



OPEN Effects of an interdepartmental handover program on nurses' safe care quality in intensive care units

Fatemeh Saleh¹, Marzieh Pazokian²✉, Mohammad Reza Haji Esmaili³, Neda Sanaie^{1b2} & Malihe Nasiri⁴

The quality of safe care is a significant concern for nurses. The importance of transferring the patient from the number of disasters and preventable events caused by poor communication within the health team is revealed; thus, standardizing the delivery process is a tool to ensure high-quality care. The purpose of this study is to develop, implement, and evaluate the interdepartmental delivery program on the quality of safe care of nurses. This quasi-experimental single-group pre-post study was conducted in 2024–2025 at Loghman Hakim Hospital with 70 nurses contributing 140 handover reports selected via convenience sampling. The intervention consisted of three virtual training sessions over three weeks on WhatsApp, based on Kern's six-step educational model. Data were collected using the Rashvand et al. (2015) Safe Care Quality Questionnaire, a Demographic Information Questionnaire, Patient Physiological Information Form, and checklists for delivery and receiving nurses, validated by nursing supervisors. Data analysis was performed using SPSS version 19. Seventy nurses participated in the study. After the educational intervention, checklist adherence showed statistically significant increases from pre- to post-intervention in both receiver and ICU sender nurses ($p < 0.001$), with large effect sizes. Receiver nurses' total scores increased from 19.07 to 40.97, and sender nurses' scores rose from 24.06 to 42.73. Safe care quality scores also increased, with total ASNC scores rising from 130.49 to 133.93 ($p < 0.001$). Overall, implementation of the training program was associated with substantial pre-post changes in handover performance and safe care quality indicators; however, given the single-group pre-post design, these associations cannot be interpreted as causal effects. Following the implementation of interdepartmental handover training and standardized checklists, improvements in indicators of safe nursing care were observed; however, because the study used a single-group pre-post design without a control group, the observed changes should be interpreted as associations rather than causal effects, and further multi-center studies are needed to assess the sustainability and clinical significance of these changes.

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The health care system needs to expand practical concepts in patient care, which requires key competencies such as effective communication, teamwork, and interdepartmental collaboration¹. Communication among healthcare professionals and with patients improves awareness of patient and colleague issues².

In the U.S., hospitals lose over \$12 billion annually due to poor communication³. Nurse handovers are a critical communication point, impacting the quality and continuity of care^{4,5}, and are a World Health Organization (WHO) priority¹. Several countries, including Belgium, the U.K., China, Northern Ireland, the Netherlands, and Switzerland, have national or regional handover standards⁶.

¹Student Research Committee, School of Nursing and Midwifery, Shahid Beheshti University of Medical Sciences, Tehran, Iran. ²Associate Professor of Nursing, School of Nursing and Midwifery, Clinical Research Development Center, Loghman Hakim Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran. ³Department of Anesthesiology, School of Medicine, Critical Care Quality Improvement Research Center, Loghman Hakim Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran. ⁴Department of Pediatric Nursing and NICU, School of Nursing and Midwifery, Shahid Beheshti University of Medical Sciences, Tehran, Iran. ✉email: pazokian@sbmu.ac.ir

Globally, an estimated 1.6 million patient handovers occur daily in teaching hospitals. In the U.S., 300 million, in Australia 40 million, and in England, 100 million handovers occur annually. Studies show 37% of handovers are unsuccessful, with only 36% of Australian professionals reporting effective practices. Communication failures during handovers contribute to 70% of sentinel events, increasing patient risk. In the U.S., verbal reports are most common (81.48%), EMR use is 44.44%, and SBAR tool use is 3.7%. In Turkey, most nurses perform bedside handovers (91.5%), but 53.1% do not use structured tools. Interruptions, distractions, triage flow, and staffing issues negatively affect handovers, while cognitive ability and colleague relationships are positive factors⁷.

Globally, 80% of healthcare errors are due to ineffective handover communication, increasing morbidity, mortality, complaints, and readmissions (38% preventable in Australia)⁸.

Handover methods vary—face-to-face, audio, or computer-based—often away from the bedside, limiting patient participation⁹. Oral handovers are prone to forgotten information, causing medical errors; 65% of irreparable accidents result from weak information transfer^{10,11}.

Analyses show insufficient information in 750 PACU handovers; 24% of nurses and 39% of doctors rate handovers as ineffective^{12,13}. Key risk factors include lack of standards, time pressure, environmental issues, multiple responsibilities, poor feedback, and lack of safety culture^{14,15}.

Standardized checklists reduce handover time and omission errors, improve intraoperative handovers by 43%, and enhance patient identification, key information preparation, and documentation^{16,17}.

Standardization is vital for high-quality care, as one-third of healthcare costs relate to poor-quality care, causing 4.8–7.5 million deaths annually in low- and middle-income countries^{18–20}. Nurses spend the most time with patients, providing physical, psychosocial, and comprehensive care, which affects quality and safety^{21,22}. Poor nursing performance correlates with missed care, adverse events, and mortality²³, especially in ICUs where the stress level is high^{24,25}. For ICU nurses, accurate transmission of information with complete details is necessary to ensure the safe care of patients²⁶. It has been reported that implementing a standardized handoff tool and process with interdisciplinary and interdepartmental collaboration improved critical patient transitions from the operating room to the Neonatal Intensive Care Unit (NICU)²⁷.

In recent Iranian research, Alizadeh-Risani et al. (2024) conducted a quasi-experimental study in an emergency department, comparing the SBAR method with a modified handover model. They found that the modified model significantly improved multiple dimensions of handover: information transfer, shared understanding, working atmosphere, overall handover quality, and nurse perception of handover²⁸. Another study by Gheisari, Farzi et al. (2024) used a clinical supervision model in medical and surgical wards and showed that after six supervision sessions, intervention-group nurses had significant increases in general self-efficacy, handover self-efficacy, and communication clarity / SBAR scores compared to control. The mean Manchester Clinical Supervision Scale (MCSS) score in the intervention group was 128.98, indicating strong effectiveness²⁹. In a related study with nursing internship students, Gheisari et al. (2025) implemented an SBAR-based clinical supervision model and found that it significantly improved clinical self-efficacy, clinical decision-making, and handover skills³⁰.

Effective communication during handover prevents patient harm and improves the quality of care provided. Therefore, appropriate interdepartmental collaboration affects effective clinical handover and, consequently, the quality of safe patient care. Safe patient care is of great importance because it affects the quality of care, and achieving this goal requires interdepartmental handover to play an important role in patient safety. It was also observed in the wards that some colleagues received their patients from behind the nursing station, for example, without checking them for pressure ulcers or other issues. At the same time, a good handover ensures the consistency and efficiency of nursing actions, helps the nurse understand the patient's needs, facilitates the care cycle, and ensures a safe and effective transfer of patient responsibilities between nurses.

