Journal of Research in Clinical Medicine

J Res Clin Med, 2021, 9: 37
doi: 10.34172/jrcm.2021.037
https://jrcm.tbzmed.ac.ir

TUOMS PRESS

Original Article

Newborn's body temperature regulation: a multi-method training program

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Article info

Article History:
Received: 20 Sep. 2020
Revised: 17 Jan. 2021
Accepted: 10 Feb. 2020
e-Published: 8 Dec. 2021

Keywords:
- Nurse
- Education
- Workshop
- Newborn
- Web-based training
- In-service training

Abstract

Introduction: Newborns' incapability to self-regulate their body temperature exposes them to risk of many complications. Therefore, proper initiations of nursing interventions are crucial for ensuring early stabilization after birth. The present study aimed to evaluate the impact of a multi-method training program on knowledge and practices in neonatal nurses.

Methods: This quasi-experimental research was carried out with a pre-test–post-test and intervention-control groups design. The population consisted of 60 nurses working in the neonatal and neonatal intensive care unit (NICU) of two hospitals in Iran. The samples were selected using the convenience sampling technique. A researcher-made questionnaire was used. The validation and reliability of the questionnaire were confirmed. The nurses received a multi-method training for two weeks. They were evaluated three months later.

Results: The mean knowledge score obtained in the pre-test was 30.33 ± 2.01, and it was 47.73 ± 6.82 three months after the intervention. There was a statistically significant difference in the trend of changes in the scores of the two groups (F = 125.72, $P < 0.001$). The mean performance score in intervention group before the intervention was 60.63 ± 5.69 and after the intervention was 81.77 ± 6.37, indicating a significant difference in the trend of changes (F = 90.285, $P < 0.001$).

The correlation between knowledge and practice was significant at the 0.01 level (r = 0.544, $P = 0.002$). The previous in-service training, individuals' education, and thermoregulation knowledge were determined as predictors of performance (r = 0.651, $P = 0.013$).

Conclusion: According to the results, a multi-method training program improves the nurses' knowledge and performance in the infants' body temperature regulation care.

Introduction

The transition from the fetus to newborn is the most composite adaptation that occurs in human experience. One of the dominant adjustments is the need to rapidly increase body temperature, and struggle to accommodate an environment colder than that of the prenatal milieu. The body temperature of a fetus is 0.9°F (0.5°C) above the maternal temperature, but within a few minutes after birth, the neonatal core temperature begins to decrease.[1,2] Keeping newborns warm, especially preterm infants, can be challenging because preterm infants have an inefficient body temperature regulation.[1,3] Although infants have an early reaction to low ambient temperatures, this reaction is particularly limited in premature infants. It puts them at risk for severe hypothermia and its complications.[4] Neonatal hypothermia is common in preterm infants, which is associated with an assemblage of morbidities, including hypoglycemia, metabolic acidemia, intraventricular hemorrhage, respiratory distress, and the need for intubation as well as increased mortality.[5-7] According to the World Health Organization (WHO), neonatal mortality rate related to hypothermia is 18% to 42%.[8] Thermoregulation is influenced by many factors. One of the most important issues in this regard is the environmental condition. Health care providers and specialists play an essential role in maintaining the body temperature of the newborn baby by controlling the environmental conditions.[9] Scientists have found that keeping the ambient temperature constant for sick and premature infants is one of the key duties of the nurses in the neonatal intensive care unit (NICU).[10] To provide excellent care to infants, health care workers must have

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good knowledge, skills, and attitudes toward neonatal thermoregulation. Good knowledge and skills help maintain accurate body stability, which helps prevent further complications in an infant after birth.[8] The WHO has stated that since 1933 the infants have been exposed to hypothermia owing to lack of knowledge and equipment.[11] Changes in neonatal body temperature in developing countries require more attention due to high prevalence and complications, as well as lack of facilities in addition to lack of knowledge.[11,12] Evidence have demonstrated that the degree of empowerment of individuals in organizations is directly related to the number of the training provided in the organization.[13,14] The importance of thermoregulation in clinical care has been appreciated by health care researchers. Nursing knowledge and practice are crucial. The present study aimed to assess a multi-method education to develop the nurses' knowledge and practice in neonatal thermoregulation care.

