

Effect of Triage Training Program on Nursing Interns' Clinical Reasoning Using Immersive Virtual Simulation

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Abstract

Triage is the initial stage in providing immediate and suitable emergency nursing care and addressing clinical complaints. Clinical reasoning is the thinking technique that health professionals employ in their work to determine the optimal solution for each patient. **The study aimed to** assess the effect of a triage training program on nursing interns' clinical reasoning using immersive virtual simulation. **Research design** used was one-group pretest-posttest. **Setting:** The present study was conducted at the critical care and emergency nursing skill lab at the Faculty of Nursing, Sohag University. **Sample:** 80 nursing interns of the Faculty of Nursing at Sohag University. **Tools:** three tools were used; Structure interview questionnaire, START triage observational checklist, and clinical reasoning skills assessment scale. **Results:** the majority of the participants were male, with an average age of 23.40 ± 0.97 years. Furthermore, more than half (60%) did not receive any triage training. Also, after integrating immersive virtual reality, the mean scores for knowledge, practice, and clinical reasoning increased. Furthermore, there was an overall positive correlation between clinical reasoning, knowledge, and practice-related triage ($p = 0.020$ and 0.000 , respectively). **Conclusion:** Immersive virtual reality can help students to improve knowledge, practice, and critical reasoning skills. **Recommendations:** Using immersive virtual simulations in various clinical problems and nursing education.

Keywords: Clinical reasoning, Immersive, Nursing interns, Triage & Virtual.

Introduction:

Patients of various ages present to emergency rooms with varying degrees of clinical urgency and severity, and the majority of them are undiagnosed and unclassified when they arrive. Growing overcrowding in emergency departments may jeopardize the quality and safety of patient care (Cho et al., 2022).

Emergency triage is the process of sorting out or screening people, recognizing a life-threatening sickness or injury and prioritizing their treatment in emergency care facilities. This process begins with the first patient interaction (Khan & Fatima, 2023). Having a thorough understanding of the triage system is one of the most important aspects of healthcare knowledge (Elgazzar, 2021).

Nursing interns have a special role in implementing emergency triage and care in hospitals because they will eventually become top-notch healthcare providers. In order to make suitable triage decisions in the future for early diagnosis, efficient referral services, and patient avoidance, they need have more

knowledge about emergency triage (Andersson et al., 2022).

Starting with triage in emergency rooms, accurate decision-making based on quick clinical reasoning should be prioritized in emergency care. Emergency nursing competency related to triage is significantly impacted by clinical reasoning abilities (Hu et al., 2020).

Clinical reasoning is the process by which health practitioners determine the appropriate approach for each patient. Health care team members can quickly and accurately assess health situations by collecting cues, making exact observations, collecting data, as well as comprehending a one's problem, then develop and execute suitable interventions, evaluate consequences, and participate in reflection (Paden et al., 2023).

Nursing perception of triage was linked to clinical reasoning skills. Developing these skills entails using strategies that are sustainable in the field of nursing, focusing teaching and learning approaches that are crucial to enhancing problem-solving abilities and self-efficacy for learning (Hong et al., 2021).

The rapid advancement of information technology necessitates a shift in nursing education in order to better prepare nursing students for the complex and rapidly changing health-care environments (**Chen et al., 2020**). The existing literature emphasizes the efficacy of virtual reality technology in improving full student participation in cognitive, behavioral, and affective dimensions, suggesting that its usage in education is now a trend (**Mystakidis et al., 2021**).

Simulation is a well-established teaching tool in nursing training that helps students prepare for clinical rotations and transfer skills training from an academic to a clinical environment (**Sharoff, 2022**). Simulations provide effective learning environments in which nursing students can acquire experience, communication, clinical decision-making, working together, thinking critically, and problem-solving skills while avoiding patient harm, thereby increasing their confidence and readiness for real-world clinical practice (**Koukourikos et al., 2021**).

Immersive virtual reality enables nursing students to carry out clinical procedures with environment similar to hospital and helps them to acquire nursing experiences with real situation, even before they start working as professional nurses (**Bø, 2022**). Participants can observe the complete panorama using immersive 360° technology, creating a strong sensation of presence and immersion, as if they are essentially inside the setting (**Mystakidis et al., 2021**). Academic instructors may consider adopting virtual reality technology for providing nursing students with independent and repeated practices that will help them maintain their clinical skills over time (**Quiao et al., 2023**).