Considering the gaps in standardized interdepartmental collaboration for safe clinical handover of patients to different departments and the lack of a standard method of interdepartmental cooperation in the field of safe clinical handover between medical staff, and the necessity and need for an interdepartmental handover protocol, the research team understood the gap in interdepartmental training to improve the quality of care provided in the field of handover. Therefore, the research team decided to promote interdepartmental collaboration by developing a program to ensure safe patient handovers and prevent non-standard handovers. Thus, this study sought to investigate the importance of designing, implementing, and evaluating the interdepartmental handover on the quality of safe patient care.

Materials and methods

Study design and study setting

A quasi-experimental study was conducted with a pre-and post-intervention design. This study was structured under the Standards for Quality Improvement Reporting (SQUIRE) guidelines (Supplementary material 1). The study was conducted at Loghman Hakim Hospital, and data collection took place from February 2024 to July 2025.

Participants

The research population in the present study comprises the content of interdepartmental handover reports prepared by nurses in the ICU of a selected hospital of Medical Sciences. The nurses were selected through convenience sampling. The criteria for nurses to enter the research included having at least 6 months of work experience in an ICU and 1 year of clinical experience, having delivered at least one patient across different shifts, and a willingness to participate in the study. The inclusion criteria for reports during the delivery of nurses included the delivery of patients at the patient's bedside, and the delivery of nurses in the morning and evening shifts. The criteria for excluding reports included deliveries made during the night shift, as handover procedures at night differ in workflow, staffing, and supervision, potentially introducing variability unrelated to

the intervention^{31,32}. In addition, reports from nurses who were transferred, on leave, or absent due to illness during the study were excluded to ensure consistent exposure to the training program.

Sample size

The number of samples is obtained by using the following relationship in each group:

$$n \geq 2 \frac{(z_{\alpha/2} + z_{\beta})^2 \sigma^2}{(\mu_1 - \mu_2)^2} \quad (1-p)$$

The size of the observed effect $(\mu_1 - \mu_2)/\sigma = 0.50$ and $\rho = 0.3$.

Since the data are correlated with pre- and post-couples, one should consider a correlation coefficient of at least 0.3 (Monroe's book).

The sample size for this single-group pre-post quasi-experimental study was calculated using a paired design formula. The probability of a Type I error was set at $\alpha = 0.05$ ($Z_{\alpha/2} = 1.96$), and the probability of a Type II error was set at $\beta = 0.10$ ($Z_{\beta} = 1.28$), yielding a statistical power of 90%. A conservative estimate of the correlation coefficient between pre- and post-intervention measurements was set at $\rho = 0.3$, which is commonly used in similar educational intervention studies when prior data are unavailable^{33,34}. The expected effect size (mean difference divided by the standard deviation) was estimated from Abbaszadeh et al.³⁵, who evaluated the impact of handoff using the SBAR technique on nursing care quality. Considering these parameters, the minimum required number of participants was 59 nurses. To account for an anticipated 20% attrition, 70 nurses were recruited. Each nurse contributed 2 handover reports, totaling 140 for analysis.

Instruments

Demographic questionnaire

The tools that were used in this study included a demographic information questionnaire that included age, employment history, gender, marital status, educational background, position, overall work history, work experience in a specialty, and history of taking courses on safe quality care.

The safe nursing care assessment tool (ASNC)

The safe nursing care assessment tool (ASNC) by Rashvand et al. Includes 32 items, four sections: assessment of nursing skills, assessment of psychological safety, assessment of physical safety, and assessment of teamwork. The questions are based on a Likert scale with option five always and option one never. The highest score is 365, and the lowest is 73, with a range of poor performance (73 to 170), average performance (171 to 267), and desirable performance (268 to 365). A higher score indicates desirable performance of safe nursing care.

Researcher-made tools

researcher-made tools including (1) the patient physiological assessment form that includes 27 sections including patient safety, determining the level of care, severity of the patient's condition, vital signs, pain assessment, patient's motor status, neurological assessment, cardiovascular system assessment, respiratory system assessment, skin assessment, digestive system assessment, urinary system assessment, patient fall risk assessment, etc., (2) a checklist of tasks for the nurse delivering and receiving in ICU which include 14 and 18 statements respectively and in the form of yes or no.

Validity

To calculate content validity, CVI and CVR indices were used, and all items obtained acceptable scores. CVI and CVR for the patient's physiological assessment form were estimated to be 90% and 71%, respectively. Also, CVI and CVR for the delivery and receiver nurses' checklists were calculated as 1 and 85%, respectively. In addition, the CVI and CVR for the nurse who received the patient checklist were estimated at 93% and 81%, respectively. To validate the content of the forms and checklists, three supervisors and seven faculty members of the nursing school were given the questionnaires, and content validity was examined qualitatively and quantitatively.

Reliability

The reliability was confirmed through Cohen's kappa coefficient of 0.70 for the patient's physiological assessment form, 0.75 for the delivery nurse checklist, and 0.72 for the receiver nurse checklist.

Educational intervention development

In the present study, Kern's (2016) model was used to evaluate the Interdepartmental delivery program on the Quality of Safe Care of Nurses during Clinical Handover to ICUs. This model consists of six steps: the first step is to identify and describe the problem, the second step is to assess the needs of target learners, the third step is to determine goals and objectives, the fourth step is to determine educational solutions, the fifth step is to implement the curriculum, and the sixth step is to evaluate and provide feedback. As this project was implemented as a pragmatic quality-improvement initiative within the routine ICU workflow, systematic monitoring of intervention fidelity (e.g., session completion rates, exposure to the training content, or adherence audits) was not conducted. Although all educational modules were delivered to the participating nurses, individual-level engagement data were not recorded. However, to support consistent implementation, the research team maintained close oversight by attending training sessions, addressing participants' questions, and ensuring proper use of the standardized checklists. These pragmatic measures were intended to mitigate variability in intervention delivery, although formal fidelity data were not collected^{36,37}.

Entering the research environment and legal procedures
First step: problem identification and general needs assessment

After receiving the letter of introduction from the honorable vice-chancellor of the Faculty of Nursing and Midwifery, the researcher presented it to the president and director of the hospital, and to the director of nursing services at the selected centers, and obtained written consent from the respective centers. Informed written consent was obtained from the ward nurses to record their voices during interdepartmental delivery and completion of the demographic information questionnaire, and written consent was also obtained from the patients to record and convey their condition. After obtaining permission from the Institutional Ethics Committee of the Faculties of Pharmacy, Nursing and Midwifery University of Medical Sciences and Obtaining the Clinical Trial Approval Code, submitting a letter of introduction to the research environment officials at selected hospital and obtaining the necessary permits, by visiting the research environment, eligible participants were selected after introducing themselves, explaining the purpose of the study and obtaining written consent from them, using the convenient (accessible) sampling method while evaluating the necessary criteria for participation in the study. Therefore, the researcher attended interdepartmental handovers, noted which parts of the checklists each nurse followed, recorded them, and listed the parts that were not observed for training.

The second step: targeted needs assessment

Subsequently, given the need for interdepartmental handover, a training program was developed, and the content, approved by several supervisors and professors of the school of nursing, was delivered through several virtual training workshops.

The third step: goals and objectives

This research was carried out to develop, implement, and evaluate the Quality of Safe Care for Nurses in the Field of Clinical Handover to the Intensive Ward for nurses working in the ICU, based on a needs assessment (Table 1).

