Trauma Surgery & Acute Care Open

Disaster preparedness should represent an augmentation of the everyday trauma system, but are we prepared?

Jørgen Joakim Jørgensen ,[1,2] Peter Wiel Monrad-Hansen,[3] Christine Gaarder,[2,4] Paal Aksel Næss[2,5]

[1]Departments of Traumatology and Vascular Surgery, Oslo University Hospital, Oslo, Norway
[2]Institute of Clinical Medicine, Faculty of Medicine, University of Oslo, Oslo, Norway
[3]Departments of Traumatology and Gastrointestinal Surgery, Oslo University Hospital, Oslo, Norway
[4]Department of Traumatology, Oslo University Hospital, Oslo, Norway
[5]Departments of Traumatology and Pediatric Surgery, Oslo University Hospital, Oslo, Norway

Correspondence to
Dr Jørgen Joakim Jørgensen; joakim.jorgensen@traumatologi.no

Received 22 April 2021
Accepted 11 June 2021

To cite: Jørgensen JJ, Monrad-Hansen PW, Gaarder C, *et al*. *Trauma Surg Acute Care Open* 2021;**6**:e000760.

ABSTRACT

Background The increased frequency, geographical spread and the heterogenicity in mass casualty incidents (MCIs) challenge healthcare systems worldwide. Trauma systems constitute the base for disaster preparedness. Norway is sparsely populated, with four regional trauma centers (TCs) and 35 hospitals treating trauma (non-trauma centers (NTCs)). We wanted to assess whether hospitals fill the national trauma system requirements for competence and the degree of awareness of MCI plans.

Methods We conducted a cross-sectional survey of on-call trauma teams in all 39 hospitals during two time periods: July–August (holiday season (HS)) and September–June (non-holiday season (NHS)). A standardized questionnaire was used to evaluate the MCI preparedness.

Results A total of 347 trauma team members participated (HS: 173 and NHS: 174). Over 95% of the team members were aware of the MCI plan; half had read the plan during the last 6 months, whereas 63% at the TCs and 74% at NTCs were confident with their MCI role. Trauma team exercises were conducted regularly and 86% had ever participated. Only 63% at the TCs and 53% at the NTCs had participated in an MCI exercise. The proportion of resident surgeons and anesthetists with >4 years' clinical experience was significantly higher in TCs (88% and 63%) than in NTCs (27% and 17%). All the on-call consultant surgeons were at home, leaving interns in charge at several of the hospitals. All resident surgeons at the TCs were ATLS providers compared with 64% at the NTCs, and almost 90% of the consultant surgeons had participated in advanced trauma surgical courses.

Discussion Despite increased national focus on disaster preparedness, we identified limited compliance with trauma system requirements concerning competency and training. Strict guidelines to secure immediate notification and early presence of consultants whenever a situation that might turn into an MCI occurs should be a prerequisite.

Level of evidence Level IV. Study type: cross-sectional.

BACKGROUND

Mass casualty incidents (MCIs) are occurring frequently worldwide, ranging from terrorist attacks to natural disasters. On that background, healthcare systems need to be prepared for the next possible event. Four aspects of trauma care have been identified being valuable for MCI preparedness and response: communication, triage, transport and training.[1]

Accurate prehospital triage is essential to ensure optimal patient flow, to prevent the closest facilities from getting a disproportionally high number of patients.[2] Hospitals play a critical role in the system. The hospital MCI definition will vary with available local resources and capacity as well as trauma patient volumes, while the outcome to a large extent will depend on trauma experience and competence.[3] Hospital MCI plans have been developed in an effort to prepare hospitals for situations when their surge capacity becomes challenged.[4] To be functional, a well-designed MCI plan should be based on the everyday trauma organization, adjusted for the specific needs of multiple patients.

In addition to implementing and maintaining a trauma system, MCI plans should mandate regular training and testing of the different elements of the plan, including tabletop exercises for core personnel.[5] The individual task of the hospital staff, on the other hand, is to fill the competency requirements and to know their own role in an MCI.

