

# Effect of Nursing Protocol Regarding Nasal Skin Breakdown for Preterm Infants Receiving Continuous Positive Airway Pressure

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## ABSTRACT

**Context:** Neonates, particularly those born premature, may require ventilation assistance immediately after birth since their lungs may not be fully developed. The use of nasal continuous positive airway pressure (CPAP) is increasing as a means of respiratory support in many premature infants. So, the presence of nasal skin breakdown may be seen as a complication.

**Aim:** Evaluate the effect of nursing protocol regarding nasal skin breakdown for preterm infants receiving nasal continuous positive airway pressure (CPAP).

**Methods:** A quasi-experimental research design was utilized to conduct the current study. The study conducted at Neonatal Intensive Care Units (NICUs) and Surgical Neonatal Intensive Care Unit "SNICU" of Benha Specialized Pediatric Hospital at Benha city. A convenient sample of nurses (70) working in NICU and SNICU and a purposive random sample of (77) preterm infants included from the settings mentioned above. Those premature infants were divided into two groups (study and control) (35) in the control group and (42) in the study group, who selected according to the power analysis equation based on the total number of preterm infants admitted to the setting mentioned above during 2017. Three tools were used. A structured interviewing questionnaire was designed to assess nurses' sociodemographic characteristics, nurses' knowledge regarding CPAP, care provided to preterm infants undergoing CPAP, and nasal skin breakdown. The second tool was a nursing practice observation checklist to assess nurses' practice regarding nasal CPAP. The third tool was Preterm Medical Assessment Record. It is designed to assess the characteristics of preterm infants and medical data of preterm infants. The last tool was the Neonatal Skin Condition Score (NSCS) scale, designed to assess the neonates' skin condition.

**Results:** Findings of the present study revealed a statistically significant difference ( $P < 0.05$ ) pre and post-nursing protocol implementation regarding CPAP, the role of the nurse caring for preterm infants undergoing nasal CPAP, and nasal skin breakdown. The results also revealed a highly statistically significant difference in nursing practice regarding care for preterm infants undergoing nasal CPAP pre and post-nursing protocol implementation at ( $p < 0.001$ ). Nasal Skin Breakdown in the study group was significantly less than in the control group at a different time of assessment at ( $p < 0.001$ ).

**Conclusion:** It can be concluded that the research hypothesis is accepted; nursing protocol implemented for nurses improved their knowledge and practice as well as reduced nasal skin breakdown in the preterm newborns receiving NCPAP. The study recommended applying the nursing protocol for nurses caring for preterm infants to reduce nasal skin breakdown during CPAP ventilation, an effective and safe non-invasive intervention in all NICUs as a standard of care for all preterm infants.

**Keywords:** Nursing protocol, nasal skin breakdown, preterm infants, Continuous Positive Airway Pressure

## 1. Introduction

Preterm birth is defined as live birth that occurs before 37 completed weeks or 259 days of gestation. Prematurity can be further classified based on birth weight or gestational age. Based on their age at birth, preterm neonates categorized into extremely preterm (<28 weeks), very preterm (28 to <32 weeks), and moderate to late preterm (32 to <37 completed weeks of gestation) (Howson, Kinney, McDougall & Lawn, 2013 & National Institutes of Health, 2015).

The incidence of preterm birth ranges from 5% in European countries to 15% in African countries. Africa and

South Asia account for 60% of them, while the incidence rate of preterm birth in Iran is 9% (World Health Organization, 2015). According to WHO, every year, about 15 million neonates are born prematurely worldwide, and that is more than one in 10 of all neonates born globally. Almost 1 million die each year due to complications of preterm birth. Across 184 countries, the preterm birth rate ranges from 5% to 18% of neonates born. In India, out of 27 million neonates were born every year, 3.5 million were born prematurely (World Health Organization, 2018).

Approximately most preterm infants in the neonatal intensive care units (NICUs) need oxygen therapy supplementation, such as a nasal cannula, headbox, nasal continuous positive airway pressure (NCPAP), and endotracheal intubation (Jatana et al., 2010; Ho, Subramaniam, & Davis, 2015). Nasal CPAP is a cost-

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effective and minimal invasive respiratory support for both term and preterm infants with respiratory distress syndrome. Moreover, it is considered an excellent alternative method to avoid long-term endotracheal intubation, leading to acquired pulmonary complications (Gupta, Saini, Murki, Kumar, & Deorari, 2015).

The Continuous Positive Airway Pressure (CPAP) is a technique of airway management in which positive intrapulmonary pressure is applied artificially to the airways, whereby distending pressure is created in the alveoli in a spontaneously breathing infant throughout the respiratory cycle. Continuous Positive Airway Pressure (CPAP) is a non-invasive method for applying a constant distending pressure level during inhalation and exhalation to support spontaneously breathing infants with lung diseases. CPAP is an "open-lung approach" used to manage infants predisposed to developing airway instability, edema, and atelectasis (Aziz & Abdul-Hamza 2017b).

Continuous positive airway pressure (CPAP) distends the continuous pressure in spontaneously breathing for preterm neonates and increases the lung's functional residual capacity, resulting in better gas exchange for these infants. Also, it reduced the risk of mortality by 48% and the need for surfactant and mechanical ventilation by about 50%. So, it has become the standard of care in managing sick preterm infants with respiratory distress (Thukral, Sankar, Chandrasekaran, Agarwal & Paul 2016).

Preterm infants on NCPAP need special attention and close monitoring by health care providers to assure proper delivery of pressure to the alveoli. The nasal skin of the preterm infant is very fragile, which makes it susceptible to breakdown if continuous pressure is exerted on it by the nasal interface. 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 discontinuing the use of NCPAP. Health professionals in the NICUs, especially nurses, should prevent/minimize nasal breakdown, which occurs due to improper nasal prong. When caring for preterm infants with NCPAP prongs, nurses should monitor for signs of nasal trauma such as dryness, redness, bleeding, abrasion of the skin, and narrowing the nasal passage (Bonner & Mainous 2018).

Nasal trauma is also a common problem with CPAP. It is mostly caused by incorrect positioning of the prongs. An observational series found significant nasal complications in 13.2% of neonates with seven or more days of nasal CPAP. Injuries included columellar necrosis, seen in 5.5%, ulceration in 6 nasal cavities (3.3%), granulation in 3 nasal cavities (1.6%), and vestibular stenosis in 4 nasal cavities (2.2%). Intranasal complications are seen as early as 8 to 9 days after nasal CPAP (Donn & Sinha, 2015).

Nasal skin breakdown in preterm infants receiving NCPAP is preventable. Several nursing cares are essential to prevent or decrease the risk of a nasal breakdown in these infants 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 essential care modalities used to decrease the risk of

interface-associated nasal skin breakdown (Bonner & Mainous 2018).

