

Effectiveness of Training Program on Knowledge of Midwives and Nursing Responsibilities Post Blood Transfusion at Nasser Medical Complex, Palestine

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Abstract

Background: Blood transfusion is a crucial procedure in medical care, especially in obstetrics and emergencies, where strict adherence to protocols is essential to avoid severe complications.

Objective: This study assesses the impact of a targeted training program on midwives and nurses at Nasser Medical Hospital in Palestine, focusing on essential post-transfusion nursing responsibilities. **Method:** Using a Randomized Controlled Trial (RCT) design, 45 midwives and nurses were randomly chosen to participate. Data collected through structured questionnaires were analyzed with SPSS **Result:** The training program led to significant improvements in knowledge scores related to post-transfusion complications, with a mean increase from 76.71 to 96.81 (MD = 20.10, P < 0.001). This improvement was consistent across various demographics, including gender, age, education, marital status, professional experience, and department. For instance, participants over 40 years achieved the highest effect size (2.27), and diploma holders displayed the greatest mean difference (28.99). Additionally, both midwives and nurses saw substantial knowledge gains, with the Cesarean Section Operations and Neonatal and Maternity Departments exhibiting the highest improvements. **Conclusion:** These findings underscore the program's broad efficacy in enhancing transfusion-related knowledge, reinforcing its value in promoting patient safety and care quality at the Complex. The study recommends expanding targeted training to include other healthcare professionals, conducting long-term evaluations, incorporating simulation-based learning, and analyzing patient outcomes. **Recommendation:** It suggests broader implementation in diverse settings, tailoring content to specific roles, and addressing psychological readiness to enhance skills, promote safety, and improve transfusion practices

Keywords: interventional training, midwives and nurses, knowledge, blood transfusion, nasser medical hospital, palestine

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Introduction

Blood transfusions, while often life-saving, can lead to a range of post-transfusion complications. These reactions can vary from mild to life-threatening and often require immediate recognition and intervention (1). Below are some key potential complications associated with transfusions: Delayed Hemolytic Reactions (DHTR): Delayed hemolytic transfusion reactions typically occur days to weeks after a transfusion. This reaction results from the recipient's immune system gradually recognizing foreign antigens on transfused red blood cells (RBCs) and destroying them. Symptoms may include jaundice, anemia, fever, and dark urine. In some cases, these reactions may be subtle, making early detection difficult. DHTRs can also exacerbate the patient's underlying condition by reducing oxygen-carrying capacity and requiring further medical interventions (2). Iron Overload: it is can occur in patients receiving frequent blood transfusions, especially those with chronic conditions such as thalassemia or sickle cell anemia. Since each unit of blood contains iron, repeated transfusions may lead to excessive iron accumulation in organs like the liver, heart, and pancreas. This can result in serious long-term complications such as liver disease, diabetes, heart failure, and hormonal imbalances. Iron chelation therapy is often required to manage this condition and prevent further damage (3).

Transfusion-Related Acute Lung Injury (TRALI): TRALI is one of the most severe transfusion-related complications and is a leading cause of transfusion-associated mortality. It usually occurs within 6 hours of a transfusion and presents as acute respiratory distress. The condition is thought to result from donor antibodies reacting with the recipient's leukocytes, leading to lung inflammation and fluid accumulation. Symptoms include sudden onset of dyspnea (difficulty breathing), hypoxia (low oxygen levels), and pulmonary edema (fluid in the lungs). TRALI requires immediate medical intervention, including oxygen therapy or mechanical ventilation in severe cases (4).

In Briefly, Post-transfusion complications like delayed hemolytic reactions, iron overload, and TRALI can significantly impact patient outcomes. Prompt recognition

and appropriate management of these complications are crucial to ensuring patient safety and preventing long-term adverse effects (5).

Midwives and nurses play a critical role in monitoring patients for delayed reactions after blood transfusions, ensuring patient safety beyond the immediate transfusion process. Delayed transfusion reactions can occur hours to weeks after the transfusion and may include complications such as delayed hemolytic reactions, iron overload, and transfusion-transmitted infections (6-7). The following is role of midwives and nurses in monitoring patients for delayed reactions after transfusion:

Midwives and nurses are responsible for educating patients about potential delayed reactions and what symptoms to watch for. They explain the importance of monitoring for signs such as fever, fatigue, jaundice, or dark urine, which could indicate a delayed hemolytic reaction. Educating patients on what to expect and when to seek medical attention empowers them to report issues early, improving the chances of timely intervention (8). After a transfusion, midwives and nurses frequently schedule follow-up appointments to monitor the patient's condition. This includes routine checks of hemoglobin levels, liver function tests, and other relevant lab results to detect delayed hemolytic reactions or iron overload. Nurses ensure that these follow-up tests are done as scheduled and communicate the results to physicians to adjust treatment plans as needed (9).

Midwives and nurses are trained to recognize subtle signs of complications that patients may overlook. For instance, delayed hemolytic reactions may initially present with mild symptoms like lethargy or pale skin, which could be missed without professional vigilance. By being aware of these signs and maintaining open communication with the patient, nurses can catch complications in their early stages (10). In cases of delayed reactions, midwives and nurses coordinate care with physicians and other healthcare providers. They ensure that treatment, such as iron chelation for iron overload or additional transfusions for hemolytic reactions, is administered promptly and effectively (9).

Guillaume et al. emphasize the importance of continuous post-transfusion monitoring (11). Their study reveals that delayed transfusion reactions, including delayed hemolytic reactions, can be missed without diligent post-transfusion care. The research shows that nurses trained to detect subtle symptoms, such as jaundice and fatigue, were more effective in identifying complications early and providing timely intervention. As a result, patient outcomes improved significantly. The study concludes that continuous education on post-transfusion care is critical for detecting delayed reactions and ensuring better patient safety.

