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UK healthcare staff experiences and perceptions of a mass casualty terrorist incident response: a mixed-methods study

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ABSTRACT

Introduction System learning from major incidents is a crucial element of improving preparedness for response to any future incidents. Sharing good practice and limitations stimulates further actions to improve preparedness and prevents duplicating mistakes.
Methods This convergent parallel mixed methods study comprises data from responses to an online survey and individual interviews with healthcare staff who took part in the responses to three terrorist incidents in the UK in 2017 (Westminster Bridge attack, Manchester Arena Bombing and London Bridge attack) to understand limitations in the response and share good practices.
Results The dedication of NHS staff, staff availability and effective team work were the most frequently mentioned enabling factors in the response. Effective coordination between teams and a functional major incident plan facilitated an effective response. Rapid access to blood products, by positioning the blood bank in the ED, treating children and parents together and sharing resources between trauma centres were recognised as very effective innovative practices. Recent health emergency preparedness exercises (HEPEs) were valued for preparing both Trusts and individual staff for the response. Challenges included communication between ambulance services and hospitals, difficulties with patient identification and tracking and managing the return to 'normal' work patterns post event. Lack of immediately available clinical protocols to deal with blast injuries was the most commonly mentioned clinical issue. The need for psychosocial support for responding and supporting staff was identified.
Discussion Between-agencies communication and information sharing appear as the most common recurring problems in mass casualty incidents (MCIs). Recent HEPEs, which allowed teams, interdisciplinary groups, and different agencies to practice responding to similar simulated incidents, were important and informed actions during the real response. Immediate and delayed psychosocial support should be in place for healthcare staff responding to MCIs.

INTRODUCTION

Mass casualty terrorist incidents have sadly become more frequent events in lives of many communities across the globe.[1] In the UK, 2017 witnessed an unprecedented number of terrorist attacks.[2] The Manchester Arena bombing alone left 22 people dead, 116 people required hospital treatment and many more were left with psychological and emotional trauma.[3 4] As of November 2019, the

Key messages

What is already known on this subject
► Previous mass casualty incidents (MCIs) have shown how important factors like teamwork, communication, training and a coordinated response plan can be for an effective response. Thorough analysis of each incident, and subsequent implementation of lessons identified can improve response. First responders' perspectives are often not a focus of postincident research.

What this study adds
► This convergent mixed methods study of front-line staff who responded to three MCIs in the UK in 2017 reinforced the importance of teamwork, communication between individuals, teams and centres, and familiarity and training using the hospital's major incident plan. Staff reported difficulties with obtaining information from the scene, advanced warning and even distribution of patients, lack of protocols for ballistic injuries and a lack of attention to staff psychological needs.

UK threat level from international terrorism was recognised as 'substantial', meaning an attack is likely,[5] thus highlighting the importance of emergency preparedness.

Healthcare services play a crucial part in any mass casualty response and are expected to be ready to provide the best care for casualties. Each mass casualty incident (MCI) is an opportunity to learn as there are always things that worked well and practices that would benefit from further review.[6] Scientific publications providing analysis of medical response to MCIs were acknowledged for having a significant effect on improving medical strategies.[7] By taking into account lessons identified from terrorist attacks in Paris, Boston and Brussels,[7–9] effective initiatives were introduced into the health emergency preparedness system and activities in the UK.[2] Sharing limitations and practices that did not work well stimulates further improvements to prevent duplicating mistakes.[10] Sharing successful practices promotes global collaboration to improve the medical response by adopting best methods for successful outcomes.[1]

Further, healthcare staff are required to participate in mandatory emergency preparedness training

and exercises.[11] Such exercises can validate if lessons from real-life major incidents (MIs) have actually been learnt, as well as help to refine and improve the system in preparation for future incidents. As such, exercises are another crucial component of improving preparedness for MCIs. In the field of emergency preparedness, the lessons learnt approach assumes that learning from experience—both from exercises and previous incidents—improves practice and helps to minimise avoidable deaths.[10]

The evidence-base in the field of emergency preparedness is dominated by data reported from the USA.[12] Sharing experiences of the UK health emergency responders will contribute to the field by providing a UK perspective on the response to a MCI, perceived level of staff emergency preparedness and to determine whether lessons from previous incidents have been addressed. In this study, we aimed to understand the experiences of health staff involved in the response to three MCIs in the UK in 2017 (the Westminster Bridge attack (22 March),[13] the Manchester Arena bombing (22 May)[2] and the London Bridge attack (3 June)),[14] to identify practices that worked well, and determine limitations in the system response that, if addressed, may improve responses to MCIs in the future.

