Chapter 5
Disaster Management

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Abstract The keys to the success of any disaster management program are the identification of vulnerabilities, preparation to address identified weaknesses, and continued education aimed toward risk mitigation. Whether accomplished through mass education, hands-on training, emergency services integration, or simple communication, a comprehensive disaster management plan can help even the most remote regions to succeed under duress. A robust disaster response begins with extensive preparation through preventative measures. In conjunction with these preventative measures, risk mitigation develops plans to prevent the unnecessary loss of life or property. Preparation, the final phase before the actual disaster event, enacts the actual mitigation measures identified in previous steps. The response phase, the first portion to take place after the actual event, focuses on addressing the actual threats and protecting public interests. In this phase, the Emergency Operations Center and Incident Command System establish a chain of command. Lines of communication are created, human casualties undergo triage, and assets are dispersed in the most effective manner possible to treat all those in need. After the conclusion of the immediate response, the community as a whole begins to rebuild, and new opportunities for change are identified. With recovery, the cycle continues as lessons learned from the prior incident drive future prevention, mitigation, and preparation efforts.

Keywords Disaster management · Mass casualty · Risk mitigation · Incident command

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Key Points/Clinical Pearls

- Utilization of a triage algorithm such as the pediatric-specific JumpSTART can help improve outcome of all patients.
- Thorough planning for potential disasters is important to prepare for all possibilities and includes a through analysis of strengths and weaknesses.
- The Emergency Operations Center and Incident Command System establish a chain of command and ensure lines of communication are maintained.
- Partnering with other hospitals, local and state governmental organizations and federal assets can overcome previously identified vulnerabilities
- A thorough review of any disaster event and after-action evaluation is important to plan and prepare for future events.

Learning Objectives

- Identify the five phases of disaster management
- Understand the structure and function of an Incident Command System
- Develop an understanding of basic triage principles
- Identify the differences in pediatric and adult triage algorithms

Initial Management of the Trauma Patient

Rapid assessment and immediate triage of casualties in disaster scenarios are essential in order to provide the greatest benefit to the largest number of people. Patients may quickly be grouped into minimal, delayed, immediate, or expectant categories based upon simple observations or criteria. Once the primary triage is completed, the process is repeated until all casualties have been either treated or expired.

Initial Radiographic/Ancillary Studies

Implementation of the Model Uniform Core Criteria (MUCC) utilizing triage algorithms such as Simple Triage and Rapid Treatment (START), Sort-Assess-Life Saving Interventions-Triage (SALT), or the pediatric-specific JumpSTART can help to improve outcomes of all patients involved in disaster scenarios.

Introduction

Although we cannot predict catastrophic events, we must make every effort to prepare ourselves for the moment a disaster strikes. Attributed to Benjamin Franklin more than 200 years ago, the adage “by failing to prepare, you are preparing to fail” has remained timeless. Whether accomplished through mass education, hands-on training, emergency services integration, or proper communication, a comprehensive disaster management plan can help any group to succeed under duress [1]. In this section, we will provide an overview of the five phases of disaster management, define the concept of an incident command system, and highlight the use of disaster management planning in mass casualty situations.

The Five Phases of Disaster Management

Prevention

In order to effectively plan and prepare for a disaster, a group must first identify their vulnerabilities. Whereas coastal communities bear the overarching burden of major weather events such as hurricanes and flooding, inland dryer climates are at constant risk of fire and drought. Large, urban areas become targets of Active Shooter/Hostile Event (ASHE) type incidents, such as terrorist events, whereas rural communities may be devastated by a smaller industrial hazard. Regardless of the nature of a disaster, we can more readily mitigate the ensuing fallout if we identify our vulnerabilities and plan accordingly. The first phase of disaster management, prevention, involves planning for possible disasters and enacting small changes that help prepare for those scenarios. Examples of preparation include outlining evacuation routes from buildings, setting muster points for evacuees, and performing drills pertaining to natural disaster or ASHE-type events. While prevention planning contributes to the overall preparation for a disaster, this phase does not involve making major changes to policy or procedure.