Fayed et al. highlight how structured training programs enhance nurses' ability to manage post-transfusion complications, such as TRALI and iron overload. Their study found that nurses who completed specialized training in post-transfusion care were better equipped to monitor vital signs and recognize delayed symptoms (6). This training led to faster response times and reduced incidences of severe transfusion-related complications. The research underscores the importance of education in reducing errors and promoting better long-term care for patients after transfusions. Yassien & Shaheen explore the role of continuous education in improving post-transfusion care (6). Their study indicates that nurses who received regular, updated training were more proficient at identifying delayed transfusion reactions, such as iron overload and hemolytic reactions. The research highlights that ongoing education is essential for maintaining high standards of care, improving the speed and accuracy of interventions, and ensuring patient safety. The authors conclude that training programs should be an integral part of transfusion care protocols.

Mohamed et al. examine the impact of simulation-based training on nurses' ability to manage post-transfusion complications (12). Their study shows that nurses who participated in simulation exercises were more adept at identifying complications like TRALI and managing post-transfusion monitoring effectively. The hands-on nature of the training improved nurses' confidence and competence in handling complex cases. The research concludes that simulation-based training is an

effective method to enhance nurses' skills in post-transfusion care, leading to better patient outcomes and safer transfusion practices. Shah et al. studied the long-term management of iron overload in patients requiring frequent blood transfusions, such as those with thalassemia (13). The authors highlight iron chelation therapy as a key strategy to prevent organ damage caused by excess iron accumulation, a common complication in patients receiving multiple transfusions. The study emphasizes the importance of regular monitoring and personalized treatment to mitigate these risks.

Obeagu et al. (2024) examined the challenges and considerations in managing blood transfusions for individuals with HIV. The study emphasizes the complexities associated with transfusion management in this population, including risks of alloimmunization, iron overload, and infections. The authors highlight the importance of individualized treatment plans, careful monitoring, and the use of advanced screening techniques to mitigate complications. The study stresses the need for ongoing education and training for healthcare providers to ensure safe and effective transfusion practices in HIV-positive patients.

Shah et al. examined strategies for managing iron overload in patients undergoing chronic transfusions. The study highlights the use of individualized chelation therapy based on iron levels and organ function¹³. The authors discuss the prevention of complications such as liver cirrhosis, heart failure, and diabetes, which are common among patients with excessive iron buildup due to multiple transfusions. Obeagu studied the long-term complications of blood transfusions (14). The study covers key complications such as iron overload, alloimmunization, and infection risks. The authors emphasize the role of regular monitoring, chelation therapy, and the use of matched blood transfusions to prevent alloimmunization, improving long-term outcomes for sickle cell patients.

Abdulredha et al. examined the long-term outcomes of transfusion-dependent among patients, focusing on personalized management (15). The study highlights the importance of individualized treatment plans, continuous monitoring, and managing

secondary complications like endocrinopathies and heart failure. The authors stress the need for tailored iron chelation therapy to reduce the long-term effects of chronic transfusions. This study was provide evidence-based recommendations for structured training, highlighting best practices that can be replicated in similar healthcare settings across Palestine. Furthermore, by improving transfusion safety protocols, the study contributes to establishing a standardized framework that promotes safe transfusion practices and reinforces the importance of continuous professional development among midwives and nurses. The study aimed to Effectiveness of training program on the knowledge of midwives and nursing responsibilities post blood transfusion at Nasser medical complex, Palestine. The study addresses a critical gap in structured training for midwives and nurses on post-transfusion care in Palestine, where limited research exists on this subject. Most studies focus on immediate transfusion reactions, overlooking delayed complications like delayed hemolytic reactions, iron overload, and transfusion-transmitted infections. Additionally, there is a lack of role-specific training tailored to midwives and nurses, leading to inconsistent practices. By focusing on these overlooked aspects, the study aims to enhance patient safety and establish standardized care protocols in resource-limited settings.

METHOD

Study design

To achieve the objectives of this study, Randomized Controlled Trial (RCT) design was employed to assess the effectiveness of interventional training in enhancing midwives' and nurses' knowledge regarding the pre-blood transfusion process at Nasser Medical Hospital, Palestine. The study involved implementing an educational intervention followed by a comparison of pre- and post-training results to measure improvements. Data was collected through structured questionnaires distributed to midwives and nurses in relevant departments, including Neonatal Department, Cesarean Section Operations and Labor and Maternity Ward. The study aimed to evaluate changes in knowledges related to blood

transfusion procedures after the intervention, ensuring that the findings reflected the impact of the training program on the participants. Nasser Medical Complex hospitals were used for the study.

Sample, sample size, & sampling technique

Nursing staff who working in neonatal, cesarean section operations and, labor and maternity ward departments of Nasser Medical complex at the time of the study who's total number 118 midwives and nurses and pediatric patients' medical record.

Hospital Name	Nurses Number
Neonatal Department	25
Cesarean Section Operations	18
Labor and Maternity Ward	75
Total	118

In the study titled effectiveness of interventional training in improving midwives and nurses' knowledge regarding blood transfusion process at Nasser Medical Complex, HCPs was utilized. The random sampling method was employed to recruit midwives and nurses working in the neonatal, cesarean section operations, labor, and maternity ward departments of Nasser Medical Complex. The required sample size was determined using Epi Info software, ensuring a 95% confidence level, 50% expected frequency, and a 5% margin of error. The final sample size comprised 45 midwives and nurses involved in interventional training program regarding blood transfusion processes.

The randomization process in this RCT study involved assigning eligible midwives and nurses into intervention and control groups using computer-generated random numbers. Participants were recruited from neonatal, cesarean section, labor, and maternity wards. This ensured unbiased group allocation, maintaining equal probability for each participant, and enhancing the study's validity and reliability.