The nurse has a vital role and responsibility in caring for infants receiving CPAP. Nursing care must be taken to avoid soft tissue injury for preterm neonates, particularly to the nasal mucosa, nasal septum, and philtrum. Nasal trauma is a common problem with NCPAP and is mostly caused by incorrect positioning of the prongs. So, the nasal device must not be pushed up against the columella; selecting appropriate-size prongs, constant nursing vigilance, and attention to correct positioning are necessary to prevent nasal injury during NCPAP (Imbulana, Manley, Dawson, Davis & Owen, 2018).

## 2. Significance of the study

The global prevalence rates of nasal traumas for preterm neonates ranged between 20 and 42.5% (Bonfim, Vasconcelos, Sousa, Silva, & Leal, 2014). Preterm birth is estimated by 10% -12% from neonates born in Egypt (Helmy, 2016). Meanwhile, preterm neonates in Neonatal Intensive Care Units (NICUs) of Specialized Pediatric Hospital at Benha city in 2016 estimated as 939 preterm infants, with most of them under CPAP ventilation (Benha Specialized Pediatric Hospital Statistics Department, 2016). So, this study helps decrease nasal skin breakdown for preterm infants, which will decrease the duration of hospital stay. Consequently, decreases cost and increases the quality of provided care, and decreases liability for infection.

## 3. Aim of the study

The present study aimed to evaluate the effect of nursing protocol regarding nasal skin breakdown for preterm infants receiving nasal continuous positive airway pressure (CPAP) through:

- Assessing nurses' knowledge and practice regarding nasal skin breakdown for preterm infants receiving nasal CPAP.
- Designing and implementing a nursing protocol for nurses regarding nasal skin breakdown for preterm infants receiving continuous positive airway pressure.
- Evaluating the effect of implementing a nursing protocol on nurses' knowledge and practice regarding nasal skin breakdown for preterm infants receiving continuous positive airway pressure.
- Evaluating the effect of implementing the nursing protocol on the nasal skin breakdown for preterm infants receiving nasal CPAP.

### 3.1. Research hypotheses

- Nurses exposed to the nursing protocol will exhibit better knowledge and competent practices than their preintervention level.
- The preterm infant cared for by trained nurses on the nursing protocol will have less nasal skin breakdown than the control group.

## 4. Subjects & Methods

### 4.1. Research design

A quasi-experimental research design was utilized to accomplish the present study.

### 4.2. Research setting

This study was carried out at Neonatal Intensive Care Units (NICUs) and Surgical Neonatal Intensive Care Unit "SNICU" of Benha Specialized Pediatric Hospital affiliated to the Egyptian Ministry of Health and Population and Specialized Medical Centers at Benha City, Egypt, where this hospital being of highest capacity of preterm infants. This hospital is composed of one NICU on the third floor in building "A" and Surgical Neonatal Intensive Care Unit "SNICU" on the third floor in building "B." NICU on the third floor contains two rooms, the 1<sup>st</sup> room had 31 incubators, and the 2<sup>nd</sup> room had three incubators. Building "B" contains two rooms on the third floor with 12 incubators.

### 4.3. Subjects

The study sample consisted of two groups:

Sample A: A convenient sample of all available nurses (70) working at the previously mentioned study settings included in this study.

Sample B: A simple random sample of 77 preterm infants selected during data collection in the previously mentioned study settings. The sample size was calculated based on the previous year's report regarding the admission of preterm infants who were requiring nasal CPAP at Benha Specialized Pediatric Hospital. The total number of infants was 939 (*Benha Specialized Pediatric Hospital statistics department, 2017*). They divided into two unequal groups control and study groups under the following inclusion criteria:

- Less than 37 weeks of gestation.
- On continuous positive airway pressure nasal (CPAP) ventilation.
- Free from any congenital anomalies.
- Free from any skin problems

The sample size calculated utilizing the following equation *Yamane, (1967)*.

$$n = \frac{N}{1 + N(e)^2}$$

Where:

n=sample size

N=total population

e=margin error (0.05)

A total of 77 preterm infants were recruited in the current study. They were randomly allocated into two groups: group (1) control group included (35) preterm infants receiving only routine nursing care, and group (2) study group included (42) preterm infants receiving nursing care based on nasal skincare protocol.

Technique: The control group was firstly assessed in the first three months of data collection. This technique applied to avoid and reduce bias during data collection.

Additionally, study group-related intervention and assessment were applied in the next three months.

### 4.4. Tools of the study

Four tools were utilized to collect data pertinent to the current study. These tools consisted of the following:

#### 4.4.1. A structured interviewing questionnaire

It was designed by the researchers in light of relevant studies and researches (*Hockenberry & Wilson 2015*). It was written in an Arabic language and composed of two parts. The first part concerned sociodemographic characteristics of studied nurses such as age, gender, academic qualifications, years of experience, and attendance of previous training courses regarding CPAP ventilation.

The second part composed of 3 sections:

Nurses' knowledge regarding Nasal CPAP. It included definition, indications when starting nasal CPAP, side effects of nasal CPAP, complications, precaution to be taken during connection to nasal CPAP, prevention of nasal CPAP, induced complications, and when start weaning from nasal CPAP. It encompassed eight multiple-choice questions.

Nurses' knowledge regarding nursing care provided to preterm infants undergoing CPAP such as; observation of the site of nasal CPAP, the appropriate size of nasal CPAP, sterilization of nasal CPAP, observation of nasal cavity, frequency of nasal suction, the technique of nasal suction, complications that happen to the nose of a preterm infant, nursing role regarding the care of the nose of preterm infants before connection to nasal CPAP, nursing role regarding the care of the nose of preterm infants during connection to nasal CPAP, nursing role regarding the care of the nose of preterm infants after weaning from nasal CPAP, prevention of nasal skin breakdown and how to deal with complications affected the nose of the preterm infant. It includes 12 multiple-choice questions.

Nurses' knowledge regarding nasal skin breakdown involved information such as (definition of nasal skin breakdown, degrees of nasal skin breakdown, early manifestations of nasal skin breakdown, late manifestations of nasal skin breakdown, predisposing factors for nasal skin breakdown, prevention of nasal skin breakdown and prognosis of preterm infants with nasal skin breakdown). It includes seven multiple-choice questions.

#### Scoring system for knowledge

Nurses' knowledge was evaluated upon completing the interviewing questionnaire as the studied nurses' knowledge was checked with a model key answer. Accordingly, the complete, correct answer scored (2) scores, the incomplete correct answer was given (1) score and (0) for incorrect or do not know answers. The total score ranged from 0-54 (27 questions ×2). Then, the subtotal score for each knowledge part and total knowledge was categorized as a score of 75%, and more considered good, a score between 50% to less than 75% was considered average. In comparison, a score below 50% was considered poor.

