

Evaluation of Hospital Preparedness and Response to Trauma Through a Full-Scale Disaster Drill: A Multimethod Study

Kripa Maharjan

kripamaharjan@pahs.edu.np

Patan Academy of Health Sciences

Aakash Bhandari

Patan Academy of Health Sciences

Aayush Chaulagain

Patan Academy of Health Sciences

Shruti Silwal

Patan Academy of Health Sciences

Mala Deep Upadhaya

Coventry University

Amit Chand

Patan Academy of Health Sciences

Research Article

Keywords: disaster preparedness, hospital incident command system, mass casualty incident, simulation exercise, triage

Posted Date: October 11th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-11109693/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

Additional Declarations: No competing interests reported.

Abstract

Background

Hospitals play a central role in managing trauma-related mass casualty incidents (MCIs), and full-scale simulation exercises (FSSEs) are widely used to test institutional preparedness. This study aimed to assess the structure and execution of a trauma-related disaster drill, identify systemic gaps in triage, communication, and patient disposition, and analyze the operational flow of the hospital incident command system (HICS).

Methods

A multimethod retrospective study was conducted at a tertiary-care hospital following a full-scale trauma disaster drill simulating a two-bus collision with approximately 100 casualties. A standardized five-domain checklist was scored independently by three observers, and inter-rater agreement was assessed using Fleiss' kappa. Time-motion analysis tracked five simulated patients from arrival to disposition. HICS activation and role performance were mapped using a swim lane process-flow analysis and compared against expected protocol benchmarks. Qualitative data were analyzed thematically.

Results

Inter-rater reliability across checklist domains was moderate to good (overall Fleiss' kappa = 0.558). Triage was initiated without measurable delay from patient arrival, but downstream processes were slower. HICS activation (14 minutes 52 seconds) and triage-officer assignment (16.8 minutes) both exceeded protocol benchmarks, while siren activation (29 minutes 56 seconds) and initial patient triage were within expected limits. Thematic analysis of interviews identified four major domains of concern: planning constraints, communication gaps, resource/logistical barriers, and team role confusion.

Conclusions

Frontline clinical response, particularly triage, was a consistent strength, but systemic inefficiencies in communication infrastructure, command coordination, and resource logistics represent the principal barriers to optimal mass casualty response.

Background

Hospitals play a central role in managing trauma-related disasters, particularly mass casualty incidents (MCIs) arising from natural disasters, road traffic collisions, terrorist attacks, or other violent events. Effective management of such events requires coordinated systems spanning triage, communication, logistics, and leadership structures, along with trained personnel capable of rapidly scaling operations to accommodate large numbers of casualties.^{1,2}

To build and test this capacity, many hospitals conduct trauma disaster drills that examine key operational domains such as triage accuracy, inter-team coordination, communication flow, and resource management.³ Full-scale simulation exercises (FSSEs) have been shown to help hospital staff strengthen relevant skills while surfacing latent weaknesses in emergency systems that might otherwise remain undetected until a real event occurs.^{3,4} Incorporating realistic elements, such as standardized patients and mass-casualty simulation (MAC-SIM) cards, further enhances drill fidelity and allows more precise measurement of institutional performance.⁵

Despite the widespread use of disaster drills, the literature suggests that many hospitals do not systematically evaluate long-term outcomes, and that lessons identified during drills are inconsistently translated into official policy.⁶ Evaluations that combine quantitative performance metrics with qualitative staff perspectives rather than relying on a single method are

particularly scarce, especially in resource-constrained, low- and middle-income settings where infrastructure and staffing limitations may shape drill performance differently than in high-resource contexts.

This study aims to address that gap by evaluating the preparedness and response of a tertiary-care hospital in Nepal through a full-scale trauma disaster drill, using a multimethod approach. Specifically, the study sought to assess the structure and execution of the drill using a standardized, inter-rater-validated checklist; identify systemic gaps in triage, communication, and patient disposition through time-motion analysis of simulated patient flow; and analyze the operational flow of the Hospital Incident Command System (HICS) against expected protocol benchmarks.

