anonymous nature of the survey may have mitigated this to some degree. Finally, this was a relatively small sample of people with disabilities, recruited from list serves, and there may be response bias and lack of generalizability to other people with disabilities. However, our findings are similar to those of a much larger and diverse survey²² and are an important first step in discerning the potential role of the PA in the emergency planning of people with disabilities. Clearly, additional nationally representative random sample studies are warranted, as well as more in-depth qualitative studies, to increase our knowledge on the barriers to preparedness in this context.

Conclusions

The vulnerability to emergencies that people with disabilities have can be mitigated to some extent by three major factors: the availability of personal assistance, experience with prior disasters, and most importantly, disaster preparedness. In this study, we provided evidence of the important role of the PA in emergency preparedness. Careful preparedness planning, in close consultation with the PA, can result in a higher degree of preparedness. Therefore, there is a compelling need for specialized training and education of the PAs with respect to emergency preparedness. It may be helpful to provide dyad training on emergency preparedness for these and other vulnerable populations, such as home-care recipients and their homecare aides. Clearly, in spite of numerous resources and readiness campaigns launched in the past decade, much more work remains to be done, especially in better understanding the barriers to preparedness in vulnerable populations. Researchers have developed models of preparedness that integrate and build on health research on protective behaviors and suggest that the goal of improving disaster preparedness will be achieved by applying these models.⁴⁹ Research is, therefore, needed on the factors that motivate people to prepare for disasters, as well as the barriers to preparedness. This may help inform more effective strategies for preparedness planning and risk reduction with this and other at-risk groups. This avenue of research may lead to more

effective ways of assuring the preparedness of these populations, thereby reducing their vulnerabilities.

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References

1. Powell R: *The Impact of Hurricanes Katrina and Rita on People With Disabilities: A Look Back and Remaining Challenges*. Washington, DC: National Council on Disability, 2006.
2. Ridgeway J: *Katrina: A Story of Survival and Papa Joe's New Community. Impact: Feature Issue on Disaster Preparedness and People with Disabilities*, Volume 20. Minneapolis, MN: Institute on Community Integration, University of Minnesota, 2007: 1-36.
3. Hemingway L, Priestly M: Natural hazards, human vulnerability, and disabling societies. *Rev Disabil Stud*. 2006; 2: 57-67.
4. Gershon RRM, Magda LA, Riley HEM, et al.: The World Trade Center evacuation study: Factors associated with initiation and length of time for evacuation. *Fire Mater*. 2012; 36(5-6): 481-500.
5. Boyce J: Let them eat risk? Wealth, rights and disaster vulnerability. *Disasters*. 2000; 24(3): 254-261.
6. Chou Y, Huang N, Lee C, et al.: Who is at risk of death in an earthquake? *Am J Epidemiol*. 2004; 160(7): 688-695.
7. Osaki Y, Minowa M: Factors associated with earthquake deaths in the great Hanshin-Awaji earthquake, 1995. *Am J Epidemiol*. 2001; 153: 153-156.
8. Disabled World Towards Tomorrow: Disaster and emergency planning for seniors and persons with disabilities. Available at <http://www.disabled-world.com/disability/emergency/#reference>. Accessed January 22, 2013.
9. Disabled World Towards Tomorrow: Disability in America infographic, 2011. Available at <http://www.disabled-world.com/disability/statistics/american-disability.php>. Accessed January 22, 2013.
10. National Council on Disability: The State of Housing in America in the 21st century: A disability perspective. Letter of Transmittal 2010. Available at http://www.ncd.gov/publications/2010/Jan192010#_Toc948. Accessed January 16, 2013.
11. Masozera M, Bailey M, Kerchner C: Distribution of impacts of natural disasters across income groups: A case study of New Orleans. *Ecol Econ*. 2007; 63(2-3): 299-306.
12. Fothergill A, Peek LA: Poverty and disasters in the United States: A review of recent sociological findings. *Nat Hazards*. 2004; 32: 89-110.
13. Federal Emergency Management Agency: Ready, 2012. Available at <http://www.ready.gov/>. Accessed January 22, 2013.
14. Federal Emergency Management Agency: Citizen corps, 2012. Available at <http://www.citizencorps.gov/>. Accessed January 22, 2013.
15. DeBastiani SD, Strine TW: Household preparedness for public health emergencies—14 states, 2006-2010. *Morbidity Mortality Weekly Report*. 2012; 61(36): 713-719.
16. Federal Signal Safety and Security Systems: Uncovering the safety concerns of Americans, 2010. Available at http://www.alertnotification.com/pdf/federal_signal_public_safety_survey.pdf. Accessed January 16, 2013.
17. National Center for Disaster Preparedness: *The American Preparedness Project: Executive Summary; Where the US Public Stands in 2011 on Terrorism, Security, and Disaster Preparedness*. New York: National Center for Disaster Preparedness, Mailman School of Public Health, Columbia University, 2011.
18. Centers for Public Health Preparedness Network: 2006-2007 ASPH/CDC vulnerable populations collaboration group preparedness resource kit, 2007. Available at <http://preparedness.asph.org/perlc/documents/VulnerablePopulations.pdf>. Accessed January 16, 2013.
19. Ablah E, Konda K, Kelley CL: Factors predicting individual emergency preparedness: A multi-state analysis of 2006 BRFSS data. *Biosecur Bioterror*. 2009; 7(3): 317-330.
20. Murphy ST, Cody M, Frank LB, et al.: Predictors of emergency preparedness and compliance. *Disaster Med Public Health Prep*. 2009; 7: S1-S8.
21. Bethel JW, Foreman AN, Burke SC: Disaster preparedness among medically vulnerable populations. *Am J Prev Med*. 2011; 40(2): 139-143.
22. Smith DL, Notaro SJ: Personal emergency preparedness for people with disabilities from the 2006-2007 Behavioral Risk Factor Surveillance System. *Disabil Health J*. 2009; 2(2): 86-94.
23. Uscher-Pines L, Hausman AJ, Powell S, et al.: Disaster preparedness of households with special needs in southeastern Pennsylvania. *Am J Prev Med*. 2009; 37(3): 227-230.
24. Daugherty JD, Eiring H, Blake S, et al.: Disaster preparedness in home health and personal-care agencies: Are they ready? *Gerontology*. 2012; (58): 322-330.
25. Gershon RRM, Magda LA, Canton AN, et al.: Pandemic-related ability and willingness in home healthcare workers. *Am J Disaster Med*. 2010; 5(1): 15-26.
26. American Red Cross Disaster Services: Disaster preparedness for people with disabilities. Available at http://www.handicap-international.fr/bibliographie-handicap/5CooperationInternationale/contextes_urgence/DisasterPrepa.pdf. Accessed January 15, 2013.
27. Disastersrus.org: disAbility preparedness: Get a plan. Available at http://www.disastersrus.org/mydisasters/disability/disability_preparedness.htm. Accessed August 18, 2012.
28. Federal Emergency Management Agency: Guidance on planning for integration of Functional Needs Support Services (FNSS) in general population shelters, 2010. Available at http://www.fema.gov/pdf/about/dic/fnss_guidance.pdf. Accessed January 16, 2013.
29. Federal Emergency Management Agency: American Red Cross. Preparing for disaster for people with disabilities and other special needs, 2004. Available at http://www.redcross.org/images/MEDIA_CustomProductCatalog/m4240199_A4497.pdf. Accessed January 16, 2013.
30. National Organization on Disability Emergency Preparedness Initiative: Prepare yourself, disaster readiness tips for people with

- mobility disabilities. Available at <http://nod.org/assets/downloads/Readiness-Tips-Disabilities.pdf>. Accessed January 16, 2013.
31. National Organization on Disability Emergency Preparedness Initiative: Prepare yourself disaster readiness tips for people with developmental or cognitive disabilities. Available at <http://nod.org/assets/downloads/Readiness-Tips-Developmental-Cognitive-Disabilities.pdf>. Accessed January 16, 2013.
 32. US Department of Homeland Security and US Department of Transportation: Nationwide plan review phase 2 report, 2006. Available at <https://www.hsdl.org/?abstract&did=464258>. Accessed August 20, 2012.
 33. American Public Health Association's Get Ready campaign: General preparedness tips for people living with disabilities. Available at <http://www.getreadyforflu.org/facts/GeneralDisability.pdf>. Accessed January 16, 2013.
 34. American Public Health Association's Get Ready campaign: Preparedness tips for people with hearing disabilities. Available at <http://www.getreadyforflu.org/facts/Hearing.pdf>. Accessed January 16, 2013.
 35. American Public Health Association's Get Ready campaign: Preparedness tips for people with mobility disabilities. Available at <http://www.getreadyforflu.org/facts/Mobility.pdf>. Accessed January 16, 2013.
 36. American Public Health Association's Get Ready campaign: Preparedness tips for people with vision disabilities. Available at <http://www.getreadyforflu.org/facts/Vision.pdf>. Accessed January 16, 2013.
 37. Brault MW: *Americans with Disabilities*, 2010. Washington, DC: US Department of Commerce, US Census Bureau, 2012.
 38. Norris FH, Smith T, Kaniasty K: Revisiting the experience-behavior hypothesis: The effects of Hurricane Hugo on hazard preparedness and other self-protective acts. *Basic Appl Soc Psychol*. 1999; 21(1): 37-47.
 39. SurveyMonkey: *SurveyMonkey* [computer program]. Palo Alto, CA: SurveyMonkey.com, LLC.
 40. Kincaid JP, Fishburne RP, Rogers RL, et al.: Derivation of new readability formulas (Automated Readability Index, Fog Count and Flesch Reading Ease Formula) for Navy Enlisted Personnel. *Vol Research Branch Report 8-75*. Millington, TN: Naval Technical Training Command, 1975.
 41. United States Census Bureau: American Community Survey (ACS), 2010. Available at <http://www.census.gov/people/disability/methodology/acs.html>. Accessed January 23, 2013.
 42. SPSS: *SPSS* [computer program], Version 21.0. Chicago, IL: IBM, SPSS, Inc., 2012.
 43. Ballantyne M, Paton D, Johnston D, et al.: *Information on Volcanic and Earthquake Hazards: The Impact on Awareness and Preparation*. Wellington: Institute of Geological and Nuclear Sciences, 2000.
 44. Riad JK, Norris FH: *Hurricane Threat and Evacuation Intentions: An Analysis of Risk Perception, Preparedness, Social Influence, and Resources*. Newark, DE: Disaster Research Center, University of Delaware, 1998.
 45. Russell LA, Goltz JD, Bourque LB: Preparedness and hazard mitigation actions before and after two earthquakes. *Environ Behav*. 1995; 27(6): 744-770.
 46. Dooley D, Catalano R, Mishra S, et al.: Earthquake preparedness—Predictors in a community survey. *J Appl Soc Psychol*. 1992; 22(6): 451-470.
 47. Mulilis JP, Duval TS: Negative threat appeals and earthquake preparedness—A Person-relative-to-event (pre) model of coping with threat. *J Appl Soc Psychol*. 1995; 25(15): 1319-1339.
 48. Kailes JI: *Emergency Evacuation Preparedness: Taking Responsibility for Your Safety, A Guide for People with Disabilities and Other Activity Limitations*. Pomona, CA: Center for Disability Issues and the Health Professions, Western University of Health Sciences, 2002.
 49. Paton D: Disaster preparedness: A social-cognitive perspective. *Disaster Prev Manage*. 2003; 12(3): 210-216.

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REFERENCES

References are organized in AMA format; that is, they are to be cited numerically in the text and in consecutive order, including the first three authors followed by et al., and listed at the end of the article in the following format:

Journal articles— 1. Mudd P, Smith JG, Allen AZ, et al.: High ideals and hard cases: The evolution of opioid therapy for cancer pain. *Hastings Cent Rep.* 1982; 12(2): 11-14.

Books— 1. Bayles SP (ed.): *Nutritional Supplements and Interactions with Analgesics*. Boston: GK Hall & Co., 1978.

Book chapters— 1. Martin RJ, Post SG: Introducing alternative prescribing strategies. In Smith J, Howard RP, Donaldson P (eds.): *The Oncology Management Handbook*. Madison, WI: Clearwater Press, 1998, pp. 310-334.

Web sites— Health Care Financing Administration: HCFA Statistics at a glance. Available at: www.hcfa.gov/stats/stahili.htm. Accessed December 27, 2002.

Public health preparedness and response competency model methodology

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Abstract

Objective: *The Pandemic and All-Hazards Preparedness Act calls for establishing a competency-based training program to train public health practitioners. To inform such training, the Centers for Disease Control and Prevention and the Association of Schools of Public Health managed groups of experts to produce a competency model which could function as a national standard of behaviorally based, observable skills for the public health workforce to prevent, protect against, respond to, and recover from all hazards.*

Design: *A systematic review of existing competency models generated a competency model of proposed domains and competencies.*

Participants: *National stakeholders were engaged to obtain consensus through a three-stage Delphi-like process.*

Results: *The Delphi-like process achieved 84 percent, 82 percent, and 79 percent response rates in its three stages. Three hundred sixty six unique individuals responded to the three-round process, with 45 percent ($n = 166$) responding to all three rounds. The resulting competency model features 18 competencies within four core learning domains targeted at midlevel public health workers.*

Conclusions: *Practitioners and academics have adopted the Public Health Preparedness and Response Core Competency Model, some of whom have formed workgroups to develop curricula based on the model. Efforts will be needed to develop evaluation materials for training and education programs to refine the model as well as for future training and education initiatives.*

Key words: public health preparedness, competencies, midlevel

Introduction

To bolster all-hazards preparedness and response efforts, the Pandemic and All-Hazards Preparedness Act (PAHPA), enacted in 2006, called for the “development of a competency-based training program to train public health practitioners.”¹ Responsibility for the implementation of the law was delegated to the Centers for Disease Control and Prevention (CDC), which had a long-standing cooperative agreement with the Association of Schools of Public Health (ASPH).² To enhance the preparation of the public health workforce and because ASPH had experience in competency development,³ CDC project officials partnered with ASPH to spearhead the Public Health Preparedness and Response Core Competency Model initiative.

As competency-based education (CBE) and training are essential for improving performance,^{4,5} the intent of this project was to create an initial framework for guiding the public health workforce toward improved readiness for and proficient performance in emergencies. The competency model was designed to provide a proposed national standard of behaviorally based, observable skills for midlevel public health workers to prevent, protect against, respond to, and recover from all hazards, reflecting all four US Department of Homeland Security mission areas. This all-hazards framework is consistent with the National Response Framework, the Target Capabilities

List, and PAHPA. In fact, research suggests that a person's competence in one hazardous scenario (eg, tornado) denotes competence in another type of hazardous situation (eg, anthrax outbreak).^{6,7}

The target audience for these competencies is the midlevel worker who is employed in a public health organization or has responsibility for public health functions in a nonpublic health organization. The model defines a midlevel public health worker as an individual with 5 years of experience with a master of public health (MPH) degree equivalent or higher degree in public health, or an individual with 10 years of experience and a high school diploma, bachelors, or nonpublic health graduate degree. The model includes competencies that midlevel workers, regardless of their employment setting, are expected to demonstrate to assure readiness for all-hazards events.

The model presumes a proficient level of performance—less than expert, but more than novice. A proficient midlevel public health worker having these competencies would be expected to perform assigned prevention, protection, response, and recovery roles, in accordance with established national, state, and local health security and public health policies, laws, and systems as needed, without requiring extensive refresher training or resorting to step-by-step direction. In addition, the model is built on a groundwork of three other sources that inform the ability of any one worker to fulfill job expectations, as applicable to a given worker's prior training, role/function, and/or on-the-job experience: foundational public health competencies (eg, Council on Linkages between Academia and Public Health Practice, ASPH Master's Degree in Public Health Core Competency Model), generic health security or emergency core competencies (eg, National Incident Management System [NIMS] courses or other competency sets from national initiatives), and position or professional-specific competencies (eg, applied epidemiology, public health nursing, public health education, and public health law).