Methods

This quasi-experimental study was performed with a control group and pre-test/post-test design. The study population consisted of all nurses working in the neonatal ward and NICU in two hospitals, each of which was university-affiliated. The sampling method was a census of all nurses working in NICU at three various levels, who were willing to participate in the study. Then the selected samples were randomly assigned to either the control or intervention groups. The inclusion criteria were having a minimum of six-month work experience in the neonatal ward or NICU. Nurses who did not attend the site less than six hours during the training period and who did not participate in the workshop were excluded from the research. In this study, according to the previous studies, the common variance was calculated as 1.5. According to $\alpha = 0.05$ and test power of 0.80 at a significant level of 0.95, the sample size was calculated to be 27 and owing to the sample loss, 30 people were assigned to each group.

$$n = 2\left[\frac{(z_\alpha + z_\beta)\sigma}{\mu_2 - \mu_1}\right]^2 = 2\times\left[\frac{(1.96+0.84)\times 1.5}{18.6-17.3}\right]^2 = 27 = 30$$

The collecting data tool used in this research was a questionnaire consisting of three parts. The first part included demographic characteristics (gender, age, educational degree, shift work, temperature balance training, employment status, and work experience) and the second part contained 20 items including four items on the concept of temperature equilibrium (thermoregulation), five items on temperature balance mechanisms, four items were related to the symptoms of hypothermia, four items on physiological equilibrium temperature, and finally three items assessed the effects and adverse of hypo/hyperthermia. Furthermore, a 30-item nursing practice checklist was applied including eight items on the correct assessment of infant body temperature, ten items on preventing infant body temperature balance, five items on specific premature infants and seven items on considerations for the neonates who were particularly sick. For preparing the performance checklist questions, the study of Najafi Pour et al was used in the nursing performance audit research in hypothermic neonatal care.[15]

Reliability and validity of the questionnaire

To determine the reliability of the knowledge questionnaire, it was given to 20 nurses with a bachelor's degree, who worked in a NICU in Tehran. They evaluated it in a re-test by a two-week interval. The data obtained before and after the intervention were analyzed by paired t-test ($P < 0.05$). Furthermore, Cronbach's alpha was calculated as 0.926.

Reliability of the performance part, which was measured based on a three-option Likert scale with responses of "done right", "not done", and "not be done" in the nurse's activities on maintaining the infant's body temperature balanced observed by the researcher. To evaluate the reliability of the observational performance checklist concurrently with the researcher, a nurse colleague with a master's degree in NICU observed the performance of ten nurses working with the neonate to adjust the body temperature and completed the checklist. The correlation coefficient of the observations was measured simultaneously, which confirmed the correlation coefficient above 0.7. Furthermore, the kappa coefficients of two completed checklists were calculated and there was no significant difference between the two checklists ($P > 0.05$). To assess the face and content validity of the tools of this study, the questionnaire was submitted to five faculty members of Tehran University of Medical Sciences, including neonatal nursing professors and pediatricians. Furthermore, the opinions of 10 NICU staff with a master's degree were asked and their corrective suggestion was carried out by consulting the research team. These nurses who piloted the study were not included in the final sample of the study (Figure 1).

Intervention

Nurses in the neonatal ward and NICU department of the two hospitals were randomly divided into intervention and control groups after signing the informed consent forms. The knowledge questionnaire was completed by the nurses and the performance checklist by the observer. Then, two weeks later the subjects in the intervention group received a research training program including a one-day workshop on high-risk infant care training, temperature-balance physiology, how to work with a warmer, incubator, hot and humid oxygen delivery methods, and how premature infants are exposed to disturbed temperature equilibrium. The website was furthermore introduced to nurses at www.inicna.com, where the nurses under study entered the site with their username and password, and could access training on proper bathing and timely feeding. Breastfeeding tips for infants and ways to prevent