Methods

A multimethod retrospective study, integrating quantitative and qualitative approaches, was conducted at Patan Academy of Health Sciences, a tertiary-care hospital in Lalitpur, Nepal, following a full-scale trauma disaster drill. The drill simulated a collision between two buses at Lubhu, Lalitpur, resulting in a scripted mass casualty scenario of approximately 100 casualties. The exercise involved emergency responders, medical and nursing staff, hospital security and police personnel, the Hospital Incident Command Team, logistics and administrative staff, and role-players drawn from undergraduate medical and nursing student batches, alongside independent observers and evaluators from the drill coordination team, the Health Emergency Operation Centre (HEOC), and metropolitan police. Data were collected from multiple archival and primary sources generated during and after the drill, including: after-action reports and observer checklists, hot and cold debriefing summaries, meeting minutes from emergency preparedness teams, forms completed during the drill (triage records, HICS logs, patient-tracking forms), feedback forms from staff and observers, semi-structured interviews with key personnel, and real-time event and timeline reports.

A standardized evaluation checklist, developed with reference to guidelines from the World Health Organization (WHO), the Federal Emergency Management Agency (FEMA), and the Hospital Emergency Response Training (HERT) program, was used to assess the drill across five domains: pre-drill planning and structure, drill execution, command and control, resources and logistics, and post-drill evaluation and debriefing. Each item was rated independently by three trained observers on a three-point scale (Yes / Partial / No), with space for contextual comments. Inter-rater agreement was quantified using Fleiss' kappa, interpreted according to conventional thresholds (< 0.40 poor, 0.40–0.60 moderate, 0.60–0.75 good, > 0.75 excellent agreement).⁷ The number of observers (three) reflected the trained personnel available for deployment to this evaluation role during the drill.

In parallel, semi-structured key informant interviews (KIIs) were conducted in person by three of the authors (Kripa Maharjan, MD; Aakash Bhandari, MBBS; Aayush Chaulagain, MBBS), a mixed-gender team of physicians in emergency medicine at the study institution, each with prior interviewing experience; as colleagues at the same institution, the interviewers had a pre-existing professional relationship with participants. Participants were briefly informed about the purpose of the session beforehand, and all had been directly involved in the drill. KIIs involved 21 participants, including drill planners, emergency department coordinators, members of HICS and senior clinical staff, exploring planning challenges, communication flow, resource adequacy, and role clarity. The target sample size was determined by the goal of obtaining perspectives from all major functional roles engaged in the drill, rather than a predetermined numerical target, and recruitment concluded once all major functional roles had been represented rather than through formal assessment of thematic saturation. Participants were purposively recruited based on their functional role in the drill, consistent with criterion-based sampling conventions for qualitative key informant research as reflected in the COREQ reporting guidelines, rather than through convenience or self-selected recruitment; no approached participant declined to take part or withdrew. Interviews were conducted individually in a hospital office, with only the interviewer and participant present, using a semi-structured interview guide that was developed specifically for this study, informed by FEMA and HERT frameworks and expert-validated at the study institution; this guide has not been published previously and is provided in English as Additional file 3. Interviews were not repeated with any participant. Each interview lasted approximately 15 minutes and was audio-recorded and subsequently transcribed, with no additional field notes taken; transcripts were returned to participants for review and confirmation. Interview transcripts were analyzed using thematic analysis, involving data familiarization, initial coding, theme generation, review and refinement, and final synthesis;

coding was performed manually by three coders without the use of qualitative analysis software, and participant feedback on the final themes was not obtained. Statistical analyses were performed using Python Version 3.11 (Python Software Foundation, Wilmington, Delaware, USA), with the statsmodels and scikit-learn packages.

Five simulated patients, representative of major clinical pathways (general surgery, trauma operating theatre, intensive care unit transfer, an obstetric case, and a deceased/"black" triage-category case), were tracked from initial entry through triage, treatment initiation, and final disposition using structured logs completed by assigned postgraduate residents. These pathways were deliberately selected, rather than randomly sampled, to provide structured case tracking across the distinct casualty-routing categories anticipated in the drill scenario; the number of pathways tracked (five) corresponds to the number of distinct casualty-routing categories identified in the drill scenario, rather than a statistically derived sample size. This case-tracking design was not intended to yield a population-representative sample for inferential analysis, and its findings are interpreted accordingly (see Limitations). Time intervals between successive stages were calculated. Individual pathway durations were reported descriptively, and mean (SD) values were calculated across the five representative pathways for overall time-motion measures. Exploratory factor analysis (EFA) was additionally performed on time-based performance variables to identify latent system-level contributors to operational efficiency and delay; sampling adequacy was assessed using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity, factors were extracted using principal component analysis, and Varimax rotation was applied to improve interpretability.