This article describes the process and methods that were implemented to create the competency model, presents results from the development process, and discusses use, strengths, and limitations of the model to improve worker readiness.

Methods

Multiple stakeholders involved throughout the process

The core competency initiative began in April 2009 as noted in the timeline illustrated in Figure 1. The project team was comprised of members of ASPH staff, CDC officials, and two consultants, working collaboratively to implement the initiative.

In June 2009, the Leadership Group (LG) for the project was formed and comprised of 20 national leaders in the preparedness and response field, from academic and local, state, and federal public health practice entities. One person representing accredited graduate schools of public health (Gotsch) and another person representing public health practice (Keck) were designated as cochairs of the LG to oversee the initiative. The LG was tasked with defining guidance for the model's development, including the scope of the project, project tenets, target audience, and performance level. The LG drafted 11 preliminary domains, under which the competencies would be developed.

In August 2009, the LG along with CDC subject matter experts were invited to edit the draft domains through a combination of focus groups, small group discussions, and individual comments. Upon approval of the initial domain slate, the project team solicited feedback from national academic experts and practitioners through the first of three rounds of a Delphi-like process. The methodology differed from a traditional Delphi method in that the participants were not a consistent panel that responded to every assessment round, and the project team edited some competencies, based on analysis of the responses received, to enhance clarity for forthcoming rounds.

Feedback was requested from a broad range of public health experts and midlevel practitioners across the United States. Individuals were recruited to participate in the initiative via e-mail, organizational newsletters, in-person meetings, presentations, exhibits, and the ASPH web page. To facilitate electronic distribution during the electronic Delphi-like review process, potential participants were required to submit their e-mail addresses to project personnel. A comprehensive list of the contributors to the competency project, listed

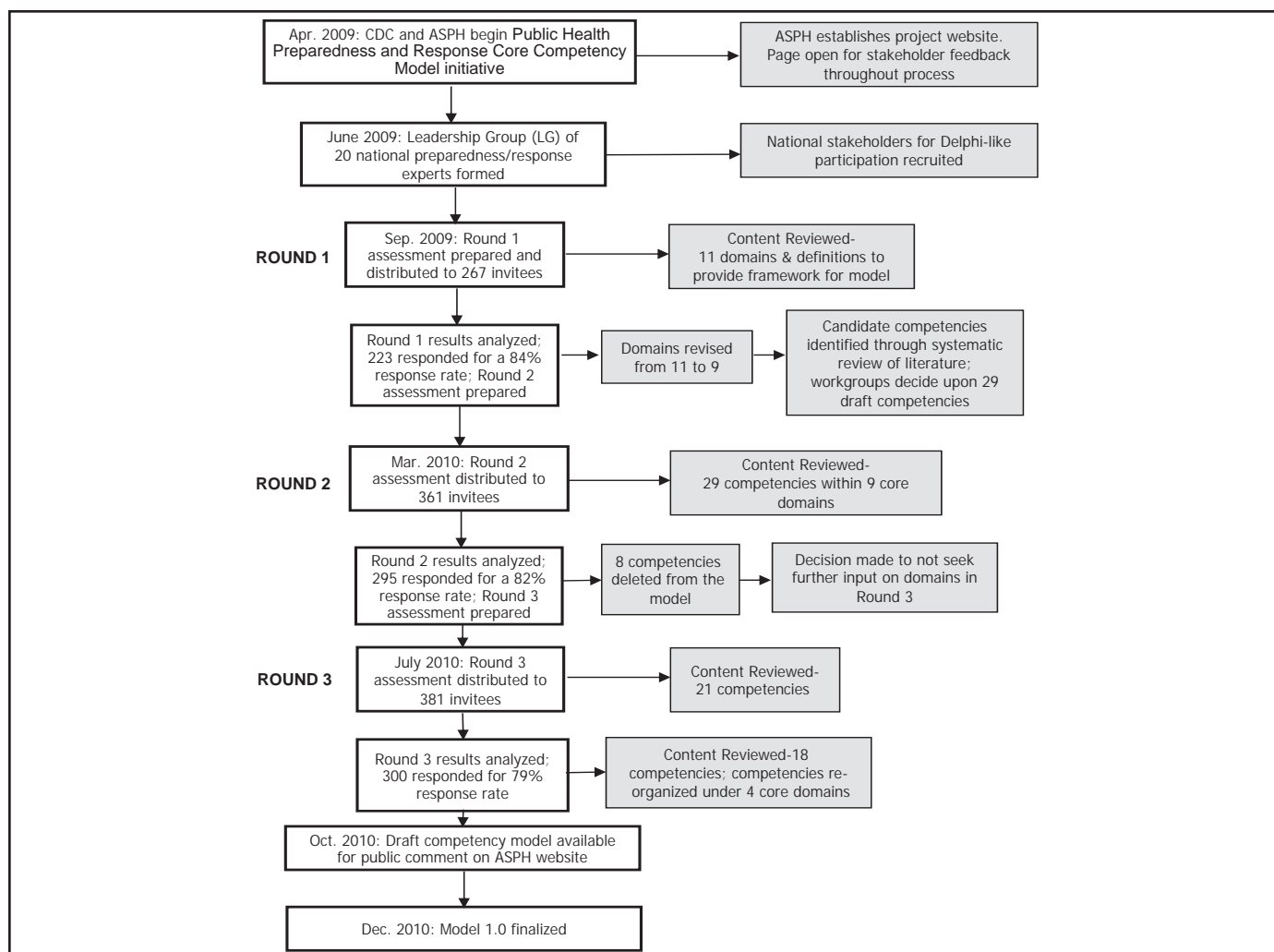


Figure 1. Timeline of initiative's activities.

by their affiliation at time of participation in the 2009-2010 project period, is available online.⁸

To keep the broad range of partners informed about project progress, ASPH established a web page⁹ in order both to communicate the objectives and progress of the initiative and for stakeholders to provide feedback on the model, resulting in an open and transparent process. Face-to-face meetings, conference calls, and e-mail were used consistently, and webinars (later archived on the Web site) were conducted prior to rounds two and three and prior to the release of the model.

Procedures

This project was deemed “not human subjects” by the University of Kansas School of Medicine-Wichita’s

Human Subjects Committee, therefore no Institutional Review Board review was required.

Three assessment rounds were offered via Survey Monkey,¹⁰ with the first assessment round including the 11 draft domains and their definitions. Participants were asked to accept, accept with changes, or reject each draft domain. Following analyses of the results, the project team deleted the “Information Management” domain and combined the “Surveillance” and “Investigation” domains into one domain, then tightened domain definitions, and finally repurposed the original domain definitions to serve as draft competencies.

ASPH staff then examined more than 60 public health preparedness and response competency frameworks, models, journal articles, government reports,

web portals, public health practice, and academic association training products to identify content that corresponded with the nine domains prepared for the second round.¹¹ From these resources, ASPH staff developed a draft slate of ~1,100 competencies, of which 201 candidate competencies were highlighted for consideration by workgroups of subject matter experts representing federal, state, local, and tribal public health, academia, and the private sector for each of the nine domains. Their task was to refine their domain definitions and develop the initial draft of core competencies. The 29 competencies and revised domain definitions that emerged from the workgroups were included in the second round. Staff sent an e-mail request to each potential participant with an Internet link in March 2010. Participants were asked to read each competency and to vote to accept the competency as is, delete it, or change the competency; they could also propose competencies during this round. Three reminder e-mails were sent to nonresponders in the 2 weeks the site was open.

For the final round, potential participants were provided a link to the round in July 2010 via an introductory e-mail. Unlike previous rounds, the domain names and definitions were not presented, nor used as an organizing device. This change of approach intended to present the model as a holistic set. Each of the 21 proposed competencies was listed with two response options: “accept as is” or “suggest change.” Respondents were also prompted to comment on the model as a whole and provide demographics. After 2 weeks and five reminder e-mails, the round closed. The project team convened in August 2010 to draft competency model version 1.0. The project team removed two of the 21 competencies presented in round 3, which had lower acceptance rates, and subsumed them under the remaining competencies. They also moved the overarching “incident command structure” competency (“Perform assigned role within the organization’s incident command structure”) to become a performance goal of the entire model. The project team reassembled the remaining 18 competencies into the following four new overarching domains: Model Leadership, Communicate and Manage Information, Plan for and Improve Practice, and Protect Worker Health and Safety (Figure 2). In October 2010, model 1.0 was

released and comments from the field were requested. The model was approved by the LG in December 2010.

Analysis

Staff downloaded respondents’ data from Survey Monkey into Microsoft Excel and tabulated frequencies. Pattern coding was used to characterize qualitative responses. This analysis option was used due to its ability to collate large amounts of qualitative content into distinct, meaningful units. Each qualitative response was reviewed to identify emergent patterns and themes, and then was coded and sorted. The most prevalent themes gleaned from qualitative analysis were then reviewed and compared to the quantitative results for each competency.

Multiple researchers independently viewed the qualitative and quantitative results and made recommendations for major revision, minor revision, or no revision. These results were then compared among researchers so final recommendations could be made.

Results

In the three rounds of stakeholder input, the Delphi-like process achieved 84 percent, 82 percent, and 79 percent response rates (Figure 1). A total of 366 unique individuals responded to the three-round process, with 45 percent ($n = 166$) responding to all three rounds.

In the third round, demographic data were collected (Table 1). Most respondents reported having an advanced terminal degree, either a PhD/MD/JD/doctorate-level (46 percent) or master-level degree (38 percent). Nearly half of the participants (48 percent) reported working for a local health department (21 percent), federal agency (15 percent), or state health department (12 percent). Half of respondents indicated having either 5-9 years (26 percent) or 10-19 years (24 percent) of work experience in public health. Sixty-seven percent of respondents indicated having either 5-9 years (39 percent) or 10-19 years (28 percent) of work experience in emergency preparedness and response.

The model contains 18 competencies within the following four domains: Model Leadership, Communicate and Manage Information, Plan for and Improve Practice, and Protect Worker Health and Safety (Figure 2). The Model Leadership domain refers to the responsibility of

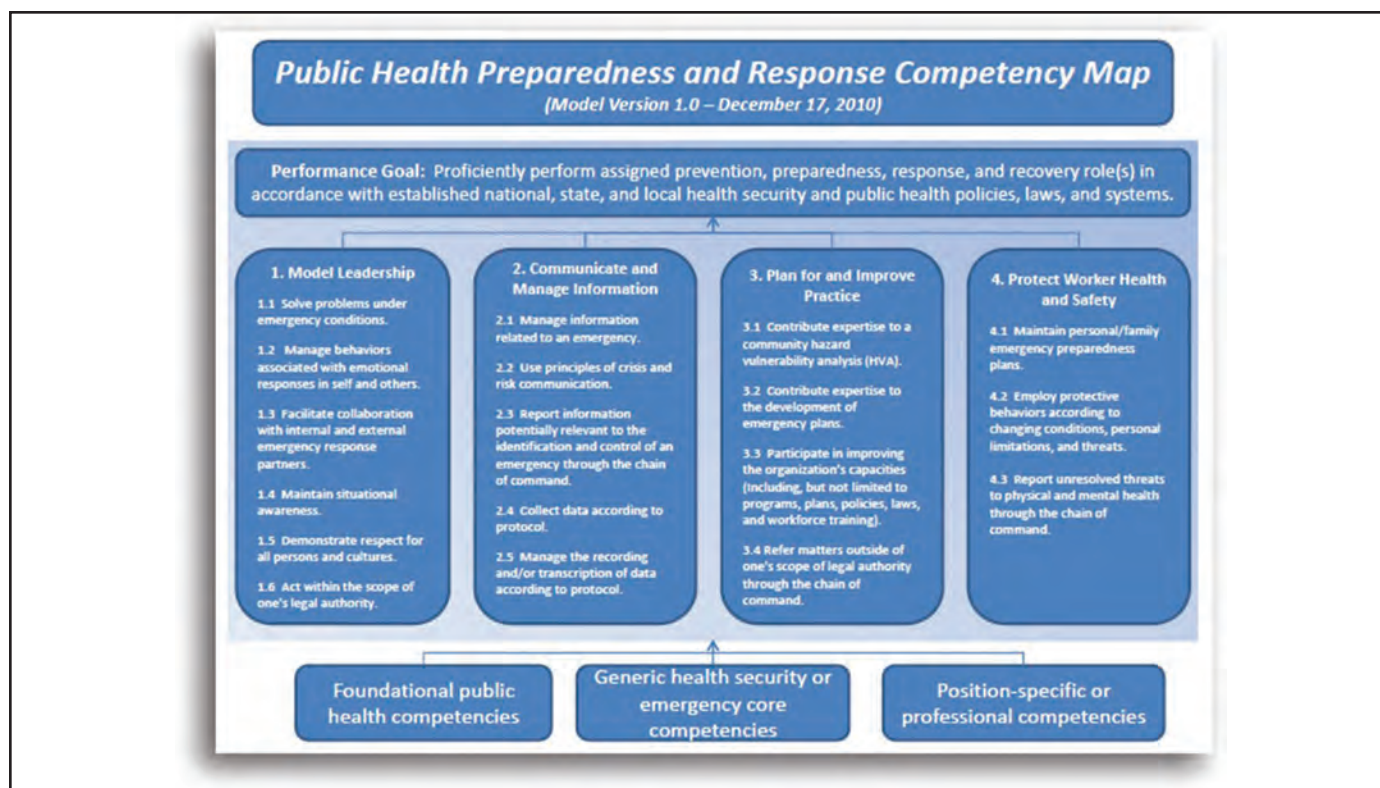


Figure 2. Public health preparedness and response core competency model version 1.0.

midlevel workers to contribute expertise in all phases of emergencies. It is not intended to transform midlevel workers into managers, but it reflects the perspective that all public health workers provide leadership in the way they perform their jobs. Communicate and Manage Information domain refers to the midlevel workers' need to clearly communicate information before, during, and after emergencies. This domain is far broader than the specialized technical expertise expected of public information officers. Plan for and Improve Practice domain refers to midlevel workers' need to contribute to planning and improvement processes such as hazard vulnerability analyses and emergency plans. Protect Worker Health and Safety domain refers to the need for workers to care for themselves and fellow workers before, during, and after emergencies.

Discussion

PAHPA mandates CBE and the development of core curricula. The model resulting from this initiative is competency-based and provides a benchmark for all midlevel workers to facilitate performance of their

regular or specially assigned duties during an emergency, in addition to the demands placed on them before, during, and after an emergency. The model does not propose that all midlevel public health workers become emergency preparedness and response specialists.

When PAHPA legislation was passed in 2006, there was one set of competencies for public health workers that was 4 years old, which was developed by a small expert panel.¹² Because competency models typically have a lifespan of 3-5 years,³ it was time to update the existing framework with the many lessons learned since 2002. As new national security challenges arise, changes in public health practice occur, and science and technology evolve, subsequent iterations may diverge from Model 1.0. Therefore, this project represented an effort to provide a more current competency model that was widely vetted by interested stakeholders and that incorporated lessons learned from educating the public health workforce.

