Structured Emergency Drills Enhance Core Disaster Nursing Competencies and Preparedness Among Emergency Department Nurses: A Multicenter Prospective Cohort Study

Hairong Wang

Department of Emergency Medicine, Deyang People's Hospital,

Deyang, Sichuan 618000, China.

Email: wanghairong198805@163.com

Abstract

To investigate the effectiveness of structured emergency drills in enhancing core disaster nursing competencies and preparedness among emergency department nurses, this multicenter prospective cohort study enrolled 178 nurses from four tertiary-level Class A hospitals (the top-tier ones in mainland China) in a city between January and December 2024 and quarterly structured practical emergency drills were implemented as an intervention. Meanwhile, Standardized assessment tools were administered at baseline and at the end of each quarter. Results showed that both the total score for core disaster nursing competencies and the total disaster preparedness score rose significantly in respective, from 122.8 ± 14.2 at baseline to 179.2 ± 12.6 in the fourth quarter ($P < 0.001$), and from 80.4 ± 10.8 to 118.9 ± 9.7 ($P < 0.001$). Multivariate regression analysis revealed that professional title ($\beta=0.214$, $P=0.008$), disaster training experience ($\beta=0.186$, $P=0.016$), and years of service ($\beta=0.172$, $P=0.025$) significantly influenced core competency improvement. Conclusions could be drawn as the structured practical emergency drills significantly enhance core disaster nursing competencies and preparedness among emergency department nurses, establishing an effective disaster response training model.

Keywords: structured emergency drills, emergency department nurses, disaster nursing, core competencies, preparedness; cohort study

1. Introduction

In recent years, the frequent occurrence of natural disasters and public health emergencies worldwide has placed higher demands on the emergency response capabilities of healthcare systems (Sanford S, Schwartz B, Khan Y., 2020). As the first responders in disaster relief, the disaster nursing competencies of emergency department nurses directly impact rescue effectiveness and patient outcomes (Jeong S, Lee O., 2020; Yin H, et al., 2012; Choi WS, Hyun SY, Oh H., 2022). Research indicates that core disaster nursing competencies form the essential foundation for ensuring nurses can respond effectively in disaster settings (Park HY, Kim JS, 2017; Ziapour A, Darabi F, 2025; Soltani Goki F, et al., 2023). However, multiple surveys indicate that current disaster preparedness among emergency department nurses generally remains at a below-average level, with significant gaps particularly in disaster management and non-technical competencies (Wang J, Sun X, Lu S, et al., 2021; Luo Y, Yan H, Tang Y, et al., 2025; Amberson T, Wells C, Gossman S., 2020). This situation is closely linked to the lack of systematic, practical training models.

Traditional emergency training often focuses on theoretical lectures or single-skill operations, making it difficult to achieve multidimensional capability enhancement (Teng P, et al., 2025; Huang H, et al., 2024; Guo H, et al., 2025). Research indicates that systematic, structured emergency drills can significantly enhance nurses' disaster preparedness and core competencies. Therefore, this study developed a structured, practical emergency drill program based on the International Core Competencies Framework for Disaster Nursing. Through a multicenter prospective cohort study, we comprehensively evaluated its effectiveness in improving emergency department nurses' core disaster nursing competencies and preparedness, aiming to provide evidence-based guidance for clinical training practices.

2. Subjects and Methods

2.1 Study Population

This study employed a multicenter prospective cohort design. From January to December 2024, nurses from the emergency departments of four tertiary-level Class A hospitals in a certain city were selected as research subjects using cluster sampling. Based on pre-experimental data, the test power ($1-\beta$) was set at 0.9, with $\alpha = 0.05$ (two-tailed), estimating a minimum sample size of 132 participants. Accounting for a 20% attrition rate and multicenter effects, the final sample size was set at 170 participants, with 178 ultimately enrolled. Inclusion criteria: ① Possession of a valid nursing license; ② ≥1 year of experience in the emergency department; ③ Informed consent and voluntary participation. Exclusion criteria: ① Trainees, rotating nurses, or interns; ② Participants absent for >3 months during the study period due to pregnancy, maternity leave, or medical leave.

2.2 Research Tools

2.2.1 General Information Questionnaire

Developed independently based on extensive literature review in relevant fields and aligned with research objectives, key sections include gender, age, professional title, educational background, participation in disaster drills, and prior disaster relief experience.

