

## Effect of a Comprehensive Total Parenteral Nutrition Training Program on Knowledge and Practice of Nurses in NICU

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### Abstract

**Background:** Parenteral nutrition is a lifesaving therapy for many infants who are unable to tolerate enteral feedings. It fulfils preterm neonates' needs for growth and development when their sizes or conditions preclude enteral feeding. Virtuous nursing care and close biochemical monitoring are absolutely essential for successful parenteral nutrition therapy. Since poor knowledge in parenteral nutrition can causes severe impairment to neonatal infants, the conduction of this study is essential.

**Aims:** The present study aims to: (1) examine the knowledge and practice of nurses in total parenteral nutrition (TPN); (2) employ training programs for improving knowledge and practice in management of TPN in new-borns.

**Method:** A quasi-experimental study was carried out in Sarem Maternity Hospital in Tehran, Iran. The study population included nurses working in Neonatal Intensive Care Unit (NICU) who were included in the study using headcount census method (n=30). A two-part questionnaire including demographic information; 20 multiple choice questions on the nurses' knowledge of TPN therapy and 19-item 3-point Likert-type checklist on administration of TPN completed by observing the nurses' practice. To examine the reliability of the practice part, Cronbach's alpha method was used ( $\alpha=0.78$ ). Study interventions were mentoring education by the researcher and researcher-developed training manual and educational video and guidelines about neonatal parenteral nutrition. Before and after intervention data were collected and compared using paired t-test.

**Results:** The mean scores of nurses' knowledge before and afterward parenteral nutrition (PN) training program were  $11.93\pm 1.91$  and  $17.56\pm 1.59$ , respectively. The mean scores of the nurses' practice earlier and after training program were  $38.84\pm 2.96$  and  $40.15\pm 3.02$ , respectively. Comparing the mean scores of the nurses' familiarity, before and after taking the training course, demonstrated a significant difference ( $p<0.0001$ ). The knowledge of the nurses in all areas of parenteral nutrition prescription was significantly improved after the employment of mentoring method ( $p<0.05$ ). Despite an increase in the post-intervention total score, the nurses' practice, before and after, the intervention was not statistically significant ( $p<0.05$ ).

**Conclusion:** There is a breach between nursing knowledge and practice in prescribing parenteral nutrition. The gap between knowledge and practice in this area can lead to more morbidity and negative influences on the infant. Therefore, it is required that the gap between knowledge and practice is known as the infant gets less damage.

**Keywords:** parenteral nutrition, nurse, neonatal intensive cares, knowledge, practice

## 1. Background

Parenteral nutrition is indicated for initiation of nutrition support for premature and high-risk neonates; as it provides nutritional support when enteral intake is not possible or does not provide sufficient caloric requirements. The initial goal of PN is to minimize losses and preserve existing body stores; it progresses to provide nutrition in order to promote growth and development.

Parenteral nutrition (PN) is a sterile intravenous solution of protein, dextrose and fat in combination with electrolytes, vitamins, trace elements and water. PN for the premature infant includes; (1) adequate calories for energy expenditure and growth, (2) carbohydrates to prevent hypoglycemia and in combination with lipids to provide the caloric intake to meet the energy needs of the infant, (3) adequate protein intake, including essential amino acids, to achieve positive nitrogen balance required for growth, (4) fatty acids to prevent essential fatty acid deficiency and maximize overall non-protein energy intake and (5) essential nutrients including minerals i.e. calcium magnesium, and phosphorus, electrolytes, vitamins, and trace elements (e.g. copper, zinc, and selenium), which are desired for growth (Poindexter et al., 2006).

Nurses' roles in administrating of PN are; assessing patients, fluid balance recording, daily weight of patients, checking of PN prescription, ensuring specific PN solution written, check PN solution, line care and connection/running of intravenous PN infusions (Al-Rafay & Al-Sharkawy, 2012).

Newborn infants in neonatal intensive care units (NICU), mainly the frail and premature newborns whom are often in need of effective nutritional support. These needs are frequently met by the administration of PN, especially during the early stages of life. The nutrient level of preterm neonates, particularly the extremely low birth weight (ELBW) infants, is rarely adequate to meet their needs (Olsen, Richardson, Schmid, Ausman, & Dwyer, 2002). As a result, these newborn infants will suffer from serious nutritional deficiencies during post-birth stages (Shamsuddin, 2003). TPN is globally used for infants under 1,500 grams or infants with surgical complications caused by congenital or acquired diseases such as necrotizing enterocolitis (Clark et al., 2003).

