



HAL
open science

Learning from terrorist mass casualty incidents: a global survey

Rosel Tallach, Sharon Einav, Karim Brohi, Kirthi Abayajeewa, Paer-Sellim Abback, Chris Aylwin, Nicola Batrick, Mathieu Boutonnet, Michael Cheatham, Fabrice Cook, et al.

► To cite this version:

Rosel Tallach, Sharon Einav, Karim Brohi, Kirthi Abayajeewa, Paer-Sellim Abback, et al.. Learning from terrorist mass casualty incidents: a global survey. *British Journal of Anaesthesia*, 2022, 128 (2), pp.e168-e179. 10.1016/j.bja.2021.10.003 . hal-04015186

HAL Id: hal-04015186

<https://hal.science/hal-04015186>

Submitted on 12 Mar 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Learning from terrorist incidents: A global survey

GIMLi (Global Initiative for MCI Learning) Collaborative

Authors:

Rosel Tallach^{*1, 2}, Sharon Einav³, Karim Brohi¹, Kirthi Abayajeewa⁴, Paer-Sellim Abback⁵, Chris Aylwin⁶, Nicola Batrick⁶, Mathieu Boutonnet⁷, Michael Cheatham⁸, Fabrice Cook⁹, Sonja Curac¹⁰, Stephanie Davidson¹¹, Hilary Eason¹², Nick Fiore¹³, Christine Gaarder¹⁴, Sanjeewa Garusinghe⁴, Eric Goralnick¹⁵, David Grimaldi¹⁰, Kritaya Kritayakirana¹⁶, Jacques Levraut¹⁷, Tobias Lindner¹⁸, Sven Mårdian¹⁸, Ashley Padayachee¹⁹, Sabeena Qureshi⁶, Suneil Ramessur²⁰, Mathieu Raux²¹, Amila Ratnayake²², Michael Römer¹⁸, Hobnojit Roy²³, Eunice Tole²⁴, Sheila Tose²⁵, Fernando Turégano Fuentes²⁶, Tobias Gauss²⁷

*Corresponding author: rosel.tallach1@nhs.scot

1 Royal London Hospital, London, UK

2 Raigmore Hospital, Inverness, UK

3 Shaare Zedek Medical Center, Jerusalem, Israel

4 National Hospital of Sri Lanka, Colombo, Sri Lanka

5 Hôpital Beaujon, AP-HP, Clichy, France

6 St Mary's Hospital, London, UK

7 Hôpital Instructions des Armées Percy, Paris, France

8 Orlando Regional Medical Center, Orlando, Florida, USA

9 Hôpital Mondor, AP-HP, Paris, France

10 Erasme Hospital, Brussels, Belgium

11 Sunrise Hospital and Medical Centre, Las Vegas, Nevada, USA

12 Royal Manchester Children's Hospital, Manchester, UK

13 Sunrise Children's Hospital, Las Vegas, Nevada, USA

14 Oslo University Hospital, Oslo, Norway

15 Brigham and Women's Hospital, Boston, Massachusetts, USA

16 King Chulalongkorn Memorial Hospital, Bangkok, Thailand

17 Centre Hospitalier Universitaire de Nice, France

18 Charite Universitätsmedizin, Berlin, Germany

19 Christchurch Hospital, Christchurch, New Zealand

20 St Thomas' Hospital, London, UK

21Pitié-Salpêtrière, AP-HP, Paris, France

22 Military Hospital Narahenpita, Colombo, Sri Lanka

23 BARC Hospital, Mumbai, India

24 Aga Khan University Hospital, Nairobi, Kenya

25 Salford Royal Foundation Trust Hospital, Manchester, UK

26 Gregorio Marañón University General Hospital, Madrid, Spain

27 Hôpital Beaujon, AP-HP, Clichy, France

Drs Tallach and Gauss proposed the concept, composed the surveys, analysed the results and co-authored the paper. Professors Einav and Brohi advised on content and presentation. All other authors contributed to the first and second questionnaires, as well as reviewing and commenting on the draft manuscripts, and are listed in alphabetical order.

Abstract

Introduction: Reports published directly after Terrorist Mass Casualty Incidents (TMCI) tend to be positive and may fail to examine difficulties encountered. An anonymised platform may enable discussion and collaboration on the challenges faced. Our aim was to identify where to focus improvement for future response.

