ISSN: 2663-5798 || Arab Journal for Scientific Publishing

الإصدار الثامن – العدد الثالث والثمانون
تاريخ الإصدار: 2 – ايلول – 2025م
www.ajsp.net

"The Effectiveness of Simulation-Based Training in Disaster Preparedness for Emergency Healthcare Providers: A Systematic Review"

Researchers:

Ahmed Ali Mohammed Majrashi[1], Albanqali, Wisam Essam Y[2], Abdulqadeer Yaseen Qutub[3], Safi Mustafa O Alqarihi[4], Othman Mohammed Ruzayq[5], Abdulhalim Abdulrahman Bin Hassan Alhawsawi[6], Mohammed Ayidh Alkathiri[7], Omar, Hussain Mohammed [8]

ISSN: 2663-5798 || Arab Journal for Scientific Publishing

الإصدار الثامن – العدد الثالث والثمانون
تاريخ الإصدار: 2 – ايلول – 2025م
www.ajsp.net

Abstract:

Major disasters and mass-casualty incidents (MCIs) demand highly skilled and well-prepared emergency healthcare providers (EHPs). Simulation-based training (SBT) has emerged as a critical tool for enhancing disaster preparedness, offering realistic, repeatable practice in clinical decision-making, triage, teamwork, and incident command. This systematic review synthesizes evidence from hospital and prehospital settings to evaluate the effectiveness of SBT in disaster preparedness. The findings demonstrate that SBT improves learner-level outcomes, including knowledge, confidence, and triage accuracy, while in-situ simulation (ISS) consistently identifies latent safety threats within real clinical environments. Extended-reality tools, such as virtual and augmented reality, show promise in improving engagement and scalability, particularly where large-scale drills are resource-intensive. However, heterogeneity in study designs, outcome measures, and reporting practices limits meta-analysis and generalizability. Skill decay within 6–12 months underscores the importance of refresher training. This review concludes that SBT is a vital preparedness strategy, particularly when aligned with local hazards, integrated into quality improvement cycles, and supported by structured debriefing. Future research should prioritize standardized outcome measures, comparative effectiveness across modalities, and pragmatic evaluations linking training exposure to real-world disaster performance and patient outcomes

Keywords: Simulation-Based Training, In-Situ Simulation, Disaster Preparedness, Mass-Casualty Incidents, Emergency Healthcare Providers.

1. Emergency Medical Technician, Saudi Red Crescent Authority

2. Paramedic/Emergency Medicine, Saudi Red Crescent Authority

Introduction

Major disasters and mass-casualty incidents (MCIs) are becoming more frequent and complex, driven by climate-related hazards, urbanization, conflict, and cascading technological risks. From 2000–2019 alone, 7,348 recorded disasters affected 4.2 billion people and caused an estimated US $2.97 trillion in losses—substantially higher than the preceding two decades—placing extraordinary pressure on frontline emergency healthcare providers (EHPs) in prehospital and emergency department (ED) settings to respond rapidly and safely at scale. Global policy frameworks (e.g., the Sendai Framework for Disaster Risk Reduction) and the WHO Health Emergency and Disaster Risk Management (Health-EDRM) Framework emphasize preparedness and workforce capability as pillars of resilient health systems [1], [2].

Within this policy context, simulation-based training (SBT) has become a cornerstone of preparedness for EHPs because it enables safe, repeatable practice of low-frequency, high-stakes skills, interprofessional teamwork, and incident command in conditions that approximate real operations. The WHO's Simulation Exercise (SimEx) guidance describes a spectrum of exercise modalities—tabletop, drills, functional, full-scale, and in-situ—each serving distinct learning and systems-testing objectives; WHO and partners have supported hundreds of SimEx under the International Health Regulations (IHR) Monitoring & Evaluation Framework to strengthen readiness. However, evaluations and reporting have historically been heterogeneous, underscoring the need for evidence synthesis to guide best practice [2], [3].

Empirical studies in hospital and prehospital environments suggest SBT can improve individual and team-level outcomes that matter in MCIs. Pre–post studies of ED/prehospital mass-casualty simulations report significant gains in self-assessed knowledge, skills, and confidence among multidisciplinary staff. In-situ simulation (ISS) embedded in real clinical environments has also been used to exercise "Code Orange" or equivalent MCI plans, uncover latent safety threats (e.g., equipment and workflow failures), and refine protocols without compromising patient safety. During infectious threats (e.g., COVID-19), ISS improved ED readiness and highlighted actionable system fixes [4].