TPN in neonates, compared with adults, is a major challenge as the required nutrients and their levels are not standardized and are rather determined based on the infant's weight. In addition, the required electrolytes and glucose level in this group significantly fluctuates particularly within preterm infants (Storm, Young, & Sandler, 1995).

Parenteral nutrition improves nutritional condition of infants who are small for gestational age. There are however risks such as; sepsis, thrombosis, and many metabolic disorders associated with administration of this treatment. According to the reports, the greatest risks related to TPN- infusion are hypokalemia, hypomagnesemia, hypophosphatemia, hypoglycemia, metabolic acidosis, and hyperammonemia. In addition, leakage of TPN may result in the accumulation of fluid in the pericardial, subdural, and pleura spaces and in some cases, lead to death (Steinbach et al., 2008). Mechanical complications are important as the effects are usually immediate and contribute to an increased length of stay, increased hospital costs, need for subsequent interventions, and mortality rate. These include failure to place the catheter, pneumothorax, arterial puncture, pulmonary embolism, air embolism, dysrhythmia, and death (McGee & Gould, 2003).

Results from a study in 2004 in the Seattle Children's Hospital did not statement any parenteral nutrient-induced deaths, though on average, there were nine mistakes in every 1,000 parenteral nutrition prescriptions given to the patients with the frequency of 3.5 to 17.5 per month. According to this study, it was determined that the frequency, severity, and extent of medication errors in all hospital wards demonstrated that parenteral nutrition mistakes were considered as risky medication errors (Turpin et al., 2011).

Knowledge and skill of the nurses that administer this therapy are two essential factors in preventing errors. Appropriate nursing care and careful biochemical monitoring are required for a successful parenteral nutrition therapy (Chaudhari & Kadam, 2006). In addition, appropriate clinical guidelines on relative amounts of the constituents of parenteral nutrition solutions lead to the proper nutritional support and protect the neonates from possible risks of PN therapy (Peaverini, Beach, Wan, & Vyhmeister, 2000). Therefore, development of a training program to improve the knowledge, practice and skills of nurses is the first step towards an improved method and a reduced number of complications.

Despite nurses' academic knowledge on this nutritional technique, nurses still perform poorly. A study in Jamaica showed that despite having the required knowledge, 85% of the nurses did not carefully observe the safety precautions of nursing practice (Figueroa et al., 2008). Byrd et al. demonstrated that knowledge-practice gap still exists within newborn pain management. Increased caregiver education remains a necessity, but

strategies that address resistance to change practice within healthcare settings must also be considered (Byrd, Gonzales, & Parsons, 2009).

On the other hand, the employed training method is also important. Employing academically-educated nurses, as advisors, in a hospital alters the caring methods they use and improves the caring outcomes. The presence of an advisor or instructor will help nurses, under the novice to expert continuum training, complete the course quicker (Latham, Hogan, & Ringl, 2008).

Mentorship requires an informal, usually face-to-face, communication in a certain period between the trainer and trainee (Andrews & Chilton, 2000). Personal satisfactions of the trainee, career success, and professional involvement are the advantages of this method (LaFleur & White, 2010). Since poor knowledge and practice in parenteral nutrition cause irreparable damage to the newborn infants, the conduction of this study seems crucial.

This study aimed at determining the knowledge and practice of nurses in TPN, the advantages of using training programs for improving their practice in caring infants under TPN, in-service training, and minimizing the prescription mistakes and TPN complications.

## 2. Method

This is a quasi-experimental interventional study, in which the pre- and post-intervention data were compared. An approval was obtained from the Ethics Committee of the Tehran University of Medical Sciences. The study population included all nurses working in NICU of Sarem Maternity Hospital. They totally were included in the study using headcount census method (n=30). A two-part questionnaire including demographic information (in the first part) and 41 questions on the nurses' practice and knowledge about TPN (in the second part) was completed.

The knowledge-related part consists of 22 multiple-choice questions, which was completed by the nurses. The practice part consists of a 19-item checklist on TPN completed by two researchers through observing the nurses' practice in seven days, before practicing the research intervention. Each of these two researchers compared the nurses' practice separately with the prepared checklist and then completed the checklist. One month after the completion of knowledge questionnaire and practice checklist, the nurses underwent a comprehensive training program that included a clinical course using a mentoring method. In this method, by the time the nurses who worked in the NICU started to give parenteral nutrition prescription, they underwent a training course in different areas of TPN as follows: objectives, application, various solutions, prescription methods and steps, precautions to be followed-up, monitoring the infant receiving parenteral nutrition, and TPN recording. These trainings repeated three times for every nurse. All of them received training in all preparation stages, from prescription though monitoring the infant receiving parenteral nutrition. They could ask their questions from the mentor during clinical work. In addition, from the first day of the training, a training manual and a CD were given to them for further review of the contents. One month after the completion of the training course, the knowledge questionnaire was answered by the nurses once again. The practice checklist was also completed by the researchers through observing the practice of the nurses in 7 days. Then, pre- and post-intervention results were also compared.

