Building resilient health systems through simulation exercises to strengthen emergency preparedness and response

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Background

The COVID-19 pandemic exposed systemic failures in health systems globally, reigniting interest in how these systems adapt during emergencies (*6*,*7*). Some of the challenges include fragmented decision-making systems, inconsistent risk communication, difficulties in policy adaptation, and coordination breakdowns, particularly in aligning national and subnational responses and integrating interventions across sectors (*8*). Weaknesses in resource allocation led to critical shortages, especially in low- and middle-income countries (*9*). Gaps in workforce training and institutional learning hindered real-time adaptation (*6*,*10*). These challenges indicate the need for structured learning, including through simulation exercises (SimEx), to proactively identify gaps and stress-test response strategies (*11*).

The Eastern Mediterranean Region (EMR) faces frequent public health emergencies, including outbreaks of cholera, zika, mpox, COVID-19, MERS-CoV, polio, measles, dengue fever, leishmaniasis, and conflict-related crises (*1*). These underscore the need for robust emergency preparedness through learning health systems, which are critical for resilience, because they enable systematic learning and the application of insights to adapt to challenges (*2*).

Learning is central to health system resilience, facilitating absorption, adaptation and transformation in response to shocks and stressors (*3*). Simulation exercises are a cornerstone of such systems, enabling practical testing of policies, protocols and response capabilities. Frameworks, such as the WHO early action review (EAR), after action review (AAR) and intra-action review (IAR) (*4*) focus on retrospective learning. However, SimEx, in contrast, proactively tests systems under controlled conditions, addressing pivotal questions such as "Are we learning effectively?" SimEx facilitates iterative learning through single-, double- and triple-loop frameworks. Single-loop learning enhances operational efficiency by refining existing processes, while double-loop learning critically assesses whether strategies are appropriate. Triple-loop learning fosters systemic transformation, ensuring continuous adaptation and institutionalisation of best practices (*5*). Sheikh et al introduced a framework that emphasises learning at the individual, team and organisational/cross-organisational levels (*12*). The framework incorporates different modalities—information, deliberation and action—and evaluates effectiveness through these iterative loops (Figure 1). SimEx operationalises this by addressing key questions: "Are we doing things right?" "Are we doing the right things?" and "Are we learning effectively?" By systematically addressing these, SimEx enhances preparedness, response and resilience.

The role of WHO in simulation exercises across the EMR

WHO has consistently facilitated SimEx as a vital component of the International Health Regulations Monitoring and Evaluation Framework (IHR-MEF) (*13*). Since 2016, WHO has supported over 331 SimEx globally, including 18 conducted in 9 EMR countries. These exercises range from tabletop discussions to full-scale simulations, and they address scenarios such as mass gatherings, infectious disease outbreaks and public health emergencies (*14*).

The 18 SimEx conducted in the EMR is an indication of the region's commitment to strengthening health emergency preparedness and response capabilities. Facilitated in collaboration with national governments, these exercises have targeted regionally relevant challenges such as MERS-CoV and subregional infectious disease threats. Countries like Iraq, Jordan, Oman, Qatar, and Saudi Arabia have used SimEx to evaluate and enhance critical capacities, including emergency plan coordination, communication strategies and interagency collaboration. For example, Saudi Arabia has a well-documented history of conducting regular SimEx to enhance preparedness for the Hajj seasons (*15*–*17*). These exercises are integral to ensuring the safety and efficiency of operations during the annual pilgrimage. They focus on cross-sectoral collaboration and real-time scenario testing, demonstrating how structured SimEx can validate emergency plans, enhance coordination and strengthen response capabilities in the context of unique mass gathering scenarios.

Other notable initiatives in the region include the use of SimEx for mass gatherings by Lebanon and Pakistan and for unified health preparedness frameworks by Iraq and Qatar. Egypt, Oman and Turkey prioritised regional coordination and interoperability for earthquake response and IHR-related exercises (*18*,*19*). These activities tested and helped refine preparedness frameworks and promoted cross-border cooperation and information-sharing, significantly enhancing the capacity to manage complex health emergencies in the region.