In Norway, the initial national trauma plan was designed in 2007; a first version was implemented in the South East health region in 2010. The plan describes two levels of care: regional trauma center (TC) and non-trauma center (NTC). The NTCs have general surgical capabilities 24/7 and should be able to provide initial care, including damage control resuscitation, before transfer of severely injured patients to the regional TC. Based on these concrete recommendations and the lessons learned after the largest terrorist attack in Norway on July 22, 2011,[6–9] the national trauma plan was revised in 2017. The plan describes all aspects of trauma care including individual competencies, course requirements and team training (Box 1).[10]

In this study, we wanted to investigate the individual awareness of the MCI plan and adherence to defined trauma team requirements in all hospitals receiving trauma patients in Norway through a telephone interview of the on-call trauma team key personnel at two different time points.

METHODS

Norway has 5.3 million inhabitants and is organized in four healthcare regions (population range 400 000 to 3.2 million), each with a regional TC similar to a US level I or level II TC.[11] Each region has 4 to 14 NTCs admitting trauma patients. These

Box 1 Relevant clinical and educational requirements according to the National Norwegian Trauma Plan for the different categories of interviewed personnel

Surgical trauma team leader
Minimum of 4 years of surgical training, ATLS, advanced trauma team and operative course, trauma team CRM training.
Trauma team anesthetist
Minimum of 4 years of anesthetic training, ATLS, advanced trauma team and operative course, trauma team CRM training.
Consultant surgeon
Board-certified general surgeon, ATLS, advanced trauma team and operative course, trauma team CRM training.
Consultant anesthetist
Board-certified anesthesiologist, ATLS, advanced trauma team and operative course, trauma team CRM training.
Emergency room nurse
Trauma nursing course, trauma team CRM training.

ATLS, advanced trauma life support; CRM, crew resource management.

Box 2 Translated version of the survey

Years of experience
ATLS/trauma nursing course*
DSTC†
Knowledge of the hospital's MCI plan
Read MCI plan within last 6 months
Familiar with own role during an MCI
Would feel competent during an MCI
Confident with own hospital's competency during an MCI
Increased focus on MCI preparedness after July 22, 2011
Number of trauma team simulations per year
Last participation in trauma team simulation‡
Hospital MCI alertness exercises per year
Last participation in MCI alertness exercise‡
Hospital triage tabletop exercises per year
Last participation in triage tabletop exercise‡
Hospital ER evacuation exercises per year
Last participation in hospital ER evacuation exercise‡
Hospital ICU evacuation exercises per year
Last participation in hospital ICU exercise‡
Hospital MCI exercises per year
Last participationin hospital MCI exercise‡

*TNCC, ATCN or KITS (Norwegian trauma care course).
†Or equivalent.
‡Time given in months.
ATCN, advanced trauma care for nurses; ATLS, advanced trauma life support; DSTC, definitive surgical trauma care; ER, emergency room; ICU, intensive care unit; MCI, mass casualty incident; TNCC, trauma nursing care course.

hospitals will have general surgical capabilities 24/7, and the ability to stabilize and transfer patients to the TC according to predefined transfer criteria. Hospital patient populations vary greatly,[12] and the hospitals will have different thresholds for MCIs ranging from 2 to 12 critically injured patients. The only equivalent to a level I TC[11] in Norway is Oslo University Hospital (OUH-U) in the southeastern health region covering 3.2 million inhabitants.

We conducted a cross-sectional survey during the period August 2017–July 2018 at all 39 hospitals admitting trauma patients in Norway, focusing on relevant trauma clinical and educational requirements for trauma key personnel (Box 1) and degree of MCI plan awareness. One might fear that the competence among the staff on call might be poorer during the holiday season (HS). Therefore, personnel in the 4 TCs and 35 NTCs were interviewed in July/August (HS) and September–June (non-holiday season (NHS)). The telephone interview consisted of 21 questions presented to the on-call emergency room (ER) nurse, senior resident surgeon, senior resident anesthetist, consultant surgeon and consultant anesthetist (Box 2). These healthcare workers would be essential in the early stage of an MCI. The interviews were based on voluntary participation and were conducted by two consultant trauma surgeons at OUH-U on weekdays between 08:00 and 16:00.