Activation and operational steps of the Hospital Incident Command System (HICS) were reconstructed from observer forms, command logs, and role-assignment sheets. The sequence and timing of actions across ICS roles (Incident Commander, Triage Officer, Logistics Officer, Safety Officer) were organized into a swimlane process-flow diagram. For each major task, the observed sequence and timing were compared against the expected protocol benchmark to determine protocol match, and summary indicators – time to HICS activation, number of tasks delayed or missed, and roles not clearly followed – were tabulated.

This study used anonymized archival data (reports, checklists, logs) for Objectives 1 and 3, which did not require individual written consent. Objective 2, involving direct interviews, required and obtained written informed consent from all participants, with confidentiality maintained throughout. Ethical approval was obtained from the Institutional Review Committee (IRC Approval No. FLW2512192170). All documents were stored on a password-protected computer accessible only to the principal investigator. The quantitative observational component of this study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines, and the qualitative interview component was reported in accordance with the Consolidated Criteria for Reporting Qualitative Research (COREQ) guidelines. Completed STROBE and COREQ checklists are provided as supplementary material (Additional files 1 and 2, respectively).

During the preparation of this manuscript, the authors used ChatGPT [version 5.6 Luna] (OpenAI, San Francisco, California, USA) for grammar checking and language correction; the graphical abstract was prepared with the assistance of Canva, with all content specified by the authors. The authors reviewed and edited all AI-assisted output and take full responsibility for the content of the published article.

Results

The drill was activated at 14:00 following a simulated collision of two buses at Lubhu, Lalitpur on March 7, 2025. The incident was first reported by a bystander to hospital police at 14:02, triggering activation of the Hospital Incident Command System and a strategic coordination meeting at 14:16. The emergency siren was activated at 14:31, and the first simulated victim arrived at the hospital at 14:42. Full-scale medical response, with definitive care initiated by triage priority, began at 14:55, and the incident was declared under control at 15:18. The exercise, including preparation for hot debriefing, concluded at 16:00.

Assessment of the standardized checklist across the five evaluation domains by three independent observers demonstrated moderate to good overall agreement, with an overall Fleiss' kappa of 0.558, indicating acceptable consistency in how observers interpreted and scored drill performance across pre-drill planning, execution, command and control, resources and logistics,

and post-drill evaluation domains. Time-motion tracking of five representative simulated patients revealed that time from arrival to triage was negligible across all pathways (0 minutes in all traced cases), indicating prompt frontline triage response.

Beyond the five tracked pathways, additional bottlenecks were identified in ancillary services: laboratory investigations ordered at 15:19:40 were not reported until 16:12:01, a turnaround of 52 minutes 21 seconds, and a scheduled X-ray at 15:00 did not occur at all because of unresolved confusion around the hospital's zero-billing policy for disaster victims. A supply delay of two minutes was also noted at the triage point due to a shortage of trolleys. Across the drill overall, systemic delays and errors were most frequently attributable to resource or operational bottlenecks (7 [5.5%]), followed by communication gaps or issues (3 [2.3%]), with security lapses and process confusion each accounting for a smaller proportion (1 [0.8%] each) (Table 2).

Time-motion analysis of the five representative patient pathways demonstrated consistently rapid frontline response, with immediate triage achieved across all cases. Greater variability was observed in downstream processes, particularly in ICU transfer and final patient disposition. The longest total pathway duration was observed for the ICU-transfer pathway (31.1 minutes), while the shortest was observed for the obstetric pathway (12.4 minutes) (Table 1). These findings indicate that workflow delays were primarily attributable to interdepartmental coordination and resource-dependent processes rather than initial clinical assessment.