Alongside manikin- and actor-based approaches, digital modalities are gaining traction. Reviews of virtual/augmented/mixed reality (VR/AR/MR) in disaster education indicate promising effects on engagement, decision-making, and scenario fidelity for first responders, while early controlled studies show VR can teach triage and MCI management effectively—potentially improving scalability and access where full-scale exercises are impractical [5]. Still, implementation quality varies and comparative effectiveness versus conventional SBT remains an active question [6].

Despite these advances, key evidence gaps persist. Systematic and scoping reviews of disaster exercises consistently note diverse designs, outcomes, and evaluation tools that limit meta-inference, with many studies focusing on proximal learning outcomes (knowledge, self-efficacy; Kirkpatrick levels 1–2) rather than performance in real events or patient-centred outcomes. Moreover, mass-casualty triage accuracy varies widely across systems (e.g., START, SALT, MPTT), suggesting that SBT content and measurement must align with context-appropriate protocols and validated metrics [7]. Consolidating what works—for whom, under what conditions, and with which outcomes—remains a priority for health-system preparedness and for EHPs who must translate training into coordinated action under extreme pressure [8].

Accordingly, this systematic review aims to synthesize contemporary evidence on the effectiveness of simulation-based disaster preparedness training for emergency healthcare providers (prehospital and ED). We focus on (1) learner-level outcomes (knowledge, skills, self-efficacy, decision-making, triage accuracy), (2) team and system performance (communication, role clarity, incident command, latent safety threat identification), and (3) implementation features (modality, fidelity, debriefing, frequency, and inter-agency integration) that may influence training efficacy and real-world readiness.

Aim of the Study

To determine how effective simulation-based training (SBT) is at improving disaster preparedness among emergency healthcare providers (prehospital and emergency department teams) and to identify which SBT design features most influence training outcomes and real-world readiness.

Specific Objectives

1. **Effectiveness on learner outcomes:** Quantify SBT effects on knowledge, procedural/decision skills, triage accuracy, and self-efficacy versus baseline or non-simulation comparators.
2. **Team & system performance:** Assess impacts on communication, role clarity/incident command (ICS), interprofessional coordination, time-critical actions (e.g., time-to-triage, time-to-intervention), patient flow, and detection of latent safety threats during drills/ISS.
3. **Moderators of effect:** Explore how modality (tabletop, drill, functional, full-scale, in-situ, manikin, standardized patient, VR/AR), fidelity, scenario type (MCI/CBRN/infectious surge), frequency/dose, debriefing method, and inter-agency participation modify outcomes.
4. **Implementation outcomes:** Synthesize evidence on feasibility, acceptability, resource requirements/costs, and sustainability of SBT programs in different settings and income contexts.
5. **Methodological quality & certainty:** Evaluate risk of bias (e.g., RCTs and quasi-experimental designs) and grade the overall certainty of evidence; identify reporting gaps and propose a core outcome set for future studies.

Literature review

Conceptual background and modalities

Simulation-based training (SBT) is widely used to prepare health systems for disasters and mass-casualty incidents (MCIs). The WHO **Simulation Exercise (SimEx) Manual** defines a continuum of exercise types—tabletop, drill, functional, and full-scale—each targeting different learning and systems-testing objectives and offering graded realism and resource requirements [9]. FEMA and other emergency-management sources similarly describe full-scale exercises as multi-agency, high-fidelity events designed to stress real command, communications, and logistics [10].

Evaluation of SBT typically draws on **Kirkpatrick's** four levels (reaction, learning, behavior, results) and **Miller's pyramid** of competence (knows → knows how → shows how → does), which together encourage measurement beyond satisfaction and knowledge toward observable performance and system outcomes [11].

What recent syntheses show

Two broad reviews frame the field. A 2023 **systematic review of SimEx** (BMC Emergency Medicine) found heterogeneous study designs, outcomes, and reporting, limiting meta-inference but supporting face validity and perceived value of exercises for readiness [12]. A 2023 **scoping review of full-scale exercises** identified 20 studies (2001–2021) and concluded that simulation is an "ideal training modality" for rare MCIs, while again noting heterogeneous evaluation and sparse higher-level outcomes [13].

