Information Management During Mass Casualty Events

Steven B Nelson MSc RRT FAARC

Preparing for a mass casualty event starts long before the event. Being able to provide care during an event requires collecting information about processes, equipment, supplies, and personnel to anticipate different situations. Planning should include an impact analysis to identify and prioritize critical services that need to be maintained. Impact analysis is carried out in concert with the entire health care delivery organization, not by individual departments. Planning may include addressing inadequate staffing, disrupted supply chains, and loss of information systems. Care may need to be provided in alternate locations, without access to the usual information resources. Mass casualty events also depend on the availability of communications to inform others on the emergency response teams, as well as to inform patients and the public. *Key words: mass casualty, information technology.* [Respir Care 2008;53(2):232–238.

Introduction

Mass casualty preparedness is an art. There is no concrete definition of a mass casualty event; it may be as small as a multi-vehicle accident in a rural community that overwhelms an emergency room for hours, a weather event that effects thousands in a city for weeks, or a pandemic outbreak that cripples health care delivery in a large region for months. It is broadly considered to be any event that causes more casualties or patients than for which the local health care agencies can provide care.

Preparation suggests that all risks should be evaluated and expected; however, that is probably not possible, since, in the words of the former United States Secretary of Defense, Donald Rumsfeld:

> . . . there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns—the ones we don't know we don't know."[1]

Mr Nelson presented a version of this paper at the 40th Respiratory Care Journal Conference, "Mechanical Ventilation in Mass Casualty Scenarios," held July 16–17, 2007, in Reno, Nevada.

Mr Nelson is an employee of Sun Microsystems, Santa Clara, California, a company that provides products and services that could be used in a mass casualty situation.

Correspondence: Steven B Nelson MSc RRT FAARC, Sun Microsystems, 8314 W 128th Street, Overland Park KS 66213. E-mail: sbn_kc@mac.com.

Mass casualty information management starts by identifying risks to information and communications. Risks are identified by understanding the processes involved in providing patient care, the systems and software that provide essential information to patients and practitioners, and the vendor resources that provide everything from staffing to disposable gloves and circuits. Once this information is collected, an impact analysis will assist in prioritizing responses to establish appropriate levels of care during an event. Departmental preparations need to include methods to communicate with staff, other agencies, the public, and patients.

This paper is intended to be supplementary to a corporate or institutional disaster plan. It is aimed at departmental issues that may need particular attention. Data-center disaster recovery and business continuity plans are in the realm of information technology departments. They may not include protecting the information assets that departments tend to accumulate. Identifying them is important to assure that a department can continue to function as effectively as possible.

Be prepared to adapt any plan as soon as it is implemented. As Prussian Field Marshal Helmut von Moltke is credited with saying, "No plan survives first contact with the enemy," or in this case, no plan survives past the arrival of the first patient.

Situational awareness is a term derived from military tactics. It has its modern roots in the Korean War, where fighter pilots learned to observe the other pilot's actions and orient accordingly before making decisions and acting. In a mass casualty scenario, it can also mean that you have all the information you need to avoid being surprised in the current situation.[2] Disasters and mass casualty events do not follow predictable, linear progressions, so decisions and actions need to be based on "what is," not on "what should be." Observations need to be constantly updated as mass casualty events progress. The collection and exchange of information is critical to provide responses to a changing scenario.

Identifying Risks to Information

Departmental preparation starts by identifying threats and risks to the flow of information. A threat is an event with an adverse impact or outcome. A simplified definition of risk is the probability of a threat occurring, multiplied by the consequences. For example, a threat might be an ice storm. The risk of an ice storm disabling a community for several days is measurable in Missouri, but the risk is practically nonexistent in southern Arizona.

Risks are managed in 4 ways. They can be removed, reduced, assigned, or accepted. Removing a risk may be the most difficult, especially if there is a potential for human input. Managing a server in a respiratory care department is a risk that can be removed by turning the system over to an information technology group. Risk reduction may be accomplished by using redundant computers or making backups of programs and databases. Assigning risk means that a third party, such as an insurance company or computer service bureau, will assume the risk for you. Finally, in many cases where the effect or probability of a risk is low, it is may be easiest to accept the risk.