Mapping of ICS activation and role-based actions onto a swimlane process-flow diagram (Fig. 1) showed that, while the overall command sequence and role hierarchy were maintained, several key actions exceeded expected protocol timeframes. HICS activation occurred 14 minutes 52 seconds after the initial report, exceeding the 5-minute benchmark, and triage-officer assignment (16.8 minutes) similarly exceeded its 10-minute benchmark. Siren activation, at 29 minutes 56 seconds, fell just within the 30-minute benchmark, and initial patient triage occurred immediately on arrival, well within the 15-minute benchmark. Laboratory report turnaround (52 minutes 21 seconds) substantially exceeded the 30-minute benchmark (Table 3). Overall, the incident command system took 14.9 minutes to activate, four tasks were delayed, no tasks were entirely missed, and one instance of a role not being clearly followed was recorded (Table 4).

Thematic analysis of key informant interviews, triangulated with hot and cold debriefing records, identified four major domains of concern, each comprising more specific sub-themes (Table 5). These themes converged closely with structured debriefing findings. Participants and observers consistently identified timely activation of disaster response protocols, efficient evacuation of outpatient cases to create surge capacity, well-prepared reception of casualties, effective triage and categorization by injury severity, and strong interdepartmental coordination as notable strengths of the response. Conversely, siren audibility, overcrowding in critical care areas, communication gaps around the hospital's zero-billing policy (which delayed diagnostic imaging), unreliable HICS phone communication compounded by the absence of CCTV monitoring in the command room, patient-coding inconsistencies affecting billing and record-keeping, and incomplete activation of the hospital's media/VIP management plan were identified as the principal areas for improvement. Unanticipated operational issues included restricted bus access to the intended casualty drop-off gate due to height clearance, miscommunication that led to an influx of non-clinical volunteer staff, and uncertainty over billing responsibility for unaccompanied victims under the zero-billing policy.

Table 1
Time-motion tracking of simulated patients

Patient Pathway	Entry Time	Triage Time	Treatment Start	Disposition Time	Entry→Triage	Triage→Tx	Tx→Disposition	Total Time (min)
General Surgery	14:40:35	14:40:35	14:50:06	15:04:00	0 m	9 m 31 s	13 m 54 s	24.53
Trauma OT	14:45:54	14:45:54	14:55:29	15:11:22	0 m	9 m 35 s	15 m 53 s	26.47
ICU Transfer	14:46:38	14:46:38	14:52:53	15:16:30	0 m	6 m 15 s	23 m 37 s	31.13
Pregnancy Case	15:08:09	15:08:09	15:09:23	15:20:15	0 m	1 m 14 s	10 m 52 s	12.40
Black Patient	14:40:30	14:40:30	14:49:30	15:09:03	0 m	9 m 00 s	19 m 33 s	19.05

Table 2
Systemic delays and errors

Variable	Cases (n)	Percentage (%)
Resource / Operational Bottlenecks	7	5.5
Communication Gaps / Issues	3	2.3
Security Lapses	1	0.8
Process Confusion	1	0.8

Table 3
Protocol comparison: observed versus expected incident command system performance

Task	Expected Benchmark	Observed Time	Protocol Match
HICS Activation	< 5 min of report	14 min 52 s	No (Delayed)
Triage Officer Assignment	< 10 min of report	16.8 min	No (Delayed)
Siren Activation	< 30 min of report	29 min 56 s	Yes (On Time)
First Patient Triage	< 15 min of arrival	0 min	Yes (Immediate)
Lab Report Turnaround	< 30 min	52 min 21 s	No (Delayed)

Table 4
Incident command system performance summary

Indicator	Value	Notes
Time to activate HICS (min)	14.9	Strategic meeting initiated at 15 minutes post-report
Number of tasks delayed	4	Included delayed siren activation and multiple communication issues (e.g., physical relay of VIP-arrival information after failure to reach security by phone at 45 minutes)
Number of tasks missed	0	No critical tasks were entirely missed based on log entries
Roles not clearly followed (count)	1	Security protocol breach: an unauthorized visitor was present in the HICS room at 66 minutes

