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The Efficacy of a Protocolized Nursing Care on Nasal Skin Breakdown in Preterm Neonates Receiving Nasal Continuous Positive Airway Pressure

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Abstract

Background: Nasal continuous positive airway pressure (NCPAP) is an effective method of ventilation in newborns with respiratory distress syndrome (RDS). Using an appropriate nasal skin care protocol is identical to prevention or reduction of nasal skin breakdown in those who receive NCPAP. This study aimed to investigate the effectiveness of an evidence-based clinical care protocol on nasal skin integrity in preterm newborns who receive NCPAP.

Materials and Methods: A Randomized Controlled Trial was used to conduct the study. A cohort of 110 preterm newborns with a gestational age (GA) of 25 to 36 weeks, receiving nasal continuous positive airway pressure (NCPAP) for RDS in the neonatal intensive care unit of a university teaching hospital were selected to perform the study. They were randomly assigned to a protocolized nasal skin care (group A) or to a group receiving the routine care (group B). Nasal skin integrity of the preterm neonates, were measured on a daily basis for 10 days using the Neonatal Skin Condition Scale (NSCS) 24 hours after placement of NCPAPs in both groups.

Results: Each intervention and control group included 55 neonates. 65.50% of neonates in the control group and 47.30% of neonates in the intervention group were male. Repeated measures analysis showed that NSCS scores were significantly lower in intervention group receiving nasal skin care in accordance with the protocol than the control group receiving the routine nasal skin care (P=0.000).

Conclusion: In this study, the protocolized care reduced nasal skin breakdown in the preterm newborns receiving NCPAP. Therefore, it can be used as an effective method in nasal skin care in neonates who are treated by NCPAP.

Key Words: Nasal continuous positive airway pressure, Nasal skin breakdown, Preterm neonate Protocolized nasal skin care.

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1- INTRODUCTION

Based on to date data, more than one in 10 neonates are born preterm worldwide (1). Prematurity is the main cause of death among babies in the first 4 weeks of life and preterm birth is currently the second main cause of death after pneumonia in children younger than 5 years (2). Annually, over 1 million children pass away due to complications of preterm birth. Neonates who survive often face lifetime disabilities including cognitive-learning disabilities, visual impairment, hearing issues (3), and chronic respiratory symptoms (4).

According to World Health Organization (WHO), the incidence of preterm birth ranges from 5% in European countries to 15% in African countries and Africa and South Asia account for 60% of them (5). Based on a review study in 2015, the incidence rate of preterm birth in Iran is 9%. Given the high incidence rate of preterm birth worldwide, critical care in the first days after birth is a key factor in survival of preterm newborns. Preterm birth is defined as livebirth that occurs before 37 completed weeks or 259 days of gestation (1). Prematurity can be further classified based on birth weight or gestational age. Based on their age at birth, preterm neonates are categorized into extremely preterm (< 28 weeks), very preterm (28 to < 32 weeks), and moderate to late preterm (32 to < 37 completed weeks of gestation) (6).

Neonates born preterm are at high risk of a number of prematurity-related complications. Respiratory support is a vital care in preterm neonates with respiratory failure or respiratory distress (RD) which often is secondary to surfactant deficiency (7). Approximately all patients in the neonatal intensive care unit (NICU), need a method of supplemental oxygen therapy, such as nasal cannula, oxygen given via headbox, nasal continuous positive airway pressure (NCPAP) and endotracheal intubation (8, 9). Nasal CPAP is a cost-effective and minimal invasive respiratory support for both term and preterm neonates with respiratory distress syndrome (10, 11). Moreover, it is frequently used as a good alternative method to avoid long-term endotracheal intubation which can lead to the acquired pulmonary complications (8).

Since introduction of CPAP by Gregory et al. in 1971 (12), different types of CPAP ventilation modalities have been produced by the researchers to provide oxygen support and ventilatory care (13). To date, CPAP can be delivered through different interfaces include nasal prong, nasopharyngeal tube, nasal mask, face mask, nasal cannula and neonatal helmet. In addition, NCPAP is an effective method of ventilation in postextubation period to prevent atelectasis and need for endotracheal intubation whose indication is inevitable in treating the preterm neonates.

CPAP through nasal interface or NCPAP is the most common method of CPAP in the neonatal intensive care units (NICU). Nasal CPAP applies a constant pressure of forced air into the lungs and prevents atelectasis by improving functional residual capacity (FRC). Increasing FRC through CPAP, leads to improvements in gas exchange, an increase in the partial pressure of oxygen dissolved in the blood (PaO2), and conversely, a reduction in the level of the partial pressure of carbon dioxide PaCO2 (14). Other mechanisms of CPAP function include regulation of breathing pattern, reduction of thoracic distortion and surfactant release enhancement (14).