#### **4.4.2. Nursing Practice Observation Checklist**

It was adopted from *Chen, Chou, Chou, Tsao, & Hsieh (2017)* to assess nurses' practice toward preterm neonates undergoing Nasal CPAP ventilation. It included three performance checklists with a total of 27 steps. They distributed as installation of Nasal CPAP (10 steps), maintenance of Nasal CPAP (7 steps), and nasal skincare (10 steps).

##### *Scoring system for the checklist*

A score of (2) gave for correctly done, a score of (1) for incorrectly done, and a score of (0) for not done. The total score ranged from 0-54. Total scores converted into percent scores, where the score of  $\geq 80\%$  considered competent practice and a score  $< 80\%$  considered incompetent practice.

#### **4.4.3. Preterm Medical Assessment Record**

It was composed of two parts as follow:

Part 1 included the characteristics of preterm infants, such as age, gestational age, gender, birth weight, and current weight.

Part 2 encompassed the medical data of preterm infants, such as medical/surgical diagnosis, causes for nasal CPAP connection, complications during nasal CPAP connection, duration of connection to nasal CPAP, and physiological parameters.

#### **4.4.4. Neonatal Skin Condition Score (NSCS)scale**

This tool is designed to facilitate the assessment of skin conditions. It is copyright of the *Association of Women's Health, Obstetric and Neonatal Nurses (AWHONN) (2001)* and reproduced with their kind permission. This scale measures three main signs of skin, included dryness, erythema, and breakdown. Each item score of the three subscales ranges from 1 to 3. In each item, score 1 shows healthy nasal skin integrity, and score 3 shows the worst skin integrity. Accordingly, the total NSCS score ranges from 3 to 9. Score 3 demonstrates a normal nasal skin condition, and the preterm infant who achieves a score of 9 has the worst nasal skin condition.

#### **4.5 Procedures**

**Preparatory phase:** A review of the past and currently available literature related to the research problem using books, evidence-based articles, periodicals, and magazines were done to be acquainted with all aspects of the study problem and also to develop relevant tools for data collection and designing the content of nursing protocol. This period extended from the beginning of May 2018 to the end of June 2018.

Tools validity was tested through a jury of three experts in the pediatric nursing field to test the tool's clarity, relevance, comprehensiveness, simplicity, and applicability. Modifications of the tools were made according to the experts' judgment on the clarity of sentences, appropriateness of the content, and sequence of items. According to their review, the experts agreed on the contents, and minor modifications were done to the

contents. Testing the reliability of the tools was done by using Cronbach's alpha test. The reliability score was 0.86. A psychometric study showed adequate inter-rater reliability for each of the three subscales and the total scale (65.9% to 89%) for the NSCS scale. This phase took one month in July 2018.

**Ethical and legal considerations:** Permission to carry out the study was obtained from the hospital manager and the supervisor of NICUs and SNICU in the previously mentioned study settings by submitting an official letter issued from the Dean of Faculty of Nursing, Benha University. All studied nurses assured that participation in the study was voluntary, nurses are informed of the purpose, procedures, benefits, and nature of the study. Each nurse had the right to withdraw from the study at any time without any rationale. Then, oral consent was obtained from them. Nurses informed that obtained data would not be included in any further researches or job evaluation. Confidentiality and anonymity of data assured through coding of all data, and all information have taken was protected.

The pilot study was carried out on 10% of studied subjects (7 nurses and six preterm infants) over one month (August 2018). The purpose was to ascertain the feasibility of the study, the clarity, and the applicability of the tools. It also helped to estimate the time needed for filling out the forms. Based on the pilot results, the necessary modifications to the study tools made and pilot study subjects excluded later from the study sample.

**Fieldwork:** The actual fieldwork was carried out for six months (from the beginning of September 2018 to the end of January 2019). The researchers were available at the previously mentioned settings three days/week (Monday, Thursday, and Wednesday) in NICU and SNICU in the morning shift to collect data using the previous data collection tools.

**Assessment phase:** In the beginning, the researchers interview each nurse, introduced themselves to each nurse included in the study, explained the aim of the study, duration, and activities, and took oral consent to participate in the study before data collection. Then, each nurse was asked to fill the structured interviewing questionnaire sheet individually to collect baseline data and assess nurses' learning needs (tool I). After that, the researchers fill the preterm medical assessment record (tool III). Also, the researchers observed each nurses' practice during demonstrating routine care for preterm infant to assess their care provided for preterm infants (tool II). Meanwhile, the researchers started to assess preterm infants' nasal conditions for risk of nasal skin breakdown in the control group after receiving routine hospital care by nurses.

Moreover, the researchers measured nasal skin break down at baseline in the second day following the start of the connection to nasal CPAP when nasal skin break down was not expected and then conducted on the seventh days and 14<sup>th</sup> day (when nasal skin breakdown expected) for three times in total by using (tool IV). The researchers filled out the study tools, and the average times required for completion of each tool were around 15-25 minutes.

Planning phase: The nursing protocol designed by the researchers after an extensive review of related literature and the needs identified in the assessment phase. An Arabic booklet concerning the prevention and management of nasal skin breakdown preterm infants connected to nasal CPAP was prepared and given to studied nurses.

Nursing protocol contents included a definition of the preterm infant, nursing care for preterm infants, definition, and indications of CPAP, when starting nasal CPAP, side effects of nasal CPAP, complications, precaution to be taken during connection to nasal CPAP, prevention of nasal CPAP induced complications and when start weaning from nasal CPAP. Additionally, the technique of nasal suction, complications that happen to the nose of a preterm infant, nursing role regarding the care of the nose of preterm infants before, during, and after connection to nasal CPAP and after weaning from nasal CPAP, prevention of nasal skin breakdown and how to deal with complication affected the nose of the preterm infant.

Implementation phase: The nursing protocol was implemented in about two months. It was carried out in 6 sessions (2 sessions for theory and four sessions for practice). A schedule suitable for nurses developed to conduct the nursing protocol includes; date, place, topic, time, and duration of each session. The nursing care protocol consisted of two parts, the theoretical part and the practical parts cover the protocol items. It was challenging to take all nurses simultaneously; thus, they divided into nine groups of about 7-8 nurses in every session.

The duration of theory sessions 30-45 minutes for each session, and practical sessions ranged between 45 to 60 minutes for three days/week for nine weeks. At the beginning of each session, the researchers concluded what was given through the previous session and objectives of the new one, considering using simple and clear language to suit the nurses. Different teaching methods were used, including small group discussions, lectures, brainstorming, role-playing, demonstration, and re-demonstration. The teaching aids used were colored posters and Microsoft PowerPoint presentation 2010. Each nurse of all studied groups obtained a copy of the nursing protocol handout explaining all elements in the Arabic language.

