Emergency Mass Critical Care

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Introduction

At any moment regular television programming could be interrupted with news of the emergence of a new strain of infective agent, a major industrial accident, or a terrorist event. Many devastating events are widespread and naturally occurring, like hurricanes, in which we have ample warning time to enact preparation plans; while others, like earthquakes, volcanoes, or tsunamis may kill or injure thousands before the news reports hit the airwaves. Industrial accidents and terrorist events are usually sudden and occur without any warning. Any of these events may have a local or regional effect; some may even have a global impact [1]. Regardless of the cause, after such an event, large amounts of the populace will be seeking medical care, whether from their primary care providers, public health departments, or local hospitals.

As healthcare professionals it is our duty to be prepared for any of the above, to be able to provide the best possible care to our communities. This requires an awareness of the vulnerabilities of one's region, as well as on-going global surveillance. Development of a response plan is requisite for any hospital to have a significant expectation to be able to respond in a meaningful way to a sudden disaster that leaves large amounts of the population seeking emergency medical care. Preparedness plans include performing hazard-vulnerability analysis (HVA), coordinating of response plans with all potentially involved entities, reviewing results of routine drilling, and revising the plan based on results of practice. In order to prepare and plan accordingly for different possible scenarios that may overwhelm routine operations, it is essential to identify available resources, specifically people,

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materials, and physical locations – often referred to as; staff, stuff, and space [2].

Within this chapter we will focus our attention on the most important considerations for managing patient care within the hospital with an emphasis on critical care in response to a mass casualty incident (MCI), as we plan to expect the unexpected.

Definition

Disaster preparedness medicine focuses on preparation, response, surge, administration of resources, and recovery from events that generate demands that overwhelm the local medical community's capacity to deliver care.

Emergency mass critical care (EMCC) [3] is defined as the organization of critical care delivery when presented with situations manifested by increased – and for the most part – unexpected demand or surge. This results in a shortage of specialized staff, medical equipment, supplies, and available patient care areas. This lack of resources could actually limit the number of patients that can be treated while maintaining accepted standard of care interventions. When faced with an overwhelming demand for care that far outstrips the resources, in order to increase the chances of survival for the largest number of patients, only essential processes may be maintained during an MCI.

Considerations

Historically, disaster preparedness has concentrated on the management of multiple trauma casualties, generated by accidents, weather events, civil disturbances, or armed conflicts [4,5]. In these situations, the most severely injured frequently die on-scene, often before the arrival of first responders. Those that initially survive and are able to be transferred to hospitals usually have nonlife-threatening injuries during the initial period. However, many of the survivors may have prolonged hospitalizations and require critical care services due to the development of severe sepsis, acute lung injury (ALI), acute respiratory distress syndrome (ARDS) [6], or multiple organ dysfunction syndrome (MODS) [7–10]. This pattern forces us to realize that our disaster preparedness must include a focus on caring for the critically ill for a period of time well beyond the initial insult.

Critical care, in particular the provision of mechanical ventilation and hemodynamic support, becomes the mainstay of treatment when highly contagious or lethal biological agents are encountered, as in a pandemic influenza or a biological terrorist attack. It is also crucial when dealing with severe, life-threatening exposures to chemicals [11] or radiological agents that result in acute respiratory compromise and other severe organ dysfunctions.

In most instances, the ability to expand critical care capacity at any given time is limited. Hospital critical care units are often fully occupied, or do not have enough

staff to be at capacity, whether due to shortage or economic strategy. For this reason, when presented with an unexpected, large-volume surge in demand, the hospital census, and in particular lack of available critical care beds, can become a limiting factor for survival [12,13]. It is important to keep in mind that in these situations, the duration of surge demands on emergency departments may be several hours, while the critical care support required may last from days to weeks after the initial incident [14].

Throughout the world, public health departments and civil defense, antiterrorist, and military agencies have developed scenarios that focus on predicting the potential numbers of casualties. The USA's Center for Disease Control (CDC) has made software available for public access [15] (e.g., Flu Surge) that can help estimate the potential surge of different patients geographically. The majority of plausible events result in overwhelming numbers of critically ill patients who without critical care available to them will not survive [12].

Hospitals should have a pre-established organizational structure to be activated in emergency situations. In the USA and many other areas of the world, the Hospital Incident Command System (HICS) [16], initially developed in California, has been used for this purpose (see Fig. 30.1).