Generally, CPAP systems contains three main parts: **1**. An interface which includes a mask or prong that fits over the nose, **2**. A circuit or tube for continuous flow of inspired air, and **3**. A driving force or generator which provides an appropriate positive pressure with desired fraction of

inspired oxygen. Nasal prong or mask is secured upon the nostrils by a headdress that is worn on the crown of the head (15, 16). Nasal CPAP is performed through nasal cavity hence understating the development, anatomy and function of nose are identical for this study. The nose is a pyramidal-like limb and consists of external nose and nasal cavity. Both are divided, through a septum, into left and right halves. The external nose has two orifices called nostrils which are separated from each other by the nasal septum. The lateral edge of the nose is called ala nasi which is round and movable. Philtrum is the vertical groove between the nose and the upper lip. The posterior portion of each nare opens into the nasopharynx and are called choanae. The nose has a number of functions which include cleansing, smelling, and serving as a reservoir for sinus and nasolacrimal duct secretions. In addition, it has an important role in air humidification and respiration (17).

Beside the valuable advantages of ventilation by NCPAP system, our clinical experience in the hospital and review of the literature showed numerous complications in application of NCPAP in neonates particularly in preterm newborns such as dislogage of prongs, airway obstruction, leakage of air from infant's mouth and nasal skin damage. One of the most unpleasant and painful NCPAP-related complication is the risk of nasal skin breakdown. It commonly occurs on areas under high pressure of nasal interface, mostly on the nasal bridge but can take place at any area under pressure of mask or prong which are used to connect the ventilation system to the patient's nose (18). A review study addressed an incidence rate of 20% to 60% nasal skin damage in newborns receiving NCPAP (19). There are numerous patient-related risk factors which can accelerate the occurrence of nasal skin damage, but our review of the literature shows that its occurrence is often associated with inappropriate care in delivery of ventilation (20). Newborns on NCPAP need a special attention and close monitoring by care providers to assure proper delivery of pressure to the alveoli. Nasal skin of the premature neonate is very fragile which makes it susceptible to breakdown if continuous pressure is exerted on it by the nasal interface (21). Skin breakdown leading to nasal trauma is a serious complication of NCPAP delivery, because a severe nasal skin breakdown can be a satisfactory reason for the specialist to discontinue the use of NCPAP. Health professionals in the NICU especially the associated nurses should minimize nasal breakdown due to improper nasal prong or mask placement. When caring for patients with NCPAP prongs, providers should monitor for signs of nasal trauma such as dryness, redness, bleeding, abrasion of the skin and narrowing of the nasal passage (21).

Nasal skin damage in a neonate receiving NCPAP is preventable. A number of nursing cares are important to prevent or decrease the risk of nasal breakdown in patients who are treated with NCPAP. Selecting the right mask size, using a tolerable pressure for fixing the interface, proper fitting of NCPAP prongs or mask, avoiding over-tightening of the head strap, and using Hydrogel are some important care modalities which are used to decrease the risk of interface-associated nasal skin breakdown (16, 21). These caring interventions for prevention of nasal skin breakdown were used as a care protocol in the current study. Therefore, this study was conducted to examine the efficacy of a protocolized nursing care on nasal skin breakdown in preterm neonates receiving NCPAP.

2- MATERIALS AND METHODS

2-1. The Study design and samples

A randomized controlled clinical trial

was used to conduct the study. This study was performed in a neonatal intensive care ward (NICU) of Al-Zahra teaching hospital affiliated to Tabriz University of Medical Sciences from July 10, 2015 to April 20, 2016. A cohort of 110 preterm neonates with a gestational age (GA) of 25 to 36 weeks, receiving nasal continuous positive airway pressure (NCPAP) for RDS were recruited in the study. The eligible 110 neonates were randomly assigned to a protocolized nursing care on nasal skin care (group A) or to a group receiving the routine care (group B). Premature neonates or neonates with birth gestational age less than 37 weeks who were treatable by NCPAP due to RDS after birth were included in the study.

In addition, term births, hyperglycemic neonates and those with nasal abnormalities were excluded from the study. The intervention and control groups were not different in terms of birth weight, gender, gestational age and days on NCPAP. The usual time of NCPAP administration was immediately after or within 6 hours after the births. The main cause of NCPAP prescription by the attending physician were respiratory distress and asphyxia after preterm birth. Based on the physician order, the initial O2 levels administered to the neonates fluctuated between 4 and 5 cm H2O.

2-2. Procedure

Before the data collection, the study project approved by the ethics committee of Tabriz University of Medical Sciences. Furthermore, this study was registered in the Iranian Registry of Clinical Trials (IRCT) under code of IRCT201411054617N11.

