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عنوان البحث

In What Ways Can Simulation-Based Training Contribute to Hospital Preparedness
for Disasters in Jeddah Second Health Cluster Retrospective Study (2020-2025)

دراسة استرجاعية كيف يمكن للتدريب القائم على المحاكاة أن يساهم في جاهزية المستشفيات للكوارث
في جدة التجمع الصحي الثاني (2020-2025)

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Introduction:

Unexpected crises, including natural disasters, pandemics, and mass casualty incidents, increasingly define the global health landscape. Hospitals, as critical agents with primary healthcare infrastructure, are primarily responding effectively to such events. These hospitals' success in handling a surge of patients, services running, and protecting staff and resources directly affects the resilience and the public health impacts of these events. However, the dynamic nature and variation of disasters make them a big challenge for conventional preparedness strategies. In hospitals, effective disaster preparedness is not only about having plans; it is about ensuring that healthcare workers possess a combination of knowledge and skills, with confidence, to implement these plans under dire pressure [1].

Simulation-based training (SBT) has evolved into a highly effective learning tool in the field of medical education, particularly in healthcare settings. SBT provides an excellent and safe environment for healthcare professionals to train and practice critical skills in a realistic environment without risking patient safety. This approach enables repeated learning, provides instantaneous informative feedback, and allows for the discovery and correction of shortcomings in a non-punitive environment. SBT, also known as team-based training, extends beyond the acquisition of individual skills to encompass interdisciplinary cooperation and system-wide readiness, making it an indispensable tool for enhancing organisational preparedness for complex humanitarian emergencies [2].

Global threats necessitate a robust capacity for disaster preparedness and response. The rapid spread of global travel, public gatherings such as the Hajj pilgrimage, and various

environmental factors underscore the need for resilient healthcare systems. Within this framework, health clusters have been established to facilitate the delivery and coordination of care across various facilities. The Jeddah Second Health Cluster plays a primary role in addressing significant gaps in health and safety for its beneficiaries. Understanding how advanced training methods, such as SBT, can be effectively incorporated into the preparedness endeavours of critical systems is necessary to foster regional health security.

This is a proposal for a retrospective study to evaluate the impact of simulation-based training on hospital disaster preparedness in the Jeddah Second Health Cluster over the previous five years (2020-2025). By examining existing training programs, evaluating their effectiveness, and identifying areas for improvement, this study aims to provide informative findings that can guide future policy and practice. This discovery will contribute to the growing body of knowledge on disaster preparedness and simulation education, enhancing the preparedness of community members who may play a role in psychosocial first aid.

مشكلة الدراسة:

Study Problem:

Although improvements have been made in health infrastructure and emergency management guidelines, hospitals often struggle to access the most appropriate recommended therapies for responding to large-scale disasters. Most of these problems can be attributed to a lack of experience among healthcare staff in coping with chaotic events. The lack of teamwork among various departments and outside agencies, along with a tendency to be inflexible in responding quickly to changing crises, further exacerbates the issue. Traditional

didactic methods of education, while imparting basic knowledge, often fail to develop critical skills such as teamwork and interaction essential for real-world disaster response [3].

The gap between theoretical knowledge and practical application is evident during actual emergencies, which can have a detrimental impact on patient outcomes and burden healthcare services. Particularly in hospital disaster preparedness, numerous challenges exist. Real-world disaster incidents are infrequent, making hands-on experience difficult for healthcare workers. This limited real-world exposure can result in reduced preparedness levels. Moreover, training often cannot fully capture the complexity and challenges of disaster situations, such as high numbers of casualties and limited resources.

The effectiveness of current training programs in the Jeddah Second Health Cluster, particularly regarding simulation-based approaches, has yet to be consistently evaluated. While the cluster plays a vital role in Saudi Arabian healthcare, understanding how well simulation training contributes to preparedness is crucial. Without an evident appreciation of the benefits and limitations of existing simulation-based training activities, practical improvements and assignments cannot be made. The objective of this retrospective study is to assess the extent to which simulation-based training has improved hospital disaster preparedness initiatives over the last five years in the Jeddah Second Health Cluster.

أهمية الدراسة:

The Importance of this Study:

This investigation has implications of local, regional, and global significance for several reasons.