Planning and drills must contemplate a wide range of situations, with different degrees of social and institutional disruption. Basic plans should include response to an isolated or local event with an intact support infrastructure. Complex planning should anticipate response to a widespread disaster with loss of institutional and commercial facilities in an entire community or region. It is important to specifically determine anticipated needs and plans when large-scale events often disrupt access to external supply lines for both the hospital and the entire community.

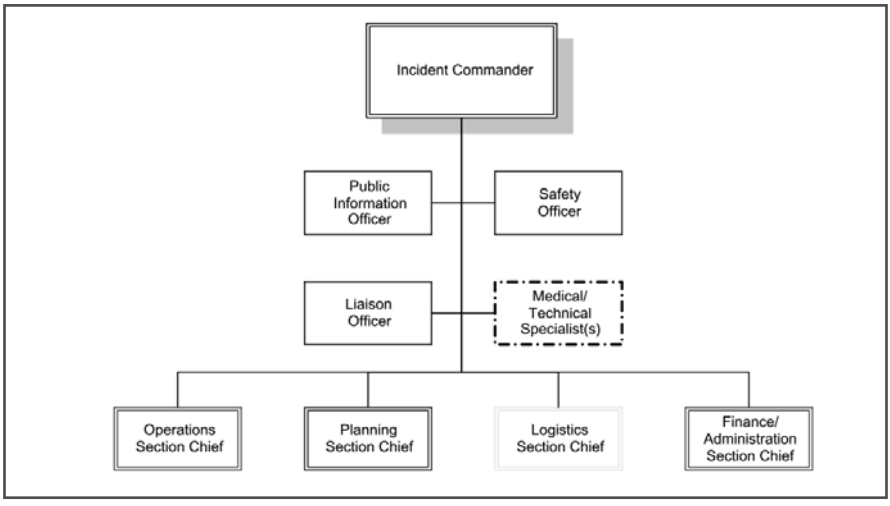

Fig. 30.1 Hospital Incident Command System (HICS) – Basic management structure. Distribution of authority and responsibility for primary management functions within HICS.

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Risk

Geographical, social, economic, and political factors are essential considerations when defining the risks for a given location. Completing an HVA tool, like the one suggested by Kaiser Permanente [17] or by the Joint Commission of the United States [18], can be useful in defining priorities. The HVA tool considers three major areas: Probability, Risk (or Impact), and Preparedness, and is presented in Appendix 1. The HVA should be based on an "all hazards approach," establishing an initial list of all possible disasters, regardless of their likelihood, geographic impact, or potential outcome. This list can be divided into typical categories that include natural, technological, and human events. The list will later be prioritized, taking into consideration the probability of occurrence, overall impact, current level of preparedness, and time requirements.

The probability of occurrence can be derived from historical records, statistics, and expert opinions. The impact of various events should also be evaluated as many can be ameliorated by sufficient back-up systems, i.e., generators for the loss of electrical power.

Some communities have specific seasonal disasters like hurricanes, tornadoes, floods, or wildfires. The dependence on technology and continued integrity of supply lines must be considered as well. The tool uses the qualitative terms of high, medium, low, or no probability of occurrence.

The potential risk or impact must be analyzed to include a variety of factors, listed as follows in order of importance:

- Threat to human life
- Threat to health and safety
- Property damage
- Systems failure
- Economic loss
- Loss of community trust/goodwill
- Legal ramifications

The HVA tool gives the highest score individually to the threat to human life, followed by the threat to health and safety. The remaining elements from the table: property damage, systems failure, economic loss, loss of community trust, and legal ramifications are all considered together when determining the level of risk.

An organization's preparedness plan(s) developed to manage any given disaster should also involve the input of community agencies, as healthcare facilities will not be responding to an emergency by themselves.

The coordination with the local emergency medical system and other hospitals is necessary, as planning for patient disposition should be determined before any event occurs. Police and fire departments are also very important, as security may need to be augmented. All plans need to be tested and studied in order to detect potential flaws. In the USA, the Joint Commission [19] requires for accreditation a minimum of 4 drills per year, two of them as tabletop exercises and the others with full simulation of casualties and hospital flows.

Once the HVA tool is completed, the factors are multiplied to give an overall total score for each hazard. i.e., a hazard with no probability of occurrence for a given organization is scored as zero, and will automatically result in a zero for the total score. This tool may help in a more objective prioritization of preparedness planning.

