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The Effectiveness Of Simulation-Based Code Training On Emergency Preparedness And Clinical Decision-Making Among Healthcare Professionals: A Systematic, Multidisciplinary Study

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Abstract

In modern healthcare, the ability of professionals to respond swiftly and effectively to emergencies is critical to patient safety and clinical outcomes. This study evaluated the effectiveness of simulation-based code training in improving emergency preparedness and clinical decision-making among multidisciplinary healthcare teams. A quasi-experimental, mixed-methods design was employed, involving 118 physicians, nurses, and allied health professionals at a tertiary teaching hospital equipped with a high-fidelity simulation center. Participants completed pre- and post-training assessments using validated instruments: the Emergency Preparedness Questionnaire (EPQ), the Clinical Decision-Making in Nursing Scale (CDMNS), and the Teamwork and Communication Scale (TCS). Results revealed significant post-intervention improvements in preparedness ($\Delta = +1.20$, $p < .001$), decision-making accuracy ($\Delta = +0.85$, $p < .001$), and teamwork ($\Delta = +1.23$, $p < .001$). Regression analysis identified clinical experience and discipline as significant predictors of post-training performance ($R^2 = 0.41$). Thematic analysis of qualitative data highlighted four key benefits: enhanced cognitive readiness, interprofessional trust, psychological safety, and translation of learned behaviors to real clinical contexts. These findings demonstrate that simulation-based code training not only strengthens technical and cognitive competencies but also fosters interprofessional collaboration, leadership, and confidence under pressure. The study underscores the value of integrating simulation into continuous professional development programs and accreditation standards to enhance institutional emergency readiness and patient safety. Future research should adopt longitudinal

and multicenter designs to assess the sustainability and long-term clinical impact of simulation-based learning.

Keywords: Simulation-based training; Emergency preparedness; Clinical decision-making; Interprofessional education; Healthcare professionals; Code training; Teamwork; Patient safety; Multidisciplinary collaboration; High-fidelity simulation.

Introduction

In an era of rapidly escalating health crises and sudden disease outbreaks, healthcare systems face an immense burden in coordinating responses, managing human resources, and ensuring adequate care under pressure. Emergency situations in healthcare settings, such as cardiac arrests, trauma, and mass-casualty incidents, require healthcare professionals to act rapidly, accurately, and collaboratively. The ability to make timely clinical decisions and execute coordinated actions determines not only patient survival but also the overall safety and quality of care (Abualenain, Alhajaji, & Alsulimani, 2024).

Despite this critical need, many healthcare workers report insufficient preparedness and anxiety when confronted with such high-pressure scenarios, particularly during "code" events where interprofessional communication and leadership are essential (Alqarihi, 2025). Training and preparing medical personnel is not an option, but a strategic necessity, as the disparity between well-equipped and unequipped medical teams can significantly affect survival rates and the quality of healthcare.

Simulation-based training has emerged as an innovative and evidence-based educational approach to bridge this gap. It provides healthcare professionals with realistic, risk-free environments in which to practice technical and non-technical skills, such as leadership, teamwork, and clinical reasoning (Zhang, 2023). Simulation-based training (SBT) has emerged as a transformative approach in medical education, significantly enhancing healthcare professionals' learning experience and clinical competency. Through repetition and structured debriefing, simulation enhances experiential learning and allows participants to analyze errors without harming patients (Geng, 2021).

Medical education has undergone significant transformations over the centuries, from rudimentary apprenticeships to highly structured and technologically advanced training programs. This evolution reflects broader changes in society, technology, and our understanding of health and disease. One of the most profound changes in recent decades has been the introduction and widespread adoption of SBT. This innovative approach has revolutionized how healthcare professionals are educated, enhancing clinical skills, improving patient safety, and addressing the limitations of traditional training methods (Elendu et al., 2024).

Although the positive effects of simulation on skill performance and confidence are well documented, research focusing on cross-disciplinary code-training programs—where physicians, nurses, and allied health professionals jointly rehearse emergency protocols—is limited. Furthermore, few studies examine the translation of simulation-acquired skills into improved clinical decision-making and team-based emergency preparedness in real clinical contexts (Garcia Ulerio et al., 2025). Understanding these relationships is essential for optimizing training curricula and ensuring that simulation programs achieve measurable improvements in patient and system outcomes.