Local Level Firstly, the findings will directly inform the provision of the Science Technology organization to the local community in the event of a storm, serving the Jeddah Second Health Cluster by evaluating its disaster preparedness simulation training in-depth. This evaluation will showcase best practices that can be adopted and pinpoint where further action is needed for further development or intervention. By understanding the significance of SBT over the last 5 years, the cluster will be able to refine its training practices, support resource management, and better adapt to the needs of the exercisers. Rationing, and ultimately, shore up its hospitals to confront various scenarios. Additional funds are provided to the region for responding to the needs of more than 3 million people living in the area, as well as the beneficiaries it serves [4].

While the Kingdom continues to develop and host mass gatherings, the healthcare system's ability to respond to disasters is paramount. The findings of this study may serve as a case study for other health clusters and hospitals across all regions of Saudi Arabia, providing evidence-based proposed recommendations for integrating and advancing simulation-based training in their disaster preparedness frameworks. Such alignment with national health priorities highlights the study's relevance and high potential for translation purposes.

Academic and Scientific Perspective Lastly, the impact of this study on academia and science remains to be determined, particularly in the context of the existing literature on simulation-based education in healthcare and disaster preparedness. Despite increasing awareness of the benefits of SBT, the content and manner of its implementation among more affluent replacement populations—whether the industry experienced the same skill shortages as it does now remains to be seen.

Retrospective studies on its long-term effects on hospital preparedness within a specific regional context, such as Jeddah, are few. This study aims to provide empirical evidence on how SBT can enhance various dimensions of preparedness, including competencies, teamwork, and confidence, among health professionals. These results will be of interest to researchers and practitioners regarding the effectiveness of simulation in high-stakes environments and its role in promoting a culture of readiness.

Lastly, the study has relevance for international health security. Disasters, whether natural or engineered, frequently cross national boundaries and thus require a collaborative and coordinated international response. By disseminating best practices and lessons learned in this effort, the Second Health Cluster, this study could contribute to international recommendations and approaches for preparedness, emphasizing the vital importance of building responsive systems on these extendible foundations—resistance to and recovery from various types of stresses. In an increasingly interconnected world, enhancing the readiness of individual health systems supports the overall resilience of the health community.

أهداف الدراسة:

Objectives of the study:

The objective of the present work is to thoroughly review the extent to which pressure concentration/time consumption affect maximal implementation, which hospital disaster preparedness in the Jeddah Second Health Cluster is strengthening through simulation-based training (SBT) interventions from 2020 to 2025.

To attain this goal, the study will aim at the following specific objectives:

To determine and describe the number of simulation-based hospitals in the Jeddah Second Health Directory, Cluster for 2020-2025. This includes the design of such training initiatives.

To assess the perceived effectiveness of simulation-based training in increasing the capacity of healthcare workers to improve the skills, confidence, and capacity of healthcare providers. Interventions to enhance the knowledge and skills in turbulent environments are expected to be substantial.

To assess the effect of simulation-based training on selected hospital disaster preparedness, such as the response time, coordination of departments, management of resources, and compliance with emergency regulations. The aim is to measure the actual benefits of SBT for organizational readiness.

To explore potential barriers and facilitating factors influencing the successful use of simulations for disaster preparedness in the Jeddah Second Health Cluster. It is essential to understand these factors in order to develop more effective and sustainable training methods.

To develop evidence-based recommendations for design, evidence for the development, implementation, and evaluation of simulation-based training programs in supporting hospital disaster preparedness, in addition to the Jeddah Second Health Cluster and potentially other similar healthcare settings. These objectives aim to create a comprehensive understanding of SBT's involvement in

disaster preparedness, moving beyond anecdotal evidence towards a systematic review that may inform future strategic planning and resource management.

