

Mechanical Ventilation Support in Neonates: Care, Monitoring, Weaning

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Abstract

Background: Mechanical ventilation support (MVS) is frequently administered on neonates with inadequate or ineffective respiratory functions. This study aimed to determine the MVS-related practices of nurses working in a neonatal intensive care unit.

Methods: The study sample included 127 nurses in a neonatal intensive care unit at five public hospitals between January and May, 2016. Two forms were used to determine their demographics and MVS-related practices. The data were evaluated using the SPSS 20.0 software.

Results: This study found that all nurses changed the circuits and settings for each patient; used distilled water in the humidifier; and assessed and recorded abdominal distension, presence of bleeding in mouth and nose, respiratory function, efficiency of ventilation in obstruction, blood pressure, pulse and nutritional status by monitoring mechanical ventilation support in the neonatal intensive care unit.

Conclusion: This study found that all nurses in the neonatal intensive care unit did not perform all practices necessary for the MVS. Preparation of a standard care form similar to the form in this research is recommended to provide neonates with safe, competent and standard nursing care.

Keywords: *Newborn; Neonatal Intensive Care Units; Mechanical Ventilation*

Abbreviations

MVS: Mechanical Ventilation Support; NNPs: Neonatal Nurse Practitioners; NICU: Neonatal Intensive Care Unit; MV: Mechanical Ventilator; NICN: Neonatal Intensive Care Nursing; NRP: Neonatal Resuscitation Program

Introduction

MVS is used for neonates who suffer from inadequate ventilation and oxygenation in order to prevent collapsed lungs, provide alveolar ventilation, get rid of the accumulated carbon dioxide, increase lung volume, and to support and ease respirations in the neonate [1-3]. For successful MVS and quick transition to spontaneous respiration, ventilator should be operated effectively, ventilator support should be adjusted appropriately by the disease, and nutritional status, vital signs, infection symptoms, blood gas and radiological findings of the neonates should be monitored and recorded [1,4]. MVS is weaned gradually when the neonate shows recovery signs and makes spontaneous respiratory efforts depending on lung development, infection symptoms and findings, electrolyte imbalance, age, weight, nutritional status, and the neonate is allowed to perform the respiration function [2,3].

Various complications can occur during MVS due to intense, aggressive procedures, long term hospitalization, and ventilator incompatibility. The most common complications of mechanical ventilation are nosocomial infection, pulmonary hemorrhage, pneumonia, pneumothorax and atelectasis [5-7]. Single-use ventilator circuits, appropriate sterilization of multiple-use ventilator circuits, the use of distilled water in the humidifier as well as aspiration of tracheal tube obstructions are needed to prevent and/or diagnose early such complications, and the newborn should be assessed rapidly and problems should be addressed immediately in case of the disconnection of tube from the trachea, sudden worsening and bradycardia [6,8].

Effective implementation of these practices is the responsibility of each neonatal health care team member. Neonatal nurse practitioners (NNPs) monitor the neonates' treatment and care and record them 24 hours a day [3]. They provide education and counseling for the family in line with the care needs of the neonate. NNPs also monitor mechanical ventilator use and the neonate under ventilation,

prevent potential problems or bring solutions on MVS when necessary, and wean the support [3,8-11]. MVS is frequently used in high-risk neonates. There is no study examining what kind of practices related to the MVS the NNPs in neonatal intensive care unit (NICU) carry out abroad and in Turkey. This study was to describe of knowledges and practices related to the MVS the NNPs in the Level II and III NICUs of five public hospitals in Istanbul, Turkey. Flow diagram of the study is presented in figure 1. This study can give NNPs in NICU actively participating, developing them, increasing their knowledges related to the MVS, and developing patient care skills. In addition, this study can provide resources for the content planning of in-service training, and to standardize forms used with MVS. The objectives of this study were to describe of knowledges and practices related to the MVS the participants.

