ORIGINAL RESEARCH

The Incident Command System in Disasters: Evaluation Methods for a Hospital-based Exercise

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Abbreviations:
HEICS = hospital emergency incident command system
ICS = incident command system
min = minutes
US = United States of America

Keywords: data collection; definitive treatment; disasters; drills; evaluation; exercise; hospitals; incident command system; methods; times; transport; triage

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Abstract

Objectives: No universally accepted methods for objective evaluation of the function of the Incident Command System (ICS) in disaster exercises currently exist. An ICS evaluation method for disaster simulations was derived and piloted.

Methods: A comprehensive variable list for ICS function was created and four distinct ICS evaluation methods (quantitative and qualitative) were derived and piloted prospectively during an exercise. Delay times for key provider-victim interactions were recorded through a system of data collection using participant- and observer-based instruments. Two different post-exercise surveys (commanders, other participants) were used to assess knowledge and perceptions of assigned roles, organization, and communications. Direct observation by trained observers and a structured debriefing session also were employed.

Results: A total of 45 volunteers participated in the exercise that included 20 mock victims. First, mean, and last victim delay times (from exercise initiation) were 2.1, 4.0, and 9.3 minutes (min) until triage, and 5.2, 11.9, and 22.0 min for scene evacuation, respectively. First, mean, and last victim delay times to definitive treatment were 6.0, 14.5, and 25.0 min. Mean time to triage (and range) for scene Zones I (nearest entrance), II (intermediate) and III (ground zero) were 2.9 (2.0–4.0), 4.1 (3.0–5.0) and 5.2 (3.0–9.0) min, respectively. The lowest acuity level (Green) victims had the shortest mean times for triage (3.5 min), evacuation (4.0 min), and treatment (10.0 min) while the highest acuity level (Red) victims had the longest mean times for all measures; patterns consistent with independent rather than ICS-directed rescuer activities. Specific ICS problem areas were identified.

Conclusions: A structured, objective, quantitative evaluation of ICS function can identify deficiencies that can become the focus for subsequent improvement efforts.

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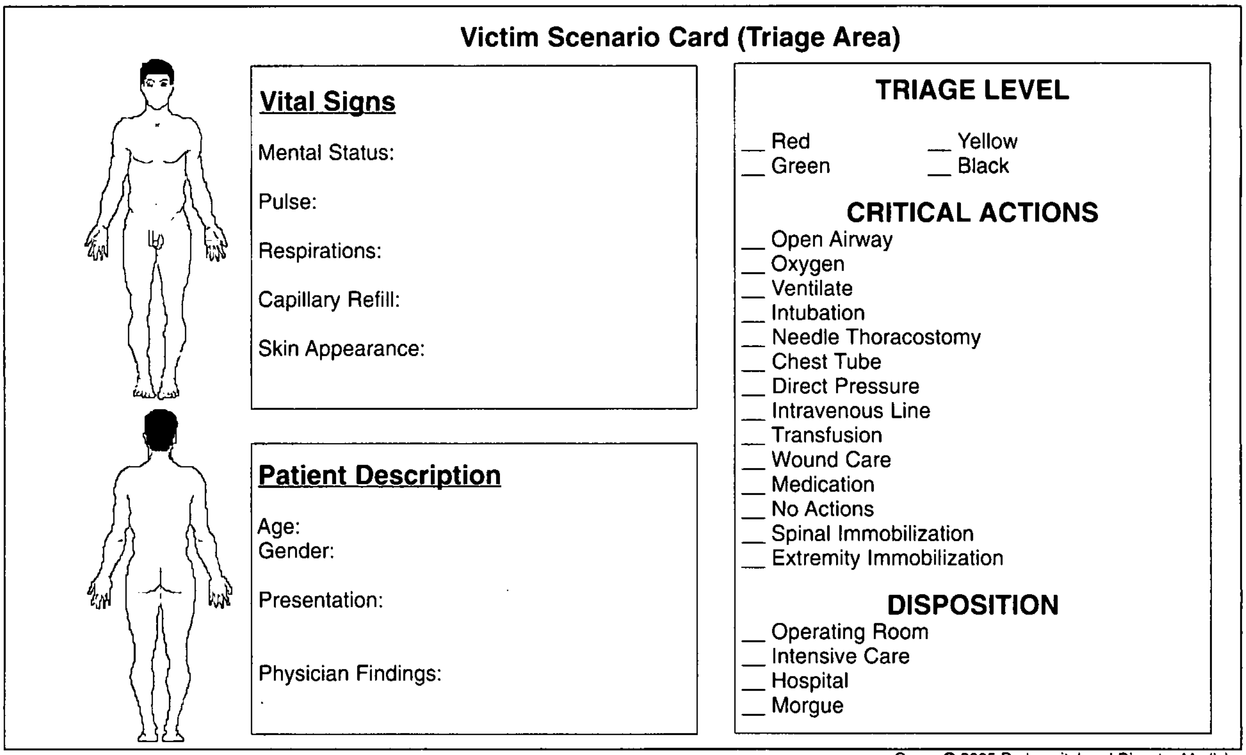
Introduction