تساؤلات الدراسة

Study Questions

Based on our goals, this research will aim to answer the following questions:

1. What types of simulation-based training programs have been implemented for hospital disaster preparedness in the Jeddah Second Health Cluster between 2020 and 2025, and what are their characteristics (e.g., frequency, duration, target audience, content)?
2. How do healthcare professionals and trainers perceive the effectiveness of simulation-based training in enhancing their knowledge, skills, and confidence related to disaster response?
3. What observable impacts has simulation-based training had on specific indicators of hospital disaster preparedness, such as inter-departmental coordination, resource allocation efficiency, and adherence to emergency protocols during simulated or actual disaster events?
4. What are the main barriers and facilitators encountered during the implementation and integration of simulation-based training for disaster preparedness within the Jeddah Second Health Cluster?

5. What recommendations can be made to optimize simulation-based training programs for improving hospital disaster preparedness in the Jeddah Second Health Cluster based on the findings of this study?

فروض الدراسة:

Study Assignments:

In order to answer the research questions discussed and achieve the goals we described earlier, the following could be undertaken:

Review of Literature: Review all the available literature on healthcare simulation, hospital disaster preparedness, and comparable studies in Saudi Arabia and the Middle East. This will provide a concept and a review of the current state of knowledge.

Development of the Data Collection Instrument: Design and validate data collection instruments, including surveys, questionnaires, interview guides, and data extraction forms, to gather information on training and performance metrics. These tools will be developed to collect both quantitative and qualitative data.

Simulation-Based Training Programs Identification: Collaborate with the Jeddah Second Health Cluster management and the related hospital departments to estimate the total number of simulation-based training programs for disaster preparedness hosted by the cluster in the period 2020-2025. This will involve reviewing logbooks, lesson plans, and roll boards.

Employee and Trainer Surveys/Interviews: Complete and analyze surveys and semi-structured interviews with a demographically representative sample of health care professionals who have undergone SBT, and the trainers delivering these programs. These will measure subjective effectiveness and confidence levels, and gather qualitative information on their experiences.

Review of Performance Information: Retrospectively review, if available, simulation and actual emergency performance data or disaster drill results within the cluster's hospitals. This could include metrics such as response times, communication performance, resource usage, and protocol adherence to assess the actual SBT effect.

Barrier and Facilitator Identification: Through surveys, interviews, and document reviews, determine systemic and operational barriers that may have impaired the efficacy or application of SBT, as well as factors that facilitated its success.

Data Analysis: Utilize statistical and qualitative data analysis methods as appropriate to analyze the collected data. Quantitative data will be analyzed with descriptive and inferential statistics, and qualitative data will undergo thematic analysis to discern common threads and themes within the dataset.

Recommendation Formulation: Based on the synthesis of all results, generate recommendations for improvement, grounded in improvement evidence and achievable objectives.

Preparing Reports and Briefs: Prepare and distribute all necessary information, analysis, documentation, and recommendations to complete the research proposal and final report. Disseminate findings to all relevant stakeholders in the Jeddah Second Health Cluster and policymakers.

الدراسات السابقة:

Previous Studies:

Simulation-based training (SBT) remains a strong approach for improving healthcare provider (HCP) performance. Disaster medicine has been a readiness for all contingency situations, including medical response. It has been the subject of extensive research globally. Numerous studies have consistently highlighted the positive effects that SBT has on learning outcomes, perception development, and participant confidence. This section reviews key findings from the literature, particularly from studies conducted in Saudi Arabia, to provide the background for this study.

It is an internationally recognized fact that SBT plays a central role in contemporary medical education and training. For example, a systematic review conducted by Al-Ghamdi and others (2023) highlighted that simulated scenarios enhance team performance and communication during emergencies[5]. Another study, published by the Society for Simulation in Healthcare (SSH), stated that SBT provides a safe space for purposeful practice, where learners can make mistakes and get instant feedback without compromising patient safety[6]. This extended learning is crucial for developing the intricate cognitive and psychomotor capabilities required in high-stakes environments, such as disaster response.

As a mechanism for disaster preparation, studies have demonstrated the efficacy of SBT as a mentalizing intervention to ward off disaster stress and close the gap between theory and practice. A study by Arshad et al. (2024) on disaster simulation training for medical undergraduate graduates also found that "professional skills and internships enhanced their self-confidence and that an internship was the primary factor in receiving and accepting job offers," as part of preparedness for disaster management[7]. Similarly, a report by the World Health Organization noted that more than 50% of patients were initiated on non-standard, non-recommended regimens. The WHO recommends the practice of regular simulation exercises as a critical aspect of hospital emergency response planning, discussing their role in identifying deficiencies in protocols and coordinating the management of different units[8].