Universal obstacles include growing service demand due to people's complex health needs, insufficient or limited human resources, insufficient health-system funding, fast-paced and limited-time care, and climate challenges. These problems are prompting stakeholders to devise innovative ways for improving healthcare access, health professionals' knowledge and competence, and patient outcomes (**Walton et al., 2022**).

Operational definitions:

Immersive virtual simulations: are digitally produced settings that provide users a realistic and engaging experience. These simulations frequently use technologies such as virtual, augmented, and mixed reality (MR) to immerse participants in a three-dimensional realm in which they can interact with the surroundings as well as virtual objects or characters.

Clinical reasoning is a manner by which healthcare providers receive and analyze information, create conclusions, and decide on appropriate patient care measures. It entails critical thinking, problem solving, and the application of medical knowledge to evaluate

a patient's condition, make a diagnosis, and devise a treatment strategy.

Significant of study:

Nursing interns have a future unique role in emergency treatment in hospitals. Crowding has been linked to a variety of negative outcomes, including delays in life-saving interventions, greater complication rates, and higher 30 days mortality rates of emergency department admission (**Uggla et al., 2021**). This could be improved by upstream triage, which assists health professionals and actively participates in each part of the decision-making procedure through clinical reasoning. Immersive virtual simulation enables skill guidance, which begins with certain skill sets and progresses to more complicated scenarios. (**Foronda et al. 2020**). The current study aims to examine the role of immersive virtual reality in developing cognitive and practical skills.

Aim of the study: To assess the effect of a triage training program on nursing interns' clinical reasoning using immersive virtual simulation

Research hypothesis:

H1: The triage training program affects nursing interns' clinical reasoning positively using immersive virtual simulation.

H2: Participants' level of clinical reasoning will correlate positively with their level of knowledge and practice related to triage.

Subject and Methods

Research design

The one-group pretest-posttest quasi-experimental research design was used. It is a method in which the result of interest is measured twice: once before and subsequent to exposing a non-random group of nursing interns to a specific intervention/treatment (**Miller et al., 2020**).

Setting

The study was done in the critical care and emergency nursing skill lab at Sohag University's Faculty of Nursing.

Sample:

A convenience sample of 80 nursing interns enrolled in the study during their internship year. The period of training take place during the months of June and July 2024 in the critical care and emergency area at Sohag University Hospital.

$$n = \frac{N Z^2 \sigma^2}{Z^2 \sigma^2 + N e^2}$$

$$n = \frac{375 \times (1.96)^2 \times (0.256)^2}{(1.96)^2 \times (0.256)^2 + 375 \times (0.05)^2} = 79.386 \cong 80$$

Where:

$Z = 1.96$ [standard scores],

$e = 0.05$ [error], $\sigma = 0.256$ [SD],

$N = 375$ [population],

$n = 80$ [sample]

Data collection Tools:

Three tools were used to collect data pertinent to the study:

Tool (I): Structure interview questionnaire: This tool was developed by the researchers after examining related literature (Walton et al., 2022; Bø, 2022), and consisted of two parts:

Part one: Personal data: It was concerned with personal characteristic such as age, sex, and attendance of related course.

Part two: Knowledge assessment structured interview: It was developed by the researchers to assess the level of knowledge regarding triage system. It consisted of 25 open-ended questions organized in three dimensions; General knowledge about triage (10 items), Knowledge about the START system (5 items), and Knowledge about tag categorization (10 items). Questions were scored as the following: right responses received one point, don't know, and wrong responses received zero points. The entire knowledge of nursing interns was scored at 25.

Tool II: START Triage observational Checklist: It was adopted from Elbaih and Alnasser 2022, to assess the nursing interns' practice regarding START triage through 12 items arranged into two dimensions; General status (4 items), and Respiration, Perfusion and Mental status (RPM) (8items). It was based on a 3-point Likert scale comprising 3 (performed correctly), 2 (performed incorrectly), and 1 (not performed).

Tool III: The Clinical Reasoning Skills Scale (CRS): It was adopted from Koivisto et al. (2020) to assess the clinical reasoning abilities of nursing interns. This tool contained 25 points divided into six subscales: Gathering information (four points), Analyzing information (five points), Detecting problems/issues (four points), Setting objectives (four points), Taking action (five points), and Evaluating outcomes (three points). Nursing interns rated their clinical reasoning abilities on a 5-point Likert scale (1=very poor, 5=excellent), with higher scores indicating stronger capabilities.

Validity and Reliability of data collection tools:

Content validity was done by a jury of five experts from three critical care nursing programs at Assuit University and two nursing administration at Sohag University. Every suggestion and constructive criticism provided by the experts was considered in the development of the final edition of the data collection tools.