Evaluation Phase: After completing the protocol contents, the nurses' knowledge and practice were evaluated immediately after implementing the nursing protocol. The post-tests were administered using the same pretest data collection tools. Additionally, the researchers asked nurses to apply nursing protocol on preterm infants (study group) and evaluate nasal skin condition by using the Neonatal Skin Condition Score (NSCS) scale (tool IV). The average number of preterm infants receiving nasal skincare/week was ranged from 6-7, while the number of them in the control group was 5-6 per week.

#### 4.5 Data analysis

The collected data were categorized, analyzed, and tabulated using the SPSS computer program Version 21. Numerical data expressed as the mean and standard

deviation. Qualitative data expressed as frequency and percentage. A comparison between qualitative variables carried out by using a parametric Chi-square test. Correlation among variables analyzed using the Pearson correlation coefficient. A statistically significant difference is considered at a p-value  $\leq 0.05$ . A highly statistically significant difference was considered at p-value  $< 0.001$ , and no statistically significant difference was considered at p-value  $> 0.05$ .

#### 5. Results

Table 1 shows the nurses' sociodemographic characteristics; it observed that the mean age of the studied nurses was  $25.51 \pm 6.12$  years. More than one-third (38.6 % & 35.7%) had a technical institute of nursing and a diploma of secondary nursing school. Additionally, it noticed that exactly two-fifths (40.0%) of nurses had experience from 5 to less than eight years.

Figure 1 illustrates that the majority (91.4%) of the studied nurses are females, while the minority (8.6%) were males.

Figure 2 shows that less than two-thirds (62.9%) of the studied nurses did not attend training programs regarding nasal CPAP, while more than one-third (37.1%) attended training programs regarding nasal CPAP.

Table 2 reveals the personal characteristics of the study and control preterm infants. It found that the mean age of the control and study group were ( $11.85 \pm 9.53$  &  $11.16 \pm 9.58$ ), respectively. It indicated no statistically significant difference ( $P > 0.05$ ) between the studied preterm infants in age, gestational age, and gender.

Table 3 shows a comparison of the study and control preterm infants according to their medical data. It found that more than two-thirds (68.6%) of the control group had respiratory distress syndrome compared with (59.5%) in the study group, with a nonsignificant difference between the two groups. More than three-quarters (78.6%) of the study group had no complications during their connection to nasal CPAP. In contrast, less than two-thirds (62.9%) of the control group had complications during their connection to nasal CPAP before nursing protocol implementation. The mean duration of connection to nasal CPAP in the control and study group were ( $11.11 \pm 9.29$  &  $13.52 \pm 9.15$ ), respectively.

Table 4 clarifies the comparison of the study and control preterm infants according to their physiological parameters before, during, and after weaning from nasal CPAP. It found that the majority (80.0% & 81.0%) of the control and study group had abnormal respiration before connection to nasal CPAP, respectively.

Table 5 represents nurses' knowledge regarding nasal CPAP pre and post-nursing protocol implementation. It found that there was a statistically significant difference ( $P < 0.05$ ) pre and post-nursing protocol implementation regarding the definition of nasal CPAP, the indication of nasal CPAP. Also, regarding when starting nasal CPAP, side effects of nasal CPAP, the complication of nasal CPAP, precaution during connection to nasal CPAP,

prevention of complications, start weaning from nasal CPAP, and the total knowledge of this domain.

Table 6 reveals nurses' knowledge regarding caring for preterm infants undergoing nasal CPAP pre and post-nursing protocol implementation. It was observed that there was a statistically significant difference ( $P < 0.05$ ) regarding all care components pre and post-nursing protocol implementation.

Table 7 shows nurses' knowledge regarding nasal skin breakdown pre and post-nursing protocol implementation. It found that there was a statistically significant difference ( $P < 0.05$ ) between pre and post-nursing protocol implementation regarding all knowledge components of nasal break down.

Table 8 reveals distributions of the studied nurses according to their practice regarding care for preterm infants undergoing nasal CPAP pre and post-nursing protocol implementation. It found that there was a highly statistically significant difference ( $P < 0.001$ ) between pre and post-nursing protocol implementation.

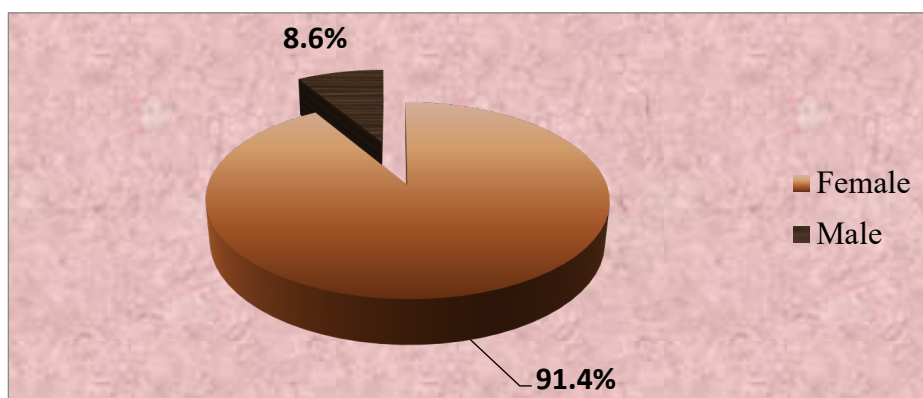
Table 9 illustrates a comparison of the studied nurses according to their practice regarding care for nasal skin for preterm infants undergoing nasal CPAP pre and post-nursing protocol implementation. It found that there was a highly statistically significant difference ( $P < 0.001$ ) pre and post-nursing protocol implementation.

Table 10 elaborates nurses' total knowledge and practice pre and post nursing protocol implementation and indicated that there were statistically significant differences ( $P < 0.05$ ) between the studied nurses' total knowledge, and there were highly statistically significant differences ( $P < 0.001$ ) regarding total practice level pre and post nursing protocol implementation.

Table 11 demonstrates a statistically significant difference ( $P \leq 0.001$ ) between control and study groups regarding their total score in the first week, and there was a highly statistically significant difference ( $P < 0.001$ ) between control and study groups regarding their total score in the second and third week.