Mitigation

The second phase of disaster management, mitigation, involves making actual changes keyed toward minimizing loss of life and destruction of infrastructure. Mitigation must occur before the actual disaster event. When performed well, this step assists a group in protecting the public, preventing injuries or loss of life, decreasing fiscal losses, and enhancing recovery efforts. According to the Federal Emergency Management Association (FEMA), hazard mitigation involves four steps: (1) organize the planning process and resources, (2) assess the risks, (3) develop a mitigation strategy, and (4) adopt and implement a plan [2–4]. The first step, organizing the planning process and resources, begins after creating a comprehensive list of actual and hypothetical risks. Once these risks or vulnerabilities are identified, experts are contacted to address every aspect possible. As preparation begins, local agents must communicate their concerns to both the regional and territorial (state) levels. Vulnerability varies by region and by available resources. In times of duress, the division of assets between communities can be a very valuable strategy [5].

Risk assessment is accomplished through many avenues. Structural engineering surveys can identify physical hazards that have not been addressed. Common structural questions include: are windows impact rated, are structures secured to the ground or freestanding, do runoff areas have adequate drainage, etc. Education assessments may include determining if residents have been taught basic first aid

and if they know where emergency shelters are located. Policy revision during risk assessment may evaluate whether or not proper codes are being followed and if the land is zoned appropriately. Once the assessment has been completed, it is then the responsibility of those in charge to develop a strategy to address areas of vulnerability and enact a plan of change.

Preparedness

The third phase of disaster management, preparedness, is the final phase before the actual disaster event. Once a mitigation plan has been created and opportunities for improvement are identified, preparation for each event begins. Initially, there is a focus on education. Countless training courses addressing common knowledge deficits are available through various government agencies such as the National Fire Academy (NFA), the Center for Domestic Preparedness (CDP), and the Emergency Management Institute (EMI). Through a combination of education, training, tabletop exercises, drills, and simulation, we as a whole are able to better prepare for the majority of our vulnerabilities [6].

The Organizations Preparing for Emergency Needs (OPEN) training site (https://community.fema.gov/opentraining) highlights ten specific steps that should be addressed in preparing for any major incident. Whether it is a terror attack, natural disaster, or industrial accident, the following steps are critical in preparing the community to respond. The ten steps to be addressed are:

1. Understanding our risks
2. Safeguarding critical information
3. Identifying the population to be served
4. Mitigating risks
5. Establishing communication plans
6. Determining essential activities
7. Establishing supply chains
8. Testing and updating strategies
9. Formalizing plans
10. Training all individuals that are necessary to success [7].

The crucial aspect is of these ten specific steps is training the individuals. A proper plan can only be executed if the personnel involved understand the process and train accordingly so that they are equipped for any complications that may arise.

In March of 2011, the President of the United States formally addressed the issue of disaster preparedness by publishing Presidential Policy Directive 8 (PPD-8). PPD-8 called for the establishment of the National Preparedness System (NPS); "This directive is aimed at strengthening the security and resilience of the United States through systematic preparation for the threats that pose the greatest risk to the security of the Nation…" [8]. The goal of the NPS was to create "a secure and resilient nation" while providing a framework to sustain our preparatory efforts.

Response

Arguably the most important phase of disaster management, the response phase occurs immediately following the disaster event. In this phase, attention must be focused on addressing the actual threats, enacting previously created plans, and protecting the safety of all those affected. The first main objective is to rescue people and personnel in harm's way while neutralizing any immediate threats. Once people are safely evacuated, it becomes easier to address the dangers at hand. However, it may occasionally be necessary to address any immediate threats prior to evacuating the affected parties. An example of this scenario involves shutting down power grids in structure fires so that emergency personnel may effectively move through a space without concern of electrical injuries to themselves.

Once the safety of people and property has been established, the second main objective is to begin triaging immediate needs. Upon identifying these needs, it becomes possible to adequately dispense resources. After cataloging the scope of the disaster, the available assets are then divided, and the "clean-up" begins. Local assets are engaged, relief measures are mobilized, and all attention is directed toward restoring normal order and operations. In addition to aiding the immediate recovery, attention is also turned toward planning for the long-term recovery effort that will be required.

Recovery

The final phase of disaster management, recovery, begins after the immediate response efforts have concluded. Recovery is a long-term phase that may last months, years, or even decades. In the short term, essential aspects such as food supply chains, water treatment facilities, and adequate shelter must be re-instated. Additionally, restoration of public utilities such as electricity, sewage, and fuel supply assist with supporting the operations of necessary institutions such as hospitals. Once people are able to return to their homes and places of work, a recovery plan can be created that prioritizes restoration assets. In some cases, demolition of damaged structures may be more beneficial than repair. One of the most important parts of the restoration phase is documentation of lessons learned to facilitate better preparation for future events.