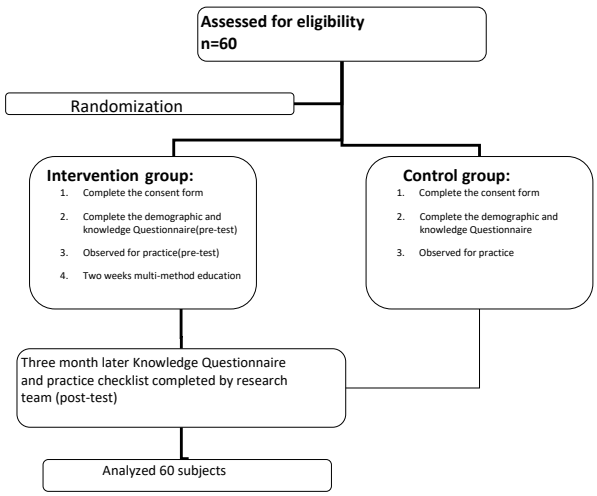

Figure 1. Study flow chart

hypothermia were provided through PowerPoint software and portable document format (PDF) and teaching videos. As well, the important pedagogic materials were provided in the workshop and the educational website was studied through a compact disc at the end of the workshop. This multi-method education lasted for two weeks. After three months, nurses' knowledge and practice of temperature equilibrium were measured again by nurses Knowledge and Practice Questionnaire, and the data were analyzed at 95% significance level in the two groups by SPSS version 16.

Results

A total of 60 nurses participated in two groups, i.e. intervention and control. There was no difference in demographic variables such as age, educational qualification, employment status, and shift work in two groups. The greater part of the participants in the control (96.7%) and intervention (70.0%) groups did not receive any training in thermoregulation. There was a statistically significant difference between the two groups regarding thermoregulation using Fisher exact test ($P=0.0027$). Forty percent of the subjects in the control group and 76.7% of the subjects in the intervention group were in the NICU. In the control group, 13.3% of the subjects and 43.3% of the subjects in the intervention group had passed the training course on prevention of neonatal hypothermia. Relevant differences were observed between the two groups ($P=0.004$). The majority of the participants in the two groups had work experience of 2-10 years; 60.0% of the subjects in the control group 70.0% of the subjects in the intervention group. Chi-square test showed no significant difference between the two groups ($P=0.383$).

The mean score of overall thermoregulation knowledge in the two groups was 31.1 ± 2.59 for the control group and 30.33 ± 2.01 for the intervention group before performing the intervention, using independent t-test that showed no significant difference ($P=0.205$). However, after the intervention, there was a significant difference ($P<0.000$) between the intervention and control groups (32.07 ± 2.92 vs. 47.73 ± 6.82). The analysis of variance showed a statistically significant difference in the trend of changes in the scores of the two groups, indicating the effectiveness of the intervention on the intervention group ($F=125.72$, $P=0.000$). Post hoc analysis showed the difference between the two groups (Figure 2).

Dissimilar results were found in thermoregulation knowledge area. There was no significant difference between the two groups before and three months after the intervention in the concept of thermoregulation ($F=.923$, $P=0.432$). Moreover, no difference was observed in symptoms of hypo/hyperthermia area ($F=1.651$, $P=0.182$), There could be found a significant difference between the two groups before and three months after the intervention in the adverse effect of hypo/hyperthermia ($F=24.06$, $P=0.000$), physiology of thermoregulation ($F=25.582$, $P=0.000$), and temperature balance disturbance mechanisms ($F=44.917$, $P=0.000$). Post-hoc analysis showed the higher-level of thermoregulation knowledge in three areas of the intervention group three months after the intervention (Table 1).

There was no significant difference in the mean performance of the control group (59.17 ± 5.17) and intervention group (60.63 ± 5.69) before the intervention ($t=-0.111$, $P=0.912$). The mean performance of the two groups three months after the intervention was 60.57 ± 5.53 for the control group and 81.77 ± 6.37 for the intervention group, indicating a significant difference. However, there was a significant difference between the two groups three months after the intervention ($t=13.755$, $P=0.000$). Analysis of variance showed a statistically significant difference in the trend of changes in the scores of the two groups ($F=90.285$, $P=0.000$). The post-hoc revealed the effectiveness of the intervention.