**Table (1): Frequency and percentage distribution of the studied nurses according to their characteristics (n=70).**

Sociodemographic characteristics	No.	%
<b>Age in years</b>		
Less than 20	4	5.7
20->25	26	37.2
25->30	22	31.4
30->35	18	25.7
Mean $\pm$ SD	25.51 $\pm$ 6.12	
<b>Academic qualifications</b>		
Postgraduate	4	5.7
Bachelor of nursing science	14	20.0
Technical Institute of nursing	27	38.6
Diploma of secondary nursing school	25	35.7
<b>Years of experience</b>		
Less than two years	10	14.3
2->5	20	28.6
5->8	28	40.0
$\geq$ Eight years	12	17.1



**Figure (1): Percentage distribution of the studied nurses according to their gender (n=70).**

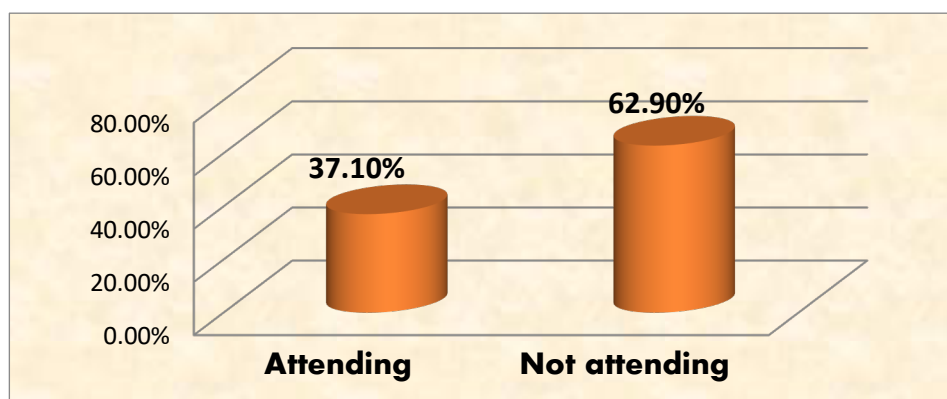


Figure (2): Percentage distribution of the studied nurses according to their attendance to training programs regarding nasal CPAP (n=70).

Table (2): Comparison of study and control group preterm infants according to their characteristics (n=77).

Preterm infants' characteristics	Control group (n=35)		Study group (n=42)		X <sup>2</sup>	P-value
	No	%	No	%		
<b>Age in days</b>						
Less than one day	3	8.6	2	4.8	6.029	>0.05
2->5	10	28.6	11	26.2		
5->10	9	25.7	14	33.3		
≥10	13	37.1	15	35.7		
Mean ±SD	11.85±9.53		11.16±9.58			
<b>Gestational age in weeks</b>						
28->30	3	8.6	5	11.9	5.810	>0.05
30->32	9	25.6	10	23.8		
32->34	8	22.9	11	26.2		
34->37	15	42.9	16	38.1		
<b>Gender</b>						
Male	20	57.1	26	61.9	7.400	>0.05
Female	15	42.9	16	38.1		
<b>Birth weight in grams</b>						
Less than 1500	7	20.0	14	33.3	10.829	≤ 0.05
1500>2000	13	37.1	12	28.6		
2000>2500	8	22.9	3	7.1		
≥2500	7	20.0	13	31.0		
Mean ±SD	2015±524.49		1974±712.60			
<b>Current weight in grams</b>						
Less than 1500	4	11.4	12	28.6	11.971	≤ 0.05
1500>2000	10	28.6	9	21.4		
2000>2500	13	37.1	11	26.2		
≥2500	8	22.9	10	23.8		
Mean ±SD	2095±561.79		2087±722.53			

**Table (3): Comparison of the study and control of preterm infants according to their medical data before nursing protocol implementation (n=77).**

Medical data of preterm infants	Control group (n=35)		Study group (n=42)		X <sup>2</sup>	P-value
	No	%	No	%		
<b>Medical/ surgical diagnosis</b>						
Respiratory distress syndrome	24	68.6	25	59.5	6.429	>0.05
Meconium aspiration syndrome	4	11.4	5	11.9		
Pneumonia	2	5.7	5	11.9		
Tracheoesophageal fistula	5	14.3	7	16.7		
<b>Causes for nasal CPAP connection</b>						
Recurrent apnea	18	51.4	19	45.2	14.500	≤0.05
Cyanosis	8	22.9	18	42.9		
Poor prognosis	9	25.7	5	11.9		
<b>Complication during nasal CPAP connection</b>						
Yes	22	62.9	9	21.4	11.159	≤0.05
No	13	37.1	33	78.6		
<b>Duration of connection to nasal CPAP in days</b>						
Less than 5	12	34.3	11	26.2	6.621	>0.05
5->10	9	25.7	12	28.6		
10->15	2	5.7	4	9.5		
≥15	12	34.3	15	35.7		
Mean±SD	11.11±9.29		13.52±9.15			

**Table (4): Comparison of the study and control preterm infants according to their physiological parameters before, during, and after connection to nasal CPAP (n=77).**

Physiological Parameters of preterm infants	Control group (n=35)						Study group (n=42)						X <sup>2</sup>	P-value
	Before connection to nasal CPAP		During connection to nasal CPAP		After weaning from nasal CPAP		Before connection to nasal CPAP		During connection to nasal CPAP		After weaning from nasal CPAP			
	No	%	No	%	No	%	No	%	No	%	No	%		
<b>Respiration</b>														
Normal	7	20.0	14	40.0	22	62.9	8	19.0	18	42.9	28	66.7	2.31	>0.05
Abnormal	28	80.0	21	60.0	13	37.1	34	81.0	24	57.1	14	33.3		
Mean ±SD	58.95±60.11		10.89±53.71		49.05±8774		7.94±56.80		8.50±52.45		8.30±47.35			
<b>Pulse</b>														
Normal	20	57.1	25	71.4	24	68.6	22	52.4	32	76.2	29	69.0	4.82	≤0.05
Abnormal	15	42.9	10	28.6	11	31.4	20	47.6	10	23.8	13	31.0		
Mean ±SD	147.00±20.2		141.74±20.18		137.54±24.86		145.47±24.35		137.54±21.54		139.33±22.44			
<b>Temperature</b>														
Normal	25	71.4	28	80.0	25	71.4	29	69.0	37	88.1	30	71.4	6.429	≤0.05
Abnormal	10	28.6	7	20.0	10	28.6	13	31.5	5	11.9	12	28.6		
Mean ±SD	37.1686±.6172		37.19±0.52		36.86±1.63		37.15±0.60		37.11±0.49		36.88±1.50			
<b>O<sub>2</sub> saturation</b>														
Normal	7	20.0	25	71.4	28	80.0	29	69.0	37	88.1	30	71.4	5.18	≤0.05
Abnormal	28	80.0	10	28.6	7	20.0	13	31.5	5	11.9	12	28.6		
Mean ±SD	5.9±90.11		4.7±94.1		97.19±.2.2		91.15±.2.6		97.11±.1.4		98.8±1.5			



**Table (5): Comparison of the studied nurses' knowledge regarding nasal CPAP pre- and post-nursing protocol implementation (n=70).**