The Incident Command Structure

Whether bracing for or mobilizing in response to an imminent threat, a structured hierarchy of personnel must be identified with the establishment of a clear, unified command. An incident command system (ICS), a well-organized, pre-planned

response tree establishing a chain of command, is an invaluable tool for disaster preparation. The ICS incorporates all available assets (emergency services, equipment, communications centers, etc.) into one fully functional web of services, all functioning together to move toward recovery. The National Incident Management System (NIMS) identifies six areas critical to an effective ICS: (1) establishment of a clear command presence, (2) appointment of an operations manager, (3) development of a planning division, (4) development of a logistics division, (5) intelligence collection and investigations, and (6) creation of a finance/administration division [9].

The command presence, often located in the Emergency Operations Center (EOC), acts as the control node and ultimately organizes all information to or from the scene. The incident commander, ultimately in charge of all assets, leads the ICS from the EOC. While individual chains of command may still be enacted, the incident commander is granted unified authority over the entire response. The planning division develops an action plan and modifies it based on immediate needs. The operations division assists the incident commander by tracking all progress and enacting the action plan. The logistics division, a close partner of operations, assists with tracking personnel and provides the actual assets as needed. The intelligence/investigations division is uniquely tasked with identifying the cause of the incident and collecting any information that may assist in neutralizing the threat. Finally, the finance/administration division monitors the costs of the response and provides guidance as to the distribution of fiscal assets. A graphical depiction of the ICS can be seen in Fig. 5.1 below [10].

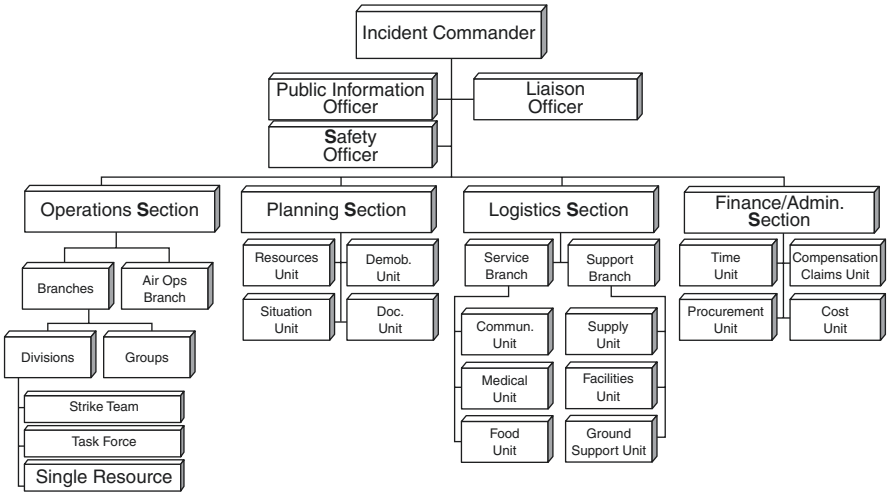

Fig. 5.1 Recommended structure of the incident command system. [Federal Emergency Management Agency—May 2008]

Specific Considerations in Mass Casualty Events

Immediate Triage

In the event of a large-scale disaster, human casualties may be inevitable. The American College of Surgeons Committee on Trauma (ACS COT) published a consensus statement in 2003 regarding disaster management, specifically the management of events resulting in massive numbers of casualties [11]. As numbers rise, the system can rapidly become overwhelmed. Because a large percentage of critical injuries require surgical intervention, it is essential to involve surgeons at the local, regional, state, and national levels when planning for a response. The ACS COT offers multiple education courses to providers throughout the world in an effort to instill at least basic training in the stabilization of traumatically injured patients. Advanced Trauma Life Support (ATLS) and Rural Trauma Team Development Courses both target hospital-based providers in smaller systems to familiarize them with the basic triage of injured patients. Completion of these courses by emergency personnel aids preparation for disaster response as it trains providers to identify weaknesses, utilize available assets, and incorporate them into the regional network as required. Additionally, the Department of Homeland Security established a course entitled "You are the Help until Help Arrives" that outlines five life-saving acts any member of a community can reasonably perform in the event of an emergency. These acts include: calling 9-1-1 to activate emergency personnel, ensuring the scene is safe for responders, stopping any obvious bleeding through packing and compression, strategically positioning injured patients, and providing comfort while waiting for trained personnel to respond [12].

