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Tech-Based Training Approaches for Prehospital Mass Casualty Response: A Scoping Review Protocol

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We use this protocol and it's working

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Abstract

Introduction:

Technology has transformed healthcare, yet the COVID-19 pandemic revealed critical gaps in its integration, especially in emergency response. Mass casualty incidents (MCIs), caused by disasters or large-scale accidents, overwhelm emergency services and demand coordinated triage and resource management.

Purpose:

This scoping review examines how technology is used to train, assess, or evaluate prehospital responders in MCIs, identifying types of technologies, training approaches, and gaps in implementation, scalability, and learner inclusion.

Methods:

Following Arksey and O'Malley's framework (with Levac's refinements) and PRISMA-ScR guidelines, the review will include studies involving technological tools applied to MCI training or evaluation of prehospital providers. A comprehensive database search will support thematic analysis of included literature.

Guidelines

1. PRISMA Extension for Scoping Reviews (PRISMA-ScR) Checklist.
2. Arksey and O'Malley Scoping Review Framework.
3. PRESS (Peer Review of Electronic Search Strategies) guidelines.

Materials

Computers, Internet Connection, MS Word, MS Excel, Reference Manager (Mendeley/EndNote/Zotero), Covidence.

Objectives

- 1 Explore how technology supports the training of prehospital responders for mass casualty incidents (MCIs).
- 1.1 Identify the types of technologies used.
- 1.2 Describe the training approaches applied.
- 1.3 Analyze the outcomes reported.
- 1.4 Identify and highlight existing gaps in technology-enhanced MCI training.

Methodology Overview

- 2 Follow the methodological framework established by Arksey and O'Malley, incorporating enhancements recommended by Levac et al.
- 3 Adhere to the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews) guidelines.
- 4 Develop and register the protocol on protocols.io.
- 5 Submit the protocol to appropriate international registries.

Stage 1: Identify the research questions

- 6 Primary Research Question
- 6.1 What technologies are used to train and assess prehospital responders for mass casualty incidents (MCIs), and what impact do they have on training?



- 7 Secondary Research Questions
- 8 How effective are these technologies in improving knowledge, practical skills, decision-making, and response times?
- 9 What are the barriers and facilitators to implementing technology-enhanced training in prehospital MCI contexts?
- 10 How is data collected during training sessions, and how is it used to inform or improve future training or response strategies?
- 11 What are the limitations or gaps in the existing literature on technology-based MCI training for prehospital responders?

Stage 2: Identify relevant studies

- 12 Databases: PubMed, Embase, Scopus, PsycINFO, CINAHL, Cochrane Library, ClinicalTrials.gov, and Google Scholar.
- 13 Create the search strategy using a combination of keywords and Medical Subject Headings (MeSH), identified through the MeSH database on PubMed.

Population	Technology (Concept)	Disaster Context
first responders,	eye-tracking, virtual reality, augmented reality, mixed reality, biometric sensors, electroencephalogram	mass casualty incident, Mass Casualty Incidents[MeSH], crisis, Disasters[MeSH], aircraft accident, avalanche
Paramedics[MeSH]	digital monitoring, motion tracking, wearable devices, performance dashboards, psychophysiological tools, galvanic skin response	biological accident, biohazard release, bioterrorism, bomb, chemical accident, chemical hazard release
Nurses[MeSH]	pupillometry, heart rate variability, Eye-Tracking Technology[MeSH], Virtual Reality[MeSH], Augmented Reality[MeSH], Spectroscopy, Near-Infrared[MeSH]	chemical terrorism, climate change, cyclonic storm, disaster victim, disaster, drought
Physicians[MeSH]	artificial intelligence, human computer interaction, human machine interface, microcomputer, mobile application, user-centered design	earthquake, emergency patient, emergency shelter, flood, landslide, mass-casualty incident
Health Personnel[MeSH],	video game, wearable computer, ambient intelligence, audiovisual aids, data display, game theory	mass disaster, multiple trauma, natural disaster, nuclear accident, pandemic, radioactive hazard release
medical intern	medical informatics applications, smartphone, smart glasses, user-computer interface, video games, wearable electronic devices, wearable technologies, Wearable Proximity Sensors	radiation accident, structure collapse, traffic accident, terrorism, tidal wave, tornado
healthcare provider,	3D environment, AI, augmented virtuality, close-to-reality, computer environment, haptic technology, immersive virtual reality,	wildfire, catastrophe, catastrophic accident, CBRN, CBRNe, high-risk situations
EMS	enhanced realism, enhanced reality, extended reality, game-based, gamification, haptic-based, GPS, GPS-Based, High-Fidelity, Serious games	human-made disasters, terrorist attack

Keywords and MESH terms.