This questionnaire was prepared by reviewing Parenteral Nutrition Chapter of the Neonatal Intensive Care Nursing, the last update of [www.uptodate.com](http://www.uptodate.com) on parenteral nutrition solutions in infants and neonates, and a review article titled "Parenteral Nutrition in NICU" published by the Association of America's Children in 2011. Validity of the questionnaire was obtained using the face validity and content validity methods. Form of the questions and their distribution were adjusted to research objectives, using the opinions of 10 experts as follows: seven NICU nursing instructors, two neonatologists, and one clinical pharmacy specialist. Their opinions were also employed to adapt research objectives with the contents of the questions. To evaluate the reliability of the research instrument, test-retest and Cronbach's alpha techniques were used. To this end, test-retest trial was employed to find the reliability of the knowledge-related multiple choice questions in a one-month interval. To examine the reliability of the 3-point Likert-type practice part, Cronbach's alpha method was used ( $\alpha=0.78$ ).

The t-test method was used to compare the nurses' knowledge and practice in TPN before and after the intervention. Selection of a hospital for performing the intervention was a limitation of the study, which might affect the results

## 3. Results

Half of the participants were under 30 years of age. All were female, and 60% of them had less than five years of work experience. In addition, 56% of them were on shiftwork. In terms of education, 93% had bachelor degree, and 7% had master degree. Ninety percent were contractual employees, and 23% of them had undergone a PN

training course.

As can be seen in Table 1, the mean scores of the nurses' knowledge before and after the parenteral nutrition were  $11.93 \pm 1.91$  and  $17.56 \pm 1.59$ , respectively. According to the data analysis, the mean scores of the knowledge before and after the completion of the research's training course were significantly different ( $p < 0.001$ ).

The mean scores of the practice before and after parenteral nutrition were  $38.84 \pm 2.96$  and  $40.15 \pm 3.02$ , respectively. According to data analysis, the mean scores of the practice before and after the completion of the research's training course were not significantly different ( $p = 0.07$ ).

Table 1. Mean scores of the nurses' knowledge and practice before and after parenteral nutrition education

	mean	SD	DF	paired t-test	p-value
Nursing knowledge before intervention	11.93	1.91	29	-14.09	<0.001
Nursing knowledge after intervention	17.56	1.59			
Nursing practice before intervention	38.84	2.96	29	-1.84	0.07
Nursing practice after intervention	40.15	3.02			

According to Table 2, none of the demographic information affected the knowledge and practice scores of the nurses, either before or after the intervention.

Table 2. Differences between the nurses' knowledge and practice in parenteral nutrition according to demographic factor

variables	knowledge		practice	
	pre	post	pre	post
Age	$r=0.250$	$R=0.282$	$R=0.210$	$R=0.152$
	$p=0.182$	$P=0.132$	$P=0.303$	$P=0.421$
Job experience	$R=0.161$	$R=0.123$	$R=0.204$	$R=0.042$
	$P=0.396$	$P=0.517$	$P=0.317$	$P=0.825$
Education level	$R=0.062$	$R=0.11$	$R=0.065$	$R=0.182$
	$P=0.746$	$P=0.952$	$P=0.752$	$P=0.335$
Employment Type	$R=0.189$	$R=0.092$	$R=0.061$	$R=0.194$
	$P=0.316$	$P=0.627$	$P=0.752$	$P=0.303$
Courses of parenteral nutrition education	$R=0.320$	$R=0.294$	$R=0.841$	$R=0.309$
	$P=0.484$	$P=0.522$	$P=0.066$	$P=0.499$
Shift	$R=0.151$	$R=0.014$	$R=0.222$	$R=0.070$
	$P=0.427$	$P=0.943$	$P=0.276$	$P=0.714$

\* =  $\alpha$  is significant at 0.05

As can be seen in Table 3, there are significant differences in all eight sub-areas of knowledge after educational intervention. The mean score of the knowledge before and after training indicates that training intervention positively affected all of those areas.