When preparing plans derived from the HVA keep in mind that there is no perfect plan to address every potential threat and all plans will need to be developed with a degree of flexibility to adjust, while still preserving a core structure. Also, there may be significant social issues affecting staffing as healthcare workers (HCWs) and support staff may not be able to come to work due to: community compromise, lack of transportation, illness of dependents or self, fear, closed schools, lack of basic utilities or food; they have essentially gone into a "family survival" mode. Planning should also address how to support the HCWs to facilitate them coming to work and also having their basic needs met.

Needs

It is of utmost importance to develop an EMCC Committee at your hospital, with representatives from all departments that will be involved in the response. The initial task of this committee is to complete an evaluation, with a "staff, stuff, and space" approach. Detailed inventories of equipment and their functional state, supply levels and their distribution should be completed and reviewed carefully. Hospitals should plan to maintain enough supplies and foodstuffs to be able to function for at least 10 days without any deliveries, to be prepared for an adequate response to a large-scale event that disrupts usual supply routes or community infrastructure. Coordination with external agencies may provide assistance in an organized regional response with better resource utilization, back-up systems, and "shared" costs when building inventories of equipment and supplies.

With the input of building engineers, floor plans should be analyzed to identify areas that could be potentially converted to Intensive Care Unit (ICU) wards, or isolation wards with improvised seals to generate negative pressure areas, via portable units or by reversal of ventilation systems. Personnel contact information and rosters should be maintained and updated regularly to ensure current contact information is available. Creative planning may include provision for child care or temporary schooling if there is discontinuation of community services (i.e., closed schools), to enable HCWs to work and have their basic needs met.

Recommendations

The following is a summary of recommendations for preparing a Disaster Preparedness plan and delivery of EMCC, based on the most recent publications from the American College of Chest Physicians Task Force [2] and the Fundamentals

of Disaster Management (FDM) [20] course of the Society of Critical Care Medicine, with emphasis in the Staff, Stuff, and Space orientation:

Staff

1. In any circumstance, and specially when facing a disaster, it is of utmost importance to maintain or, when necessary, enhance the protective measures of all HCW. Failure to do so may leave the institution in a situation with an excessive demand for resources and limited HCWs. The lack of available HCWs may be due to disease, injury, or fear of acquiring disease and exposing families and close contacts. Therefore, it is paramount that the HCW is reassured that their level of personal protective equipment (PPE) is more than adequate and that continuous surveillance, screening, and quality compliance programs have been implemented across the facility for their protection.
2. Staffing plans require careful consideration, as due to direct and indirect situations, their actual number may be lower than during routine operations, as the hospital faces an increased demand. Some key points include:
   - Decision making and patient management should be performed by the most experienced physicians, nurses, and ancillary personnel available, and within their scope of work.
   - Physicians and nurses without significant critical care experience may be reassigned to ICU areas following a tiered staffing organization (Fig. 30.2). Adequate ratios of supervision must be maintained with experienced personnel, utilizing clear guidelines and protocols. Previous basic training with courses like Fundamental Critical Care Support course (FCCS) [21] and FDM would facilitate this model.
3. Rationing of critical care should only be considered after all efforts at augmentation have been exceeded. The province of Ontario, Canada, after their experience during the Severe Acute Respiratory Syndrome (SARS) epidemic, developed a critical care/ventilator triage protocol based on the Sequential Organ Failure Assessment score (SOFA) [22] to be used in case of a pandemic, in view of the potential limitation in the number of ventilators. All decisions should follow well-defined, objective protocols using this score or similar approaches. All patients should receive basic care, including comfort and palliative support in extreme situations, even when the standard of care cannot be maintained.
4. Biological threats [24,25]:
   - Hospitals are high-risk areas for secondary spread of contagious diseases.
   - Hospitals should implement high-level PPE whenever an infectious agent is suspected, and adjust the level of protection, once the contagion is identified.
   - Agents transmitted by droplet may require higher precautions (i.e., airborne), when patients are subjected to high risk for aerosolization procedures or devices; these may include:
     - Noninvasive ventilators