The impact of reported disasters is increasing, with more disaster events in 2002 than in any previous year of the last decade and an estimated 608 million people affected worldwide.[1] Recent events such as those of 11 September 2001, the anthrax attacks in 2001, and the severe acute respiratory syndrome (SARS) epidemic in 2003 have captured the attention of populations, governments, and healthcare organizations around the world. One positive consequence of the resulting interest in critical-event readiness has been an increased scrutiny of existing preparedness efforts. This has led to a growing realization that nearly all currently accepted disaster preparedness practices are based largely upon anecdote and are lacking systematic study or objective validation.


Victim Scenario Card (Triage Area)

Vital Signs

Mental Status:

Pulse:

Respirations:

Capillary Refill:

Skin Appearance:

Patient Description

Age:
Gender:

Presentation:

Physician Findings:

TRIAGE LEVEL

__ Red __ Yellow
__ Green __ Black

CRITICAL ACTIONS

__ Open Airway
__ Oxygen
__ Ventilate
__ Intubation
__ Needle Thoracostomy
__ Chest Tube
__ Direct Pressure
__ Intravenous Line
__ Transfusion
__ Wound Care
__ Medication
__ No Actions
__ Spinal Immobilization
__ Extremity Immobilization

DISPOSITION

__ Operating Room
__ Intensive Care
__ Hospital
__ Morgue

Figure 1—Sample Victim Scenario Card

Disaster simulations have been a cornerstone of critical-event preparedness historically and are considered a fundamental tool for both regional and institutional readiness.[2,3] In fact, both the US and International Joint Commissions for Accreditation of Healthcare Organizations (JCAHO) now mandate that every hospital stage at least two disaster exercises annually, including at least one community-wide practice exercise to assess communications, coordination, and the effectiveness of command structures.[4] Hospital disaster training can take various forms ranging from full-scale exercises to drills that test specific skills. Hospital disaster simulations serve dual purposes, functioning simultaneously as training interventions and as an opportunity for individual and institutional performance evaluation. Although substantial resources are allocated for hospital disaster exercises and related training exercises, little consideration has been directed at assessing the effectiveness of such activities. Systematic evaluation of every hospital disaster simulation would allow determination of overall training effectiveness as well as enable identification of specific response components requiring further attention.

The incident command system (ICS) arguably is the most essential component of institutional disaster response, functioning as the "central nervous system" in directing all response activities. As such, assessment of performance during a disaster exercise cannot be meaningfully accomplished without including an objective, critical evaluation of ICS functional effectiveness. Unfortunately, no generally accepted methodology currently exists for the evaluation of hospital-based exercises and there are no previous reports of quantitative, objective methods used for ICS evaluation.

Therefore, a set of generic evaluation methods and tools for hospital-based disaster simulations were derived, piloted, and tested, with particular attention directed toward establishing a road-map for objective assessment of ICS functions during exercises. More specifically, the goals of the project were to:

1. Derive, categorize, and define the key variables needed for evaluation of ICS function;
2. Develop flexible, standard, data collection methods and instruments for recording the performance of ICS activities during an exercise;
3. Prospectively pilot these methods and instruments during an actual hospital-based disaster simulation; and
4. Determine the human resource needs for successful exercise evaluation.

Methods

Study Design

This report describes the development and first prospective application of an original set of data collection methods and instruments designed to enable a systematic, objective, and quantitative evaluation of ICS functions during a hospital-based disaster exercise. The project was not intended to grade or directly compare the exercise response performance between institutions or individuals (summative evaluation). Rather, hopefully the application of the described methods will generate specific and constructive feedback for institutional and provider performance in a structure allowing hospital leadership and disaster coordinators to implement improved planning and training activ-

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ities (formative evaluation). This project was exempt from review by the lead author's Institutional Review Board.

Setting and Participants

The opportunity to pilot the derived methods occurred following a request from the Ministry of Health of Panama via the US non-governmental organization, Emergency International, Inc. to help plan and implement a disaster exercise in Panama City. The exercise scenario included a simulated fire within the hospital's Intensive Care Unit, with patients and injured staff evacuated to an outdoor triage area, and then transported to various sites for more definitive care. Participants included 45 hospital and public safety staff, as well as 12 US volunteers.