In Saudi Arabia and the Middle East, the acceptance and assessment of SBT in disaster preparedness are gaining momentum. In Saudi Arabia, a study by Disaster Simulation compared didactic learning of airway management during disaster situations with that of Al-Malki and Al-Hussain (2023). They found that the "The effectiveness of the airway linear education simulation in clinical situations" approach was more effective. A nurses' training program increased nursing staff emergency readiness, with an enhancement in knowledge, skills, and clinical judgment[9]. A similar local study, conducted by Al-Qahtani et al. (2024), examined the impact of education on undergraduate nursing students' disaster evacuation knowledge and skills, reporting a positive effect on their clinical preparedness[10]. These results are consistent with the global consensus on SBT and emphasize its importance in regional health systems.

In addition, studies from the Middle East have investigated SBT about specific crises, such as pandemics. In a research study on health (El-Sayed & Hassan, 2023), the authors highlight the practical

value of simulation training during the COVID-19 pandemic, emphasizing its role in enhancing responses to crises through training and preparing healthcare workers[11].

This demonstrates the flexibility that SBT offers in responding to various types of disasters, ranging from emergency responses to health emergencies. Although these studies offer convincing evidence of the value of SBT, further research is required on its long-term retrospective comparisons. Most of the existing research focuses on the acquisition of skills by a single individual or the short-term effects. The studies will address this gap by offering a long-term perspective- a complete five-year retrospective study from the Jeddah Second Health Cluster, providing unique insights into the sustained effects and challenges of introducing SBT to a regional healthcare system's disaster preparedness framework.

المنطلقات النظرية للدراسة:

Theoretical premises of the Study:

The study is grounded in several theoretical frameworks, which collectively provide an embedded framework within the theory that offers an informative lens through which to consider the effects of simulation-based training on hospital disaster preparedness. These theories explain how learning occurs in artificial environments and how people and institutions learn to adapt, emphasizing the principles that should guide effective emergency responses.

Experiential Learning Theory (ELT): is based on David Kolb's Experiential Learning Theory , and it is essential to understand how

these learning approaches work in conjunction with one another. Simulation facilitates learning. ELT argues that learning is a natural and ongoing experience. It is based on a four-phase educational cycle: (a) Concrete Experience (CE) during which the learner experiences something new or looks at something old from a new perspective (condition 2); (b) Reflective Observation (RO), i.e., the student reflects upon the experience from diverse views; (c) Abstract Conceptualization (AC), the process during which the learner constructs novel concepts or revises already known abstract notions through reflection; and (d) Active Experimentation (AE)—where the learner takes this new information to a new context, to create new concrete experiences [12]. Within simulation-based training for disaster preparedness, simulating terrorist events is recommended. Itself provides the Concrete Experience. Participants actively engage in realistic situations, confront problems, and make decisions. The debriefing session following the simulation is critical for Reflective Observation, where apprentices consider themselves, reflect, and assess their performance, including what they did, how they thought, and how they felt during the task. Through guided discussion, participants are progressing toward Abstract Conceptualization; they make abstractions about effective responses to disasters, how to manage communication, and how to work in a team. Lastly, as demonstrated in future simulations, these learned concepts are applied to real-life emergencies in Active Experimentation, which supplements the learning gained from the Detachment-based time cycle

Adult Learning Theory (Andragogy)- Malcolm Knowles's Adult Learning Theory, also known as Andragogy, offers guiding principles for the effective teaching of adult learners, serving as a case in point for professional development in healthcare. Andragogy proposes that adult learners are self-directed, have extensive knowledge of

opportunities, hold a reservoir of knowledge filled with experience, and have a background of potential learning experiences within the learning environment. They are goal-oriented, relevance-oriented, pragmatic, and internally motivated [13].

Simulation training aligns well with these values. Adults are more engaged when the learning is relevant to their work and when they are allowed to apply new knowledge immediately. Simulations provide an advantageous and challenging learning environment that allows healthcare providers to have direct involvement and gain mastery of the job processes relevant to their disaster response roles. The self-directed nature of adult students is enhanced when they participate actively in simulations and reflect on themselves during the debriefing. Based on the existing experiences of participants and focusing on real-world problem-solving, SBT is particularly beneficial for healthcare professionals.