A pilot study was conducted to examine the reliability of these tools through determining their internal consistency with Cronbach's alpha coefficient. The scores were (0.91) for the tool I structure interview questionnaire, (0.87) for the START Triage observational checklist, and (0.92) for the clinical reasoning skills scale. (Koivisto et al., 2020).

Ethical considerations:

On May 29th 2024, Sohag University's Nursing Faculty Ethics Committee allowed the research, which was approved by IRB No. (173). After discussing the nature and objective of the study, nursing interns verbally agreed to participate. The nursing interns assured that no harm would result from the participation. The freedom to engage, decline, or withdraw at any moment was communicated to all participants. All information was kept totally confidential. Any information obtained was kept completely private.

Field work

The Dean of Sohag University's Nursing Faculty has given her official clearance. The study was accessible to participants assigned to a training area in critical care units between June and July 2024. Prior to enrollment, all participants were told about the study's purpose as well as the training program's methodology.

The field work was consisted from the following three phases:

Phase I: The preparatory phase: The development of training program sessions' content and data collection tools was done after reviewing current, past, national, and global literature on triage training and clinical reasoning skills assessment using periodicals, publications, books, and computer searches. The holding of training program sessions was coordinated with the nursing director of Sohag University Hospitals and the nursing interns' training manager at the Faculty of Nursing.

Pilot study

The pilot research was done prior to the start of data gathering. It was conducted on 10% of the study sample (8) of nursing interns in order to assess the clarity, objectiveness, practicality, and relevance of tools, as well as to calculate the time required for data collection. After the pilot study, no changes were made. The pilot study was omitted from the study sample.

Phase II: Implementation phase. Researchers employed a number of instructional methods, including lectures, group discussions, and brainstorming. Different teaching materials include sharing photographs, and videos. Aside from that, there was an illustrated, colorful booklet about the applications of virtual reality and triage, as well as a power point presentation with information about selected topics (triage, other triage systems, the START system, clinical reasoning, and a written scenario).

Initially, each participant took 10 minutes to complete a questionnaire about triage Tool I. Furthermore, their practice levels were recorded using the START observational checklist (Tool II) while dealing with four case scenarios representing various emergency cases. The maximum time for them to respond was 30 minutes. The researcher checked participants' clinical reasoning skills (Tool III) while participant's dealing with each case.

The training program was provided through three training sessions as the following:

- Session one (theoretical / 3hours): included an introduction, definition of triage, purpose, role of the nurse, and an ABCDE assessment.
- Session two (theoretical & practical / 3hours): covered (START triage system, and clinical reasoning strategies).
- Session three (practical / 5 hours for each group): participant nursing interns divided to eight groups; ten participants at each group. Then, the researchers demonstrated how to categorize patients according to START triage using immersive virtual reality and using clinical reasoning strategies during categorization. The researchers guided them while

participants practiced the simulated situations and gave them immediate feedback and re-demonstrated for correction.

Phase III: Evaluation phase: The post-training program knowledge and practice level and clinical reasoning skills related to triage were assessed by using the same study data collection tools at the first. In order to measure the correct and accurate effect of training on learners, there must be enough time for them to exhibit the abilities they have learnt in their environment (Wang & Wilcox, 2006). So, the post program evaluation was made by the researchers after three months of the training program to assure really the effectiveness of the training program on the participants knowledge, skills, and practices.

Statistical Analysis:

All data were input and sorted into a unique chart for each participant. The acquired information was coded, evaluated, and tallied. Data was entered and analyzed using the statistical software package SPSS 26.0. Descriptive statistics were used to present frequency and percentages for qualitative variables, as well as averages and standard deviations for quantitative variables.

The paired samples test was performed to compare categorical variables, and correlation analysis was carried out using the Pearson correlation coefficient (r). To investigate the correlations, multivariable analyses were performed (a single multivariate ANOVA model of each dependent variable with background variables and time, pre-test, and post-test as categorical independents). The degree of significance was classified as: $P > 0.05$ non-significant, $P < 0.05$ significant, and $P < 0.01$.