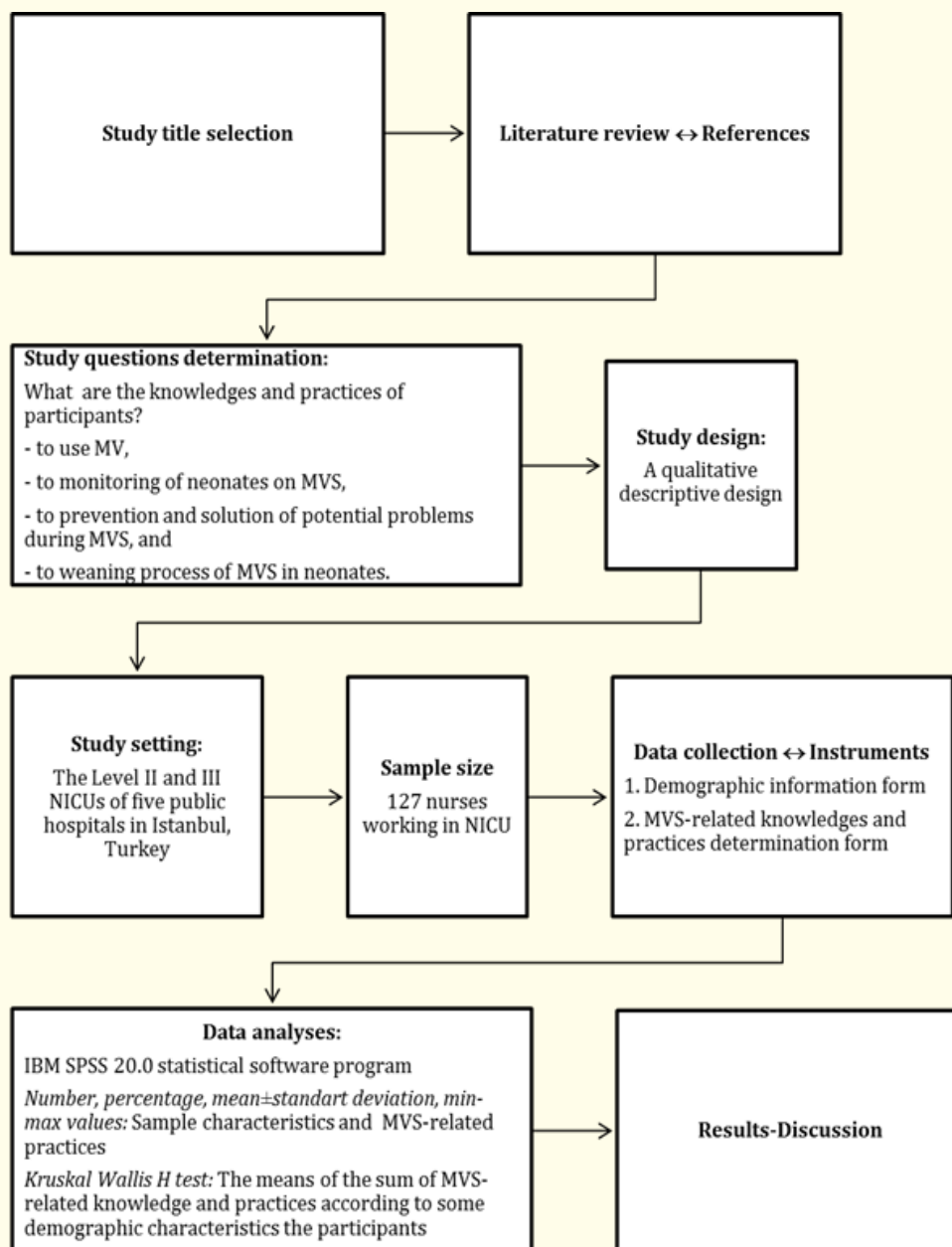


Figure 1: Flow diagram of the study.

What are the knowledges and practices of the participants?

- Using mechanical ventilator (MV),
- Monitoring of neonates on MVS,
- Prevention and solution of potential problems during MVS,
- Weaning process of MVS in neonates.

Location and the participants of the study

This study was conducted between January and May 2016 in the Level II and III NICUs of five public hospitals in Istanbul which have a NICU and the permission of which was granted for the study. The combined number of NNPs in these units was 186. A total of 127 NNPs who volunteered to participate and had been working in the NICU for at least one year were included in this study.

Ethical consideration

Permissions were granted from one university in Istanbul, Turkey (No. 2015/11-01, 06/11/2015) and five public hospitals affiliated with three Secretariat General of Public Union Clinical Research Ethics Committees (No.77517973-770, 20/03/2016, No. 97175836-770, 20/04/2016, No. 35778018-770, 07/03/2016,) for ethical purposes. Information about the purpose of the study and the data collection forms was given to the participants prior to the study. The written and verbal consents were obtained from the participants who agreed to participate voluntarily in this study.

Instruments

The study data were collected using two forms. These forms were developed by the researchers to obtain data about the participants. MVS-related practice determination form and demographic information form were prepared by researchers using relevant literature [1-4,6,8,12] and expert opinion (4 neonatologists, 8 NNPs in the NICU).

Demographic information form

Demographic information form includes age, gender, educational status, occupation and duration of the study at the NICU, the level of NICU, the participation in neonatal resuscitation program (NRP), NICU and mechanical ventilation courses of the participants.