Methods: We conducted a mixed methods analysis of clinicians' experiences of leading during a TMCI. Initial contact and correspondence were by email. An initial questionnaire asked about what worked well, what didn't work, what were the ongoing challenges and any implemented changes. A qualitative analysis of these responses was followed by a second questionnaire with Likert questions derived from elicited themes.

Results: 33 participants responded from 22 hospitals who had received casualties from a terrorist incident, representing 17 cities across low-middle to high-income countries.

Our thematic analysis elicited themes of sufficient – sometimes abundant- human resource although coordination of staff presentation was a significant challenge. Difficulties highlighted were communication, coordination, security procedures and management of blast injuries. These were seen as rate limiting ahead of consumption of physical resource. Highest implemented changes were education on specific injuries, revision of plans, and exercises. Persisting challenges were lack of time allocated to training or psychological wellbeing. The follow-up Likert questionnaire demonstrated highest agreement on the need for re-triage at hospital (90%), coordination roles (85%), need for flexibility (100%) and the benefit of large-scale exercises (95%).

Conclusion: The significant outcome was a focus on organisation of human response, not on consumption of physical supplies.

Introduction

A mass casualty incident (MCI) has the capacity to overwhelm the resources available.¹ When the cause is a terrorist event, or deliberate acts of violence, the profound desire is to show that the response was more than capable of caring for the injured, that 'good' was able to triumph over 'evil'.² When such emotive language is employed, it is difficult for organisations to objectively analyse their response and to embed improvements should such an event ever occur again. Indeed, hospital officials have been criticised for not admitting that the care of casualties at their institution was anything less than optimal.³

The rarity of terrorist MCIs (TMCI) also means that maintenance of preparedness is not prioritised where budgets are increasingly stretched.⁴ When there is minimal critique of real-life response, then resources will be prioritised elsewhere. The significant impact of TMCI on the patients themselves, on the receiving institutions and on society prompt examination of the potential to respond, but real incidents may highlight problems not foreseen by untested plans.

While learning points published in the immediate aftermath of an event help other hospitals understand what to expect and therefore improve their own preparedness,⁵⁻⁸ exploring the challenges may require the anonymity of a collaborative safe space. Additionally, review can occur of whether problems identified at the time have been rectified. In this study we aimed to provide realistic and robust evidence of where to focus attention in the intrahospital response to TMCI, which has not received as much attention as the prehospital arena, based on broad and anonymised clinician experience. We hypothesized that collaborative anonymity would enable clinicians to express critical views and describe experiences otherwise considered too sensitive.

Methods

We report the results of this two-staged mixed methods study in accordance with Standards for Reporting Qualitative Research (SRQR) recommendations.⁹ The initial open response survey used thematic analysis to identify codes and themes. These themes informed a second quantitative survey to measure response agreement within each of the themes. The surveys were focussed on physicians' observations regarding service provision during a TMCI. Feedback was invited from a variety of healthcare systems.

Ethics

This was an anonymised service evaluation survey without patient identifiable data. The Institutional Review Board (IRB) of the French Society of Anaesthesia and Critical Care raised no ethical issues regarding the research protocol (IRB approval number 00010254---2021_009). The study was also registered in the United Kingdom (NHS Clinical Effectiveness Unit project registration number 2020/21 – 036).

Participant contact

Participants were physicians who had played a leadership role in their hospital's response to a TMCI. The physicians were identified via conference networking (5), contacts made via the International Masters in Trauma Science programme based at Queen Mary University, London (QMUL) (4), onwards contact from initial participants (4), already established contacts in mass casualty planning (10), and through literature searches (10). This relatively restricted sample was contacted for the qualitative insight they could contribute, rather than aiming for a large sample size.¹⁰ Efforts to limit bias were by inviting responses from a variety of healthcare systems, by revisiting the raw data on each round of thematic analysis, and returning elicited themes to all participants to verify authenticity.

Inclusion / Exclusion

Participants were clinicians from any institution known to have received patients from a TMCI within the last 15 years. Contact was made with clinicians from any discipline from low-middle-income countries (LMIC), upper-middle-income countries (UMIC) and high-income countries (HIC).¹¹

Exclusion criteria pertained to MCIs not caused by acts of terror; such as natural disasters, pandemics, or building collapse as it was hypothesized that these could result in a different time scale, needs, and emotional response from responding clinicians. Countries with ongoing conflict sufficient to affect their healthcare infrastructure and low-income-countries (LIC) were excluded as the baseline setting in which care could be provided was already precarious. Finally, we restricted the sample to clinicians to focus on one facet of TMCI response.