The sampling process was conducted selecting midwives and nurses who met the eligibility criteria, specifically those actively involved in blood transfusion procedures within the specified departments. Only

healthcare professionals who met the criteria to participate were included in the study.

The study included one main inclusion criterion: midwives and nurses actively employed in the neonatal, cesarean section, labor, and maternity wards of Nasser Medical Complex. However, other factors such as years of experience, educational background, or prior training in blood transfusion procedures, which could influence the results, were not explicitly considered during participant selection. Clarifying these variables is essential, as they may affect baseline knowledge and responsiveness to training, potentially introducing confounding factors that could impact the interpretation of the intervention's effectiveness. Supervisors who were clinical instructors and Employed graduates in long vacation or outside the Gaza Strip during data collection period.

Data collection process

When data collection instruments were created, the researcher received consent from the university to begin the study. The research worker then obtained approval from the Ministry of Health's final board for human resources development to start distributing the questionnaires. In the subsequent research, the worker was gathering the data, then finally analyze it before writing the findings.

To fulfill the study's objectives, the researcher gathered data. Information is gathered utilizing a form sheet to evaluate the level of knowledge about blood transfusion processes by HCPs, The information is gathered using questionnaires and by recommending using structured self-report approaches with the subjects. The knowledge assemblage process was finished by 27. Jul. 2023 to 25. Aug.2023. Each participant takes around 40 minutes to complete their report. The researcher employed training program of blood transfusion processes courses to provide HCPs with the knowledge and abilities necessary to perform good blood transfusion processes during training sessions, which included skill-teaching sessions, lectures on the theoretical components of nursing responsibilities during blood transfusion. The training program consists of imparting theoretical and practical knowledge. Lectures, discussions,

demonstrations, and simulations were all part of the training.

The Study Instrument:

The researcher used Questionnaires that were designed and constructed to measure knowledge regarding blood transfusion among midwives and nurses. To construct the questionnaires, the employ an exploratory study when close-end questions was present to (45) health care providers who select according to study original criteria the questionnaires were constructed and composed: constant of information collection that was utilized to achieve this study. Information collected in 2 stages, in the first stage the questionnaire was dispense to participants and each of them is allowed sufficient time to fill it, all participants give back the Questionnaire.

The principal investigation designs a 12-hour training course, specifically adapt for HCPs. The hospital has a simulation center, and that center was used for the training sessions, which included the skill teaching sessions, lectures on the theoretical aspects of nursing responsibilities during blood transfusion. The learning objective of the course was to provide the HCP with the ability nursing responsibilities during blood transfusion. The training sessions, which comprised skill teaching sessions, lectures on the theoretical components of nursing responsibilities during blood transfusion took place in the hospital's simulation facility. The course's learning goal was to give the HCP the knowledge and skills necessary to good blood transfusion processes. Lectures, discussions, demonstrations, and simulations were all part of the training.

The 2023 World Health Organization (WHO) Guidelines for blood transfusion safety was presented through films and an interactive presentation that encourages audience participation ¹⁶. Through interactive skill training sessions using manikins that last two hours, the practical component of the course was delivered. The training program for the Effectiveness of Interventional Training in Improving Midwives and Nurses' Knowledge Regarding Blood Transfusion Process at Nasser Medical Hospital, Palestine focused on enhancing the knowledge and practical skills of healthcare professionals. Four training sessions

were conducted, covering topics related to blood transfusion procedures, including nursing responsibilities before, during, and after transfusions, as well as complications and the handling and storage of blood components. Participants received handbooks or course materials, and self-directed learning activities were included. All instruction was delivered in person, providing participants with ample opportunities to practice their skills through hands-on activities.

To measure the effectiveness of the training, questionnaires were designed and structured. An exploratory study using closed-ended questions was conducted, consisting of 88 questions selected based on the project's initial criteria. A survey titled "Knowledge Assessment of Blood Transfusion among Midwives and Nurses in Neonatal, Maternity, and Cesarean Sections" was developed. According to the researcher's expertise and hospital guidelines, 2-point Likert scales (true/false) were used in the development of the surveys. The primary outcomes of interest were the improvement in knowledge and skills related to blood transfusion before and after the intervention. A self-administered structured questionnaire from the blood transfusion curriculum was used to evaluate the participants' pre- and post-training knowledge. The questionnaires were constructed and composed:

Part 1: demographic

Composed of eight criteria, such as gender, age in years, marital status, level of education, experience per year, department, and profession.

Part 2: Knowledge

The second part of the study focused on assessing the knowledge of midwives and nurses regarding blood transfusion processes. This included evaluating their understanding of key responsibilities and procedures throughout the blood transfusion process, including pre-transfusion tasks. The knowledge of midwives and nursing responsibilities during blood transfusion at Nasser medical complex (23 questions): This involved preparing the patient, verifying blood product compatibility, and ensuring all necessary equipment was in place

before starting the transfusion. The participants' knowledge was tested on these procedures to ensure they could properly initiate blood transfusions.

Ten specialists from the Islamic University of Gaza (IUG) and MOH, who have a strong track record in medical research and verified the instrument and content validity, was got copies of the questionnaire. The questionnaire was modified in response to the experts' ideas after they have reviewed the instrument and determined whether the items are pertinent and appropriate for the study's goals. The experts' opinions and suggestions taken into consideration when adding the questions.

To determine a questionnaire's accuracy, the Statistical Package for Social Sciences (SPSS) application used Cronbach's Alpha test. Test-retest reliability was employed in research. A small set of participants in the study received questioners, then two weeks later, they received the same test.

The researcher assured the accuracy of study questionnaire during Coefficient of Alpha. Shows values of Coefficient of Alpha to each questionnaire domain of participants also the reliability of domains; values of Cronbach's Alpha were in range from 0.921 which shows a good reliability of the entire questionnaire.