Knowledge components	Pre nursing protocol implementation (n=70)						Post nursing protocol implementation (n=70)						X <sup>2</sup>	P-value
	Good		Average		Poor		Good		Average		Poor			
	No	%	No	%	No	%	No	%	No	%	No	%		
Definition of nasal CPAP	16	22.9	24	34.2	30	42.9	34	48.5	20	28.6	16	22.9	19.70	0.000
Indication of nasal CPAP	16	22.9	21	30.0	33	47.1	31	44.3	26	37.1	13	18.6	10.82	0.051
When starting nasal CPAP	19	27.1	21	30.0	30	42.9	38	54.3	21	30.0	11	15.7	10.58	0.040
Side effects of nasal CPAP	14	20.0	20	28.6	36	51.4	35	50.0	22	31.4	13	18.6	11.95	0.018
The complications of nasal CPAP	22	31.4	17	24.3	31	44.3	39	55.6	16	22.9	15	21.5	17.84	0.001
Precaution during connection CPAP	16	22.9	24	34.2	30	42.9	32	45.8	19	27.1	19	27.1	17.65	.0001
Prevention of CPAP complications	19	27.1	21	30.0	30	42.9	34	48.5	16	22.9	20	28.6	7.65	0.022
Start weaning from nasal CPAP	14	20.0	24	34.2	32	45.8	34	48.5	21	30.0	15	21.5	11.96	0.018
Total	17	24.3	21	30.7	32	45.0	35	50.0	20	28.75	15	21.25	13.5	0.001

**Table (6): Comparison of the studied nurses' knowledge regarding care of preterm infants undergoing nasal CPAP pre and post-nursing protocol implementation (n=70).**

Knowledge components	Pre nursing protocol implementation (n=70)						Post nursing protocol implementation (n=70)						X <sup>2</sup>	P-value
	Good		Average		Poor		Good		Average		Poor			
	No	%	No	%	No	%	No	%	No	%	No	%		
Observation of the site of nasal CPAP	18	25.7	21	30.0	31	44.3	38	54.3	18	25.7	14	20.0	12.30	0.015
The appropriate size of nasal CPAP	14	20.0	25	35.7	31	44.3	36	51.4	21	30.0	13	18.6	13.01	0.011
Sterilization of nasal CPAP	18	25.7	23	32.9	29	41.4	37	52.8	13	18.6	20	28.6	13.05	0.011
Observation of nasal cavity	21	30.0	15	21.5	34	48.5	33	47.1	11	15.7	26	37.2	18.56	0.000
Frequency of nasal suction	18	25.7	25	35.7	27	38.6	31	44.3	25	35.7	14	20.0	16.69	0.002
The technique of nasal suction	21	30.0	22	31.4	27	38.6	35	50.0	22	31.4	13	18.6	18.78	0.000
Complications	17	24.3	28	40.0	25	35.7	38	54.3	19	27.1	13	18.6	14.83	0.005
Nursing role regarding nasal care	14	20.0	33	47.1	23	32.9	31	44.3	24	34.2	15	21.5	7.74	0.021
Nursing role during connection	20	28.6	16	22.9	34	48.5	35	50.0	16	22.9	19	27.1	9.28	0.010
Nursing role after weaning from CPAP	15	21.5	22	31.4	33	47.1	35	50.0	21	30.0	14	20.0	25.99	0.000
Managing complication affecting the nose	18	25.7	22	31.4	30	42.9	34	48.5	23	32.9	13	18.6	9.45	0.009
Total	17	24.3	33	47.1	20	28.6	46	65.7	10	14.3	14	20.0	18.32	0.005

**Table (7): Comparison of the studied nurses' knowledge regarding nasal skin breakdown pre- and post-nursing protocol implementation (n=70).**

Knowledge components	Pre nursing protocol implementation (n=70)						Post nursing protocol implementation (n=70)						X <sup>2</sup>	P-value
	Good		Average		Poor		Good		Average		Poor			
	No	%	No	%	No	%	No	%	No	%	No	%		
Definition of nasal skin breakdown	17	24.3	22	31.4	31	44.3	37	52.8	20	28.6	13	18.6	16.75	0.002
Degree of nasal skin breakdown	14	20.0	21	30.0	35	50.0	36	51.4	23	32.9	11	15.7	15.92	0.004
The early manifestation of nasal skin breakdown	15	21.5	16	22.9	39	55.6	37	52.8	20	28.6	13	18.6	12.57	0.015
the late manifestation of nasal skin breakdown	11	15.7	18	25.7	41	58.6	35	50.0	19	27.1	16	22.9	19.94	0.000
Predisposing factors for nasal skin breakdown	16	22.9	20	28.6	34	48.5	38	54.3	19	27.1	13	18.6	15.82	0.003
Prevention of nasal skin breakdown	15	21.5	19	27.1	36	51.4	33	47.1	20	28.6	17	24.3	17.51	0.001
Prognosis	13	18.6	17	24.3	40	57.1	34	48.6	21	30.0	15	21.4	19.54	0.000
Total	17	24.3	18	25.7	35	50.0	40	57.1	16	22.9	14	20.0	15.34	0.015

**Table (8): Comparison of the studied nurses' practice regarding installing and maintaining nasal CPAP pre and post-nursing protocol implementation (n=70).**

Procedures	Pre nursing protocol implementation (n=70)						Post nursing protocol implementation (n=70)						X <sup>2</sup>	P-value
	Correctly done		Incorrectly done		Not done		Correctly done		Incorrectly done		Not done			
	No	%	No	%	No	%	No	%	No	%	No	%		
<b>Installation</b>														
Physiological parameters	13	18.6	20	28.6	37	52.8	47	67.1	13	18.6	10	14.3	46.77	0.000
Move the NCPAP cart to the bedside; wash hands.	14	20.0	21	30.0	35	50.0	49	70.0	14	20.0	7	10.0	46.00	0.000
The appropriate size of NCPAP	19	27.1	19	27.1	32	45.8	43	61.4	11	15.7	16	22.9	54.96	0.000
NCPAP fixation	10	14.3	29	41.4	31	44.3	52	74.3	11	15.7	7	10.0	25.87	0.000
Suction before application	19	27.1	21	30.0	30	42.9	45	64.3	14	20.0	11	15.7	54.23	0.000
Use a sterile swab to clean and moisten nasal cavities.	12	17.1	20	28.6	38	54.3	47	67.1	13	18.6	10	14.3	35.33	0.000
Lubricate tube, then place a curved side down into the nose.	18	25.7	23	32.9	29	41.4	43	61.4	18	25.7	9	12.9	62.32	0.000
Keep a small space between the tip of the septum and the bridge between the tube	21	30.0	18	25.7	31	44.3	38	54.3	14	20.0	18	25.7	75.45	0.000
Attach the tube and secure it to the hat with paper tape.	15	21.5	24	34.2	31	44.3	43	61.4	17	24.3	10	14.3	50.19	0.000
Fix the tubing straight	19	27.1	23	32.9	28	40.0	43	61.4	13	18.6	14	20.0	58.87	0.000
<b>Maintenance</b>														
Check the oxygen and ventilator setting frequently.	15	21.5	21	30.0	34	48.5	47	67.1	15	21.5	8	11.4	50.97	0.000
Gentle suction and avoid unnecessary airway suction.	16	22.9	24	34.2	30	42.9	40	57.1	21	30.0	9	12.9	51.81	0.000
Avoid excessive flexion, extension, or rotation of the head and neck;	13	18.6	23	32.9	34	48.5	41	58.6	17	24.3	12	17.14	14.50	0.006
Check position every hour without pressure on nares.	10	14.3	25	35.7	35	50.0	43	61.4	21	30.0	6	8.6	11.34	0.012
Remove DuoDerm in the morning during bathing	12	17.1	28	40.0	30	42.9	42	60.0	15	21.5	15	21.5	33.13	0.000
Assess the nasal skin integrity carefully.	16	22.9	20	28.6	34	48.5	46	65.7	13	18.6	11	15.7	49.90	0.000
Check for any dislodgement in tubing or adjust the position	18	25.7	23	32.9	29	41.4	47	67.1	14	20.0	9	12.9	46.92	0.000