Survey structure

a) First survey

The first survey (Table 1) was emailed to participants between August 2019 and October 2020. We opted for open questions so as to allow respondents to express their own priorities. The main focus of questions was the incident response: what worked well; what did not work; had changes been implemented and what challenges remained. The questionnaire was kept simple to optimise response rates.

b) Second survey

After qualitative analysis of the first survey, the revealed themes were used to build a structured online questionnaire to confirm if we had accurately captured the priorities of the participants. This was sent to all respondents to the initial survey, distributed in November 2020 and was conducted using a Google Survey form, responses therefore being anonymous to the reviewers. Responses were expressed on a Likert scale with values between 1-10.

Data analysis

The responses to the first survey were examined independently by the two lead authors (Anaesthetist in the UK; intensive care physician in France) who had themselves been involved in leadership roles in TMCI. They conferred following repeated rounds of coding to agree on identified themes, these themes then reappraised by revisiting the original raw data. Following Braun and Clarke's model of thematic analysis,¹² these themes were explored to exhaustion, where no new themes could be elicited on further rounds of

revisiting the raw responses. Participants were then invited to review and comment on the extracted themes.

Responses to the Likert scale were classified as follows: 1-3 correspond to *NO*, 4-6 correspond to *MAYBE*, 7-10 to *YES*. A strong agreement was defined as more than 70% of respondents providing the same answer.¹³

Results

Of the 27 clinicians approached, 22 responded (81%). This represented 20 mass casualty incidents in 17 cities between 2004 and 2017 (Table 2). In 7 cases, collated responses from various roles were received from a single institution. 100% of first-round respondents also completed the second-round questionnaire. Respondents were from emergency medicine (5), adult and paediatric anaesthesia (11), adult and paediatric surgery (10), intensive care (5), emergency planner (1) and operating theatre co-ordinator (1).

Themes elicited from first survey (Table 3)

Surge capacity can be defined as having the staff, stuff, structure and systems to provide care despite a sudden or excessive rise in demand.¹⁴ The following themes that arose are presented within the context of these three topics.

- **Staff**

Staff call-in systems were secondary to social media

While some hospitals operated simple phone lists to call in staff, these were cumbersome and slow. Other hospitals had automated call-in systems dedicated to call in large numbers of staff for such an emergency, but these were either not activated, activated the entire system, or activated too late. What was found to be useful was social media and group messaging systems.

“Our Mass Casualty activation protocol was slow to be enacted. - Word of mouth and social media spread the news faster. Almost a year later no clear pathway exists.”

“Full activation of all locations... - 4 locations, 20,000 employees.”

Considerable human resource – but in need of coordination

The most frequently mentioned positive theme was mobilisation of human resource. The rapid, spontaneous, sometimes unsolicited attendance of off-duty staff was frequently referenced.

“Many good Samaritan medical professionals came to the hospital once the news was noticed. (Mass casualty protocol was not activated)”

“It was inspiring to see how many healthcare providers showed up to help. Surgeons, nurses, anaesthesia providers, technicians, cleaning crews. Even providers from other states.”

However, this enthusiastic volunteer workforce in itself was identified as a hinderance as the rapid influx of staff eager to help required coordination and direction.

“The hallmark of response was rapid congregation of an overwhelming number of staff... This resulted in unhindered health care support as well as aggregation of unskilled bystanders overcrowding the premises.”

“Lots of doctors responded resulting in a lot of waiting around– many were not given anything to do but were not sent home because of rumours of more casualties.”

Coordination was a significant focus in responses to all domains (what worked well, what didn't work, implemented change and persisting challenge). Identified assets were leadership, clearly defined roles, trusted relationships and practiced plans. Themes around implemented changes identified work applied to clarifying roles.

“Several of the strategies used were not in the existing MCI plan, but was dependent on the leaders present.”

“Task cards - All departments (now) have individual task cards on the response needed.”

Unfamiliarity with profile of injuries in a civilian context

Even for staff accustomed to damage control procedures, the profile of injuries from incidents involving ballistics and blast was unfamiliar to many. Some participants working in paediatric or adult hospitals had to deal with complex injuries in an unfamiliar age range.

“LIMITED EXPERIENCE. Paediatric trauma is rare let alone mass casualty scenarios.”

“There was a degree of unfamiliarity with the management of blast injuries and wounds caused by shrapnel. These types of injuries are unusual in the civilian population and we lacked the necessary experience and expertise in dealing with these injuries. “

“The paediatric hospital had to manage the care of seriously wounded adults (evacuated by relatives), which put them in great difficulty.”