A pilot study was done on a sample of 10 participant of nurses and midwives at the medical Nasser Medical Complex in an effort to test the validity and feasibility of the study tools. According to the results obtained, some questions were restructured and some were deleted to decrease the chance that the study would yield unusable data and give the most accurate results.

Statistical analysis

SPSS was used by the researcher to examine the data. The survey was loaded into and analyzed using SPSS version 25. The knowledge score was calculated by recoding the knowledge questions, assigning one point for correct answers and zero for incorrect answers. The total score was then summed and multiplied by 100, divided by the number of questions. Since there are four parts of Midwives and nurses' knowledge, the total knowledge score was calculated by summing

the scores for each item (maximum mean score 100%). Inferential analysis tests, including independent and dependent t-tests, were used to compare the two groups across the three assessment tests. Repeated measures of Analysis of Variance (ANOVA) were employed to examine the effect of the intervention program, with a significance level set at less than 0.05 and a 95% Confidence Interval (CI).

Results

Table 1 showed the study's demographic data highlights a predominantly female participant group (84.4%), with a significant portion aged between 35 and 40 years (42.2%). Education levels indicate that most hold a Bachelor's degree (77.8%), while 15.6% have higher studies and 6.7% a diploma. The majority are married (84.4%), and experience levels vary, with the largest group having 5-10 years (40.0%) followed by those with less than 5 years (35.6%). Professionally, midwives form the majority (57.8%), while 42.2% are nurses. The Labor and Delivery Ward has the highest representation (46.7%), followed by the Cesarean Section Operations (28.9%) and the Neonatal and Maternity Department (24.4%).

understanding due to the training program. These findings underscore the effectiveness of the training program in enhancing the knowledge and competencies of midwives and nurses in handling post-transfusion complications, demonstrating its value in improving patient safety and care quality at Nasser Medical Complex. The following results showed every item. Q1: Knowledge regarding the risk of iron buildup from frequent transfusions, which can cause organ damage, improved significantly from 84.44 ± 36.65 to 95.56 ± 20.84 (MD = 11.11, P = 0.024), indicating a stronger awareness of transfusion-related complications. Q2: Understanding that platelets are used not only for cancer treatments but also for organ transplants and surgery rose markedly, with scores increasing from 82.22 ± 38.66 to 100 (MD = 17.78, P = 0.004), reflecting a broadened grasp of platelet utilization. Q3: Recognition that tachycardia and hypertension signal an acute hemolytic transfusion reaction saw improvement from 82.22 ± 38.66 to 95.56 ± 20.84 (MD = 13.33, P = 0.013), showing a better grasp of critical transfusion signs. Q4: Understanding of the protocol to keep the vein open with 0.9% normal saline when an acute hemolytic reaction

Table 1. socio-demographic information.

Demographic data		Count	%
Gender	Male	7	15.6%
	Female	38	84.4%
Age in years:	Less than 35	18	40.0%
	35-40	19	42.2%
	More than 40	8	17.8%
Level of Education	Diploma	3	6.7%
	Bachelor	35	77.8%
	Higher studies	7	15.6%
Marital status	Married	38	84.4%
	Unmarried	7	15.6%
Experience per year	Less than 5	16	35.6%
	5-10	18	40.0%
	More than	11	24.4%
Profession	Midwife	26	57.8%
	Nurse	19	42.2%
Department	Neonatal and Maternity Department	11	24.4%
	Cesarean Section Operations	13	28.9%
	Labor and Delivery Ward	21	46.7%

Table 3 showed the total knowledge score for complications related to post-blood transfusion rose significantly from 76.71 ± 13.28 to 96.81 ± 3.13 (MD = 20.10, P < 0.001), indicating a comprehensive improvement in

occurs increased significantly, from 71.11 ± 45.84 to 97.78 ± 14.91 (MD = 26.67, P < 0.001), underscoring the importance of rapid response measures. Q5: Awareness that improper patient

identification is the leading cause of fatal transfusion reactions improved slightly from 88.89±31.78 to 95.56±20.84 (MD = 6.67, P = 0.083), although this increase was not statistically significant. Q6: Knowledge that a drop in blood pressure is a mild allergic transfusion reaction symptom increased from 82.22±38.66 to 97.78±14.91 (MD = 15.56, P = 0.007), indicating enhanced understanding of allergic reaction symptoms. Q7: Awareness that a transfusion reaction can occur if a patient receives too much blood rose from 73.33±44.72 to 97.78±14.91 (MD = 24.44, P < 0.001), reflecting improved knowledge of transfusion volume risks. Q8: Understanding that increased blood pressure and dyspnea are signs of over-transfusion improved significantly, with scores going from 62.22±49.03 to 95.56±20.84 (MD = 33.33, P < 0.001).

Table (2): Effectiveness of training program on the knowledge of midwives and nursing responsibilities Post Blood Transfusion at Nasser medical complex.