Implementation

The researcher, while introducing himself to the research units, explained the objectives of the study and resolved existing questions and ambiguities. Then, the quality of safe care provided by nurses was assessed using the Rashvand et al. (2015) questionnaire (nursing skills assessment, psychological safety assessment, physical safety assessment, and teamwork assessment) by the head nurses for nurses working in the desired departments. The participants under study are the inter-departmental handover reports of nurses working in intensive care units in selected hospitals of the University of Medical Sciences. After obtaining the consent of the head nurse, relevant departments, and the officials of each shift, and ward nurses to record their voices during inter-departmental handover, and completing the demographic information questionnaire, the number of inter-departmental handovers in the morning and evening shifts in the ICUs was recorded. The researcher, having a list of the names of the inter-departmental handover patients, was present in the relevant wards and recorded the process of handover and handover of the patient from the critical ward to the operating room or other wards and vice versa by the nurses and nursing assistants, and this process continued until the participants were completed. Written consent was obtained from the patients to record their handover. Using checklists, the nurses' handover methods were reviewed and recorded before the intervention. All checklist-based observations were conducted by a single trained observer (the primary researcher). Using a single observer minimized scoring variation because no additional observers were available during the routine clinical workflow. Nurses' care safety and quality score was calculated; on the other hand, non-observed items were listed for interdepartmental training. In the next stage, educational classes (Table 1) and researcher intervention took place. During this time, the wards were visited in shifts, and the nurses' questions and concerns about implementing the checklists at the bedside were addressed.

Educational strategies

Virtual interdepartmental handover training sessions were held over three weeks, with three separate sessions on the WhatsApp social space. During each session, explanations for each chapter of the training manual were provided in audio files, along with participants' questions for evaluation. The content of the Interdepartmental Handover Training Manual was used in the training sessions. In this manual, the first chapter covers general objectives, specific objectives, definitions, differences between interdepartmental handover and shift handover, main barriers to effective nursing handover, and in the second chapter, explanations of the patient physiological assessment form for the delivery nurse and explanations of the checklist of tasks for the delivery nurse in the special ward, and in the third chapter, explanations of the patient physiological assessment form for the receiver

Session	Meeting title	Training method
First	Introduction, general objective, specific objective, definitions, experiences, barriers, gaps in perceptions, key elements of effective delivery, and a brief explanation.	Booklet, audio file, evaluation
Second	includes descriptions of the patient's physiological assessment form for the delivery nurse, descriptions of the checklist of duties for the delivery nurse in the special ward, and descriptions of the checklist of responsibilities for the paramedic.	Booklet, audio file, evaluation
Third	includes descriptions of the patient's physiological assessment form for the receiving nurse and the special ward receiving nurse task checklist.	Booklet, audio file, evaluation

Table 1. Educational content outline.

nurse and explanations of the checklist of tasks for the receiver nurse in the special ward, which was prepared by the researcher. The content of the patient physiological assessment form in 27 sections includes patient safety, determining the level of care, severity of the patient's condition, vital signs, pain assessment, patient's motor status, neurological examination, cardiovascular system examination, respiratory system examination, skin examination, digestive system examination, urinary system examination, patient fall risk assessment, bed sore risk assessment, thromboembolism risk, presence of drain, presence of edema in the limbs, habits, volume and type of fluids received, diagnostic procedures performed, precautions, patient medical history, tests performed, consultation, medications used and received, discharge, and last medication received in the previous section. Checklist of duties of the delivery nurse of the special ward: includes 14 statements and is answered with a yes or no. Which includes: checking the doctor's transfer order, coordinating with the destination department, communicating with the patient's family, completing the transfer and transport office, checking the file documents, transporting the patient safely, having resuscitation equipment on the special transport bed, checking the transport vehicle to ensure it is in good condition, having an oxygen capsule with sufficient reserves, actively identifying the patient, completing the nursing report, providing information on the physiological assessment form to the transferee, informing in case of actions that have not been taken for any reason, it is important to inform the relevant authorities. The checklist of duties of the receiver nurse of the special ward includes 18 statements and is answered as yes or no. Which includes: Active identification of the patient, self-introduction, recording the conditions of delivery in the nursing report and transfer log, checking the nursing reports of the originating ward, paying attention to the safety and infection control standards in the accreditation standards and the standards of the infection control unit, transferring the patient to the designated bed, checking the information on the physiological examination form with the delivery person, placing the patient in the appropriate position and checking all the patient's connections, whether all the connections are fixed and have their normal function, paying attention to the absence of kinks and blockages in the connection tubes, paying attention to the absence of connections from their original location, checking any changes in the patient's clinical signs and manifestations, providing necessary training, paying attention to the cleanliness of the patient and his/her equipment, communicating with the patient's companion, raising the bedside, recording actions in the nursing report, carrying out urgent orders, observing the correct position of the client (Supplementary material 2).

Evaluation and feedback

After the intervention, the quality of safe care was re-measured and compared. During this period, the researcher observed the interdepartmental handover process across shifts and notified nurses of any issues. Descriptive statistics (frequency, frequency percentage, mean, and standard deviation) were used for data analysis, and inferential statistics (paired t) were used to determine significance.

Mthical consideration

This research adhered to all ethical guidelines outlined in the Declaration of Helsinki. Informed written consent was obtained from both nurses and patients before the commencement of any audio recordings. The sole purpose of the audio files was to record the clinical handover process. To ensure participant confidentiality, transcribed versions were replaced with coded identifiers, and all identifying information was removed or anonymized. This research received ethical approval from the Ethics Committee of Shahid Beheshti University of Medical Sciences (IR.SBMU.PHARMACY.REC.1402.112) and was registered with the Iran Clinical Trials Registry (IRCT20231015059729N1; Date 25-10-2023). Data collection commenced in February 2024, ensuring that the trial was registered prospectively. Readers can direct any inquiries or requests for access to anonymized data to the corresponding author.

Data analysis

Descriptive statistics (frequency, frequency percentage, mean, and standard deviation) were used to analyze the data, and paired t-tests were used to compare the scores before and after, due to their normality. Data analysis was performed with SPSS version 19 software (Fig. 1).

Results

Participant characteristics

In the study, seventy nurses participated. 64.3% of them were women. Their mean age was 32.97 ± 6.68 . Their average employment history was 9.24 ± 5.95 . Their average work experience in the intensive ward was 6.94 ± 5.58 . 54.3% of participants were married, and half had completed safe care quality courses (Table 2).

Normality test

The Kolmogorov–Smirnov test was used to assess normality, and the data were normally distributed ($p > 0.05$) for all measured variables.

