

Enhancing Team Performance through Mock Drills in Disaster Medicine and Emergency Medical Services

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Abstract

Background: Effective disaster management depends on the well-coordinated performance of teams within disaster medicine and emergency medical services (EMS). Mock drills serve as an important cornerstone of training for these team members, yet their effectiveness in optimizing team performance remains an area of active investigation. Present narrative review examines the understanding of the applicability of mock drills to further enhance team performance in disaster medicine and EMS.

Method: An extensive search of pertinent literature was carried out to identify studies investigating the application of mock drills in disaster preparedness training. The review examines the documented advantages, drawbacks, and prospective research areas for this training method.

Results: Mock drills significantly enhance knowledge, communication, and problem-solving skills among disaster medicine and EMS team members. However, transforming these gains into sustained improvements in real-world scenario performance requires further exploration. Merging discussion-based and operation-based drills, customizing scenarios for EMS/paramedic difficulties, and integrating psychological stressors are promising approaches for optimizing drill design. Integrating insights from the learning sciences and conducting longitudinal research studies are necessary for maximizing knowledge retention and establishing the long-term impact of drills on real-world performance. Finally, the potential of virtual reality (VR), artificial intelligence (AI), and serious game-based platforms warrants further investigation for their ability to create immersive and dynamic training simulations.

Conclusions: Mock drills offer an important and variable tools for enhancing team performance in disaster medicine and EMS. By optimizing drill design, maximizing learning and retention, and embracing technological advancements, this training modality can be further refined to ensure optimal preparedness for the complexities of real-world disaster response.

Index Terms: Mock drills, disaster medicine, emergency medical services, team performance, communication, training simulation, paramedics

I. Introduction

The landscape of emergency medical services (EMS) is constantly evolving, demanding a highly skilled and adaptable workforce. In addition to the standard management of acute illness and injuries, contemporary EMS providers must be prepared to respond to these types of diverse range of large-scale emergencies, such as natural disasters, mass casualty incidents (MCIs), and public health crises. These events create unique challenges, marked by limited resources, chaotic conditions, and a surge in critically ill patients. Effective management hinges on the coordinated efforts of a well-rehearsed team, able to make quick and efficient decisions under extreme pressure.[1]

Mock drills, meticulously designed simulations that mimic real-world disaster scenarios, have become a fundamental part of effective disaster preparedness in EMS.[2] These exercises provide a controlled environment for teams to practice communication, resource allocation, triage protocols, and critical clinical skills in a high-fidelity setting. By simulating the stress and chaos characteristic of disaster situations, mock drills reveal potential shortcomings in current protocols and communication channels, promoting ongoing improvement and adaptation. [3]

The efficacy of mock drills can transcend the realm of technical skill development. Growing evidence indicates that these exercises promote neuroplasticity, the brain's ability to adapt and form new neural connections.[4] Regular exposure to simulated disaster scenarios strengthens cognitive pathways associated with decision-making, situational awareness, and crisis resource management. This results in

improved team performance under pressure, with clearly enhanced communication, coordination, and problem-solving during real-world disasters.[5]

Disaster preparedness encompasses more than just technical and cognitive readiness. The psychological toll of MCIs and large-scale emergencies can be profound for EMS personnel.

Mock drills provide a safe environment for teams to face anticipated stressors and anxieties associated with these events. By promoting open communication and debriefing sessions after simulations, mock drills can cultivate team resilience and psychological preparedness, mitigating the risk of post-traumatic stress disorder (PTSD) and burnout in the aftermath of a real disaster.[6]

Contemporary disaster response requires the smooth collaboration of a diverse group of healthcare professionals, including emergency physicians, nurses, paramedics, and mental health specialists. Mock drills offer a valuable opportunity to refine interprofessional communication and teamwork. By integrating personnel from various disciplines into simulated scenarios, mock drills cultivate a shared understanding of roles and responsibilities, optimizing coordinated patient care during MCIs.[7]

Meticulously designed simulations that mimic real-world disaster scenarios, known as mock drills, have become a fundamental component of effective disaster preparedness for EMS, with paramedics at the forefront. These exercises provide a controlled environment for paramedic teams to practice critical skills such as communication, resource allocation, triage protocols, and advanced clinical interventions in a high-fidelity setting. By replicating the stress and chaos inherent in disaster situations, mock drills reveal potential shortcomings in current protocols and communication channels, fostering continuous improvement and adaptation for paramedic teams.[8]

This review article aims to analyze the current body of research work done analyzing the impact of mock drills on team performance in disaster medicine and EMS, with a particular focus on the benefits for paramedics.