Training

Training for MCIs was recognised as necessary, whether by table-top exercises, leadership training, focused drills or larger scale simulations. However, many were frustrated by their organisation’s resistance to prioritising it.

“There is only training at the prehospital level, but not in-hospital.”

“It was at times hard to get staff released to attend the training sessions. This improved as the number of incidents increased.”

Participants who had taken part in pre-existing training exercises positively identified these as having helped in their response.

“The response did not occur in a vacuum. The training and drills... allowed the trauma teams to practice...with the same multidisciplinary communication and team-based approach.”

Military collaborative / previous experience is invaluable

The underrepresentation of ballistics and blast injuries in routine civilian trauma was identified as a persisting challenge to good care in TMCI, although some institutions retained these skills amongst their own staff due to repeated MCIs. Identified means of managing this deficit were to draw on regionally available military personnel, as well as educating surgical and anaesthetic staff on the nature of these injuries.

“Most consultants (have) more than 10 to 15 years of experience and specifically experienced in managing blast related MCI due to (previous) bomb attacks in public places.”

“Damage Control Surgery principles were not followed with the first few patients – following advice from the military this changed for subsequent operations.”

“A multidisciplinary team with military experience came two days after the incident and were of immense help but it would have been useful to have had them there 24 hours earlier”

Psychological safety

While some reported a positive initial boost from having provided good care under extreme circumstances the theme returned to systemic underappreciation of the psychological impact of witnessing such trauma.

“We continue to have staff who are receiving regular counselling while a few have left healthcare altogether.”

“It is unavoidable to experience anger towards the absurdity of the tragedy.”

“The neuropsychology team... did not feel they were adequately trained to provide psychological debriefing sessions for the staff involved. We (now) have a dedicated psychologist for major trauma who has undergone additional training to support hospital staff involved in the response to a major incident.”

The Likert survey revealed that only 22% of our responding clinicians worked in hospitals with proactive psychological support, and steps to relieve psychological burden on health professionals after an MCI was available to only 36%.

- **Structure And Systems**

Security

Participants reported lack of lockdown (single hospital entry point protected by security staff)¹⁵ and fear of or rumour of secondary attacks within the hospitals. This was despite all hospitals having a plan for hospital protection during an MCI.

“Security did attend ED but did not secure the other entrances. We just had to put that to the back of our minds and deal with the patients in front of us.”

Only one hospital, due to its proximity to governmental buildings reported that their security procedures were effective.

“The lockdown process was extremely efficient. Security staff are well drilled.”

Necessity of Triage

Triage is derived from the French verb, “trier” meaning “to sort” and in MCI management conveys the model of allocating resources for arriving patients.¹⁶ Responses from systems that ordinarily rely on pre-hospital triage found that in a TMCI many patients were conveyed by bystanders and therefore by-passed pre-hospital triage.

“[Hospital] triage made it possible to assess patients arriving very quickly - accompanied by relatives - and those evacuated immediately who could not be triaged in the field.”

This element of having to initiate primary triage at the doors of the hospital was also referenced by those where pre-hospital triage is not embedded.

“Only 20% of arriving casualties required immediate medical treatment, as there was no prehospital triage. On the downside, there was overcrowding at the casualty.”

The centrality of hospital triage to the subsequent success of the response was underlined by it being the focus of implemented changes with training, tools, and space allocated in revised plans.

Communication difficulties

Communication is essential but was frequently identified as being sub-optimal. The paucity of information from the scene hampered preparation in the hospital. Communication within the hospital was difficult between different areas and made significantly harder by repeated handovers.

“All communications with the scene had failed. Cellular networks crashed and (we had) no information about the number of expected casualties”

“Initial team handed over care to theatre and then moved on to the next patient – huge drain on that team and information lost in handover.”

“Multiple specialties operating on patients but priorities not identified and communication between surgical specialties and to/from anaesthetists was not optimal.”

Some centres – notably who had recently participated in MCI simulations, identified good communication:

“All communication regarding the need for critical care admission or the need to go directly to theatre from ED was between three key individuals. This proved to be highly effective

with clear communication and the avoidance of confusion which was crucial as all patients had the same mechanism of injury and some were only identified by a hospital number in the initial period.”