High-Reliability Organization (HRO) theory, developed by Karl Weick and Kathleen Sutcliffe, focuses on organizations that operate in hazardous environments yet are successful in preventing disasters. Five attributes characterize HROs: (1) preventive versus reactive, (2) sensitivity to operational safety, (3) commitment to resilience, (4) deference to expertise, and (5) preoccupation with failure [14].

Commitment to resilience, building the capability of institutions to adapt to meta-normal changes in the environment, to rise against novelty; deference to expertise, giving the floor to the elites, the leaders with the most expertise in making decisions, irrespective of their hierarchical position.

Ultimately, hospital disaster preparedness occurs in a high-risk environment. Simulation-based training can be an important in promoting HRO concepts in healthcare settings. By continually exposing staff to not only potential failures in a safe environment, but also through simulations, it instils a preoccupation with failure and promotes learning from mistakes. Complications in a disaster simulation thus support an aversion to reduce readings and increase operational sensitivity.

Problem-solving and quick adaptation are encouraged during simulation training, along with a commitment to resilience. This focus on teamwork and interdisciplinary work in SBT may lead to an over-reliance on expertise, allowing the voice of the highest-status person to be heard more frequently and giving less weight to dissenting viewpoints. This study will implicitly demonstrate how SBT influences the development of these HRO attributes within the Jeddah Second Health Cluster.

Stress and Coping Theory

According to Richard Lazarus and Susan Folkman's Stress and Coping Theory, stress is viewed as an outcome of a judgment process in which a person perceives a situation as a threat, assesses the challenges it poses, and then evaluates the resources available to meet them[15]. In disaster situations, doctors and medical professionals are under extreme physical and emotional stress. Effective coping strategies are crucial for maintaining optimal performance and preventing burnout.

Simulation training offers a safe environment for experiencing stress and its implications, thereby facilitating the development of clinical

competencies by allowing participants to generate and rehearse coping strategies. By repeatedly participating in high-fidelity scenarios, healthcare professionals can become inured to the shock of an initial disaster, learn how to manage their emotional responses and pressure decision-making. This repeated exposure, combined with a debriefing that incorporates psychological and emotional aspects, may promote self-efficacy and hardiness, and consequently, enhance coping ability.

Such theoretical bases provide an elaborate framework for analyzing the role of simulation in disaster medicine training for hospitals. They influence the inquiry about how SBT promotes learning, cultivates adult learners, individual managers in the face of uncertainty, promotes organizational reliability and individual resilience in the face of crisis.

المنهجية وطرق البحث:

Methodology and Research Methods

This is a retrospective study that will be conducted using a mixed methods approach, integrating such as recording instruments, without discriminating against either quantitative or qualitative methods digital methods of data collection and analysis to generate a thorough description of how the use of simulation-based training has been improved at individual hospitals in the Jeddah Second Health Cluster. A mixed-methods approach is especially appropriate for this research, as it enables the data to be triangulated, providing stronger and multiple lines of evidence. It provides a more comprehensive understanding of the phenomena under exploration than either quantitative or qualitative methods, respectively [16].

Study Tools:

The successful completion of this research will depend on the use of existing, as well as the development of new, multidisciplinary scientific and technological approaches. Specially designed study instruments were developed to obtain complete and accurate information. These tools are chosen to address the variety of research questions and to enable the collection of both quantitative and qualitative data.

Structured Questionnaire Purpose: To capture quantitative data on efficiency that was perceived to occur during SBT, individuals' self-assessed knowledge, skills, self-efficacy, and attitudes of preparedness of a sample of healthcare-serving organizations from the included studies. Content: The questionnaire will include several parts, comprising: (a) age, sex, occupation, and number of degrees (e.g., medicine, dentistry) collected by 10 questionnaires; (b) scale items assessing previous experience (years of experience, SBT participation, number of SBT experiences, experience with patients with mental illness); and (c) attitudes and views on the educational values of SBT as well as the training needs of both trainers and trainees. A sense of improvement in specific knowledge areas, skills, and other aspects is expected to be perceived while at work.