Statistical analyses comparing the two time periods and TCs compared with NTCs were done with SPSS V.25. Kolmogorov-Smirnov/Shapiro-Wilk histograms and normal quartile plots were used to test for normality. Numerical data are reported as median with IQR and categorical data as frequencies (n) and percentages (%). Mann-Whitney U test was used to compare numerical data, and Fisher test or χ^2 test was used to compare categorical data. Statistical significance was set as a two tailed p value of <0.05.

The institutional data protection officer at OUH-U had no objections to this study.

RESULTS

Only two of the 349 trauma team members who were invited to participate in the study refused. Of the 347 participants, 173 were interviewed in the HS and 174 in the NHS. There were no statistical differences between the two time periods. The number of personnel in the different categories is presented in table 1. In total, 155 consultants, 114 residents and 78 nurses participated in the survey. Fourteen NTCs had an attending consultant anesthetist as the only anesthetist on call. A total of 40 staff was interviewed at TCs and 307 at NTCs.

table 1As shown in table 2, the TCs had more experienced residents compared with NTCs. The proportion of surgical residents with >4 years' experience was 88% in TCs and 27% in NTCs ($p<0.05$). For anesthesiology residents, the trend was similar, with 63% in the TCs and 17% in NTCs ($p<0.05$). All on-call consultant surgeons (100%) and more than half of the consultant anesthetists (38% at TCs, 61% at NTC) had to be called in from home after working hours. There was no difference between the experiences of ER nurses at TCs compared with NTCs.

Advanced trauma life support (ATLS) is a course for doctors focusing on the initial assessment and management, while definitive surgical trauma care (DSTC) is a course for surgical teams focusing on surgical decision-making. All surgical residents at the TCs were ATLS and DSTC providers compared with 64% and 32% at the NTCs, respectively. A higher proportion of resident anesthetists were ATLS providers at the TCs compared with NTCs (75% vs 54%, $p<0.05$).

Almost 90% of the consultant surgeons were DSTC providers, while significantly fewer consultant surgeons were ATLS providers at the TCs compared with the NTCs (63% vs 87%, $p<0.05$).

Over 95% of the study population was aware of the hospital MCI plan, but only half had read the plan during the last 6 months, with no difference between the personnel in TCs and the NTCs (table 3). More than 85% of all the interviewed persons

Table 1 Number of personnel in the different categories

	TC	NTC
Anesthetist		
Consultant, in-house	5	27
Consultant, standby*	3	43
Resident, in-house	8	33
Resident, standby*	0	2
Surgeon		
Consultant, in-house	0	0
Consultant, standby*	8	69
Resident, in-house	8	39
Resident, standby*	0	24
Nurse	8	70

*30 min standby time.
NTC, non-trauma center; TC, trauma center.

were familiar with their MCI role, while fewer felt confident in fulfilling the role (63% in TCs vs 74% in NTCs, NS). The majority were confident with their hospital's level of competence, and more staff at TCs compared with NTCs reported an increased MCI awareness in their institution after July 22, 2011 (78% vs 56%, p<0.05)table 3.

Regular simulated training was conducted in all hospitals. The vast majority of personnel (86%, 299 of 347) had participated in a trauma team exercise with significantly more in NTCs compared with TCs (89% vs 68%) (table 4). The median time in months since the last trauma team training participation was 3 for staff at NTCs compared with 6 at TCs with the majority performed by residents.

MCI alertness exercises were conducted with a median of every second month for both TCs and NTCs, and the majority

Table 2 Experience and provider status in the different personnel categories

	TC	NTC
Anesthetist		
Consultant experience (years)	20 (15–29)	20 (12–29)
Consultant ATLS provider, n (%)	7 (88)	57 (81)
Resident experience (years)	4 (3–11)	3 (2–3)*
Resident with more than 4 years' experience, n (%)	5 (63)	6 (17)*
Resident ATLS provider, n (%)	6 (75)	19 (54)*
Surgeon		
Consultant experience in years	16 (14–31)	23 (14–28)
Consultant ATLS provider, n (%)	5 (63)	60 (87)*
Consultant DSTC provider, n (%)	7 (88)	62 (90)
Resident experience (years)	6 (5–8)	2 (1–4)*
Resident with more than 4 years' experience, n (%)	7 (88)	17 (27)*
Resident ATLS provider, n (%)	8 (100)	40 (64)*
Resident DSTC provider, n (%)	8 (100)	20 (32)*
Nurse		
Experience (years)	10 (5–29)	12 (5–20)
Trauma nursing course provider, n (%)	6 (75)	63 (90)