MVS-related knowledges and practices determination form

MVS-related practice determination form examined the use of MV by NNPs (8 items), neonatal monitoring of MVS (10 items), prevention-solution of potential problems during MVS (9 items) and MVS weaning process (9 items). The items in the form are shown in table 1 and 2. The participants responded each item in the form with either “yes” or “no”. In the upper part of both forms, there is a directive explaining the purpose of the research, how to respond to the form, and the answers to be used for research only.

The use of MV	n (%)
I replace the ventilator circuits and sets for each patient	127 (100)
I use distilled water in the humidifier	127 (100)
I ensure that the circuit equipment is sterile	125 (98.4)
When I make a mistake with the ventilator, I share it verbally	116 (91.3)
I verify the directed settings of the ventilator	111 (87.4)
I adjust and apply the oxygen concentration in case of an emergency	114 (89.8)
I apply the directed settings of the ventilator	108 (85)
When I make a mistake with the ventilator, I report it in writing	98 (77.2)
Monitoring	n (%)
I assess abdominal distension	127 (100)
I monitor the compliance with the ventilator	126 (99.2)
I assess abnormal findings in the stool	126 (99.2)
I monitor intake and output	125 (98.4)
I assess muscle tone and edema	125 (98.4)
I check gastric residual	123 (96.9)
I monitor the vital signs every one or two hours	120 (94.5)
I monitor breath and heart sounds	119 (93.7)
I listen for bowel sounds	113 (89)
I monitor blood gas values	103 (81.1)

Table 1: Practices regarding monitoring and use of MV of the participants.

Preventing and resolving potential problems	n (%)
I observe for the presence of bleeding from the mouth and nose	127 (100)
I evaluate the effectiveness of ventilation in obstruction	127 (100)
When tracheal tube is obstructed, I perform aspiration	126 (99.2)
I observe for the signs of pneumothorax and pneumonia and report to the physician	126 (99.2)
I report the arrest and hemothorax to the physician follow the directives and monitor	126 (99.2)
I observe for the presence of petechia and ecchymosis of the skin	126 (99.2)
I observe for neonatal incompatibility with the ventilator	125 (98.4)
I check the connections in the MV related issues and I report it in writing	124 (97.6)
If the tracheal tube is displaced, I use a self-inflating balloon for the respiration of the neonate.	123 (96.9)
The weaning process	n (%)
I assess respiratory functions	127 (100)
I monitor blood pressure and heart rate	127 (100)
I assess nutritional status	127 (100)
I plan with the physician to wean the ventilation procedure	126 (99.2)
I assist the physician	126 (99.2)
I assess body temperature	126 (99.2)
I monitor signs and symptoms of infection	125 (98.4)
I enable the radiological follow-ups to be maintained and report it to the physician	111 (87.4)
I report blood gas results to the physician	108 (85)

Table 2: Practices regarding preventing and resolving problems and weaning process of MVS of the participants.

Procedure

The data forms were filled out by the participants in NICU. The duration for completing the forms took 8 - 10 minutes. The participants were alone while filling out the data forms and were informed not to solicit any help from researchers.

Statistical Analyses

Demographic characteristics, MVS-related knowledges and practices of the participants were analyzed by using frequencies and percentages for nominal level variables, means ± standard deviations and median (min-max) for continuous variables. The means of the sum of MVS-related knowledges and practices according to demographic characteristics of the participants were analyzed by using the Kruskal Wallis H test. All statistical analyses were performed with SPSS version 20.0 (IBM SPSS Statistics, Armonk, NY, USA). Statistical significance was accepted at p < 0.05.

Results

Sample Characteristics

The majority of the participants in the study were female (92.9%), and the mean age of the participants was 27 ± 6. The education level was undergraduate (62.2%) and associate degree graduates (15%). Of the participants, 80.3% were working in the Level III NICU. The mean duration of working as the participants was 5.56 ± 5.68 years; the mean duration of working in the NICU was 3.62 ± 3.88. This study found that 83.5% of the participants participated in a NRP, 46.5% participated in a neonatal intensive care nursing (NICN) course and 29.9% participated in the mechanical ventilation course.

Assessment of MVS-related Knowledges and Practices of the Participants

All of the participants who participated in this study were found to “change ventilator circuits and sets in each patient”, “use distilled water in the humidifier” and “assess abdominal distension” (Table 1). This study found that all of the participants observed for “the presence of bleeding in the mouth and nose”, and they evaluated “effectiveness of ventilation in obstruction”, “respiratory function”, “nutritional status” and “blood pressure and heart rate” (Table 2).