Table 1. Simple 2×2 Matrix to Prioritize Risks*

	Probability Low	Probability High
Effect low	1	2
Effect high	3	4

* Risks with low probability and low effect (area 1) require minimal or no departmental effort to address, whereas risks in area 4 probably require institution-wide policies or procedures.

Risk analysis is a specialized area of practice. It is generally carried out on a regional basis by a coordinated team that includes first responders and health care delivery organizations. It is commonly included as part of a hazard vulnerability analysis, which takes a very broad view of an impact on an area.

The same principles, however, can be applied at a simplified level to departmental situations. There are many elaborate schemes to identify the impact of a specific risk, but a useful, quick analysis can be done using a standard 2×2 matrix as shown in Table 1. A risk that falls in square 1 may require minimal attention, whereas a risk in square 4 will usually require a great deal of planning, including coordination among several departments or organizations. Some scales break down the effects into a quantitative series of dollar values and the probabilities into percentage ranges, which may be overly fastidious from a departmental viewpoint. An example of a departmental risk analysis is the use of reusable versus disposable ventilator circuits. A communicable disease outbreak may have a greater risk of cross-contamination of ventilator patients from the processing of reusable circuits than a multiple-victim transportation accident, but disposable circuits may become scarce commodities during an outbreak. The type of event may be a determining factor in the decision.

Threats may have widely varying onsets. A massive outbreak of a communicable disease may be detected days or weeks before it causes an impact that stresses the local health delivery system. This allows time to prepare for the event by adjusting staffing to appropriate levels, ordering and stockpiling supplies, and activating disaster plans. In 2005, Hurricane Katrina was predicted to hit the Gulf Coast region several days before actual landfall. This allowed pre-staging emergency resources at a safe distance from the expected affected areas. Despite these efforts, further aggravation brought on by compounding disastrous events impaired the subsequent ability to respond. The severe acute respiratory syndrome (SARS) epidemic, once it was recognized, also allowed governments a period of time to formulate monitoring and responses to prevent further spread of the disease. Singapore's governmental response was well documented about detecting, protecting, and monitoring their population.[3]

Other threats may allow a few hours for preparation. Flash floods, failures of earthen dams, blizzards, and other meteorological events are typical. An event with a similar onset might include preparation for an influx of patients from an adverse event outside the local region.

Finally, some threats occur with little or no warning. Tornadoes, earthquakes, transportation accidents, and terrorist events, including nuclear, chemical, or biological attacks, fall into this category. In the case of Greensburg, Kansas, on May 4, 2007, the first instance of an Enhanced Fujita Scale-5 tornado provided less than 20 minutes of warning to the hospital. Patients were all safely removed to a secure area shortly before the hospital was destroyed by the 1.7-mile-wide tornado. The massive radar echo was observed by the National Weather Service in Dodge City, Kansas, which issued a "tornado emergency" for only the fourth time since that designation was created in 1999.[4]

Risks that are particular to information systems may occur independently of mass casualty events but can still have as dire a consequence on the ability to deliver health care. Most common in this category is a computer virus that disables information systems or the network infrastructure. Hospital information-technology departments are tasked with providing protection for these events, and that discussion is outside the scope of this paper. However, it is the responsibility of all computer users to know the acceptable-use policies and understand how to prevent introducing computer viruses into systems.

Identifying Information Needs

Knowing the many possible sources of information and how information is managed is the first step to being able to determine which are critical to have access to or maintain during mass-casualty events. Departmental preparation includes an inventory of processes, systems, and vendors.

Process Inventory

The process inventory should identify critical pathways needed to initiate care, report and chart, and discharge and transfer patients. These pathways will also include scheduling appropriate resources, and handling supplies needed for patient care.

Process inventories are useful when loss of information systems requires reverting to a manual system. The process inventory will show the functions that need to be restored first in order to continue providing patient care. The process inventory may also be used to create paper forms to facilitate manual data collection and later data entry when systems are again available.