**Table (9): Comparison of the studied nurses' practice regarding care for nasal skin for preterm infants undergoing nasal CPAP pre and post-nursing protocol implementation (n=70).**

Procedures	Pre nursing protocol implementation (n=70)						Post nursing protocol implementation (n=70)						X <sup>2</sup>	P-value
	Correctly done		Incorrectly done		Not done		Correctly done		Incorrectly done		Not done			
	No	%	No	%	No	%	No	%	No	%	No	%		
Physical examination of nasal skin every day.	15	21.5	24	34.2	31	44.3	40	57.1	17	24.3	13	18.6	58.13	0.000
Examination of the nasal cavity every shift	16	22.9	21	30.0	33	47.1	31	44.3	18	25.7	21	30.0	52.25	0.000
Ensuring proper placement of nasal prong /6 hours	11	15.7	22	31.4	37	52.9	50	71.4	10	14.3	10	14.3	35.71	0.000
Delivery of humidified oxygen	17	24.3	28	40.0	25	35.7	45	64.3	13	18.6	12	17.1	45.56	0.000
Daily gentle massage upon nasal septum / 6 hours	12	17.1	20	28.6	38	54.3	35	50.0	16	22.9	19	27.1	56.91	0.000
Topical antibiotic ointment to damaged area /6 h.	15	21.5	21	30.0	34	48.5	45	64.3	17	24.3	8	11.4	58.58	0.000
If bleeding occurs, suctioning was prohibited	19	27.1	15	21.5	36	51.4	47	67.1	14	20.0	9	12.9	61.39	0.000
If hyperemia, check pressure source and remove it	13	18.6	17	24.3	40	57.1	42	60.0	16	22.9	12	17.1	59.91	0.000
Irrigation with sterile saline, then hydrocolloid dressing were performed.	21	30.0	18	25.7	31	44.3	43	61.4	17	24.3	10	14.3	64.77	0.000
If the condition deteriorated, a plastic surgeon would be consulted	13	18.6	20	28.6	37	52.8	40	57.1	13	18.6	17	24.3	40.48	0.000

**Table (10): Comparison of the studied nurses' total knowledge and practice regarding nasal CPAP pre and post-nursing protocol implementation (n=70).**

Items	Pre nursing protocol implementation (n=70)		Post nursing protocol implementation (n=70)		X <sup>2</sup>	P-value
	No	%	No	%		
<b>Total knowledge level</b>						
Good (75-≥100%)	13	18.6	42	60.0	14.743	0.005
Average (60-≥75%)	26	37.1	16	22.9		
Poor (0-<60%)	31	44.3	12	17.1		
<b>Total practice level</b>						
Competent (≥80)	7	10.0	42	60.0	44.600	0.000
Incompetent (<80)	63	90.0	28	40.0		

**Table (11): Total mean score of neonatal skin condition score scale in the control and study group of preterm infants in the first, second, and third weeks after connection to nasal CPAP (n=77).**

Neonatal Skin Condition Score (NSCS) scale	Control group (n=35) Mean ±SD	Study group (n=42) Mean ±SD	Independent T-test	P-value
1 <sup>st</sup> week after connection to nasal CPAP	4.2857±1.8402	3.2857±.83478	3.156	0.002
2 <sup>nd</sup> week after connection to nasal CPAP	5.6857±3.54109	3.4762±1.32955	4.893	0.000
3 <sup>rd</sup> week after connection to nasal CPAP	6.9714±2.24245	4.9048±2.04593	4.225	0.000

## 6. Discussion

Continuous Positive Airway Pressure (CPAP) is a well-established model of respiratory support in preterm neonates. Advancement in CPAP technology and a better understanding of various respiratory diseases increase the survival of extremely preterm neonates on CPAP. So, nurses need to update their knowledge and enhance their practices about the care of preterm infants undergoing CPAP to prevent/minimizing the occurrence of nasal skin breakdown (Fisher & Kacmarek 2018).

The present study was quasi-experimental included 77 preterm infants on nasal CPAP, and 70 nurses from Benha Specialized Pediatric Hospital worked at Neonatal Intensive Care Units (NICUs) and Surgical Neonatal Intensive Care Unit (NICUs). This study aimed to evaluate the effect of nursing protocol regarding nasal skin breakdown for preterm infants receiving nasal CPAP.

Regarding the characteristics of the studied nurses, the present study results reveal that the mean age of the studied nurses was  $25.51 \pm 6.12$  years. This finding may be due to the appointment of new staff from newly graduated nurses each year in the hospital. This finding is supported by Mohammed, El-Sharkawy, Abdelsadek, and Said (2019) in a study about the "Intervention program for nurses about the care of preterm neonates undergoing continuous positive airway pressure." The study found that the mean age of the studied nurses was  $26.02 \pm 5.10$ .

Additionally, this result was supported by Otheeb and Aburaghif (2016) in a study about "Assessment of nurses' knowledge and practices toward isolation techniques among children with hepatitis at Pediatric Teaching Hospitals in Baghdad City," who found that most of their study sample was within 20-29 years. In contrast with Mohammed, Khamis, and Sabry (2018), in a study about "Effect of preterm neonates' developmental supportive care program on nurses' performance regarding nurses' age." They found that less than half of the studied nurses were between 30 to less than 40 years, and 4% were 50 years or more.

Regarding studied nurses' academic qualifications, the present study reveals that less than two-fifths of them had a technical institute of nursing. This finding supported by Mohammed et al. (2019) found that 52.7% were nursing technicians. This finding agrees with Buraihi and Mohammed (2017) in a study about "Effectiveness of an educational program on nurses' knowledge concerning preventing post-thoracic surgery complications at AL-Najaf Teaching Hospitals," who demonstrated that the highest percentage of the study sample are technical nursing institute graduates. In contrast, Bakhshi, Montaseri, Edraki, Razavi, and Haghpanah (2018), in a study about "Impact of instructions on the developmental status of premature infants on the clinical practice of neonatal intensive care unit (NICU) nurses," reflected that the majority of the NICU nurses had a master's degree.