Various areas of thermoregulation performance revealed different results. There was no significant difference between the two groups in preventing infant's body temperature disturbance before and three months after the intervention ($F=0.509$, $P=0.981$). Moreover, no

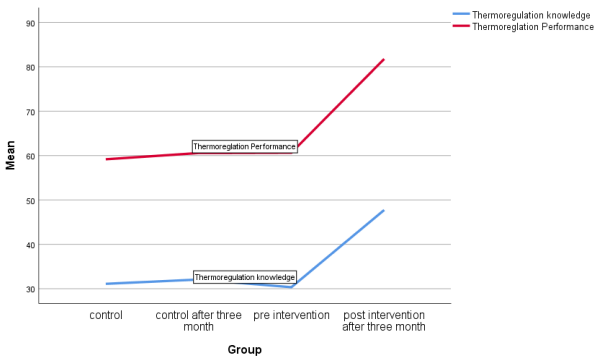

Figure 2. The nurse's thermoregulation knowledge and performance mean's graph

Table 1. Comparison of nursing thermoregulation knowledge's scopes

		Control	Intervention	
		Mean (SD)	Mean (SD)	
Mechanisms of tem*P*erature disru*P*tion	Before	7.37 (1.57)	7.62 (1.02)	t=-0.194, *P*=0.84
	After 3 month	7.57 (1.35)	12.73 (3.44)	t=-7.64, *P*=0.000
		t=-0.439, *P*=0.662	t=-7.72, *P*=0.000	F=44.917, *P*=0.000
Sym*P*toms of hy*P*o/hy*P*erthermia	Before	5.47 (1.04)	5.13 (0.86)	t=1.327, *P*=0.19
	After 3 month	5.47 (1.07)	5.67 (0.71)	t=-0.85, *P*=0. 0.399
		t=0.000, *P*=1.000	t=-2.617, *P*=0.000	F=1.65, *P*=0.18
Physiology of thermoregulation	Before	7.7 (1.76)	6.77 (1.6)	t=-2.13, *P*=0.037
	After 3 month	7.63 (2.17)	11.4 (3.08)	t=-5.472, *P*=0.000
		t=-0.000, *P*=1.000	t=-7.279, *P*=0.000	F=25.582, *P*=.000
Adverse effect of hy*P*o/hy*P*erthermia	Before	6.93 (1.21)	7.53 (1.22)	t=-2.012, *P*=0.04
	After 3 month	7.13 (2.17)	10 (2.361)	t=-5.842, *P*=0.148
		t=-0.13, *P*=0.897	t=-5.076, *P*=0.000	F=24.06, *P*=0.000
Conce*P*ts of thermoregulation	Before	5.93 (0.94)	5.67 (0.88)	t=-1.12, *P*=0. 264
	After 3 month	5.93 (0.94)	6 (0.52)	t=-0.338, *P*=0.737
		t=0.000, *P*=1.00	t=-1.77, *P*=0.081	F=0.923, *P*=0.432
Overall thermoregulation knowledge	Before	5.47 (1.04)	5.13 (0.86)	t=1.327, *P*=0.19
	After 3 month	5.47 (1.07)	5.67 (0.71)	t=-0.85, *P*=0. 0.399
		t=-1.35, *P*=0.182	t=-13.39, *P*=0.000	F=125.72, *P*=0.000

difference was observed in the premature infant's body temperature consideration area (F=1.651, *P*=0.182). The mean difference was observed in the two groups in assessment of infant's body temperature (F=38.068, *P*=0.000), and sick neonate thermoregulation care (F=18.955, *P*=0.000) before and three months after the intervention. Post hoc analysis showed a higher level of thermoregulation performance in these two areas in the intervention group three months after multi-method education (Table 2).

The correlation between knowledge and practice was significant at the 0.01 level (r=0.544, *P*=0.002). According to the analysis results, previous in-service training in thermoregulation (r=-0.314, *P*=0.015), degree of education (r=0.637, *P*=0.000), pre-intervention knowledge (r=0.681, *P*=0.000), pre-intervention performance (r=0.790, *P*=0.000), thermoregulation knowledge were detected as predictors (R=0.657, *P*=0.013). These variables were selected as the affecting post-intervention performance.

