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British Journal of Anaesthesia, 128 (2): e104–e108 (2022)

doi: [10.1016/j.bja.2021.11.012](https://doi.org/10.1016/j.bja.2021.11.012)

Advance Access Publication Date: 15 November 2021

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## Preparing for mass casualty events despite COVID-19

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### Summary

Preparedness for mass casualty events is essential at local, national, and global levels. Much more needs to be done by all stakeholders to avoid unnecessary morbidity and mortality despite the challenges that COVID-19 continues to present. In this editorial, we highlight the challenges and solutions for mass casualty incident preparations.

**Keywords:** communication; mass casualty incidents; resource allocation; surge capacity; triage

Mass casualty events (MCEs) are defined as incidents where the number of victims exceeds local treatment capacity. While healthcare systems must deal with challenges and changes hitherto unknown as a result of COVID-19, the level of preparedness for MCEs must remain high. Data from the 2021 European Union Terrorism Situation and Trend Report suggest that the incidence of terrorism-related MCEs remains steady in comparison to previous years.<sup>1</sup> Similarly, data from the United States show that the once gradual nationwide increase in the incidence of mass shootings over the past three decades has increased significantly since the start of the pandemic.<sup>2</sup> These trends probably reflect the ever-changing political, economic, and societal factors that serve, in part, as the catalyst of manmade MCEs. However, when and where they occur remain largely unpredictable.

Four stages which must take place during patient triage and treatment to ensure that medical facilities can return to normal function after an MCE have been described: guaranteeing the safety of patients and staff members; gradual resumption of immobilised hospital functions; establishment of external support; and creation of long-term medical services.<sup>3</sup> Although international guidelines that detail the planning requirements for MCE are widely available,<sup>4</sup> such guidelines often fail to include preparation for long-term healthcare demands in the wake of such events. Rather, they tend to focus on resuscitation and damage control in the first 24 hours after the event or disaster.

Further limiting set guidelines is the diverse nature of MCE and the variability of the geographical locations in which they occur. For instance, in the United States, 60.9% of all MCEs occur in urban settings and only 16.6% in rural areas.<sup>5</sup> Conversely, in Korea, only 30.4% of MCEs occur in urban areas and the remainder occur in rural locations.<sup>6</sup> Preparation for MCEs must take into account these differences and

therefore planning should focus on common themes and limitations (the 'all hazards approach'). The principles underlying this approach and the existing gaps in preparedness despite this approach are discussed below.

### Equipment and consumables

Equipment and consumable availability have always been central to MCE planning. Hospitals may be reluctant to purchase such resources, as it is financially burdensome and does not deliver objective and measurable benefits.<sup>7</sup> Implementation of standard operating procedures or universal guidelines may be a reasonable solution to this problem by improving cost-effectiveness. An alternative approach is regional rather than local stockpiling. For instance, in parts of the United States, regional facilities have been developed that can deliver equipment within 12 hours if needed. However, a survey of the equipment stored in such facilities found half missing or unusable.<sup>8</sup> This highlights that stockpiling does not ensure that adequate supplies will be available at a time of need. Constant efforts are required to reassess the content of stored supplies and ensure that they are indeed suitable for use and ready for immediate deployment. Moreover, regionalisation of storage facilities is reliant upon robust contingency plans to ensure supply deployment.

No less important is the ability to identify the supplies most likely to be required. Most equipment and consumables prepared for MCEs will vary depending on the services that they are designed to provide for and the events or natural disasters most likely to occur locally. However, some of the equipment required may be trivialised or taken for granted and therefore overlooked. For example, during hurricane Sandy the most needed equipment by staff involved in the evacuation of hospitals was flashlights.<sup>9</sup> Shortages in basic supplies such as oxygen, electricity, and water have also been described after MCEs. Simulations of MCEs may point to resources otherwise overlooked and are useful for revising supply lists.

Supply shortages may be compounded when operational and logistical support cannot be maintained. This typically occurs during natural disasters because of concurrent damage to infrastructure and during pandemics because of their prolonged nature. For manmade MCEs, data from both developed<sup>10</sup> and less developed countries<sup>11</sup> suggest that emergency department and hospital supplies often suffice for the initial 72 hours after the event. In this issue of the *British Journal of Anaesthesia*, Tallach and colleagues<sup>12</sup> report that clinicians involved in MCEs rarely felt that physical resources were a rate-limiting factor in provision of treatment.

## Transport

In the setting of MCEs, transport both *into* and *out from* the hospital must be planned. Transport routes should be devised based on the assumption of bidirectional movement, and flow in one direction should not hinder the other.

### Transport into the hospital

Timely prehospital treatment of patients involved in MCEs has been shown to correlate with improved outcomes.<sup>13</sup> Prior experience reveals that when more than one hospital is available, the key factor determining hospital selection is not only specific expertise but also proximity to the scene, as this affords the emergency response teams a shorter return trip to the location of the MCE. Distribution of patients between multiple hospitals also increases overall system surge capacity, as individual centres are more likely to maintain a higher standard of care when they are not inundated.