Values are median and IQR unless stated otherwise.
*Denotes p value of <0.05.
ATLS, advanced trauma life support; DSTC, definitive surgical trauma care; NTC, non-trauma center; TC, trauma center.

Table 3 Reported MCI preparedness

	TC	NTC
Knowledge of the hospital's MCI plan	37 (93)	294 (96)
Read MCI plan within last 6 months	19 (48)	160 (52)
Familiar with own role during an MCI	33 (83)	271 (88)
Would feel competent during an MCI	25 (63)	226 (74)
Confident with own hospital's competency during an MCI	34 (85)	249 (81)
Increased focus on MCI preparedness after July 22, 2011	31 (78)	171 (56)*

Values are n (%).
*Denotes p value of <0.05.
MCI, mass casualty incident; NTC, non-trauma center; TC, trauma center.

reported having participated in such (78% in TCs and 68% in NTCs, respectively (NS)). Less than 25% had participated in a triage exercise and less than 15% had participated in ER and/or ICU evacuation exercises. Far more had participated in a full-scale hospital MCI exercise (63% at TCs vs 53% at NTCs, NS) (table 4).

DISCUSSION

We performed a national survey assessing awareness and knowledge of MCI plans and adherence to relevant trauma system criteria. Although more than 95% of the interviewed trauma team members were aware of their hospital's MCI plan, limited compliance with trauma system requirements concerning competency and training was identified in both TCs and NTCs.

Recent studies, including the experience gained in Norway on July 22, 2011,[7] have demonstrated that the closest hospital in the event of an MCI will receive the highest number of patients, indicating the need for MCI preparedness at all hospitals receiving trauma victims.[13–15]

Most Norwegian hospitals have limited exposure to trauma, that is, receive very few severely injured on an annual basis, and have limited surgical trauma competency.[12] However, due to the settlement pattern in Norway, including a lot of small communities with long transportation distances to the regional TC, the NTCs have to be prepared to take care of severely injured patients under normal circumstances as well as under an MCI.[12 16 17] Due to strict work-hour regulations and the fact that trauma competent personnel is a limited resource in Norway,

Table 4 MCI maintenance

	TC	NTC
Participated in TT simulation, n (%)	27 (68)	272 (89)*
Last participation in trauma team simulation	6 (2–36)	3 (2–8)*
Participated in MCI alertness exercise, n (%)	31 (78)	208 (68)
Last participation in MCI alertness exercise	2 (1–6)	2 (1–6)
Participated in triage exercise, n (%)	12 (30)	70 (23)
Last participation in triage tabletop exercise	7 (2–24)	11 (4–20)
Participated in hospital ER evacuation exercise, n (%)	7 (18)	44 (14)
Last participation in hospital ER evacuation exercise	18 (9–24)	15 (7–36)
Participated in hospital ICU exercise, n (%)	1 (3)	31 (10)
Last participation in hospital ICU exercise	18 (18–18)	12 (6–24)
Participated in hospital MCI exercise, n (%)	25 (63)	164 (53)
Last participation on hospital MCI exercise	18 (9–30)	12 (6–24)

Values are months, median (IQR) unless stated otherwise.
*Denotes p value of <0.05.
ER, emergency room; ICU, intensive care unit; MCI, mass casualty incident; NTC, non-trauma center; TC, trauma center; TT, trauma team.

one might fear that the competence among the staff on call might be poorer during the HS. However, no differences between the two periods were found.

