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Effect of Training Nurses in the Process of Weaning Premature Infants from Mechanical Ventilation on Infection Incidence in Neonatal Intensive Care Units

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ABSTRACT

Background: Respiratory distress syndrome and lung infection are the most common lung problems and the leading cause of mortality in preterm neonates. The prolonged use of endotracheal tubes and mechanical ventilation increases the risk of airway injury, pneumonia, and chronic lung disease. Nursing interventions can be considered a vitally important factor in the success of endotracheal intubation in premature infants. Therefore, the present study aimed to investigate the effect of training nurses in the process of weaning premature infants from mechanical ventilation on neonatal outcomes in the neonatal intensive care unit (NICU).

Methods: The present quasi-experimental study was performed on 46 nurses and 312 premature neonates admitted to the NICU of Akbarabadi Hospital in Tehran in 2020. The subjects were entered into the study using the census method; subsequently, they were examined three months before and three months after the intervention. The data collection instrument was a two-part researcher-made questionnaire encompassing demographic characteristics of nurses and preterm infants, the length of hospital stay, length of mechanical ventilation, and incidence of infection. Data were analyzed in SPSS software (version 22) using an independent t-test and chi-square test. A p-value less than 0.05 was considered statistically significant.

Results: The results demonstrated that despite a significant reduction in the number of infections after the intervention compared to before the intervention, there was no statistically significant difference between the two time periods in terms of neonatal outcomes (p=0.194). The results also indicated that nurses' training reduced the chances of neonatal infection by about 1.5 times (OR=1.498).

Conclusion: As evidenced by the results of the present study, although a reduction was observed in neonatal outcomes after nursing education, it was not statistically significant, indicating that other factors, such as nurses' adherence to hand hygiene protocols, duration of intervention, sample size, and educational content, were also involved in this regard and affected the results of this study.

Keywords: Infection, Nursing education, Premature infants, Weaning process

Introduction

Infancy is a very important and critical periods for babies, leading to a high rate of infant mortality. Therefore, providing, maintaining, and promoting the level of neonatal health as an important indicator of development has a special place in health services (1). One of the problems of infancy is premature birth; that is to say, which is when a baby is born before 37 weeks of pregnancy. Despite remarkable advancements in medical science, the birth of premature neonates is still considered one of the major social challenges. It leads to economic and psychological problems in the family, as well as a waste of financial and human resources (2).

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According to global statistics, it is estimated that about 15 million premature infants are born each year. Of these, 10% are born between 28 and 32 weeks, 5% are under 28 weeks, and the rest are between 28-37 weeks. Premature birth is one of the leading causes of death in infants and also the second leading cause of death in children under five years of age (3). Approximately 90% of extremely premature infants are born in high-income countries with access to the best nursing facilities and intensive care, and 10% are born in low-income countries with minimal physical facilities and human resources (4). The rate of preterm birth is reported to be 5%-9% in Europe and developed countries. According to studies conducted in Iran in 2012, more than 1 in 10 infants is born prematurely, and each year, out of 1,266,500 live births, 163,900 premature infants are born, 7,900 of whom die due to prematurity complications (5).

Infants born before 37 weeks of gestation develop respiratory distress syndrome due to surfactant deficiency, which is the most common lung problem and the leading cause of morbidity and mortality in premature infants. The prevalence of this syndrome increases with decreasing gestational age and birth weight (6). Therefore, premature infants with respiratory failure will need mechanical ventilation. The main goal is to minimize abnormal changes and complications from treatment. The proper management of preterm infants with respiratory failure and proper use of ventilators have been major issues in neonatal medicine. However, the long-term use of endotracheal tubes and mechanical ventilation increases the risk of airway injury and chronic lung disease (7).