Many Preparedness and Emergency Response Learning Center (PERLC) representatives (principal investigators and their staff at CDC-funded entities at

Table 1. Characteristics of round three respondents		
Demographic factors	All respondents	
	N	Percent
Educational attainment		
PhD/MD/JD/doctorate level degree	135	46
Masters degree	111	38
College degree	39	13
2+ years of college but no degree	4	1
Associates degree	4	1
Less than 2 years of college	2	1
Organization type		
Academic	93	33
Local health department	63	21
Federal agency	44	15
State health department	34	12
Non profit/philanthropic	17	6
Other (healthcare)	9	3
Other (multi agency)	8	3
For-profit	6	2
Other (misc.)	6	2
Other (regional entity)	5	2
Other (retired)	5	2
Tribal	2	0
Public health work experience		
5-9 years	77	26
10-19 years	72	24
20-29 years	60	20
30+ years	45	15
<5 years	41	14
Emergency preparedness and response work experience		
5-9 years	115	39
10-19 years	81	28
<5 years	44	15
20-29 years	39	13
30+ years	16	5
Total	N = 295	

accredited, graduate schools of public health who are charged to implement competency-based training) participated in developing this competency model. This level of participation from those who were later tasked with delivering competency-based training and education was of great benefit. The competency model

has also been reviewed by others who provide training and education (ie, Project Public Health Ready and Advanced Practice Centers' representatives) to assess workers' skills, evaluate readiness, and identify the need for supplemental training. Moreover, the competencies have been used to inform the Public Health Preparedness Capabilities¹³ for the Public Health Emergency Preparedness grants, they were a significant contributor to the health professions core model,¹⁴ and the competencies led to the development of the related knowledge, skills, and attitudes (KSAs)¹⁵ which were used by the PERLCs and others to operationalize competencies in trainings. Other potential users of the model include policy makers, planners, employers, academic faculty and professional trainers, individual workers, evaluators, accrediting bodies, and researchers.¹⁶

Strengths of the initiative

There were a number of strengths in the planning and implementation of this initiative. First, engaging multiple stakeholders throughout the process was a critical component to the successful completion and implementation of this initiative. As with competency models previously developed by ASPH, this model represents the thinking of a national expert panel, but with the inputs of additional subject matter experts and the vetting from extraordinarily broad stakeholders. Hundreds of academics and practitioners across the country were actively engaged throughout the process. Many respondents participated in all three rounds. The project team and the LG dedicated 20 months of time and expertise to develop this model. Although some funding supported this effort, the development process extended far beyond the available resources, and the final result would not have been possible without the commitment of the broad array of individuals who invested their time in the project.

Second, to allow for such a stakeholder-driven, participatory process to occur, numerous communication channels had to be developed and maintained (ie, Web site, webinars, e-mails, teleconferences, and face-to-face meetings). Although the response rates slightly decreased from the first to the third assessment rounds, the number of respondents in each round expanded

(from 223 to 300) resulting in additional stakeholders who were engaged in the initiative. This process was a substantial task to coordinate, especially considering the communication needs of a nearly 2-year initiative.

Third, exemplified by the number of key stakeholders involved and the amount of data generated, the project team was successful in efforts to be inclusive and consensus oriented. This was critical to sustain engagement throughout the development process and essential for the model's adoption and implementation. The project team and LG decision making was conservative and measured; any proposed deviation from the consensus was carefully considered against the intent of the stakeholders.

Fourth, the consistent iteration of the model represents an asset of the initiative. The Delphi-like process allowed for hundreds of stakeholders to provide their feedback. Moreover, the use of an electronic medium allowed for all these stakeholders to participate in a relatively short period per iteration.

Fifth, the entire model was built on a foundation of existing data, resources, models, and literature identified in ASPH's systematic review of the literature and developed resources. At its core, this effort was centered on evidence-based content.

Finally, the model was developed in response to federal legislation that was accompanied by funding to fulfill the mandates. The PAHPA legislation would not have produced this participatory, expert-informed process had funding not been allocated for the development of the model. In addition, continued financial means to support the implementation and evaluation of the model by a national network of training centers, specifically the PERLC, is helping to operationalize the framework toward enabling improvements in the readiness of certain segments of the public health workforce.

Limitations

This model, as is true of any competency model in an emerging field, is limited by the absence of empirical evidence that these are the correct competencies or the only competencies that apply. The process of extracting competencies from observed behavior of the target audience is labor intensive and works only when many members of the target audience engage in

the specified behavior on a regular basis. Because of the relative infrequency of emergency events and the lack of a history of all midlevel public health workers achieving proficiency in preparedness and response, a validation study to observe these competencies in work settings would be difficult to achieve. By the time version 2.0 of the model is developed, it may become possible to design a more empirical process.

Another challenge that could be considered a weakness is the potential overlap and, therefore, possibilities for confusion between this model and those more recently promulgated or in development by other entities. Competencies completed in 2012 through an effort of the American Medical Association (AMA) Center for Public Health Preparedness and Disaster Response (CPHPDR) and funded by the Centers for Disease Control and Prevention's Terrorism Injuries: Information Dissemination and Exchange (TIIDE) program aim to provide a foundational set of competencies for anyone entering the health/public health/medical practice field, and thus would be foundational to the competency set described here.¹⁷ Entitled "Core Competencies for Disaster Medicine and Public Health," this new model includes having a personal preparedness plan. Adoption of the just-stated model would render comparable competencies in the Public Health Preparedness and Response Competencies redundant. Similar issues will arise when competencies are developed for entry-level public health workers and more advanced public health workers—the groups on either side of the target audience for this model.

The methods used by this project, specifically, the use of an electronic assessment may allow for greater errors. However, the anonymity of Delphi-like electronic participation facilitates the process and increases the reliability of the group consensus.¹⁸⁻²⁰

Conclusions and next steps

The Public Health Preparedness and Response Core Competency Model was developed through a comprehensive, inclusive process to ensure the end-product would be both expert and evidence informed and representative of national lessons learned. The model includes actionable and measurable outcomes,

assuring that public health workers can demonstrate the desired behaviors.

Practitioners and academics have adopted this model, many of whom have formed workgroups to develop curricula based on the model. Specifically, the PERLC have identified a draft set of KSAs they believe are requisite to the model, and they are assessing their relevance in workplace training. This work will be necessary in revealing the model's strengths and weaknesses, and thus will enable critical appraisal and suggestions for adjustments to the model. Efforts will be needed to develop evaluation materials for training/education programs that will refine the model and training/education initiatives. Midlevel public health workers will need opportunities for initial and refresher training/educational opportunities to ensure that each competency is acquired.

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References

1. Pandemic and All-Hazards Preparedness Act of 2006, Pub. L. No. 109-417, 120 Stat. 2831 (December 19, 2006).
2. Richmond A, Hostler L, Leeman G, et al.: A brief history and overview of CDC's Centers for Public Health Preparedness Cooperative Agreement Program. *Public Health Rep.* 2010; 125(suppl 5): 8-14.
3. Calhoun JC, Ramiah K, Weist EM, et al.: Development of a core competency model for the master of public health degree. *Am J Public Health.* 2008; 98: 1598-607.
4. Committee on the Health Professions Education Summit: *Health Professions Education: A Bridge to Quality*. Washington, DC: Institute of Medicine, 2003.
5. Turnock BJ: Roadmap for public health workforce preparedness. *J Public Health Manag Pract.* 2003; 9(6): 471-80.
6. Powkes V, Ablah E, Oberle M, et al.: Emergency preparedness education and training for health professionals: A blueprint for future action. *Biosecur Bioterror.* 2010; 8(1): 79-83.
7. Ablah E, Tinius AM, Konda K: The National Training Strategy: Collective lessons learned. *J Public Health Manag Pract.* 2009; 15(suppl): S31-S35.
8. List of contributors [Internet]. Washington, DC: Association of Schools of Public Health. Available at <http://www.asph.org/document.cfm?page=858>. Accessed December 14, 2011.
9. Public Health Preparedness and Response Core Competency [Internet]. Washington, DC: Association of Schools of Public Health. Available at <http://www.asph.org/document.cfm?page=1081>. Accessed December 14, 2011.
10. Survey Monkey [online survey program]. Palo Alto, CA: SurveyMonkey.com, LLC. Available at <http://www.Surveymonkey.com>. Accessed December 14, 2011.
11. Competency resources [Internet]. Washington, DC: Association of Schools of Public Health. Available at <http://www.asph.org/document.cfm?page=1126>. Accessed December 14, 2011.
12. Gebbie KM: *Bioterrorism and Emergency Readiness: Competencies for All Public Health Workers*. New York, NY: Columbia School of Nursing, CDC, 2002.
13. Centers for Disease Control and Prevention, Office of Public Health Preparedness and Response: Public health preparedness capabilities: National standards for state and local planning. March 2011. Available at www.cdc.gov/phpr/capabilities. Accessed November 28, 2012.
14. Walsh L, Subbarao I, Gebbie K, et al.: Core competencies for disaster medicine and public health. *Disaster Med Public Health Prep.* 2012; 6(1): 44-52.
15. Association of Schools of Public Health and Centers for Disease Control and Prevention: *Knowledge, Skills and Attitudes (KSAs) for the Public Health Preparedness and Response Core Competency Model*. Washington, DC: ASPH 2012.
16. Gebbie KM, Weist EM, McElligott JE, et al.: Implications of preparedness and response core competencies for public health. *J Public Health Manag Pract.* 2013; 19: 3.
17. Walsh L, Subbarao I, Gebbie K, et al.: Core competencies for disaster medicine and public health. *Disaster Med Public Health Prep.* 2012; 6(1): 44-52.
18. Campbell SM, Shield T, Rogers A, et al.: How do stakeholder groups vary in a Delphi technique about primary mental health care and what factors influence their ratings? *Qual Saf Health Care.* 2004; 3:428-434.
19. Dalkey NC: *The Delphi Method: An Experimental Study of Group Opinion*. Santa Monica, CA: United States Air Force Project Rand, 1968.
20. Delbecq AL, Van de Ven AH, Gustafson DH (eds.): *Group Techniques for Program Planning: A Guide to Nominal Group and Delphi Processes*. Glenview, IL: Scott, Foresman and Company, 1975.

La Gloria, Mexico: The possible origins and response of a worldwide H1N1 flu pandemic in 2009

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Abstract

This article traces the spread and route of the H1N1 pandemic in 2009 from its possible origin in La Gloria to Mexico City. A lack of health control measures or nonpharmaceutical interventions (NPIs) in La Gloria accounts for the unprecedented high basic reproductive number (R_0) in that town and a higher incidence of H1N1 flu in Mexico City. We analyzed data collected from Mexican news articles, the Healthmaps dataset, the Google search engine, and telephone interviews with Mexican community physicians and residents. Our article uses a simple Susceptible Infected and Recovered model based on the data collected, to show the relationship between the disease curve and the implementation of NPI use. As a result of this study, we conclude that, with strict government measures to control the disease over an extended period of time, it is possible that many hundreds or even thousands of lives might be saved in the future.

Key words: La Gloria, Mexico, R_0 , $R(t)$, nonpharmaceutical interventions

Introduction

In the spring of 2009, an influenza outbreak caused by a novel Type A (H1N1) virus called the “swine flu” or “pig flu” attracted considerable news media attention. Much of this attention was likely derived from the world health community’s prior anticipation of a possible global pandemic of H5N1, the “bird flu” from Southeast Asia. The novel H1N1 flu virus was first identified in the village of La Gloria, Mexico on April 23, 2009 and shortly thereafter it was

reported in the United States, Canada, and the rest of the world. However, there had been speculation that the first cases actually appeared in California in late March.¹ The incidence of this infectious disease soon caused the World Health Organization (WHO) to declare the outbreak to be a worldwide pandemic. We can characterize this virus and identify its outbreak potential through learning how infectious it is, and how many people it can reach. We learn this through understanding its basic reproductive number.

The most important parameter characterizing the extent of the spread of an infectious disease is R_0 , the “basic reproductive number.” R_0 is defined to be the mean number of new infections created by a newly infected person in a fully susceptible population. In practice, this implies that R_0 is the average number of new infections created by a newly infected person until that person retires to bed and self-isolation. This is important and a valuable characteristic at the beginning of the disease when everyone is most susceptible (ie, does not have immunity). When R_0 is greater than 1.0, then from generation to generation of the disease, there is early exponential growth in the numbers infected. Measuring this early growth factor is the usual way to estimate R_0 . R_0 is replaced by $R(t)$, where $R(t)$ is defined to be the mean number of new influenza infections created by a newly infected person at time t in the epidemic/pandemic.²

In modeling the progression of the flu through the population, we examine how the behavioral patterns of the residents change during the course of the pandemic—this will impact the model and its assumptions.

In particular, we are interested in possible behavioral changes including reduced numbers of daily face-to-face contacts, coughing and sneezing into elbows, use of hand sanitizers, etc. Since none of these behavioral changes involve medications, they are referred to as nonpharmaceutical interventions (NPIs). We believe that R_0 is influenced by NPIs that limit the frequency of face-face contact (λ) and decrease the probability of spreading the infection such as hand washing, hand sanitizer usage, etc (p). In other words, at one level of complexity we believe $R_0 = \lambda p^2$ —past this it becomes arbitrarily complex.

In this article, we (1) revisit the early days of the H1N1 2009 outbreak in Mexico using La Gloria as a type of natural experiment (town where it could have started and had no NPI implementation) and describing how it may have propagated to Mexico (tracing the possible spread of the flu); (2) investigate the time period of the spread of the pandemic from La Gloria to Mexico city; and (3) using the Susceptible Infected and Recovered (SIR) model, look at how increased emphasis on the use of NPIs in Mexico City by the government may have reduced the number of infections in the population.

Methodology

Our research was derived from surveillance of the data regarding day-to-day progression of the H1N1 2009 pandemic collected from the WHO and the Center for Disease Control (CDC), and the European Center for Disease Prevention and Control (ECDC) Web sites. The ECDC Web site provided daily situation reports on the H1N1 virus, whereas the WHO and CDC Web sites only gave updates every few days; therefore, we worked primarily with data from the ECDC. These reports provided an overview of the pandemic through epidemiological updates, recent publications, newly confirmed cases, and a regularly updated cumulative number of cases for selected countries, including Mexico.

We used Healthmap and the Mexican Google search engine to trace the spread of the disease. To relate the spread of the disease to the implementation of NPIs during a specific time period, we looked for indicators of increasing interest in NPIs. We used the

Healthmap database and Google to find news articles from Mexico related to NPI recommendations and practices in Mexico.

Healthmap is a Web site that collects daily reports on diseases from all over the Internet. It marks the articles by country of origin and date. Articles from Mexico about NPIs were easily tracked down on this Web site. To retrieve more Mexican newspaper articles from Spring 2009, we used Google with search terms like “La Gloria H1N1” and “Granjas Carroll La Gloria.” Google allowed us to search within specific time periods for articles published during the pandemic outbreak in Mexico. Using both of these methods, we located a significant sample of the articles and news alerts about NPI use in Mexico published between the months of April and July 2009. Analysis of these articles allowed us to determine which articles gave more emphasis to NPI usage by the government during the H1N1 pandemic in Mexico. We noticed the emphasis on NPI implementation was strict in the beginning of the pandemic but was then relaxed. For the simulation model, we use three different time situations: first is with no NPI at all; second is with strict and then relaxed NPI emphasis; and the third is assuming we continue the strict emphasis time period longer than was observed in Mexico in reality.

Mexican community physicians and residents were contacted over-the-phone to verify the information provided in the Mexican newspapers and to clarify the commute patterns of the working residents in La Gloria. We were not able to locate the exact commute patterns of the residents in La Gloria to Mexico City in our Internet search.

The SIR model describes the following system of ordinary differential equations:

$$dS/dt = -\beta N S I/t$$

$$dI/dt = \beta N S I/t - \alpha I/t$$

$$dR/dt = \alpha I/t$$

$$R_0 = \beta N/\alpha$$

where $S(t)$ is the percentage of susceptible in the population, $I(t)$ is the percentage of infected people in the population, and $R(t)$ is the percentage of recovered people in the population.

In this SIR simulation model, we used the estimated value¹⁷ of βN (contact rate) to be 0.57 with no



Figure 1. La Gloria, Mexico.⁴⁶

emphasis on NPI use, 0.46 with relaxed emphasis on NPI implementation, and 0.42 with strict emphasis on NPI implementation. We estimated α by assuming setting $1/\alpha$ to the mean period of infection, which was taken to be on average of 3 days. Our SIR model estimates accounts for these different practices by adjusting the contact rate βN (and hence R_0) as a function of time (Figure 2).