The single most important step in the prehospital setting involves proper triage of the patients. Triage, from the French "to sort," in the setting of mass casualty situations, is the initial process of prioritizing patients based on the care they require. Secondarily, their care is weighed against the number of casualties present and the number of assets available to assist. This care is rendered with the mantra "the greatest good for the greatest number of patients" in mind [13, 14]. The classic triage system, also known as the START (Simple Triage and Rapid Treatment) categorized patients according to four colors with corresponding tags that could be placed on the patient. These four colors represented four patient categories: the walking wounded (green tag), those with a delayed need for care (yellow tag), those with an immediate need for care (red tag), and those patients you expect to succumb to their injuries (black tag). However, traditional triage methods have proven to be cumbersome in providing the initial screening and do not take into account constantly fluctuating needs. To prevent mistriage and avoidable delays, a more modern approach has been suggested to rapidly triage patients [15].

The Model Uniform Core Criteria (MUCC), a proposed universal standard for field triage, relies upon three major concepts to establish the triage priority of

injured patients; these three concepts comprise the "SALT" (Sort-Assess-Life Saving Interventions-Triage) method [16]. The first concept, "Global sorting," relies upon the idea that patients with the least severe injuries are more readily able to comply with basic commands. Using the Walk, Wave, Still approach, patients demonstrate tasks in decreasing complexity to help stratify the severity of their injuries [15]. Upon initial arrival, patients are ordered to stand and walk to a designated area. Those who are strong enough/capable enough to move on their own oftentimes do not have any significant injuries. With this decreased threat of imminent collapse, the "walking wounded" become the lowest priority for evaluation. Next, the remaining patients are asked to perform a task such as waving at the provider. Accomplishing a complex task such as "wave with your right hand" implies the integrity of higher order processing and again tells you that a patient is not in imminent danger; these patients become a second-tier priority. Finally, all those who lay still and do not walk or wave are identified, and an immediate evaluation is performed.

After sorting into the above categories, each patient is examined individually. Starting with the "still" group, life-saving interventions such as hemorrhage control, airway adjustment,or chest decompression are performed [16]. If the patient is breathing, they are then re-triaged to the more traditional categories. If they are not breathing, they are declared unsalvageable and moved to the expectant collection point. If the patient is breathing, demonstrates purposeful action, has a palpable pulse, and has no obvious source of ongoing hemorrhage, they are triaged as either delayed or minimal. Delayed patients, by definition, have more significant injuries, whereas minimal patients have minor injuries only. For patients whose distinction is unclear (those who fail to demonstrate purposeful movement, are breathing erratically, do not have a pulse, or are continuing to hemorrhage), they are classified as either immediate or expectant. Immediate patients are likely to survive with proper intervention, whereas expectant patients are likely to die from their injuries. Figure 5.2 below provides a basic outline of the SALT triage algorithm.

JumpSTART is a pediatric triage tool that uses a similar algorithm during mass casualty incidents. This algorithm is equivalent to a combination of START and SALT triage methods [17, 18]. Starting with the walking assessment, there is a quick transition to the individual assessments. Any child who is able to walk over is taken to a separate location for secondary triage. All remaining patients undergo primary triage. Patient evaluation order in primary triage starts with infants and toddlers, moves to young children who cannot walk on their own, and is followed by children carried over by adults.

The JumpSTART assessment differs from adults in that breathing is not a simple yes or no question. If the patient is breathing, other vital signs such as pulse and respiratory rate are considered. An abnormally high or low pulse rate or respiratory rate is indicative of an emergent condition requiring immediate intervention. If all vitals are appropriate, triage then moves on to the evaluation of the mental status of

