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Author(s): Harjula, Tuomas; Tuomikoski, Anna-Maria; Roivainen, Petri

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EMERGENCY MEDICAL SERVICES PREPAREDNESS FOR TERRORISM: A SCOPING REVIEW

Terrorism is one of the current challenges of emergency medical services (EMS) preparedness. A prominent change in EMS preparedness between 2000-2020 has been a shift from primarily preparing for chemical, biological, radiological, and nuclear (CBRN) terrorism to preparing for terrorism carried out with more conventional means like weapons, explosives, and vehicles.

The concept of EMS should be reformed to answer the demands of these modern-day threats. A change to proactive measures from the prevailing reactive actions demands a similar paradigm shift in EMS that police forces have undergone in the United States following Columbine and in Finland following Jokela and Kauhajoki. For EMS this could include adapting tactics and equipment that allow trained providers to operate closer to victims in an ongoing incident.

This review examines the preparedness of prehospital first responders to the threat of terrorism between 2000-2020 and collates best practices for the benefit of all actors in the prehospital field. The results of this review can be utilized in the planning and execution of pre-hospital medical response(s) at any level.

BACKGROUND

When preparing for the threats of our modern international environment, one of the facets of preparedness is the readiness to respond to terrorism. As a part of this response, emergency medical services (EMS) providers must integrate preparedness plans in their operative processes^{1,2}.

This review aims to identify the state of prehospital EMS terrorism preparedness and collate the best practices of EMS's modern preparedness. Modern EMS has a limited amount of scientific research devoted to it and thus lends itself well to scoping reviews.

Review questions: 1. How has EMS terrorism preparedness changed since the start of the millennium? 2. What are the current best practices of EMS terrorism preparedness?

METHODS

This scoping review was conducted according to the guidance provided by JBI (before known as: Joanna Briggs Institute)³. The review protocol was not registered.