II.Aims & Objectives

This narrative review article aims to thoroughly assess the available literature on the effect of mock drills on team performance in disaster medicine and emergency medical services (EMS), with a specific focus on the advantages for paramedics. To achieve this goal, the review will assess the effectiveness of mock drills in improving core teamwork skills, enhancing cognitive function relevant to disaster response, and promoting psychological preparedness, and facilitating interprofessional collaboration within EMS teams.

III.Methodology

This narrative review employed a comprehensive approach to analyze the existing literature on the impact of mock drills on team performance in disaster medicine and emergency medical services (EMS), with a particular focus on the benefits for paramedics.

A comprehensive search for relevant studies was conducted across multiple electronic databases, including PubMed, MEDLINE, CINAHL, and Cochrane Library. The search strategy utilized a combination of controlled vocabulary (MeSH terms) and keywords related to disaster medicine, emergency medical services, mock drills, and team performance. The specific search terms and Boolean operators were customized for each database to maximize the retrieval of relevant articles.

Inclusion criteria: Research papers focused on EMS personnel, particularly paramedics with a significant paramedic presence; investigated the use of mock drills in disaster preparedness training; assessed the impact of mock drills on team performance, including communication, coordination, decision-making, or psychological preparedness; and were peer-reviewed research articles, such as randomized controlled trials, observational studies, or qualitative studies exploring the live experiences of EMS personnel with mock drills.

Exclusion criteria: Studies not published in English, abstracts, editorials, letters to the editor, or case reports, and studies focusing on disaster preparedness for other healthcare professionals outside the EMS or disaster response context.

Selection Process

After the initial search, duplicate articles were removed. Titles and abstracts were then screened to identify studies potentially meeting the inclusion criteria. Any disagreements were resolved through discussion and, if necessary, consultation with a third reviewer. Full-text articles of the selected studies were retrieved and thoroughly reviewed to ensure they aligned with the research objectives. A narrative review approach was implemented to integrate the findings from the selected studies.

IV. Results

Improved Triage Accuracy and Efficiency

Previous research findings have demonstrated the significant role of mock drills in enhancement of triage skills, which constitute a primary competency in MCIs. [9]. Research findings showed that team members involved in multi-day disaster simulations significantly improved their readiness in terms of rapidly assessing patient acuity and making appropriate usage of triage protocols. [10]

This improvement was especially attributed towards the repeated practice of standardized triage algorithms in a real life scenarios, allowing a sense of familiarity and confidence in making judgements under pressure. [11] Similar type of research study by Kirkpatrick et al. reported that mock drills implementing real life presentations and resource limitations ultimately led to a reduced mis-triage rates and a more effective allocation of scarce medical resources. [12]

Enhanced Communication and Collaboration

Effective level of communication and team collaboration are important factors for getting successful disaster responses. The reviewed available literature strongly focused on the positive outcomes of mock drills on these essential angle of enhanced team coordination and overall performance. [13] Sultan et al. also noted a considerable enhancement in team communication after involvement in disaster simulations programs. These improvements consisted of clearer and sound information exchange, minor redundancy, and a more coordinated approach towards the patient care. [7] The mock drills also provided a concrete platform for team members to practice inter-professional communication skills, favoring the collaboration between diverse healthcare professionals, like physicians, nurses, and paramedic staff. [14] Additionally, the debriefing sessions followed by the drills served as important opportunities for team members to identify communication gaps and development of newer strategies accordingly to improve vital information exchange in real-world emergency situations. [15]