Checklist adherence

The following table shows the results of the checklist of receiver delivery nurses before and after the educational intervention. A paired t-test was used to interpret the data. After the educational intervention, there was a statistically significant difference ($p < 0.001$). After the intervention, the difference in the average total checklist score for the receiving delivery nurses was significant ($p < 0.001$). The mean total score for receiver delivery nurses increased significantly from pre-test to post-test. The total difference between before and after was 21.90, and we saw changes in both the mean and the standard deviation (SD) in each part. The percentage of change

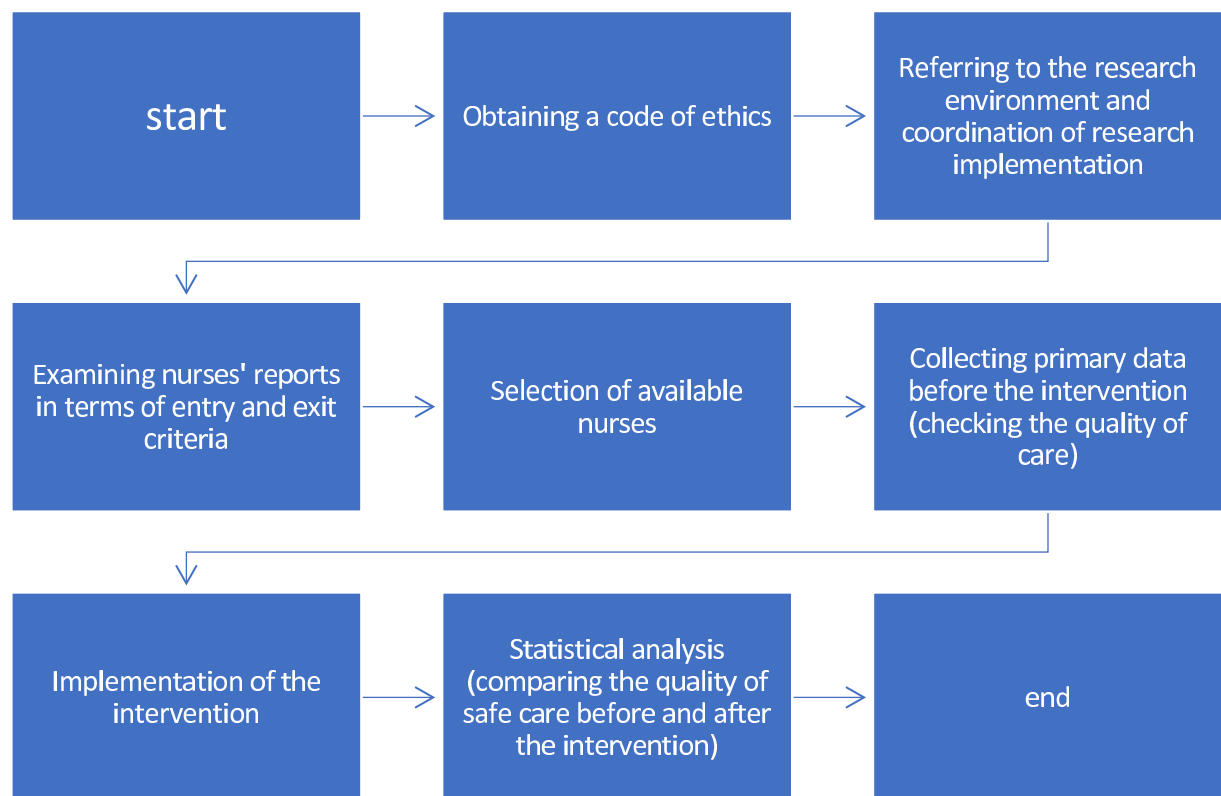


Fig. 1. Study process.

Variable	N(%)
Gender	
Female	45(64.3)
Male	25(35.7)
Marital status	
Single	32(45.7)
Married	38(54.3)
Educational status	
Bachelor's degree	67(95.7)
Master's degree	3(4.3)
History of completing safe care quality courses	
Yes	35(50.0)
No	35(50.0)

Table 2. Demographic variables.

in the mean was 114.84 (21.9 scores), and the Percentage of change in the standard deviation was 57.81 (1.77 scores) (Table 3).

ICU sender checklist adherence

The following table shows the results of the intensive care unit delivery nurses' checklist before and after the educational intervention. A paired t-test was used to interpret the data. In this part, there is a significant difference in the scores obtained, indicating that the total score increased after the intervention. Among the participants, the score after the training program was 42.73, compared to 24.06 before; the difference between the two time periods was 18.671. The percentage of change in the mean was 77.60, and the Percentage of change in the standard deviation was 16.62. Post-intervention adherence on the ICU Sender Checklist was associated with large within-group effect sizes compared to pre-intervention scores. Adherence to physiological examination items showed a very large effect (Cohen's $d=2.79$), ICU nurse duties and paramedic-related duties both demonstrated large effects (Cohen's $d=1.43$ and 1.25 , respectively), and overall checklist adherence exhibited a very large effect

Stage	Pre-intervention	Post-intervention	Paired t-test results	
Variable	Mean $\pm$ SD	Mean $\pm$ SD	P-value	Difference
Physiological examination	11.93 $\pm$ 3.06	29.76 $\pm$ 4.41	< 0.001	17.83
Duties of the receiver delivery nurses of the intensive care unit	7.14 $\pm$ 1.60	11.21 $\pm$ 1.85	< 0.001	4.07
Total	19.07 $\pm$ 3.29	40.97 $\pm$ 5.06	< 0.001	21.90

Table 3. Mean and standard deviation in the checklist of receiver delivery nurses of the intensive care unit before and after the intervention.

Stage	Pre-intervention	Post-intervention	Paired t-test results		Effect size	95% Confidence Interval	
Variable	Mean $\pm$ SD	Mean $\pm$ SD	P-value	Difference	Point Estimate	Lower Limit	Upper Limit
Physiological examination	10.41 $\pm$ 2.98	23.99 $\pm$ 4.21	< 0.001	13.57	2.790	2.267	3.307
Duties of the intensive care unit delivery nurse	7.84 $\pm$ 1.43	10.97 $\pm$ 1.62	< 0.001	3.13	1.431	1.094	1.762
Duties of a paramedic	5.80 $\pm$ 1.12	7.77 $\pm$ 0.97	< 0.001	1.97	1.249	0.933	1.559
Total	24.06 $\pm$ 3.98	42.73 $\pm$ 4.64	< 0.001	18.67	3.055	2.493	3.613

Table 4. Mean and standard deviation in the checklist of the intensive care unit delivery nurse before and after the intervention.

Stage	Pre-intervention	Post-intervention	Paired t-test results	
Variable	Mean $\pm$ SD	Mean $\pm$ SD	P-value	Difference
Nursing skills assessment	63.66 $\pm$ 11.22	65.83 $\pm$ 10.11	< 0.001	2.17
Psychological safety assessment	14.80 $\pm$ 3.76	15.20 $\pm$ 3.44	< 0.001	0.400
Physical safety assessment	30.23 $\pm$ 4.32	30.59 $\pm$ 4.17	< 0.001	0.357
Teamwork assessment	21.80 $\pm$ 3.60	22.31 $\pm$ 3.29	< 0.001	0.514
Total	130.49 $\pm$ 19.83	133.93 $\pm$ 18.23	< 0.001	3.443

Table 5. Comparison of the quality of safe care provided by nurses in the area of patient transfer to the intensive care unit before and after the intervention.