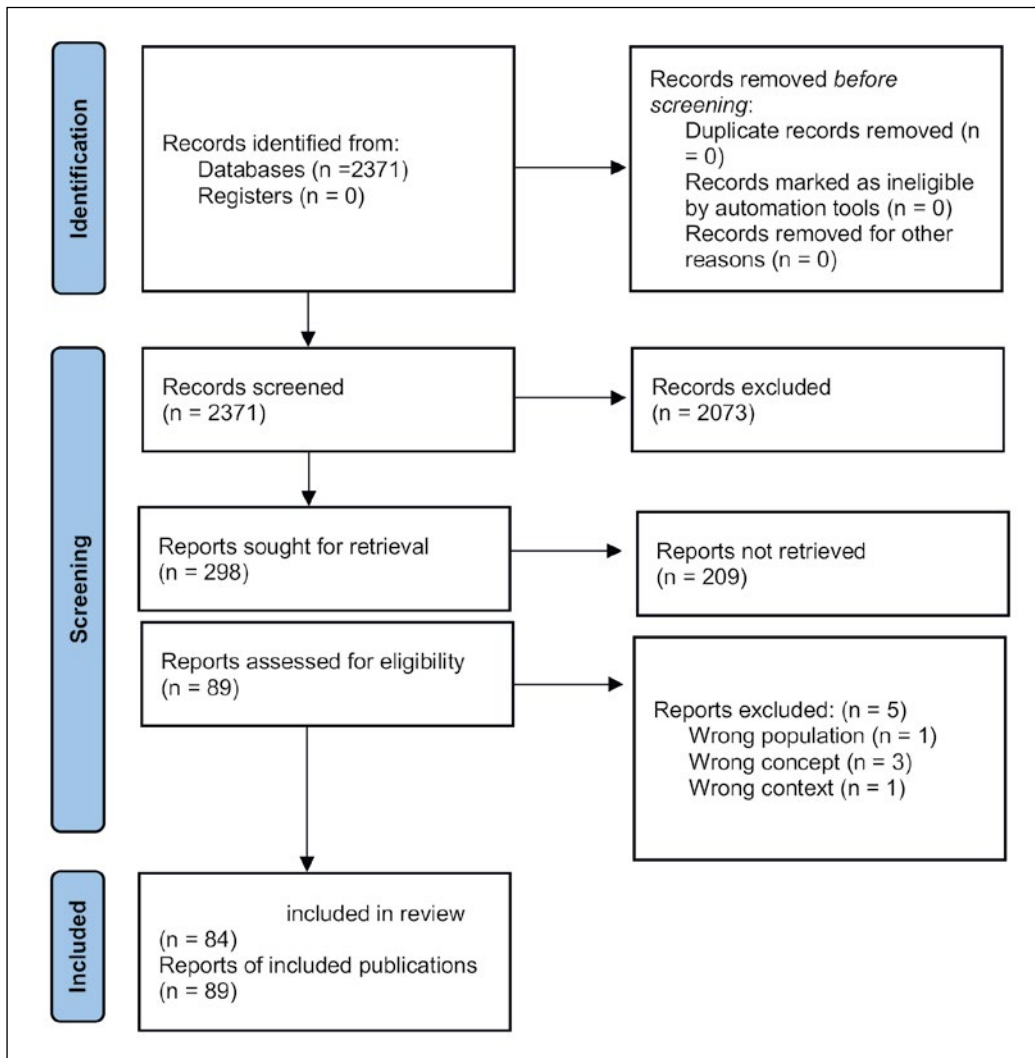
Inclusion criteria

Inclusion and exclusion criteria were developed using the "Population, Concept,

Context (PCC)" -model³. EMS organisations and providers were considered the population, preparedness for terrorism the concept, and prehospital EMS the context. Only Finnish and English language publications were considered. The coverage period is 01.01.2000–09.10.2020. More detailed background about the criteria, search phrases, data sources, and search strategy can be found in the original thesis paper⁴.

Selection and data extraction

The selection of publications was performed by a single researcher based on the inclusion criteria. To ensure the inclusion of all relevant publications, the database search, selection, and data extraction were all performed twice. Data were extracted to a table and identified by sources of evidence, their relation to the review question, the main result(s), publication quality characteristics, and country of publication/nationality of main author(s). The search strategy used and the selection process is presented in Figure 1 in accordance with the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement by Page et al.⁵.



PRISMA flow chart with the article search process. A “report” is defined as “a journal article, preprint, conference abstract, study register entry, clinical study report, dissertation, unpublished manuscript, government report, or any other document providing relevant information.” <https://researchguides.gonzaga.edu/nurs561/prisma>, Box 9

The selection process began with the archiving of the preliminary results (n=298) according to database, language, and inclusion (n=89) or exclusion (n=209). Publications were excluded at this step if they were not relevant to the subject matter based on their title or abstract. In addition, theses, dissertations, meeting minutes and references to other databases included in the search were removed from the results. Disqualified publications were categorised

based on the reason for exclusion and included in the archive to ensure reviewability. The publications chosen for full-text review were collated in a review table and categorised by theme for archiving. A parallel archive dividing the final publications into scientific and grey literature was also formed.

The data extraction table for full-text reviewed publications included fields for the publication’s details, theme, data related to

the review with page reference, and possible notes with page reference if applicable. All data relevant to practices in the thematic fields were catalogued. The data table is available from the corresponding author on reasonable request.

RESULTS

The database searches produced 2 371 results. Of these results, 298 abstracts were read, and 89 qualified for a full text review. Five more were removed after a full text review. The review therefore consists of 84 publications. The total number of reviewed publications (n=89) is higher than the selected number, as one publication was an edited volume with six suitable chapters.

Characteristics of included publications

Of the results, 21 were based on scientific research. The remaining 63 were grey literature. The scientific research papers included literature reviews conducted with varying methodologies in addition to interview- and survey-research papers. The grey literature consisted mostly of professional magazine articles and exercise reports.

Towards more conventional threats

In the selected publications, there were themes that endured throughout, and ones that evolved into something new, with the most prominent changes seen in EMS field tactics. A major driver of change in most of the thematic areas was a gradual move from chemical, biological, radiological, and nuclear (CBRN) threats to emphasising more conventional threats. Between 2000 and 2020, there was very little change in the CBRN -threat preparedness processes⁶⁻³², and towards the end of the period conventional threats³³⁻⁶⁰ all but phased out CBRN ones.

In emphasising conventional threats, EMS systems have developed ways to meet these contemporary challenges. A good example of this is the civilian adaptation of tactical combat casualty care (TCCC), tactical emergency casualty care (TECC), and its inclusion in civilian EMS systems' tactics^{35,38,42,43,46,47,51,52,55,56}. Below is a summary of the review results.