Evidence suggests that infants who are weaned from mechanical ventilation are more likely to have a higher mortality rate and develop such complications as mechanical ventilation pneumonia and lung damage (8). In addition, the use of mechanical ventilation in premature infants, despite its rescue and usefulness, is usually associated with complications, such as nosocomial infections, laryngeal injuries, tracheomalacia, bronchopulmonary dysplasia, immune disorders, atrophy of respiratory muscles, and neonatal developmental disorders (9). Furthermore, the results of studies in this field demonstrated that ventilator-associated pneumonia (VAP) is one of the most common infections in patients who are mechanically ventilated and hospitalized in special wards (10-

12). Therefore, early neonatal weaning from the ventilator and premature removal of the endotracheal tube has been considered in infants in order to reduce the risk of nosocomial pneumonia, sepsis, and chronic lung disease (13).

The decision to start weaning the infant from the mechanical ventilator is difficult, and many variables, including medical treatment, the environment, and the patient him/herself, can determine the process of endotracheal tube removal. Success in the process of weaning infants from mechanical ventilation requires cooperation between nurses and physicians, as well as experience, skill, and sound judgment (13, 14). Nurses face several challenges in the process of admitting premature infants, including shifts and night care, as well as monitoring and care management to prevent infection and its long-term complications in infants (15).

Nonetheless, nursing interventions can be considered a critical factor in the success of endotracheal intubation in premature infants. The high survival rate of premature infants in the neonatal intensive care unit (NICU) can be attributed to the appropriate technology and excellent performance of nurses (16). Nurses in NICUs are among the first people who can control the environment surrounding the neonate and bring them physiological stability before and after the removal of the endotracheal tube. In addition, success in neonatal endotracheal intubation requires cooperation between physicians and nurses, as well as the experience and skills of nurses. Furthermore, the essential skills of nurses working in the NICU include adherence to hand hygiene as a straightforward and cheap method in the reduction of nosocomial infections, knowing the regulatory parameters of mechanical ventilation, correct and sterile suction of the neonate's mouth and throat after endotracheal tube removal, correct position after endotracheal tube removal, and proper feeding of premature infant (17).

Niknafs (2015) also referred to the role of nurses in his study and stated that nurses' standard care in a principled manner could be effective in reducing the incidence of mechanical ventilation in infants (18). There is a dearth of studies on the weaning of premature infants from mechanical ventilation and the effects of nursing education on the rate of neonatal infection in Iran (18-20). Therefore, the present study aimed to determine the effect

of training of nurses in weaning premature infants from mechanical ventilation on infection incidence in NICUs.

Methods

This quasi-experimental study aimed to examine the effect of training of nurses in weaning of premature infants from mechanical ventilation on the incidence of ventilator-related infection in the NICUs. This study was performed on 46 nurses and 312 premature infants admitted to the NICU of Akbarabadi Hospital in Tehran in 2020. The researcher approached the eligible nurses in the NICU of the hospital with information about the study. The nurses were then informed about the study, and written consent was obtained from those who volunteered, and they completed the questionnaire at the hospital. Due to the limited sample size, the census method was conducted. All preterm infants admitted to the NICU of eligible neonates were selected for study within three months before the intervention (21. 11. 2020 to 19. 2. 2021) and three months after the intervention (21. 3. 2021 to 22. 6. 2021).

The inclusion criteria entailed 1) being born at 37 weeks, 2) being connected to a ventilator for at least 6 hours, 3) bronchopulmonary dysplasia, and 4) absence of severe congenital anomalies. On the other hand, the exclusion criterion was severe asphyxia. In the present study, the intervention was in the form of a workshop conducted by a research assistant (neonatal specialist) in the form of lectures, slides, and group discussions on global guidelines on separating premature infants from mechanical ventilation for nurses working in the neonatal ward. Before the intervention, pre-tests, including tests for infection of hospitalized infants, were performed, and three months after the intervention, post-tests were performed.

In this study, participants were assessed for the incidence of infection in infants three months before and three months after training through their infection records. The data collection tool consisted of a two-part questionnaire designed by the researcher based on previous similar studies. The first part of the questionnaire included personal and social characteristics of nurses, including gender, age, marital status, level of education, work experience in the NICU, employment status, type of work shift, and questions about training courses.