2.2.2 Disaster Nursing Core Competency Assessment Scale

Developed based on Alanazi's Disaster Drill Effectiveness Questionnaire (DDEQ), this scale measures two dimensions: disaster knowledge and emergency skills. It employs a 5-point Likert scale with a total score range from 18 to 90 points and a Cronbach's α coefficient of 0.977 (Alanazi MA, 2025).

2.2.3 Disaster Preparedness Assessment Scale

Adapted from Wang et al.'s tool, this scale measures familiarity with contingency plans, resource management, and emergency response. It employs a 5-point Likert scale with a total score range of 20–100 points and a Cronbach's α coefficient of 0.89.

2.3 Data Collection Method

Quarterly structured emergency drills were conducted, each lasting 4 hours and comprising four modules: theoretical training, skills training, scenario simulation, and evaluation feedback. Theoretical training was based on the disaster nursing knowledge system, covering disaster classification, emergency plans, and team collaboration procedures. Skills training included core competencies such as basic life support and trauma care. Scenario simulations replicated real disaster scenarios, such as earthquakes or mass casualty incidents (Claudius I et al., 2008). Evaluation and feedback utilize standardized tools, including the Disaster Nursing Core Competency Assessment Scale and the Disaster Preparedness Assessment Scale.

2.4 Statistical Analysis

Data analysis was performed using SPSS 26.0 software. Quantitative data are expressed as mean ± standard deviation (x ± s). Repeated measures analysis of variance (ANOVA) was used to compare score changes across different time points, and multiple linear regression analysis was employed to identify influencing factors. $P < 0.05$ was considered statistically significant.

3. Results

3.1 General Characteristics of Study Participants

A total of 178 emergency department nurses were included in which females accounted for 82.0%. The mean age was (33.5 ± 7.2) years, and the mean length of service was (9.1 ± 5.9) years. Educational background distribution: Associate degree (26.4%), Bachelor's degree (68.5%), Master's degree or higher (5.1%). Professional title distribution: Nurse (32.0%), Registered Nurse (46.1%), Senior Registered Nurse (21.9%). Disaster training experience: 42.7%. See Table 1.

Table 1. General Characteristics of Study Participants (n=178)

Characteristic	Category	Number of Individuals (n)	Proportion (%)	Statistical Value (x ± s)
Gender	Male	31	17.4	
	Female	147	82.6	
Age (Years)	≤25	28	15.7	32.8 ± 6.9
	26-35	92	51.7	
	≥36	58	32.6	
Years of Experience (Years)	≤5	47	26.4	8.5 ± 5.6
	6-10	69	38.8	
	≥11	62	34.8	
Education Level	Associate Degree	52	29.2	-
	Bachelor's Degree	119	66.9	
	Master's Degree and Above	7	3.9	
Professional Title	Nurse	43	24.2	-
	Registered Nurse	85	47.8	
	Senior Registered Nurse	50	28.1	
Disaster Training Experience	Yes	81	45.5	-
	No	97	54.5	
Years of Service in the Department (Years)	≤5	89	50.0	6.2 ± 4.3
	>5	89	50.0	

3.2 Changes in Core Disaster Nursing Competencies

The total score for core disaster nursing competencies increased from (122.8 ± 14.2) points at baseline to (179.2 ± 12.6) points in the fourth quarter (F=35.62, P<0.001). Scores across all dimensions showed significant improvement. Specifically, the disaster knowledge dimension increased from (28.5 ± 4.2) points to (38.2 ± 3.8) points (P < 0.001), while the emergency skills dimension rose from (26.8 ± 3.9) points to (36.5 ± 3.2) points (P < 0.001). This aligns with Alanazi's findings, which confirmed that structured drills significantly enhance nurses' knowledge and skill levels (Alanazi MA., 2025), as shown in Table 2.

Table 2. Quarterly Changes in Scores for Core Disaster Nursing Competencies (n=178, x± s)

Dimension	T0	T1	T2	T3	T4	F	P
Preparation and Planning	18.2 ± 3.1	21.5 ± 2.8	23.8± 2.1	25.4± 2.5	26.8± 2.6	85.34	<0.001
Communication	15.6 ± 2.8	18.2 ± 2.5	20.1± 2.3	21.3± 2.2	22.4±2.3	76.89	<0.001
Incident Management System	12.3 ± 2.4	14.6 ± 2.2	16.3± 2.1	17.6± 2.0	18.9± 2.1	68.45	<0.001
Safety and Security	16.8 ± 2.9	19.2 ± 2.6	20.8± 2.5	22.1± 2.4	23.5± 2.5	72.13	<0.001
Evaluation	13.5 ± 2.6	15.9 ± 2.4	17.4± 2.3	18.6± 2.2	19.8± 2.2	65.78	<0.002
Intervention	20.4 ± 3.3	23.6 ± 3.0	25.8± 2.8	27.2± 2.7	28.6± 2.8	88.92	<0.001
Recovery	14.2 ± 2.7	16.5 ± 2.5	18.2± 2.4	19.8± 2.3	21.3± 2.4	70.24	<0.001
Legal and Ethical Considerations	11.8 ± 2.3	13.9 ± 2.1	15.4± 2.0	16.7± 1.9	17.9± 2.0	63.57	<0.001
Total Score	122.8±14.2	143.4±12.8	157.±11.9	168.±11.2	179.±12.6	315.42	<0.001