METHODS

As part of a larger convergent parallel mixed methods study health responders to three MCIs in the UK in 2017 (the Westminster Bridge attack,[13] the Manchester Arena bombing[2] and the London Bridge attack[14]) were invited to participate anonymously in an online survey exploring questions about their experiences with the response and aspects of their training that supported and prepared them to respond to those incidents. Participants were then asked to provide their contact details if they were willing to be contacted to participate in additional individual semistructured follow-up phone interviews to explore in depth their experiences with the mass casualty response; those participants who further confirmed their availability for an interview were interviewed. The overall aim of the study was to explore the perceptions and experiences of healthcare staff regarding both individual and system response to a MI, to identify factors which both limited and enhanced their abilities to respond effectively to such an incident, including prior preparedness training. The convergent mixed methods design was chosen to bring together the benefits of a larger sample size allowed by the survey with the depth and breadth of exploration allowed by interviews.[15]

Strand 1: survey

In this convergent mixed methods study,[15 16] data were initially collected by means of an anonymous onine survey of responders to the Westminster Bridge attack, the Manchester Arena bombing and the London Bridge attacks of 2017. Data collection took place during August–December 2017. Healthcare organisations who took part in these responses (Ambulance Services, NHS Trusts, Clinical Commissioning Groups (CCG), NHS England, Public Health England (PHE), NHS Improvement and NHS Mental Health Trusts) were asked to share a link to the online survey with their staff. Healthcare staff who responded to any of these three MIs were eligible to take part in the study. The survey content was designed in consultation with emergency preparedness experts, including PHE and NHS England emergency preparedness specialists, military, clinicians and members of public. The survey included closed-ended and open-ended questions to address the study aim (online supplemental material file 1). Qualitative survey data were subjected to summative content analysis[17 18] to identify prevalent factors that contributed

to the response, and factors that did not go well in the response. The factors were further analysed to identify emerging themes. Coding was completed by the first author (ES) and reliability and validity were checked by asking another researcher (PR) to independently code open-ended survey responses. The coding agreement was checked using NVIVO V.11 and was in the range of 83.3%–97.3% indicating good agreement and consistency.

Strand 2: interviews

An invitation to take part in a follow-up interview was offered within the online survey.

Interviews were conducted based on a semistructured topical guide, exploring the experiences of participants in a conversational way. This approach is appropriate for a phenomenological study,[19] to encourage participants to articulate their experiences openly and to avoid introducing too many prior assumptions or biases from the research team. Interview participants discussed in depth their experiences with the response as well as shared their perspectives about emergency preparedness training, and the role of health emergency preparedness exercises (HEPEs) in preparing them for the response.[20]

Interviews were conducted by telephone from 31 October 2017 to 29 December 2017 with the responders to the Manchester Arena bombing. The average interview length was 48 min (range 27–69 min). The semistructured topical interview schedule (online supplemental material file 2), developed in consultation with the project advisory group, comprising clinicians, emergency preparedness experts and members of public, was used to guide the interview. All interviews were audio recorded and transcribed verbatim.

Interviews were conducted by trained and experienced researchers ES, a senior research fellow, who conducted 18 interviews, and who supervised author NB, who conducted three interviews. Both researchers have experience in conducting qualitative interviews and focus groups, and together the members of the research team have significant experience undertaking and reporting qualitative research.[21] To avoid recall bias, the interviewers made notes of observations and perceptions of each interview, immediately after the interview.

The transcribed interview data were subjected to a thematic analysis using the following approach: (1) becoming familiar with the data; (2) generating initial codes; (3) searching for themes; (4) reviewing themes and (5) defining and naming themes.[22] The initial coding of interview data was undertaken by ES inductively, using the explicit or surface meaning of the data, without attempts at interpretation; and openly, without using a pre-existing coding frame. This allowed initial analysis to generate as many codes as were needed to characterise the data. The data were further reviewed, searching for themes among the open codes. These themes were explored with other members of the research team, and coding reliability and validity were checked by asking another researcher (PR) to independently apply generated codes to two randomly selected transcripts using NVIVO V.11. The coding agreement achieved for both transcripts was good and in the range of 88.3%–99.6%.