Even though there was not a concomitant mass casualty event, in 2002, Beth Israel Deaconess Medical Center in Boston had a network configuration problem that caused a complete shutdown of their clinical information system for about 4 days. They were able to revert to a paper-based system that allowed critical processes to continue. This included hand-delivery of around 3,000 laboratory tests per day.[5] Their openness about the event has provided valuable guidance to other hospitals when planning for loss of information infrastructure.

Systems Inventory

The systems inventory should include hardware and software normally used within the department. In many cases this will extend beyond the hospital's information systems. In this sense, a system is a collection of interrelated elements that are each required to provide a service. Respiratory care departments have a history of being early adopters of technology and may not realize the extent of dependence on technology.

The systems inventory needs to include all devices necessary to provide patient care: not just computers and terminals. If a ventilator is connected to a remote monitoring and alarm location, each component between the endotracheal tube and the monitoring technician must be cataloged if it is necessary to maintain this functionality.

Caregivers at the bedside may be using personal digital assistants to record information or calculate values. Is any proprietary software being used? Can you transfer the software to other devices, or is there an alternative available on personal computers? Wireless communication systems from companies such as Vocera Communications, SpectraLink, and Nortel are being deployed within departments. How will loss of a communication system impact the ability to deliver care? A number of departments have developed internal Web sites for documenting policies and procedures, or for training. Is this information available from an alternative source? If temporary workers are brought in, can they find this information quickly? Devices that can run off standard replaceable batteries may be more useful during extended outages than devices that require recharging from wall outlets. What devices will survive extended power outages?

Vendor Inventory

Vendor inventories extend beyond simple contact information for existing suppliers. They may include alternate supply sources and external staff resources.

Identification of critical supplies can lead to evaluating alternatives. A ventilator that requires a unique circuit may be less desirable than one that can use circuits crafted from rolls of bulk tubing. Local suppliers may not be able to respond, so a list of vendors outside the region should be created. This might include the contact information for national sales offices of preferred vendors. If an event is widespread, a plan dependent on sharing supplies and resources with other regional health care providers (a so-called mutual aid agreement) may fail.

Contact information for staffing resources is useful for short-duration events. Longer-duration events may require access to state licensing boards to verify credentials if there is an influx of people from outside the region. The American Association for Respiratory Care (http://www.aarc.org/links/links_affiliates.asp) and National Board for Respiratory Care (http://www.nbrc.org/statelicagencies.htm) maintain Web sites with this information. The American Association for Respiratory Care has also been useful in quickly notifying qualified personnel about specific needs during past events.

Table 2 provides a starting point for the different types of inventories. Specific details will be different for each care delivery location, such as hospital, field hospital, or home care.

Impact Analysis

After the inventories are done, an impact analysis, sometimes called a "business impact analysis," can be used to determine interdependencies between departments and services. It is used to set criteria for returning critical areas to service in order to meet patient-care needs. Impact analysis is done at an institutional level and uses departmental input and direction. From an information-technology perspective, it prioritizes the systems that need to be operational, along with an expected time frame. From a respiratory care perspective, it may include increasing staff hours, altering routine therapy orders, or stopping some procedures altogether.

The impact analysis will also define an end point for an event, or what is considered the return to a normal operating state. The definition of "normal" may well be different for each affected department, so that some departments may be able to recover faster than others.

Table 2. Sample Items for Information Resource Inventory

Inventory	Examples
Processes	New-patient notification
	Change to patient care
	Progress notes
	Discharge and transfer notes
	Staff scheduling
	Inventory management
Systems	Devices
	Hospital information system terminals
	Department Web server
	Diagnostic and monitoring equipment
	Personal digital assistants, laptops, portable computers
	Software
	Staff assignment software
	Productivity software
	Monitoring software
	Department-specific spreadsheets
	Software licenses
	Network resources
	Department web pages
	Vendor manuals
	Procedure manuals
Vendors/suppliers	Consumables
	Order
	Receive
	Stock
	Staffing
	Local agencies
	AARC mailing lists
	NBRC credential verification
	State licensing agencies
	Supplemental equipment
	Regional emergency response organizations