Our findings enhance communication, resource management, and confidence in disaster situations. It is a sense of capability to manage a disaster or address its consequences and effects effectively.

Development: The questionnaire will be developed by a published, detailed plan and validated by a disaster expert panel.

Semi-structured Interview Guide: Objective: To collect detailed qualitative data from informants (healthcare providers, SBT trainers, hospital administrators) about their experiences, thoughts, difficulties, and facilitators regarding SBT and disaster preparedness. The guide will contain open-ended questions designed to investigate the influences of SBT. Development: The interview guide will be developed by the research team, influenced by the literary examination. It will be tested with a sample of people from the target population.

Document Review Checklist Purpose: The aim is to review existing data and extract information systematically. Content: The tool will aid the review of SBT program curricula, attendance records, post-simulation debriefing reports, and reports on disaster drills or real-life events. Development: A checklist will be developed to collect data on the types of simulations, applications, and results obtained.

Statistical Software Purpose: For quantitative data analysis. Examples: SPSS, or similar software. Descriptive and inferential statistical analyses will be conducted using these software tools.

Qualitative Data Analysis Software: Objective: To facilitate the structuring, coding, and theming of qualitative data. Examples: NVivo, ATLAS.ti, or equivalent software. Analysis of themes and patterns. These study tools will enable a comprehensive understanding of the primary and secondary aspects of the research.

Limitations of the Study:

While this retrospective study is designed to provide valuable insights into the impact of simulation-based training on hospital disaster preparedness, it is important to acknowledge several potential limitations that may influence the scope and generalizability of its findings.

Retrospective Design: The inherent nature of a retrospective study means that it relies on existing data and past events. This can lead to challenges such as incomplete or missing data, inconsistencies in record-keeping over the five years, and reliance on self-reported information, which may be subject to recall bias. It may also be difficult to establish direct causality between SBT and preparedness outcomes, as other confounding factors might have influenced preparedness levels during the study period.

Data Availability and Quality: The success of the study depends on the availability and quality of historical data from the Jeddah Second Health Cluster hospitals. Access to comprehensive training records, detailed debriefing reports, and objective performance metrics from past drills or actual events may vary across institutions or over time. If data are scarce or of poor quality, it could limit the depth and breadth of the analysis.

Self-Reported Data Bias: A significant portion of the data, particularly regarding perceived effectiveness, knowledge, skills, and confidence, will be collected through surveys and interviews. Self-reported data

can be influenced by social desirability bias, where participants may provide answers they believe are expected or socially acceptable, rather than their actual perceptions. While efforts will be made to ensure anonymity and confidentiality, this bias cannot be eliminated.

Generalizability: The study focuses specifically on hospitals within the Jeddah Second Health Cluster. While the findings will be highly relevant to this context, their direct generalizability to other health clusters, regions, or countries with different healthcare systems, cultural contexts, or disaster profiles may be limited. However, the methodologies and conceptual insights may still be transferable.

Lack of a Control Group: As a retrospective study, it is not feasible to include a control group that did not receive SBT. This makes it challenging to definitively attribute all observed improvements in preparedness solely to simulation-based training, as other concurrent initiatives or external factors could have played a role. The study will attempt to mitigate this by analyzing trends over time and correlating them with SBT implementation.

Scope of Disaster Preparedness: Disaster preparedness is a multifaceted concept. This study will focus on aspects directly influenced by SBT, such as individual and team performance, coordination, and adherence to protocols. However, other critical components of preparedness, such as infrastructure resilience, supply chain management, or long-term recovery planning, may not be fully captured within the scope of this research.

Ethical Considerations for Retrospective Data: Although ethical approval will be obtained, working with retrospective data,

particularly performance data, necessitates careful consideration of privacy and confidentiality. Ensuring that all data is anonymized and handled by ethical guidelines is paramount, but this may also impose limitations on the Level of detail that can be accessed or reported.

Despite these limitations, the study is expected to provide valuable and actionable insights into the role of simulation-based training in enhancing hospital disaster preparedness within a significant healthcare cluster, contributing to both local practice and the broader academic applications.

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