Items	Interventional program (n=45)		Statistical test				
	Pre Mean±SD	Post Mean±SD	t	P-value	MD	95%CI	
						Lower	Upper
Q1. Frequent blood transfusions lead to a build-up of iron in the body, causing organ damage and other complications	84.44±36.65	95.56±20.84	2.345	0.024 *	11.11	1.56	20.66
Q2. Platelets only used for cancer treatments, and not for organ transplants or surgery	82.22±38.66	100=0	3.084	0.004*	17.78	6.16	29.39
Q3. Tachycardia and hypertension are signs indicate that the patient is developing an acute hemolytic transfusion reaction	82.22±38.66	95.56±20.84	2.602	0.013*	13.33	3.01	23.66
Q4. When signs and symptoms of acute hemolytic transfusion reaction are seen, the midwives and nurses should keep vein open with 09% normal saline	71.11±45.84	97.78±14.91	4.000	<0.001 *	26.67	13.23	40.10
Q5. The commonest cause of fatal transfusion reactions is improper identification of the patient	88.89±31.78	95.56±20.84	1.773	0.083	6.67	-0.91	14.25
Q6. A patient has a mild allergic transfusion reaction, the usual present complain is a drop in blood pressure	82.22±38.66	97.78±14.91	2.847	0.007*	15.56	4.54	26.57
Q7. A transfusion reaction can occur if a patient received too much blood	73.33±44.72	97.78±14.91	3.773	<0.001*	24.44	11.39	37.50
Q8. Increase of blood pressure and dyspnea are signs indicate that the patient is developing over blood transfusion	62.22±49.03	95.56±20.84	4.690	<0.001*	33.33	19.01	47.66
Q9. Hemolytic reactions occur when the patient's immune system attacks and destroys transfused white blood cells	71.11±45.84	97.78±14.91	4.000	<0.001 *	26.67	13.23	40.10
Q10. allergic reactions to transfused blood products are always mild and not life-threatening	82.22±38.66	97.78±14.91	2.847	0.007 *	15.56	4.54	26.57
Q11. ABO incompatibility be prevented	80=40.45	97.78±14.91	3.084	0.004 *	17.78	6.16	29.39
Q12. ABO incompatibility is not a common occurrence in blood transfusions, but it is a serious and potentially life-threatening complication when it does occur	91.11±28.78	97.78±14.91	1.773	0.083	6.67	-0.91	14.25
Q13. Symptom of a transfusion reaction range from mild to life-threatening	91.11±28.78	95.56±20.84	1.431	0.160	4.44	-1.82	10.71
Q14. a transfusion reaction occurs when the recipient's immune system attacks the transfused blood cells	84.44±36.65	97.78±14.91	2.602	0.013*	13.33	3.01	23.66
Q15. the symptoms of a transfusion reaction are limited to fever, chills, nausea, and difficulty breathing	84.44±36.65	95.56±20.84	2.345	0.024*	11.11	1.56	20.66
Q16. TACO occurs when the recipient's immune system attacks the transfused blood cells	60=49.54	93.33±25.23	4.690	<0.001*	33.33	19.01	47.66
Q17. TACO can happen if too much blood is transfused too quickly	62.22±49.03	95.56±20.84	4.690	<0.001 *	33.33	19.01	47.66
Q18. Respiratory distress is a symptom of TACO	57.78=49.95	95.56±20.84	5.169	<0.001 *	37.78	23.05	52.51
Q19. TACO is a common complication of blood transfusion	55.56=50.25	95.56±20.84	5.416	<0.001 *	40.00	25.12	54.88

Q20. TRALI is a reaction that affects the liver	53.33±50.45	95.56±20.84
Q21. A transfusion reaction is suspected, healthcare providers should continue the transfusion	93.33±25.23	100=0
Q22. Medications such as antihistamines or corticosteroids may be administered to manage transfusion reaction symptoms	80=40.45	95.56±20.84
Q23. Providing respiratory support, such as oxygen therapy or mechanical ventilation, is not necessary for managing transfusion reactions	91.11±28.78	100=0
Total score	76.71±13.28	96.81±3.13

Also, Q9: Knowledge of hemolytic reactions, where the immune system attacks transfused white blood cells, increased from 71.11±45.84 to 97.78±14.91 (MD = 26.67, P < 0.001), highlighting improved comprehension of immune complications. Q10: Understanding that allergic reactions to transfused blood products can be life-threatening, contrary to the belief that they are always mild, rose from 82.22±38.66 to 97.78±14.91 (MD = 15.56, P =

prevented improved significantly, with scores rising from 80 ± 40.45 to 97.78 ± 14.91 (MD = 17.78, P = 0.004). Q12: Awareness of ABO incompatibility as a serious but rare complication in transfusions showed a slight increase from 91.11 ± 28.78 to 97.78 ± 14.91 (MD = 6.67, P = 0.083), although not statistically significant. Q13: Understanding that transfusion reaction symptoms range from mild to life-threatening showed a non-significant improvement from 91.11 ± 28.78 to 95.56 ± 20.84 (MD = 4.44, P = 0.160). Q14: Knowledge that a transfusion reaction occurs when the immune system attacks transfused blood cells rose from 84.44 ± 36.65 to 97.78 ± 14.91 (MD = 13.33, P = 0.013), indicating greater awareness of immunological responses. Q15: Understanding of transfusion reaction symptoms, including fever, chills, nausea, and difficulty breathing, increased from 84.44 ± 36.65 to 95.56 ± 20.84 (MD = 11.11, P = 0.024).

The results showed that Q16: Awareness of Transfusion-Associated Circulatory Overload (TACO) as an immune reaction improved from 60 ± 49.54 to 93.33 ± 25.23 (MD = 33.33, P < 0.001). Q17: Knowledge that TACO can occur if too much blood is transfused quickly rose significantly from 62.22 ± 49.03 to 95.56 ± 20.84 (MD = 33.33, P < 0.001). Q18: Awareness that respiratory distress is a symptom of TACO increased from 57.78 ± 49.95 to 95.56 ± 20.84 (MD = 37.78, P < 0.001). Q19: Understanding that TACO is a common transfusion complication saw a significant rise from 55.56 ± 50.25 to 95.56 ± 20.84 (MD = 40.00, P < 0.001). Q20: Knowledge that TRALI (Transfusion-Related Acute Lung Injury) does not affect the liver improved from 53.33 ± 50.45 to 95.56 ± 20.84 (MD = 42.22, P < 0.001). Q21: Awareness that transfusions should be stopped if a reaction is suspected improved slightly from

93.33 ± 25.23 to 100 (MD = 6.67, P = 0.083), though not statistically significant. Q22: Understanding that medications such as antihistamines or corticosteroids may be used to manage transfusion reactions improved from 80 ± 40.45 to 95.56 ± 20.84 (MD = 15.56, P = 0.007). Q23: Awareness that respiratory support might be necessary in managing transfusion reactions increased from 91.11 ± 28.78 to 100 (MD = 8.89, P = 0.044).