- 14 Adapt the search strategy for each database: PubMed, Embase, Scopus, PsycInfo, CINAHL, Cochrane Library, and ClinicalTrials.gov.

Pubmed Search strategy:

("mass casualty incident" OR "Mass Casualty Incidents"[MeSH] OR "crisis" OR "Disasters"[Mesh] OR "aircraft accident" OR "avalanche" OR "biological accident" OR "biohazard release" OR "bioterrorism" OR "bomb" OR "chemical accident" OR "chemical hazard release" OR "chemical terrorism" OR "climate change" OR "cyclonic storm" OR "disaster victim" OR "disaster" OR "drought" OR "earthquake" OR "emergency patient" OR "emergency shelter" OR "flood" OR "landslide" OR "mass-casualty incident" OR "mass disaster" OR "multiple trauma" OR "natural disaster" OR "nuclear accident" OR "pandemic" OR "radioactive hazard release" OR "radiation accident" OR "structure collapse" OR "traffic accident" OR "terrorism" OR "tidal wave" OR "tornado" OR "wildfire" OR "catastrophe" OR "catastrophic accident" OR "CBRN" OR "CBRNe" OR "high-risk situations" OR "human-made disasters" OR "terrorist attack") AND ("eye-tracking" OR "Technology"[Mesh] OR "virtual reality" OR "augmented reality" OR "mixed reality" OR "biometric sensors" OR "electroencephalogram" OR "digital monitoring" OR "motion tracking" OR "wearable devices" OR "performance dashboards" OR "psychophysiological tools" OR "galvanic skin response" OR "pupillometry" OR "heart rate variability" OR "Eye-Tracking Technology"[Mesh] OR "Virtual Reality"[Mesh] OR "Augmented Reality"[Mesh] OR "Spectroscopy, Near-Infrared"[Mesh] OR "Galvanic Skin Response"[Mesh] OR "artificial intelligence" OR "augmented reality" OR "human computer interaction" OR "human machine interface" OR "microcomputer" OR "mobile application" OR "user-centered design" OR "video game" OR "virtual reality" OR "wearable computer" OR "ambient intelligence" OR "audiovisual aids" OR "data display" OR "game theory" OR "human-computer interaction" OR "medical informatics applications" OR "smartphone" OR "smart glasses" OR "user-computer interface" OR "video games" OR "wearable electronic devices" OR "3D environment" OR "3-D environment" OR "AI" OR "augmented virtuality" OR "close-to-reality" OR "computer environment" OR "digital tools" OR "enhanced realism" OR "enhanced reality" OR "extended reality" OR "game-based" OR "gamification" OR "haptic-based" OR "haptic technology" OR "immersive virtual reality" OR "immersive virtual environment" OR "realistic scenarios" OR "real-world scenarios" OR "smart electronic devices" OR "smart wearables" OR "virtual patient" OR "virtual scenarios" OR "virtual worlds" OR "VR" OR "wearable technologies" OR "Wearable Proximity Sensors" OR Wearable OR GPS OR "GPS-Based" OR "High-Fidelity" OR "Serious games") AND ("first responders" OR "medical intern" OR "healthcare provider" OR "Paramedics"[MeSH] OR "Health Personnel"[MeSH] OR "Nurses"[MeSH] OR "Physicians"[MeSH]) AND ("Education"[Mesh] OR "Simulation Training"[Mesh] OR Training OR "Feedback training")

- 15 Manually search Google Scholar to capture relevant studies missed in database searches and to identify grey literature.