(Cohen's $d = 3.06$). These results indicate a substantial pre–post difference in checklist adherence; however, in the absence of a concurrent control group, the magnitude of these effects cannot be attributed solely to the intervention (Table 4).

ASNC scores

The following table shows that all dimensions of the quality questionnaire on nurses' safe care were significantly improved. The score of the safe care quality questionnaire after the training program (133.93 $\pm$ 18.23) was higher than before the program (130.49 $\pm$ 19.83). In the measurement of nursing skills, the difference before and after was 2.17; in the dimension of mental safety assessment, the difference between before and after was 0.4; in the dimension of physical safety, the difference between before and after was 0.357; in the dimension of team work assessment, the difference was 0.514. In the total score section, we had an increase of 3.44. It was statistically significant ($p < 0.001$). The percentage of change in the mean was 2.57, and the Percentage of change in the standard deviation was 8.07 (Table 5).

Multivariable regression analysis

To explore potential confounding factors, a multivariable regression model was performed with the post-intervention safe care score as the dependent variable and demographic/professional characteristics as predictors. The results showed that none of the examined variables—including sex ($F = 0.029$, $p = 0.865$), ICU work experience ($F = 0.453$, $p = 0.503$), baseline safe care score ($F = 0.056$, $p = 0.813$), and age ($F = 0.488$, $p = 0.487$)—had a statistically significant association with the outcome (Table 6). The model error term remained large ($MS = 21.858$), indicating substantial unexplained variance. The regression analysis suggests that participants' demographic or experiential characteristics did not influence the observed improvements in checklist adherence and safe care quality.

Discussion

The present study aimed to develop, implement, and evaluate an interdepartmental delivery program to improve the quality of safe care provided by nurses during Clinical handover to intensive care departments in selected hospitals. In the present study, the average quality of safe nursing care was reported before the intervention.

Variables	Type III sum of squares	df	Mean square	F	pvalue.
Sex	0.633	1	0.633	0.029	0.865
Icu	9.901	1	9.901	0.453	0.503
Safe care	1.231	1	1.231	0.056	0.813
Age	10.664	1	10.664	0.488	0.487
Total	129285.000	70			

Table 6. Multivariable regression analysis of demographic and professional predictors of post-intervention safe care scores.

Nurses in the chosen hospital’s critical ward had poor performance in assessing the quality of safe nursing care before the intervention, which may have been because clinical nurses did not use any tools to evaluate their own and colleagues’ performance or to identify weaknesses. The highest level of performance in the dimensions of quality of safe nursing care before the intervention was reported in the nursing skills assessment, physical safety assessment, Team performance assessment, and psychological safety assessment dimensions, respectively. The average quality of safe nursing care was reported after the intervention. Nurses in the critical ward of a selected hospital had a poor performance level in assessing the quality of safe nursing care after the intervention. The highest level of performance in the dimensions of safe nursing care quality was reported in the nursing skills assessment, physical safety assessment, Team performance assessment, and psychological safety assessment, respectively. The results obtained had improved compared to before the intervention, but the nurses’ performance level still showed a poor score. The results of the present study show that implementation of the program was associated with statistically significant pre–post improvements in the quality of safe nursing care; however, because of the single-group pre–post design without a concurrent control group, these changes cannot be unambiguously attributed to the intervention and may also reflect concurrent threats to internal validity such as history, maturation, testing, seasonal variation in clinical workload, and Hawthorne effects related to direct observation^{38,39}. Other factors that affected the study results included failure to prioritize patient needs, fatigue and burnout, failure to share concerns with other nurses, development and implementation of self-made care routines, failure to pay attention to the importance of initial assessment, failure to monitor staff performance, need for more and sufficient time to implement the protocol, lack of sufficient cooperation from the nurse in front of the patient during handover, nurses’ work experience, such that nurses with less work experience relied more on using the tools, reliance on their previous knowledge, etc.

Moghadam et al. in 2018 showed that the majority of nurses in the emergency department adequately provided safe care. In this study, the standard questionnaire for quality of nursing care, the Quality Patient Care Scale, was used, and the statistical results showed significant relationships between demographic variables and quality of nursing care, and between professional characteristics and the quality of holistic nursing care. The results of this study also showed that the more the amount of monthly overtime hours was increased, the less the quality of nursing care was reduced, and the results of the study showed a significant relationship between the variables of age, amount of overtime hours, type of employment, and satisfaction with sleep quality in nurses with the quality of nursing care of patients. However, in the present study, the relationship of these variables was not examined due to the type of study²².

Arnaud Bruynil et al.’s study titled “Unfinished nursing care in intensive care units and the mediating role of the relationship between the nurse’s work environment and the quality of care and nurses’ well-being” was conducted in 2024 and was assessed using the Nursing Work Environment Index (PES-NWI) scale and the perception of the quality and safety of care through the Likert scale. Also, burnout risk was assessed using the Maslach Burnout Inventory. As in the present study, at least one unfinished nursing care activity was reported by most nurses, and an increase in unfinished nursing care was associated with a significant decrease in the quality and safety of care. It was concluded that monitoring unfinished nursing care in the intensive care unit is an important initial indicator of problems affecting nurses’ well-being and the perceived quality of care⁴⁰.

In this study, a customized ICU handover checklist was developed, rather than relying solely on standardized tools such as SBAR or ISBAR, which are widely used for structured communication during handovers. While SBAR/ISBAR facilitate concise reporting of patient information, they may not fully capture the complex, multidimensional requirements of ICU care, including detailed physiological assessment, team coordination, and psychological safety of both patients and staff. The tailored checklist in this study was specifically designed to reflect the ICU workflow and responsibilities of both sending and receiving nurses, covering 27 sections of physiological assessment and task-specific duties to ensure safe patient transfer. This approach allowed comprehensive monitoring of handover quality, addressing both completeness of information and adherence to safe care standards. Compared to previous studies using SBAR/ISBAR, which often showed partial improvements in communication or patient safety outcomes^{41,42}, our intervention demonstrated large effect sizes across multiple domains of handover adherence and safe nursing care quality. The ICU-specific focus of the checklist may explain the observed differences, the inclusion of both pre- and post-intervention structured observations, and the integration of task- and patient-centered criteria, which were not consistently addressed in prior SBAR-based studies. Therefore, this study suggests that customized, context-specific handover tools can complement standardized methods to improve patient safety and the overall quality of nursing care in critical care settings.