Strengthened Human Resource Management

Significant lack of human resources is a defining factor of disaster situations. Previously published research studies projected on the efficacy of mock drills in further adaptation of teams with the skillsets necessary for the management of restricted human resources effectively. [16] Previous researchers have studied the burden of a resource-restricted MCI simulation on a team members of emergency medical services. An interesting study by Skryabina et al. noted that involvement in the drill exercise considerably improvised the team members ability to prioritize resource allotment, further improvise with restricted instruments, and make sound decisions in relation with the utilization of life-saving interventions. [17] Research by Kyomuhangi et al. (2022) targeting on health system improvisation in low to middle-income countries, their study findings about the Maximizing Engagement for Readiness and Impact (MERI) approach gives a valuable thought for disaster preparedness training. The MERI framework especially focuses on the significance of developing readiness through a combination of capacity-building activities, stakeholder engagement, and a well structured implementation protocol. These core principles can be efficiently implemented to disaster preparedness education programs, assuring that healthcare team members are not only equipped with the necessary skillsets but also having the motivation and collaborative spirit required for navigating the complexities of disaster response and preparedness. [18]

MERI Approach: Using the strength of MERI framework, disaster preparedness education programs can follow the SOPETAR Process Model. As described in **Table 1**, this cyclical model shows a group of steps which involves Scan, Orient, Plan, Equip, Train, Act, & Reflect – that helps in implementing various process at different levels (district, healthcare facility, community). By systematically scanning the environment for present resources and requirements, orienting team members to disaster situations, and joint planning and equipping of the team members, the SOPETAR model translates a well-rounded training

strategy. The training (Train) and action (Act) phases directly transforms the acquired knowledge into clinical practice through mock drills and various exercises. Lastly, reflection, by the nature of the debriefing process, is what allows the training program to continue on its path for improvement and adaptation, thereby enhancing a learning culture for preparedness within health teams. [18]

Table 1: The MERI Approach for Disaster Preparedness Training [18]

Component	Description	Relevance to Disaster Preparedness Training
MERI Change Strategies	Activities that develop general and disaster-specific capabilities for effective response.	Examples: Workshops on triage protocols, communication skills training, team resource management exercises...etc.
SOPETAR Process Model	A cyclical model guiding implementation at different levels (district, facility, community).	Scan: Evaluate existing resources and disaster vulnerabilities.
		Orient: Educate participants on potential disaster scenarios.
		Plan: Collaboratively develop response plans and protocols.
		Equip: Provide necessary supplies and equipment for disaster response.
		Train: Conduct mock drills and simulations to practice skills.
		Act: Implement response plans during a disaster.
		Reflect: Debrief after drills and real-world events to identify areas for improvement.
MERI Motivational Framework	Fundamental factors that enhance intervention adoption and team motivation.	Self-reliance: Encourage team-members to take ownership of their preparedness.
		Collective action: Foster collaboration between different healthcare disciplines.
		Embeddedness: Integrate training into existing workflows.
		Comprehensiveness: Address diverse disaster scenarios and team needs.
		Transparency: Ensure clear communication throughout the training process.

Psychological Resilience and Stress Management

Disasters can be highly stressful for healthcare workers, with the potential to imbalance their judgment and decision-making ability. The literature review by Wang et al. shed light on the role of mock drills in strengthening psychological resilience and promoting effective stress management. [19] Studies suggested that participation in disaster simulations served as a form of psychological fortification. By exposing teams to the stressors associated with MCIs in a controlled environment, the drills allowed them to develop coping strategies and build confidence in their ability to handle the emotional challenges of disaster response. [20] Furthermore, the debriefing sessions following mock drills provided a safe space for teams to discuss their emotional responses and develop strategies for maintaining composure and clear communication under pressure.[21]

Individual and Organizational Benefits

Our review of the literature reveals a variety of benefits for both individuals and organizations participating in mock drills. At the individual level, mock drills have been shown to improve knowledge, skills, attitudes, and perceptions (KSAPs) related to emergency response.[22] The benefits extend beyond the individual level to impact organizational preparedness as well. Mock drills are a valuable tool for identifying weaknesses and shortcomings in existing emergency plans and procedures. By simulating real-world scenarios, drills expose weaknesses in communication protocols, resource allocation, and overall response strategies. This allows organizations to proactively address these shortcomings and refine their plans before a crisis strikes.[23] Moreover, the after-action review process associated with mock drills provides a structured opportunity to identify lessons learned and translate them into actionable improvements. [24] Regular participation in mock drills can thus lead to a continuous cycle of improvement, ensuring that organizations remain prepared to effectively respond to a wide range of disasters and emergencies.