Table 5
Thematic analysis of key informant interviews

Domain	Theme	Key Findings
Planning Issues	Simulation fidelity vs. clinical continuity	Difficulty maintaining an element of surprise while still needing to pre-inform staff for infrastructure setup; frontline staff experienced procedural confusion balancing drill protocols with ongoing care of real emergency department patients; rushed preparation due to limited planning time and lack of dedicated meeting space.
	Multidisciplinary and systems integration gaps	Planning inadequately integrated associate departments (housekeeping, billing/cash) and external partners (security, satellite hospitals); verbal notifications alone were insufficient, with a need identified for practical departmental rehearsals; scope was largely trauma-focused and did not address a broader range of potential disaster types.
Communication Gaps	Infrastructure reliability and activation clarity	Technical failures affected formal notification tools, including malfunctioning sirens, bells, and phone lines during the critical initial trigger phase; considerable ambiguity existed about official trigger points; heavy reliance on informal channels such as word-of-mouth and personal mobile applications in the absence of a secure, centralized communication system.
	Strategic-operational command disconnect	Limited real-time coordination between the Hospital Incident Command System and frontline teams; absence of a mediator-level or field-liaison role to relay updates and oversee departmental preparations; notable gaps in communication between hospital command and external security personnel at triage points.
Resource Challenges	Logistical and structural infrastructure barriers	Planning did not account for vehicle access restrictions or the inaccessible location of the disaster equipment store; two-way patient traffic through shared entry/exit paths caused physical congestion; scarcity of trolleys and mattresses, alongside confusion over responsibility for retrieving specific medical supply sets.
Team Role Confusion	Personnel density and role ambiguity	Unassigned staff and spontaneous volunteers outnumbered patients in places, causing congestion in triage zones; lack of individual task definitions led to clustering, with five to six staff members attending a single patient simultaneously; basic science faculty and other non-clinical staff lacked specific assignments and were left idle or uncertain of their duties.

Discussion

This study evaluated hospital preparedness and response to a simulated mass casualty incident using a multimethod approach that integrated quantitative performance metrics with qualitative staff perspectives. The findings demonstrate that while frontline clinical processes – particularly initial triage – were performed efficiently, significant systemic gaps persisted in communication, logistics, and command coordination.

The moderate to good inter-rater reliability ($\kappa = 0.558$) observed across checklist domains supports the reliability of the evaluation tool used in this study, while also suggesting that certain aspects of disaster preparedness – particularly those relating to logistics and communication – were less consistently implemented or interpreted by different observers than more procedural, clinically-anchored domains such as triage. This pattern is consistent with the broader recognition that non-clinical domains (e.g., communication systems, resource allocation) are often more variable and less standardized than core clinical procedures in hospital disaster settings.⁷

The time-motion analysis provided valuable insight into patient flow and operational efficiency during the disaster drill. While all five representative patient pathways demonstrated immediate triage on arrival, reflecting strong frontline preparedness, delays became increasingly apparent during subsequent stages of care, particularly in ICU transfer, laboratory reporting, and diagnostic services. These findings suggest that the principal constraints in disaster response were not related to initial clinical assessment but rather to downstream coordination, resource mobilization, and interdepartmental processes. Such bottlenecks have important implications for patient throughput during mass casualty incidents, where delays in investigations, definitive treatment, or disposition can reduce surge capacity and compromise overall system performance. Although the time-motion

analysis was based on a limited number of purposively selected representative cases and therefore should not be considered fully representative of all patients managed during the exercise, it effectively identified critical workflow vulnerabilities that aligned with observations from the checklist evaluation and qualitative interviews, thereby strengthening the overall interpretation through methodological triangulation.

Time-motion analysis reinforced this pattern: triage was consistently initiated without delay, reflecting effective frontline readiness, whereas downstream processes showed greater variability. The ICU-transfer pathway had the longest observed total duration (31.1 minutes), while laboratory reporting required 52 minutes 21 seconds, substantially exceeding the 30-minute benchmark. This suggests that although the hospital was well prepared for rapid patient intake, internal workflow bottlenecks beyond initial assessment can meaningfully affect overall casualty throughput and, by extension, patient outcomes during a real mass casualty event. These results align with hospital disaster-preparedness literature that identifies resource allocation, interoperability of communication systems, and coordination of inter-departmental transfers as key challenges that can compromise overall response efficiency. The exploratory factor analysis reinforced this distinction between rapid, well-executed clinical actions (response and consultation time) and more variable, system-dependent total case duration, pointing to complex inter-departmental transfers and resource mobilization as the primary drivers of delay rather than frontline clinical decision-making itself.⁸