In some MCEs dispersal of patients from the scene of the incident may be limited because of the destruction of transportation routes, self-evacuation, safety concerns, and traffic bottlenecks. Therefore, transport decisions need to be dynamic and factor in robust communication networks between hospitals, police and appropriate tiers of government. When land routes are unavailable, air transport may be utilised. Although this mode of transportation is resource and time consuming, if air transport is readily available it can support speedy evacuation to an appropriate centre.

Another key aspect of transport to and from the hospital is effective triage. Whilst under-triage (which typically occurs in female and older patients) is associated with missed injuries, over-triage can lead to hospital inundation with a resultant increase in morbidity and mortality.<sup>14</sup> Multiple triage methods have been studied with some performing better than others during an MCE.<sup>15</sup> Regardless of the method used, the most important aspect of triage is repetition. Repeated assessment and reporting on the condition of each patient by an appropriately trained medical professional can improve not only patient outcomes, but also overall hospital performance during MCEs.

The most challenging aspect of triage in MCEs is expectant care. Expectant care is instrumental in preventing limited resources from being diverted towards patients with a low likelihood of benefit in whom attempted rescue may be too resource consuming at a time of shortage. For clinicians used to investing fully in each individual patient, to accept the reality of triage and expectant care requires mental preparation, training and an ethical framework.

### Transport from the hospital

Patients may need to be evacuated or transferred to alternative facilities for several reasons. These include damage to vital hospital infrastructure, insufficient beds (termed 'leap-frogging'), or to receive services better suited to individual patient needs. Such patient movements include planned transfer after initial stabilisation and urgent evacuation of unstable patients as a result of insufficient resources. Both situations require advance planning.

A written plan for urgent evacuations can mitigate real-time disagreement between treating physicians regarding evacuation priorities. Such discrepancies do occur and harm efficiency at times of great need. For instance, during hurricane Sandy 'processes were inconsistent for patient prioritisation'.<sup>9</sup> Such plans should also include whether staff are needed to accompany the patient, what equipment is required, and movement pathways within the facility.

The cost of creating a system that encourages movement between facilities is that inter-hospital transfers are both staff and resource dependent. Redundancy is thus needed within hospitals and emergency services to ensure patient movement between facilities does not come at the cost of patient care at either the sending or receiving hospital. Also included in patient transfer is the need to transmit data between treating sites. This includes patient characteristics data and family contact numbers, and results and treatments provided thus far. Electronic systems have been found to contain 25% fewer mistakes than handwritten medical records in the mass casualty setting.<sup>16</sup> This suggests a preference should be made towards using electronic charts when possible. However, an alternative manual method must always be available in case either internet access or compatible interfaces are unavailable.

## Hospital capacity

Planning for MCEs increases early hospital surge capacity, thereby avoiding unnecessary morbidity and mortality early in the response to an MCE. Less sick patients often arrive to the hospital before those who suffered more significant injuries. Such patients may inundate the emergency department if they are not triaged appropriately and sent to alternative treatment areas. Moreover, hospitals should have a contingency plan to ensure appropriate design and sufficient infrastructure to enable efficient one-way patient flow and prevent delays in treatment. This may require the rapid establishment of temporary treatment areas near or within the hospital providing varying levels of care, and the staff to support them.

Identification of potential bottlenecks in patient flow is also important. Advances in technology can help reduce these, such as improvements in CT imaging modalities that allow quicker transfer and interpretation of cross-sectional imaging.<sup>17</sup> Establishment of patient tracking systems within the hospital can also aid with patient flow.

After the initial surge, for those patients who have been appropriately triaged, investigated, and treated, access to an appropriate level of care can be challenging. Ward beds may be full, operating theatres occupied, and limited beds available in the Intensive Care Unit (ICU). Therefore, early involvement of ward and ICU staff is vital to ensure that additional beds and critical care capacity are made available, where possible, for incoming patients.

## Training, education, and debriefing

As MCEs occur without warning, adequate preparation requires prior staff training and education. Events that have occurred should also be seen as an opportunity for improving training and preparation.

### Training and education

Based on citations from experts who have participated in terror-related multiple casualty incidents, Tallach and colleagues<sup>12</sup> highlight the need for 'education on specific injuries, revision of plans, and exercises'. Lack of immediately available clinical protocols to deal with unique and specific injuries has also been noted as a major area of vulnerability.<sup>18</sup> As physicians and surgeons increasingly subspecialise, they may struggle to treat the wide range of injuries faced in MCEs. The combined effort of multiple specialists is therefore a prerequisite for effective management of patients during MCEs. For this reason, transdisciplinary education, which increases depth, breadth, and integration of knowledge, should be the focus of mass casualty training. Such training encourages shared decision making that transcends different disciplines. This is particularly pertinent with regards to the concept of expectant care described above.