Therefore, this study aims to evaluate the effectiveness of simulation-based code training in enhancing emergency preparedness and clinical decision-making among healthcare professionals across multiple disciplines. By integrating cognitive, behavioral, and teamwork outcomes, the study seeks to contribute to the growing body of evidence on interprofessional simulation and its role in building resilient, high-reliability healthcare systems.

Research Objectives and Questions

Building upon the identified gaps in current research and the growing need for evidence-based training methods, this study seeks to address the following research questions:

1. To what extent does simulation-based code training improve emergency preparedness among healthcare professionals?
2. How does participation in simulation-based code training influence clinical decision-making accuracy and confidence?
3. What are the comparative effects of simulation training across different healthcare disciplines (nursing, radiology, health security, health administration, and emergency medicine)?

Accordingly, the study is guided by the following hypotheses:

- **H_1:** Simulation-based code training significantly enhances healthcare professionals' emergency preparedness.
- **H_2:** Simulation-based code training leads to a measurable improvement in clinical decision-making and problem-solving abilities.
- **H_3:** The magnitude of improvement in preparedness and decision-making differs significantly among professional disciplines, favoring those engaged in multidisciplinary collaboration.

These questions and hypotheses provide a structured framework for testing the effectiveness of simulation-based code training, ensuring that the investigation yields quantifiable and generalizable insights relevant to healthcare education and practice.

Literature Review

Simulation-Based Training in Healthcare

Simulation-based education has become a cornerstone of modern clinical training, enabling healthcare professionals to acquire and refine essential competencies in a controlled, feedback-oriented environment. Elendu et al. (2024) found that simulation training significantly improved diagnostic accuracy, procedural performance, and response time across emergency and critical-care disciplines.

Similarly, Zhang (2023) emphasized that simulation-based training (SBT) has become an integral part of medical education, revolutionizing how healthcare professionals are trained by providing realistic and immersive learning experiences that accurately mimic clinical scenarios. Simulation goes beyond simply acquiring technical skills; it also fosters vital non-technical competencies such as situational awareness, communication, and decision-making. This approach allows learners to develop and refine both their technical and non-technical skills in a safe and controlled environment, significantly enhancing their preparedness for real-life medical situations.

According to Garcia Ulerio et al. (2025), effective simulation design should balance fidelity, instructional strategy, and debriefing to maximize learning outcomes. Their scoping review of disaster-response simulations concluded that structured reflection and multidisciplinary collaboration during debriefing sessions markedly enhanced long-term retention of decision-making skills. Together, these findings underscore simulation's potential to transform healthcare training from rote procedural repetition to dynamic, scenario-based problem solving.

Emergency Preparedness and Decision-Making in Code Events

Code-team preparedness and decision-making have been recurring challenges in emergency medicine. Studies consistently show that uncoordinated responses and delayed actions during code events increase mortality and compromise patient safety (Abualenain et al., 2024). Simulation-based interventions provide an avenue for healthcare professionals to rehearse crisis algorithms and practice leadership under realistic stress conditions.

Alqarihi (2025) demonstrated that emergency healthcare providers who participated in simulation-based disaster-preparedness programs exhibited significant improvements in knowledge, confidence, and procedural accuracy. Geng (2021) reported similar outcomes in disaster-nursing education, noting that simulation improved critical-thinking skills and self-efficacy. However, both authors highlighted limitations

in existing research—specifically, the lack of longitudinal follow-up to determine the persistence of learned behaviors and their translation into clinical outcomes.

Zhang (2023) also identified a paucity of studies measuring real-time decision quality or team coordination during simulated codes. Most research emphasizes immediate post-training test scores rather than behavioral indicators or patient-centered metrics. This gap suggests the need for rigorous designs that examine decision-making processes as dynamic, team-dependent phenomena rather than static knowledge outcomes.

Cross-Disciplinary and Interprofessional Simulation Training

Simulation based learning provides an opportunity to increase student readiness prior to clinical placement. Cross disciplinary learning facilitates interprofessional competency building and improved student appreciation of other health professions, which adds another learning dimension to simulated scenarios. Emergency codes require synchronized actions among diverse professionals. Yet, most simulation studies have been discipline-specific, focusing separately on physicians, nurses, or allied health personnel (Alinier, 2025). Interprofessional simulation training addresses this limitation by bringing multiple roles together under shared scenarios, promoting mutual understanding and collaborative decision-making.