The mean of the total number of the participants knowledges and practices for MVS was 34.4 ± 2.4 (Table 3). There were no significant differences between the mean of the sum of MVS knowledges and practices according to the education level of the participants ($H = 1.594$, $p = 0.661$), working years at NICU ($H = 1.040$, $p = .595$), the level of the unit ($H = 1.396$, $p = 0.498$), participation in the NRP ($H = .571$, $p = .450$), NICN ($H = 2.432$, $p = .119$) and mechanical ventilation courses ($H = .465$, $p = .495$) ($p > 0.05$).

MVS-related knowledges and practices of the participants	Mean \pm SD	Median (min-max)
Practices regarding the use of MV	7.3 \pm 1.0	8.0 (4.0 - 8.0)
Practices for monitoring the neonatal in MVS	9.5 \pm 1.1	10.0 (2.0 - 10.0)
Practices for preventing and resolving potential problems in MVS	8.9 \pm 0.3	9.0 (7.0 - 9.0)
Practices regarding the weaning process of MVS	8.7 \pm 0.7	9.0 (6.0 - 9.0)
The sum of MVS-related practices of the participants	34.4 \pm 2.4	36.0 (24.0 - 36.0)

Table 3: The mean of the total number of participants' practices for MVS.

Discussions

This study has implications for nursing education, management, and practice. This study yields three principal findings:

1. The participants constituting the sample group have knowledge related to the MVS,
2. The participants constituting the sample group perform important practices for the use of ventilator, neonatal monitoring, and potential problems during ventilation support and weaning of support in neonates on MVS, and
3. There were no significant differences between the mean of the sum of MVS knowledges and practices according to the characteristics of the participants.

This study also found that the participants paid attention to sterilize ventilator equipment, change ventilator circuits for each patient, and use distilled water in the humidifier to prevent nosocomial infections (Table 1). It was extremely important result that these practices for the prevention of medical errors and infections were carried out by all NNPs participating in this study. Studies showed that NNPs have a low level of tendency towards infection-induced and other medical errors [13-15]. These results demonstrate that nurses perform practices for the use of mechanical ventilation and to prevent medical errors related to infections in the light of literature.

Nurses are required to document and verbally report observations and results of their follow-up, treatment and care practices. This study found that NNPs preferred using verbal reporting instead of documentation of medical errors - incidents while using ventilator (Table 1). Studies showed that the nurses did not document the medical errors - incidents [14,16-18]. These results were very important because they indicate the factors that extend the duration of stay in the intensive care-hospital and increase the mortality rates for neonates. In recent years, in nursing, there has been increased interest in evidence-based studies, the use of protocols - standards-based nursing care forms - to ensure safe, qualified and standardized nursing care. Therefore, it is thought that the form developed and used in this study can be evaluated as a protocol.

Physicians and NNPs in the NICU have a responsibility for monitoring patient's blood gas values, and listening to breath, heart and bowel sounds. The NNPs who participated in this study performed a large number of the knowledges and practices to monitor neonates on MVS (Table 1). The mean number of these knowledges and practices was high (Table 1). Monitoring of clinical and biochemical parameters has an important role in the neonatal healing process [11,19]. Adherence to standards of care may have prevented patient harm [18,20-22]. These results show that nurses are aware of the importance of patient monitoring and documentation, and they fulfill their responsibilities by performing necessary practices.

MVS is a life-saving practice. However, the neonatal must be observed continuously and carefully to prevent any complications that may occur during and after the procedure. All of the NNPs were found to monitor the presence of bleeding from the mouth and the nose and assess the effectiveness of ventilation in obstruction for the above-mentioned purpose. The study showed that the vast majority of

NNPs (99.2%) performed aspiration of the tracheal tube if obstructed, observed petechiae, ecchymosis, ventilator incompatibility, pneumonia, pneumothorax and hemothorax, and reported relevant findings to the physician (Table 2). Studies showed that complications related to mechanical ventilation occurred in 6 - 9% [23]; 13.1% [24]; 13.2% [25] and 18.9% [5] of neonates in MVS. However, this study also found that the nurses monitored the mechanical ventilator connections and reported it in writing less frequently than the other knowledges and practices (Table 1). Studies found that nurses reported procedural, charting, transcription errors [18]; missed nursing care [26-30] According these results, it is necessary that NNPs attends training programs on the use of MVS, periodical maintenance of the equipment is performed regularly, and the connections of the mechanical ventilator are controlled continuously to avoid mistakes related to technical operations such as controlling the connections of the mechanical ventilator and to ensure that the neonate begins spontaneous respiration as soon as possible.

Conclusion

This study found that the majority of the NNPs have knowledge related to the MVS and perform important practices for the use of ventilator, neonatal monitoring, and potential problems during ventilation support and weaning of support in neonates on MVS. This study results have implications for nursing education, management, and practice.

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