Mojgan Rivaz et al. conducted another study titled “Investigating the Relationship between Professional Partnership and the Quality of Nursing Care in Intensive Care Units” in 1402. The quality of nursing care was assessed using the Persian version of the Nursing Care Quality Scale (CNCQS) by Kay et al. (2017). The average

score for the dimensions of nursing care quality (physical environment, nursing process development, nurse characteristics, nurses' job requirements, ethical behavior, patient outcomes) was reported as relatively favorable and differed from the results of the present study. Unlike in the present study, the level of cooperation among nurses in intensive care units was appropriate. In line with the present study, this study selected the intensive care unit due to the complex and critical conditions of patients and the need for excellent cooperation and various interactions between skilled personnel to achieve quality care, and similar to the present study, the need for improving the quality of nursing care was noted⁴³. In the study by Nadia Hojjati-Rad et al. entitled "Investigating the views of head nurses on how nurses perform in providing safe care to patients during the coronavirus outbreak", similar to the present study, they used the Rashvand et al. questionnaire, which, according to head nurses, the level of safe performance of nurses in the Covid-19 epidemic in the hospitals studied was at an average level. The results of this study showed that there is a positive relationship between the dimensions of nurses' safe behaviors, and the highest relationship was between the physical safety assessment dimension and the teamwork assessment dimension. Also, in this study, the results were compared with demographic variables, so that the average score of safe behaviors in older nurses and nurses with fewer working hours per week was higher than that of younger nurses or those with longer working hours. The results showed that the average score of safe behaviors in nursing skills in people with fewer average hours per week was higher than that of nurses with longer average working hours, and also the average score of safe behaviors in the dimensions of physical safety and teamwork in nurses with fewer working hours was higher than that of nurses with longer working hours. The results also showed that there is a relationship between nurses' age and physical safety behavior: older nurses observed more physical safety behaviors than younger nurses. The differences in this study include the different research environment, namely two separate hospitals, in both general and intensive care units, and the time of the study (the coronavirus epidemic)⁴⁴.

In a 2020 study titled "Communication Challenges of Critical Care Nurses During Handovers," Jang-Wen-Ahn et al. examined shift-to-shift and multiple interdepartmental handovers from the perspective of critical care nurses. In line with the current study, it was concluded that structured and formatted handovers, along with the use of checklists, are effective in reducing harmful outcomes such as information omissions and documentation errors and in improving the care process⁴¹. In a study titled "Creating a Handover Tool Between the Operating Room Team and the Pre-Intervention Area," conducted in 2022. Similar to the present study, the team developed and implemented a standardized checklist to address inconsistencies in handover. It was shown that the use of evidence-based guidelines incorporated into the handover checklist reduced omissions and preventable errors. And in line with the present study, the use of the handover tool led to better implementation of interdepartmental communication. Subsequently, the communication tool improved the process and reduced errors during handover, thereby enhancing patient safety⁴⁵. In the study by Remi dos Santos titled "Improving patient safety and continuity of care through training nurses on standard handovers in postanesthesia care: A quality improvement project," conducted in 2024, an educational intervention was implemented and evaluated to improve nurses' skills in using the IPASS handover tool. Consistent with the present study, improving nurses' familiarity with the I-PASS protocol improved patient data transfer and potentially increased patient safety. As in the present study, nurses were encouraged to use and adhere to the handover tool⁴⁶. The purpose of the present study was consistent with Olufemi Olawale's study in 2024, so that the project was focused on educating staff on standardized communication tools to ensure patient information is transferred effectively and efficiently in the organization⁴⁷. Also in Citra Suraya et al.'s 2024 study, Team STEPPS (Team Strategies and Tools to Enhance Performance and Patient Safety) effectively increases the patient safety culture, as evidenced by improved communication, handover, transitions, and a decreased frequency of reports regarding side effects⁴⁸.

Similar to our findings, a standardized tool can contribute to different aspects of safe care. For example, the study of Veronica Chaica et al. 2024 states that the results obtained highlighted four main aspects that underpin the usefulness of ISBAR as a tool for interdepartmental and standardized communication⁴⁹. It was also concluded in the study of Sophia Agbomah et al.'s 2024 that it is possible to improve completeness, duration, and satisfaction through the use of a standardized hand-off reference tool⁵⁰.

In contrast to the present study, in Marit Hegg Reime et al.'s study, there were no significant improvements from baseline to post-intervention regarding adherence to the ISBAR communication scoring tool⁵¹. The limitations of this study include the lack of studies conducted on developing, Implementation and Evaluation of the interdepartmental handover and the quality of safe care in the field of handover, limitations in comparing the results of the study with similar studies, and since this study was conducted only within the critical ward of selected hospital, the generalizability of its results to other wards and hospitals is challenging. Also, the type of ward and intensive workload can cause limitations.

Strengths

The study is notable for its focus on a crucial patient safety concern: the standardization of interdepartmental handovers in intensive care. The project's key strengths comprise an intervention design built on Kern's curriculum development model, the application of the validated ASNC instrument and researcher-generated operational checklists, reporting of content validity indices (CVI/CVR) and inter-rater reliability (Cohen's κ), and the practical implementation of the intervention in a clinical context. The intervention was both cost-effective and easily reproducible (virtual WhatsApp-based training), and the pre-post design enabled evaluation of post-training changes.

Limitations

This study has several limitations. The single-group quasi-experimental design, reliance on convenience sampling, and single-center nature of the study limit internal validity and restrict the generalizability of the findings. The absence of a control group, coupled with the lack of assessor blinding, since ASNC scores were

completed by head nurses, may introduce measurement bias. More specifically, because no concurrent control group was available, several well-recognized threats to the internal validity of single-group pre–post designs cannot be ruled out and may have contributed to the observed pre–post differences^{38,39,52}. First, history effects, such as concurrent hospital-wide patient-safety initiatives, accreditation activities, changes in ICU staffing, or other quality-improvement programs occurring during the 2024–2025 study period, may have independently influenced handover behavior and safe-care indicators. Second, maturation effects, including increases in nurses' clinical experience, familiarity with ICU workflow, or natural skill development across the multi-month study window, may have produced part of the observed improvement irrespective of the educational program. Third, seasonal variation in patient acuity, admission volume, and unit workload between the pre- and post-intervention periods may have differentially affected handover practices and ASNC scores. Fourth, repeated measurement using the same instruments may have introduced testing effects, in which nurses' awareness of the assessment domains influenced their later performance. Fifth, because data were collected through direct on-site observation, Hawthorne effects, in which participants modify their behaviour because they know they are being observed, are a particularly important threat in this study. Prior work in healthcare settings has shown that overt direct observation can substantially inflate compliance estimates compared to covert observation (for example, a difference of approximately 23% points in hand-hygiene compliance), and that the magnitude of this effect varies by occupation and setting, including critical care units⁵³. Accordingly, part of the post-intervention improvement in checklist adherence may reflect reactivity to observation rather than a true change in routine handover behaviour. This design was chosen due to practical constraints and the need to implement the intervention within routine ICU operations without disrupting patient care. Statistical transparency was initially limited due to the absence of reported effect sizes and confidence intervals, which have now been added, although this remains a constraint of the original analysis plan. Furthermore, because the project was implemented as a pragmatic quality-improvement initiative within the routine ICU workflow, no formal intervention fidelity assessment was conducted; session completion, exposure to the training content, adherence to the checklists, and participation rates were not recorded, limiting the ability to interpret the mechanisms underlying observed changes. Checklist-based assessments were performed by a single observer, and inter-rater reliability was not evaluated, which may further limit the robustness of adherence and performance measurements. Although the ASNC tool and checklists are established and relevant for ICU handover assessment, the observed changes in ASNC scores were modest, raising questions about clinical significance. Binary checklist items (yes/no) may also oversimplify adherence and fail to capture nuances of handover quality. Finally, although the researcher-developed instruments underwent content validation, their construct validity and long-term reliability have not yet been fully established, indicating the need for more comprehensive psychometric evaluation in future studies. Taken together, these limitations highlight that while the findings suggest potential benefits of structured interdepartmental handover training, they should be interpreted with caution, and further multi-center, controlled studies with rigorous fidelity monitoring are warranted to confirm effectiveness and clinical relevance.