Results and Discussion

Ground zero: La Gloria, Mexico

Even though the novel H1N1 flu virus was first reported on April 23, 2009, in the village of La Gloria, located in the state of Veracruz in the Perote valley of Mexico, the Mexican Health Ministry could not verify this report (Figure 1). However, supporting evidence from news articles and interviews with members of the community suggest that the H1N1 outbreak originated in La Gloria. La Gloria has a population of 2,243 individuals³ and is flanked by both mountains and a collection of pig farms—some belonging to the US pork company, Smithfield Farms. These farms raised about a million pigs each as of 2008.⁴ The community of La Gloria believes that the unhygienic conditions of the closest farm, 5 miles away, Granjas Carroll de México, led to the start of the H1N1 pandemic.⁵⁻⁹ This claim has not been substantiated by rigorous testing of the farm's animals and workers.

From February to early April of 2009, many residents of La Gloria fell ill with nonspecific respiratory

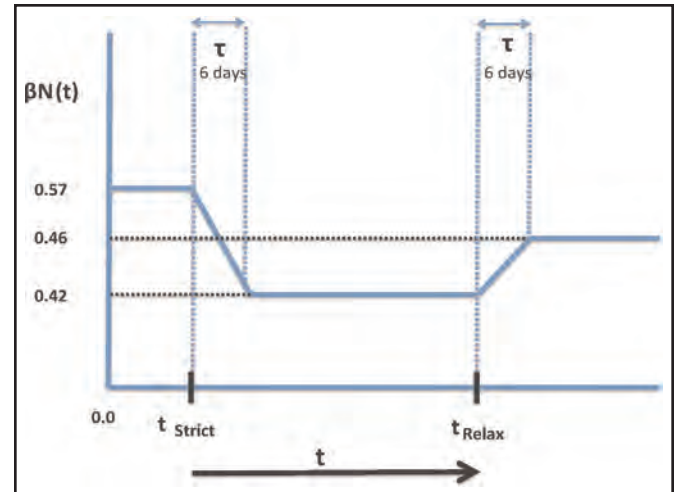


Figure 2. Modeling NPI use through changing the contact rate βN as a function of time. The below plot shows how β is modeled in the case of strict then relaxed NPI use. This figure shows the assumed values for strict and then relaxed versus strict throughout for possible implementation of NPIs. Beta values are then plotted against time period “Tau.” We estimated strict and relaxed periods based in the data we collected from the news articles shown in Table 1.

illnesses, exhibiting flu-like symptoms such as high fevers and chills, body aches, and sore throats.^{5,7-9} Reports of infections in La Gloria date back to February 18, 2009.^{6,9} By the end of April, the infection had spread to about 60 percent of the La Gloria community (about 1,350 individuals).^{5,8} By this time, 218 individuals in Mexico City were also reported to be showing symptoms of respiratory illness, and the deaths of two people in La Gloria and five in Mexico City had been attributed to this illness.^{10,11}

Although early incidence of the flu suggests its origin in La Gloria, the widespread use of NPIs did not occur in this village until most of the flu had run its course. Dr. Armando Romeo Aguilar Cano, MD, director of the Calidad de la Atención Clínica (the Quality Medical Care Clinic), worked in La Gloria during the outbreak and in his interview on April 12, 2010, he validated that almost no precautions in the form of NPIs were taken in La Gloria between February and April 2009 to stop the spread of the flu. Once the first case of H1N1 flu was confirmed in late April, however, Dr. Cano corroborates that measures of isolation, quarantine, and segregation, such as a “health fence,” were

imposed on the population of La Gloria. Occurring in late April 2009 (after 60 percent had become infected), these measures, unfortunately, came too late to significantly impact the epidemic curve of La Gloria.¹¹

Spread of the pandemic from La Gloria to Mexico City

The spread of the virus from La Gloria to Mexico City is readily explainable. Approximately half of the employed residents of La Gloria work in Mexico City. Their commute of approximately 180 km via bus was an ideal vehicle for the spread of the flu.⁸ From February to the beginning of April, those with work in Mexico City continued to commute from La Gloria despite the outbreak of illness in their city. Some left at the beginning of the week, others left later in the week. Due to the length of the commute, residents typically remained several days in the city before returning home. However, this trend altered during the week before Easter, on April 12, 2009. Most La Gloria residents working in Mexico City and many of their relatives came back to La Gloria to celebrate the holiday.¹² When Easter was over, most of them returned to work, creating a concentration of commuters who had been in contact with the flu-like illness, heading toward Mexico City (see Figure 3). Not surprisingly, the peak of H1N1 flu pandemic in Mexico occurred during the final days of April.¹³ This elevated flux of travel between La Gloria and Mexico City during and around Easter, combined with a concurrent peak in H1N1 flu specific to the greater Mexico City area, bolsters the model citing La Gloria as the point of origin of the H1N1 pandemic.¹⁴

Through lack of implementation of NPIs in La Gloria, the disease progressed rapidly to Mexico City and then all of Mexico. The possible vehicle of spreading was the busy bus stations in Mexico City, which received passengers from La Gloria (ill or not ill) and took them to different regions in Mexico. An interview with the bus company Autobuses de Oriente (ADO) on June 29, 2010, revealed that buses run regularly from Mexico City to Ciudad Cardel and Zempoala, both of which are geographically close to La Gloria. An interview with Donny Holaschutz (student at MIT-SDM) on July 13, 2010, revealed that there are buses running from each of these cities to La Gloria. It was also found that the bus stations did not adhere to any NPI use and

would carry passengers even if they were severely sick. The interview also relayed conversations with 10 other people who lived in La Gloria, each of whom stated that about 50 to 70 percent of the residents of La Gloria commuted to Mexico for work. Given the capacity of ADO buses (about 50 people) and their frequency, we calculated that about 29 percent of these commuters travel per day from La Gloria to Mexico City (Figure 3).

The first death confirmed to have been caused by H1N1 could be attributed to this commuting network as well. Maria Adela Gutierrez from Oaxaca, Mexico was partnered with a coworker in Mexico City who reportedly had a persistent cough and who was from the Perote region (includes La Gloria) where the H1N1 flu was first discovered. Gutierrez fell severely ill with pneumonia-like symptoms shortly after working with this person and died on April 13, 2009.¹⁵

As H1N1 was not diagnosed as a novel and perhaps very serious flu until well into the outbreak in La Gloria, we assume that behavioral patterns, in terms of human-to-human contacts and illness prevention practices (which both can influence the value of R0) remained unchanged in La Gloria until late April.

Fraser et al.¹⁶ estimated the R0 value to be between 1.4 and 1.6 in the month of April. Cruz Pacheco et al.,¹⁷ a research group from Mexico, estimated R0 to be 1.716 using the Kermack and McKendrick SIR model. Their approach used data from the Secretaría de Salud de México for the period April 10 to April 20, 2009, an interval that overlaps the weeks (April 1 to April 20, 2009) we chose to analyze.

NPI use may have reduced disease transmission

In this section, we report the results of the analysis of the spread of H1N1 outside of La Gloria after late April 2009. As mentioned earlier, data on the day-to-day progression of the disease came from the databases of the CDC, the WHO, and the ECDC.¹⁸ From this, we computed the predicted number of cases taking into account the reported 2.5-day incubation period.¹⁹

The steady and possible faster decrease in the disease curve for Mexico appears to be consistent with the government initiative to enforce NPI use and diagnose those exhibiting influenza-like symptoms early on.¹³ Using surveillance data of morbidity and mortality rates

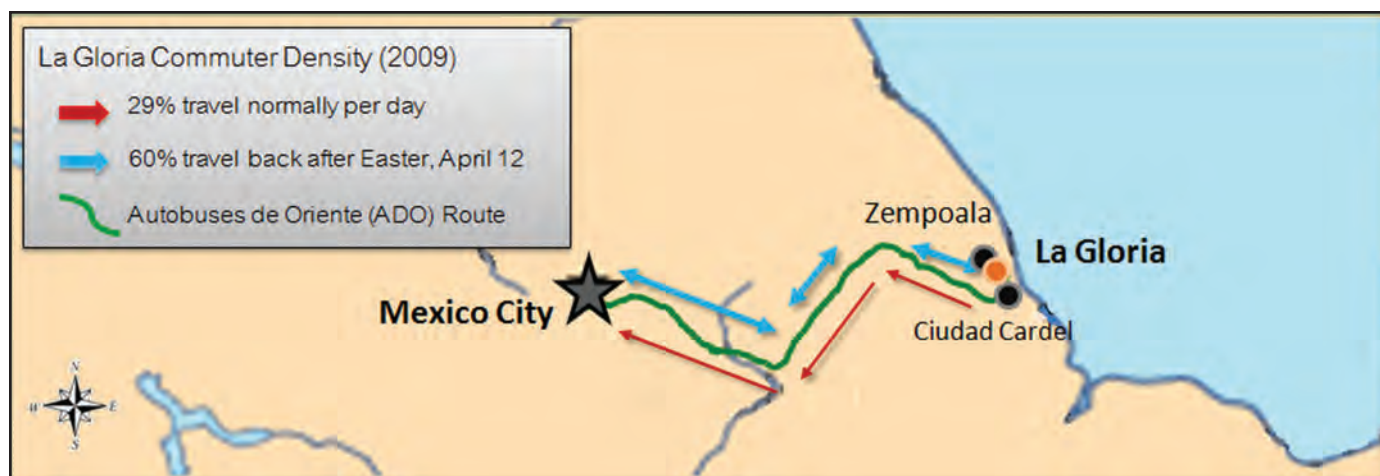


Figure 3. Travel between La Gloria and Mexico City for February to April 2009. There are two possible routes from La Gloria to Mexico City by bus. An interview with the bus company ADO on June 29, 2010, revealed that buses run regularly from Mexico City to Ciudad Cardel and Zempoala, both of which are geographically close to La Gloria. An interview with Donny Holaschutz on July 13, 2010, revealed that there are buses running from each of these cities to La Gloria. The interview also relayed conversations with 10 people who lived in La Gloria, each of whom stated that about 50 to 70 percent of the residents of La Gloria commuted to Mexico for work. Given the capacity of ADO buses (about 50 people) and their frequency, we calculated that about 29 percent of these commuters travel per day from La Gloria to Mexico City. With the exception of Easter Week, these commuters stay in the Mexico City for several days to work before heading back to La Gloria.

in 32 Mexican states collected from April 24 to December 2009 by the Mexican Institute for Social Security, Chowell et al.¹³ estimated $R(t)$ to be 1.8-2.1, 1.6-1.9, and 1.2-1.3 for spring (April 1 to May 20), summer (May 21 to August 1), and fall (August 2 to December 31) waves of the pandemic, respectively. Although it is not possible to know if NPIs such as hand hygiene and cough etiquette were actually implemented by the citizens of Mexico, the emphasis on their implementation, as evident in news articles within months of the initial outbreak, is suggested to have encouraged the general trend of NPI use among the population.

Studies such as that of Boelle et al.,²⁰ suggest the R_0 for Mexico ranged from 2.2 to 3.1. Cruz Pacheco et al.¹⁷ also studied the spread of the pandemic in Mexico City with and without various sanitary control measures, using the Kermack and McKendrick mathematical model as they did with La Gloria. From this, they estimate an R_0 value of 1.72 for Mexico City during the early weeks of the pandemic.

A glance at the more widespread emphasis on NPIs in Mexico after the experience in La Gloria reveals that self-isolation, social distancing, and school closures were the main methods emphasized

during the beginning of the pandemic in April 2009. Mexico City was then almost shut down during the week of April 23, 2009 (see Table 1). From May 2009 onward, Mexican newspapers and government reports emphasized hand washing, coughing etiquette, and social distancing (see Table 1). In conjunction with the focus on NPIs and in the absence of any vaccines or other medical interventions, $R(t)$ possibly decreased faster during this time period.

Using the SIR simulation model we were able to compare the disease curve without the emphasis on NPI use in Mexico and strict and relaxed emphasis on NPI use coinciding with the time period that NPIs were emphasized in Mexico. Our simulation results showed that the curve would be less steep if the strict implementations were applied for longer period of time. (Figure 4) The difference between the two curves (strict and then relaxed vs strict for longer period) is about 0.35 percent, which estimates to 75,000 fewer infections given if the population of Mexico City is 21.2 million.

Conclusion

We conclude that La Gloria is the possible town (with no NPIs) where H1N1 started in 2009 in early

Table 1. Emphasis of non-pharmaceutical interventions over time

Type of NPI	April 1 to April 20	April 23 to May 15	May 15 to June 1	June 1 to June 15	June 15 to July 1	July 1 to July 15
Social distancing	Enforced (scattered) ²¹	Advised ²²⁻²⁶	No article found	No article found	Advised ²⁷	No article found
School closing	No article found	Enforced (Mexico City) ²⁸⁻³⁴	No article found	No article found	Enforced (scattered) ³⁵	No article found
Public space closing (ie, museums)	No article found	Enforced (Mexico City) ³¹⁻³³	No article found	No article found	No article found	No article found
Hand hygiene	No article found	Assisted ^{34,36,37}	Assisted ³⁸	Advised ³⁹	Advised ³⁰	Advised ⁴⁰
Isolation	Enforced (hospitals) ³⁹	Enforced (hospitals) ³⁹	No article found	No article found	No article found	No article found
Face masks	No article found	Assisted ^{32,41}	Advised ³⁸	No article found	No article found	No article found
Coughing etiquette	No article found	No article found	Advised ³⁸	Advised ^{42,43}	Advised ³⁰	Advised ⁴⁰
City shutdown	No article found	Enforced (Mexico City) ^{37,44,45}	No article found	No article found	No article found	No article found

The metrics used for the table are as follows: Enforced (laws mandating the NPI, likely occurred), Assisted (NPIs were recommended and items such as hand sanitizers were distributed to help the public implement them), Advised (NPI implementation was recommended by officials), No article found (no advisories advocating the implementation of NPIs was found).

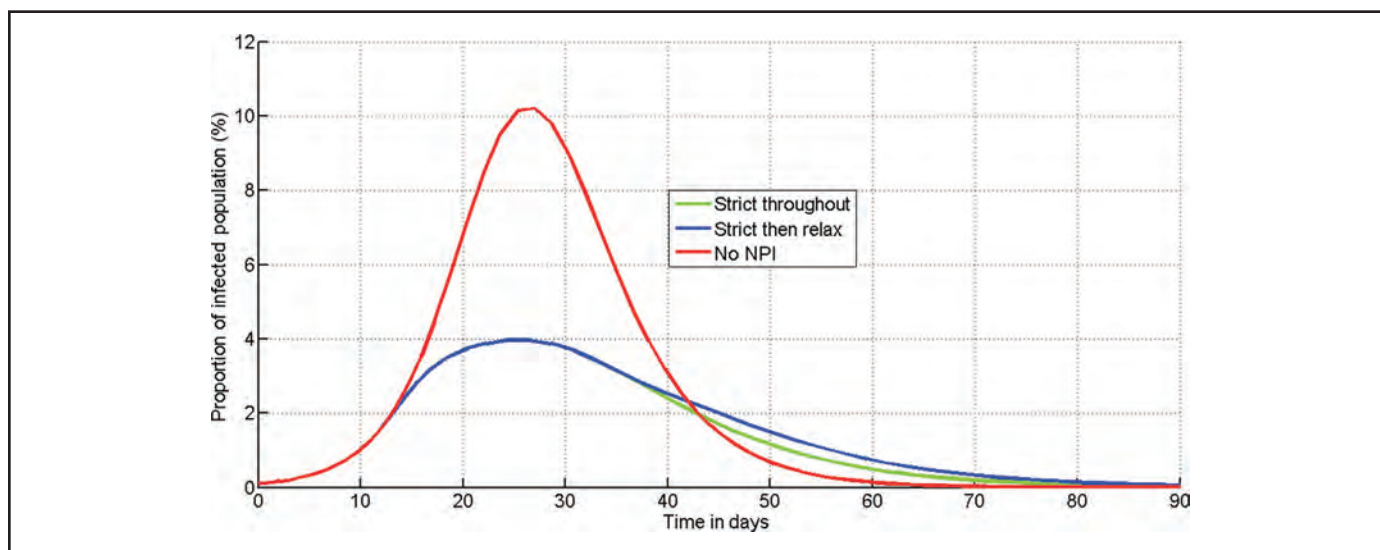


Figure 4. SIR model showing disease curves with strict NPI use, with strict then relaxed NPI use, and without NPI use in Mexico. The figure shows the three different disease curves plotted against the function of time. The red curve shows increase in the percentage of infected population with no use of NPIs while the blue curve shows the percentage of population with strict use of NPIs meaning decrease in the contact rate starting at 12 days. On the other hand, the green curve indicates the infected population on the use of NPIs starting at 12 days and then relaxed right after the period of 35 days.