In line with a convergent mixed methods design, the analysis of the data from the two strands, survey data and interview data, is done independently and the results are then merged.[15] This allows the two types of data to contribute to a more complete understanding of the phenomenon.

To further reduce the risk of bias, all interview participants were given an opportunity to review and comment on study results. Feedback received from eight participants indicated that

their views had been appropriately reported; the remainder did not respond to further contact from the research team.

PATIENT AND PUBLIC INVOLVEMENT

Patients and the public were not involved in the conduct of this study.

RESULTS

Strand 1: survey participants

Healthcare staff (n=86) responded to the survey and identified as first responders to one of three major terrorist incidents in the UK in 2017: 79 (92%) participants identified as responders to the Manchester Arena bombing, 4 (5%) as responders to the London Bridge attack and 3 (3%) as responders to the Westminster Bridge attack. Survey participants identified predominantly as White British (68, 79%), with equal numbers of participants identifying as men and women. The majority of participants reported being between 50 and 59 years of age (39.5%), with 84.8% having either postgraduate level (doctoral 25, 29% or master's (27, 31.4%)) or undergraduate (21, 24.4%) qualifications. Most responders were from NHS Acute Trusts (64, 74%), and worked in primarily clinical roles (44, 51%), and the majority (60, 70%) identified has having performed an operational role in the response (table 1 provides demographic data of survey participants).

Strand 2: interview participants

In response to the invitation to participate in an individual interview, 59 participants indicated a willingness to be contacted, including four participants from London attacks. Of these, 21 interviews were completed with those participants who further responded to a personal invitation for an interview and were available, and all were with responders to the Manchester Arena bombing. Interview participants comprised those in clinical roles (n=12), including seven medical consultants and a consultant clinical psychologist (table 2 interviewee data). All except two participants were from NHS Acute Trusts (n=19); one was employed by NHS England, and one from the PHE National Incident Coordination Centre. Participants identified as women (n=11) and men (n=10) and most gave their age as between 40–49 (n=6) or 50–59 (n=7) years old. All except two interviewees identified ethnically as White British (n=19); one identified as being of other White background and one of white and black African origin. Participants reported a broad range of work experience, ranging between 1 and 42 years (median experience 4 years).

Summative content analysis of the open-ended survey questions obtained from 86 health responders identified prevalent factors that enabled and inhibited responders' own and their organisation's responses to the three major terrorist incidents. Interview data obtained from 21 responders to the Manchester Arena bombing provided further depth about these factors.

The results below summarise the most prevalent themes which emerged in the open-ended responses, supported by the data from the semistructured interviews. Identified themes are explained and supported by appropriate quotes from the data. Numbered illustrative quotes from interview participants correspond to their unique survey participant number.

Factors that enabled an effective response to a mass casualty terrorist incident

NHS staff engagement

Participants and their colleagues' engagement with the response was identified as being central to its effectiveness. The willingness to help and overwhelming support and commitment

Table 1 Survey participants demographic data (N=86)

	Number
Participating organisations	
CCG	3
Acute Trust	64
Ambulance Service	5
NHS England	7
PHE	5
NHS Improvement	1
Mental Health Trust	1
Emergency response role in the incident	
Operational (Bronze)	60
Tactical (Silver)	14
Strategic (Gold)	4
Support	3
Strategic+tactical	1
Operational +tactical	4
Day role	
EPRR	7
Clinical	44
Managerial	20
Scientific	2
Support	8
Communication	2
Major incident response involvement, times (mean, SD)	3.0 (3.7)
Experience, years (Mean, SD)	9.0 (8.7)
Gender identification	
Female	39
Male	39
Prefer not to say	1
Age	
18–29	6
30–39	12
40–49	23
50–59	34
60 or over	4
Prefer not to say	6
Education	
Doctorate degree (eg, PhD, MBBS)	25
Masters/postgraduate degree	27
Undergraduate degree	21
A-level or equivalent	2
GCSE or equivalent	2
Prefer not to say	2
Ethnicity	
British white	68
Irish	1
Any other white background	5
White and black African	1
White and Asian	1
Indian	1

CCG, Clinical Commissioning Groups; EPRR, Emergency Preparedness, Resilience and Response; GCSE, General Certificate of Secondary Education; PHE, Public Health England.