AARC = American Association for Respiratory Care
NBRC = National Board for Respiratory Care

Impacts on and Alternatives to Existing Clinical Information Systems

Different types of threats have different impacts on information management. The major impact on information services during a mass casualty event is managing the sudden influx of patients. Electronic medical records systems should expand to meet the patient registration demands. Workflow analysis and simulated disaster testing will help determine the surge capacity of the system in meeting the demand. The ability to enter unidentified patients into the system should be verified before an event happens. Once a patient is identified, there needs to be a method to merge that record to an existing patient record so that the patient's complete history is rejoined and available.

A facility may need to set up temporary patient-care sites in a remote location, such as a school, auditorium, or parking lot. For instance, the Carolinas Medical Center's Carolinas MED-1 mobile hospital system (http://www.carolinasmed-1.org)[6] has two 53-foot tractor trailers (one trailer for patient care, with nearly 1,000 square feet of indoor treatment space, and one trailer for support and storage), 6 critical care beds, 7 general beds, a dental/ear-nose-and-throat treatment chair, a tent system that can add 100 exterior beds, level-1 trauma center, diagnostic capabilities, pharmacy, laboratory, radiology, ultrasound, and telemedicine uplinks. Getting access to clinical information systems at a remote facility may be a simple matter if the communications infrastructure remains intact. Alternatively, the electronic medical records system should be evaluated to see if it can run in a disconnected mode, and if it operates differently, training needs to be made available to highlight the differences.

Most commercial clinical information systems are composed of huge databases that run on large servers in controlled environments with massive storage arrays and require software that is only licensed to run in a specific configuration. They generally include automated data entry from a diverse collection of diagnostic devices and have network connections to terminals located in nearly every department and at patient bedsides. In the event of a disaster none of those may be available or the facility itself may be rendered unusable.

A disaster may require that an electronic medical records system be created de novo. There are a number of open-source electronic medical records systems that can be easily and quickly installed on computers as small as a laptop and deployed to any health care site.[7] Open-source electronic medical records systems avoid the problems of commercial licensing issues. They can be placed in remote venues as a stand-alone solution, configured for office or clinic settings, or be used to run large multicenter institutions. VistA is the most widely known example. It has been used to provide electronic medical records in hospitals and care facilities in the Veterans Administration system since 1985.[8] World VistA, an open-source collaboration, was begun in 2002 to add functionality for services that were not found in VistA, such as pediatrics and obstetrics support (http://www.worldvista.org).

VistA is a flexible electronic medical records system that includes modules for home-based primary care, home telehealth and out-patient clinics, as well as all of the standard functions a hospital requires. VistA's National Health Exchange and Patient Data Exchange modules provide a simple interface to send or retrieve patient information with other institutions using VistA or its derivatives. Small systems can be configured to provide only the services that are required for a site.

A benefit of an interoperable, stand-alone system is that data can be collected on paper records in real time. It can then be transcribed by staff later, even from remote locations, and synchronized with the patient record when the time is appropriate. If an alternative to the existing electronic medical records is chosen, training and refresher courses must be provided to familiarize workers prior to use. Quick-reference guides should also be available to help new users get oriented. Configuring only the functions that are required for immediate patient care will reduce the set of instructions that need to be learned.

Sharing Information

Information will be needed by a number of different groups, and creative measures may be required to keep all of them informed. Procedures need to address information needs of personnel notifications, patient records, public information, and interagency communications.

The regular respiratory care staff requires access to the usual information sources, including scheduling and record-keeping. If existing staff needs to be supplemented with additional personnel, special procedures may need to be created that can rapidly create and activate accounts and provide system access for them.

Contacting staff may become difficult if telephone service is disrupted. Standard land-line phones are the slowest to be reconnected, whereas cellular service can be restored in as little as a few hours. Portable cell towers can be moved into an area on small trailers and connected to telephone switching offices. However, cellular service may be overwhelmed by voice calls. Most cell phones are capable of receiving text messages. Text messaging service requires less bandwidth and provides reliable delivery. Messages can be received while a phone is in use on a voice call or stored and sent to a phone when it is turned back on.