Preparedness planning

The main themes of preparedness planning have remained relatively unchanged during the review period. An all-hazards approach is recommended as the foundation for preparedness planning^{6,8,12,28,37,51,61,62}. A good plan is flexible and scalable to fit any circumstances^{24,37}, and should be made in close coordination with other responding agencies and health services in the region^{8,10,13,16,23,25,37,40,41-44,54,62-64}. These preparedness plans should be tested both as tabletop exercises (TTX) and in practice^{13,37,54,65}.

As we get closer to the end of the review period, there are calls to include arrangements for responders' psychological well-being in preparedness plans^{36,37,60,66-71}. There are also recommendations to use modern tools such as geographic information systems (GIS) and mathematical modelling to supplement the planning process⁷²⁻⁷⁵.

Training and education

Training and education are present throughout the literature, and the recommended topics follow the general change in expected threat profiles outlined above⁶⁻⁶⁰. As with planning, training should also serve the purpose of preparing responders for all foreseeable hazards^[67]. It is important to collect feedback from training and exercises to expose any weaknesses or points of improvement on the responder or organisational level(s)^{60,76,77}.

Towards the end of the review period, there is an increased emphasis based on treatment and field tactics training^{34,35,38,44-47,52-54,58,72}. TCCC, TECC, Rescue Task Force, and 3 -Echo training are presented as possible, partly supplementary concepts^{34,35,38,41-43,46,47,51,52,54-56,58,70}. In addition to tactical concepts, the standardisation of training courses and subjects over a wider operational area is recommended to ensure the same baseline knowledge for all responders^{35,67,78-80}. It is also highly recommended to include other regional responders in training and exercises^{10,37,42,43,46,47,56,60,63,65,67,68,76,77}.

Tactics

The most visible change in field tactics is a shift to more dynamic mobile tactics. Coun-

tries where first responders have more frequent brushes with terrorist incidents have been the forerunners in this process: mainly Israel ^{13,21,33,57,72}, the United States ^{34,38,39,42,43,46,47,52,53,58}, and France ^{36,44,55}.

The rollout of new tactical concepts manifests as a shift to a more standardised approach to field tactics ^{35,38,42,43,46,47,52,55,56} and moving emergency medical services closer to the hot zone, with a more proactive approach to patient care ^{38,41,43,46,52,54,56,58,72}. However, there is no universally agreed field tactic, triage, or treatment algorithm in the literature.

Technology

The needs and priorities of EMS technologies remain relatively unaffected. Recommendations for cameras, field telemetry capacities, and redundant communication devices are present throughout ^{33,41,45,56,60,68,72,81,82}.

The most interesting finding in relation to modern technology is the previously mentioned incorporation of GIS and mathematical modelling in preparedness planning ^{41,72,74,75}. Some of these models can also be utilised in real time to complement decision making ⁷³.

Consumables, medications, and equipment

As can be expected, developments relating to consumables, medications, and equipment are mostly dictated by the changes in tactics. As the review period progresses, tourniquets and haemostatic bandages become more prominent ^{35,36,39,41-43,48,53,55,58,70}, tranexamic acid is recommended for bleeding patients more frequently ^{35,36,56,58}, and the adjustment of response equipment is recommended for the requirements of the current mission ^{46,47,70}.

It is noteworthy that the equipment recommended for CBRN-preparedness remains fairly constant during the review period. The medications, protective equipment, and other equipment utilised when responding to these threats has seen little to no change in the last twenty years.

Best practices

The main current best practices in terrorism preparedness in EMS as derived from

the findings are as follows. An all-hazards approach ^{6,8,12,28,37,51,61,62} should be adapted to preparedness planning, which should be carried out on a larger scale than locally ^{8,10,13,16,23,25,29,37,40-44,54,62,63}. Plans should be exercised to ensure a smooth response ^{12,18,25,29,41,61,83-85}, and these exercises should include other responders ^{10,37,42,43,46,47,56,60,63,65,67,68,76,77}. Feedback is to be collected from exercises and hard responses, and the collected feedback should be utilised to develop actions in the field for the better ^{29,56,60,66,76,77}. To assist planning and decision making, modern technology may be utilised ^{41,72-75}, and the use of gamified, network-, and VR-based platforms for training and education should be considered ^{17,36}.