Discussion

The results of this study showed that most nurses had moderate knowledge of thermoregulation before the intervention, i.e. 68% in the control group and 61.7% in the intervention group, and only 31.42% of them had good knowledge. In the study of Demissie et al, 65% of health care workers were aware of situations affecting neonatal hypothermia, such as low birth weight, and 64% of the staff were aware of the mechanisms of temperature disruption.[16] This study proved that there was a significant improvement in knowledge after the multi-method education intervention (*P*<0.000). This study coincided with a study by Purnamasari et al who evaluated the momentous improvement in nurses' knowledge in prevention of hypothermia in newborns after heat loss prevention education.[17] The results of this study are in line with those found by Chang et al,[18] which appraised significant improvement in nurses' knowledge after an information program about thermoregulation in neonates was provided.

In the present study, three months after performing the multi-method training in knowledge domains such as physiology of thermoregulation, mechanisms of temperature disruption, and hypo/hyperthermia complications significant improvement was revealed (*P*=0.000). However, though there was a marked improvement in the concept of thermoregulation and hypo/hyperthermia symptoms, the statistical tests showed no significant difference (*P*>0.05). Regarding the knowledge domains, Mendoza et al found that after the educational intervention, the nurses' performance in the domains of the concept of hypothermia, heat loss mechanisms, temperature evaluation, symptoms and risk factors of hypothermia, physiological consequences, preventive measures, documentation, and knowledge in relation between body temperature adjustment centers showed a significant improvement in their knowledge (*P*=0.005).[19] This lack of meaningful improvement in some areas considered in the present study can be

Table 2. Comparison of nursing thermoregulation performance's scopes

		Control	Intervention	
		Mean (SD)	Mean (SD)	
Preventing infant body tem*P*erature disturbance	Before	20.97 (3)	21.07 (2.94)	t=.13, *P*=0.897
	After 3 month	21.03 (2.93)	21.27 (2.75)	t=-0.318, *P*=0.752
		t=.931, *P*=0.587	t=-0.272, *P*=0.787	F=. 509, *P*=0.981
Premature infants body tem*P*erature consideration	Before	10.47 (1.89)	10.47 (1.89)	t=0.00, *P*=1
	After 3 month	10.47 (1.88)	11 (1.89)	t=-1.092, *P*=0.279
		t=-0.000, *P*=1.000	t=-1.09, *P*=0.279	F=0.597, *P*=0.618
Sick neonate thermoregulation care	Before	14.5 (2.3)	14.53 (2.33)	t=0.056, *P*=0.956
	After 3 month	14.67 (2.45)	18.17 (1.94)	t=-6.17, *P*=0.000
		t=0.787, *P*=0.271	t=6.55, *P*=0.000	F=18.955, *P*=0.000
Assessment of infant body tem*P*erature	Before	15 (2.39)	15.57 (2.34)	t=-0.927, *P*=0.358
	After 3 month	15.37 (2.32)	21.07 (3.1)	t=8.044, *P*=0.000
		t=0.471, *P*=0.725	t=7.74, *P*=0.000	F=38.07, *P*=0.000
Overall thermoregulation *P*erformance	Before	59.17 (5.17)	60.63 (5.69)	t=.111, *P*=0.912
	After 3 month	60.57 (5.53)	81.77 (6.37)	t=-13.76, *P*=0.000
		t=-0.937, *P*=0.334	t=-13.55, *P*=0.000	F=90.285, *P*=0.000

due to various causes such as motivation, attitude, and educational issues, which need to be noticed in clinical training.

Consistent with the results of the present study, Öztürk and Dinç indicated that web-based training had a positive effect on staff's catheterization skills while they used the traditional method of training for the control group. They reported that the integrated approach of web-based teaching with the classroom teachings was more effective on nurses' knowledge and performance ($P=0.02$).[20]

This study showed that nurses' performance before the intervention had 61.8% of the standard and it increased to 87%after the educational intervention, which was statistically significant ($P=0.000$). Although, inconsistent with the results of the present study, Najafi Pour et al indicated that nurses' performance in NICU had only 45% of the standards regardless of the training course on hypothermia. Also, mere knowledge would not change attitudes and performance since facilities and environmental conditions affect performance as well.[15]