March with a high R_0 . The disease spread from La Gloria to Mexico City and beyond appears to be readily explainable by travel patterns between the two. Many residents of La Gloria commute to work in Mexico City regularly throughout a given week. When Easter arrived in April 2009, the majority of the commuters headed back home to La Gloria to spend time with their families. They then departed en masse to Mexico City after the holidays. Based on the data collected, H1N1 likely followed these commuters back to their workplaces in Mexico City, where the outbreak of H1N1 flu was garnering much more media attention and, as a result, there was a greater incentive to use NPIs. Three weeks after Easter, Mexico City effectively shut down for 5 days by the government regulations to prevent further spread of the H1N1 virus and thus possibly causing a rapid decrease of incidences in Mexico City. Using our simulation model results, we suggest a prolonged emphasis on the use of NPI controls in the future.

In short, while acknowledging the various other factors that may influence the spread of pandemics, conclusions from our study model proposes early, strict and prolonged implementation of NPIs in general which may effectively decrease a pandemic curve and its potential to become a serious public health threat.

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References

- Casey N: In California, cases suggest border origin. *Wall Street J*. May 1, 2009. Available at <http://online.wsj.com/article/SB124113696409275445.html>. Accessed July-September 2009.
- Larson RC: Simple models of influenza progression within a heterogeneous population. *Oper Res*. 2007; 55(3): 399-412.
- Instituto Nacional de Estadística y Geografía: Archivo Histórico de Localidades, 2009. Available at <http://mapserver.inegi.gob.mx/dsist/ahl2003/index.cfm>. Accessed July-September 2009.
- Underwood H: La Gloria: Is this 'ground zero' for swine fever? *The First Post*. April 28, 2009. Available at <http://www.thefirstpost.co.uk/47237/news-comment/news-politics/la-gloria-mexico-is-this-ground-zero-for-swine-fever-swine-flu>. Accessed April 30, 2009.
- Rodriguez O: Swine flu's ground zero? Residents say nearby farm. *Associated Press*. April 28, 2009. Available at <http://www.foxnews.com/story/0,2933,518199,00.html>. Accessed July-September 2009.
- Martinez R: Extraño brote epidemiológico causa la muerte a dos bebés en Veracruz. *Proceso*. April 2, 2009. Available at <http://www.proceso.com.mx/rv/modHomelDetalleExclusiva/67678>. Accessed July-September 2009.
- Brownstein J, Freifeld C, Madoff L: Influenza A (H1N1) virus, 2009—Online monitoring. *N Engl J Med*. 2009; 360(21): 2156.
- Rodriguez OR: Patient zero? Mom of first confirmed case talks. *MSNBC*. April 28, 2009. Available at http://www.msnbc.msn.com/id/30461857/ns/health-infectious_diseases/. Accessed July-September 2009.
- Morales AT: Cerco sanitario en Perote, tras muerte en marzo de bebé por gripe porcina. *Periódico de La Jornada*. April 28, 2009. Available at <http://www.jornada.unam.mx/2009/04/28/index.php?section=politica&article=012n2pol>. Accessed July-September 2009.
- Las vacunas del sector salud se agotaron. *Terra MEXICO*. April 22, 2009. Available at <http://www.terra.com.mx/articulo.aspx?articuloId=817210&ref=1>. Accessed July-September 2009.
- Wilson J: Swine flu in Mexico—Timeline of events. *Bio surveillance*. April 24, 2009. Available at <http://www.freerepublic.com/focus/bloggers/2237818/posts>. Accessed July-September 2009.
- Carroll R, Tuckman J: UN team seeks swine flu's ground zero. *The Guardian*. May 1, 2009. Available at <http://www.guardian.co.uk/world/2009/may/01/swine-flu-mexico-la-gloria-un>. Accessed July-September 2009.
- Centers for Disease Control and Prevention (CDC): Update: Novel influenza A (H1N1) virus infection-Mexico, March to May 2009. *MMWR Morb Mortal Wkly Rep*. 2009; 58(21): 585-589.
- Chowell G, Echevarria-Zuno S, Simonsen L, et al.: Characterizing the epidemiology of the 2009 influenza A/H1N1 pandemic in Mexico. *PLoS Med*. 2011; 8(5): e1000436.
- Rodriguez OR: First Mexico flu death ignited desperate hunt. *MSNBC*. April 30, 2009. Available at <http://www.msnbc.msn.com/id/30492441>. Accessed July-September 2009.
- Fraser C, Donnelly CA, Cauchemez S, et al.: Pandemic potential of a strain of influenza A (H1N1): Early findings. *Science*. 2009; 324(5934): 1557-1561.
- Cruz-Pacheco G, Duran L, Esteva L, et al.: Modelling of the influenza A(H1N1)v outbreak in Mexico City, April-May 2009, with control sanitary measures. *Euro Surveill*. 2009; 14(26): pii: 19254.
- European Centre for Disease Prevention and Control: 2009 pandemic influenza A(H1N1). Available at <http://www.ecdc.europa.eu/en/healthtopics/H1N1/Pages/home.aspx>. Updated 2010. Accessed July-September 2009.
- Centers for Disease Control and Prevention (CDC): Updated interim medications for the use of antiviral medications in the treatment and prevention of influenza for the 2009-2010 season. H1N1 flu. Available at <http://www.cdc.gov/h1n1flu/recommendations.htm>. Updated December 7, 2009. Accessed July 2010.

20. Boëlle PY, Bernillon P, Desenclos JC: A preliminary estimation of the reproduction ratio for new influenza A (H1N1) from the outbreak in Mexico, March-April 2009. *Euro Surveill.* 2009; 14(19): pii: 19205.
21. Zavala JC: Evacuación area de Urgencia. *Diario Despertar De Oaxaca.* April 19, 2009. Available at <http://www.diariodespertar.com/mx/Agenda/8822-Evacan-rea-Urgencias.html>. Accessed July-September 2009.
22. Flu outbreak is being monitored. *BBC News.* April 27, 2009. Available at http://news.bbc.co.uk/2/hi/uk_news/northern_ireland/8019968.stm. Accessed July-September 2009.
23. 103 dead in swine flu outbreak. *WZZM13.* April 26, 2009. Available at <http://www.wzzm13.com/news/story.aspx?storyid=108566>. Accessed July-September 2009.
24. Minister: WHO rejects closure of Mexican border despite swine flu outbreak. *China View News.* April 25, 2009. Available at http://news.xinhuanet.com/english/2009-04/25/content_11254538.htm. Accessed July-September 2009.
25. CDC says 'worried' about swine flu outbreak. *Reuters.* April 24, 2009. Available at <http://www.reuters.com/article/idUSN2445294320090425>. Accessed July-September 2009.
26. Killer flu. *Lanka Business Online.* April 27, 2009. Available at <http://www.lankabusinessonline.com/fullstory.php?nid=1099642164>. Accessed July-September 2009.
27. Velasco E, Román JS: Confirma la Ssa el deceso de 116 personas por el virus A/H1N1 y 8 mil 279 contagiados. *La Jornada.* June 24, 2009. Available at <http://www.jornada.unam.mx/2009/06/24/index.php?section=sociedad&article=046n1soc>. Accessed July-September 2009.
28. Nasaw D, Weaver M: Swine flu outbreak spreads. *guardian.co.uk: News Blogs.* April 27, 2009. Available at <http://www.guardian.co.uk/news/blog/2009/apr/27/swine-flu>. Accessed July-September 2009.
29. What You Should Know About Swine Flu. *Forbes.* April 27, 2009. Available at <http://www.forbes.com/2009/04/27/swine-flu-faq-lifestyle-health-swine-flu.html>. Accessed July-September 2009.
30. Sypsa V, Hatzakis A: School closure is currently the main strategy to mitigate influenza A(H1N1)V: A modeling study. *Euro Surveill.* 2009; 14(24): pii: 19240.
31. New swine flu has pandemic potential. *RedOrbit.* April 26 2009. Available at http://www.redorbit.com/news/health/1676666/mexican_flu_outbreak_causing_pandemic_concerns/index.html. Accessed July-September 2009.
32. Mexico closes schools after flu outbreak kills 20. *CRIENGLISH.com.* April 24, 2009. Available at <http://english.cri.cn/6966/2009/04/24/1461s478462.htm>. Accessed July-September 2009.
33. Carroll J: Swine flu death toll climbs. *Fierce Vaccines.* April 24, 2009. Available at <http://www.fiercevaccines.com/story/swine-flu-outbreak-triggers-pandemic-alarm/2009-04-24>. Accessed July-September 2009.
34. Health authorities rush to tackle killer flu in US, Mexico. *Physorg.com.* April 24, 2009. Available at <http://www.physorg.com/news159778101.html>. Accessed July-September 2009.
35. Xinhua: Mexico reports 3 new A/H1N1 flu deaths, disease outbreak in Yucaton. *CRIENGLISH.com.* June 24, 2009. Available at <http://english.cri.cn/6966/2009/06/24/1601s496035.htm>. Accessed July-September 2009.
36. International Security for Infectious Diseases: Acute respiratory disease - Mexico, swine virus suspected. April 24, 2009. Available at http://apex.oracle.com/pls/otn/f?p=2400:1001:39064960859941::NO::F2400_P1001_BACK_PAGE,F2400_P1001_PUB_MAIL_ID:1010,77182. Accessed July-September 2009.
37. Trotta D: nMexico scrubs itself clean to combat flu outbreak. *Reuters.* May 8, 2009. Available at <http://www.reuters.com/article/idUSN07411581>. Accessed July-September 2009.
38. Contingencia: 30 días después. *El Universal.* May 23, 2009. Available at <http://www.eluniversal.com.mx/notas/599802.html>. Accessed July-September 2009.
39. Xinhua: Mexico's A/H1N1 death toll rises to 89. *Global Times.* May 28, 2009. Available at <http://world.globaltimes.cn/health/2009-05/433000.html>. Accessed July-September 2009.
40. Angeles CM: Perdió México \$40 mil millones por el A/H1N1, afirma José Ángel Córdova. *La Jornada.* July 4, 2009. Available at <http://www.jornada.unam.mx/2009/07/04/index.php?section=sociedad&article=031n1soc>. Accessed July-September 2009.
41. Lacey M, McNeil Jr DG: Fighting deadly flu, Mexico shuts school. *The New York Times.* April 24, 2009. Available at <http://www.nytimes.com/2009/04/25/world/americas/25mexico.html?partner=MOREOVERNEWS&ei=5040>. Accessed July-September 2009.
42. Solono LP, Quintero J: Descarta la SEP propagación del virus A/H1N1 en primeras de Cuauhtepc. *La Jornada.* June 6, 2009. Available at <http://www.jornada.unam.mx/2009/06/06/index.php?section=capital&article=026n1cap>. Accessed July-September 2009.
43. Rodriguez R: Medidas de prevención contra influenza seánpermanents: Ssa. *El Universal.* June 4, 2009. Available at <http://www.eluniversal.com.mx/notas/602701.html>. Accessed July-September 2009.
44. Fox M: Flu spreads in U.S., world, winds down in Mexico. *Reuters.* May 7, 2009. Available at <http://www.reuters.com/article/idUSTRE5430S820090507>. Accessed July-September 2009.
45. Mexico businesses facing flu regulation. *UPI.com.* May 8, 2009. Available at http://www.upi.com/Top_News/2009/05/08/Mexico-businesses-facing-flu-regulations/UPI-14351241789303/. Accessed July-September 2009.
46. Zehbrauskas A: A street in La Gloria. *The New York Times Online.* Available at <http://www.nytimes.com/imagepages/2009/04/29/world/29mexico02.ready.html>. Accessed April 29, 2009.

Assessing hospital disaster preparedness in Shiraz, Iran 2011: Teaching versus private hospitals

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Abstract

Background: In disasters, hospitals play a crucial role in supplying essential medical care to the society but there is no standardized checklist for assessing hospital disaster preparedness.

Objectives: The objective of this study was to recognize and compare almost all the components of disaster preparedness between teaching and private hospitals in Shiraz, Iran, focusing on incident command systems (ICS), communications, surge capacity, human resources, supply management, logistic service, case management, surveillance, laboratory and operating room management.

Methods: From May to August 2011, we assessed the preparedness of teaching and private hospitals in Shiraz, using the 10-key component World Health Organization checklist.

Results: Twenty four out of 31 hospitals responded. The scores for preparedness of ICS, communication, surge capacity and human resources was 73.9 percent, 67.3 percent, 49 percent, and 52.6 percent respectively. The preparedness scores for supply management and logistic services were 68.5 percent and 61.8 percent. While the levels of preparedness of laboratory and operating room management were low, preparedness of the surveillance system and case management were 66.7 percent and 70.8 percent, respectively. The average total preparedness of all hospitals was 59.5 percent, with scores of 62.2 percent in teaching hospitals and 55 percent in private hospitals.

Conclusion: At the time of our study, the total preparedness among hospitals was at the intermediate

level, but in some key components such as operating room management, surge capacity, and human resources, the total preparedness was very limited and at an early stage of development, therefore, requiring urgent attention and improvement.

Key words: hospitals, preparedness, disasters

Introduction

Natural or man-made disasters can all result in a significant imbalance between supply and demand for resources.¹ Disasters cause much human and financial loss. Each year, on average, tens of millions of people are affected by disasters with tens of thousands of deaths and tens of billions of dollars of economic loss.²

Management of disasters includes four phases: a) mitigation (including possible actions to prevent the circumstance), b) preparedness (defined as actions to minimize catastrophic impact of hazards), c) response (including actions to preserve the lives and environment, ie, secondary prevention of harms), and d) recovery (bringing the community back to normal condition).³

Considering the mission of hospitals in the community, these institutions have a crucial role in preparedness and response phases of disaster management.^{4,5} In recent years, especially after events of 2001, public awareness about hospital preparedness increased and many published studies assessed preparedness and response of hospitals during disasters, concluding that hospital preparedness was limited and still at early stages.⁶⁻⁸

Iran, due to its geographical location, is prone to natural disasters. On an average, every 10 years; thousands

of people are affected by huge earthquakes with magnitudes greater than 7 in Richter scale.⁹ Moreover, the strategic position of Iran in the Mideast makes it prone to man-made disasters. Most surveys in Iran have assessed some components of preparedness or models of structure management, all of which have shown that preparedness is drastically low. However, none of them assessed the overall preparedness and the components of preparedness.^{5,9-11} Thus, this study aimed to identify, quantify, and compare the major components of disaster preparedness between teaching and private hospitals in Shiraz, Iran, focusing on incident command systems (ICS), communications, surge capacity, human resources, supply management, logistic service, case management, surveillance, laboratory, and operating room management.

Methods

Research design

A cross-sectional descriptive design was used in this research.

Study setting

The study was conducted from May to August 2011 and was planned to include all private and teaching hospitals in Shiraz, Iran.

Data collection tool

The data collection tool for our study utilized a hospital preparedness checklist for pandemic influenza, including 11 key components of hospital-based management. Under each component, a list of yes/no questions regarding the status of implementation of the recommended actions specific to that component was included.⁴ Many of the principles and recommendations outlined in the checklist were generic and applicable to other disaster situations. We modified the checklist and it was reviewed by experts to ascertain its validity. Reliability of the checklist was established using Cronbach alpha coefficient (0.85).

The final, checklist had a total of 54 questions, with 10 key components, including ICS, communications, surge capacity, human resources, supply management, logistic service, case management,

surveillance, laboratory service, and operating room management (see Appendix).