Tactical casualty care guidelines should be included more widely ^{38,42,43,46,47,51,52,55,56}, including a change from the classic ABCDE algorithm to MARCH or C-ABC ^{35,41,43,47,58,70,81}. Moving EMS action closer to the hot zone in close coordination with law enforcement should be considered to expedite treatment and evacuation ^{38,41,43,46,52,54,56,58,72}. In addition to changes in planning and tactics, EMS should be equipped to deal with these contemporary threats, including adequate personal protective equipment (CBRN and ballistic) ^{6,9,21,28,29,46,47,70}, and the mental welfare of first responders should be considered in planning, during calls, and after calls ^{36,37,60,66-71}.

An overarching finding is that EMS operations should be standardised throughout. This includes triage, field tactics, leadership and management systems, patient information systems, feedback collection, and training materials.

DISCUSSION

According to the results of the review, the challenge of terrorism by conventional means has influenced the development of EMS preparedness in the last twenty years. A main finding was an overall progress towards a more standardised, proactive, and flexible response. The best practices outlined above may be construed as the most important results of this review.

In our modern global world, it is not optimal for all EMS systems to generate their

own plans, standards, and tactics. Any modern organisation should be sufficiently open to identify the best practices coined by others and not be too proud to embrace them. Management in these organisations must have the ability to own their possibly inferior prior decisions and push for change. Modern tools can and should be used to facilitate this change.

The basics of preparedness planning should be similar for all EMS systems. The preparedness plan cannot be too detailed without risking uselessness, and should allow some real-time modifications during a developing response situation. Triage, prehospital care, determining the destination for patients, and transporting them there remain the core requirements of EMS provision. As these are the core competences of EMS in an everyday setting, incorporating the existing communication systems, protocols, cooperative relations between providers, and the capabilities of local health services in the plans should make manoeuvring within the initial chaos easier.

The similarities between the tactics employed by those EMS systems who respond to terrorism frequently can be viewed as an outline of the current golden standard. It is notable that these civilian EMS tactics follow practices derived from military medicine. Development-friendly leadership will go a long way in implementing these recommendations. However, such comprehensive change requires not only commitment from organisational management, but also a political impetus. The hypothetical long-term cost-effectiveness of standardised field tactics and techniques can be offered as a motivator when selling the idea, as initiating the change will require monetary investment.

The aforementioned mathematical models and GIS tools provide new dimensions to preparedness planning, with the ability to run simulations with local resources prior to an actual incident. In addition, a real-time response may benefit from these tools to establish safe zones and manage response assets with up-to-date information on the incident location's changing environment, the capabilities and capacity of local treatment facilities, and even real-time traffic updates.

However, not even a working tactic can be implemented without the right equipment. Treatment equipment should be suitable for special patient groups such as paediatric patients, who are expected to be among the casualties of a terror attack. Special emphasis should be placed on adequate and appropriate PPE for responders, as their safety is paramount.

A common national framework for EMS all the way down to the tactical level could provide synergic benefits, but would not be a solution by itself. Educating EMS responders in tactical thinking, procuring the necessary equipment, and changing the basic working model from reactive to proactive will require more work. It is readily apparent that Finnish EMS systems are already taking steps to adapt to these new requirements. An excellent example of this is the Tactical EMS (TEMS) -model that is currently nationwide, albeit with regional differences in its adaptation and use.

This crucial change is ultimately likely to fail wherever providers are not willing to shift their basic paradigm for field tactics from guaranteed safety to "safe enough" within the boundaries of local laws and regulations. Herein lies a major hurdle: it is not only a matter of changing how the medi-

CENTRAL POINTS

- Emergency medical services preparedness has shifted towards more flexible, proactive measures.
- Threat profiles highlight the threat of conventional weapons over chemical, biological, radiological, or nuclear ones.
- Preparedness should be standardised over geographical and operational boundaries.
- Treatment should be brought close to the patients even in situations of elevated threat.
- Responder safety is paramount and should be considered already at the planning stage.