Information systems

Tracking patients was a problem for all; LMI countries did not have ready access to pre-populated documentation, and high- income countries relying on electronic systems found they failed to keep up with the surge in casualties. Respondents were divided on the solution to this problem. Paper based systems were slightly more favoured during initial stages but created problems later in integrating with usual hospital information systems. The continuity of care provided by at least one healthcare provider remaining with the patient throughout was a common positive theme.

“The electronic health record was rendered useless and 1 to 1 continuous nursing was essential... Information was written on paper, scraps of paper, bed sheets, and even tape on patient’s bodies as the medical record.”

“Information systems were the universal bottleneck to timely, safe care”

- **Stuff**

Equipment

Consumption of physical resource was seldom mentioned in participants responses, including from LMIC. Where it was referenced, it was in conjunction with organisation and training of staff, which remained the overarching determinant:

“We could not move our echograph across patients [because] we did not succeed to avoid to have too much people in the trauma bay.”

“...a surgical tray containing instruments defined by experts was developed...Surgeons need to be trained in dealing with this sort of trauma in civilian life.”

“Despite being already above capacity, ICU and HDU beds cleared in an hour by critical care consultant and nursing team.”

Quantitative analysis of second consolidation survey (Table 4)

The follow-up Likert questionnaire confirmed the themes identified by demonstrating highest agreement on the need for re-triage at hospital (90%), coordination roles (85%), requirement for flexibility (100%) and the benefit of large-scale exercises (95%). The most refuted questions referred to whether surgical equipment ('No' 75%), blood ('No' 70%) or beds ('No' 70%) had been a limiting factor.

Discussion

Common to all reflections from the incidents represented in this survey was the focus on human resource, not space or supplies. The results show a very high level of agreement on the organisational themes of: communication, leadership, triage, coordination, flexibility, and training. The absence of leadership, lack of triage, crowding of the resuscitation room due to insufficient coordination and perseveration of chaos due to poor communication, all cited as impediments, add weight by the impact of these factors when they are absent.

Surge capacity has been defined simply as the “ability of the health care system to manage patients who require specialized evaluation or interventions”¹⁷ but this does not convey the impact of rapid arrival of critically injured patients, that a hospital may receive in two hours the volume of patients it would normally see in a day. If this number is averaged over the whole incident the intensity of resources required at its peak will be underestimated.⁶ The suddenness of response required by a TMCI is at the sharpest end of any mass casualty response, and therefore represents the harshest environment for rapid organisation.¹⁴

Where many learning points published following TMCI have honoured their staff by celebrating how many responded, our findings suggest that unless this is a well-rehearsed response it is likely to be disorganised. Disorganisation reduces the availability of physical resource and frustrates responders. Even if physical resource and hospital structure were optimally suited to the incident, if the appropriate number of staff are not called in, or are not familiar with mass casualty principles, patient flow and critical interventions will be hindered.

An MCI is an event which has the capacity to overwhelm resources available.¹ This resource is commonly believed to be physical supplies,¹⁸ but while our respondents did mention these, they were not the rate limiting steps. This runs counter to popular public perception. For example, blood transfused following the bombings in London (2005), Madrid (2004) and New York (2001) did not cause supplies to run out.⁶ Blood management practices have changed in the last decade, and the patients cared for following the shootings in Las Vegas in 2017¹⁹ and Christchurch in 2019²⁰ received a greater proportion of blood products, yet blood delivery was still found to be competent. Perceived delay or lack of availability of

human resource is also a common concern.²¹ Our results show that human resource is likely to be plentiful, but it is imperative that it is trained, coordinated and directed.

This priority of an efficient and effective human resource – “staff” - and the secondary or delayed importance of “stuff”²² warrant a reorientation of attention.

Training has consistently been identified as advantageous in mass casualty response,²³⁻²⁵ has consistently been called for following MCIs²⁶⁻²⁸ and yet fails to consistently reach the very people who are required to respond.² Frequent drills and familiarisations were fundamental to the calmness and efficiency of response of military personnel to the bombing of the Civilian Aviation Authority in Beirut,²⁹ but comment is made that this is harder to prioritise in the civilian context and our survey results corroborate this. Despite being centres that have experienced MCIs, all of whom attest to the advantages gained by training, 36% still underwent no regular training following the incident. A survey conducted of Canadian trauma centres³⁰ revealed that 43% had not run a drill in the last two years. In Norwegian trauma centres only 63% of surgeons and anaesthetists (53% at non-trauma centres) had ever participated in an MCI exercise,³¹ and mass casualty training may not be prioritised in LMIC due to perceived lack of cost effectiveness in an already constrained system.³² Given the universal emphasis in our survey on coordinated human resource, deliberate safeguarding of time allocated to practice and maintain familiarity must be ensured.