from NHS staff were the most frequently mentioned enabling factors. The availability of all specialities of staff allowed necessary procedures to be put in place quickly and effectively and to provide high-quality dedicated care to each patient. Staff were

Table 2	Interview participants' daily jobs (N=21)		
Participants daily jobs		**No.**	**Job category**
Consultant		8	Clinical (12)
Nurse		3	
ED advanced practitioner		1	
Divisions governance lead for surgery		1	Managerial (3)
Head of trust communications		1	
Theatre manager		1	
Emergency planning officer (EPO)		5	EPRR (5)
Blood transfusion services		1	Non-clinical (1)

EPRR, Emergency Preparedness, Resilience and Response.

supported well by their senior colleagues and were praised for knowing their roles and effective organisation of their work.

> Response from staff not on duty was overwhelming—lots of doctors and nurses arrived and volunteered their services. Ancillary staff on hand—porters, clerical staff, cleaners went above and beyond to provide care. Lots of radiologists on duty. [survey]

> There were enough staff for a whole team for each patient. [survey] Everybody had clear roles…So, it felt very ordered and organised, really. [09]
> There were a lot of senior people who were aware of what their roles were and what their action cards required them to do. They knew what to do and so we were able to maintain a very effective flow from ED into theatres. [28]
> All patients had the best trauma care I have ever seen in 17 years ED experience [survey]

Effective teamwork
Teamwork, both within functional teams and between various teams within a Trust, was explicitly articulated by participants as a key factor of the successful clinical response. Responders praised the work of their own teams, specifically acknowledging elements of human bonding, built on working, training and socialising together, willingness to help and trust in their colleagues to do their best in the response as factors that contributed to effective team working. Awareness of team strengths and limitations, strong team leadership, the clarity of staff roles within their teams and the teams place in the response were the factors that facilitated effective team response. Effective collaboration between various teams within a Trust was explicitly acknowledged by responders. The importance of a prior relationship that allowed trust and good understanding of roles and challenges between different clinical teams was highlighted, that factor facilitated effective communication between teams during the response and optimised multidisciplinary patient care

> I think that first of all,…there was an overwhelming contribution of different elements of the team…So that human bonding and that eagerness to help in an emergency was extremely important…. The second aspect is the interactions that we had with other teams. Our Radiology Department has a very good relationship with other teams, A&E, neurosurgery, surgery and medical teams and I think that was crucial… So I think the main reason why things worked so well in this situation of mass casualties was because beforehand we had built this very strong relationship of mutual understanding and collaborative decisions about so many other situations. [64]

> Obviously, everyone just worked really well as a team. That was probably the best it's ever worked. [65]

Within and between team communication
Effective communication in the response involved communication within teams, effective communication between different clinical teams and between trauma centres. Good communication within teams allowed for effective staff engagement with work, without duplicating efforts. Effective communication between teams facilitated timely sharing of information about patients to optimise their care as a multidisciplinary team and facilitated appropriate use of resources. According to participants effective communication between trauma centres facilitated resource sharing and was enabled by direct phone contacts between the sites tactical leaders. Personal mobile phones, and in particular, the messaging application WhatsApp, enhanced communication during the response.

> Very good communication from all staff about the patients that were coming up from A&E, their injuries and what was needed for surgery. [survey]

> Good communication with other trauma centres—e.g. was able to send cardio-thoracic surgeon there as we had 5 in department. [survey]
> Using the WhatsApp group was good, because one of the major incident plans says you've got to ring people to come in. But obviously just by using a WhatsApp group you can send a message very quickly to lots of people and lots of people responded very quickly as well. So that was good. [63]
> Personal mobile phones were best way of communicating between teams on the night. Also communicated with other hospitals. [survey]

Coordination of initial response and patient's care
Good coordination of initial response included rapid and effective deployment of staff to the places they would be needed in a response, as well as preparing departments to receive the casualties. There were regular multidisciplinary update meetings, which respondents felt facilitated coordination of multiple teams involved in care of trauma patients. Between-teams coordination allowed effective utilisation of resources, and minimised delays, by optimising flow and care of patients through the system. A senior liaison person was appointed to coordinate work of different teams during the response. Secondary transfers were reduced by enabling specialists to be moved between trusts within a major trauma network (MTN) to meet patient needs, instead of the normal practice of patients being retransferred to hospitals where specialists are available.