Participating hospitals and interview

Of a total of 31 hospitals in Shiraz, 24 participated in our study (response rate: 77.4 percent). The nonparticipant hospitals included three military, three single-specialty hospitals, and one social security hospital. After necessary coordination to obtain a permit to visit the hospitals and perform the study, a face-to-face interview was conducted with the chairman of the disaster committee of each hospital. When response to a question was positive, the interviewee was required to provide documentations on the subject.

Data analysis

Data entry was performed by a researcher and rechecked by another author. Statistical analysis was carried out using the SPSS statistical software package (version 11.5). Data were presented using descriptive statistics in the form of frequencies and percentages.

Results

Of the 24 hospitals participating in our study, 15 were teaching hospitals (62.5 percent) and nine were private (37.5 percent). As noted in Table 1, the highest percentage of total preparedness was related to ICS (73.9 percent). Of 24 hospitals, 20 had an active or ad hoc incident command group, specific locations for them and a policy on continuity of decisions, but only 11 hospitals designated a focal point for coordination and management. Total preparedness in the area of communication was 67.3 percent. The component with the highest score was related to establishing mechanisms for sharing information and the lowest percentage was allocated to communication with all staff about prioritization of patients. In surge capacity, total preparedness was 49 percent. Only four hospitals identified ways for expanding inpatient capacity although many of them had a plan to cancel nonessential services in disaster situations. Total preparedness in human resources was 52.6 percent. The highest percentage was assigned to updating the staff contact list, but surprisingly none of the hospitals had addressed temporary licensing for those staff who might be

Table 1. Comparison of 10 key components of hospital disaster preparedness between teaching and private hospitals

Preparedness components*	Teaching hospitals, percent (n = 15)		Private hospitals, percent (n = 9)		All hospitals, percent (n = 24)	
	Y	N	Y	N	Y	N
A) Incident command system	49 (81.7)	11 (18.3)	22 (61.1)	14 (38.9)	71 (73.9)	25 (26.1)
B) Communication	64 (71.1)	26 (28.9)	33 (61.1)	21 (38.9)	97 (67.3)	47 (32.7)
C) Surge capacity	57 (47.5)	63 (52.6)	37 (51.4)	35 (48.6)	94 (49.0)	98 (51.0)
D) Human resources	62 (51.7)	58 (48.3)	39 (54.2)	33 (45.8)	101 (52.6)	91 (47.4)
E) Supply management	95 (70.4)	40 (29.6)	53 (65.4)	28 (34.6)	148 (68.5)	68 (31.5)
F) Logistic service	59 (65.6)	31 (34.4)	30 (55.5)	24 (44.5)	89 (61.8)	55 (38.2)
G) Case management	46 (76.6)	14 (23.4)	22 (61.1)	14 (38.9)	68 (70.8)	28 (29.2)
H) Surveillance	28 (62.2)	17 (37.8)	20 (74.1)	7 (25.9)	48 (66.7)	24 (33.3)
I) Laboratory services	31 (68.9)	14 (31.1)	13 (48.1)	14 (51.9)	44 (61.1)	28 (38.9)
J) Operation room management	12 (26.7)	33(73.3)	5 (18.5)	22 (81.5)	17 (23.6)	55 (76.4)
Total	503 (62.2)	307 (37.8)	274 (55.0)	212 (45.0)	777 (59.5)	519 (40.5)

*Detailed questions of each 10 key components of hospital disaster preparedness shown as appendix.

working outside their areas of expertise. In supply management, total preparedness was 68.5 percent. The quality of contingency items prior to purchasing was assessed in nearly all hospitals, but the role of hospital pharmacy in providing pharmaceuticals for other alternative treatment sites was defined only in 10 hospitals. As to logistic services, total preparedness was 61.8 percent, with hospital security and implementation methods for the disposal of waste most likely to be planned for, and the estimation of additional supplies required was least likely. Total preparedness for case management was 70.8 percent. Nearly all respondent hospitals had strategies for admissions, internal transfer, referral, and discharge of patients. With respect to availability of intensive care unit preparedness, the percentage was low. In surveillance, total preparedness was 66.7 percent, with unusual health events scoring the highest percentage and the lowest percentages were related to early warning and monitoring, and information that

needed to be collected. Total preparedness in laboratory services was 61.1 percent. Eighteen out of 24 hospitals identified essential laboratory supplies and 10 of them had back up laboratory personnel/services. The lowest percentage of total preparedness was related to operating room management (23.6 percent). Only four hospitals had identified additional sites for conversion to operating room and storage equipment to prepare new operating rooms and nine of them were related to cross training of healthcare providers for the operating room. On an average, total preparedness in all hospitals was 59.5 percent; 62.2 percent in teaching hospitals; and 55.0 percent in private hospitals.

Discussion

While hospital preparedness is essential for proper management of disasters and the reduction of adverse impacts,⁷ the results of the participating hospitals of this study revealed that preparedness was at an intermediate level, with wide variability across items.

A process that distinguishes our study from prior surveys was assessment and comparison of almost all components of disaster preparedness among teaching and private hospitals using face-to-face interviews and a review of documentation supporting responses. In this study, preparedness in the area of ICS was higher than other key components, and higher than the results of Ojaghi et al.'s study (22 percent). The reasons for the difference may be related to the type of the checklist used and method of ranking questions.¹² Our results were lower than that of the report by Kaji (96 percent) and Li (93.3 percent), perhaps reflecting different hospital and community standards.^{1,7} The level of preparedness in communication in our study was intermediate, and this was higher than the results of Daneshmand et al. (54.2 percent) and Ojaghi (37.3 percent), this may be due to progress in time and more access to back-up communication systems such as the Internet, mobile devices, pager, and satellite telephone.^{5,12} Nevertheless, given the importance of communication systems in disasters, measures for improving this field seem to be necessary.

The result of surge capacity in our study has been ranked slightly less than 50 percent, which was higher than reported by Higgins and Kanji (27 and 29 percent, respectively), and this could be explained by the differences in applying the checklist; we used an eight-item checklist while the aforementioned studies used only a single question.^{1,8} The human resources in our study had an average level higher in comparison to Daneshmand et al.'s study (44.3 percent).⁵ The level of our preparedness in supply management was similar to that of Ojaghi et al. (36.1 percent).¹² It seems that the differences are related to different resources allocation to the provinces in Iran according to population in each province. Total preparedness in logistic services was similar to the results of Maleki's study (65 percent).¹⁴

Although we found a good level of case management preparedness in our survey, to the best of our knowledge, there was no similar study in the literature. The surveillance preparedness level in the present study was higher than that in Li (55.5 percent) and Higgins's (56.5 percent) studies.^{7,8} We assessed the surveillance systems with three items while Higgins assessed the surveillance system by a 10-item

checklist. The level of laboratory preparedness in our study was intermediate, which is less than the results reported in Li's study (97.4 percent).⁷ Our total preparedness in the field of operating room management was very low. We did not find any previous study that evaluated the level of preparedness in the field of operating room management. Preparedness in almost all key components, were higher in the teaching hospitals than the private hospitals except for three components. These findings could be explained by the fact that due to law enforcement and more supervision, teaching hospitals are more concerned with regards to disaster preparedness. Conversely, private hospitals that have higher financial resources allocated them to items that cost more such as surge capacity, human resources, and surveillance systems.

Limitations

Our study has several limitations. First, the results of this study could not be generalized to all hospitals in Iran, because only non-military hospitals in Shiraz participated in this study. Second, there is no standard instrument for assessment of hospital preparedness and we had to compare our findings to results of studies that assessed the level of preparedness with different checklists. Third, nonparticipating hospitals (mostly military ones) might differ from the participating ones. Usually, military hospitals have a higher level of preparedness, especially in ICS and communications items. Finally, all the questions in the checklist were restricted to "yes"/"no" answers, although clearly more explanation was required.

Conclusions

Although total hospital preparedness in this study was relatively acceptable, preparedness in some areas, such as operating room management, surge capacity, and human resources appears to be limited. To create and sustain an acceptable level of preparedness for dealing with disasters, we need to know the principals of the preparedness pyramid, which includes planning, infrastructure, knowledge, capabilities, and training. We recommend that the Iranian Ministry of Health establish assessment programs with measurable and reliable criteria and provide continuous efforts

to assess the levels of hospital preparedness periodically. Policy makers should address the necessary investments needed in the construction of infrastructure and capacities. As preparedness needs interinstitutional team work, enhancement of management at all levels is necessary.

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References

1. Kaji AHH, Lewis RJ: Hospital disaster preparedness in Los Angeles County. *Acad Emerg Med*. 2006; 13: 1198-1203.
2. Keeney GB: Disaster preparedness: what do we do now? *J Midwifery Women's Health*. 2004; 49: 2-6.
3. Abd elazzeem H, Adam S, Mohamad G: Awareness of hospital internal disaster management plan among health team members in a university hospital. *Life Sci J*. 2011; 8(2): 42-52.
4. World Health Organization: Hospital preparedness checklist for pandemic influenza focus on pandemic (H1N1), July 7, 2009. Available at http://www.euro.who.int/data/assets/pdf_file/0004/78988/E83006.pdf. Accessed January 29, 2012.
5. Daneshmandi M, Amiri H, Vahedi M, et al.: Assessing the level of preparedness for confronting crisis such as flood, earthquake, fire and storm in some selected hospitals of Iran [in Persian]. *Iranian J Military Med*. 2010; 12:167-171.
6. Adini LB, Goldberg A, Laor D, et al.: Assessing levels of hospital emergency preparedness. *Prehosp Disaster Med*. 2006; 21: 451-57.
7. Li X, Hung J, Zhang H: An analysis of hospital preparedness capacity for public health emergency in four regions of China: Beijing, Shandong, Guandong, and Hainan. *BMC Public Health*. 2008; 8: 319.
8. Higgins W, Wainrigh C, Lu N, et al.: Assessing hospital preparedness using an instrument based on the mass casualty disaster plan checklist: Results of a statewide survey. *Am J Infect Control*. 2004; 32:327-32.
9. Izadkhan YO, Hosseini KA: An evaluation of disaster preparedness in four major earthquakes in Iran. *J Seismol Earthquake Eng*. 2010; 12: 61-75.
10. Shams L, Yarmmohamadian MH, Atighechian G, et al.: Hospitals preparedness for HEICS establishment in Isfahan University of Medical Sciences [in Persian]. *J Rescue*. 2010; 2(1): 33-42.
11. Mohebifar R, Tabibi SJ, Asefzadeh S: Esigning a structure of disaster management [in Persian]. *J Health Admin*. 2008; 11(33): 47-56.
12. Ojaghi Sh, Norizad S, Mahbobi M, et al.: Disaster crisis handling preparedness level of hospitals in Kermanshan [in Persian]. *Behbood*. 2009; 13(42): 267-274.
13. Maleki M, Khoshkam M, Shojae P: Preparation aspects of supplies encounter disasters in selected hospitals of Iran University of Medical Sciences [in Persian]. *J Health Information Management*. 2008; 5(1): 73-81.
14. Maleki M, Shojae P: Hospitals preparation in disasters: Security [in Persian]. *J Health Admin*. 2007; 10(28): 65-70.

Appendix: Detail questions of each ten key components of hospital disaster preparedness

Preparedness components	Teaching hospitals, percent (n = 15)		Private hospitals, percent (n = 9)		All hospitals, percent (n = 24)	
	Y	N	Y	N	Y	N
A) Incident command systems						
1. Establish active or ad hoc incident command group	14 (93.3)	1 (6.7)	6 (66.7)	3 (33.3)	20 (83.3)	4 (16.7)
2. Designate specific location as a hospital command system	14 (93.3)	1 (6.7)	6 (66.7)	3 (33.3)	20 (83.3)	4 (16.7)
3. Designate a focal point for coordination and management	7 (46.7)	8 (53.3)	4 (44.4)	5 (55.6)	11 (45.8)	13 (54.2)
4. Appoint prospective replacements for guarantee the continuity of decisions	14 (93.3)	1 (6.7)	6 (66.7)	3 (33.3)	20 (83.3)	4 (16.7)
Total	49 (81.7)	11 (18.3)	22 (61.1)	14 (38.9)	71 (73.9)	25 (26.1)
B) Communication						
1. Establish mechanisms to sharing information	14 (93.3)	1 (6.7)	8 (88.9)	1 (11.1)	22 (91.7)	2 (8.3)
2. Brief the hospital staff on their roles within the incident action plan	12 (80.0)	3 (20.0)	8 (88.9)	1 (11.1)	20 (83.3)	4 (16.7)
3. Ensure that all decisions on patient prioritization are communicated to all staff	7 (46.7)	8 (53.3)	2 (22.2)	7 (77.8)	9 (37.5)	15 (62.5)
4. Ensure the collection, processing, and reporting of information	8 (53.3)	7 (46.7)	3 (33.3)	5 (55.6)	11 (45.5)	13 (54.2)
5. Appoint a public information spokesperson to coordinate communication	10 (66.7)	5 (33.3)	4 (44.4)	5 (55.6)	14 (58.3)	10 (41.7)
6. Ensure reliable and sustainable primary and back-up communication systems	13 (86.7)	2 (13.3)	8 (88.9)	2 (22.2)	21 (87.5)	3 (12.5)
Total	64 (71.1)	26 (28.9)	33 (61.1)	21 (38.9)	97 (67.3)	47 (32.7)
C) Surge capacity						
1. Calculate maximal case admission capacity	4 (26.7)	11 (73.3)	3 (33.3)	6 (66.7)	7 (29.2)	17 (70.8)
2. Use available planning assumptions to estimate increase in demand	6 (40.0)	9 (60.0)	1 (11.1)	8 (88.9)	7 (29.2)	17 (70.8)
3. Identify ways of expanding hospital in-patient capacity	2 (13.3)	13 (86.7)	2 (22.2)	7 (77.8)	4 (16.7)	20 (83.3)
4. Identify potential gaps in the provision of healthcare	6 (40.0)	9 (60.0)	4 (44.4)	5 (55.6)	10 (41.7)	14 (58.3)
5 Release additional capacity to appropriate alternative treatment sites	11 (73.3)	4 (26.7)	8 (88.6)	1 (11.1)	19 (79.1)	5 (20.8)
6 Identify additional sites for conversion to patient care units	7 (46.7)	8 (53.3)	4 (44.4)	5 (55.6)	11 (45.9)	13 (54.1)
7 Cancel the nonessential services	11 (73.3)	4 (26.7)	8 (88.9)	1 (11.1)	19 (79.1)	5 (20.9)
8 Adapt the admission and discharge criteria according to available treatment capacity and demand	10 (66.7)	5 (33.3)	7 (77.8)	2 (22.2)	17 (70.9)	7 (29.1)
Total	57 (47.5)	63 (52.6)	37 (51.4)	35 (48.6)	94 (49.0)	98 (51.0)

Appendix: Detail questions of each ten key components of hospital disaster preparedness (continued)