Results:

Table (1): Frequency distribution of personal data of participant nursing interns (N=80)

Personal data	No	%
Gender		
Male	50	62.5
Female	30	37.5
Did you attend any training, course or workshop about triage?		
Yes	32	40
No	48	60
Age (M±SD)	23.40 ± 0.97	

Table (2): Comparison of the Pre- and Post-Test Scores of knowledge in participant nursing interns (N=80)

Items	Pretest	Posttest	T	P
	Mean ± SD	Mean ± SD		
General knowledge about triage	6.35 ± 1.28	8.59 ± 0.867	12.034	0.000**
General knowledge about START	2.42 ± 1.12	4.29 ± 0.750	11.652	0.050*
Tag categorization	5.32 ± 1.97	7.48 ± 1.05	8.083	0.000**
Total	14.10 ± 2.88	20.35 ± 1.80	15.444	0.000*

*Statistically significant at $p \leq 0.05$

** Highly Statistically significant at $p \leq 0.01$

Table (3): Comparison of the Pre- and Post-Test Scores of practices among participant nursing interns (N=80)

Items	Pretest	Posttest	T	P
	Mean \pm SD	Mean \pm SD		
General	8.70 \pm 3.34	13.28 \pm 2.09	15.525	0.000**
Respiration, perfusion and mental status (RPM)	4.84 \pm 2.28	6.76 \pm 1.46	12.862	0.050*
Total	11.54 \pm 4.07	20.04 \pm 2.57	12.409	0.005*

*Statistically significant at $p \leq 0.05$ ** Highly Statistically significant at $p \leq 0.01$ **Table (4): The difference between mean scores of nursing interns' clinical reasoning skills pre-post program (N=80)**

Items	Pretest	Posttest	T	P
	Mean \pm SD	Mean \pm SD		
Collecting information	2.65 \pm 1.20	3.33 \pm 0.78	4.005	0.000**
Processing information	3.35 \pm 1.71	4.11 \pm 1.31	1.583	0.050*
Identifying problems/issues	2.10 \pm 0.70	3.85 \pm 0.60	2.528	0.000**
Establishing goals	2.78 \pm 0.87	3.51 \pm 0.64	2.468	0.016*
Taking action	3.28 \pm 1.33	4.36 \pm 1.07	4.402	0.000**
Evaluating outcomes	2.00 \pm 1.00	2.91 \pm 0.64	4.116	0.000**
Total	16.05 \pm 5.53	19.68 \pm 2.27	5.954	0.030*

* Statistically significant at $p \leq 0.05$ ** Highly Statistically significant at $p \leq 0.01$ **Table: (5) Correlation between total mean score of participant nursing interns' clinical reasoning, Knowledge and Practice related triage (N=80).**

Items	Knowledge related triage		Practice related triage	
	r	sig	r	sig
Practice related triage	0.215	0.046*		
Clinical reasoning	0.363	0.020	.476**	0.000**

 $r =$ Pearson Correlation,** Highly Statistically significant at $p \leq 0.01$

Table (1): Illustrates that the highest percentage of the studied population is male (62.5 %), with mean ages 23.40 \pm 0.97 years old. Moreover, over half (60%) didn't attend any training, course or workshop about triage

Table (2): Reveals that after applying immersive virtual reality, the mean knowledge scores of nursing interns improved significantly. ($p = 0.000$)

Table (3): Reveals that the mean practice scores of nursing interns improved significantly after the implementation of immersive virtual reality ($p = 0.005$).

Table (4): Shows the difference in mean scores of nursing interns' clinical reasoning skills before and after the training. Nursing interns' clinical reasoning skills improved significantly after the program in all six subscales compared to before.

Table (5): Clarifies the Pearson analysis results of the total mean score of participant nursing interns' clinical reasoning, Knowledge and Practice related triage. Pearson analysis reported a positive significant correlation between clinical reasoning, knowledge

and practice related triage ($p = 0.020$ & 0.000 respectively).

Discussion:

Teaching methods should prepare learners for confronting these challenges. In keeping with this age of progress, the complexity and velocity of production of nursing knowledge are increasing. As a result, superficial learning and insufficient knowledge have had a negative impact on nursing students' interactions with patients and their families. To address these challenges, nurses should adopt new teaching methods that prevent superficial learning, promote critical thinking skills, and increase students' memory and clinical reasoning. The goal of this study was to use immersive virtual simulation to assess how a triage training program affected nursing interns' clinical reasoning skills.

Regarding personal data of the nursing interns, the survey found that the majority of nursing interns were male, with an average age of 23.40 \pm 0.97. In addition, more than half did not participate in the triage training program. This is equivalent to

Guerrero & colleagues (2022). Who reported that the majority of the study subjects were male, but their average age was higher than in the current study. Contrary to **Chang's (2022)** findings, which evaluated the effect of immersive virtual reality on post-baccalaureate nursing students' learning satisfaction and their capacity to use an indwelling urinary catheter, the majority of their participants were female.