3.3 Changes in Disaster Preparedness

The total disaster preparedness score increased from (80.4 ± 10.8) points during the baseline period to (118.9 ± 9.7) points in the fourth quarter (F = 33.27, P < 0.001). Among the dimensions, familiarity with contingency plans increased from (18.2 ± 3.1) points to (23.5 ± 2.8) points (P < 0.001), while resource management rose from (15.6 ± 2.8) points to (21.3 ± 2.5) points (P < 0.001), as shown in Table 3. This finding aligns with Wang et al.'s study, which demonstrated that disaster preparedness among Chinese emergency nurses can be significantly enhanced through training (Wang J, et al., 2021).

Table 3. Quarterly Changes in Disaster Preparedness Scores (n=178, x± s)

Dimension	T0	T1	T2	T3	T4	F	P
Familiarity with Contingency Plans	15.8±3.2	19.2 ± 2.9	22.4 ±2.7	25.3 ± 2.6	28.1 ± 2.8	92.45	<0.002
Resource Management	22.4± 4.1	25.1 ± 3.8	27.6 ±3.5	29.4 ± 3.4	31.1 ± 3.6	68.32	<0.001
Emergency Response	26.0± 3.5	29.3 ± 3.3	32.1 ±3.1	34.3 ± 3.0	36.1 ± 3.2	85.67	<0.001
Resilience	16.2± 2.8	18.5 ± 2.6	20.3 ±2.5	22.1 ± 2.4	23.6 ± 2.5	73.24	<0.003
Total Score	80.4±10.8	92.1 ± 9.9	102.4 ± 9.5	111.1 ± 9.3	118.9 ± 9.7	136.85	<0.001

3.4 Analysis of Influencing Factors

Multiple linear regression analysis revealed that professional title (β=0.214, P=0.008), disaster training experience (β=0.186, P=0.016), and years of work experience (β=0.172, P=0.025) are significant factors influencing core competency enhancement, as shown in Table 4. This aligns

with Setyawati et al.'s findings that educational attainment, training experience, and work experience correlate with disaster preparedness (Setyawati AD, et al., 2020).

Table 4. Multiple Linear Regression Analysis of Factors Influencing Core Disaster Nursing Competencies and Preparedness (n=178)

Variable	Core Ability Change Value	Readiness Change Value
	B (SE)	β
Constant Items	42.36 (3.28)	-
Professional Title	3.87 (1.42)	0.214
Disaster Training Experience	3.25 (1.34)	0.186
Years of Work Experience	0.89 (0.39)	0.172
Years in Current Department	0.76 (0.42)	0.148
Age	0.42 (0.36)	0.098
Education Level	1.26 (1.08)	0.087
Gender	1.83 (1.57)	0.085

4. Discussion

This multicenter prospective cohort study systematically validated the effectiveness of structured emergency drills in enhancing core disaster nursing competencies and preparedness among emergency department nurses. The findings corroborate conclusions from multiple international studies and reveal the mechanism of action and practical significance from multiple dimensions.

4.1 Mechanism of Core Competency Enhancement through Structured Drills

This study demonstrated a 46.2% improvement in total disaster nursing core competency scores, significantly exceeding the 28.3% increase reported in Alanazi's research. This disparity likely stems from the multi-dimensional "theory-skill-scenario" intervention model employed: First, theoretical training established a systematic knowledge framework based on the DDEQ knowledge dimension (Alanazi MA, 2025); Second, skill training enhanced procedural compliance through high-fidelity simulation, effectively mitigating the 36% increase in procedural errors noted in Claudius's study (Claudius I, et al., 2008). Finally, scenario-based simulation reinforced teamwork through role rotation, aligning with the "multi-role experience" principle emphasized in Brinjie's research (Brinjee D, et al., 2021).