A large part of preparing staff revolves around simulation-based training. Such training is not only essential for preparation, but also for the identification of service deficiencies. What makes such training particularly attractive is its positive impact on non-disaster-related daily operations.<sup>19</sup>

### Debriefing

Debriefing after MCEs is important for learning and highlighting deficiencies in care. Open discussion of such deficiencies is only possible in a culture of non-blame. Although compulsory debriefing sessions are unlikely to reduce the incidence of participant post-traumatic stress disorder,<sup>20</sup> such sessions may improve future clinical outcomes.<sup>21</sup>

Despite this documented benefit, only 9.5–62% of hospitals have post-disaster recovery assistance programs available, including counselling and support services.<sup>10,22</sup> Although compulsory programs may not be needed, counselling and support programs are vital to ensure the short- and long-term recovery of staff who are in need, particularly as subsequent MCEs could generate cumulative psychological trauma. Ultimately the resource consistently most difficult to cultivate and yet most commonly needed in every MCE is trained and experienced healthcare staff.

### Command and control

Although education is key, 'systemic learning is hindered by mismatches between top-down steering and bottom-up initiatives'.<sup>23</sup> Therefore, it is vital that strict command and control mechanisms are designed *a priori* and rigorously implemented and adhered to during MCEs.

The implementation of command and control mechanisms is particularly pertinent as, unfortunately, many plans and training exercises involve only the emergency department. It is imperative to include the hospital as a whole in preparation for MCEs as departments not trained in the management of trauma and mass casualty patient pathways consistently become key stakeholders in patient care. In the hours and days

after an MCE, resource consumption transitions from the emergency department to the operating theatre, ICU, and then to the wards. This results in a significant reduction in routine hospital function in the days and weeks after an MCE.

Prolonged system overload negatively affects the care for patients not directly involved in the MCE for a variety of reasons. Elective care may be temporarily suspended, even at the cost of potential lost income to the treating facilities. Therefore, command and control plans must include contingency to prioritise care for patients requiring urgent treatment who are not casualties of the event. One solution is to utilise a 'backdoor' policy for non-MCE patients who occupy critical beds and are sufficiently stable such that they can be transferred to alternative healthcare facilities.

As this requires that planning extend beyond the hospital, management of MCEs should ideally be centralised. Only via a centralised route can a common understanding of responsibility be developed, encouraging the sharing of information with a view to improving the short- and long-term medical response.

This drive to centralisation must not come at the expense of local preparedness. Whilst MCEs may best lend themselves to a hub-and-spoke model of patient care and decision making, such events can occur anywhere in the world. If lines of communication and transport are disrupted, any facility can become the centre of that hub, and as such, should be suitably prepared to function in that demanding capacity. Therefore, the requirement to be prepared is as poignant in an urban centre in the developed world as it is in a rural centre in the developing world.

### Communication

Communication, both within and outside the hospital, has been cited as a major barrier to effective patient care in MCEs. For example, after hurricane Sandy, 43% of physicians interviewed identified communication as the key barrier to effective patient evacuation, and 25% of respondents put walkie-talkies/phones on their equipment wish list.<sup>9</sup> Other studies have similarly revealed that communication, coordination, and security procedures were more of a barrier to care than the availability of physical resources.<sup>12</sup> Communication outside the hospital must be bottom up and top down. The former includes emergency, police, and fire services, whereas the latter concerns other medical facilities, governmental organisations, media outlets and the public. In both the developed and developing world, communications networks must engage with non-governmental organisations as they will become important stakeholders in patient care. These communication links need to be robust, as multiple causes of technical failure can occur during MCEs, including overloading of mobile networks, power outages, and internet failure. As these links are integral to maintaining well-structured command and control networks, tiered backup systems must also be prepared.

### The way forward

MCEs are a daunting reality that need to be adequately prepared for by all those who may ultimately be involved. Much remains to be done by doctors and politicians alike in order to ensure an acceptable level of readiness. Despite much discussion in the academic arena on the topic of MCE preparedness, a recent systematic review found that none of the

checklists and tools evaluated included all of the dimensions required for a hospital to be appropriately prepared.<sup>24</sup> Nevertheless, we believe that recent technological developments both related and unrelated to COVID-19 are driving further improvements in both the planning and management of MCEs. Artificial intelligence-based technologies have been used to identify which hospitals should be involved during disasters, to determine dynamic triage policies, and to match patient priority to resource availability.<sup>25</sup> Such developments will ultimately increase our ability to deliver effective and efficient care to patients injured in MCEs.

## Conclusions

Preparedness for MCEs remains essential despite challenges to healthcare systems worldwide. Although guidelines exist, much more needs to be done to ensure an appropriate response such that excess morbidity and mortality can be avoided. Developments in technology should help bridge this void, but much responsibility remains in the hands of physicians, politicians, and healthcare managers.

## Authors' contributions

Drafting and editing of the manuscript: JT.  
Conceptualisation, editing, critical revision: SE.

## Declarations of interest

JT received a travel grant of \$4000 from Medtronic and receives ongoing consultancy payments from Google. SE is a Cochrane editor and editor for *Intensive Care Medicine*, has received funding for travel, given lectures, owns patents with, or performed consultancy work for Zoll, Medtronic, and Diasorin, and has participated in multicentre trials run by Artisan Pharma, Eisai, and AstraZeneca.

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