Methods of Measurement

Data needs were determined first by cataloguing the operational skills required and the relevant outcomes for effective ICS function during a hospital-based disaster. Then, a comprehensive list was generated of those variables (along with their definitions) whose objective analysis would be needed to assess the adequacy of disaster response with respect to ICS (Appendices 1 and 2). The most relevant measure of overall ICS function, in a simulated or actual disaster, must be the efficiency and the appropriateness of victim rescue and treatment activities. Thus, the "primary" outcome measures for this evaluation were the directly measurable (delay) times for key provider-victim interactions, such as times to triage, treatment, and transportation. Data collection instruments were created to record each movement of the mock victims and the providers, as well as the timing and nature of the many simultaneous victim-provider interactions. A redundant system of data collection using both patient-based and observer-based instruments was employed to allow compilation of data from both sources into a more complete data set. Additional forms were used to track patient and provider movement through the disaster scene and triage area entrances and exits.

It was hypothesized that comparison of expected and observed data concerning response delays would demonstrate patterns of provider response that directly would reflect and thereby allow identification of specific strengths and/or weaknesses in ICS functions. However, since this type of "pattern analysis" only might identify relatively large-scale ICS problems, additional means to pinpoint the causative communications and/or decision-making failures also were needed. A set of structured, standardized, post-drill surveys were developed to allow each drill participant to "cross-evaluate" the roles of the ICS with respect to orders received and other communications occurring during the event. More specifically, two complementary post-drill surveys were piloted: one for drill participants in the "command tiers" of the ICS, and one for all other providers. The surveys included a series of closed-ended questions, all designed to determine the participant's level of understanding of their assigned roles and to elicit their perceptions concerning organization, communications, and operations.

Evaluation team members, including an observer assigned specifically to monitor the Incident Commander's activities, were instructed to record the occurrence and nature of "critical" communications among command personnel during the drill (Appendix 2). Additionally, all observers noted narrative comments concerning ICS functions throughout the event. Further, a structured, drill participant debriefing session was conducted immediately after termination of the exercise. This moderator-led discussion posed a series of open-ended questions with responses recorded by videotape and subsequently reviewed by the evaluation team in order to capture any further observations.

	Time to Triage at Scene: minutes (range)	Time to 1st Move at Scene: minutes (range)	Time to Treatment Area: minutes (range)
By Triage Level			
Black	4.0	-	-
Red	4.2 (2.0–9.0)	12.4 (5.0–22.0)	15.9 (9.0–25.0)
Yellow	3.8 (2.0–6.0)	10.5 (5.0–18.0)	13.3 (6.0–21.0)
Green	3.5 (2.0–5.0)	4.0	10.0
By Zone			
1	2.9 (2.0–4.0)	8.7 (4.0–17.0)	11.2 (9.0–16.0)
2	4.1 (3.0–5.0)	13.6 (5.0–22.0)	17.2 (6.0–25.0)
3	5.2 (3.0–9.0)	11.8 (5.0–18.0)	15.0 (10.0–21.0)

Table 1—Mean values for times (minutes) by triage category and scene zone

Each mock victim was identified by a laminated, numbered victim scenario card worn around the victim's neck (Figure 1). These double-sided cards (in Spanish) had one side designed for initial responder contact at the scene, while the reverse side was used in the triage/treatment area. The cards had a brief description, a body drawing identifying simulated injuries, initial vital signs, four possible triage levels and critical actions. There were 11 possible critical actions to be selected at the scene and 14 critical actions that could be selected at the triage/treatment area.

For evaluation purposes, the disaster scene was divided into three observation zones. Each zone was assigned one evaluator with additional evaluators being assigned to the triage and treatment areas. Each observer was to gather objective data about the victim-provider interactions within their assigned zone. Data recorded included: (1) arrival, interaction, and victim movement times; (2) responder triage assessments; and (3) critical actions performed. Additional "checkpoint" observers were located at the single entrance/exit to the incident scene and at the entrance/exit to the casualty collection point to monitor the times that patients and providers passed through each of these points.