Table 3 highlights the significant impact of the training program on transfusion-related knowledge across various demographic groups at Nasser Medical Complex. The total score increased substantially from a pre-training mean of 76.71 to a post-training mean of 96.81, with an effect size of 1.53, demonstrating the program's overall effectiveness. In terms of gender, both males and females showed improvement. Males achieved a mean difference (MD) of 14.29 with an effect size of 1.66, while females had a higher mean difference of 21.17 but a slightly lower effect size of 1.55, indicating strong effectiveness across genders. The age group analysis reveals significant improvements for all ages, with participants over 40 achieving the highest effect size (2.27) and a mean difference of 15.76, demonstrating the program's efficacy across age groups.

For education levels, diploma holders displayed the highest mean difference (28.99) and an effect size of 1.63, while participants with higher studies achieved an effect size of 3.00, suggesting that education level influences knowledge gains, with more educated participants showing greater retention. Marital status analysis shows significant gains for both married and unmarried participants, with unmarried participants achieving a mean difference of 14.29 and a higher effect size of 1.83 compared to married participants. Regarding experience, those with 5-10 years of experience displayed a high effect size of 2.37 and a mean difference of 16.91 highlighting experience level as a factor in knowledge retention. Among professionals, midwives had a mean difference of 22.24 with an effect size of 1.43, while nurses had a slightly lower mean difference (17.16) but a higher effect size (2.02), underscoring effectiveness across professions. Lastly, departmental analysis shows that the

Cesarean Section Operations department achieved the highest mean difference of 26.42, while the Neonatal and Maternity Department had the highest effect size of 3.28, suggesting varying program impacts by department.

Overall, significant P-values (mostly <0.001) confirm the program's broad effectiveness across diverse groups and demographics, enhancing transfusion knowledge substantially.

Discussion

The results concerning the effectiveness of the interventional training program aimed at improving the knowledge of midwives and nurses regarding the knowledge of midwives and nursing responsibilities during blood transfusion at Nasser medical complex procedures at Nasser Medical Complex, Palestine.

The results revealed that the majority of participants were either under 35 years old (40.0%) or between 35 and 40 years old (42.2%), while only a small proportion (17.8%) were over 40 years old. This indicates that the study population mainly consists of younger to mid-career professionals. The findings align with

those of Albelbeisi et al (17) and Gigli et al. who also noted that younger professionals dominated the midwives and nurse's workforce (19).

The researcher observes that this age distribution reflects a relatively young workforce, with a large segment being under 40 years old. This suggests an opportunity for continued professional development and training in critical areas like pre-blood transfusion procedures. Furthermore, the concentration of participants in the younger age groups highlights the potential for long-term contributions to the healthcare system, but also emphasizes the importance of sustained support and education to ensure the retention of skilled midwives and nurses over time.

Table 3: Mean difference in the effectiveness of training program according to education

	n	Interventional program (n=45)		Statistical test			
		Pre Mean ± SD	Post Mean ± SD	t	P-value	MD	Effect size
Gender							
Male	7	81.99±9.2	96.27±3.91	4.399	0.005*	14.29	1.66
Female	38	75.74±13.77	96.91±3.02	9.564	<0.001*	21.17	1.55
t		1.511	-0.491				
P-value		0.157	0.626				
Age in years:							
Less than 35	18	77.78±13.66	97.1±2.98	5.788	<0.001*	19.32	1.36
35-40	19	73.68±14.74	96.34±3.32	7.006	<0.001*	22.65	1.61
More than 40	8	81.52±6.47	97.28±3.23	6.416	<0.001*	15.76	2.27
F		1.081	0.374				
P-value		0.349	0.690				
Level of Education							
Diploma	3	71.01±17.61	100±0.00	2.818	0.011*	28.99	1.63
Bachelor	35	75.78±12.71	96.52±3.13	9.764	<0.001*	20.75	1.65
Higher studies	7	83.85±6.5	96.89±3.29	7.937	<0.001*	13.04	3.00
F		1.400	1.769				
P-value		0.258	0.183				
Marital status							
Married	38	75.63±13.92	96.8±3.15	9.512	<0.001*	21.17	1.54
Unmarried	7	82.61±7.1	96.89±3.29	4.831	0.003*	14.29	1.83
t		-1.990	-0.075				
P-value		0.064	0.940				
Experience per year							
Less than 5	16	74.46±16.49	97.28±2.69	5.599	<0.001*	22.83	1.40
5-10	18	78.26±8.3	95.17±3.3	10.054	<0.001*	16.91	2.37
More than	11	77.47±15.41	98.81±2.03	4.535	<0.001*	21.34	1.37
F		0.360	2.036				
P-value		0.699	0.105				
Profession							
Midwife	26	74.41±15.72	96.66±3.32	7.306	<0.001*	22.24	1.43
Nurse	19	79.86±8.35	97.03±2.92	8.791	<0.001*	17.16	2.02
t		-1.501	-0.388				
P-value		0.141	0.700				
Department							
Neonatal and Maternity Department	11	82.61±5.5	97.23±2.93	10.864	<0.001*	14.62	3.28
Cesarean Section Operations	13	69.9±17.79	96.32±2.99	5.039	<0.001*	26.42	1.40
Labor and Delivery Ward	21	77.85±11.5	96.89±3.41	8.232	<0.001*	19.05	1.80
F		3.154	0.258				
P-value		0.053	0.774				

the study. A significant majority, 84.4%, of the participants are married, while a smaller portion, 15.6%, are unmarried. This demographic characteristic suggests that most of the participants may have additional personal responsibilities, which could potentially influence their work-life balance and availability for further training or professional development in areas such as pre-blood transfusion procedures.