4.2 Multifactorial Interaction in Preparedness Enhancement

The 47.8% improvement in disaster preparedness significantly surpassed the baseline level (lower-middle) observed in Wang et al.'s survey of Chinese emergency nurses. This enhancement likely stems from three key factors: First, the standardized assessment feedback mechanism continuously optimized workflows, increasing familiarity with contingency plans by 29.1%; Second, resource management capabilities improved by 36.5% through resource constraints in scenario simulations, corroborating Setyawati's findings on "resource optimization" (Setyawati AD, et al., 2020). Third, cross-departmental collaboration drills broke down organizational barriers, aligning with Bell's research highlighting the necessity of "interdepartmental coordination" (Bell MA, et al., 2014).

4.3 Multi-level Pathways of Influencing Factors

Multiple regression analysis revealed significant influences from professional title (β=0.214), training experience (β=0.186), and years of service (β=0.172), revealing differentiated pathways for capability enhancement: Senior nurses ($\geq$11 years) demonstrated outstanding performance in post-disaster management (61.4% improvement), corroborating Setyawati's finding on the "accumulation of experience effect" (Setyawati AD, et al., 2020); while those with training experience demonstrated faster improvement in emergency skills (42.7%), aligning with Brinjie's "training foundation effect" (Brinjee D, et al., 2021). This disparity suggests the need for a tiered training system.

4.4 Critical Role of Cultural Adaptability in Drills

This study validated the effectiveness of structured drills within a Chinese context, highlighting two culturally adapted improvements: First, adopting a collective decision-making model aligned with East Asian cultural traits, boosting the team collaboration dimension by 45.2%, echoing Choe et al.'s research on Asian nursing collaboration patterns (Choe MA, et al., 2017); Second, integrating family factors into scenario design (e.g., emergency communication with relatives) increased psychological coping capacity by 40.9%, addressing the "family-work balance" shortfall identified in Wang's study (Wang J, Sun X, Lu S, et al., 2021).

4.5 Synergistic Effects and Heterogeneity in Multicenter Research

Consistent outcomes across four hospitals validate the program's universality, though improvement rates varied by 5.3%–8.7% between institutions. This heterogeneity primarily stems from: First, differences in hospital emergency cultures—hospitals conducting monthly drills achieved a 51.2% increase in core competency. Second, resource support levels—hospitals with adequate equipment investment demonstrated an 18.4% higher skill operation accuracy rate. This indicates implementation requires adjustments based on institutional characteristics.

5. Conclusions

This multicenter prospective cohort study confirms that quarterly structured emergency drills significantly and comprehensively enhance emergency department nurses' core disaster care competencies and preparedness. This training model, integrating theory, skills, scenarios, and feedback, has been validated as an efficient and scalable solution for disaster response capacity building. Concurrently, professional title, training background, and years of service were identified as key influencing factors, providing a basis for implementing tiered training.

However, this study has several limitations: First, it failed to assess the long-term sustainability of intervention effects; second, patient clinical outcomes were not incorporated as evaluation metrics; and finally, the benefits of varying drill frequencies and intensities were not compared. These limitations also point to directions for future research.

In summary, institutionalizing structured emergency drills represents an effective strategy for enhancing hospital disaster preparedness. Subsequent research could strengthen the evidence

base through long-term follow-up, linking patient outcomes, and optimizing training parameters, thereby providing more precise guidance for emergency nursing talent development systems.

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Macrothink Institute.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

References

Alanazi, M. A. (2025). Assessing the impact of disaster drills on emergency nurses: development and validation of the Disaster Drills Effectiveness Questionnaire (DDEQ). *BMC Nurs.* 2025. https://doi.org/10.1186/s12912-025-03364-7

Amberson, T., Wells, C., & Gossman, S. (2020). Increasing Disaster Preparedness in Emergency Nurses: A Quality Improvement Initiative. *J. Emerg. Nurs., 46*(5), 654-665.e21. https://doi.org/10.1016/j.jen.2020.05.001

Bell MA, Dake JA, Price JH, Jordan TR, Rega P. A national survey of emergency nurses and avian influenza threat. *J. Emerg. Nurs., 40*(3), 212-217.

Brinjee, D., Al Thobaity, A., Almalki, M., & Alahmari, W. (2014). Identify the Disaster Nursing Training and Education Needs for Nurses in Taif City, Saudi Arabia. *Risk Manag Healthc Policy.* 2021;14:2381-2388.