TIIVISTELMÄ

Terrorismi on yksi nykyajan haasteista ensihoidon varautumisessa. Suuri muutos ensihoidon varautumisessa terrorismiin vuosina 2000-2020 on ollut pääasiällisen uhkakuvan muutos CBRN-uhista konventionaalisiin aseisiin, räjähteisiin ja ajoneuvoin toteutettuun terrorismiin.

Ensihoidon toimintakonsepti tulisi päivittää vastaamaan näitä moderneja vaatimuksia. Siirtyminen proaktiiviseen toimintaan hallitsevasta reaktiivisesta toiminnasta vaatii ensihoidossa vastaavaa paradigmanmuutosta, jonka poliisivoimat ovat käyneet läpi Yhdysvalloissa Columbinen kouluampumisen jälkimainingeissa ja Suomessa Jokelan sekä Kauhajoen vastaavien hirmutekojen jälkeen. Ensihoidolle tämä voisi tarkoittaa sellaisten taktiikoiden ja varusteiden käytön omaksumista, jotka mahdollistaisivat auttajien toiminnan lähempänä avun tarpeessa olevia myös korkeamman uhkan tilanteissa.

Tämä katsaus tarkastelee ensihoidon varautumista terrorismiin kuluneiden kahdenkymmenen vuoden aikana, sekä pyr-

kii kokoamaan parhaiksi havaitut käytännöt kaikkien ensihoidon toimijoiden hyödynnettäväksi. Katsauksen tuloksia voidaan hyödyntää millä tahansa tasolla ensihoidon toimintaa suunniteltaessa ja toteutettaessa.

YDINASIA

- Ensihoidon varautumisessa on siirrytty kohti joustavampia, proaktiivisia toimintamalleja.
- Uhkaprofiileissa painotetaan konventionaalisia uhkia kemikaalisten, biologisten, radiologisten ja ydinuhkien sijaan.
- Varautumista tulisi yhdenmukaistaa sekä standardoida maantieteellisten ja toimijarajojen ylitse.
- Hoito tulisi pyrkiä saamaan mahdollisimman lähelle potilaita myös korkean uhkan tilanteissa.
- Auttajien turvallisuus on ensisijaisen tärkeää ja siihen pitää jo varautumissuunnitelmissa kiinnittää huomiota.

cal services think, but other responding organisations must also be willing to accept this change and invest time and effort in coordinating their actions with the EMS's new way of operating. Law enforcement and other responding security forces will be at the heart of that change. While keeping all this in mind, it bears repeating that the safety of responders must remain as the foremost consideration. A responder who becomes a casualty is in no position to help those in need.

STRENGTHS AND LIMITATIONS OF THE REVIEW

Non-digital publications could have provided additional information relevant to the

review, but they were excluded to ensure the repeatability and thus credibility of the review. In addition, the references of the accepted publications were not included in the material. This was another conscious decision to keep the amount of research material manageable.

All the review's steps were conducted twice in succession before moving on to the next step to counteract any bias or omissions resulting from the review being carried out by a single researcher. The inclusion phase of the review was especially prone to researcher-induced error(s), because the review included a substantial number of publications with varying methodologies. No ethical permissions were requested due to the nature of the review.

CONCLUSION

For countries where EMS systems have limited experience of responding to the threat of contemporary terrorism, it may be advisable to learn from systems that have had more exposure. It can be inferred from the literature that systems which respond to terrorism more frequently employ widely similar techniques and tactics. Additionally, research into the best practices of emergency medical care must continue to ensure the optimal use of responders and first response systems in exceptional circumstances.

As a final note for any reader who has not done so, it is recommended for EMS providers at all levels to familiarise themselves with the Hartford Consensus statements by the American College of Surgeons⁸⁶ and TECC guidelines by the Committee for Tactical Emergency Casualty Care⁸⁷. Even without a major change in the EMS paradigm, these resources may aid and advise responders and medical systems in how best to respond to high-threat calls.

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Authors

Tuomas Harjula
Master of Health Care
Head Nurse
Finnish Defence Forces Centre for Military Medicine, Sodankylä Health Centre, Sodankylä, Finland

Anna-Maria Tuomikoski
PhD
Director of Nursing Competence
The wellbeing services county of North Ostrobothnia, Oulu University Hospital, Oulu, Finland

Petri Roivainen
PhD
Principal Lecturer
Health and Social Care, Oulu University of Applied Sciences, Oulu, Finland

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