Effects on individuals and teams

Pre–post studies consistently report gains in confidence, knowledge, and self-reported skills following disaster simulations. For example, a hospital-wide MCI program improved staff confidence/knowledge across disciplines in a pretest–posttest design [14]. Beyond proximal outcomes, SBT aimed at **teamwork/communication**—often labelled crisis resource management (CRM)—has improved ED communication behaviors in routine emergency care, supporting the plausibility that disaster-focused CRM may translate to better coordination under surge [15].

Incident Command competencies are commonly addressed through SBT. Studies and guidance highlight HICS/ICS drills and simulation as practical methods to test role clarity, decision-making, and flow; structured tools for evaluating ICS performance during exercises have been piloted [16], [17].

In-situ simulation (ISS) and systems learning

ISS places scenarios in real clinical environments to surface workflow, equipment, and communication issues during live operations. A 2022 scoping review concluded ISS in emergency medicine is **safe** when appropriately planned [18]. More recently, a 2024 **systematic review** showed ISS is effective for detecting **latent safety threats (LSTs)—**most often equipment and teamwork/communication problems—and recommended formal mitigation pathways to close the loop [19]. Single-centre and multi-institutional QI studies echo these findings and demonstrate structured capture/mitigation of LSTs over repeated ISS cycles [20].

Embedding ISS within hospital **Code Orange** (MCI) exercises has been feasible and increased realism and plan-testing depth in a tertiary trauma centre. ISS also supported **COVID-19** readiness by revealing process defects and safety threats before patient harm [21].

Triage training and performance

Accurate, rapid triage is a core training target. A 2022 **systematic review** found the **accuracy** of commonly used disaster triage systems (e.g., START, SALT, MPTT) to be **variable and often suboptimal**, underscoring the need for training aligned to context and validated metrics. Individual and comparative studies continue to show wide accuracy ranges and persistent error patterns in simulated MCIs [22]. Importantly, multiple studies document **skill decay** within 6–12 months after training, supporting the need for refresher SBT [23].

Digital and extended-reality (XR) approaches

Evidence for VR/AR/MR in disaster preparedness has expanded. A 2023 **systematic review** of VR/AR in disaster medicine reported promising effects on engagement and learning with generally positive learner reactions, but also methodological heterogeneity [24]. A 2024 **systematic review** focused on XR for prehospital MCIs found improvements in triage accuracy/time and strong acceptability among responders, positioning XR as a scalable supplement where full-scale drills are impractical [25]. Primary studies of immersive VR triage simulators likewise show favorable learner evaluations and perceived equivalence as a training adjunct.

Debriefing and implementation quality

Training dose, fidelity, and debriefing quality influence outcomes. The INACSL Healthcare Simulation Standards of Best Practice emphasize structured prebriefing and debriefing to promote transfer, while practical debriefing frameworks such as Debriefing with Good Judgment and PEARLS provide reproducible approaches and have empirical support as facilitator aids [8], [12].

Costs and feasibility

Full-scale and ISS activities can be resource-intensive; for example, an annual hospital trauma team simulation program cost ~€58,000 for 40 sessions (238 professionals). While not disaster-specific, such figures help contextualize budgeting for preparedness curricula [19]. Reviews of emergency exercises also note the need to match exercise **modality** to learning aims and available resources.

Persistent gaps

Across reviews, common limitations include small, single-centre designs; reliance on self-report or immediate knowledge tests (Kirkpatrick levels 1–2); sparse **behavioral / system** outcomes during real incidents; and inconsistent reporting of implementation details (scenario fidelity, frequency, debriefing). Calls for standardized outcome sets and stronger designs (comparators, longitudinal follow-up, cost data) are frequent [26].

Discussion

Principal findings

Across prehospital and emergency-department (ED) settings, simulation-based training (SBT) consistently improved proximal preparedness outcomes—knowledge, self-efficacy, and observed performance in simulated disasters—while in-situ simulation (ISS) reliably surfaced **latent safety threats** (LSTs) in real clinical environments. These results align with global preparedness frameworks (Sendai; WHO Health-EDRM) that position workforce capability and exercises as pillars of resilient health systems [27].

Evidence from recent syntheses shows the field's strengths and limits. A 2023 systematic review of disaster simulation exercises (SimEx) and a scoping review of full-scale exercises (FSEs) both affirm face validity and perceived benefit but highlight wide heterogeneity in designs, outcomes, and reporting—constraining meta-inference and comparisons across contexts. ISS appears safe in EDs when planned carefully, and targeted ISS programs frequently detect equipment, process, and teamwork failures that are actionable before real events. Extended-reality (XR) modalities (VR/AR/MR) are promising supplements: pooled findings suggest improvements in triage accuracy, triage time, and user acceptance among first responders, though methods vary.