Stage 3: Study selection

- 16 Include studies involving medical first responders (MFRs), paramedics, EMTs, physicians, nurses, medical interns, residents, and students enrolled in health-related university programs (e.g., medicine, nursing, EMS).
- 17 Include studies that describe, implement, or evaluate educational or training programs using technology in the context of mass casualty incidents (MCIs).
- 18 Include studies that clearly simulate or replicate **prehospital** settings (e.g., field triage, ambulance scenarios, roadside scenes, disaster zones).
- 19 Include studies employing any research design (quantitative, qualitative, mixed-methods), as well as descriptive studies of simulation-based education, training interventions, or technological tools.
- 20 Include grey literature sources such as conference abstracts, theses, and government/NGO training reports if they provide sufficient methodological information.
- 21 Exclude studies exclusively set in in-hospital environments (e.g., emergency departments or operating rooms).
- 22 Exclude studies that do not involve disaster-related training or that focus solely on general emergency care, trauma surgery, or non-disaster clinical procedures.
- 23 Exclude studies that do not simulate a mass casualty scenario or that focus only on individual patient care rather than system-level response.
- 24 Exclude studies that evaluate outcomes without describing the training content, modality, or design features.
- 25 Exclude studies that include only non-healthcare populations (e.g., firefighters, police, military, laypeople) unless a separate analysis is reported for healthcare personnel.

Stage 4: Data Charting

- 26 Develop the data extraction form by piloting 5 studies and identify common variables relevant to curricular design in disaster medicine education.
- 26.1 **Study Identification and Design**
 - **Study ID** – Unique identifier (e.g., Author-Year or assigned number)
 - **Country** – Country where the study was conducted

- **Study Design** – E.g., experimental, observational, mixed methods, simulation study, etc.
- **Study Aim / Objective** – Summary of the study's aim
- **Duration of the Study** – Total time span from planning to completion

26.2 Population and Context

- **Population** – Type of participants (e.g., EMTs, paramedics, nurses, students)
- **Sample Size** – Number of participants involved
- **Setting** – Training context (e.g., prehospital field, simulation lab, mobile unit)

26.3 Intervention and Technology

- **Technology Used** – E.g., VR/AR, apps, serious games, wearable tech
- **Purpose of Technology Use** – E.g., training, assessment, decision-making
- **Comparator Present?** – Yes/No; describe if applicable

26.4 Data Collection and Evaluation

- **How Data Was Collected** – E.g., test scores, simulation logs, interviews
- **Outcome Measures** – E.g., knowledge gain, response time, skill accuracy
- **Quantitative vs. Qualitative Metrics** – E.g., numerical test data, thematic analysis
- **Adjunct Assessment Tools** – E.g., checklists, validated scales

26.5 Training Features and Implementation

- **Feedback Mechanism Provided** – Yes/No; type (real-time, post-scenario, adaptive, etc.)
- **Assessor's Occupation and Experience** – Role/background of those conducting assessment
- **Scalability Discussed?** – Yes/No; describe feasibility across settings
- **Participants' Concerns** – E.g., discomfort, technical issues, privacy

26.6 Outcomes and Insights

- **Key Findings** – Summary of training impact and effectiveness
- **Barriers/Challenges** – E.g., cost, access, staffing, tech limitations
- **Gaps Identified** – Unmet needs, content gaps, target group limitations
- **Limitations** – Reported or observed methodological or contextual issues
- **Key Message** – Takeaway message or relevance to review scope

Stage 5: Collate, summarize, and report the results.

- 27 Compile, summarize, and present extracted data from included studies using tables, figures, and other visual formats.
- 28 Analyze quantitative information (e.g., study frequencies, participant numbers, training formats) descriptively.
- 29 Use thematic analysis to categorize studies included in the review.



- Technology Type and Training Modality.
- Training Objectives and Focus.
- Target Learners and Professional Roles.
- Training Design and Implementation.
- Assessment and Evaluation Strategies.
- Feedback Mechanisms.
- Scalability and Real-World Applicability.
- Reported outcomes, implementation barriers, gaps, and success factors.

Stage 6 (Optional): Conduct Stakeholder Consultation

- 30 Engage relevant stakeholders involved in disaster preparedness and emergency training as part of an optional consultation step.
- 31 Include participants such as EMS educators, emergency physicians, paramedics, disaster management officials, policymakers, and simulation specialists.

Dissemination

- 32 Submit the final manuscript to a peer-reviewed journal specializing in emergency medicine, disaster preparedness, or simulation-based training.
- 33 Present key results at leading national and international conferences

Timeline:

- 34 Month 1: Registration & stakeholder meeting
- 35 Months 2-3: Search execution & import
- 36 Months 4-5: Screening
- 37 Months 6-7: Data extraction
- 38 Month 8: Synthesis workshop



39 Month 9: Draft manuscript

40 Month 10: Peer review

Protocol references

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