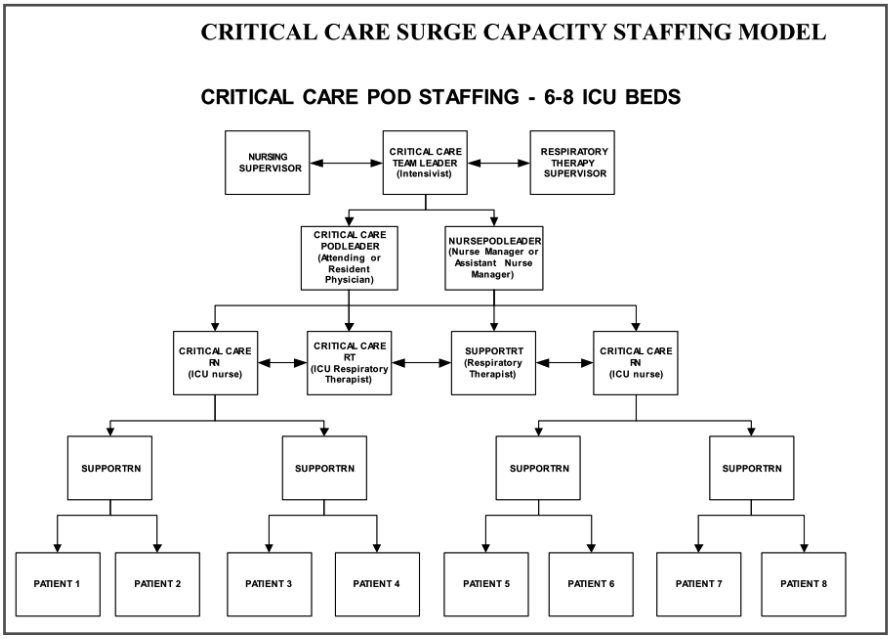

Fig. 30.2 Emergency Mass Critical Care – Example of Tiered Staffing Organization

- Endotracheal intubation
- Airway suctioning with an open circuit
- Bronchoscopy
- High flow oxygen masks
- Administration of nebulizers (i.e., bronchodilators)
- Chest tube insertion

5. Some of the CDC recommendations to don and doff PPE have been linked to an increased risk of contamination [26–28]. A summary of basic recommendations follows with modifications:
   - Strict hand hygiene and sanitation measures remain the primary interventions in decreasing the potential for transmission.
   - The PPE for routine care (no aerosolization procedures are expected) [23,24]:
     - Two layers of light, disposable, impervious gowns
     - Two layers of patient care gloves, taped longitudinally to facilitate removal as one piece with gown
     - Appropriate eye protection (regular eye glasses don't offer adequate protection)
     - N-95 mask (minimum grade)
     - Disposable surgical cap
     - Shoe covers (optional) or preferably, a nonporous, synthetic material shoe, that can be easily disinfected.
   - The highest level of airborne protection requires the use of a Powered Air Purifier Respirator (PAPR) (Fig. 30.3).

Fig. 30.3 PPE for high risk of aerosolization procedures – The team is using double layers and a PAPR for ICU use, during an intubation training session.

- PAPR for ICU use only protects against biological particles and cannot be used for decontamination procedures at the hospital's entrance, as they DO NOT offer protection for volatile chemicals. The infection control plan should clearly delineate criteria for isolation, quarantine, prophylaxis, and treatment.

6. Hospitals should prerecord instructions for personnel on a specific hotline, so they can better prepare themselves and their families for their interactions with the situation.

Stuff

7. In disaster situations, the EMCC should strive to still provide the following evidence-based, effective interventions [3]:
   - Mechanical ventilation
   - IV fluid resuscitation
   - Vasopressors
   - Antidotes and/or antimicrobials administration for specific diseases
   - Sedation and analgesia
   - Basic ICU measures:
     - Stress ulcer prophylaxis
     - Deep venous thrombosis prophylaxis

- Elevation of the head of bed to 30°
- Turning the patient routinely
- Oral care

• Renal replacement therapy
• Enteral nutrition

8. Mechanical ventilators utilized for surge response, should have the following characteristics [3,6,19]:
   • Capable of supporting pediatric and adult patients with conventional modes and deliver a PEEP of up to 20 cm H_2O
   • Have an internal compressor device that allows them to function without an external compressed air source and low-flow oxygen
   • Have alarms for: low minute volume, apnea, circuit disconnect, low gas source, low battery, and high peak airway pressures
   • Battery power for at least 4–6 h
   • Have high-efficiency filtering devices for exhaled gases, to prevent aerosolization of secretions into the environment, when dealing with a potential contagion
9. Pharmacy regulations should include clear tables and algorithms including dosing for all ages, adjustment for patients with renal and/or liver insufficiencies, substitutions, authorized prescribers, restrictions and, if authorized by health authorities, guidelines for medication shelf life extension.