> There were minimal patients within the department, because the departments had been … cleared by my colleagues earlier, in terms of the patients who had been previously there. And the department was clear and able to receive the patients from the event. [32]

> There seemed to be good coordination from a resource point of view up to theatres to know, you know, they have their teams ready. Yes, I mean, overall, I don't think it could've gone any better, really. [09]
> …the coordination between the surgical teams, especially. The various specialities. And the anaesthetists, and that coordination was really born of something which developed, that wasn't part of the major incident planning beforehand, which was a clinical multidisciplinary meeting that happened twice a day. [24]
> The scans were reported kind of almost in real time, as the patient was going through the scanner. By the time the scan had been done, pretty much the scan had been reported and we were able to then say, this patient needs to go straight to theatre or this patient goes to paediatric care and then that patient will then go straight like to our intensive care. They didn't go back to A&E. [63]
> The Greater Manchester trauma network proved that different Trusts could work together: staff moved to patients rather than simply moving patients around. [survey]

The importance of an MI plan

Responder comments indicated that the availability of an effective Trust MI Plan helped to enable and supported an effective response. Many participants valued recent opportunities to revise the plan, which made them better aware of MI response arrangements as well as refreshed their knowledge of roles and roles of their teams. Having a plan and action cards provided a structure for actions and helped to mitigate the inherent initial stress associated with an MI response. Mass casualty distribution plan was credited with allowing more efficient way of managing the distribution of a large number of casualties from the scene of the incident and across hospitals, to prevent overloading the nearest to the scene hospitals, as well as to allow trusts to be better prepared to receive casualties by knowing in advance the category and number of patients allocated by the plan. The distribution plan allowed critical care across a number of providers working as network.

> Whole process seemed to run as per the plan which was reassuring and helpful. [survey]

> Recent revision of our major incident plan meant the plan was fresh in my mind and that of the team. [survey] The feedback I got was the initial was a little bit of panic but they got their cards out, cards for each of the team members and they were very clear on those roles and they followed them pretty much to the [letter]… Once they got those there seemed to be a calmness and a process. [53] There was no time wasted between… The ambulance control didn't have to phone the hospitals to say can you take ten patients? The hospitals just knew they were going to take ten patients and that was it. So that saved lots of time and bother. It worked great, really.[22]

Effective novel practices

Responders comments indicated that several novel practices introduced during the response contributed to its effectiveness. The positioning of blood bank staff in the ED department, which was an unusual arrangement, allowed effective communication between ED and blood laboratories and enabled rapid access to blood products, that saved lives. Participants also considered as effective the arrangements that enabled them to treat the injured adults and children together in the same ward within the children's hospital, and praised effective coordination of work between paediatric and adult trauma teams.

> Having blood bank staff in dept was brilliant. [survey]

> We were able to provide any blood product requested immediately, without the need of A&E having to get in touch with the Transfusion laboratory. This meant the patients were able to receive the products as they were needed without delay. [08] As a trust we had adults that were injured being nursed next to their children in the children's hospital but those adults still required surgery. So some of what we were doing was working out between the adults and the children's side, whether the child or the parent was going to theatre, when that was going to happen… I was surprised at just being able to manage parents and children so well together.[20]

Recent HEPEs and training

Responders reported as valuable recent HEPEs for preparing them to respond by providing the opportunity to gain first-hand experience of undertaking roles, working with their response partners and making key decisions in response to a realistic MCI scenario. Taking part in exercises also gave experience of using hospital's emergency plans and gaining confidence in a mass casualty distribution plan. A few responders considered the recent HEPEs as rehearsal of their actions in the actual response that enabled more effective and confident engagement with their roles and key decision-making in the response. Regular departmental tabletop exercises were valued for enabling staff to develop knowledge of a mass casualty response and to practise their roles in a safe environment with their colleagues; an option to observe the work of colleagues and receive feedback was valuable for learning. Participants acknowledged the importance of various training opportunities for all staff to help them prepare for a mass casualty response, highlighting the importance of regular scenario-based simulations and feedback from larger Trust exercises and real incidents.