Primary Data Analysis

The flow of exercise activities was analyzed by calculating the times until triage and treatment for each victim and the relative times for victims to be transported from one location to another (e.g., scene-to-triage, triage-to-treatment

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Survey Questions	Scores		
	Scene Rescuers	Treatment Area Providers	All Participants
Incident Command System			
I had a clear understanding of my role during the exercise	1.43	1.57	1.50
I knew who was in charge	1.14	1.14	1.14
The commander of my unit was present and clearly identified	1.14	1.29	1.21
The commander of my unit gave clear orders/instructions	1.86	1.86	1.86
I received adequate information at the beginning of the exercise about the nature and scope of the event	1.14	1.57	1.36
I received clear notification of when the event was officially terminated	1.14	1.29	1.21
Mean participant (non-commander) scores	**1.31**	**1.45**	**1.38**
Operations			
The activities of my functional unit were well organized and coordinated	2.43	1.86	2.14
My professional abilities were optimally utilized	1.43	2.00	1.71
The participants working in my unit worked well together	1.57	1.29	1.43
I had a clear understanding of where each functional unit/zone was located (e.g., treatment area)	2.00	1.86	1.93
Mean participant (non-commander) scores	**1.86**	**1.75**	**1.80**
Supervision			
I had a clear understanding of when to perform assigned tasks	1.29	1.50	1.38
I knew who was in charge of my unit	1.00	1.29	1.14
Mean participant (non-commander) scores	**1.15**	**1.40**	**1.26**

Table 2—Mean values for participant (non-commander) scores obtained from the post-exercise survey (1 = strongly agree; 2 = agree somewhat; 3 = neutral; 4 = disagree somewhat; 5 = strongly disagree)

areas). As absolute response times are more reflective of the specific circumstances of the individual exercise, such as the geographic distance to the scene and the distance between the scene and staging area, they were of less interest than were the relative response times.

For the post-exercise survey, mean response scores for each question within the two surveys were calculated and categorized into semi-quantitative response categories (1.0–1.49, 1.50–1.99, 2.0–2.99, 2.5–3.0), with progressively higher mean scores reflecting an increasing deviation from the theoretical ideal of a "strongly agree" response, which was scored as 1.0. Therefore, higher mean scores indicate an overall perception among exercise participants of relatively weaker performance with regard to that particular aspect of ICS operations.

Results

The disaster exercise was staged at the Nicholas Solano Regional Hospital in Panama City, Panama. The 20 volunteer victims were moulaged according to predetermined victim scenarios prior to the exercise, and were placed in strategic scene locations, as recorded in a scene diagram. The Incident Commander was notified of an explosion at the Intensive Care Unit of the hospital at "Time 0" to initiate the exercise. Upon disaster notification, the incident command system was activated, and the pre-designated Incident Commander was notified. The Red Cross, municipal fire department, and hospital staff subsequently were notified and reported to the staging area. Victims were triaged initially at the scene, and then were transported to the triage area designated by the Incident Commander. Each victim underwent secondary triage assessment after arrival at the triage area, and then was moved to a distinct treatment location according to their triage level. Some victims who were designated as needing transfer to other local hospitals then were "mock-transported" via ambulances. After the last remaining victim was triaged, the Incident Commander terminated the exercise.

As some responders were aware of the approximate time of exercise initiation (Time 0) and were gathered near the staged scene, the first group of rescuers arrived at the scene immediately and the recorded triage time for the first victim was 2 minutes (min) after Time 0. The final victim to be triaged was evaluated at 9.0 min while the mean value

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of full triage times for all 20 victims was 4.0 min. The first victim was evacuated from the scene ("first move") at 5.2 min, the last was moved at 22.0 min, and the mean value for the "first move" times was 11.9 min. First, last, and mean times from Time 0 to arrival at the treatment area was 6.0, 25.0, and 14.5 min, respectively.

The scene was divided into three observation zones. Zone I was located closest to the only scene entrance and furthest from the site of the simulated event (fire) and had seven victims stationed within it at Time 0. Zone III, which encompassed the event site and was furthest from the scene entrance contained six victims, while the intermediately located Zone II had seven victims assigned. The mean value for the times to triage (and range) for Zones I, II and III were 2.9 (2.0–4.0), 4.1 (3.0–5.0), and 5.2 (3.0–9.0) min, respectively.

Among the 20 victims, scene rescuers assigned the highest acuity level (Red) to 10 victims and an intermediate acuity level (Yellow) to six. Low acuity (Green) and unsalvageable (Black) triage levels were each assigned to two victims at the scene. When analyzed by triage category, the mean value for the triage times for "Red" victims was 4.2 (2.0–9.0), for "Yellow" victims was 3.8 (2.0–6.0), and for "Green" victims was 3.5 (2.0–5.0) min. Both "Black" victims were triaged at 4.0 minutes.