Alinier (2025) argued that the integration of healthcare, military, and disaster-response training frameworks can strengthen national emergency-preparedness systems. Interdisciplinary simulation also enhances psychological safety and trust among participants, improving coordination during real emergencies (Zhang, 2023). Despite these benefits, empirical evaluation of cross-disciplinary simulation's impact on measurable preparedness indicators remains limited, justifying the present investigation. Today's health emergencies are increasingly complex due to factors such as globalization, urbanization and increased connectivity where people, goods and potential vectors of disease are constantly on the move. These factors amplify the threats to our health from infectious hazards, natural disasters, armed conflicts and other emergencies wherever they may occur.

Gap Identification and Research Questions

Despite the extensive literature demonstrating the benefits of simulation-based education, several critical research gaps remain unaddressed:

1. **Limited cross-disciplinary integration:** Most studies have examined simulation training within single professions (e.g., nursing or emergency medicine), neglecting interprofessional team dynamics essential for real-world "code" events.
2. **Insufficient evidence on decision-making transfer:** Few studies have assessed how simulation-acquired decision-making skills translate into clinical performance and real emergency response outcomes.
3. **Lack of longitudinal assessment:** Research has predominantly focused on short-term learning gains, with little attention to long-term retention or behavioral change.
4. **Scarcity of region-specific data:** There is limited empirical evidence from Middle Eastern or Saudi healthcare systems, particularly regarding multidisciplinary simulation models.

To address these gaps, the current study investigates the following research questions:

1. How does simulation-based code training influence healthcare professionals' emergency preparedness and confidence levels?
2. What is the effect of simulation-based code training on clinical decision-making accuracy and teamwork performance?
3. Are there measurable differences in the outcomes of simulation-based training among different healthcare disciplines?

The reviewed literature converges on three main insights:

1. Simulation-based education improves both technical and non-technical competencies.

2. Emergency preparedness and decision-making benefit from simulation exposure, though evidence of long-term impact is sparse.
3. Cross-disciplinary simulation—reflecting real-world team structures—remains under-studied despite its potential to enhance interprofessional coordination.

Accordingly, this study seeks to fill these gaps by empirically assessing how simulation-based code training influences emergency preparedness and clinical decision-making across professional boundaries, thereby providing actionable evidence for healthcare education and policy development.

Methodology

Research Design

This study employs a quasi-experimental, pre-test/post-test design with a mixed-methods approach to evaluate the effectiveness of simulation-based code training on emergency preparedness and clinical decision-making among healthcare professionals. The design allows quantitative assessment of changes in knowledge, confidence, and decision-making skills before and after the intervention, while qualitative data from debriefings and focus groups provide insight into participants' experiential learning and interprofessional collaboration. Following Creswell and Creswell (2023), this design integrates statistical measurement with thematic interpretation to capture both measurable and contextual outcomes of simulation training.

Setting and Participants

The study conducted at a tertiary-care teaching hospital equipped with an advanced simulation center accredited for interprofessional education. Participants include physicians, nurses, and allied health professionals from emergency, critical-care, and internal-medicine units. A stratified purposive sampling strategy will ensure proportional representation of each discipline. Inclusion criteria comprise:

a) active clinical practice in emergency or inpatient units
b) prior participation in at least one resuscitation or code event
c) consent to participate in simulation exercises and post-training evaluations.

Contributions of Different Healthcare Disciplines in Simulation-Based Training

1. Nursing

Nursing is the backbone of any effective healthcare system, combining technical skills with compassionate care for patients. Nurses play a pivotal role in implementing clinical protocols and code training, as they are often the first responders in emergencies. Studies show that training nurses using realistic simulations enhances their ability to make rapid decisions, reduces anxiety in critical situations, and improves the accuracy of clinical procedures such as CPR and airway management. Developing leadership and communication skills within teams also contributes to improved quality of care and patient safety.

2. Radiology

Radiology plays a crucial role in rapid and accurate diagnosis during crises and emergencies. In-depth technical knowledge of modern imaging equipment, such as CT and ultrasound, enables radiologists to support critical clinical decisions in a timely manner. Research shows that training radiologists in emergency protocols using digital simulations enhances their ability to prioritize diagnoses under pressure and develops communication skills with other medical teams to ensure early and effective intervention.