Cell phones may be used to send broadcast messages to large numbers of people in a designated group, or in a geographic area. Systems such as Chatter (http://www.2chatter.com), GroupCast (http://www.groupcast.com), and MobileSphere (http://www.mobilesphere.com) can be used to send messages to cell phone users who request being included in the notification service. These services can be configured for department staff notifications, replacing traditional phone trees that depend on people to perform a task. Other populations that might be affected by an event, such as elderly, asthmatic, or immune-suppressed patients can also received targeted notices. Other types of systems, such as CellCast (http://www.cellcast.co.uk), broadcast messages to all cell phones in a particular cell service area. Such systems are useful when indiscriminate emergency messages need to reach an area. As a response to the April 2007 shooting incident on the Virginia Tech campus, a number of universities have instituted broadcast text messaging systems.[9-11]

An essential function of any electronic medical records system used in a mass casualty event is the ability to generate copies of patient information as patients are discharged or sent to other care venues. The Certification Commission for Healthcare Information Technology tests programs for functionality, interoperability, and security. WorldVista, discussed in the previous section, is certified as meeting all requirements, along with almost 100 other products.[12]

Patients and the public will need to know what health services are available, where they are if they have been relocated, and hours of operation for clinics. They may need to access information for self-care or instructions for particular threats, such as quarantine-in-place procedures to prevent being exposed to or spreading agents. Information should be provided in an on-demand format to allow accessing it at the patient's convenience and at a pace that the user can understand. Broadcast media, such as radio or television, are appropriate for specific types of information but cannot provide on-demand access at present.

Communication and coordination during a mass casualty event are carried out by a regional response team. Depending on the level of involvement, it may include city, county, state, and federal resources. The response to hurricane Katrina demonstrated the difficulty that all the agencies had exchanging information, ranging from simple radio communication to supply lines to personnel allocation. In the aftermath, a number of lessons are being applied by response teams to existing mass casualty programs to ensure basic communications are available between the various agencies.

Low-tech and no-tech solutions should not be overlooked. Following the Greensburg, Kansas, tornado, the Kansas Adjutant General's office printed regular newsletters that highlighted community events and pointed out potential health issues during the cleanup.[13] Paper forms, derived from the process inventory, might be used in the absence of electronic systems.

Information-Collecting for Post-Event Analysis

Keeping track of everything that happens during a mass casualty event is usually not at the top of any administrative list, since the focus is simply providing health care in a situation where the delivery system has become overwhelmed. However, overlooking valuable lessons learned is a mistake.

During the Hurricane Katrina disaster, both responders and impacted residents kept Web logs ("blogs") that recorded their thoughts and feelings and provided insight into the event as it progressed. In the process, they pointed out what worked well and what problems they found.[14,15] From this nontraditional source of information, responders were able to communicate with others in the field and adapt as the situations were changing.

Internet communications can also provide information about impending disasters. In 2002, China was not providing accurate information about what they dismissed as a "flu outbreak." Canadian epidemiologists monitoring Internet Web sites and e-mail communications were able to collect information to suggest a more serious problem was occurring. Because of Canada's appeal to the World Health Organization, China finally revealed the extent of the SARS epidemic within their country.[16]

Finally, the United States Department of Homeland Security provides a Web site that publishes lessons learned, best practices, and after-action reports.[17] It requires registration before access is granted. Over 6,500 documents are in the collection, including reports from actual incidents, as well as summaries of field exercises. It includes both positive and negative observations so that adverse decisions can be avoided.

Summary

The need for information accelerates during a mass casualty event. Responses to events require the ability to collect information and analyze it in an environment that may be continually changing. Loss of communications infrastructure hampers this ability. Preparation may reduce this impairment.