Protocol development was the primary and important part of study. Using to-date evidence-based literature a care protocol was designed and was used for daily nasal care of the preterm neonates in the intervention group. An extensive literature review along with an expert group specialized in the field of skin care and neonatal care participated to develop the care protocol. **Table.1** shows the components of the protocol in both control and intervention groups.

Nasal skin integrity in the neonates was measured on a daily basis for 10 days by Neonatal Skin Condition Scale (NSCS) 24 hours after beginning of NCPAP ventilations in both groups, until full recovery from the respiratory distress and nasal breakdown (22). This tool was first used by Association of Women's Health, Obstetric and Neonatal Nurses (AWHONN). This scale measures three main signs of skin including dryness, erythema and breakdown. A psychometric study (23) showed an adequate inter-rater reliability for each of the three subscales and for the total scale (65.9% to 89%). Each item score ranges from 1 to 3. In each item, score 1 shows a normal skin condition and the score 3 shows the worst skin condition. Accordingly, total NSCS score ranges from 3 to 9. Score 3 demonstrates a normal skin integrity and the newborn who achieve score 9 has the worst skin integrity (23).

Table-1: Nursing care protocol in control and intervention groups

Nursing cares and considerations, sequences of care	Control group	Intervention group
Physical examination of nasal skin (nose tip, nares, philtrum and septum) [daily]	✓	✓
Ensuring proper placement of prong inside the nostril [in placement and q 6 h] or Ensuring proper placement of nasal mask upon the nostril [in placement and q 6 h]	✓	✓
Ensuring the distance of about 2 mm between nasal septum and prong [q 6 h]	✓	✓

Delivery of humidified oxygen	✓	✓
Ensuring normal pressure on nose [q 4 h]	✓	✓
Using a tape or shield to secure the nasal prong [on placement time]	✓	✓
Daily gentle massage upon nasal septum and the bridge [q 6 h]		✓
Regular substitution of prong with mask and vice versa [q 6 h]		✓
Lubrication of nasal skin, philtrum and septum by Hydrogel [q 6 h]		✓
Tetracycline ointment use (if wound occurred) [q 6 h]	✓	✓

Fig.1: An infant undergoing a sleep study with nasal CPAP

3- RESULTS

The pattern of nasal skin integrity in preterm neonates within and between the intervention and control groups were analyzed. Repeated measure analysis showed significant difference within and between the intervention and control groups in terms of nasal skin integrity in preterm neonates who were receiving ncpap. Within both control and intervention groups, within- subject analysis showed a significant difference between 10 caring days (df= 9, F=113.73, P =0.000).

This means that in both groups, NCPAP-related nasal skin damage started over time, approximately after the second day, and continued until about 5 days after weaning from NCPAP. Inter-subject or inter-group part of repeated-measure analysis identified a statistically significant difference between the control group and the intervention group in terms of nasal skin integrity (df= 1, F=159.37, P=0.000). **Table.2** shows the detailed between subject differences within 10 days. Furthermore, the effect of time on skin integrity was statistically significant in the inter-group phase (Time*group: df= 9, F=6.77, P=0.000).

Additional analysis after importing co-variates including gender, vitamin use, Apgar score, phototherapy and weight of the neonates did not change the statistical difference both in the intra- subject (df=9, F=11.66, P=0.000 and inter- subject phases (df=1, F=112.91, P=0.000).

Figure.1 shows the significant statistical difference between intervention and control groups both in intra- subject and inter- subject phases.

Table-2: Skin integrity score in intervention and control groups within 10 days

Days	Control	Intervention	P-value
	Mean ±SD	Mean ±SD	
Day 1	3.09±0.29	3.00±0.00	0.22
Day 2	4.65±0.84	3.14±0.40	0.00
Day 3	5.45±0.97	3.78±0.80	0.00
Day 4	6.12±0.86	4.49±1.03	0.00
Day 5	6.36±1.20	4.83±1.22	0.00
Dday 6	6.47±1.27	4.83±1.38	0.00
Day 7	6.03±1.47	4.27±1.28	0.00
Day 8	5.49±1.38	3.60±0.80	0.00
Day 9	4.89±1.13	3.27±0.55	0.00
Day 10	4.81±1.20	3.10±0.31	0.00