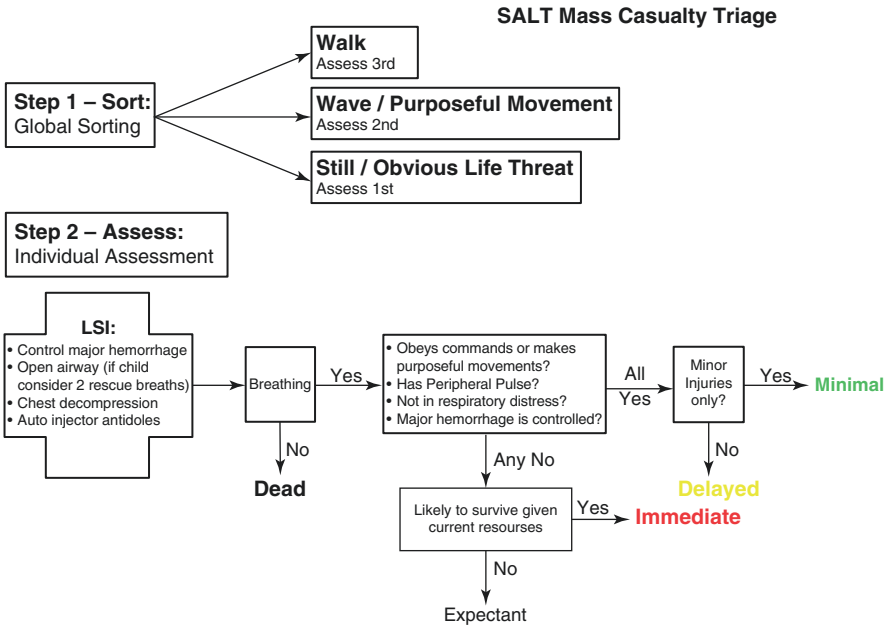

Fig. 5.2 The sort-assess-lifesaving interventions-triage/treatment (SALT) triage algorithm. *LSI* Lifesaving intervention [National Disaster Life Support Foundation—2020]

the patient through an AVPU exam (Alert, responsive to Verbal, responsive to Pain, Unresponsive). Any unexpected findings in the AVPU exam place the patient in an immediate category, whereas a non-concerning exam pushes the patient to delayed status. If the patient is not breathing during the initial phase of the assessment, the airway is repositioned, and the patient re-examined. If breathing resumes, they are labeled immediate; if breathing does not resume, they are given five rescue breaths. Successful resuscitation of the patient after rescue breaths places the patient in the immediate category. If none of the maneuvers mentioned are successful and the patient is not breathing and has no pulse, the patient is considered deceased (Fig. 5.3).

Although primary triage occurs rapidly, the process as a whole remains dynamic. Patients are reassessed, and their triage status is constantly revised; delayed patients can easily become immediate or expectant, and expectant patients may survive long enough to be re-triaged as immediate. Re-evaluation of patients, known as secondary triage, must occur on a regular basis until all patients have either expired or received appropriate treatment. Patient tracking must also be strictly maintained in an effort to document what interventions have occurred and where a patient has moved through the system.

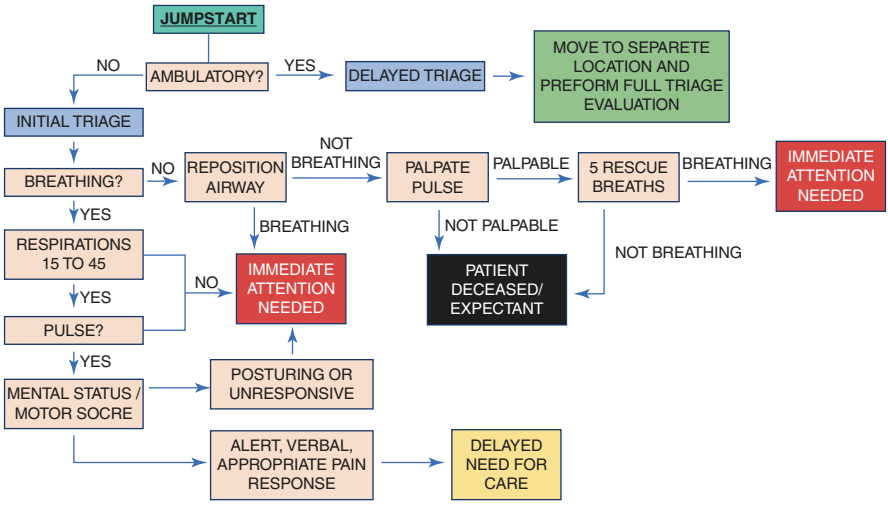

Fig. 5.3 The JumpSTART algorithm for triage of pediatric mass casualty incidents

Transportation

Disaster events can be classified as either static or dynamic [15]. *Static events* are limited in duration, and the scope of the threat is known. Examples of this are motor-vehicle crashes, farming accidents, or industrial events. There is one single moment where disaster strikes, and the event is concluded in a short period of time. In a static event, patients are more likely to remain at the scene and wait for traditional forms of assistance. Depending on the nature of the event, traditional vehicles (ambulances) may work in tandem with personally owned vehicles, air transit, or other modes of transportation. Tracking all modes of transportation and establishing sufficient lines of communication is necessary to follow transfers of patients to secondary locations. This line of communication is typically established via an EOC or incident commander on scene.