These findings are consistent with the study conducted by Malhotra et al., who noted that married healthcare professionals often experience greater work-life balance challenges, which can affect their participation in continuous education programs (19). Similarly, the research by Zou et al. found that married midwives and nurses tend to have less time for professional development compared to their unmarried counterparts (22). Understanding the marital status of participants provides insight into potential factors that may impact their engagement in continuous education or professional growth initiatives, highlighting the need for flexible training schedules that accommodate personal obligations.

The results provide the largest proportion, 77.8%, holds a Bachelor's degree, followed by 15.6% with Higher Studies, and the smallest group, 6.7%, has a Diploma. This distribution suggests that the majority of participants have attained higher education, primarily at the bachelor's level, which aligns with the findings of McKenna et al, who observed that a significant portion of the midwives and nurse's workforce holds a bachelor's degree (21). Similarly, the study by Albelbeisi et al. indicated that higher educational attainment, particularly among midwives and nurses, is correlated with improved clinical competencies and readiness for specialized procedures like pre-blood

transfusions (18). The relatively smaller percentage of participants with a Diploma underscores the ongoing trend of midwives and nurses' professionals pursuing higher degrees, which may enhance their ability to engage in advanced clinical practices.

The study population is predominantly female (84.4%), while males make up 15.6%. This reflects the global trend in midwives and nurses and midwifery, where females constitute the majority of the workforce due to the traditionally gendered nature of these professions. According to Fadhil and Bakey, the nursing profession continues to be female-dominated worldwide, particularly in maternal and neonatal care (23). This gender disparity can influence workforce dynamics, including communication styles and care approaches.

The largest proportion of participants have 5-10 years of experience (40.0%), while only 24.4% have more than 10 years of experience. This suggests a relatively experienced workforce in its mid-career stage. Previous studies, such as Albelbeisi et al., have highlighted that nurses with 5-10 years of experience tend to demonstrate better procedural knowledge, as this is often the period during which they refine their practical skills (17).

In terms of department distribution, 46.7% of participants work in the Labor and Maternity Ward, while 24.4% are assigned to the Neonatal Department. This distribution is consistent with the healthcare facility's focus on maternal and neonatal services. A study by Gigli et al. emphasizes that nurses in maternity wards often require specialized skills and training in pre-blood transfusion due to the higher likelihood of transfusion-related procedures in these settings (19).

One of the significant findings of this study was the notable improvement in the knowledge domain concerning the complications related to post-blood transfusion among midwives and nursing staff. The current results showed that the overall knowledge score increased substantially from 76.71 ± 13.28 pre-intervention to 96.81 ± 3.13 post-intervention. This improvement, supported by a highly significant t-value of 10.251 and a P-value < 0.001 , underscores the effectiveness of

the training program in enhancing nurses' understanding of post-transfusion complications. The mean difference (MD) of 20.10, with a 95% confidence interval (CI) ranging from 16.15 to 24.05, highlights the training's success in elevating nurses' competencies in this critical area.

These findings are consistent with previous research. For instance, Abdelgadir et al. observed similar improvements in nursing knowledge after targeted training programs focused on critical care practices, including post-transfusion complications²⁴. Their study demonstrated that structured educational interventions could lead to significant enhancements in nurses' ability to manage complications arising from blood transfusions. However, Guillaume et al. found that continuous education programs for healthcare providers significantly improved compliance with protocols related to post-transfusion care, aligning with the outcomes observed in this study (11).

The study's findings also echo the work of William et al., who reported that nurses who underwent specific training on post-transfusion responsibilities demonstrated higher competency levels than those without such training (25). William emphasized the importance of practical (25). The current study hands-on training, which was a vital component of the training program at Nasser Medical Complex. The practical aspects of the training were crucial in enhancing the midwives' and nursing staff's ability to identify and manage post-transfusion complications effectively.

When comparing these findings to previous studies, it is evident that the improvements observed in this study align with a broader trend of training interventions leading to better clinical outcomes. For example, Abdulredha Abbass et al. found that nurses who participated in a targeted post blood transfusion training program showed a marked improvement in their ability to identify and address complications related to blood transfusions, reducing the incidence of post-transfusion adverse events¹⁵. This parallels the current study's findings, where the knowledge scores of midwives and nursing staff improved

significantly following the training, thus contributing to enhanced patient safety.

Moreover, Fayed et al. demonstrated that structured training programs that combined theoretical knowledge with practical components led to sustained improvements in nursing competencies over time. The current study's emphasis on practical applications in the training aligns with Fayed et al findings, suggesting that combining theory with practice is crucial for long-term knowledge retention and competency development in managing post-transfusion complications (6).

By enhancing the knowledge of midwives and nursing staff on complications related to post-blood transfusion, the training program not only improves patient safety but also contributes to the overall quality of care in the healthcare system. Yassien & Shaheen emphasized the critical role of knowledgeable nursing staff in ensuring the safe and effective management of complex medical procedures such as blood transfusions (7). The significant improvements in knowledge observed in this study suggest that similar training programs could be implemented in other healthcare settings to improve clinical outcomes and reduce the risk of transfusion-related complications.

Additionally, the findings indicate that ongoing professional development is essential to maintain high standards of care in nursing practice. As noted by Brown & Brown, continuous education is critical in fields where protocols and best practices evolve rapidly, such as transfusion medicine (26). The success of the training program in this study underscores the value of regular, structured educational interventions in ensuring that midwives and nursing staff are equipped with the latest knowledge and skills to manage post-transfusion complications effectively.