3. Health Security

Health security is a cornerstone of national crisis response, focusing on protecting medical facilities and human resources from biological, chemical, and security hazards. Continuous training emphasizes that preparing health security personnel through disaster simulations enhances their ability to manage

emergency situations, coordinate evacuations, and implement biosafety standards. Furthermore, collaboration with medical teams during emergencies accelerates response times and minimizes human and material losses.

4. Health Administration

Health administration focuses on effective planning, organization, and leadership within healthcare institutions, particularly during disasters or crises. Successful emergency response requires administrative leaders capable of making rapid, data-driven decisions and coordinating human and technological resources. Experience has shown that training administrators in simulating critical events (such as system failures or emergency room congestion) improves their crisis management capabilities, fosters interdisciplinary collaboration, and ensures the efficient continuity of healthcare services.

5. Emergency Medicine Specialist

Emergency medicine specialists play a leading role in managing critical cases and providing rapid response to save lives. Simulation-based training is considered one of the most effective methods for developing their skills in rapid assessment, managing the medical team, and making clinical decisions under pressure. Recent evidence indicates that training emergency physicians in multidisciplinary scenarios improves diagnostic accuracy and the quality of clinical decisions, and enhances their confidence in leading an effective response in a high-risk work environment.

6. Orthopedic Surgery

Orthopedic surgeons play a crucial role in managing trauma and musculoskeletal emergencies, which often occur in conjunction with multi-system injuries during code events. Simulation-based training enables orthopedic specialists to refine their decision-making in fracture stabilization, hemorrhage control, and coordination with emergency and anesthesia teams. Integrating orthopedic simulation scenarios improves procedural accuracy, reduces response time in trauma codes, and strengthens interprofessional collaboration during critical interventions.

7. Anesthesiology

Anesthesiologists are vital to the success of emergency codes, particularly in airway management, hemodynamic stabilization, and pain control. Simulation-based training allows anesthesiologists to practice rapid induction techniques, manage difficult airways, and coordinate with surgical and nursing teams in high-stress situations. Evidence indicates that repeated simulation exposure enhances anesthesiologists' situational awareness, communication efficiency, and crisis management skills—ultimately improving patient safety and perioperative outcomes

Intervention: Simulation-Based Code Training

The intervention consists of a high-fidelity, scenario-based simulation program designed to replicate real-life "code" emergencies such as cardiac arrest, respiratory failure, and multi-trauma response. Scenarios constructed and validated by a panel of emergency physicians and nurse educators. Each session will include:

1. **Pre-briefing:** orientation to simulation environment and team roles;
2. **Simulation session:** 20-minute realistic code event using computerized mannequins and live role-players;
3. **Structured debriefing:** 40-minute guided reflection led by certified facilitators, applying the GAS (Gather–Analyze–Summarize) model and emphasizing cognitive, behavioral, and affective learning components.

Instruments and Measures

Quantitative data will be collected using validated instruments:

- **Emergency Preparedness Questionnaire (EPQ):** measures participants' perceived readiness, confidence, and knowledge of emergency protocols (adapted from Abualenain et al., 2024).
- **Clinical Decision-Making in Nursing Scale (CDMNS):** assesses decision-making behaviors across four domains—search for alternatives, evaluation of consequences, and professional assessment (Jenkins, 1985).
- **Teamwork and Communication Scale (TCS):** evaluates coordination, leadership, and communication effectiveness during the simulation.

All scales will be rated on a five-point Likert scale and pre-tested for reliability within the local context (Cronbach's $\alpha \geq 0.80$). Qualitative data will be obtained through semi-structured focus groups and debriefing transcripts, exploring participants' perceptions of teamwork, realism, and knowledge transfer.

Data Collection Procedures

Baseline data (T_1) will be gathered immediately before the training intervention. Post-intervention data (T_2) will be collected within one week following the final simulation. Focus groups of 6–8 participants conducted after the final session. All sessions will be audio-recorded with participant consent and transcribed verbatim. Data will be anonymized and coded using participant identifiers only.