Mock drills are fundamental to disaster preparedness, enabling teams to test their response plans and identify areas for improvement. These exercises come in a variety of formats, each with its own strengths and limitations. Tabletop exercises, for instance, provide a platform for facilitated discussion and plan review. Although tabletop exercises offer a valuable platform for discussing plans and identifying weaknesses, their static nature hinders their ability to assess the real-world dynamics of teamwork and communication during a crisis. Conversely, operation-based exercises, though effective in evaluating individual skills and resource deployment, often lack the focus on team interaction necessary for disaster medicine and emergency medical services. [26]

This underscores the potential value of exploring combined drill formats that utilize the strengths of both approaches. By incorporating facilitated discussions within operation-based exercises, responders can not only practice their technical skills but also refine their communication and collaboration strategies in a more realistic setting.[27] Additional research on the design and implementation of such combined drills is required to evaluate their effectiveness in improving team performance within disaster medicine and emergency medical services.

Beyond enhancing team performance, mock drills offer significant benefits at the organizational level. A core objective is to identify gaps and limitations in existing emergency plans and procedures. Although studies report successful identification of these shortcomings, translating "lessons learned" into actionable improvements continues to be a challenge. Limited evidence suggests that many identified issues are not fully addressed after drills. To bridge this gap, a two-pronged approach is recommended. Firstly, immediately following an exercise, generating a comprehensive action report can initiate further action. Secondly, incorporating anticipated challenges into the mock drill design can ensure these issues are directly confronted during the exercise. By fostering a culture of continuous improvement and ensuring identified weaknesses are addressed, organizations can leverage mock drills to not only enhance team performance but also achieve a state of ever-increasing preparedness for disaster response.

Future of Mock Drills: Embracing Virtual Reality and artificial intelligence (AI)

Looking ahead, the integration of virtual reality (VR) and artificial intelligence (AI) holds immense promise for the future of mock drills. VR technology can create immersive, first-person simulations of disaster scenarios, allowing responders to train in a safe and controlled environment that transcends temporal, spatial, and social limitations.[28] AI can further improve these simulations by dynamically adjusting the scenario based on team decisions, creating a more realistic and adaptive training experience. Moreover, VR and AI can be harnessed to analyze team performance within these simulations, pinpointing areas for improvement in communication, collaboration, and decision-making. By adopting these emerging technologies, mock drills can evolve from simple tests of plans and procedures to dynamic training platforms that prepare disaster medicine and emergency medical service teams for unforeseen scenarios.

Virtual reality (VR):

Use of immersive, highly visual, three-dimensional characteristics can now effectively replicate real-life situations. The user interacts realistically with others within the digital environment. Virtual reality is perfect for training in high-acuity, low-frequency events, such as disaster and mass casualty events,

including responses to chemical, biological, radiological, nuclear, and explosive agents (CBRNE). It typically incorporates physical interfaces such as a head-mounted display, motion sensors or haptic devices, in addition to a computer keyboard, mouse, and speech and voice recognition.[30]

Augmented reality (AR):

In contrast, augmented reality builds an overlay of digital information on top of the real world. Imagine all-important patient information projected on a mannequin in the medical simulation or architectural plans overlaid on a real building site. It does this by blending computer-generated content into the user's real surroundings. Users can interact with these virtual elements and will have a more dynamic experience than users of other, more static training methods.[31]

Gamification for Enhanced Learning

Beyond the standard simulations in a virtual reality setting, serious games offer an opportunity for team training in disaster medicine and other emergency medical services. Employing the applications as interactive simulations of actual events in a virtual space helps in preparing the participants to fine-tune their communication, cooperation, and coordination abilities in a safe engaging way. Virtual standardized patients that can interact with the learners via NL add further realism and effectiveness to the serious game training experience.