Challenging communication was a major theme in our survey, citing problems with handovers between disparate areas and the systems used. Good communication should be striven for and innovative, ‘low-tech’ solutions may be required, but realising this is a common failing during MCIs may assist clinicians by resetting expectations, encouraging decision-making when information is sufficient but not perfect, and therefore maintaining forward momentum.³³ Rather than frustration at the failure of targeted innovations, future attention as to how to harness the universal availability of social media may contain an already present solution.

How to gain expertise in blast injuries remains a challenge when these injuries are rare in civilian experience outside of conflict zones.^{27,34-36} The results of our survey would recommend integration of military expertise into services at a regional level, the creation of

advisory roles for senior trauma physicians allowing for early accurate decision-making during a TMCI; and education and training in blast injury management.

Psychological support for staff responding to attacks cannot be overlooked.³⁷ The degree of psychological distress has been linked to the severity of injury and negative patient outcomes,³⁸ as well as how directly clinicians were affected by the attack itself.^{39,40} Embedding psychological support proactively rather than reactively would promote healthy coping strategies and mitigate moral injury.⁴¹

Our findings are in contrast to the results of another international survey looking at preparedness of 69 major trauma centres for *potential* MCIs, most of whom had not experienced an MCI.¹ Their expectations of security, communications, and protected debrief were high, but uncertainty lay with the hospital's surge capacity. Our survey of real response revealed different priorities: surge capacity was found to be mostly capable, but communication, security and debrief in reality mostly fell short of expectations. Facets of this have been mirrored in learning points published from Lebanon,²⁶ South Korea⁴² and the UK²³. This difference in results between theoretical response and actual response demonstrates the importance of open sharing of lived experience. While there is certainly much to identify as exemplary from our participants, what sets this contribution to the literature apart is the transparency on factors that are not often discussed – i.e. what did not go well and what are ongoing concerns. We suggest this openness from our participants on impediments is due to collaborative anonymity and is the reason we have distilled such an emphasis on human factors.

Extrapolation to other types of Mass Casualty Incident

While the shape of response to a TMCI is one of the most acute requirements for hospital emergency readiness, the lessons identified can be extrapolated to other types of MCI.¹⁴ The principals identified here of training, familiarity, flexibility, triage, coordination and investment in psychological health are principles that pertain to all MCIs, although on a different timescale. The pre-eminence of staff over equipment has also been highlighted in analysis of COVID response.⁴³ The anger expressed at the “absurdity of the tragedy” has

similarly been witnessed in other MCIs.^{44,45} Although our study was focussed on TMCI these similarities suggest the foundational principles may apply across the board.

Strengths

This is a survey of lived experience from physicians who have responded to terrorist incidents, not theoretical pontification. While this is not the first study to attempt global collaboration^{1,28} it has considerable strength in its scope across economic income, and size and type of incident.

Limitations

While the number of our participants was relatively small, we were able to gain fruitful insight by using qualitative analysis. Analysis by two physicians, who themselves had responded to MCIs could incur more bias than had the themes been analysed by independent parties. The independent interrogation by two separate reviewers in different systems was a deliberate mitigation of this internal bias, and triangulation by returning the distilled themes to the participants added authenticity.

We restricted our scope to one particular clinical scenario and did not examine the strategic or Non-Government Organisation (NGO) response. Further research into the response to TMCI in low-income countries, areas of conflict and rural healthcare provision is needed.

Conclusion

The focus of preparation for future TMCIIs should be on staff, rather than on material resources. Improvements in readiness should include optimisation of staff training, alerting and organisation as well as on physical security and psychological support.

Funding and competing interests

No funding was received for this survey and no competing interests were declared by any of the participants.