The second part included the demographic characteristics of the infants, including gender, age, weight, type of delivery, and the incidence of ventilator-related infections before and after the intervention. The second part of the questionnaire was completed by the researcher before and after the intervention.

In order to assess the validity of the content, the questionnaire was administered to 10 experienced professors and faculty of the Iran University of Medical Sciences, professionals working in NICUs, and they were asked to express their views on deleting, modifying, or adding some terms of the questionnaire. After obtaining written permission from the related officials and explaining the objectives of the study, informed consent was obtained from the nurses. A total of 88 NICU nurses confirmed their participation in the study by written consent; moreover, they were assured of the confidentiality of their information.

In order to analyze the data, the normality of the data was initially checked by the Kolmogorov-Smirnov test. Data were analyzed using two sections: descriptive statistics and analytical statistics. In the descriptive statistics section, frequency and percentage, mean and standard deviation were used to describe the data. In the analytical statistics section, independent t-test and Chi-square test were used to examine the incidence of infection in the three months before and after training. The data were analyzed in SPSS software (version 22). A p-value less than 0.05 was considered statistically significant. This research was approved by the ethics committee of Iran University of Medical Sciences. Furthermore, informed consent was obtained from all participants, and they were assured of the confidentiality of information.

Results

The present study was performed on 46 nurses and 312 premature infants who were admitted to the NICU and met the inclusion criteria. Based on the results, the mean age of nurses was 34.78 ± 5.56 years, and the mean neonatal weight was 2446.33±898.92 gr. All nurses were female; the majority of them (87.0%) were married, had a work experience of 7.82±5.26 years, and held a bachelor's degree (93.5%). Moreover, the majority of premature infants were male (52%) and were born by cesarean delivery (73.1%) (Tables 1 and 2). The results denoted that no statistically significant differences were found between the characteristics of premature infants in pre-intervention and after-intervention (P≥0.05)(Table 2). In other words, the research

Table 1. Descriptive characteristics of the nurses studied in the neonatal intensive care unit

Characteristics of nurses		N (%)
Marital status	Married	40 (87)
	Single	6 (13)
Academic level	BSc	43 (93.5)
	Master	3 (6.5)
Employment status	Official	29 (63)
	Limited time	9 (19.6)
	Contractual	8 (17.4)
Shift work	Fix	3 (6.5)
	Circulate	43 (93.5)
Training course	Yes	23 (50)
	No	23 (50)
Age		Mean±SD 34.78±5.56
Total work experience		7.82±5.26
Work experience in intensive care unit		1.64±0.46

subjects were homogeneous in terms of gender, type of delivery, hospitalization history, background disease, survival status, age (weeks), and weight (grams).

The results of the Chi-square test showed that despite a significant reduction in the number of infections in the post-training phase (19) compared to pre-training (34), there was no statistically significant difference between the two time periods (before training and after training) in this (P = 0.194). Nonetheless, the OR value indicates that nurses' training has reduced the chances of infection in infants by about 1.5-fold (Table 3).

Table 2. Descriptive characteristics of the studied neonates and the results of the comparison test before and after nurses' training

Neonatal characteristics		Before intervention n=175	After intervention n=137	Statistical test
		n (%)	N (%)	
Gender	Female	84 (48)	59 (43.1)	X^2=0.745 df=1 P=0.385
	Male	91 (52)	78 (56.9)	
Labour Type	Normal	47 (26.9)	26 (19)	X^2=2.66 df=1 P=0.103
	Cesarean	128 (73.1)	111 (81)	
Hospitalization history	Yes	3 (1.7)	1 (0.7)	X^2=0.588 df=1 P=0.443
	No	172 (98.3)	136 (99.3)	
Background disease	Yes	9 (5.1)	7 (5.1)	X^2=0.121 df=1 P=0.756
	No	166 (94.9)	130 (94.9)	
Survival status	Dead	9 (5.1)	4 (2.9)	X^2=3.26 df=1 P=0.06
	Alive	166 (94.9)	133 (97.1)	
Age (weeks)	< 28	15 (8.6)	5 (3.6)	X^2=0.396 df=310 P=0.692
	29-33	43 (24.6)	50 (36.5)	
	34-37	83 (47.4)	53 (38.7)	
	37>	34 (19.4)	29 (21.2)	
	Mean±SD	34.49 ± 3.8	34.32 ± 3.3	
Weight (grams)	< 1400	28 (16)	17 (12.4)	X^2=1.06df=310 P=0.288
	1400-2800	86 (49.1)	78 (56.9)	
	2800-3200	23 (13.1)	15 (10.9)	
	3200>	38 (21.7)	27 (19.7)	
	Mean±SD	2501.25 ± 943.23	2391.42 ± 854.62	