Preparedness components	Teaching hospitals, percent (n = 15)		Private hospitals, percent (n = 9)		All hospitals, percent (n = 24)	
	Y	N	Y	N	Y	N
D) Human resources						
1. Update the staff contact list	14 (93.3)	1 (6.7)	9 (100)	0 (0)	23 (95.8)	1 (4.2)
2. Estimate staff absenteeism in advance and monitor it continuously	13 (86.7)	2 (13.3)	9 (100)	0 (0)	22 (91.7)	2 (8.3)
3. Establish a clear sick-leave policy for staff	9 (60.0)	6 (40.0)	5 (55.6)	4 (44.4)	14 (58.3)	10 (41.7)
4. Identify the minimum number of healthcare workers needed to ensure the sufficient operation	9 (60.0)	6 (40.0)	4 (44.4)	5 (55.6)	13 (54.1)	11 (45.9)
5. Prioritize staffing needs by unit and distribute personnel	8 (53.3)	7 (46.7)	8 (88.9)	1 (11.1)	16 (66.7)	8 (33.3)
6. Recruit and train additional staff	6 (40.0)	9 (60.0)	1 (11.1)	8 (88.9)	7 (29.9)	17 (70.8)
7. Cross-train healthcare providers in high-demand services	3 (20.0)	12 (80.0)	3 (33.3)	6 (66.7)	6 (25.0)	18 (75.0)
8. Address temporary licensing for staff who may be working outside their areas of expertise	0 (0)	15 (100)	0 (0)	9 (100)	0 (0)	24 (100)
Total	62 (51.7)	58 (48.3)	39 (54.2)	33 (45.8)	101 (52.6)	91 (47.4)
E) Supply management						
1. Develop an updated inventory of all equipment, supplies, and pharmaceuticals	13 (86.7)	2 (13.3)	9 (100)	0 (0)	22 (91.7)	2 (8.3)
2. Estimate the consumption of essential equipment, supplies, and pharmaceuticals on the basis of disaster	7 (46.7)	8 (53.3)	6 (66.7)	3 (33.3)	13 (54.2)	11 (45.8)
3. Consult with authorities to ensure the continuous provision of essential supplies	12 (80.0)	3 (20.0)	9 (100)	0 (0)	21 (87.5)	3 (12.5)
4. Assess the quality of contingency items prior to purchase	14 (93.3)	1 (6.7)	9 (100)	0 (0)	23 (95.8)	1 (4.2)
5. Establish contingency agreements with vendors	12 (80.0)	3 (20.0)	7 (77.8)	2 (22.2)	19 (79.1)	5 (20.9)
6. Identify physical space within the hospital for the storage and stockpiling of additional supplies	8 (53.3)	7 (46.7)	3 (33.3)	6 (66.7)	11 (45.8)	13 (54.2)
7. Stockpile essential supplies and pharmaceuticals according to national guidelines	13 (86.7)	2 (13.3)	5 (55.6)	4 (44.4)	18 (75.0)	6 (25.0)
8. Define the role of the hospital pharmacy in providing pharmaceuticals for other alternative treatment sites	7 (46.7)	8 (53.3)	3 (33.3)	6 (66.7)	10 (41.6)	14 (58.4)
9. Coordinate transportation services in establishing a contingency transportation strategy	9 (60.0)	6 (40.0)	2 (22.2)	7 (77.8)	11 (45.8)	13 (54.2)
Total	95 (70.4)	40 (29.6)	53 (65.4)	28 (34.6)	148 (68.5)	68 (31.5)

Appendix: Detail questions of each ten key components of hospital disaster preparedness(continued)

Preparedness components	Teaching hospitals, percent (n = 15)		Private hospitals, percent (n = 9)		All hospitals, percent (n = 24)	
	Y	N	Y	N	Y	N
F) Logistic service						
1. Estimate the additional supplies and introduce a mechanism to ensure the continuous availability of these supplies	3 (20.0)	12 (80.0)	0 (0)	9 (100)	3 (12.5)	21 (87.5)
2. Enable the adaptation of the support services to cope with an increased demand	4 (26.7)	11 (73.3)	1 (11.1)	8 (88.9)	5 (20.8)	19 (79.2)
3. Implement methods for the disposal waste in accordance with the standards	15 (100)	0 (0)	8 (88.9)	1 (11.1)	23 (95.8)	1 (4.2)
4. Anticipate the impact of disaster on hospital food supplies; take proactive measures to ensure the availability of food	10 (66.7)	5 (33.3)	3 (33.3)	6 (66.7)	13 (54.1)	11 (45.9)
5. Ensure the availability of appropriate back-up arrangements for essential life lines, including water, power, and oxygen	13 (86.7)	2 (13.3)	9 (100)	0 (0)	22 (91.7)	2 (8.3)
6. Solicit the input of hospital security in identifying potential security constraints	14 (93.3)	1 (6.7)	9 (100)	0 (0)	23 (95.8)	1 (4.2)
Total	59 (65.6)	31 (34.4)	30 (55.5)	24 (44.5)	89 (61.8)	55 (38.2)
G) Case management						
1. Consider establishing additional areas for triage of patients	12 (80.0)	3 (20.0)	4 (44.4)	5 (55.6)	16 (66.7)	8 (33.3)
2. Appoint a triage supervisor responsible for overseeing all triage operations	11 (73.3)	4 (26.7)	4 (44.4)	5 (55.6)	15 (62.5)	9 (37.5)
3. Implement the hospital strategy for the admission, internal transfer, referral, and discharge	14 (93.3)	1 (6.7)	9 (100)	0 (0)	23 (95.9)	1 (4.1)
4. Ensure the availability of staffed critical care beds for those patients requiring intensive care therapy	9 (60.0)	6 (40)	5 (55.6)	4 (44.4)	14 (58.3)	10 (41.7)
Total	46 (76.6)	14 (23.4)	22 (61.1)	14 (38.9)	68 (70.8)	28 (29..2)
H) Surveillance						
1. Appoint a hospital epidemiologist with the overall responsibility for activities related to early warning and monitoring in the hospital	7 (46.7)	8 (53.3)	6 (66.7)	3 (33.3)	13 (54.2)	11 (45.8)
2. Identify the information that needs to be collected and define the objectives for its use	8 (53.3)	7 (46.7)	5 (55.6)	4 (44.4)	13 (54.2)	11 (45.8)
3. Promote the reporting of unusual health events by healthcare workers	13 (86.7)	2 (13.3)	9 (100)	0 (0)	22 (91.7)	2 (8.3)
Total	28 (62.2)	17 (37.8)	20 (74.1)	7 (25.9)	48 (66.7)	24 (33.3)

Appendix: Detail questions of each ten key components of hospital disaster preparedness						
Preparedness components	Teaching hospitals, percent (n = 15)		Private hospitals, percent (n = 9)		All hospitals, percent (n = 24)	
	Y	N	Y	N	Y	N
I) Laboratory services						
1. Ensure the continuous availability of basic laboratory testing	11 (73.3)	4 (26.7)	5 (55.6)	4 (44.4)	16 (66.6)	8 (33.4)
2. Identify essential laboratory supplies and ensure their continuous availability	12 (80.0)	3 (20.0)	6 (66.7)	3 (33.3)	18 (75.0)	6 (25.0)
3. Identify back-up laboratory personnel and/or alternative laboratory services	8 (53.3)	7 (46.7)	2 (22.2)	7 (77.8)	10 (41.7)	14 (58.3)
Total	31 (68.9)	14 (31.1)	13 (48.1)	14 (51.9)	44 (61.1)	28 (38.9)
J) Operation room management						
1. Identify additional sites for conversion to operation room	3 (20.0)	12 (80.0)	1 (11.1)	8 (88.9)	4 (16.7)	20 (83.3)
2. Storage equipments to create new operation rooms	3 (20.0)	12 (80.0)	1 (11.1)	8 (88.9)	4 (16.7)	20 (83.3)
3. Cross-train healthcare providers for operation room	6 (40.0)	9 (60.0)	3 (33.3)	6 (66.7)	9 (37.5)	15 (62.5)
Total	12 (26.7)	33 (73.3)	5 (18.5)	22 (81.5)	17 (23.6)	55 (76.4)

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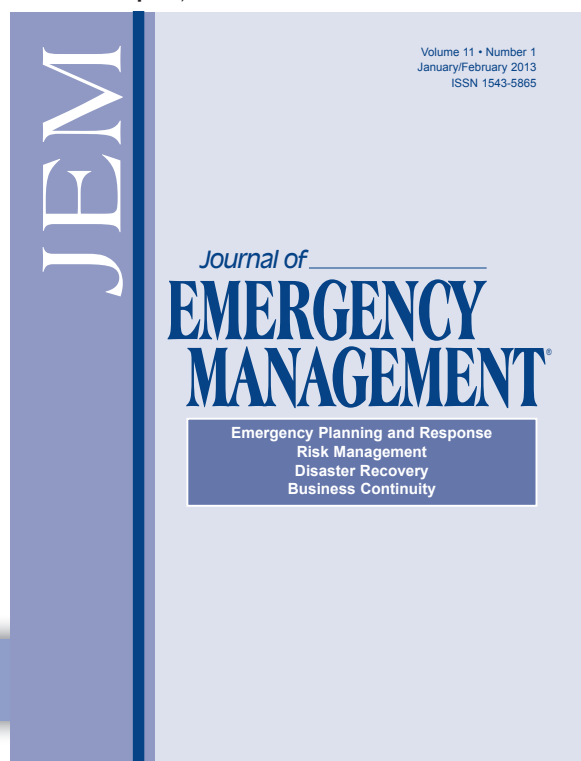
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Pediatric Surge Pocket Guide: Review of an easily accessible tool for managing an influx of pediatric patients

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Abstract

As seen in recent disasters, large-scale crisis events have the potential to cause significant pediatric death and injury. During such disaster situations, both distance and decreased mobility will likely limit access to pediatric hospitals. Thus, all hospitals, regardless if they regularly treat children or not, should anticipate an influx of pediatric patients in the event of a disaster. The Pediatric Surge Pocket Guide was developed for and distributed at a Pediatric Medical Surge Workshop held by the Los Angeles County Department of Public Health in June 2009. Designed both as a supplement to the workshop training and as an effective stand-alone resource, the Guide provides comprehensive pediatric-specific recommendations for hospitals experiencing a surge in pediatric capacity. Because of its unique pocket-size format, the Guide has the potential to be a readily accessible tool with application to a wide range of disaster or nondisaster situations, for use in hospital or nonhospital settings, and by pediatric specialists, nonspecialists, and nonclinicians alike.

Key words: pediatric, hospital surge, disaster

Introduction

Although disaster planning has been a priority on the national, state, and local levels, there still exists a persistent lack of pediatric considerations in disaster preparedness plans.^{1,2} Children are especially vulnerable in disaster scenarios due to unique physiological, developmental, and psychological characteristics, and they often require specialized care.^{3,4} In the event that

a disaster creates a surge of pediatric patients, access to pediatric hospitals or to pediatric healthcare specialists will likely be limited. Thus, nonpediatric healthcare providers, or even nonclinical personnel, may need to provide care for pediatric victims.³ In addition to comprehensive predisaster planning and training, there needs to be easily accessible just-in-time guidance for the treatment of pediatric patients.

The Los Angeles County Department of Public Health (LACDPH) took a unique approach to address this need. In June 2009, they released a Pediatric Surge Pocket Guide as part of their Pediatric Medical Surge Workshop held in Los Angeles County. This pocket guide was the result of a collaborative effort between multiple healthcare organizations, and is, to our knowledge, the first of its kind to provide comprehensive guidance to managing pediatric surge in disaster situations in compact format.

The purpose of this article is to review the development, scope, and utility of the Guide as a source of support for handling a surge of pediatric patients. Also discussed are potential next steps for improving the Guide.

Planning, Development, and Design

Produced and distributed by the LACDPH, the Pediatric Surge Pocket Guide represents the culmination of several years of pandemic and emergency preparedness planning. In collaboration with several emergency preparedness partners, including the Department of Health Services and the Los Angeles

County Emergency Medical Services Agency (LAC EMSA), the LACDPH has actively prepared for pandemics and other healthcare crisis events. A cornerstone of this effort has been promoting hospital readiness, including a series of hospital surge preparedness workshops. These workshops identified the need for increased pediatric-specific preparedness activities for hospitals given the likelihood of a surge in pediatric patients during disaster situations.

In an attempt to address this gap, the LACDPH held a Pediatric Medical Surge Workshop on June 2, 2009. Designed as a forum for discussing the unique vulnerabilities of children in disasters, this workshop specifically aimed to provide pediatric disaster resources and instruction to staff from nonpediatric hospitals as well as nonhospital settings. The workshop-planning committee included representatives from: Los Angeles County Department of Health Services, Pasadena Public Health Department, Long Beach Department of Health and Human Services, Children's Hospital Los Angeles, Pediatric Disaster Resource and Training Center (PDRTC), Hospital Association of Southern California, Huntington Hospital, and Harbor-UCLA Medical Center. During the planning phase, these key community stakeholders sought to address the knowledge gap in pediatric surge management through both a scenario-based activity during the workshop, as well as the development of a stand-alone resource that could provide assistance beyond the workshop.

Under the leadership of the LACDPH and the LAC EMSA, the development of the Guide and the accompanying tabletop exercise was tasked to a Los Angeles-based disaster consulting firm, Constant & Associates (C&A). Initially, this group considered several format options, including a tool kit or resource CD. They decided, however, that the accessibility of a pocket guide format would best fit their objectives. Over a period of 3 months, they finalized design and layout, assembled content, and reviewed the final product for accuracy and clarity. The specific recommendations included in the Guide were compiled under the advisement of a group of selected pediatric physicians, nurses from Children's Hospital Los Angeles, and LAC pediatric liaison nurses.

The Guide was designed to be a practical, simple, and useful resource for healthcare professionals responding to an influx of pediatric patients (Figures 1-4). First, the Guide details comprehensive pediatric-specific recommendations across a wide range of topics, highlighting seven key areas: 1) normal values (ie, vital signs, fluid and electrolyte requirements); 2) triage and assessment; 3) treatment and medications; 4) equipment; 5) decontamination; 6) mental health; and 7) pediatric safety and security considerations (Table 1). Additionally, the Guide was designed to be readily accessible and easy to use. As a tangible, stand-alone resource, the Guide requires no training, technology, or electricity to operate. It aggregates all critical information into one convenient, pocket-sized handbook, and the color-coded tabs allow users to rapidly find relevant sections. Lastly, the Guide was designed using an all-hazards approach, resulting in a very broad application range. There are no limitations in terms of jurisdiction, disaster or nondisaster scenarios, and hospital or nonhospital settings.

Assessment and Feedback

The application of the Guide was assessed during the June 2009 Pediatric Medical Surge Workshop, where participants used the Guide to resolve two hypothetical pediatric surge events. This workshop united more than 90 key hospital, public health, and student health administrators from across Los Angeles County. In addition to showcasing several informational presentations, the workshop distributed a tool kit of pediatric disaster resources to participants. Besides the Guide, this tool kit also included pediatric surge planning guidance, pediatric triage information, school all-hazard planning guidelines, case studies, Internet resources, and symptomology cards. Using these resources, participants collaborated in groups to develop response plans to two pediatric disaster scenarios. After each scenario exercise, workshop facilitators moderated a discussion amongst participant groups to review response plans and discuss issues encountered during the activity. At the end of the workshop, participants filled out feedback forms rating their satisfaction with the overall workshop and distributed resources.