References

1. Gabbe BJ, Veitch W, Curtis K, et al. Survey of major trauma centre preparedness for mass casualty incidents in Australia, Canada, England and New Zealand. *EClinicalMedicine* 2020; **21**: 100322
2. Stephenson J. UK nurse in Brussels praises 'spectacular' emergency response to terrorist bombing. *Nurs Times* 2016; **112**: 6
3. Hirshberg A, Holcomb JB, Mattox KL. Hospital trauma care in multiple-casualty incidents: a critical view. *Ann Emerg Med* 2001; **37**: 647–52
4. Fisher S, Duniferon N. Hospital preparedness budget cuts could severely impact emergency response [Internet]. Government and Technology; 2014 Mar Available from: <https://www.govtech.com/em/health/Hospital-Preparedness-Program-Budget-Cuts.html>
5. Hirsch M, Carli P, Nizard R, et al. The medical response to multisite terrorist attacks in Paris. *Lancet* 2015; **386**: 2535–8
6. Aylwin CJ, König TC, Brennan NW, et al. Reduction in critical mortality in urban mass casualty incidents: analysis of triage, surge, and resource use after the London bombings on July 7, 2005. *The Lancet* 2006; **368**: 2219–25
7. Davidson S, Dutton R. Lessons learned from a mass casualty incident. *ASA Monitor* 2018; 8–11
8. Moran CG, Webb C, Brohi K, Smith M, Willett K. Lessons in planning from mass casualty events in UK. *BMJ* 2017; j4765
9. O'Brien BC, Harris IB, Beckman TJ, Reed DA, Cook DA. Standards for reporting qualitative research: a synthesis of recommendations. *Acad Med.* 2014;89(9):1245-1251.
10. Côté L, Turgeon J. Appraising qualitative research articles in medicine and medical education. *Medical Teacher* 2005; **27**: 71–5
11. Fantom N, Fu H, Prince W. LICs, LMICs, UMICs, and HICs: classifying economies for analytical purposes [Internet]. Washington DC; 2021 Jun Available from: <https://blogs.worldbank.org/opendata/lics-lmics-umics-and-hics-classifying-economies-analytical-purposes>
12. Braun V, Clarke V. Using thematic analysis in psychology. *Qualitative Research in Psychology* 2006; **3**: 77–101
13. Taylor E. We agree, don't we? The Delphi method for health environments research. *Health environments research and design journal*, 2020, 13(1) 11-23

14. Barbisch DF, Koenig KL. Understanding surge capacity: essential elements. *Acad Emerg Med* 2006; **13**: 1098–102
15. El Sayed, M., Chami, A., & Hitti, E. (2018). Developing a Hospital Disaster Preparedness Plan for Mass Casualty Incidents: Lessons Learned From the Downtown Beirut Bombing. *Disaster Medicine and Public Health Preparedness*, *12*(3), 379-385. doi:10.1017/dmp.2017.83
16. Christian MD. Triage. *Critical Care Clinics* 2019; **35**: 575–89
17. Casani JAP, Romanosky AJ. Surge Capacity. *Disaster Medicine Elsevier*; 2006 [cited 2021 Aug 25]. p. 193–202 Available from: <https://linkinghub.elsevier.com/retrieve/pii/B9780323032537500352>
18. Blimark M, Örténwall P, Lönnroth H, Mattsson P, Boffard KD, Robinson Y. Swedish emergency hospital surgical surge capacity to mass casualty incidents. *Scand J Trauma Resusc Emerg Med* 2020; **28**: 12
19. Lozada MJ, Cai S, Li M, Davidson SL, Nix J, Ramsey G. The Las Vegas mass shooting: An analysis of blood component administration and blood bank donations. *J Trauma Acute Care Surg* 2019; **86**: 128–33
20. Badami KG, Mercer S, Chiu M, Yi M, Warrington S. Analysis of transfusion therapy during the March 2019 mass shooting incident in Christchurch, New Zealand. *Vox Sang* 2020; **115**: 424–32
21. Homier V, Hamad R, Larocque J, Chassé P, Khalil E, Franc JM. A Randomized Trial Comparing Telephone Tree, Text Messaging, and Instant Messaging App for Emergency Department Staff Recall for Disaster Response. *Prehosp Disaster Med* 2018; **33**: 471–7
22. Farmer P. An equation for global health equity, The 2016 Barmes Lecture, National Institute for Health. Vol 25 (1), 2017. <https://irp.nih.gov/catalyst/v25i1/an-equation-for-global-health-equity>.
23. Shirley PJ, Mandersloot G. Clinical review: The role of the intensive care physician in mass casualty incidents: planning, organisation, and leadership. *Critical Care* 2008; **12**: 214
24. Gauss T, Cook F, the Traumabase Group. Keep calm... and prepare. *BMJ Qual Saf* 2017; **26**: 786–7
25. Skryabina EA, Betts N, Reedy G, Riley P, Amlôt R. The role of emergency preparedness exercises in the response to a mass casualty terrorist incident: A mixed methods study. *International Journal of Disaster Risk Reduction* 2020; **46**: 101503