Victim flow data including mean value for the times for scene triage, "first move", and treatment area arrival are shown in Table 1. When analyzed by Zone, those victims nearest the scene entrance (Zone I) had the shortest mean values for the times to triage (2.9 min), "first move" (8.7 min), and treatment area arrival (11.2 min). Zone III, located furthest from the scene entrance, had the longest mean value for the time to triage, while Zone II had the longest mean times to "first move" (13.6), and treatment area arrival (17.2 min). When evaluated by triage category, victims designated as "Green" had the shortest mean value for the times for triage (3.5 min), "first move" (4.0 min), and treatment area arrival (10.0 min), while "Red" victims had the longest mean values for all measures.

All post-exercise participant (non-commander) survey questions concerning the ICS, along with their respective mean responses, are in Table 2. The most uniformly positive responses (mean of the scores <1.5) were given by participants to the more concrete questions, such as the participants' ability to identify the unit commanders (mean = 1.21) and to understand the decision-making role of the Incident Commander (mean = 1.14), and the Unit Commanders (1.14). Questions concerning the effectiveness of communication between commanders and the providers also resulted in generally positive responses, but showed both greater variability in the ratings and higher mean scores (1.5–2.0), indicating a perception of greater room for improvement in ICS effectiveness in this area. For example, when participants were asked if they had a "clear understanding of their role", the mean value of the scores was 1.50, and a mean of the scores of 1.86 was calculated for the question asking if the Commander of their functional unit "gave clear orders/instructions". In addition, a specific problem identified by both observer and participants during the debriefing session (poor location and inadequate marking of the treatment areas), was supported objectively by the relatively high scores (mean = 1.93) for the question asking if participants "had a clear understanding of where each zone was located". The least positive response from the survey was recorded to the question that asked if activities within their unit were "well-coordinated" (overall mean = 2.14). This lack of coordination was perceived most strongly among the scene rescuers (mean = 2.43), resulting in the survey's only mean response score in the >2.0 category.

Survey questions	Commanders
I had a clear understanding of my role during the exercise	1.13
I had a clear understanding of when to perform assigned tasks	1.50
I knew who was in charge	1.00
I received adequate information at the beginning of the exercise about the nature and scope of the event	1.63
I reported my identity and location to the Incident Commander at the beginning of the exercise	1.50
I provided an initial status report to the Command Center/Incident Commander about the conditions in my assigned area	1.38
I provided one or more status reports/updates during the exercise about changing conditions in my assigned area to the Command Center	1.38
I received clear instructions from the Incident Commander	1.00
I received clear notification of when the event was officially terminated	1.13

Table 3—Mean values for the scores from the Post-Exercise Commander Survey (1 = strongly agree; 2 = agree somewhat; 3 = neutral; 4 = disagree somewhat; 5 = strongly disagree)

The post-exercise commander survey questions and the mean values for the responses are in Table 3. Every unit commander (n = 7) gave the lowest (most positive) response possible (1.0) to the survey questions concerning the identification of leadership ("I knew who was in charge.") and the adequacy of instruction from the Incident Commander ("I received clear instructions from the Incident Commander."). The least positive (highest mean) response score of 1.63 was given to the question concerning the adequacy of dissemination of exercise information at the start of the exercise. All other responses fell into the 1.0–1.5 category.

Discussion

The importance of civilian disaster command became a significant focus of attention in the United States during

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the early 1970s after a series of major wildfires in Southern California highlighted recurrent difficulties in coordinating disaster response across multiple jurisdictions and agencies. The FIRESCOPE (*FI*refighting *RES*ources of *C*alifornia *O*rganized for *P*otential *E*mergencies) project subsequently was initiated under the direction of the National Interagency Incident Management System to integrate proven management concepts into a standardized system for directing decision-making and resource utilization.[5] Development of the Incident Command System (ICS) was the result of this cooperative local, state, and federal interagency effort to provide a consistent approach to preparedness, response, and recovery. Although this organizational structure originally was developed specifically for fire hazard response, the original ICS model has been adapted and applied by a wide range of response agencies and to emergencies of varying type, size, and complexity, including natural disasters, hazardous materials accidents, mass gatherings, and terrorist incidents.[6] More recently, the ICS model has been incorporated into the National Incident Management System (NIMS), established by Homeland Security Presidential Directive (HSPD)-5. This directive essentially declares this command structure as the US national standard, making adoption of the ICS model a prerequisite for any US agency receiving federal preparedness assistance beginning in 2005.[7]