Dynamic events, situations where the scene is constantly evolving and stability does not exist, are much more difficult to manage. Examples of dynamic incidents include active shooter scenarios, bombings, natural disasters, and Chemical, Biological, Radiological, Nuclear, and Explosives (CBRNE) type events. In a dynamic scenario, patients are more likely to flee the scene as threats continue to develop. Casualties are transported to hospitals and clinics by any means necessary, which can jeopardize prehospital triage. Mass confusion becomes a concern after disruption of the typical triage processes. Dynamic events rely heavily on a system's ability to adapt as multiple facilities, agencies and personnel are forced to deviate from traditional practices.

Hospital Based Triage

Although triage is primarily a prehospital priority, the assessment continues into the hospital phase. Arriving casualties undergo an additional evaluation to determine operative order and treatment priority. After procedures are complete, patients are again triaged by need into various units within the facility. Occasionally, a tertiary triage is performed that uncovers a need for escalation of care. A common example would include patients with major vascular injuries that are stabilized in a facility without vascular surgery capability but require vascular repair. Again, hospital triage must adapt to the situation at hand and promote the delivery of appropriate care in a timely fashion.

Real World Example

On November 5, 2017, a lone gunman opened fire on a rural church in Sutherland Springs, Texas. In the initial assault, 25 people were killed and 23 others injured [19]. The immediate location of the incident was in a very small rural community with extremely limited resources. Upon radio confirmation of a mass casualty incident, the EOC established a chain of command by directing all assets to report to the Incident Commander. The closest medical facility, a small community hospital with one emergency room (ER) physician and two to four ER nurses on staff, was extremely limited in resources that could be provided. Roughly 60 min away in San Antonio, there were two large urban level 1 trauma centers with extensive capabilities, including pediatric trauma staff.

After confirming the scene was secure, local and regional assets were mobilized to the area. Knowing the large volume trauma centers were an hour away by ground, the incident commander sent all available helicopter units to the scene to assist with critical transportation. Primary triage was completed by walking wounded and law enforcement officers. Patients were rapidly assessed and triaged into common categories. Air assets were launched to transport the most critically injured while ground transport was sent to transport the less critical in a delayed fashion. Patient destinations were split as evenly as possible by the EOC to prevent over-saturation of the receiving facilities. Because of good communication, the staff at both trauma centers were able to call for assistance which arrived in a timely enough fashion to help stabilize all critical patients.

One young patient, categorized as immediate and often referred to as the sickest patient on scene, was in obvious need of immediate, life-saving intervention. After suffering numerous gunshot wounds resulting in a pelvic fracture, femur fracture, extensive soft tissue injuries, and hemorrhagic shock, the patient was very tenuous.

Fearing the patient would not survive transport to the pediatric trauma center, the decision was made to divert the to the closest available facility. After emergent transfusion at this small facility with aggressive wound packing with hemostatic gauze, this patient was re-triaged as immediate and sent to a trauma center for definitive intervention.

As patients arrived in the receiving facilities, appropriate secondary and tertiary triage were performed. Patients were again categorized based on their need for significant intervention. Ultimately, after all patients had been transported from the scene, the incident commander relinquished command and returned operations to the normal flow. Because of the rapid mobilization of assets and expedient transfer from the scene to treatment facilities, 22 of the 23 injured patients survived the event. Most notably, the pediatric patient diverted for resuscitation prior to air transport, was successfully treated at the tertiary center and survived all injuries. The compilation of lessons learned contributed to many advancements in the region including the widespread teaching of the ACS COT sponsored Stop the Bleed® course and the creation of a large scale, prehospital whole blood resuscitation program [20].

Conclusion

The keys to the success of any disaster management program are the identification of vulnerabilities, preparation to address identified weaknesses, and continued education aimed toward risk mitigation. Whether accomplished through mass education, hands-on training, emergency services integration, or simple communication, a comprehensive disaster management plan can help even the most remote regions to succeed under duress.

Take Home Points

- A robust disaster response begins with extensive preparation through preventative measures. In conjunction with these preventative measures, risk mitigation develops plans to prevent the unnecessary loss of life or property. Preparation, the final phase before the actual disaster event, enacts the actual mitigation measures identified in previous steps.
- The response phase, the first portion to take place after the actual event, focuses on addressing the actual threats and protecting public interests. In this phase, the Emergency Operations Center and Incident Command System establish a chain of command. Lines of communication are created, human casualties undergo triage and assets are dispersed in the most effective manner possible to treat all those in need.
- After the conclusion of the immediate response, the community as a whole begins to rebuild, and new opportunities for change are identified. With recovery, the cycle continues as lessons learned from the prior incident drive future prevention, mitigation, and preparation efforts.

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