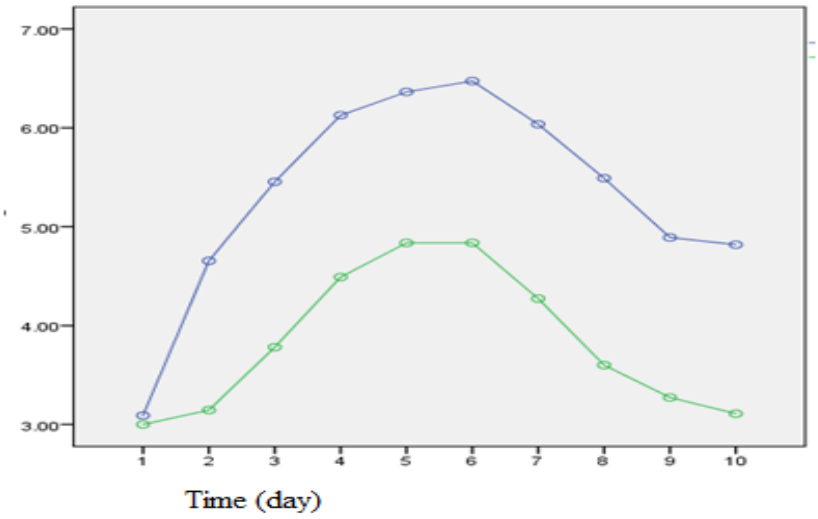

Fig.2: Changes in Nasal Skin Condition Scores over 10 observations (10 days) in the preterm neonates receiving NCPAP

4- DISCUSSION

The purpose of this study was to examine the effectiveness of a protocolized nasal skin care on prevention of nasal skin breakdown in preterm neonates receiving NCPAP. Importantly, the use of practice guideline with evidence-based components was associated with significant decrease in nasal skin damage in the neonates receiving NCPAP. Inter- group and intra-group differences were statically significant and this supports the effectiveness of the administered protocol. Notably, in this study, nasal skin integrity of preterm neonates receiving NCPAP were monitored for 10 days from first day of NCPAP placement. After placemen of NCPAP interface, fragile nasal skin of preterm neonates started to be damaged over time in both intervention and control groups, but the severity of skin damage was not similar in intervention and control groups. In fact, data analysis showed that the protocolized guideline-based care of NCPAP delivery can improve nasal skin integrity more effectively compared to the

conventional routine care. There were two types of caring considerations or components in the protocol used for intervention and control groups. The ordinary or routine caring components were used in both intervention and control groups. These protocols included measurement of head circumference to select an appropriate hat strip, selection of nasal prongs or the mask, securing the nasal prong or mask with a strip, appropriate mask fitting, administration of humidified inspiratory gases, and daily physical examination of nasal skin and nares (18). The additional interventions performed in the intervention group included administration of massage and emollient of nose with Hydrogel every 6 hours.

In this study, there were some key difference between routine care for control group and the protocolized care for the intervention group. Massage of nasal septum every 6 hours with the emollient of Hydrogel was one of the main parts of caring protocol. A study that tested a protocol including hydrogel for caring nasal skin of neonates receiving NCPAP, showed the effectiveness of the protocol in wound healing (24). In another guideline-testing study, emollient administration was introduced as an effective modality in reducing dryness and worsening of skin integrity, particularly in very preterm neonates (22).

Another study demonstrated that hydrocolloid dressing can significantly decrease the incidence and the severity of nasal injury secondary to NCPAP (25). In contrast, a study on the effectiveness of Hydrocolloid dressing on skin breakdown in premature infants receiving heated humidified high-flow nasal cannula (HHHFNC) oxygen, showed that Hydrocolloid dressing is not effective enough (22). Simultaneous use of prong and nasal mask was another consideration of care protocol in the current study. The logic for rotational use of prong and nasal mask interfaces is that when we change prong with mask and vice versa, the location of skin under pressure is changed. Therefore, this modification gives an opportunity to under-pressure point of skin to escape from skin damage (26). Congruently, a previous study showed that the incidence of nasal injury caused by nasal mask or prongs during NCPAP is different. In other words, nasal injury rate was 35% for the infants receiving NCPAP by prongs and 29% for those treated by the NCPAP system using nasal mask. In the current study both nasal devices (prong and mask) were used to connect the NCPAP system to the patients' nose. It should be noted that, the nasal prongs and masks were replaced every six hours in all patients.

4-1. Limitations of the study

Although this research was carefully prepared, the additional variables such as nurses' level of competency, environmental temperature and additional manipulation of the patients by the health professionals may influence the nasal skin integrity.

5- CONCLUSION

Application of the caring protocols to reduce skin breakdown will support NCPAP treatment success reduce mandatory intubation rates, and improve the results during NCPAP use. In the current study, nasal skin care protocol played an effective role in preventing or postponing the nasal skin damage in a sample of preterm neonates receiving NCPAP due to respiratory distress. Health professionals, particularly nurses can validate and, if necessary, modify this protocol so that it can be used in caring neonates receiving NCPAP. Conduction of further studies to test other protocols with new care modalities can be of great value in this field.

6- CONFLICT OF INTEREST: None.

7- AKNOWLEDGMENT

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