The widespread acceptance of the ICS in the prehospital setting also has prompted the creation of hospital-based ICS models. While several hospital paradigms exist, the Hospital Emergency Incident Command System (HEICS), developed by the California Emergency Medical Services Authority (Cal EMSA), is perhaps the most widely recognized hospital ICS model, and currently is mandated in all California hospitals that are part of the state disaster response system.[8] During the past decade, a variety of published reports have described the use of HEICS in both disaster exercises and actual hospital emergencies, including operational experience gained by several hospitals damaged in the 1993 Northridge earthquake.[9]

Historically, evaluation of the responses to actual or simulated disasters, when done at all, has been largely descriptive, subjective, and lacking standardization or validation.[10–13] A few published reports do suggest the potential of hospital disaster exercises to help disaster planners identify deficiencies in incident command[14,15] and to document improvement in coordination and communications after implementation of revisions in the hospital ICS.[16] In addition, general principles for disaster response evaluation have been published,[17,18] and others have documented the development and successful piloting of standardized methods for evaluation of prehospital disaster exercises.[19] However, a 2003 Evidence-based Practice Center (EPC) report from the Agency for Healthcare Research and Quality (AHRQ) on training hospital staff for bioterrorism and other critical events, described the overall evidence on the effectiveness of hospital disaster exercises, computer simulations, and tabletop exercises as "insufficient".[20] The report further stated that the methodological limitations and marked differences among the small number of studies in educational interventions, objectives, targeted audience, and evaluation methods precluded any definitive conclusions concerning the effectiveness of disaster exercises as a training tool for hospital staff.

This study indicates that a structured analysis of prospectively collected, scene response data resulted in identification of specific and correctable deficiencies in the ICS. In this drill, the "delay time" from event initiation until scene triage was related directly to the victims' geographic location at the scene, with those victims closest to the entrance (Zone 1) receiving attention first while those furthest from the entrance having the greatest delay. As "ground zero" for the event was in Zone 3 (where the greatest number of victims with serious injuries would be expected), this area should have been targeted first by arriving rescuers under the direction of the Scene Commander. Instead, the pattern observed is consistent with a scene in which each rescuer was functioning independently rather than as part of a coordinated effort. This conclusion also is supported by the recorded narrative comments of the observers who noted that upon arrival to the scene, almost every rescuer approached the closest patients to the entrance first and only moved deeper into the scene after determining that these patients already had received a triage level. This caused delays in the care of those nearest to "ground zero" (the fire). Further confirmation of this pattern is apparent in the relationship of the triage level to scene triage time as the most severely injured and highest priority patient ("Reds") had the longest triage delay while the lowest priority victims ("Greens") were attended to first, the reverse of the optimal pattern (Table 1).

From these data, it also is clear that the ineffective response pattern established within the first moments of the exercise became magnified as the exercise progressed, causing the potential clinical impact of the initial deficiency in the ICS to become more pronounced. The victim flow data demonstrates that after scene triage, the victims were transported from the scene in the order in which they were triaged (i.e., closest to the door first) instead of in order of their triage priority. For example, a two minute scene triage delay for Zone 3 victims as compared to Zone 1 victims (5 min vs. 3 min) translates into a four minute delay (15 vs. 11 min) until definitive treatment is initiated. Accordingly, the mean value for the times until treatment for the lower priority victims (Green and Yellow) was 10 and 13 min, respectively, compared to 16 min for those patients with the highest priority ("Red"), also the reverse of what is expected in an ideal response. Although it may be more time consuming to transport the more severely injured patients, it remains that the Scene Commander should have directed greater resources toward the early evacuation of this patient group as these are the only victims for which even a brief delay until definitive treatment could lead to increased mortality.

In addition to demonstrating the feasibility and utility of a standardized approach to ICS assessment, the evaluation also was designed to establish the human resource needs for such an endeavor. As was anticipated, "real time" data collection during such a rapidly paced, complex event

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is labor intensive. The methods called for simultaneous deployment of three types of observers, with varying training requirements. The greatest degree of attention (1:1 observer/subject ratio) and the highest level of experience and training was required of the observers assigned to record the activities of key personnel such as the Incident Commander. Zone observers, stationed at scene and the triage and treatment areas, required several hours of training and practice prior to the exercise, but then were able to keep-up with their assigned tasks until they exceeded a relatively consistent threshold observer/victim ratio of 1:6. Finally, although the entrance/exit observers needed only minimal training, experience demonstrated that a two observer team was required at each of the three transition points to successfully capture the identity and time of all passing victims and providers without disrupting exercise activities.