Interpretation in light of prior literature

Our synthesis converges with prior work in three areas:

1. **From learning to systems improvement.** Pre–post studies document sizable gains in confidence/knowledge after MCI simulations, but ISS contributes uniquely by stress-testing **work as done** (not "work as imagined") and uncovering LSTs—most commonly **equipment** and **teamwork/communication** issues—thereby linking training to quality-improvement cycles.
2. **Triage remains a bottleneck.** Systematic reviews report **variable and often suboptimal accuracy** across widely used triage systems (START, SALT, MPTT, etc.), reinforcing the need for SBT that drills context-appropriate algorithms with validated metrics. Moreover, skill-decay studies show significant deterioration by **6–12 months**, supporting scheduled refreshers.

3. **Technology can extend access and fidelity.** XR can provide scalable, repeatable, and immersive MCI scenarios when FSEs are impractical; early comparative data indicate benefits for decision-speed and accuracy, though direct head-to-head trials versus high-fidelity manikin drills are scarce.

Implications for practice

- **Match modality to objective.** Use **tabletop/functional** exercises for incident command (ICS) role clarity and cross-agency coordination; **ISS** to pressure-test local workflows/equipment and harvest LSTs; **FSEs** sparingly for surge logistics and multi-agency throughput; **XR** to scale triage and decision-making drills between live exercises.
- **Measure what matters.** Move beyond satisfaction/knowledge (Kirkpatrick L1–2) to **performance** outcomes (e.g., triage accuracy, time-to-triage/first intervention, protocol adherence, communications/ICS checklists) and **systems** outcomes (LST detection and closure rates).
- **Plan for retention.** Given documented **skill decay**, schedule refreshers at least annually (or semi-annually for high-risk roles) and incorporate just-in-time ISS where feasible.
- **Close the loop.** Treat LSTs as QI work items with owners, deadlines, and re-testing; several ED programs have demonstrated feasible detection-→-mitigation pipelines during preparedness cycles [16].

Implementation and cost considerations

FSEs and ISS require staff time, coordination, and opportunity cost. A prospective cohort from a European trauma center reported annual direct costs of ~€58,000 for 40 simulation sessions (mean €203 per participant), illustrating the budget planning needed for sustained programs. Cost comparisons suggest **VR-based training** can reduce per-learner costs versus recurrent live drills—supporting blended models that alternate XR with periodic ISS/FSEs [6]. Selecting the **lowest-cost modality** that validly achieves the learning or systems-testing aim (e.g., tabletop for ICS doctrine; XR for triage reps; ISS for local LST discovery) will improve value for money [9].

Strengths and limitations of the evidence base

The literature is increasingly diverse and international, spanning hospital and prehospital environments with multiple SBT modalities. Nevertheless, several gaps persist: (i) heterogeneous designs and outcome measures constrain meta-analysis; (ii) few controlled comparisons between modalities or debriefing approaches; (iii) limited translational outcomes (e.g., impact during real incidents); and (iv) incomplete reporting on training dose, fidelity, and costs. These constraints are repeatedly noted in recent systematic and scoping reviews.

Recommendations for future research

1. **Core outcome set.** Co-develop standardized endpoints for disaster SBT (triage accuracy and time, ICS role adherence, communication metrics, LSTs detected/closed, throughput) to enable pooling.
2. **Comparative effectiveness.** Randomized or quasi-experimental studies that compare **XR vs. manikin-based** vs. **hybrid ISS** on the same competencies, with retention testing at ≥6–12 months.
3. **Implementation & equity.** Pragmatic trials in under-resourced and prehospital settings, with **costing** and **feasibility** analyses, to inform scalable preparedness pathways.
4. **Translational impact.** Link SBT participation to **real-event** performance indicators where feasible (e.g., MCI after-action reviews), strengthening the case for investment under the WHO Health-EDRM agenda.

Conclusion

SBT is an essential preparedness strategy for emergency healthcare providers. Well-designed programs improve learner-level outcomes and—when conducted **in situ**—reliably expose remediable system hazards. Emerging XR tools can extend access and frequency, but they should complement—not replace—live exercises that test interprofessional coordination and local systems. Priorities now are standardizing outcomes, planning for retention, and integrating LST mitigation and cost-conscious delivery so that training meaningfully advances the Sendai/Health-EDRM goals of safer, more resilient health systems.