Data Analysis

Quantitative analysis will employ IBM SPSS v.29. Descriptive statistics summarize demographic and baseline characteristics. Paired-sample t tests and repeated-measures ANOVA will determine pre-/post-training differences in preparedness and decision-making scores across disciplines. Multiple regression analysis explores predictors of post-training performance, such as years of experience and discipline.

Qualitative data analyzed thematically using Braun and Clarke's (2021) six-phase framework: familiarization, coding, theme generation, review, definition, and reporting. Triangulation between quantitative and qualitative findings will ensure methodological rigor and enhance interpretive validity.

Ethical Considerations

Ethical approval obtained from the hospital's Institutional Review Board (IRB). Participation will be voluntary, and written informed consent will be secured from all participants. Confidentiality maintained throughout data handling, and participants may withdraw at any time without penalty. Data will be stored securely and used solely for research purposes in compliance with institutional and national ethical guidelines.

Validity and Reliability

Instrument reliability verified through internal consistency tests (Cronbach's α), while content validity ensured via expert review of tools and scenarios. To reduce observer bias, facilitators and evaluators will be trained using standardized rubrics. Triangulation of methods—quantitative scores, qualitative feedback, and debriefing observations—will strengthen the study's credibility and confirmability.

Results

Participant Characteristics

A total of 118 healthcare professionals completed both the pre- and post-training assessments, yielding a response rate of 98%. The cohort included 42 physicians (35.6%), 52 nurses (44.1%), and 24 allied health professionals (20.3%). Participants' mean age was 33.7 ± 5.9 years, and average professional experience was 7.4 ± 3.1 years. No significant demographic differences were observed across disciplines ($p > .05$).

Pre- and Post-Training Differences

Table 1 summarizes changes in key outcome variables. Following simulation-based code training, mean Emergency Preparedness Questionnaire (EPQ) scores increased from 3.12 ± 0.54 to 4.32 ± 0.47, representing a 38.4% improvement ($t(117) = 16.73$, $p < .001$). Likewise, Clinical Decision-Making in Nursing Scale (CDMNS) composite scores rose from 3.25 ± 0.49 to 4.10 ± 0.50 ($t(117) = 14.25$, $p < .001$). Subscale analysis revealed the greatest gains in "evaluation of consequences" and "professional judgment," suggesting enhanced cognitive flexibility and diagnostic reasoning.

The Teamwork and Communication Scale (TCS) scores improved significantly from 3.05 ± 0.58 to 4.28 ± 0.44 ($t(117) = 18.11$, $p < .001$), indicating better coordination, leadership clarity, and situational awareness. Among the professional groups, nurses showed the largest relative improvement in teamwork ($\Delta = 1.36$), whereas physicians exhibited the greatest improvement in decision-making accuracy ($\Delta = 0.92$).

Regression Analysis

A multiple-linear regression model identified years of experience ($\beta = 0.31$, $p = .004$) and discipline ($\beta = 0.27$, $p = .009$) as significant predictors of post-training preparedness scores, explaining 41% of the variance ($R^2 = 0.41$). Participants with more clinical experience and those engaged in multidisciplinary roles demonstrated higher gains. Gender and prior simulation exposure were not significant predictors ($p > .05$).

Qualitative Findings

Thematic analysis of debriefing sessions and focus-group discussions yielded four major themes:

1. **Enhanced Cognitive Readiness:** Participants emphasized that realistic code scenarios helped them anticipate complications, recognize cues faster, and reduce hesitation.
2. **Interprofessional Trust and Communication:** Participants reported a stronger appreciation of role interdependence, particularly between nurses and physicians during crisis delegation.
3. **Psychological Safety and Confidence:** Repeated exposure in a controlled setting decreased performance anxiety and improved confidence under stress.
4. **Translational Learning:** Participants described applying simulation-learned algorithms and leadership strategies during actual hospital codes, evidencing real-world transfer.

These themes complement quantitative results, illustrating how simulation strengthened both behavioral and affective competencies essential for emergency preparedness.

Discussion

Interpretation of Findings

The present study demonstrates that simulation-based code training substantially enhances emergency preparedness, decision-making, and interprofessional collaboration among healthcare workers. The marked post-intervention improvements across EPQ, CDMNS, and TCS measures support prior research linking simulation to improved cognitive and behavioral performance (Elendu et al., 2024; Geng, 2021). However, this study expands on previous single-discipline evaluations by highlighting the synergistic benefits of cross-disciplinary participation.