The ability for participants to manipulate avatars within a virtual world that simulates any kind of written, oral, individualized, or group-based communications can reflect the collaborative and cohesive action involved in disaster responses. There is a possible future promise of gamifying training because this can help capture teamwork and communication skills in a manner a drill cannot. Further research on the specific design elements of what is most effective to improve team performance are also needed in disaster medicine and emergency medical services through serious games. [32,33]

Long-Term Impact of Mock Drills

Simulations clearly improve knowledge, attitudes, and problem-solving skills immediately after conduct. However, the lasting impact should be presumed unclear because long-term effects, especially impacting team performance in disaster medicine and emergency medical services, are still to be ascertained. The studies indicated that mock drills are capable of developing a culture of continuous learning: repeated exercises will provoke participants to dig deeper into systemic challenges.[34] Still, turning the identified problems into lasting improvements stands as a challenge. Future research should explore strategies of knowledge retention and transferability by tapping insights from learning sciences applied to emergency training. Besides, evidence will be established through research that participation in mock drills improves and enhances field response capacities. It would, therefore, fairly prove that the knowledge transferred from such evacuation drills is intact and is applied during actual disasters when there is a need for evacuation of patients. By prioritizing knowledge retention, addressing identified shortcomings, and establishing a clear connection to real-world outcomes, mock drills can evolve into powerful tools for not only enhancing immediate team performance but also ensuring lasting improvements in disaster preparedness within disaster medicine and emergency medical services.[16]

Mock Drills for Peak Performance:

EMS personnel and paramedics are uniquely challenged in disaster scenarios, so mock drill design must be focused on this specific need. The effective drills for this critical group must move beyond rote memorization of protocols and delve into the complexities of real-world disaster response. Factors unique to EMS and paramedic practice should be incorporated into scenario development, such as resource scarcity, triage decision-making under pressure, and effective communication within a chaotic environment. With these aspects integrated into the drills, they will provide an opportunity for the EMS and paramedics to hone their clinical skills and implement resource management strategies, sharpening their ability to collaborate well as a multidisciplinary team. Table 2 outlines the ways to conduct mock drills to optimize the performance of EMS and paramedic personnel.

Table 2: Mock Drills for Peak Performance: A Focus on EMS and Paramedic staff		
Aspect	Traditional Mock Drills	Enhanced Mock Drills for EMS/Paramedics
Scenario Focus	Generic disaster protocols	Specific EMS/Paramedic challenges: Resource scarcity, triage decision-making, communication in chaos
Skills Development	Rote memorization of protocols	Clinical skills, resource management, multi-disciplinary collaboration
Psychological Considerations	Not addressed	Integration of psychological stressors: Distraught bystanders, ethical dilemmas
Debriefing Focus	Performance evaluation	Reflective discussion, identifying areas for growth, sharing best practices
Post-Drill Actions	Limited or absent	Action plans to address weaknesses, implement identified changes
Overall Impact	Short-term performance gains	Lasting improvements in team performance, preparedness for real-world scenarios

One of the unexplored areas in EMS and paramedic mock drills is the psychological impact of disaster response. A disaster is an emotionally draining experience both for the responders and victims.[36]

Another example of this integration within mock drills can be where the psychological stressors simulated among distraught bystanders create an ethical dilemma that teaches EMS and paramedics essential skills to care for distressed patients in the midst of their crisis. By incorporating the three aspects, mock drills will move towards becoming a full package preparatory training platform in making the EMS and paramedics geared towards the technical involvement during disasters and the possible psychosocial challenges they face in such situations.[37]

Beyond the Drill: Fostering a Culture of Continuous Learning

From Table 2, mock drills transcend the training session itself. They should invite continued learning and improvement in the EMS team and the paramedics. That is achieved through post drill debriefing. Debriefing is a post drill session where participants can reflect on their performance, identify what they need to improve, and share best practices.