The ICS operational analysis added a command-level perspective to these findings. Although the overall chain of command was maintained and no critical tasks were entirely missed, both HICS activation and triage-officer assignment exceeded their respective protocol benchmarks, and a security protocol breach was identified within the command room itself. Together with the qualitative finding of a strategic-operational command disconnect – including the absence of real-time monitoring (e.g., CCTV) in the HICS room and unreliable phone-based communication with security – this suggests that command-level situational awareness, rather than frontline execution, represents a key vulnerability in the hospital's current disaster response architecture. This finding is consistent with evidence that hospital Incident Command Systems must include a clear chain of command and integrated communication to enable seamless coordination among hospital personnel, emergency responders, and other agencies; when these elements are weak or poorly linked, situational awareness and decision-making become compromised. The absence of real-time monitoring and unreliable communication further reflects the broader literature that emphasizes structured, redundant communication systems and central coordination as essential for effective disaster response.⁹

Qualitative findings provided further insight into these quantitative patterns. Planning-related challenges, including limited preparation time and insufficient micro-level operational detailing, contributed to confusion during execution; although an overarching disaster plan existed, the absence of clearly defined individual roles and department-specific protocols reduced its effectiveness in real time. This mirrors hospital disaster-preparedness guidance that stresses the need for pre-established, detailed disaster response protocols and clearly defined roles within an Emergency Operations Plan, arguing that generic plans without operational specificity are less effective in real crises. Communication gaps, including ambiguous activation signals and heavy reliance on informal channels, further reduced situational awareness and delayed coordinated action. These issues resonate with the global emphasis on structured communication networks and crisis communication frameworks that link emergency operation centers, broadcasting systems, and frontline responders, and that require scientifically planned, multi-layered communication strategies rather than ad hoc or informal channels. Resource-related challenges, particularly space constraints and structural/logistical barriers such as restricted vehicle access, compounded these issues, while a paradox of overstaffing alongside workflow disruption – with unassigned staff and spontaneous volunteers outnumbering patients in some areas – highlighted the absence of role-based staff allocation and surge management strategies. Team role confusion, including the clustering of five to six staff members around single patients, reflected a gap between theoretical role assignment and practical execution, underscoring the need for more granular, scenario-based training. These observations align with the broader literature that identifies resource management, surge staffing, and clear role allocation as critical components of hospital disaster preparedness, and that emphasizes the need for comprehensive strategies integrating training, communication, and resource management.⁹

These findings are broadly consistent with existing disaster-preparedness literature, which similarly emphasizes the importance of structured communication systems, clearly defined command hierarchies, and efficient resource allocation as prerequisites for effective mass casualty response. The observed gaps in the present study reinforce that disaster preparedness is not solely a function of clinical competence but requires robust, system-level integration across communication, logistics, and command domains within hospital operations. In particular, the interplay between weak communication infrastructure, partially implemented command structures, and inefficient resource and staff allocation underscores the need for hospitals to move beyond standalone clinical protocols toward integrated, system-wide disaster response frameworks that explicitly address these non-clinical domains.¹⁰

Limitations

This study has several limitations. First, it was conducted at a single tertiary-care hospital using a simulated disaster scenario, which may limit the generalizability of the findings to other healthcare settings and real mass casualty incidents. Second, the time-motion analysis intentionally focused on five representative patient pathways selected to illustrate major casualty-routing categories rather than to provide a population-representative sample, and therefore may not capture the performance of all patients during the drill. Third, qualitative findings were derived from participant interviews and may be subject to recall and response bias despite triangulation with observer reports and debriefing records. Finally, as with all simulation-based evaluations, participant behavior may have differed from that during an actual disaster event.

Conclusions

This full-scale disaster drill revealed strong frontline clinical preparedness, particularly in rapid triage and initial patient reception, but highlighted critical systemic gaps in communication infrastructure, resource logistics, and incident command coordination. Addressing these gaps through structured, redundant communication systems, role-based staff activation protocols, and regular, focused drills is essential to strengthening institutional capacity for future mass casualty incidents. These findings support integrating regular multidisciplinary disaster drills into institutional quality-improvement programs and may inform disaster preparedness policies in resource-limited hospitals.