Limitations

Ideally, the gold standard for ICS evaluation would involve a detailed, quantitative analysis including specific assessment of all of the command functions. However, during even a modest event simulation, it is impractical to monitor, record, and interpret the numerous simultaneous decisions and communications taking place in every geographic location between responders, Unit Commanders, and the Incident Commander. Accordingly, indirect means of assessing incident command were utilized using certain proxy measures of ICS effectiveness. It is possible that some of these outcomes may not accurately reflect the actual communications and decisions made during the exercise. For example, there may be alternative explanations for the conclusion that the reverse pattern of delay times observed was due to inadequate scene direction. However, independent data from the other evaluation methods utilized further support these conclusions. In addition, although the methods were designed specifically to be generic and equally applicable to a wide variety of settings, including both developed and developing countries, the pilot study was conducted in an urban hospital of a developing country. Therefore, the methods should be tested in other settings prior to widespread application.

The post-drill participant survey and the recorded debriefing session comments also provided additional insights into ICS function during the drill. However, as generally is true of survey and other qualitative research data, the ICS performance addressed by these instruments were more difficult to record objectively and were prone to a greater variety of biases. Accordingly, these data were the most useful when considered together with more quantitative performance measures. However, as this was the first attempt at utilizing qualitative techniques for this purpose, as greater experience is gained, more sophisticated methods will be developed that will provide a more complete, objective assessment of participant knowledge, attitudes, and perceptions concerning ICS performance during such exercises.

Conclusions

A set of generic data collection methods and instruments for the objective, quantitative evaluation of the functions of the Incident Command System during a hospital-based disaster simulation have been developed and tested. In addition, a structured analysis of exercise performance data resulted in identification of specific, correctable deficiencies in incident management. This is the first peer-reviewed report of such the use of an ICS evaluative system or its prospective application. In addition, the results provide future disaster exercise planners with an experience-based estimate of the human resource requirements for adequate exercise evaluations. Efficient and effective ICS performance is one of the most critical contributors to successful disaster response. Therfore, it is essential that all institutional disaster preparedness efforts maintain a continuous focus on ICS improvement, including planning, training, and evaluation activities. Although additional experience and refinement is needed, these ICS evaluation methods provide disaster planners with an important new tool.

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Appendix 1—Definitions of terms

Designations for Locations

Casualty Collection Point: safe area designated for arrival of victims for triage and treatment

Command Center: safe, strategically chosen area designated for incident command operations

Danger Zone: perimeter surrounding incident scene within which there is a risk of future casualty

Safe Zone: safe area designated for arrival of at-risk persons and others (family, media, etc.)

Scene: perimeter within which event occurred and is expected to result in casualties

Staging Area: safe, strategically chosen area for arrival and organization of rescue and medical personnel

Designations for Individuals

At-Risk Persons: those individuals outside the boundaries of the incident scene but within the danger zone (All at-risk persons require evacuation, but do not require triage)

Casualties: those individuals who incurred injuries as a result of the event

External Activities: any interaction/communications between the responding hospital command center and outside organizations/agencies (i.e., regional disaster agency, fire department, police, public health department, media, etc.).

Internal Activities: all activities and communications within the responding hospital (e.g., hospital being evaluated).

Patients: those individuals who were hospital in-patients within danger zone prior to event (may or may not be victims)

Unit Commanders: commanders/directors of 1st tier functional units as designated in ICS structural diagram.

Victims: anyone within boundaries of incident scene at the time of event (All victims require evacuation and triage)

Designations for Communications

Notifications: all outgoing communications from incident command center/commander

Reports: all incoming communications to incident command center/commander

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Appendix 2—Definitions of variables[1] (EMT = emergency medical technician; ICU = intensive care unit; ICS = incident command system; OR = operating room; S&R = search and rescue)

Incident Command System (ICS) & System Integration

I. Command Center Operations:

Time zero: Time of initial notification call of event occurrence. All times measured in minutes from this point.
Command Center Activation: Arrival of Incident Commander at command center
Command Center Declaration: Communication of command center activation to communications Coordinator and lower tiers of ICS
Command Center Coordination – internal: Communications between Incident Commander and other command center personnel
Command Center De-activation: Closure of command center after event termination

II. External Communications (to/from command center)[2]

A. Outgoing

Activation Notification - external: First notification of disaster plan activation from command center to external agencies
Status Notification/Update – external: Communication of status of disaster operations from command center to external agencies
Termination Notification – external: Notification of termination of disaster plan activation from command center to external agencies

B. Incoming

Status Report – external: Communications of status of response from external agencies to command center

III. Internal Communications[3]

A. Vertical Communication (to/from command center)

1. Ascending

Status Report/Update – internal: Communications regarding status of designated area and response from lower tiers of ICS to command center