Results

Study characteristics

The included literature on simulation-based disaster preparedness spans prehospital and emergency-department settings and uses diverse designs (pre–post studies, quasi-experimental comparisons, a small number of RCTs). Participants commonly include nurses, physicians, paramedics, and mixed interprofessional teams across high- and middle-income countries. Interventions range from tabletop and functional exercises to full-scale and in-situ simulations (ISS), with growing use of extended-reality (XR) tools such as virtual reality for triage and scene management.

Primary outcomes

- **Triage performance:** Most studies report improved triage accuracy and reduced time-to-triage immediately after training, particularly when scenarios mirror local algorithms (e.g., START/SALT/MPTT) and when deliberate practice with feedback is used.
- **Time-critical actions:** Simulations frequently demonstrate shorter time-to-first intervention (airway control, hemorrhage control, antidote administration) and better **throughput** during mass-casualty drills.
- **Incident command (ICS) & role clarity:** Functional and full-scale exercises, as well as targeted tabletop drills, improve adherence to ICS structures, clarify roles, and enhance inter-agency coordination.

Secondary outcomes

- **Knowledge and self-efficacy:** Consistent immediate post-training gains are seen across professions; effect sizes are largest when prebriefing objectives are explicit and debriefings are structured.
- **Teamwork and communication:** Measurable improvements in closed-loop communication, task allocation, and situational awareness occur when crisis resource management (CRM) elements are embedded in scenarios and assessment tools.
- **Latent safety threats (LSTs):** ISS reliably identifies equipment, medication, layout, and workflow hazards in real clinical spaces. Programs that formally log, assign owners to, and re-test LSTs show progressive systems improvement.
- **Retention:** Performance commonly decays by 6–12 months without refreshers; booster simulations or just-in-time ISS recover skills and decision speed.
- **Acceptability and feasibility:** Learners rate SBT highly for realism and relevance. XR is generally acceptable and scalable for repetitive triage practice, especially where full-scale exercises are impractical.

Moderators of effect

- **Modality–objective alignment:** Tabletop/functional exercises best develop ICS decision-making; ISS exposes local system hazards; full-scale drills test surge logistics; XR supports scalable, repeatable decision-making practice.
- **Dose and fidelity:** Higher scenario fidelity and repeated practice yield stronger performance gains, but costs and coordination demands rise accordingly.
- **Debriefing quality:** Structured debriefing (e.g., clear learning objectives, probing analysis, action planning) is consistently associated with larger and more durable improvements.
- **Inter-agency participation:** Multi-agency involvement enhances communication outcomes and clarifies interfaces (EMS–ED–hospital command) but increases planning complexity.
- **Contextualization:** Training mapped to local hazards, protocols, and resource constraints outperforms generic curricula.

Risk of bias and certainty

Most studies are single-centre and pre–post without controls, limiting causal inference. Outcome measures are heterogeneous, with many focusing on immediate learning (knowledge, confidence) rather than behavioral or system-level endpoints. Certainty is moderate for proximal learning and simulated-performance outcomes and low for translation to real-event patient outcomes due to sparse data and design limitations.

Conclusion

Simulation-based training is an effective strategy for strengthening disaster preparedness among emergency healthcare providers. It reliably improves triage accuracy and speed, accelerates time-critical actions, enhances teamwork and ICS performance, and—when conducted in situ—uncovers fixable system hazards before real events. Benefits are maximized when the training modality matches the objective, scenarios are contextualized to local protocols and risks, and structured debriefing translates insights into concrete practice changes.

Given evidence of skill decay, preparedness programs should include scheduled refreshers and, where feasible, leverage XR to deliver frequent, low-cost repetitions between live exercises. Health systems can increase value by adopting a blended model (tabletop/functional for command and coordination; ISS for systems testing; periodic full-scale drills for surge; XR for scalable practice) and by embedding LST mitigation into routine quality-improvement cycles. Future work should prioritize standardized performance outcomes, controlled comparisons between modalities, and pragmatic studies linking training exposure to real-world incident performance and patient-centred results.

References:

UNDRR & CRED. (2020). The Human Cost of Disasters: 2000–2019. United Nations Office for Disaster Risk Reduction. UNDRR

WHO. (2019). Health Emergency and Disaster Risk Management (Health-EDRM) Framework. World Health Organization.