Obviously, regular training, both theoretical and practical, becomes even more important in the NTCs if adequate trauma care in daily practice and in an MCI situation is to be delivered.[18] Only 27% of the surgical residents in NTCs reported at least 4 years of surgical training, which is a minimum to fulfill the role as team leader during regular trauma team activation according to the criteria in the national trauma plan. On that background, the consultant surgeon on call will have to take on the role as trauma team leader in almost every Norwegian NTC and almost 90% of the interviewed consultant surgeons working in NTCs reported to be ATLS trained, which is another prerequisite to fulfill that role. Moreover, as severely injured patients might need damage control operation as part of initial care, surgeons need to be specifically trained for this. Advanced surgical course participation (like DSTC) is another criterion to be met and 90% of consultant surgeons at NTCs were DSTC trained and represents a major improvement compared with the situation before July 22, 2011.[19]

As only 32% of resident surgeons at NTCs were DSTC trained, the need for early consultant surgeon presence is evident. Even though most consultant surgeons were DSTC providers, their real MCI and trauma surgery experience is limited.[6–9 20] Frequent, goal-directed training is therefore a prerequisite to achieve acceptable preparedness in all Norwegian hospitals. Training for MCIs results in improved skills, knowledge and attitudes,[21] and the outcome of an MCI is largely dependent on preparedness.[3]

Trauma team training is especially important in low-volume centers, and in our study, almost 90% of the interviewed healthcare workers at NTCs had participated within the last 3 months. Fewer (68%) had participated in trauma team training at TCs,probably reflecting that the frequency of trauma team training is not proportional to the number of staff. That the physician-based roles in the team training in TCs were mainly covered by residents might be attributed to the fact that they are more experienced compared with the interviewed residents at NTCs. However, senior staff should be present to supervise and interfere both during training and real situations to improve performance and outcomes.[22 23] The interviewed nursing staff reported high levels of experience and competence in both NTCs and TCs. Their important role in the trauma team cannot be overestimated, including their roles as continuity carriers.

Our study revealed that in the NTCs, no consultant surgeons and less than 40% of the consultant anesthetists on call are in-house after normal working hours. Hence, simple and written guidelines to secure immediate notification and early presence of the consultants under ordinary trauma team activations as in a possible MCI situation should be mandatory.

An MCI plan is the core of a hospital's MCI preparedness.[4 5 24] Trauma care in the event of an MCI should be based on a trauma system's everyday practice.[1 5 20] MCI plans should be readily available and healthcare workers need to be familiar with their role and confident with their function during an MCI. In our study, over 95% were aware of the MCI plan, but only 50% had read the plan within the last 6 months. One can argue that knowledge of the plan is enough. In our study, on the other hand, more than 25% were not sure whether they could fulfill their designated role during an MCI, possibly reflecting the lack of regular training. Moreover, only 54% of the interviewed personnel had ever participated in a hospital MCI exercise, possibly reflecting an ever-increasing demand for hospital effectiveness. However, Norwegian law mandates all hospitals to have an MCI plan, conduct exercises and train all relevant personnel.[25 26] As full-scale MCI exercises and evacuating hospital units has an economic cost and may affect outcome in ordinary patients negatively, cheaper alternatives have to be sought. Although small-scale exercises, such as tabletop triage training, are valuable options,[5 27] in our study less than 25% reported such an experience. The need to evacuate the emergency department (ED) is a challenging task but described recently by Hojman and coworkers after the Boston marathon bombing.[28] Although only 14% had ever participated in an ED evacuation exercise in our study, preparation and training at OUH-U lead to a successful evacuation of the ED in 15 min during the twin terrorist attack in 2011.[6]

LIMITATIONS

This cross-sectional study was performed by telephone interviews of the on-call trauma team members. Team members were asked to respond to a predefined set of relevant questions (Box 2). This might lead to communication difficulties, including unpredicted unclarities in some of the questions.[19 29] A pilot test of the questionnaire might have reduced the uncertainty the interviewed personnel experienced. However, sufficient time was set aside for clarification if needed during the interviews.

Competence and experience among the personnel on call will vary in every hospital on a daily basis. The design of the study might lead to bias since it reflects the competence at a given time point. Performing interviews at two different time periods was done to reduce such effects.