Space

10. Facility protection is another crucial aspect of the response, including possible contaminations of physical spaces or systems (i.e., air handlers, water, food). Secured access may be the most important safety program during an incident, including perimeter definition and its maintenance with attention to strategic areas such as switchboards, medical gas depots, generators, and pharmacy. Enhanced security will help the facility maintain independence, as the facility may become the target of desperate community members if all other institutions in the locale have failed.
11. The plan should consider ideally a surge of up to 3 times the normal ICU census and 10-day self-sustainability [3].
12. The plan should have a graded response based on the potential size of the demand, from multiple casualty events to catastrophic situations, with clear delineation of interinstitutional coordination and participations.
13. Transfer agreements should be obtained with regional and extraregional facilities (Joint Commission requirement in the USA) [18] in situations where the hospital integrity and/or functionality are compromised.
14. The designation of resources should follow a prioritization scheme based on severity, available expertise at the site, and institutional surge capacity. The person performing TRIAGE should be experienced and follow objective guidelines with classification criteria and facilitate patient flow to predesignated surge areas

depending on level of support required and number of casualties.

15. Physical space used for delivery of EMCC should have the infrastructure to support expected critical interventions, such as mechanical ventilation (which requires a supply of medical gases), monitoring, and emergency generator-supported electricity. Areas of expansion may include elective procedure recovery wards in outpatient surgical centers, pre- and postangiography or cardiac catheterization units, and endoscopy suites.

Other suitable areas include mobile (i.e., tents or trailers) ICU facilities, and even veterinary hospitals. Many plans purposefully avoid delivering prolonged care in postanesthesia care units (crucial for the utilization of the operating rooms) and the ED, in order to maintain the functionality of these to departments as much as possible. Should more critical care space be required, consideration should be given to expand, sequentially, to intermediate or step-down care units, telemetry units, and eventually hospital wards. Other nonmedical facilities should be avoided, as they require significant repurposing for EMCC. They should be considered only in extreme circumstances on a temporary basis, when there has been a significant impairment of the hospital infrastructure.

General

16. Every hospital with critical care capabilities should have a plan to provide EMCC. This plan should be coordinated with local, regional, and national initiatives and entities.
17. The internal organization diagram for the implementation of the emergency plan should follow the HICS recommendations, including an Incident Commander and four sections: Operations, Planning, Logistics, and Finance (Fig. 30.1).
18. Hospitals should prerecord instructions on well-publicized hotline numbers, so the public at large, incoming patients and other inquirers can obtain guidance in accessing the facility or other information.
19. A web page can assist in posting information about unidentified patients or the deceased, as well as to provide instructions for HCW.
20. Coordination with local media (TV, radio, newspapers) to provide the public with instructions on how to access care in the community, as some health-care facilities may be designated to a specific type of ailment or severity. For example, hospital A may be designated the receiver for the event patients, while hospital B is accepting routine emergency care (i.e., a broken leg, dog bites, etc.)

Conclusions

Response to any MCI or disaster should be proportional to the event and objective and follow pre-established guidelines. Following an organizational structure similar to that of HICS, the plan should be implemented and carried out by the most experi-

enced personnel available (i.e., physicians, nurses administrators, facility engineers). If the amount of patients overwhelms the system to the point that critical care support needs to be rationed, clear, objective TRIAGE guidelines should be used and applied consistently [29]. These guidelines should be developed with ample consideration of the associated ethical, moral, and legal aspects addressing the potential inability to provide complex, aggressive care to all during an extreme EMCC implementation. Hospitals, physician, nurses, and legislators must work together to develop the necessary regulations and laws for their implementation.

"Previous preparation prevents poor performance." Any plan should be tested routinely with drills utilizing local and regional or national resources; it should be assessed, modified accordingly, and then retested in a continuous cycle. Only a complete and wide-spread understanding of the required response by all key participants will increase the probability of decreasing the potentially deleterious effects of an event. All preparations should have started yesterday.

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