Abbreviations

MCI
mass casualty incident
FSSE
full-scale simulation exercise
HICS
Hospital Incident Command System
ICS
Incident Command System
WHO
World Health Organization
FEMA
Federal Emergency Management Agency
HERT
Hospital Emergency Response Training
KII
key informant interview
EFA
exploratory factor analysis
KMO

Kaiser-Meyer-Olkin
HEOC
Health Emergency Operation Centre
IRC
Institutional Review Committee
ICU
intensive care unit
OT
operating theatre
GPEM
General Practice and Emergency Medicine
STROBE
Strengthening the Reporting of Observational Studies in Epidemiology
COREQ
Consolidated Criteria for Reporting Qualitative Research.

Declarations

Ethics approval and consent to participate

This study was approved by the Institutional Review Committee, Patan Academy of Health Sciences (IRC Approval No. FLW2512192170), and all procedures were performed in accordance with the relevant institutional and national guidelines and regulations, including the Declaration of Helsinki and its later amendments. Written informed consent was obtained from all interview participants; archival checklist and log data were anonymized and did not require individual consent.

Consent for publication

Not applicable. This manuscript does not contain any individual person's data, images, or videos.

Availability of data and materials

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

Not funded.

Authors' contributions

KM contributed to conception and design of the study, data acquisition, analysis and interpretation of data, and drafted the manuscript. AB contributed to data acquisition and interpretation and critically revised the manuscript for important intellectual content. AYC contributed to data acquisition and interpretation, study design and data analysis, and critically revised the manuscript. SS contributed to study design and data analysis and critically revised the manuscript. MDU contributed to study design and data analysis and critically revised the manuscript. AMC contributed to data analysis and critically revised the manuscript. All authors read and approved the final manuscript, and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. (KM: Kripa Maharjan; AB: Aakash Bhandari; AYC: Aayush Chaulagain; SS: Shruti Silwal; MDU: Mala Deep Upadhaya; AMC: Amit Chand).

Acknowledgements

The authors thank the drill coordination team, hospital administration, Department of General Practice and Emergency Medicine (GPEM) faculty and residents, role-players (first-year MBBS and Nursing students of Patan Academy of Health Sciences), and all participating hospital staff, as well as observers from the Health Emergency Operation Centre and Lalitpur Metropolitan Police.

References

1. Ingrassia PL, Pigozzi L, Bono M, Ragazzoni L, Della Corte F. Use of simulated patients in disaster medicine training: a systematic review. *Disaster Med Public Health Prep.* 2021;15(1):99–104.
2. Nekoie-Moghadam M, Kurland L, Moosazadeh M, Ingrassia PL, Della Corte F, Djalali A. Tools and Checklists Used for the Evaluation of Hospital Disaster Preparedness: A Systematic Review. *Disaster Med Public Health Prep.* 2016;10(5):781–8.
3. Abualenain J, Alhajaji R, Kamel Alsulimani L. A systematic review of the efficacy of full-scale simulation exercises in enhancing hospital disaster preparedness. *J Med Law Public Health.* 2024;4(3):419–46.
4. McGaghie WC, Issenberg SB, Cohen ER, Barsuk JH, Wayne DB. Does simulation-based medical education with deliberate practice yield better results than traditional clinical education? A meta-analytic comparative review of the evidence. *Acad Med.* 2011;86(6):706–11.
5. Bajow N, Alesa S, Shaheen FAY, Almalki A, Alshamrani A, Alotaibi R, Aloraifi A, Montan C, Lennquist S, Alotaibi M. Assessment of the effectiveness of hospital external disaster functional drills on health care receivers' performance, using standardized patients and mass cards simulation: a pilot study from Saudi Arabia. *BMC Emerg Med.* 2024;24(1):175.
6. Verheul MLMI, Dückers MLA, Visser BB, Beerens RJJ, Bierens JJLM. Disaster exercises to prepare hospitals for mass-casualty incidents: does it contribute to preparedness or is it ritualism? *Prehosp Disaster Med.* 2018;33(4):387–93.
7. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics.* 1977;33(1):159–74.
8. Khirekar J, Badge A, Bandre GR, Shahu S. Disaster preparedness in hospitals. *Cureus.* 2023;15(12):e50073.
9. Dehghani A, Ghomian Z, Rakhshanderou S, Khankeh H, Kavousi A. Process and components of disaster risk communication in health systems: a thematic analysis. *Jamba.* 2022;14(1):1367.
10. Farcas A, Ko J, Chan J, Malik S, Nono L, Chiampas G. Use of incident command system for disaster preparedness: a model for an emergency department COVID-19 response. *Disaster Med Public Health Prep.* 2021;15(3):e31–6.