In October 2023, WHO supported a simulation exercises practitioners training course in Rabat, Morocco. Over 3 days, 29 participants from various agencies were trained to design and implement country-specific SimEx relevant to public health emergencies, in collaboration with WHO and Morocco's Ministry of Health. The training culminated in a 2-day, multisectoral, discussion-based tabletop SimEx focused on a pandemic influenza outbreak. It provided an opportunity to evaluate and strengthen Morocco's pandemic preparedness and response plans. The exercise engaged participants across 6 functional working groups representing health, aviation, military, port, veterinary, and communication sectors. Key outcomes included enhanced clarity of roles, improved coordination mechanisms and a stronger understanding of escalation protocols. A participants survey indicated that 90% found the exercise valuable in improving pandemic preparedness planning, and 85% reported increased confidence in intersectoral collaboration.

These efforts highlight the transformative potential of SimEx in advancing health system resilience. The Morocco exercises fostered multiple levels of learning: single-loop learning improved informed practices, double-loop learning encouraged critical evaluation of routines, and triple-loop learning facilitated systemic improvements. The establishment of a cadre of trained facilitators is expected to sustain these gains, bolstering Morocco's health emergency preparedness and resilience.

The case for a national health simulation exercise programme

SimEx is indispensable for bolstering emergency preparedness, yet it frequently encounters challenges. For example, it is often conducted in isolation or without adequate follow-up mechanisms. Such limitations diminish the long-term impact of SimEx on health system resilience. To bridge these gaps, WHO introduced the national health simulation exercise programme (NHSEP) (*20*,*21*), which systematically integrates SimEx into the broader, coordinated capacity-building strategies.

The key elements of NHSEP are:

- *Integration with national plans:* Aligning SimEx with the response to priority health threats ensures relevance and impact within emergency response frameworks.
- *Gradual complexity:* Progression from tabletop to full-scale simulation enhances preparedness in line with evolving capacities.
- *Cross-sector collaboration:* Fosters cooperation across human, animal and environmental health sectors using the One Health approach.
- *Monitoring and evaluation:* Rigorous tracking ensures that the lessons are used for actionable improvements and system resilience.

Through these elements, NHSEP aligns closely with the health security objectives of EMR, creating structured, multiyear SimEx schedules that systematically strengthen preparedness and response capacities.

An analysis of SimEx outputs during 2016–2019 (*18*) revealed the necessity to transition from sporadic, *ad hoc* exercises to systematic and structured programmes, emphasising a "building block approach" where simpler tabletop exercises progressively evolve into more complex, full-scale simulations. This approach will enable countries to align their exercises with their capacity and priorities, ensuring practical and meaningful outcomes.

By adopting an all-hazards, multisectoral approach, SimEx will enhance interoperability and cross-sector collaboration at the national and regional levels. These exercises address threats such as infectious disease outbreaks as well as chemical, radiological and nuclear emergencies, catalysing continuous improvement.

NHSEP prioritises inclusivity, emphasising gender-sensitive approaches and addressing the needs of vulnerable populations to ensure that no one is left behind.

A cornerstone of NHSEP is building a cadre of skilled SimEx experts to design, deliver and evaluate high-quality exercises, ensuring effective implementation and long-term sustainability of these capabilities.

Although SimEx offer valuable opportunities to enhance preparedness and response, their implementation is not without challenges. Resource constraints, particularly in low- and middle-income settings, can limit the frequency, scope and realism of exercises. Conducting high-fidelity simulations requires financial investment, the right infrastructure and dedicated personnel, which may compete with other health system priorities.

Sustainability is another concern, because maintaining a cycle of exercises necessitates long-term commitment from governments and partners, as well as integration into national preparedness plans. Continuous capacity building is essential to ensure that trained facilitators and responders retain and refine their skills over time. Without appropriate mechanisms to institutionalise these competencies, there is a risk of losing momentum after initial training.

Addressing these challenges requires strategic planning, sustained funding and embedding SimEx into broader health security frameworks to maximise their long-term impact.

Conclusion

The adoption of structured SimEx under NHSEP is vital for the EMR. These exercises provide a systematic method to build, test and refine emergency preparedness and response capabilities. Policymakers, health ministries and international partners should prioritise SimEx as a foundational tool for a resilient health system. Sustained engagement with donors and technical partners is crucial to support the scaling of NHSEP across the region, ensuring its practical relevance and long-term impact. By institutionalising NHSEP, EMR can transform its capacity to anticipate and mitigate public health emergencies, ensuring a safer future for all.