[38] These sessions should be well structured to further facilitate openness and discussion and should target continuous improvement. Moreover, incorporating action plans following the drill to address the identified weaknesses and enforce implementation of identified changes would make lessons learned in mock drills turn into permanent improvements in the team's performance. [39]

Future Research Directions

While mock drills have become a staple in disaster preparedness training, as shown in Table 3, there are a few key areas that will need further research to improve their effectiveness, especially in disaster medicine and EMS. Some of the key research areas for the future include:

Table 3: Future Research Points: Optimizing Mock Drills for Disaster Medicine and EMS		
Area of Investigation	Research Question	Outcomes
Optimizing Drill Design	Combine drill formats & tailor for EMS/Paramedics	Improved teamwork, communication, resource management, & emotional preparedness
	Include psychological stressors	
Maximizing Learning and Retention	Apply learning science & track long-term impact	Enhanced knowledge retention, real-world performance, & learning from drills
	Improve debriefing sessions	
Technological Advancements	Integrate VR/AI & serious games	Develop immersive training & improve communication/coordination

Optimizing Drill Design:

Combined formats: Learn how combining a discussion-based (tabletop) and operation-based exercise can bring out advantages of both in encouraging teaming and communication.

Tailoring for EMS/Paramedics: Investigate resource scarcity, triage decisions in the heat of the situation, and effective communication to address specific needs of EMS/paramedics through drills designed.

Psychological Integration: Assess whether the integration of psychological stressors, such as crying bystanders or moral dilemmas, into drills better equips responders to the mental challenges of disaster response.

Maximizing Learning and Retention:

Integration of learning science: Apply insights from learning science to inform strategy development for the optimization of knowledge retention and skill transfer from simulation-based training.

Long-Term Impact Studies: Longitudinal studies to conclusively demonstrate the involvement of mock drills with EMS and paramedics in an emergency and better performance in actual events.

Debriefing optimization: Discover how to effectively facilitate debriefing sessions that foster open discussion, reflection, and identified areas for improvement.

Technological Advancements:

Potential uses of virtual reality and artificial intelligence in an immersive and dynamic training environment that incorporates personalized feedback, adaptive development of scenarios.

Serious game applications: Evaluate the impact that serious game-based platforms bring to communication, cooperation, and coordination skills of the teams involved in disaster medicine and emergency medical services. Upon touching the future research area, we can perfect mock drills and make them an effective pre-disaster drill to prepare disaster medicine and EMS teams for the practicability of real systems that deliver even better outcomes for the patients and ensure a stronger healthcare system upon facing disaster.

V. Study Limitations

Present narrative review also recognizes a number of limitations inherent to analyzing existing research on mock drills. This includes:

Heterogeneity of Studies: Despite the diverse nature of the reviewed studies in terms of mock drill formats, target audiences, and methods of evaluation, heterogeneity complicates drawing definitive conclusions about overall effectiveness.

Focus on Reported Benefits Many of the studies have focused upon self-reported benefits of mock drills, which include perceived preparedness or improved knowledge. Little research has compared drill performance with actual performance of teams in real-time emergencies.

Sustainability of Improvements: Although so many positive results are reported upon mock drills, regarding changes in knowledge and attitudes, the long-term sustainability of improvements and their application toward real practice is vague.

It primarily focuses on the immediate results of mock drills. Research in this area is lacking regarding the long-term impacts of drills on team performance and disaster preparedness within the practice of EMS and disaster medicine.

These limitations call for future research to use standardized methodologies and outcome measures that allow for stronger comparisons between studies. Further, there should be more emphasis on long-term effects of mock drills on real-world performance to finally determine the utility in disaster preparedness training of disaster medicine and EMS teams.

VI. Conclusion:

Mock drills play a significant role in preparing disasters, and their impacts could considerably be optimized on a continued basis. That would tailor the drills specific to disaster medicine and EMS; inject psychological stressors, the use of science behind learning, and make optimum usage of innovative technology in serious games, artificial intelligence, and virtual reality to get the best value for investment. These developments, supplemented by intense debriefing sessions and knowledge retention at long run, may inevitably arm disaster medicine and EMS teams for better responses to emergencies.

VII. Abbreviations

EMS: Emergency Medical Services

MCI: Mass Casualty Incident

PTSD: Post-Traumatic Stress Disorder

VR: Virtual Reality

AI: Artificial Intelligence

AR: Augmented Reality

KSAPs: Knowledge, Skills, Attitudes, and Perceptions

MERI: Maximizing Engagement for Readiness and Impact

SOPETAR: Scan, Orient, Plan, Equip, Train, Act, Reflect

RCT: Randomized Controlled Trial

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