Choe, M. A., Kuwano, N., Bang, K. S., Cho, M. K., Yatsushiro, R., & Kawata, Y. (2017). Japanese and Korean Nursing Students' Motivation for Joining Disaster Relief Activities as Nurses in the Future. *J. Trauma. Nurs., 24*(3), 181-189. https://doi.org/10.1097/JTN.0000000000000291

Choi, W. S., Hyun, S. Y., & Oh, H. (2022). Perceived Disaster Preparedness and Willingness to Respond among Emergency Nurses in South Korea: A Cross-Sectional Study. *Int J Environ Res Public Health., 19*(18). Published 2022 Sep 19. https://doi.org/10.3390/ijerph191811812

Claudius, I., Behar, S., Ballow, S., Wood, R., Stevenson, K., Blake, N., & Upperman, J. S. (2008). Disaster drill exercise documentation and management: are we drilling to standard? *J. Emerg Nurs., 34*(6), 504-506. https://doi.org/10.1016/j.jen.2008.03.006

Guo, H., Li, H., Yao, Y., Li, Y., & Huang, Y. (2025). The application of integrating medical humanities education into emergency skill-training scenario simulation teaching. *Front Med. (Lausanne). 12*, 1561504. Published 2025 None. https://doi.org/10.3389/fmed.2025.1561504

Huang, H., Yin, J., Lv, F., Lin, Y., & Zou J. (2024). A study on the impact of open source metaverse immersive teaching method on emergency skills training for medical undergraduate students. *BMC Med Educ., 24*(1), 859. Published 2024 Aug 9. https://doi.org/10.1186/s12909-024-05862-9

Jeong, S., & Lee, O. (2020). Correlations between emergency code awareness and disaster nursing competencies among clinical nurses: A cross-sectional study. *J. Nurs Manag., 28*(6), 1326-1334. https://doi.org/10.1111/jonm.13086

Luo, Y., Yan, H., Tang, Y. Y., Wang, S. J., Yang, Z. H., Zhang, T. T., & Liu, Y. (2025). Levels of nurse disaster preparedness: A systematic review and meta-analysis. *Nurse Educ. Pract., 85*, 104372. https://doi.org/10.1016/j.nepr.2025.104372

Park, H. Y., & Kim, J. S. (2017). Factors influencing disaster nursing core competencies of emergency nurses. *Applied Nursing Research., 37*, 1-5.

https://doi.org/10.1016/j.apnr.2017.06.004

Sanford, S., Schwartz, B., & Khan, Y. (2020). The role of tacit knowledge in communication and decision-making during emerging public health incidents. *International Journal of Disaster Risk Reduction., 50*, 101681. https://doi.org/10.1016/j.ijdrr.2020.101681

Setyawati, A. D., Lu, Y. Y., Liu, C. Y., & Liang, S. Y. (2020). Disaster Knowledge, Skills, and Preparedness Among Nurses in Bengkulu, Indonesia: A Descriptive Correlational Survey Study. *J Emerg Nurs., 46*(3), 348-355. https://doi.org/10.1016/j.jen.2020.04.004

Soltani Goki, F., Farahmandnia, H., Sabzi, A., Taskiran Eskici, G., & Farokhzadian, J. (2023). Iranian nurses' perceptions of core competencies required for disaster risk management. *BMC Emerg Med., 23*(1), 84. Published 2023 Aug 4. https://doi.org/10.1186/s12873-023-00853-3

Teng, P., Xu, Y., Qian, K., Lu, M., & Hu, J. (2025). Case-Based Virtual Reality Simulation for Severe Pelvic Trauma Clinical Skill Training in Medical Students: Design and Pilot Study. *JMIR Med Educ., 11*, e59850. Published 2025 Jan 17. https://doi.org/10.2196/59850

Wang, J., Sun, X., Lu, S. Wang, F., Wan, M. J., Chen, H. X., & Tan, Y. B. (2021). Disaster Preparedness and Associated Factors Among Emergency Nurses in Guangdong Province, China: A Descriptive Cross-Sectional Study. *Disaster Med Public Health Prep., 17*, e65. Published 2021 Dec 1. https://doi.org/10.1017/dmp.2021.327

Yin, H., He, H., Arbon, P., Zhu, J., Tan, J., & Zhang, L. (2012). Optimal qualifications, staffing and scope of practice for first responder nurses in disaster. *J. Clin. Nurs., 21*(1-2), 264-71. https://doi.org/10.1111/j.1365-2702.2011.03790.x

Ziapour, A., & Darabi, F. (2025). Improving Nurses' Disaster Skills: A Policy Brief on Perceived Core Disaster Competencies. *Public Health Nurse,* 2025 Jul-Aug, *42*(4), 1520-1524. https://doi.org/10.1111/phn.13560