Successful preparation for a department includes cataloging the information required by processes, systems, and resources needed to provide acceptable levels of care for a given event. Reviewing alternatives to existing communication and information infrastructure can prepare a department for using alternative technology, or even no technology. A post-event analysis will provide an opportunity to improve the response to subsequent events.

The last step in any plan should include the processes that need to be back in place before the event can be considered at an end, and normal operations can resume. There may be a phased return, as in a decreasing patient loads, or a complete cut-over, such as a return to a designated facility. Ultimately, every crisis will have a conclusion.

REFERENCES

1. U.S. Department of Defense, news transcript. DoD News Briefing. Sec Rumsfeld and Gen Myers. 02/12/02. http://www.defenselink.mil/transcripts/transcript.aspx?transcriptid=2636. *Accessed January 15, 2008.*

2. Wikipedia contributors. Situation awareness. Wikipedia, The Free Encyclopedia. http://en.wikipedia.org/wiki/situational_awareness. *Accessed January 15, 2008.*
3. Centers for Disease Control and Prevention. Severe acute respiratory syndrome—Singapore, 2003. Morb Mortal Wkly Rep 2003;52(18): 405-411.
4. Wikipedia contributors. Greensburg, Kansas. Wikipedia, The Free Encyclopedia. http://en.wikipedia.org/wiki/Greensburg,_Kansas. *Accessed January 15, 2008.*
5. Bednarz A. Hospital sounds alarm after 3-day struggle. 11/25/02. Network World. http://www.networkworld.com/news/2002/1125bethisrael.html. *Accessed January 15, 2008.*
6. Brooks J. MED-1: hospital on wheels. CMAJ 2006;175(6):569-570.
7. Doctorsgadgets.com. A list of open source EMR projects 3-3-2006. http://www.doctorsgadgets.com/forum/open-source-medical-software/129-list-open-source-emr-projects.html. *Accessed January 15, 2008.*
8. Department of Veterans Affairs. VistA Monograph 2005-2006. Washington DC. May 2005. http://www.va.gov/vista_monograph/docs/vista_monograph2005_06.pdf. *Accessed January 15, 2008.*
9. Georgetown University. Emergency text messaging to launch. [Georgetown] University News, August 21, 2007. http://explore.georgetown.edu/news/?ID=26590. *Accessed January 15, 2008.*
10. Page A. UB [University of Buffalo] institutes text messaging for emergency notifications 9/1/07. UB New Center http://www.buffalo.edu/news/8814. *Accessed January 15, 2008.*
11. Mayer K. [Denver] University's emergency plan to include text messaging September 07, 2007. http://www.du.edu/today/stories/2007/08/2007-08-31-emergency.html. *Accessed January 15, 2008.*
12. Certification Commission for Healthcare Information Technology. WorldVistA CCHIT Certified Ambulatory EHR 2006. http://www.cchit.org/certified/. *Accessed January 15, 2008.*
13. Kiowa County/Greensburg Public Information Update. http://www.accesskansas.org/ksadjutantgeneral/news releases/2007/greensburg disaster/special - broadcast information.pdf. *Accessed January 11, 2007.*
14. UNC Hospitals' Hurricane Katrina Response Blog. http://www.unchospitals.blogspot.com. *Accessed January 15, 2008.*
15. A Gartner blog: hurricanes: the impact. http://katrina.blog.gartner.com/blog/index.php?blogid=4. *Accessed January 15, 2008.*
16. Wikipedia contributors. Severe acute respiratory syndrome. Wikipedia, The Free Encyclopedia. http://en.wikipedia.org/wiki/severe_acute_respiratory_syndrome. *Accessed January 15, 2008.*
17. US Department of Homeland Security. Lessons learned: information sharing. https://www.llis.dhs.gov. *Accessed January 15, 2008.*

Discussion

Branson: How do you collect information?

Nelson: That's what the LLIS (Lessons Learned Information Sharing) Web site (http://llis.gov) has: all of the retrospective information. So they try to remember what happened, but there isn't a good method. The last thing people are going to be doing is thinking, "Let's write down every little step we took and deconstruct this later." But LLIS is a good place to look for it.