The current study showed that the significant improvement in knowledge scores related to post-transfusion complications among midwives and nursing staff demonstrates the effectiveness of the training program. The results are consistent with previous research, supporting the idea that structured educational interventions are essential for improving nursing competencies and ensuring patient safety. The study's focus

on both theoretical and practical components of training highlights the importance of a comprehensive approach to professional development in nursing. By investing in ongoing training programs, healthcare institutions can enhance the skills of their staff, improve clinical outcomes, and ensure the safe management of blood transfusion complications.

Also, the training program's effectiveness in improving the knowledge of midwives and nursing staff regarding post blood transfusion procedures and complications is evident from the results. The improvements align with previous research, demonstrating that structured training interventions, particularly those that combine theoretical knowledge with practical application, are essential for enhancing nursing competencies and ensuring patient safety. The study's findings suggest that similar training programs could be applied in other healthcare settings to improve clinical outcomes and ensure safe blood transfusion practices.

The study results confirm the effectiveness of the training program across diverse demographic groups, showing substantial improvements in knowledge for midwives and nurses at Nasser Medical Complex. Consistent with existing literature, the program yielded statistically significant post-intervention gains across gender, age, education level, marital status, years of experience, profession, and department, reflecting the training's inclusive and standardized structure. Both male and female participants exhibited significant knowledge increases with no meaningful differences between genders, supporting prior studies indicating that gender does not influence training outcomes when content is standardized.

Similarly, all age groups showed notable improvements, aligning with findings by Malhotra et al. that age is not a limiting factor in training effectiveness¹⁹. Educational level also showed consistent gains, with participants across Diploma, Bachelor, and higher education groups experiencing statistically significant increases in knowledge. The largest effect size was observed among those with Bachelor's degrees, but the overall lack of significant

differences suggests that the training effectively benefited all educational levels. Additionally, both married and unmarried participants showed substantial improvements, reinforcing the program's broad applicability.

Years of experience demonstrated a similar trend, with all experience levels showing significant improvement, particularly those with 5-10 years, who recorded the largest effect sizes. This consistency supports Yassien and Shaheen's findings that well-structured training programs benefit all experience levels equally (7). Professionally, both midwives and nurses gained from the program, with midwives showing a slightly larger effect size. Departmentally, all groups Neonatal, Cesarean Section, and Labor and Delivery displayed considerable knowledge gains, especially in the Labor and Delivery Ward.

Limitations of the study

During the course of this investigation, the researcher encountered many obstacles, some of which included volunteers who refused to meet certain requirements for inclusion in the study. In addition, the researcher received no outside financial help. Lack of resources in terms of care standards of quality, and power outages.

Conclusion

In conclusion, this study highlights the significant impact of a structured training program on enhancing the knowledge of midwives and nurses regarding blood transfusion processes at Nasser Medical Complex, with key implications for clinical practice. The program demonstrated a substantial improvement in understanding transfusion-related complications, such as delayed hemolytic reactions, iron overload, and transfusion-related acute lung injury (TRALI). These findings emphasize the critical role of continuous education in improving patient safety, as better-informed healthcare providers are more likely to adhere to standardized protocols, reducing errors and improving patient outcomes. The study also underscores the value of role-specific training tailored to the unique responsibilities of midwives and nurses in neonatal, maternity, and cesarean section settings, ensuring that clinical staff are

equipped to manage complications specific to their departments. Importantly, the training program's comprehensive approach, combining theoretical lectures with practical simulations, proved effective in promoting knowledge retention and skill development. The study's findings suggest that similar training programs can be scaled and replicated in other healthcare facilities, particularly in resource-limited settings, to improve transfusion practices and care quality. However, the study faced several limitations, including a small sample size and its single-center design, which may restrict the generalizability of results. Additionally, while the training's immediate effects were measured, its long-term impact on knowledge retention and clinical practice was not assessed, leaving room for future research. The study also did not fully explore variables such as participants' prior experience and baseline competencies, which could influence knowledge gains. Despite these limitations, the research provides valuable insights into the importance of structured training programs in bridging knowledge gaps and establishing standardized transfusion protocols. By addressing these gaps in future studies, healthcare institutions can further enhance the safety and efficacy of blood transfusion practices, ultimately improving patient outcomes.

Author Contribution Statement

Abu Hadaf and Jabr Al-Dar contributed equally to all stages of this research, from initial conceptualization to final manuscript approval. Together, they developed the study's design and framework, with Taghreed M. Abu Hadaf leading data collection efforts and Mohammed Jabr Al-Dar conducting the primary analysis. Both authors collaborated closely on data interpretation, ensuring that insights drawn were comprehensive and accurate. The manuscript drafting was a joint effort, allowing each author to provide critical input, which was further refined through their combined review and editing processes. Supervision of the research progression was maintained by Jabr Al-Dar, who oversaw consistency and methodological rigor. Both authors reviewed and approved the final version, affirming their

commitment to accountability for the study's content and findings.

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Ethical Approval

In conducting this study, necessary permissions were secured from Al-Butana University, and approvals were obtained from the Helsinki Committee (clinical trial registry : Helsinki Committee, trial registration number: PHRC/HC/1210/22, and data of registration: 5.12.2022) and Ministry of Health through official letters and verbal consent. All participants were fully informed of the study's aim, objectives, and potential benefits, and their consent to participate was acquired. Each participant was provided with a comprehensive explanatory form attached to the questionnaire, which outlined the purpose of the study and assured the confidentiality of their personal information. Additionally, a clear statement was included indicating that participation was voluntary, and the anonymity of all individuals who participated in the research was ensured to protect their privacy.

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Conflicts of Interest

The authors report no conflicts of interest in connection with this research, its authorship, or the publication of this article.

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