> As we had exercise Socrates in March, I thought that the trust and my department were very well prepared and responded quickly and well to the incident. [survey]

> I think had I not have had those exercise training services I don't believe I'd have been anywhere near prepared enough to respond the way we did as an organisation and me personally as a piece in that jigsaw.[31] We have, sort of, training where it's multi-speciality, training with a specific presentation, and you run a team. You have people who watch you and observe you, and then you get feedback. And all those help. All those little bits that we've been doing help. I couldn't put my finger on one specific thing. I think it's multiple things. [09]

Factors that impaired an effective response to a mass casualty terrorist incident

Communication with ambulance and media

Although good communication was helpful in ensuring an effective response, participants also mentioned how poor communication could impair or hinder an effective response. In this study, participants most often mentioned a lack of communication around activation of an MI plan and standing down from an MI. Respondents reported that there was insufficient information from the ambulance services regarding the incident, and this was felt to have delayed activation of an MI plan. Some hospitals received their first casualties from the scene before the MI was declared by their Trust; responders reported having to use their own initiative and personal contacts with ambulance command to clarify the situation. Responders also commented that the information on the incident stand down was not communicated properly, and many teams were kept on stand by for significantly longer than needed. A few participants mentioned problems with multiagency communication, and with communication between local and national teams. The lack of clarity on communication with media created uncertainty for Trust communication teams and complicated handling multiple and intensive media queries.

> So the only real challenge I would say really is there was a lack of information coming from the ambulance service and NHS England. So we never got any regular updates of what was occurring, so the only thing we knew about the incident was what we were seeing on the news.[19]

> We weren't actually, until the major incident was stood down, which was about, I think about five o'clock in the morning, for five hours we got nothing, so we weren't sure, we were, sort of, thinking are we going to get an ambulance come in.[19]

> Multi-agency communications were fragmented/patchy and not always clear, no minutes actions distributed after teleconference calls. [survey]

> There was some lack of clarity between other communication teams, and also which agency, for example, police, the ambulance, the NHS, who was leading on communications with the media. So there was quite a bit of misunderstanding, which lead to journalists going from one place to another to try and get information. [37]

A few participants reported difficulties in communicating with the staff they needed on the night of the attack, highlighting the importance of keeping staff contact details up to date and making arrangements for contacting staff at night time, if necessary. The importance of having reliable tools to assist with communication was highlighted as difficulties with various communication technologies were mentioned.

> Difficult to contact staff due to lack of home landlines and mobiles turned to night mode due to time of incident. [survey]

> Communication technology—phones and Vocera—were limited and temperamental—the best communication was staff coming to the department. [survey]

Patients identification and tracking
The second most prevalent theme in relation to what did not go well in the response related to tracking and documentation of patients. Responders highlighted their concern that the current practices of giving patients multiple different identifying numbers on their route from the scene of the incident to the hospital could present serious risk to patient safety, as well as inconsistent practices of patient tracking and record keeping during the response.

> the identification and distinguishing between patients was quite challenging…and I think it became the case that some patients were given multiple identifying numbers. And so some patients would be triaged in the pre-hospital environment and would get assigned a number there. Some patients were getting a separate hospital number on arrival to the hospital department, especially the emergency department.[24]

> We didn't use our major trauma documentation which meant that we had bits of paper floating about and an inconsistent way of recording what was going on which our major trauma documentation would have managed better. So we did have a problem with that. [20]

After event management and follow-up support
Concern was expressed that psychological well-being of staff and depletion of human and physical resources were not given appropriate consideration when managing return to 'normal' post incident, and in particular the coordination of elective surgical work. The psychological impact of the incident on healthcare staff involved in the response and recovery was one of the prevalent themes from individual interviews with 21 responders to the Manchester Arena bombing response. Healthcare staff felt unprepared to deal with psychological trauma inflicted by the incident and their part in the response, and follow-up support was limited. Organisational debrief that is a part of the system learning process from an MI was not offered to all staff and some responders felt excluded from an opportunity to share their experiences as well as to contribute to organisational learning from the incident.

> We underestimate the post-trauma of it and that's the one thing I definitely took away from this event is we are not prepared for the stress and trauma it caused. [53]

> The aftermath could have been better managed. We didn't take down nearly enough elective work or provide enough psychological support for a fragile and tired workforce in theatres and in critical care. [survey]

> I was not aware or included in any debrief following the incident, this survey being the first opportunity to say anything. [survey]

> We have never had a Trust debrief which would have provided the opportunity for the leadership team to learn and for the staff to have closure. [survey]

Patients' allocation to hospitals
Although many participants saw benefits in mass casualty distribution plan, there were nonetheless some failures to recognise capacities and capabilities of some hospitals, which resulted in an uneven and inefficient distribution of casualties by ambulance, with some trusts receiving patients they were not expecting to receive and some not receiving expected casualties despite being prepared and kept on stand by.