The results of the present study revealed that the functional domain in the field of the principles of temperature assessment and specific considerations of sick neonate had significant improvement after performing educational intervention ($P=0.000$). However, there were no significant improvements observed in the two functional domains including specific considerations of preterm ($P=0.38$) and prevention of thermal balance disturbance post-intervention ($P=0.30$). To justify this insignificance, it can be mentioned that there was inadequate equipment to prevent temperature disruption; for example, there were insufficient hats and sheets in the intervention and control groups to cover the neonate when taking a radiological photograph. However, in refuting the claim that the lack of equipment leads to malfunction, it can be said despite the alarms in the devices of hemodialysis and oxygen, nurses turn off the alarms rather than solving the problem, indicating their poor performance. In terms of functional domains, Dragovich et al stated that the performance of health care workers who received no training interventions in the areas of maternity ward warming, maternal and neonatal room warming, and blanket wrapping immediately after birth was poor. However, their performance in routine body temperature measurements as well as in maintaining temperature balance in low birth weight infants was appropriate.[21]

According to the findings of this study, the correlation between knowledge and practice was significant ($r=0.544$, $P=0.002$). Furthermore, it was found that the degree of education ($r=0.637$, $P=0.000$), pre-intervention knowledge ($r=0.681$, $P=0.000$), pre-intervention performance ($r=0.790$, $P=0.000$), and thermoregulation knowledge ($R=0.657$, $P=0.013$) were predictors that affected post-intervention performance. In contrary to the findings of the present study, D.Gould showed that nurses' knowledge of infection control was at a good level, but there was no significant relationship between their knowledge and practice.[22] Also, research in Iran on nurses' knowledge of neutropenia and their practice for infection prevention in patients with cancer showed that there was no significant correlation between nurses' knowledge of neutropenia and their practices for infection control in cancer patients ($P=0.05$),[23] which is not in line with the results of this study. Mendoza et al conducted a research in Portugal and reported that there was no significant relationship between work experience and knowledge of nurses regarding hypothermia ($P=0.36$),[19] which is

inconsistent with the results of the present study (r = 0.657, $P = 0.013$). Performance depends on many factors, and knowledge can certainly improve performance; the results of the present study well revealed this matter. Hence, Parmar et al. found that there was a significant relationship between knowledge and practices of staff nurses regarding thermoregulation of neonates.[24]

During the study, it was concerned that the nurses who were randomly assigned to the control and intervention groups were in the same ward; thus, the information were likely to leak from the intervention group to the control group. But after interpreting the results, 50% of the nurses in both wards were trained and they were in contact via virtual and face-to-face groups within the ward, the knowledge and performance of the control group three months after the training program did not change considerably. Therefore, it is not clear how many staff members in a department need to be trained to change behaviors in care departments.

Conclusion

The study piloted among 60 staff nurses. The findings showed that 18% of the nurses had poor practice and the majority of them (82%) were performing usual and good practice. Furthermore, 31.42% of them had good knowledge and most nurses had moderate to poor knowledge about thermoregulation. This different integrated in-service training methods improved the nurses' thermoregulation knowledge and led to an improvement in nurses' practice. The results of this study suggest that there is a need to improve the performance of neonatal temperature care nurses by designing various in-service training as well as to plan the involvement of a sufficient number of nurses in training programs to improve knowledge and performance of the ward staff.

Limitations of the study

Due to the developing in communication technologies and the communication of nurses in virtual groups, the possibility of information leakage from the intervention group to the control group was uncontrollable.

Conflict of Interest

The authors declare no conflict of interest for the present study.

Ethical Approval

Our research protocol was approved by the Ethics Committee of the Tehran University of Medical Sciences (Ethic cod: 9011451012-1). The informed written consent was obtained from nurses before completing the questionnaires.

Acknowledgements

This article is derived from a master's degree thesis in Intensive Care Nursing. The researchers would like to extend our sincere thanks to Tehran University of Medical Sciences, School of Nursing and Midwifery, Tehran University of Medical Sciences, Nurses of Neonatal and NICU of Kowsar and Valiasr hospitals, as well as the patients who participated in this study.

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