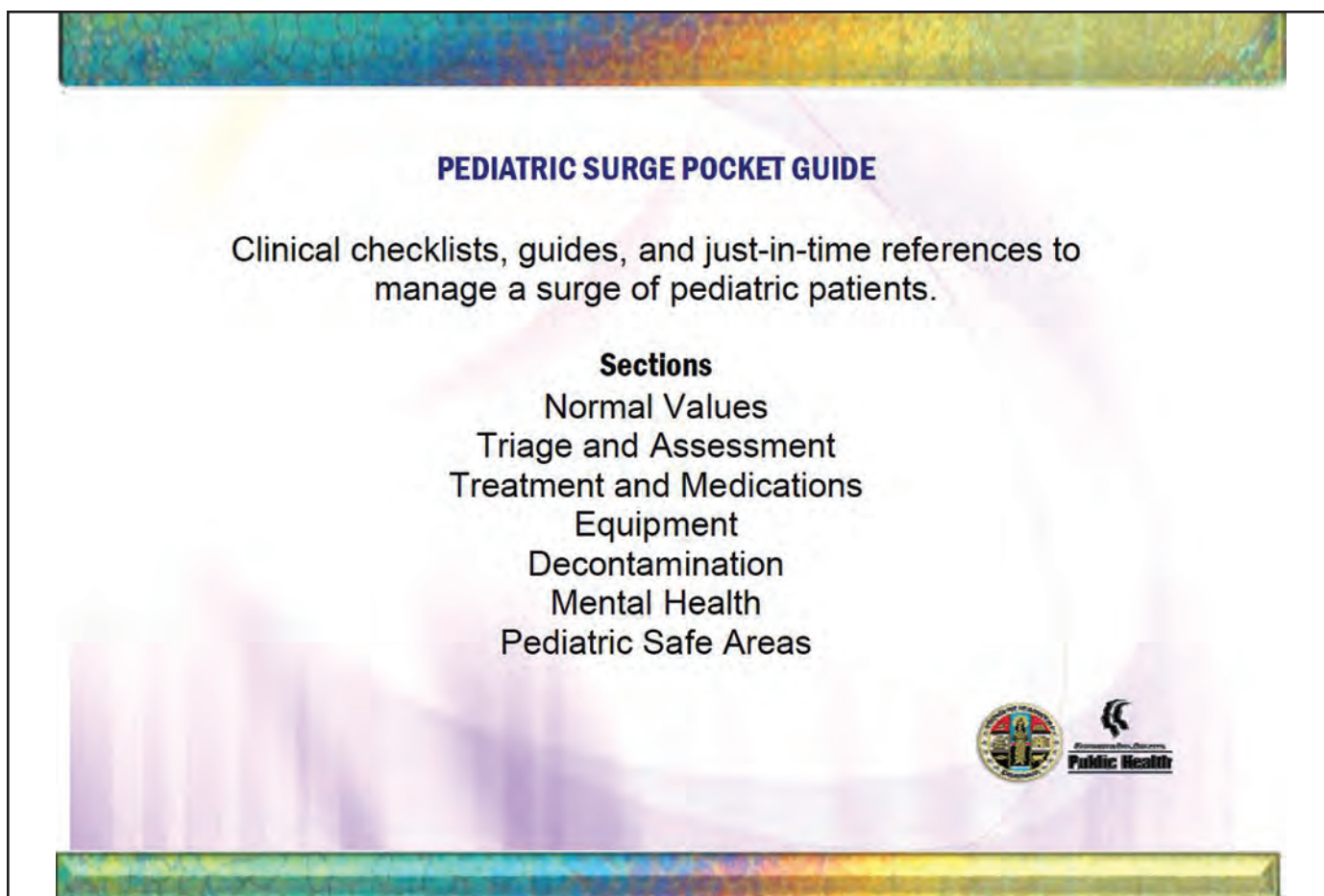


Figure 1. Front cover of the Pediatric Surge Pocket Guide, outlining the seven sections of content.

A total of 73 participants completed the two scenario exercises. The first scenario was a 6.8 magnitude earthquake across all of Southern California, focusing on a preparatory school in downtown Los Angeles, where 180 students were playing outside during recess when the earthquake occurred. Due to widespread freeway and street closures, emergency services arrived nearly an hour after the initial shock and the resulting 70 injured children were transported to a nearby nonpediatric hospital. The second scenario was a bioterrorism event, in which an aerosol canister released anthrax into a sold-out Elmo concert at the Nokia Theater, located in downtown Los Angeles. Audience members were completely unaware of the exposure, and over the next 3 days, 152 children, along with 78 adults, were hospitalized for fever and respiratory complaints.

Teams were instructed to utilize the Guide, along with the other resources provided in the tool kit, in developing their plan for managing these two pediatric surges. They were asked to consider how their facility would respond to such disaster situations, focusing on considerations unique to mass pediatric disaster scenarios, potential obstacles, and corresponding solutions. The Guide was intended to facilitate the development of response plans, providing information for adapting equipment, pediatric decontamination procedures, and mental health issues, among other topics. This exercise allowed participants to identify gaps in their response plans and consider aspects of clinical pediatric disaster care previously overlooked, especially by nonhealthcare professionals.

In the feedback forms ($n = 68$), participants nearly unanimously rated the Guide as a valuable tool that

NORMAL DEVELOPMENT		
Age	Gross Motor Skills	Fine Motor Skills
2 months	Flexed position when prone	Inhibited grasp reflex
4 months	Rolls from front to back, back to side	Carries object to mouth
6 months	Rolls from back to abdomen	Holds bottle
9 months	Sits steady, creeps or crawls	Holds objects in both hands and bangs together
12 months	Cruises well	Bangs 2 blocks together
15-18 mos	Pushes and pulls toys	Uses cup well, some spoon agility
2 years	Runs well with wide stance	Turns doorknob and unscrews lids
3 years	Climbs stairs alternating feet	Copies circles and cross
4 years	Hops, jumps, and skips on one foot	Draws person with greater than 3 body parts
5 years	Skips alternating feet	Prints some letters

Figure 2. Table detailing normal gross and fine motor development.

they would use after the workshop (mean = 4.79/5). Participants' comments included requests for additional copies of the Guide, calls for more case scenarios involving the Guide in future workshops, and a willingness to recommend the Guide to others. The consensus was that the Pediatric Surge Pocket Guide recognizes and addresses the critical need for all jurisdictions to plan for an inevitable surge in pediatric patients that can occur during a natural disaster, pandemic, or terrorist attack.

While originally created to supplement the workshop, the Guide was also designed to be a stand-alone resource, and is available for free download on the LACDPH Web site (www.publichealth.lacounty.gov/eprr/plans.htm). Hard copies are no longer available, but requests for printer-ready versions have been readily granted, allowing other jurisdictions to create their own hard copies in handbook format. The broad application of the Guide allows its use outside of Los Angeles County

in a range of crisis events as well as day-to-day operations, and in nonhospital settings, ie, schools, community, and homes. In fact, other states—Florida, Illinois, and Maine—have requested copies of the Guide, and several schools in Los Angeles have adopted the Guide for use in addressing student health.

Other tools for managing surge are available. New York City Department of Health and Mental Hygiene published a "Pediatric Disaster Toolkit: Hospital Guidelines for Pediatrics in Disasters" in 2006, a comprehensive hundred-plus page report detailing guidelines for anything from dietary needs of children to pediatric disaster training for hospitals.⁵ Similarly, the Agency for Healthcare Research and Quality released a handout titled "Pediatric Hospital Surge Capacity in Public Health Emergencies" in 2009.⁶ California Emergency Medical Services Authority and the Department of Public Health – Seattle and King County also released similar guidelines in 2010.^{7,8} While these,

ANALGESICS, PART 1: NEWBORN - 6 YEARS

Drug	Dose	Route	Newborn (3 kg)	3-6 mos (5 kg)	1 year (10 kg)	2-3 yrs (15 kg)	4-6 yrs (20 kg)
Acetamin- ophen	10-15 mg/kg/ every 4-6 hours	Oral	30-45 mg	50-75 mg	100-150 mg	150-225 mg	200-300 mg
Ibuprofen	5-10 mg/kg every 6-8 hours Max 40 mg/ kg/day	Oral	x	25-50 mg	50-100 mg	75-150 mg	100-200 mg
Morphine	0.1-0.2 mg/kg every 2-4 hours, as needed Max 15mg/ dose	IV/IM/ SubQ	0.15-0.3 mg q 4-8 hrs	0.5-1 mg	1-2 mg	1.5-3 mg	2-4 mg

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Figure 3. Analgesic medication dosing for newborn to 6 years of age.

and other related resources, provide guidelines and recommendations regarding pediatric surge capacity, none are available in pocket-sized format. The Guide effectively presents relevant information for managing pediatric surge in disaster situations in a convenient and readily available handbook.

Strengths and Weaknesses

The Guide contains several key strengths. First, it effectively summarizes recommendations across a comprehensive range of topics into a portable handbook, easily accessible in the event of a disaster. Different colored tabs identify each of the seven sections, allowing information within specific sections to be located quickly. No power source or additional device is needed. In addition, the Guide was specifically designed to be adaptable for different crisis situations, locations, and users. It is applicable for use in practice drills or during actual disasters and is not

tailored to address any specific natural or human-caused disaster scenarios. The Guide is not specific to hospital settings and contains instructions for general pediatric disaster first aid that can be used wherever a surge of pediatric victims arises. While some medication or equipment discussed in the Guide may only be found in hospital settings, it is still useful for nonhospital users to keep such information on hand, in case victims under their care are transported to a nonpediatric hospital. Also, no additional training is needed to use the Guide, and the recommendations are targeted for both pediatric specialists and nonspecialists. Overall, the accessibility and flexibility of the Guide translates into wide application and high utility.

Similarly, deficiencies in the content of the Guide have also been recognized. While the Guide is rich with information regarding the clinical care of pediatric patients in a disaster situation, it fails to touch on some key related issues, such as considerations for families in

COLOR CODE DRUG DOSES BY WEIGHT: 8-9 KG COLOR CODE: RED: 7-10 MONTHS; LENGTH: 66.5-74 CM			
RED	NORMAL VITAL SIGNS <ul style="list-style-type: none"> • Heart Rate: 100-160 • Respirations: 30-60 • B/P Systolic: >70 	ACLS DRUGS-- INITIAL DOSE <ul style="list-style-type: none"> • Adenosine: 0.85 mg • Calcium Chloride: 170 mg • Epinephrine 1:10,000: 0.085 mg • Amiodarone: 42 mg • Sodium Bicarbonate: 8 mEq 	RED
	DEFIBRILLATION Cardioversion 9 Joules 17 Joules 17 Joules Defibrillation 17 Joules 34 Joules 34 Joules	DOPAMINE (400 mg / 5 mL) <ul style="list-style-type: none"> • Add 50 mg (0.6 mL) to 100 mL bag of NS • Start at 10 mcg/kg/minute • Titrate to signs of adequate perfusion or maximum of 20 mcg/kg/minute 	
		MEDICATIONS <ul style="list-style-type: none"> • Albuterol HBN: 2.5 mg • Atropine IV: 0.17 mg • Dextrose 25% slow IV: 17 mL • Midazolam IV/IM/IN: 0.8 mg • Diphenhydramine*: 8 mg • Epinephrine 1:1,000 IM: 0.085 mg • Glucagon IM: 1 mg • Morphine Sulfate*: 0.8 mg • Naloxone IV/IM/IN: 0.8 mg • Normal Saline IV Bolus: 170 mL * IV or IM	

Figure 4. Color-coded drug dose table for weight 8-9 kg.

disaster, children and the media, and specific psychological considerations for dealing with death. Additionally, the assessment of the Guide during the scenario-based activities was not designed to evaluate specific sections of the Guide, and thus, failed to capture feedback on the utility and design of different content areas, as well as which were most useful during the mock disaster response planning. Such feedback would have been useful to determine ease of use during planning scenarios, especially for nonhealthcare professionals, as well as to identify potential improvements in the content and design of specific sections.

In terms of design, although convenient for use, the hard copy format raises issues about time sensitivity. There is no way to easily reflect changes in standards of care, such as recent changes to recommendations for dosing resuscitation medication for pediatric patients, in the Guide. Also, the only place where the publication date is listed is on the inside of

the front cover. This lack of a clearly visible publication date on all the pages means users could erroneously assume all information is up-to-date. Another related issue is the high cost associated with production of these small, spiral-bound booklets, due primarily to the use of UV-coated waterproof paper and spiral binding. This production cost places restrictions on distribution, as well as publishing updated versions. As a result, no additional hard copies were printed after the workshop.

Although hard copies of the Guide are no longer available through the LACDPH, the entire Guide is downloadable in PDF format on their Web site, and printer-ready versions can be provided for organizations looking to print their own hard copies. For those looking to duplicate the Guide, it is important to be mindful of these strengths and weaknesses, especially in terms of updates to specific recommendations and cost-effective modifications to design.

Table 1. Summary of topics discussed in each of the seven sections of the Pediatric Surge Pocket Guide

	Section title	Topics discussed
1	Normal values	Instructions for pound-kilogram conversion and weight estimation
		Normal pediatric vital sign ranges for the different phases of growth
		Progression of gross and fine motor skill development from birth to 5 years of age
		Daily maintenance fluid and electrolyte requirements
		Normal blood volume estimation and tips for IV administration
		Guidelines for appropriate infant feeding (formula and food examples, amount, frequency)
2	Triage and assessment	Algorithms and charts for different triage and assessment tools: Pediatric Assessment Triangle; JumpSTART; Wong-Baker FACES Pain Rating Scale; clinical features of mild, moderate, and severe dehydration; FLACC Post-Operative Pain Scale; Glasgow Coma Scale; Rule of Nines for pediatric burn assessment
3	Treatment and medications	Signs of hypovolemic shock and guidelines for fluid resuscitation
		Tables of dosing guidelines, route, and dose estimations by age for different medications (ie, analgesics, antibiotics, antipyretics, antivirals, asthma medications, cardiac medications, etc)
		Drug dose tables color-coded by weight
		Nerve agent and cyanide treatment charts color-coded by weight
4	Equipment	Equipment size estimations by age for ETT, L Blade, Suction, NG tube, Foley, Chest tube, LMA (cuff), C-Collar
5	Decontamination	General pediatric decontamination considerations
		Guidelines for ambulatory and nonambulatory decontamination for different ages
6	Mental health	General pediatric mental health considerations
		Guidelines for pediatric psychological first aid, a nine-step process, with specific objectives and sample questions for each step
7	Pediatric-safe areas	General security considerations for pediatric patients
		Guidelines for pediatric-safe areas, including instructions for choosing a location, suggested equipment and supplies to have on hand, and important identifiers to put on ID bands for unaccompanied children

Conclusion and Future Direction

Recently, disasters resulting in significant pediatric death and injury have brought increased awareness about the need for more comprehensive pediatric disaster preparedness planning. Providers may believe that young patients will be transferred to

pediatric hospitals. However, that is not always feasible, especially considering that disasters can severely limit mobility. In the event of a disaster affecting a large number of children, a surge of pediatric patients could rapidly overwhelm healthcare staff and facilities, and all hospitals should realize and prepare for such an

influx. The Pediatric Surge Pocket Guide is a readily available, multipurpose tool that provides clinical guides and just-in-time references to manage such a surge.

Currently, a modified version of the Guide is being developed as a quad-fold quick reference guide through a partnership between the LAC EMSA and the PDRTC at Children's Hospital Los Angeles. Additionally, in light of deficits identified, potential next steps aim to convert the Guide into a more easily adaptable and timely format—a mobile phone app. This would serve the dual purpose of both cutting production costs as well as allowing easy dispersal of updates. While there are other pediatric medicine apps (ie, Pedi-Stat, Pedi-Safe, PALS) on the market, none comprehensively provide recommendations for management of a pediatric surge. Development of this is currently being explored at Children's Hospital Los Angeles.

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References

1. Burke RV, Iverson E, Goodhue CJ, et al.: Disaster and mass casualty events in the pediatric population. *Semin Pediatr Surg.* 2010; 19(4): 265-270.
2. Gausche-Hill M, Schmitz C, Lewis RJ: Pediatric preparedness of US emergency departments: A 2003 survey. *Pediatrics.* 2007; 120(6): 1229-1237.
3. Hohenhaus SM: Practical considerations for providing pediatric care in a mass casualty incident. *Nurs Clin North Am.* 2005; 40(3): 523-533, ix.
4. Markenson D, Redlener I: Pediatric terrorism preparedness national guidelines and recommendations: Findings of an evidenced-based consensus process. *Biosecur Bioterror.* 2004; 2(4): 301-319.
5. New York City Department of Health and Mental Hygiene: *Pediatric Disaster Toolkit: Hospital Guidelines for Pediatrics in Disasters.* New York City, NY: New York City Department of Health and Mental Hygiene, 2006.
6. Agency for Healthcare Research and Quality: *Pediatric Hospital Surge Capacity in Public Health Emergencies.* Rockville, MD: Agency for Healthcare Research and Quality, 2009.
7. Emergency Medical Services Authority: *EMSC Pediatric Disaster Preparedness Guidelines: Hospitals.* Sacramento, CA: Emergency Medical Services Authority, 2010.
8. Public Health – Seattle & King County: *Hospital Guidelines for Management of Pediatric Patients in Disasters.* Seattle, WA: Public Health – Seattle & King County, 2010.



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