> Patients who should have just been treated at the [trauma centre], were sent to us and after a lengthy procedure, had to be transferred to the [trauma centre] for another lengthy operation. The hospital should have been alerted that we weren't just going to get the walking wounded as previously told and no update on what was being transferred to us. [survey]

> We weren't needed—and it made me feel useless! We didn't receive the P2 children and the walking wounded adults didn't need surgery overnight. I wonder whether we could have been utilised more as it sounds like [XXX hospital] had more than enough cases to deal with, and while they did a fantastic job, perhaps the pressure would have been reduced had they not all gone there. [survey]

Lack of preparedness and training
The lack of recent training was articulated as a factor that contributed to confusion and a lack of confidence among staff who felt less prepared and were concerned about their abilities to cope with large number of casualties. Furthermore, among staff from Trusts that were involved in recent HEPEs, respondents identified a tendency to over-rely on staff who had recently attended training. Radiologists also expressed concern about their lack of training in MI response: although they played a crucial role in the response, radiologists traditionally are not included in an MI plan, and thus are not involved in MI training. Paediatric staff also expressed concern about a lack of attention to paediatric trauma in emergency preparedness, compared with adult trauma.

> Plus—we have had no major incident planning/training/rehearsals etc for some years—(despite clinical staff requesting it and several of us contacting management many times about our concerns). This meant most staff were really confused about their roles. Importantly though—as we did not get a huge number of casualties—this did not create a problem. Had we had significantly more casualties the lack of training would certainly have been a problem. [survey]

> If I hadn't done what I'd done, the rest of it wouldn't have followed because I was the only person on-site with that level to activate the plan…. If I was off shift I'd have gone in to support them because I worry that they would not have coped with that incident.[31]

> And I don't think that the major incident structure realises how crucial it is to have the appropriate resources and the involvement in radiology to clearly define the best patient pathway and the best patient flow in radiology before going to any other department…. [64]

> There's very little awareness of the national network of paediatric intensive care, and the role of the regional paediatric critical care transport team…[24]

Clinical protocols and expertise to deal with ballistic injuries
Responders' comments indicated that a lack of relevant clinical experience, specifically with the types of injuries presented by the Manchester Arena incident, and not having access to appropriate clinical protocols, hampered an effective response. In particular, responders were concerned about lack of easily available national resources of the ballistic injury guidance in children and adults.

No complete clinical guideline immediately available for elements of blast injury management e.g., antimicrobial Rx, antiviral Rx & ophthalmology management [survey]

Didn't scan patients widely enough as not used to shrapnel wound management. Not aware of management of human shrapnel injuries—need for treatment against blood borne infection. [survey]

And we had to just work it out as we were going along rather than being able to just download a national resource of this is the blast injury clinical guideline for children, and those things already being in there….And the same for the microbiologists… And to make it more efficient, to save time, it would be helpful to have those things as a set resource…[24]

DISCUSSION

MCIs involve various organisations that come together to deliver a response and as such they form a Community of Practice (COP).[23] The COP forms the social context in which health response personnel function during an MI, requiring individuals to work with other individuals, teams and both internal and external partners (with whom they may have never previously worked) to provide the best support and care for casualties.

Experiences of frontline health staff who responded to the UK terror attacks in 2017 contribute to the COP of health emergency responders by highlighting factors that enabled them to effectively care for victims during the response as well as factors that impeded their ability to provide the highest levels of care.

The dedication and goodwill of NHS staff to do their best for patients were the most frequently mentioned enabling factor in the response. Staff availability allowed for multidisciplinary teams to be quickly formed to provide a high level of care for patients with trauma; this echoes experiences reported from several recent MCI responses[7 9 24] and is an essential feature of this COP. This study provides further evidence of factors contributed to effective team behaviours during an MI response, such as clear communication, role clarity, strong leadership, between-team and within-team coordination, and collaboration. Participants articulated the importance of promoting multiteam cooperation, which can be facilitated through regular multiteam meetings during a response, to optimise utilisation of recourses and care of trauma patients across different teams. Appointing a senior liaison person to coordinate multiteam activities proved an effective solution, consistent with practices reported from Paris terrorist attack response.[9]