Regarding the level of knowledge among nursing interns', the present study clarified that the mean scores of knowledges among nursing interns improved after implementing immersive virtual reality with highly significant. This may be due to the overcoming difficulties which participants encountered in learning throughout IVR training.

This is similar with the findings of **Guerrero & colleagues (2022).** Who investigated the effect of high-fidelity and virtual simulation training on nurses' learned knowledge and abilities for triaging probable COVID-19 patients and found that post-training knowledge was higher than pre-training knowledge with a statistically significant difference. Furthermore, virtual simulations foster knowledge and abilities in an ideal setting, allowing volunteers to regularly practice complicated skills in well-constructed clinical scenarios (**Gebreheat et al., 2022**).

Also, a quasi-experimental study conducted by **Yang & Oh (2022)** reported that immersive virtual reality has effectively enhanced nursing students' neonatal resuscitation knowledge, problem-solving skills, self-confidence, and learning motivations. Moreover, Immersive Virtual Reality improves students' competence, clinical performance, knowledge, satisfaction and confidence (**Bø, 2022**).

In contrast, **Cobbett & Snelgrove-Clarke (2016)** contended that IVS makes no impact in students' knowledge acquisition. Students chose face-to-face simulation over virtual clinical simulation, primarily due to technological limitations in their study.

Regarding the level of practice among nursing interns', the present study clarified that the mean scores of practices among nursing interns improved after implementing immersive virtual reality with highly significant. The researcher attributes that to using of IVR makes students feel that they were actually in a clinical setting and assisting them to remember the operational processes needed in learning the IVR training.

The findings are consistent with those published by **Botha et al 2021**, who found that Immersive Virtual Reality improved their research sample's skills in caring for a client with a foreign body in their right lung. Furthermore, Liaw et al. 2021 investigated the use of virtual reality simulation in transdisciplinary

round training for health-care students. Virtual Reality Simulation successfully bridged the gap between nursing school and clinical environments.

In the same line, **Chávez & colleagues 2020** indicated that the IVR-based solution was the most beneficial to enhancing their learning performance. Besides that, previous research concluded that the IVR training program was as effective as a clinical simulation for increasing their practice on simple triage in a simulated mass casualty incident (**Ferrandini et al., 2018**).

Regarding the effectiveness of using immersive virtual simulation on developing clinical reasoning skills, the current study revealed that nursing interns' clinical reasoning skills had a significant improving at post-program at all six subscales comparing with preprogram. This may be due to that interactive virtual simulations are suitable tools for combining theoretical knowledge with practice.

In the same line, previous research concluded that nursing students able to practice clinical reasoning (CR) regularly and achieve good learning outcomes in CR after receiving virtual gaming simulations (**Piispanen et al. 2024**). On the other hand, a recent study comparing immersive virtual patient simulation to traditional learning for clinical reasoning stated that immersive virtual patient simulations remain an interesting tool for training novices to adhere to the history-taking skills of a new patient in a real-life situation (**Bonnin et al., 2023**).

The study clarified that correlation analysis results of the total mean score of participant nursing interns' clinical reasoning, Knowledge and Practice related triage. There was a positive significant correlation between clinical reasoning and practice related triage. According to **Régent & his colleges (2023)**, clinical reasoning skills were related mainly to evaluate medical practice skills. Also, a randomized controlled trial on clinical virtual simulation in nursing education concluded that The use of clinical virtual simulation in nursing training has the potential to improve information retention and clinical reasoning in the short and long term, as well as boost nursing students' overall satisfaction with their learning experience (**Padilha et al., 2019**). Additionally, emergency nurses' opinion of triage was linked to clinical reasoning skills (**Bentley et al., 2019**).

Conclusion

Based on these study findings, it can be concluded that nursing interns' clinical reasoning (CR) skills increased after participating in an immersive virtual simulation during the triage training program. The results of this study indicate that immersive simulation can help students improve knowledge,

practice, and critical thinking skills necessary for triage training.

Recommendations:

- Using immersive virtual simulations in various clinical problems and nursing education.
- Provide training for faculty and facilitators on both the technical aspects of the simulation technology and effective teaching strategies to maximize the educational impact.
- Collaborate with hospitals and healthcare facilities to offer interns real-world experience and simulation training.
- Use future developments in these technologies in follow-up research to transform the teaching of health sciences.

Limitation:

The results may not be generalizable to the total student population nationwide because the study was limited to nursing students.

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