Table 3. Mean scores of the nurses' sub-areas of knowledge before and after parenteral nutrition education

Knowledge	Mean $\pm$ SD		DF	Paired t-test	p-value
	Pre (n=30)	Post (n=30)			
Goal of parenteral nutrition	$0.73 \pm 0.69$	$1.43 \pm 0.56$	29	4.82-	<0.00
Indications of parenteral nutrition	$2.53 \pm 0.62$	$2.86 \pm 0.43$	29	2.56-	0.016
Parenteral nutrition solutions	$2.70 \pm 0.70$	$3.46 \pm 0.86$	29	3.91-	<0.00

Routes of administration	0.76±0.67	2.33±0.60	29	8.83-	<0.00
Precautions to follow relating parenteral nutrition administration	1.36±0.80	2.56±0.72	29	6.37-	<0.00
Monitoring for neonates with TPN	0.86±0.34	1.00±0.00	29	2.11-	0.043
Documentation	0.73±0.44	0.96±0.18	29	2.53-	0.017
Parenteral nutrition complications	1.40±0.62	2.00±0.00	29	5.28-	<0.00

\* =  $\alpha$  is significant at 0.05

According to Table 4, no significant difference was observed in practical steps of PN before and after research intervention.

Table 4. Mean scores of the nurses' steps practice before and after parenteral nutrition education

Practice	Mean $\pm$ SD		DOF	Paired t-test	p-value
	Pre (n=30)	Post (n=30)			
Error prevention within administration of TPN	1.58±11.20	1.49±11.40	29	-0.45	0.65
Prevent from infection within administration of TPN	1.62±6.16	1.22±6.26	29	-0.28	0.77
Correct routes of administration	1.08±11.93	1.00±11.86	29	0.22	0.82
TPN complications monitoring	1.62±9.33	1.69±9.46	29	-0.47	0.63

\* =  $\alpha$  is significant at 0.05

#### 4. Discussion

In this study, the knowledge scores of the nurses in PN were above average (11.93±1.91). This may be due to the fact that in real-life work situations, the main task of a nurse is to monitor the infant receiving PN in large part of their work shift (Al-Rafay & Al-Sharkawy, 2012). Similarly, Ista and Josten emphasized that NICUS' nurses play an important role in nutrition of pre-mature children and infants. Nurses should be knowledgeable about many treatment procedures and interventions such as monitoring and caring the neonates during enteral or parenteral nutrition (Ista & Joosten, 2005).

In this study, knowledge improvement in all areas of parenteral nutrition, including objectives, methods, prescriptive step, complications, prescription precautions, solutions, and recording, showed significant difference before and after the intervention. This is while in Al-Rafay's study, a significant difference was observed in the above-mentioned areas of knowledge, except recording and PN monitoring, before and after the educational intervention. In this regard, he compared his research data with those of Brown's educational intervention in relation to the use of inactive computerized sheets to reduce error rate in PN prescription. He noticed that the application of this method systematically improved the knowledge of senior clinical nurses and pediatric residents and decreased their mistakes in PN prescription (Brown, Garrison, & Hutchison, 2007).

According to the research findings, the mean scores of the practice before and after parenteral nutrition were 38.84±2.96 and 40.15±3.02, respectively. According to data analysis, the mean of total scores of the practice, before and after the completion of the research's training course, were not significantly different ( $p=0.077$ ). In the evaluation of different areas of the practice of participated nurses, no significant improvement was observed in PN prescription mistake prevention, infection prevention, proper methods of practicing PN, and monitoring PN complications; while, in Al-Rafay's study, significant differences were observed in some areas of NICU, including safe prescription and monitoring of mechanical and digestive complications. This may be attributed to the low number of nurse-to-patient ratio, and work and unit related stressors. Taheri *et al.* showed that the main causes of error in medication prescription in NICU from the nurses' perspective included limited number of staff (9.26%), heavy work load (17.6%), physical and psychological fatigue (14.3%), and hustle and bustle of the ward (12.6%), followed by other causes (TAHERI, NOORIAN, RASSOULI, & KAVOUSI). This is while, in Al-Rafay's research, the overall practice of the nurses after the completion of training course showed a

significant difference ( $p < 0.001$ ), which was inconsistent with this study Brown *et al.* (2007) found that the PN practice score of the nurses was higher than that of pediatric residents. After educational intervention, practice scores of the residents and nurses reached the same level, indicating the effect of such intervention on the practice. This is not consistent with the present study.