Conclusion

Implementation of a structured interdepartmental handover program, designed according to a formal educational model and supported by standardized checklists, was associated with statistically significant pre–post improvements in indicators of safe nursing care and handover adherence. Because the study used a single-group pre–post design, these findings should be interpreted as associations rather than causal effects, and concurrent threats to internal validity, including history, maturation, seasonal variation, testing effects, and Hawthorne effects related to direct observation, cannot be excluded as partial explanations for the observed changes. Comprehensive confirmatory studies, including multicenter, randomized, or mixed-effects designs featuring blinded assessment, covert or routinely embedded observation, and prolonged follow-up, are essential to determine causality and generalizability.

Implications for practice

Implementing a structured interdepartmental handover program based on standardized checklists and targeted training may support improvements in the quality and safety of care in ICU. Hospitals are encouraged to adopt these checklists as formal procedures, integrate them into electronic medical records (EMR), and establish mandatory training programs for nurses, including initial instruction and periodic refresher sessions. Continuous monitoring using measurable indicators, such as checklist adherence rates, handover-related incidents, ASNC scores, and 30-day readmission rates, should be implemented to evaluate the effectiveness and sustainability of the intervention. Additionally, involving clinical leaders and designating unit champions to provide on-site support, ensuring a “no-interruption” environment during handovers, and implementing feedback and continuous improvement mechanisms are essential for achieving lasting clinical and organizational outcomes.

Suggestions for future research

Studies should be conducted to develop solutions and implement interventions to improve the quality of safe nursing care among nurses. Also, Various dimensions of safe care quality should be examined. It is essential that the existing interdepartmental handover programs and their relationship with the quality of safe nursing care be checked as a general concern. Quantitative and qualitative studies should be conducted in the future, and educational planning should be conducted in this area.

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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References

- Desmedt, M., Ulenaers, D., Grosemans, J., Hellings, J. & Bergs, J. Clinical handover and handoff in healthcare: a systematic review of systematic reviews. *Int. J. Qual. Health Care*. **33** (1), mzaa170 (2021).
- Keshmiri, F. & Hosseinpour, A. The correlation between perception of patient safety and professionalism and adherence to interprofessional professionalism among members of the surgical team. *J. Med. Educ. Dev.* (2022).
- Cho, M. Evaluating therapeutic healthcare environmental criteria: architectural designers' perspectives. *Int. J. Environ. Res. Public Health*. **20** (2), 1540 (2023).
- Pakcheshm, B., Bagheri, I. & Kalani, Z. The impact of using ISBAR standard checklist on nursing clinical handoff in coronary care units. *Nurs. Pract. Today*. **7** (4), 266–274 (2020).
- Lee, D.-H. & Lim, E.-J. Effect of a simulation-based handover education program for nursing students: A quasi-experimental design. *Int. J. Environ. Res. Public Health*. **18** (11), 5821 (2021).
- Le, A., Lee, M. A. & Wilson, J. Nursing handoff education: An integrative literature review. *Nurse Educ. Pract.* 103570. (2023).
- Seid, A., Hussien, W. Y., Bahru, J. M., Ahmed, A. & Semanew, Y. Patient handover practice of nurses and associated factors in South Wollo Zone Public Hospitals, Ethiopia. *Sci. Rep.* **15** (1), 13194 (2025).
- Moyo, P., Anderson, J., Francis, K. & Biles, J. Exploring the experiences and perceptions of the utilisation of structured clinical handover frameworks by nurses working in acute care settings: A scoping review. *J. Clin. Nurs*. **33** (11), 4297–4313 (2024).
- Abdollahi, L., Jaber, P. S. & Rokhfarooz, D. The effect of using SBAR model in shift handover on patient and nurse satisfaction in the emergency department. (2022).
- Dadashzadeh, A. et al. Investigating the patient handover process in the emergency department from the perspective of pre-hospital emergency personnel. *Nurs. Midwifery J.* **20** (6), 459–468 (2022).
- Elnaz Parsarad, A., Farahani, A. S. & Jambarsang, S. *Auditing of nursing handover to next shift in Neonatal Intensive Care Unit of selected hospitals affiliated with (Qazvin University of Medical Sciences, 2021).*
- Kaltoft, A., Jacobsen, Y. I., Tangsgaard, M. & Jensen, H. I. ISBAR as a structured tool for patient handover during postoperative recovery. *J. PeriAnesthesia Nurs.* **37** (1), 34–39 (2022).
- Hinding, B., Deis, N., Gornostayeva, M., Götz, C. & Jünger, J. Patient handover—the poor relation of medical training? *GMS J. Med. Educ.* **36**(2). (2019).
- Dusse, F. et al. Completeness of the operating room to intensive care unit handover: a matter of time? *BMC Anesthesiol.* **21**, 1–8 (2021).
- Leroy, Q. & Bonsall, A. Implementation and evaluation of an evidence based handoff tool for use by anesthesia during transfer of care of post-CABG Patients to the Intensive Care Unit. (2023).
- Palicka, J. J. Standardization of postoperative patient handoff using the situation background-assessment-recommendation (SBAR) Checklist. (2023).
- Galli, A. et al. Improvement of nursing handover in emergency department: a prospective observational cohort study. *Discover Health Syst.* **4** (1), 3 (2025).
- Malekzadeh, J., Etezadi Jam, T., Mazlom, S. & Taseiri, A. A standardized shift handover protocol: improving nurses'safe practice in the area of medication and intravenous line in intensive care units. *Nurs. Midwifery J.* **11** (6), 0 (2013).
- Moghadam, F., Pazokian, M., AbbasZadeh, A. & Zadeh, E. F. The relationship between moral distress and safe nursing care in emergency wards nurses. *J. Nurs. Educ. (JNE)* **9** (4). (2020).
- Sherwood, G. & Barnsteiner, J. *Quality and safety in nursing: A competency approach to improving outcomes* (Wiley, 2021).
- Motamedzadeh, M., Sarvary, M. H. & Ebadi, A. Comparison of quality nursing safe care in corona and non-corona wards. *Paramedical Sci. Military Health.* **16** (2), 34–41 (2021).
- Asgari, Z., Pahlavanzadeh, S., Alimohammadi, N. & Alijanpour, S. Quality of holistic nursing care from critical care nurses' point of view. *J. Crit. Care Nurs.* **12** (1), 9–14 (2019).
- Cho, S. H., Lee, J. Y., You, S. J., Song, K. J. & Hong, K. J. Nurse staffing, nurses prioritization, missed care, quality of nursing care, and nurse outcomes. *Int. J. Nurs. Pract.* **26** (1), e12803 (2020).
- Kalantari, M., Sajadi, S. A. & Pishgooie, S. A. H. Evaluation of nurses' performance from nurses' viewpoints on providing safe care to patients in AJA hospitals in 2018. *Military Caring Sci. J.* **5** (3), 173–181 (2019).
- Rezaee, N., Salar, A. & Keykha, A. Nurses' experience of nursing care in the intensive care unit: a qualitative study. *J. Crit. Care Nurs.* **13** (2), 46–53 (2020).
- Etezadi, T., Malekzadeh, J., Mazlom, S. R. & Tasseeri, A. Nursing handover written guideline implementation: A way to improve safe performance of nurses in intensive care units. *Evid. Based Care.* **2** (2), 7–18 (2012).
- Gallois, J. B. et al. Handoff tool improves transitions from the operating room to the neonatal intensive care unit. *Pediatr. Qual. Saf.* **8** (5), e695 (2023).
- Alizadeh-risani, A., Mohammadkhah, F., Pourhabib, A., Fotokian, Z. & Khatooni, M. Comparison of the SBAR method and modified handover model on handover quality and nurse perception in the emergency department: a quasi-experimental study. *BMC Nurs.* **23** (1), 585 (2024).
- Gheisari, F., Farzi, S., Tarrahi, M. J. & Momeni-Ghaleghasemi, T. The effect of clinical supervision model on nurses' self-efficacy and communication skills in the handover process of medical and surgical wards: an experimental study. *BMC Nurs.* **23** (1), 672 (2024).
- Gheisari, F. et al. The effect of an ISBAR-based clinical supervision model during handover on clinical decision-making and self-efficacy of nursing internship students: a quasi-experimental study. *BMC Med. Educ.* **25** (1), 815 (2025).
- Lim, H. & Kim, S. H. Navigating night shifts: a qualitative study of exploring sleep experiences and coping strategies among nurses. *BMC Nurs.* **24** (1), 385 (2025).
- Baldwin, C. M. et al. American Academy of nursing policy recommendations to reduce and prevent negative health outcomes and health care costs among night shift nurses: An AAN consensus paper. *Nurs. Outlook.* **73** (1), 102344 (2025).
- Walters, S. J. et al. Sample size estimation for randomised controlled trials with repeated assessment of patient-reported outcomes: what correlation between baseline and follow-up outcomes should we assume? *Trials* **20** (1), 566 (2019).
- Bujang, M. A. An elaboration on sample size determination for correlations based on effect sizes and confidence interval width: a guide for researchers. *Restor. Dent. Endod.* **49** (2), e21 (2024).
- Abbaszade, A. et al. Evaluation of the impact of handoff based on the SBAR technique on quality of nursing care. *J. Nurs. Care Qual.* **36** (3), E38–E43 (2021).
- Akiba, C. F. et al. We start where we are: a qualitative study of barriers and pragmatic solutions to the assessment and reporting of implementation strategy fidelity. *Implement. Sci. Commun.* **3** (1), 117 (2022).