Some of the questions were related to the respondents' memory of the last time different categories of exercises were performed. Since some exercises had more relevance to one personnel group than to others, that might influence the responses. The reported frequency of training is likely due to recall bias or simply describes the respondent's own participation in team training. Finally, self-assessment is subjective and introduces a bias per definition.

CONCLUSION

Despite increased focus on disaster preparedness at a national level after the 2011 attacks, we identified limited compliance with trauma system requirements concerning competency and training with reference to daily trauma care as well as to MCI situations. Strict guidelines to secure immediate notification and early presence of consultants whenever a situation that might turn into an MCI occurs should be a prerequisite. The awareness and content of existing MCI plans should be continuously improved to be able to meet the challenges of future MCIs.

Contributors All authors have made substantial contributions to the conception and design of the work, the acquisition, analysis and interpretation of data, and have drafted the work or substantively revised it. They have all approved the submitted version (and any substantially modified version that involves the author's contribution to the study) and have agreed both to be personally accountable for the author's own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved and the resolution documented in the literature.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not required.

Ethics approval The institutional data protection officer at Oslo University Hospital had no objections to this study and ruled that no formal ethical approval was required in this particular case. Verbal consent was obtained from the study participants.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. Deidentified participant data are available upon reasonable request from the corresponding author.