Table 3. Comparison of the incidence of infection in the neonates studied three months before and three months after nurses' training

Time	Incidence of infection		Chi-square	OR	CI 95%
	Yes n (%)	No n (%)			
Three months before the intervention	34 (19.4)	141(80.6)	X^2=1.68 df=1 P=0.194	1.498	(0.812 – 2.763)
Three months after the intervention	19 (13.9)	118 (86.1)			

Discussion

The present quasi-experimental interventional study was conducted to determine the effect of training of nurses in the process of weaning premature infants from mechanical ventilation on the rate of ventilator-related infection in the NICU in 2020. In this regard, the results suggested that despite a significant reduction in the number of infections in the post-training phase, there was no statistically significant difference between the two times (before training and after training) in terms of the number of infections. The results of studies in this field have pointed to the effectiveness of the training of medical staff in preventing infection among patients (23-23).

In this regard, the results of the study by Abou Zed et al. in 2019 pointed out that the use of nursing guidelines improved the performance and knowledge of nurses to prevent pneumonia in neonates under mechanical ventilation (24). Inconsistent with the findings of the present research, the results of the study by Azab et al. in 2015 illustrated that the implementation of infection prevention methods can reduce the rate of ventilator-related infection and the duration of mechanical ventilation (25). The results of a study by ChadaniOsti et al. in 2017 demonstrated that ventilator-related infection is one of the most common nosocomial infections in patients undergoing ventilators, and this infection can increase the length of hospital stay and mortality rate. Meanwhile, nurses play a vital role in controlling and preventing ventilator-related infection. Therefore, training of nurses in the pathophysiology and risk factors of ventilator-related infections can help them prevent this problem. They concluded that ventilator-dependent infection prevention protocols are effective in the reduction of neonatal infections (26). Furthermore, based on evidence, respiratory infections and pneumonia in premature infants are highly correlated with the duration of their mechanical ventilation (15, 27, 28).

The results of a study by Rastogi et al. in 2012 pointed out that several factors, including chorioamnionitis, the type of intubation, surfactant use, arterial duct opening, sepsis, anemia, apnea, and birth weight, were significantly affected by weaning time(29). The success rate of weaning off the ventilator depends on the infant's lung conditions (30). According to the results of these studies, it is concluded that apart from educating nurses, several other factors are involved in the development of infection in infants and should be controlled.

Conclusion

The results of this study pointed out that despite a significant reduction in the number of infections in the post-training phase, there was no statistically significant difference between the two time periods (before training and after training) in this regard. Therefore, according to the findings of the present study and the positive effect of education on the quality of nursing care based on the available evidence, it is concluded that despite the improvement of neonatal outcomes after nursing education, it was not statistically significant. This finding suggests that other factors, such as nurses' adherence to hand hygiene protocols, duration of intervention, sample size, and educational content, were involved in this regard and affected the results of the study.

Therefore, it is suggested that these cases be considered in future studies. Furthermore, the coincidence of the Covid-19 outbreak with the present study and the resulting limitations could possibly have negative effects on the type of training and its implementation, which is one of the limitations of this study. Finally, according to the general findings of this study, it can be claimed that the training of nurses has clinically positive results. Therefore, the results of the present study can be of great help to health care managers to train nurses in the NICUs, enhance the quality of nursing care, and improve neonatal outcomes.

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Conflicts of interest

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