2. Descending

Hospital Disaster Declaration: First notification from Incident Commander to Communications Coordinator (phone operator)
Activation Notification – internal: Initial disaster plan activation notification of lower tiers of ICS
Status Notification/Update – internal: Communication of status of disaster operations from Incident Commander to lower tiers of ICS (Unit Commanders)
Termination Notification – internal: Notification of termination of disaster plan activation from Incident Commander to lower tiers of ICS (Unit Commanders)

B. Horizontal Communication (between functional Unit directors)

Communications monitored between:

Scene Coordination – external: Scene Commander and other Unit Commanders
Scene Coordination – internal: Scene Commander and scene rescuers (hospital medical personnel, security, EMTs, fire, etc.)

Triage Area Coordination – external: Triage Commander and other Unit Commanders
Triage Area Coordination – internal: Triage Commander and triage area responders (physicians, nurses, security, EMTs, etc.)

Treatment Area Coordination – external: Treatment area Commander and other Unit Commanders
Treatment Area Coordination – internal: Treatment area Commander and treatment area responders (physicians, nurses, security, EMTs, etc.)

Staging Area Coordination – external: Staging area Commander and other Unit Commanders
Staging Area Coordination – internal: Staging area Commander and rescuers arriving at the staging area (EMTs, fire, police, medical personnel, security, etc.)

S&R Coordination – external: S&R Commander and other Unit Commanders
S&R Coordination – internal: S&R Commander and S&R personnel

Security Coordination – external: Security Commander and other Unit Commanders
Security Coordination – internal: Security Commander and security personnel

Materials Coordination – external: Materials Coordinator and other Unit Commanders
Materials Coordination – internal: Materials Commander and materials personnel

Public Affairs – external: Public affairs Commander and other Unit Commanders
Public Affairs – internal: Public affairs Commander and public affairs personnel

Clinical Units – external: Clinical Units Commander and other Unit Commanders
Clinical Units – internal: Clinical Units Commander and individual clinical Units (OR, ICU, nursing, pediatrics, etc.)

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Appendix 2 (continued)—Definitions of variables[1] (EMT = emergency medical technician; ICU = intensive care unit; ICS = incident command system; OR = operating room; S&R = search and rescue)

C. Clinical Operations

Scene Clinical Operations

Scene Response: Service, identification and time of scene arrival for each provider
First Move: For each casualty, time until transport from initial location at scene
Scene Transport: Time each casualty removed from the scene
Scene Triage: For each victim, time until initial assessment by a scene provider
Triage Category – scene

- *Non-urgent (green):* Ambulatory patient with minor or no injuries and stable vital sign
- *Urgent (yellow):* Significant injuries, no immediate threat to life, stable vital signs
- *Emergent (red):* Unstable vital signs or potentially life-threatening injuries
- *Unsalvageable (black):* Dead or non-survivable injuries

Scene Treatment: For each casualty, time until the first critical action was performed
Critical Actions - scene: Critical actions performed on each casualty at scene

- Manually open the airway
- Place patient in rescue position
- Administration of oxygen
- Ventilation with bag-valve-mask device
- Initial control of hemorrhage
- Initiation of an intravenous line
- Immobilization of spine and/or extremities
- Application of wound dressings
- Needle decompression of pneumothorax

Casualty Collection Area Clinical Operations

Collection Area Triage Arrival: For each casualty, time until arrival at collection area triage
Collection Area Triage: Time until repeat triage assessment at casualty collection area
Triage Category – collection area

- *Non-urgent (green)*: Ambulatory patient with minor or no injuries and stable vital signs
- *Urgent (yellow):* Significant injuries, no immediate threat to life, stable vital signs
- *Emergent (red):* Unstable vital signs or potentially life-threatening injuries
- *Unsalvageable (black):* Dead or non-survivable injuries

Treatment Area Arrival: Appropriateness and time of treatment area arrival
Treatment Initiation: Time until casualty collection area critical action.
Collection Area Disposition: Time until disposition decision from the triage area (OR, home, etc.)
Final Disposition: Transfer to in-patient hospital, OR, ICU, morgue, discharge.
Hospital Critical Actions:

- Manually opening the airway
- Administration of oxygen
- Ventilation with a bag-valve-mask device
- Endotracheal intubation
- Needle decompression of pneumothorax
- Thoracostomy tube placement
- Control of hemorrhage
- Initiation of an intravenous line
- Blood transfusion
- Immobilization of spine or extremities
- Wound care/suturing
- Administration of analgesics
- Administration of antibiotics or other medication
- None

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