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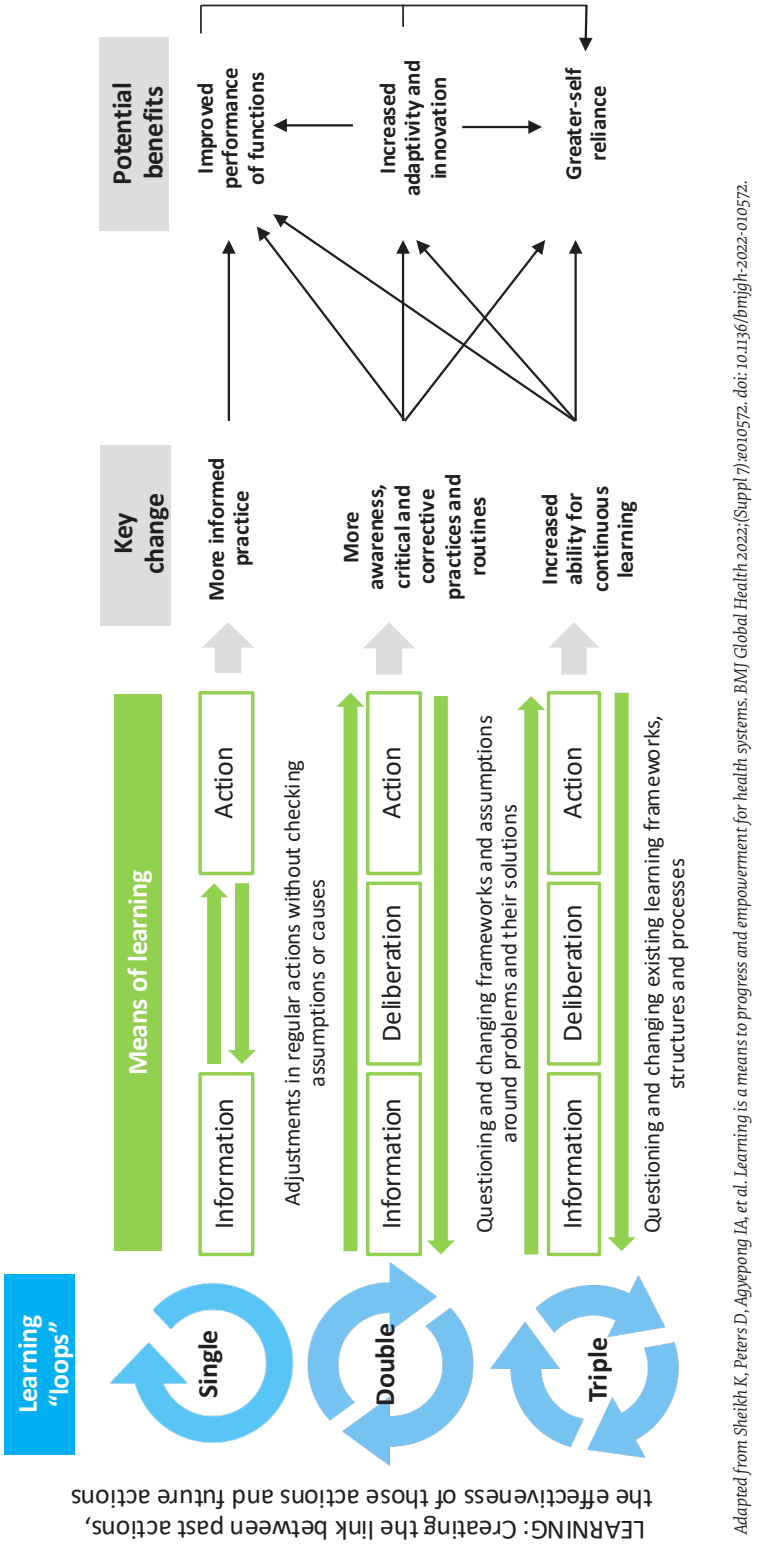

Figure 1 Benefits of learning health systems in the context of simulation exercises (adapted from Sheikh K, Peters D, Agyepong IA, et al. Learning is a means to progress and empowerment for health systems. BMJ Global Health 2022; 7)

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