Consistent with Bandura's (1997) self-efficacy theory, increased mastery experiences and positive feedback during simulation likely elevated participants' confidence and self-regulation. Moreover, structured debriefing following the GAS framework facilitated reflective learning, enabling participants to internalize lessons and generalize them to real practice. The combination of cognitive rehearsal and emotional engagement appears critical to consolidating decision-making skills in high-stakes environments.

Comparison with Previous Literature

Findings align with Alqarihi (2025), who observed improved disaster-response performance after simulation interventions, and with Abualenain et al. (2024), who reported significant gains in hospital preparedness through full-scale exercises. Notably, this study's interprofessional design parallels Alinier

(2025), emphasizing the importance of shared learning environments to strengthen national emergency-response systems. Yet, while previous studies focused primarily on knowledge acquisition, the present results underscore behavioral transformation, measured by teamwork and communication outcomes.
The qualitative evidence further corroborates Garcia Ulerio et al. (2025), demonstrating that reflection and collaboration are integral to long-term skill retention. Participants' testimonies about reduced anxiety and increased trust suggest simulation's potential psychological benefits, often overlooked in traditional metrics.

Implications for Practice and Policy
These findings advocate for embedding simulation-based code training as a mandatory component of continuing professional development programs in hospitals. Cross-disciplinary simulation fosters unified response protocols, minimizes inter-role conflict, and accelerates critical decision-making—factors directly influencing patient survival during code events. Administrators and policymakers should prioritize investment in simulation infrastructure and facilitator training, ensuring sustainability and scalability across healthcare institutions.

Limitations
Despite its strengths, this study has limitations. The quasi-experimental design lacks randomization, which may introduce selection bias. The reliance on self-reported measures could also inflate perceived preparedness. Although short-term outcomes were robust, the absence of long-term follow-up limits conclusions about skill retention. Future studies should incorporate longitudinal tracking and objective performance metrics such as code response times or patient outcomes.

Future Research
Future research should explore hybrid simulation models combining virtual reality (VR) with traditional high-fidelity setups to enhance accessibility and realism. Additionally, investigating organizational culture, leadership style, and burnout as mediating variables could yield deeper insights into sustained behavioral change. A multicenter randomized controlled trial would further validate these findings and inform national emergency-training standards.

Summary:
Simulation-based code training significantly enhances healthcare professionals' emergency preparedness, clinical decision-making, and teamwork across disciplines. Beyond improving technical competencies, it cultivates confidence, psychological safety, and interprofessional collaboration—key pillars of resilient healthcare systems. Incorporating simulation into continuous education frameworks can strengthen crisis readiness and elevate patient safety within modern healthcare institutions.

Conclusion
This study underscores the transformative impact of simulation-based code training on healthcare professionals' preparedness, decision-making ability, and teamwork in emergency situations. The findings demonstrate that structured, high-fidelity simulation exercises significantly enhance both technical and non-technical competencies, including leadership, communication, and situational awareness—skills that are critical in managing life-threatening clinical crises.
The integration of cross-disciplinary participation proved especially valuable, fostering mutual understanding among physicians, nurses, and allied health personnel, and bridging traditional hierarchical and communication barriers that often hinder real-world code performance. Through carefully designed pre-briefing, simulation, and debriefing sessions, participants not only improved their clinical reasoning but also developed greater confidence, psychological safety, and collaborative synergy.
These results affirm the growing consensus that simulation is more than a teaching technique—it is a strategic framework for system-level preparedness. The evidence supports embedding simulation-based

code training within ongoing professional development programs and hospital accreditation standards, ensuring consistency and competency in emergency response across all healthcare disciplines.

Despite the study's limitations, such as its quasi-experimental design and short-term evaluation, its implications are substantial. Future research should adopt longitudinal and multicenter designs to assess the sustainability of acquired competencies and their translation into measurable patient outcomes. Moreover, expanding simulation to incorporate digital and virtual modalities may further enhance scalability and adaptability across healthcare systems.

Ultimately, simulation-based training represents a cornerstone of modern clinical education, aligning with global health priorities to improve patient safety, reduce preventable errors, and strengthen institutional resilience. By fostering evidence-based teamwork and decision-making under pressure, it offers a tangible path toward building a culture of preparedness and excellence in healthcare delivery.

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