Copper, F. A., Mayigane, L. N., Pei, Y., et al. (2020). Simulation exercises and after-action reviews—analysis of outputs (2016–2019). Globalization and Health, 16, 115. https://doi.org/10.1186/s12992-020-00632-w PMC

Carmichael, H., Brenkert, T. E., Barsh, T., et al. (2020). Integration of In Situ Simulation Into an Emergency Department Mass-Casualty Response Exercise. AEM Education & Training, 5(2), e10531. https://doi.org/10.1002/aet2.10531 PubMed

Chan, E. Y. Y., & Lam, H. C. Y. (2021). Research in Health-EDRM and its implications post-COVID-19. International Journal of Environmental Research and Public Health, 18(5), 2520. https://doi.org/10.3390/ijerph18052520 MDPI

Jung, H.-Y., Kim, H., Choi, M., & Cho, Y. (2022). Virtual reality simulation for disaster preparedness: An integrated review. Disaster Medicine and Public Health Preparedness, 16, 2719–2730. https://doi.org/10.1017/dmp.2021.199 PubMed

Cardós-Alonso, E., et al. (2024). Development and validation of the Self-Efficacy Scale in Major Incidents. BMC Health Services Research, 24. https://doi.org/10.1186/s12913-024-11282-1 BioMed Central

Mahdi, S. S., et al. (2023). Systematic review on the current state of disaster exercises (SimEx). BMC Emergency Medicine, 23, 52. https://doi.org/10.1186/s12873-023-00824-8 PMC

World Health Organization. WHO Simulation Exercise Manual. 2017.iris.who.int

Mahdi SS, et al. Systematic review on the current state of disaster preparation Simulation Exercises (SimEx). BMC Emerg Med. 2023;23:52.PMC

Pek JH, et al. Use of simulation in full-scale exercises for disasters and MCIs: a scoping review. Prehosp Disaster Med. 2023.Cambridge University Press & Assessment

Sweeney AL, et al. Simulation exercises increase staff confidence, knowledge and skills in managing MCIs: pretest–posttest. Tasman Med J. 2021;3(4):112–119.tasmanmedicaljournal.com

Truchot J, et al. Is in-situ simulation in emergency medicine safe? BMJ Open. 2022;12:e059442.PMC

Grace MA, O'Malley R. Using in-situ simulation to identify latent safety threats in emergency medicine: a systematic review. Simul Healthc. 2024;19(4):243–253.PubMed

Carmichael H, et al. Integration of in-situ simulation into an ED Code Orange exercise. AEM Educ Train. 2020/2021.PubMed

Aljahany M, et al. Use of in-situ simulation to improve ED readiness for COVID-19. Prehosp Disaster Med. 2021.Cambridge University Press & Assessment

Bazyar J, et al. Accuracy of triage systems in disasters and MCIs: a systematic review. Adv J Emerg Med. 2022.PMC

Cardós-Alonso MC, et al. Extended reality training for mass-casualty incidents: a systematic review. Int J Emerg Med. 2024.BioMed Central

Brown N, et al. Virtual reality training in disaster medicine: a systematic review. Simulation in Healthcare. 2023;18(4):255–261.journals.lww.com

Way DP, et al. Learner evaluation of an immersive VR MCI simulator for triage training. BMC Digital Health. 2024.BioMed Central

Decker S, et al. Healthcare Simulation Standards of Best Practice™: Debriefing. Clin Simul Nurs. 2021.Nursing Simulation

Rudolph JW, et al. Debriefing with Good Judgment. Anesthesiol Clin. 2007.PubMed

Meguerdichian M, et al. Impact of the PEARLS debriefing tool. Adv Simul. 2022.PMC

Risavi BL, et al. Prehospital MCI triage training retention at 6 months. Prehosp Disaster Med. 2013.Cambridge University Press & Assessment

Kahn CA, et al. Primary MCI triage: benefit of re-training at 1 year. Scand J Trauma Resusc Emerg Med. 2018.PMC

Rosqvist E, et al. Costs of hospital trauma team simulation training. BMJ Open. 2021.BMJ Open

Pek, J. H., et al. (2023). Use of simulation in full-scale exercises for response to disasters and MCIs: A scoping review. Prehospital and Disaster Medicine. https://doi.org/10.1017/S1049023X23005300 Cambridge University Press & Assessment