Al-Rafay did not find a significant difference in the nurses' practice of in the improvement of metabolic and infectious complications before and after the intervention. The researchers attributed that to the lack of relevant knowledge and low clinical experience. In evaluation of parenteral nutrition prescription practice, Marshall *et al.* found that the practice of the nurses in this area was not correlated with NICU which can be attributed to the lack of valid and reliable studies on many issues of effective PN. In addition, any change in PN prescription system is another key in the successful implementation of this nutritional method. The implementation of clinical guidance of intravenous injection is not possible without investigating the atmosphere and leadership issues (Marshall, West, & Aitken, 2011). Kuzma *et al.* showed that the NICUs where the scores of leadership, personnel coordination, and problem-solving are higher, the rates of nurses' successful practice and their job satisfaction are higher, too (Kuzma-O'Reilly *et al.*, 2003).

In addition, the mere knowledge will not result in attitude and practice development since the environmental facilities and conditions affect the practice. Hilmas *et al.* attributed the PN prescription errors to three factors: lack of knowledge about optimal prescription of PN solution; the mere knowledge is not a solution and the modification of NICUs for supporting clinical decisions may be required; and finally, frequent phone calls to correct PN prescriptions can reduce the need for caring the patient and mitigate negative effect on the personnel working in pediatric ward and pharmacy (Hilmas & Partyka, 2004).

Due to the close patient-nurse interactions, nurses play an important role in realizing care objectives, and thus their productivity is very crucial. Achieving high productivity requires that the trainees obtain the maximum amount of knowledge, efficacy, and skills needed for their future career during the training courses. The available clinical trainings do not adequately prepare trainees in achieving clinical competence and skills (Rahmani *et al.*, 2011). In Iran, due to the lack of time or instructors' skills, training is conducted in the form of clinical work and education, and practical education in the presence of a mentor is less practiced (Adib-Hajbaghery, 2009).

Memarian *et al.* evaluated the monitoring methods training for the nurses working in the men's surgical ward by supervisors trained in the post-operative nursing care documenting. Research findings indicated that after the intervention, the quality of nursing care recording was improved from poor ( $p = 0.501$ ,  $z = 0.663$ ) to moderate. The difference in the quality of recording by nurses was significant ( $p < 0.05$ ). Results showed that a training program through mentorship improved the quality of nursing care recording (Memarian, Vanaki, & Rahmani, 2013). Therefore, development of a training program to improve the knowledge, practice and skills of nurses is the first step to improve that method and reduce its complications.

## 5. Conclusion

The knowledge of the nurses in all areas of parenteral nutrition prescription was significantly improved after the employment of training program ( $p < 0.05$ ). Regarding practice, however, despite an increased post-intervention total score, the nurses' practice, before and after intervention, was not statistically significant ( $p < 0.05$ ). The gap between knowledge and practice in this area can lead to increased morbidity and its damaging effects on the infant. Therefore, it is required that the gap between knowledge and practice is known as the infant gets less damage. This demands more attention from the authorities to the effects of training and practical usage of knowledge on the practice of nurses and the reduction of the gap between their knowledge and practice.

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## Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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Nurse practitioners get advanced training in nursing so they can take their careers a step farther. By getting graduate-level education, they can operate independently or under the supervision of a physician. Entering a Bachelor of Science in Nursing (BSN) program promptly after high school is the most direct route to an immediate post-secondary career in nursing. However, many nurses turn to bachelor's degree studies after first gaining work experience in the field following the achievement of an LPN diploma or associate degree in nursing. Provides a framework of nursing and ethics as it applies to nursing practice. Students complete professional exercises to enhance their understanding of ethical issues affecting nurses and effective ways to respond to them. The program improves overall neonatal care and practices and should be widely implemented in NICU's wanting to enhance neuroprotective care of premature and/or sick infants. © 2015 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license. is evidence demonstrating that a comprehensive program that addresses neonatal intensive care unit (NICU) design, experience design and workflow, unit policies, staff training, and transformational change within a quality improvement framework can positively impact preterm infant brain development and long-term outcomes, a review of this literature reveals a lack of research addressing professional development on this topic. Parenteral nutrition is a life-saving modality, but one that also carries risks for potentially life-threatening complications. comprehensive management. The selection of a needleless connector with a proven safety record and appropriate disinfection of the septum are critical components of this effort. 11,35,42,54 The impact of mechanical valves on CLABSI rates merits further investigation. 55 Research is also needed to explore the effects of various flushing practices on CLABSI rates and to delineate optimal techniques for locking vascular access devices. 54 Measures aimed at limiting manipulation of the catheter hub may reduce the risk of CLABSI. 35 In acute care settings, policies that restrict tubing-catheter disconnections during routine patient care should be considered.