26. El Sayed M, Chami AF, Hitti E. Developing a Hospital Disaster Preparedness Plan for Mass Casualty Incidents: Lessons Learned From the Downtown Beirut Bombing. *Disaster Med Public Health Prep* 2018; **12**: 379–85
27. NHS Confederation. When-tragedy-strikes [Internet]. NHS: NHS; 2018 Jun Available from: <https://www.nhsconfed.org/publications/when-tragedy-strikes>
28. Russo RM, Galante JM, Holcomb JB, et al. Mass casualty events: what to do as the dust settles? *Trauma Surg Acute Care Open* 2018; **3**: e000210
29. Hubbard ZS, Henderson F, Armonda RA, Spiotta AM, Rosenbaum R, Henderson F. The shipboard Beirut terrorist bombing experience: a historical account and recommendations for preparedness in events of mass neurological injuries. *Neurosurg Focus* 2018; **45**: E18
30. Gomez D, Haas B, Ahmed N, Tien H, Nathens A. Disaster preparedness of Canadian trauma centres: the perspective of medical directors of trauma. *Can J Surg* 2011; **54**: 9–16
31. Jørgensen JJ, Monrad-Hansen PW, Gaarder C, Næss PA. Disaster Preparedness Should Represent an Augmentation of the Everyday Trauma System – But Are We Prepared? [Internet]. In Review; 2020 Nov Available from: <https://www.researchsquare.com/article/rs-103685/v1>
32. Khan T, Quintana L, Aguilera S, et al. Global health, global surgery and mass casualties. I. Rationale for integrated mass casualty centres. *BMJ Glob Health* 2019; **4**: e001943
33. Pearce AP, Naumann DN, O'Reilly D. Mission command: applying principles of military leadership to the SARS-CoV-2 (COVID-19) crisis. *BMJ Mil Health* 2021; **167**: 3–4
34. Thompson T, Lyle K, Mullins SH, Dick R, Graham J. A state survey of emergency department preparedness for the care of children in a mass casualty event. *Am J Disaster Med* 2009; **4**: 227–32
35. Dick EA, Ballard M, Alwan-Walker H, et al. Bomb blast imaging: bringing order to chaos. *Clin Radiol* 2018; **73**: 509–16
36. Milwood Hargrave J, Pearce P, Mayhew ER, Bull A, Taylor S. Blast injuries in children: a mixed-methods narrative review. *bmjpo* 2019; **3**: e000452
37. Brooks SK, Dunn R, Amlôt R, Rubin GJ, Greenberg N. Protecting the psychological wellbeing of staff exposed to disaster or emergency at work: a qualitative study. *BMC Psychol* 2019; **7**: 78
38. Caramello V, Bertuzzi L, Ricceri F, et al. The Mass Casualty Incident in Turin, 2017: A Case Study of Disaster Responders' Mental Health in an Italian Level I Hospital. *Disaster med public health prep* 2019; **13**: 880–8

39. Weiniger CF, Shalev AY, Ofek H, Freedman S, Weissman C, Einav S. Posttraumatic stress disorder among hospital surgical physicians exposed to victims of terror: a prospective, controlled questionnaire survey. *J Clin Psychiatry* 2006; **67**: 890–6
40. Einav S, Shalev AY, Ofek H, Freedman S, Matot I, Weiniger CF. Differences in psychological effects in hospital doctors with and without post-traumatic stress disorder. *Br J Psychiatry* 2008; **193**: 165–6
41. Pfefferbaum B, Flynn BW, Schonfeld D, et al. The integration of mental and behavioral health into disaster preparedness, response, and recovery. *Disaster Med Public Health Prep* 2012; **6**: 60–6
42. Cha M-I, Choa M, Kim S, et al. Changes to the Korean Disaster Medical Assistance System After Numerous Multi-casualty Incidents in 2014 and 2015. *Disaster Med Public Health Prep* 2017; **11**: 526–30
43. Vranas KC, Golden SE, Mathews KS, et al. The Influence of the COVID-19 Pandemic on ICU Organization, Care Processes, and Frontline Clinician Experiences: A Qualitative Study. *Chest* 2021; S0012-3692(21)01069-2
44. Brophy JT, Keith MM, Hurley M, McArthur JE. Sacrificed: Ontario Healthcare Workers in the Time of COVID-19. *New Solut* 2021; **30**: 267–81
45. Watt RG. Grenfell Tower fire – a tragic case study in health inequalities. *Br Dent J* 2017; **223**: 478–80