The importance of emergency preparedness training within this COP was emphasised through participants' feedback. First, the knowledge of response roles was facilitated by departmental training opportunities and larger scale HEPEs. Staff who did not receive any training in an MI response felt confused and less confident in responding and identified an over-reliance on staff who were trained. Second, effective novel practices, such as the positioning of blood bank staff in the ED department (which allowed quick access to blood products), and treating injured children and parents together in the same ward enhanced the response and ultimately saved lives. These novel solutions were largely supported by recent system-level simulation exercise experiences in response to a similar simulated incident.[20] This suggests the potential value of regular multidisciplinary training, including a broader range of specialties (eg, blood bank, radiology and paediatric trauma) to facilitate understanding of roles and coordination in the response. Third, workable incident plans, which supported the response well, were tested and refined through recent HEPEs; those training opportunities also

built confidence in the system's capability to cope with the allocation from NHS England's mass casualty distribution plan.[20]

A few limitations were noted. The impact of an MCI on health staff psychological well-being was underestimated, and support for the immediate and delayed psychological and social impacts of traumatic events was identified by participants in its absence. This need has been previously articulated[25] but this research indicates that it has not been sufficiently addressed and needs to be given specific attention within this COP.[26] Staff debrief which is a part of the Emergency Preparedness, Resilience and Response framework in England could offer opportunities to share experiences in the response and offer psychosocial support by providing a forum to share emotions and feelings in the immediate aftermath of events as well as in the medium term.[25]

Participants reported that poor intra-agency communication was the most common issue that they experienced, and were unambiguous about the importance of communication during MIs as key for a successful response. Indeed, information sharing has been the most prevalent theme identified in other MIs regardless of the nature of the threat or where and when it occurs[10]; it remains a common problem in MCIs for this COP.[24]

Participants also noted that due to the limited experience of UK civil surgeons with ballistic injuries,[2] specific training and availability of clinical protocols on blast injuries could improve a future response; the use of nationally available resources should be promoted and practised.[27] Problems with mass casualty patient identification and tracking were identified in this study; although highlighted previously,[1 2] these remain as another recurring problem for this COP. Failure to correctly identify patients can result in a serious risk to patient safety; learning from positive experiences of colleagues can be of benefit[24] and implementation of modern technologies can be considered and practised in field exercises.[28 29] Any MCI has long-term implications for primary care and community services, and careful considerations need to be in place before returning to 'business as usual', with thorough considerations given to physical and psychological state of responding and support staff. Future training would benefit from including scenarios to allow practising not only the immediate response but a postincident stage too.

The issues identified in this study—especially ones which have been previously highlighted, yet seemingly not addressed in this COP—must be incorporated into future HEPEs. Further, exercises should, as a matter of course, include a mechanism for ensuring that testing and planning efforts are successful and that effective practical solutions are widely shared.

Strengths and limitations

The study reports systematically analysed quantitative and qualitative data on the experiences of a large sample of healthcare responders to an MCI. The data were collected soon after the incidents,[30] and its quality allowed for detailed and systematic analysis of staff experiences to be undertaken. Interview data and qualitative survey data were used to triangulate and confirm each other, as is common in an exploratory mixed method design.[15]

However, as the study is reliant on self-report data from a voluntary sample of respondents, some self-selection bias may have occurred when recruiting participants.[31] Response to the survey from the London incidents was very low, and

so this study mainly relies on reports from the experiences of healthcare staff with the Manchester Arena response. Study participants are dominated by operational staff in clinical roles, but not all clinical specialities are represented; most notably absent were junior doctors. There was little ethnic diversity among study participants, who primarily identified themselves as White British.

Unanswered questions and future research

This research helps to draw out on what worked well and what did not work well in a MCI response from the experiences of those directly caring for casualties during the response. For many participants, this study was the only time anyone had asked them about what happened in the MI. To improve responses to MIs, much more of this kind of research must be undertaken. The study also supports earlier reported findings that healthcare staff were unprepared for the negative psychological impact of the mass casualty terrorist incident.[26] Evidence on how to best support trauma-exposed staff, and what kind of interventions might be successful in reducing the distress experienced during and after an MCI, is limited.[32] Further work would strongly be advocated to research the best ways of training and supporting healthcare staff exposed to traumatic experiences such as responding to an MCI.

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