Figures

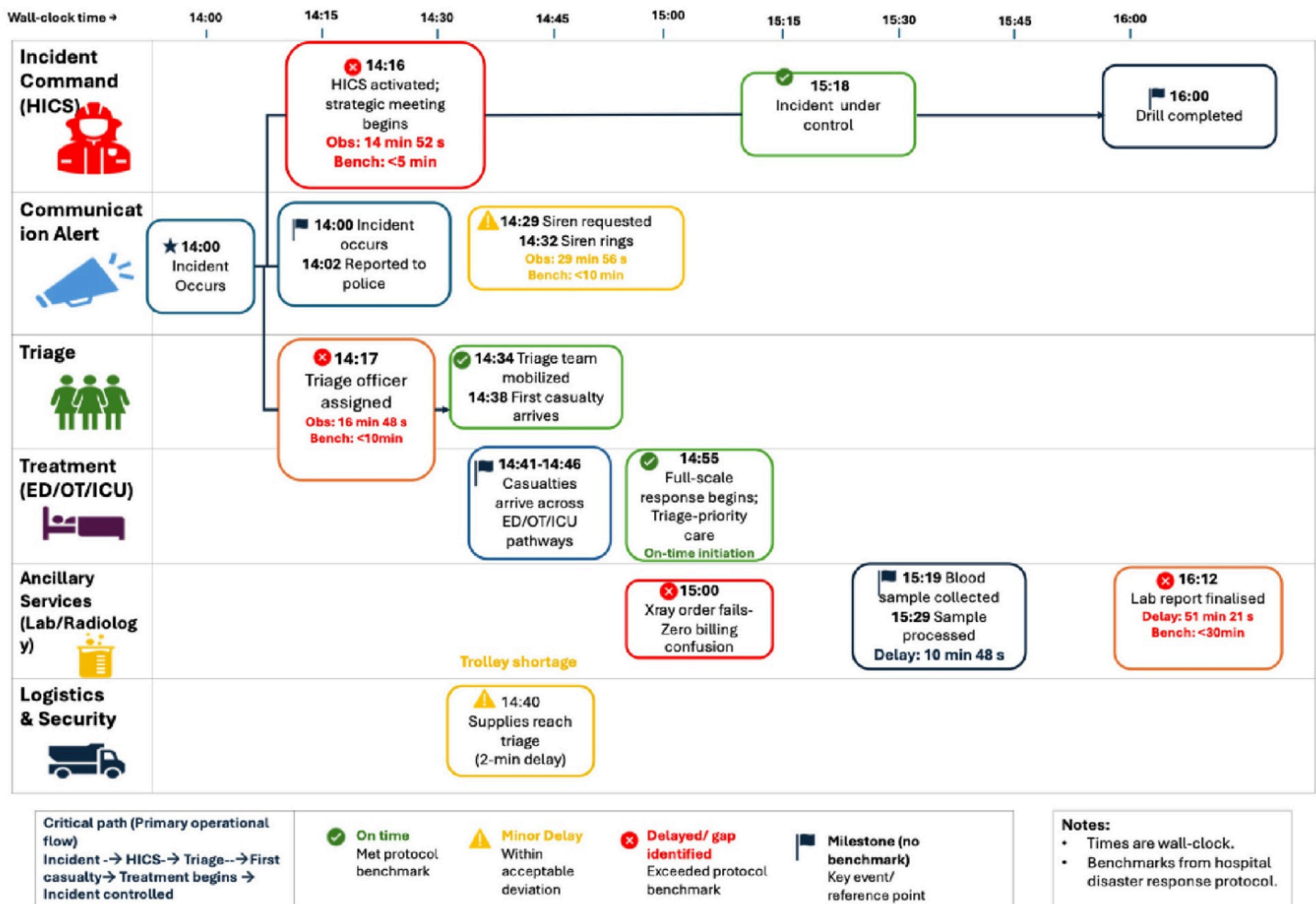


Figure 1

Swimlane process-flow diagram of Hospital Incident Command System activation and role actions.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [COREQChecklist.docx](#)
- [STROBEChecklist.docx](#)
- [INTERVIEWguide.docx](#)