ORCID iD
Jørgen Joakim Jørgensen http://orcid.org/0000-0003-0876-1296

REFERENCES

1 Bachman SL, Demeter NE, Lee GG, Burke RV, Valente TW, Upperman JS. The impact of trauma systems on disaster preparedness: a systematic review. *Clin Pediatr Emerg Med* 2014;15:296–308.
2 Melmer P, Carlin M, Castater CA, Koganti D, Hurst SD, Tracy BM, Grant AA, Williams K, Smith RN, Dente CJ, *et al*. Mass casualty shootings and emergency preparedness: a multidisciplinary approach for an unpredictable event. *J Multidiscip Healthc* 2019;12:1013–21.
3 Ben-Ishay O, Mitaritonno M, Catena F, Sartelli M, Ansaloni L, Kluger Y. Mass casualty incidents - time to engage. *World J Emerg Surg* 2016;11:1–3.
4 Sayed El M, Chami AF, Hitti E. *Developing a hospital disaster preparedness plan forMass casualty incidents: lessons learned from the Downtown Beirut bombing. DisasterMed public health PreP*. : Cambridge University Press, 2017:1: 1–7.
5 Hirshberg A, Holcomb JB, Mattox KL. Hospital trauma care in multiple-casualty incidents: a critical view. *Ann Emerg Med* 2001;37:647–52.
6 Gaarder C, Jorgensen J, Kolstadbraaten KM, Isaksen KS, Skattum J, Rimstad R, Gundem T, Holtan A, Walloe A, Pillgram-Larsen J, *et al*. The twin terrorist attacks in Norway on July 22, 2011: the trauma center response. *J Trauma Acute Care Surg* 2012;73:269–75.
7 Waage S, Poole JC, Thorgersen EB. Rural hospital mass casualty response to a terrorist shooting spree. *Br J Surg* 2013;100:1198–204.
8 Sollid SJ, Rimstad R, Rehn M, Nakstad AR, Tomlinson A-E, Strand T, Heimdal HJ, Nilsen JE, Sandberg M, Collaborating group. Oslo government district bombing and Utøya island shooting July 22, 2011: the immediate prehospital emergency medical service response. *Scand J Trauma Resusc Emerg Med* 2012;20:3–12.
9 Rimstad R, Sollid SJM. A retrospective observational study of medical incident command and decision-making in the 2011 Oslo bombing. *Int J Emerg Med* 2015;8:1–10.
10 NKT-T Working Group. National trauma plan–Trauma system in Norway 2016 [Internet]. 2016. www.traumeplan.no.
11 American College of Surgeons. *Resources for optimal care of the injured patient 2014*. Chicago IL: American College of Surgeons Committee on Trauma, 2014.
12 Dehli T, Gaarder T, Christensen BJ, Vinjevoll OP, Wisborg T. Implementation of a trauma system in Norway: a national survey. *Acta Anaesthesiol Scand* 2015;59:384–91.
13 Carles M, Levraut J, Gonzalez JF, Valli F, Bornard L. Mass casualty events and health organisation: terrorist attack in NICE. *Lancet* 2016;388:2349–50.
14 de Ceballos JPG, Turégano-Fuentes F, Pérez-Díaz D, Sanz-Sánchez M, Martin-Llorente C, Guerrero-Sanz JE. 11 March 2004: The terrorist bomb explosions in Madrid, Spain--an analysis of the logistics, injuries sustained and clinical management of casualties treated at the closest hospital. *Crit Care* 2005;9:104–11.
15 Hogan DE, Waeckerle JF, Dire DJ, Lillibridge SR. Emergency department impact of the Oklahoma City terrorist bombing. *Ann Emerg Med* 1999;34:160–7.
16 Røislien J, van den Berg PL, Lindner T, Zakariassen E, Uleberg O, Aardal K, van Essen JT. Comparing population and incident data for optimal air ambulance base locations in Norway. *Scand J Trauma Resusc Emerg Med* 2018;26:42.
17 Wisborg T, Ellensen EN, Svege I, Dehli T. Are severely injured trauma victims in Norway offered advanced pre-hospital care? National, retrospective, observational cohort. *Acta Anaesthesiol Scand* 2017;61:841–7.
18 Kristiansen T, Søreide K, Ringdal KG, Rehn M, Krüger AJ, Reite A, Meling T, Naess PA, Lossius HM. Trauma systems and early management of severe injuries in Scandinavia: review of the current state. *Injury* 2010;41:444–52.
19 Kristiansen T, Ringdal KG, Skotheimsvik T, Salthammer HK, Gaarder C, Naess PA, Lossius HM. Implementation of recommended trauma system criteria in south-eastern Norway: a cross-sectional Hospital survey. *Scand J Trauma Resusc Emerg Med* 2012;20:5.
20 Pedersen MJB, Gjerland A, Rund BR, Ekeberg Øivind, Skogstad L. Emergency preparedness and role clarity among rescue workers during the terror attacks in Norway July 22, 2011. *PLoS One* 2016;11:e0156536–12.
21 Rosenfeld JV, Mitra B, Smit DV, Fitzgerald MC, Butson B, Stephenson M, Reade MC. Preparedness for treating victims of terrorist attacks in Australia: learning from recent military experience. *Emerg Med Australas* 2018;30:722–4.
22 Long AM, Lefebvre CM, Masneri DA, Mowery NT, Chang MC, Johnson JE, Carter JE. The golden opportunity: multidisciplinary simulation training improves trauma team efficiency. *J Surg Educ* 2019;76:1116–21.
23 Capella J, Smith S, Philp A, Putnam T, Gilbert C, Fry W, Harvey E, Wright A, Henderson K, Baker D, *et al*. Teamwork training improves the clinical care of trauma patients. *J Surg Educ* 2010;67:439–43.
24 Lewis AM, Sordo S, Weireter LJ, Price MA, Cancio L, Jonas RB, Dent DL, Muir MT, Aydelotte JD. Mass casualty incident management preparedness: a survey of the American College of surgeons Committee on trauma. *Am Surg* 2016;82:1227–31.
25 Ministry of Health and Care Services. *Law on health and social preparedness (helseberedskapsloven). Lov-2000-06-23-56*, 2001:1–8.
26 Ministry of Health and Care Services. *Regulations on requirements for preparedness planning and preparedness work, etc. according to the law on health and social preparedness FOR-2001-07-23-881*, 10 Aug 2001:1–3.
27 Lennquist S. Education and training in disaster medicine. *Scand J Surg* 2005;94:300–10.
28 Hojman H, Rattan R, Osgood R, Yao M, Bugaev N. Securing the emergency department during terrorism incidents: lessons learned from the Boston marathon Bombings. *Disaster Med Public Health Prep* 2019;13:791–8.
29 Streiner DL, Norman GR, Cairney J. *Health measurement scales: a practical guide to their development and use*. 5th edn. Oxford; New York: Oxford University Press, 2015.