37. Ashcraft, L. E. et al. A systematic review of experimentally tested implementation strategies across health and human service settings: evidence from 2010–2022. *Implement. Sci.* **19** (1), 43 (2024).
38. Miller, C. J., Smith, S. N. & Pugatch, M. Experimental and quasi-experimental designs in implementation research. *Psychiatry Res.* **283**, 112452 (2020).
39. Siedlecki, S. L. Quasi-experimental research designs. *Clin. Nurse Spec.* **34** (5), 198–202 (2020).
40. Bruyneel, A., Bouckaert, N., Pirson, M., Sermeus, W. & Van den Heede, K. Unfinished nursing care in intensive care units and the mediating role of the association between nurse working environment, and quality of care and nurses' wellbeing. *Intensive Crit. Care Nurs.* **81**, 103596 (2024).
41. Ahn, J. W., Jang, H. Y. & Son, Y. J. Critical care nurses' communication challenges during handovers: A systematic review and qualitative meta-synthesis. *J. Nurs. Adm. Manag.* **29** (4), 623–634 (2021).
42. Balasi, L. R. et al. Research paper professional nursing autonomy and safe nursing care in newly graduated nurses working in emergency departments. (2024).
43. Rivaz, M. & Tehranineshat, B. The relationship between professional collaboration and quality of nursing care in intensive care units: A cross-sectional study. *Crit. Care Nurs.* **16** (3), 31–40 (2023).
44. Hojati rad, N., Soltani, Y., Fotokian, Z. & Hadizadeh, M. Head nurses' perspective on nurses' performance in providing safe care to patients during corona outbreak. *J. Casp. Health Aging.* **8** (2), 1 (2023).
45. Ortutay, R., Levin, R., Orfe, T. & McGough, N. Creation of a handoff tool between the preprocedural area and OR team. *J. PeriAnesthesia Nurs.* **37** (4), e24 (2022).
46. dos Santos, R. Improving patient safety and continuity of care by educating nurses about standardized handoffs in the post-anesthesia care unit: A quality improvement project. (2024).
47. Olawale, O. *Staff Education Program to Enhance Patient Handover Communication* (Walden University, 2024).
48. Suraya, C. S. C., bin Sansuwito, T., Dioso, R. I. & Wisuda, A. C. Effective communication in nursing: a comprehensive systematic review of best practices. *J. Nurs. Sci. Res.* **1** (1), 34–48 (2024).
49. Chaica, V., Marques, R. & Pontifice-Sousa, P. (eds) *ISBAR: A Handover Nursing Strategy in Emergency Departments, Scoping Review* (MDPI, 2024).
50. Agbomah, S. & Summers, S. Implementation of a standardized handoff reference tool from the intensive care unit to the operating room. (2024).
51. Reime, M. H., Tangvik, L. S., Kinn-Mikalsen, M. A. & Johnsgaard, T. Intrahospital Handovers before and after the Implementation of ISBAR Communication: A quality improvement study on ICU nurses' handovers to general medical ward nurses. *Nurs. Rep.* **14** (3), 2072–2083 (2024).
52. Schweizer, M. L., Braun, B. I. & Milstone, A. M. Research methods in healthcare epidemiology and antimicrobial stewardship-Quasi-experimental designs. *Infect. Control Hosp. Epidemiol.* **37** (10), 1135–1140 (2016).
53. Wu, K. S. et al. Identifying heterogeneity in the Hawthorne effect on hand hygiene observation: a cohort study of overtly and covertly observed results. *BMC Infect. Dis.* **18** (1), 369 (2018).

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Author contributions

[MP]: Conceptualization, Formal analysis, Methodology, Project administration, Data Curation, Supervision, Writing - Original Draft, Writing - Review & Editing. [FS]: Formal analysis, Data Curation, Writing - Original Draft, Review & Editing. [MH]: Formal analysis, Data Curation, Supervision, Writing - Original Draft. [NS]: Formal analysis, Data Curation, Visualization, Writing - Review & Editing. [MN]: Formal analysis, Data Curation, Visualization, Writing - Review & Editing.

Declarations

Competing interests

The authors declare no competing interests.

Additional information

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Correspondence and requests for materials should be addressed to M.P.

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