Regarding years of experience for studied nurses, the present study reveals that about two-fifths of the studied nurses had five to less than eight years of experience. This

result probably due to the young age of the studied nurses. The decreases in years of nurses' experience have a negative effect on their performance regarding provided care for preterm infants. Precisely this was the same result for Mohammed et al. (2019). The finding of the present study also was supported by Aziz and Mansi (2018) in a study about "Assessment quality of nursing care provided to neonates with respiratory distress syndrome at an intensive care unit in Al-Nasiriyah City Hospitals," who showed that half of the studied nurses had less than two years of experience in neonatal care unit and pediatric nursing filed.

Moreover, the study finding following Abd-Elbaky, Mohamed, and Nagib (2018) in a study about the "Impact of a simulated education program on nurses' performance of invasive procedure at intensive care units" showed that most of the studied nurses had less than five years of experience. The study result disagreed with Mahmoud, Khalaf, & Mohammed (2016) in a study about "the effect of the endotracheal suction intervention on oxygen saturation level in preterm infants," who revealed that more than half of studied nurses had  $\geq$  nine years of experiences.

Regarding the gender of the studied nurses, the present study reveals that most of the studied nurses were females, which might due to the study of nursing was exclusive for females only till a few years ago in Egypt. Thus the profession of nursing in Egypt was mostly feminine. Sabaq and Said (2015) supported these results in a study about "Effect of educational program on nurses' performance regarding safe medications administration through nasogastric tube among critically ill children," who found that 95.2% were females.

Obaid, Hussein, and Noori (2016) also supported this finding in a study entitled "Nurses' knowledge concerning neonatal sepsis in neonatal intensive care units at pediatric teaching hospitals in Baghdad City," which reflected that most of the studied nurses were females. Hiba (2016), in a study about "Effectiveness of an education program on nurses' knowledge concerning complications prevention of mechanical ventilation at an intensive care unit in Al-Hussain Teaching Hospital at Nassiriyah City," and found that most of the study sample were females.

The present study shows that about two-thirds of the studied nurses did not attain training programs regarding nursing care provided to preterm neonates undergoing CPAP. This result agreed with Mohammed et al. (2019); Elsobkey & Amer (2018) in a study entitled "Effect of educational guidelines program about nursing care of neonates receiving Continuous Positive Airway Pressure," and revealed that more than two-thirds of the studied nurses did not have training course regarding CPAP.

The result of the present study disagrees with Aziz and Abdul-Hamza's (2017a) finding in a study entitled "Effectiveness of an educational program upon nurses' knowledge toward the continuous positive airway pressure (CPAP) machine in neonatal intensive care unit at AL-Husseini and the Pediatric Teaching Hospital." The study finding demonstrated that more than two-thirds of the

studied nurses attended training courses regarding intensive care for the newborn and had one to two courses.

According to the gestational age of preterm infants, the present study shows that around two-fifths of both groups had a gestational age between 34->37 weeks, with a non-statistically significant difference between both groups. This finding agreed with *Mohammed et al. (2019)*, who reflected that 81.8% of preterm infants were between 32-≤36 weeks. *Mahmoud et al. (2016)* also supported this finding, who reported that more than two-thirds of preterm infants had the gestational age 32-≤36 weeks. These findings may reflect that the preterm infants with gestational age 32-≤36 are at high risk of being ventilated.

This result disagrees with *Zhu, Zhao, Tang, Yan, and Shi (2017)* in a study entitled "Non-invasive high-frequency oscillatory ventilation versus nasal continuous positive airway pressure in preterm infants with moderate-severe respiratory distress syndrome: A preliminary report," which demonstrated that most of the studied preterm neonates were between 28-34 weeks.

The present study's finding demonstrates that about three-fifths of the studied preterm infants were males in both groups; this occurred because males tend to develop RDS more than females. *Mohammed et al. (2019)* supported this result that more than three-quarters of the studied preterm neonates were males. This finding also agreed with *Zhu et al. (2017)*, who viewed that nearly two-thirds of the studied preterm infants were males. Additionally, these findings disagreed with *Sivanandan et al. (2018)* in a study about "Target oxygen saturation among preterm neonates on supplemental oxygen therapy: A quality improvement study," demonstrating that more than two-thirds of the studied preterm neonates were females.

Regarding the characteristics of preterm infants, the present study reflects that more than half of the study and control groups had respiratory distress syndrome. This finding supported by *Abdelghany, Ouda, and El-hamshary (2012)* in a study entitled "Quality of nursing care for neonates undergoing mechanical ventilation at Benha City" and revealed that more than half (55.8%) of the studied neonates had respiratory distress syndrome. This finding is also supported by *Mahmoud et al. (2016)*, who demonstrated that nearly half of studied preterm infants had respiratory distress syndrome.

Moreover, this finding agreed with *Elsobkey and Amer (2018)*, who showed that most preterm infants connected to CPAP had respiratory distress syndrome. From the researchers' point of view, this is a common complication of preterm birth. Moreover, *Imbulana et al. (2018)* added that respiratory distress syndrome is a common clinical critical illness. It is also a common newborn, pediatric disease with a higher incidence in preterm infants because those preterm infants have a shorter gestational age, congenital hypoplasia, immature lung development, and a lack of pulmonary surfactant causes alveolar damage and dyspnea.

Regarding knowledge of studied nurses about nasal CPAP, the present study shows that near two-thirds of the

studied nurses had good knowledge after program implementation compared to two-fifths had poor knowledge pre-program with a statistically significant difference between the two phases. This finding is supported by *Mohamed et al. (2019)*, who reflected that most studied nurses had correct answers regarding definition and causes during post-program implementation compared with the minority of them who had complete answers during pre-program implementation. This finding was also in agreement with *Bakhshi et al. (2018)*, who showed a significant improvement in the knowledge scores of nurses about nursing care of premature infants undergoing CPAP after program implementation.

The result of the current study was also supported by *Elsobkey and Amer (2018)*, who showed that most nurses had a knowledge deficit regarding CPAP before program implementation, while post-program implementation, there was a statistically significant in most knowledge components. Additionally, the present study's findings also following the findings of *Hiba (2016)*, who revealed a highly significant improvement in the studied nurses' knowledge about CPAP post-program implementation. In addition to agreeing with *Aziz and Abdul-Hamza (2017a)*, they reported a highly statistically significant difference in the studied nurses' knowledge about CPAP between pre- and post-program implementation.

Regarding nurses' knowledge regarding nasal skin breakdown for preterm neonates undergoing CPAP, the present study shows a highly statistically significant difference after implementing the nursing protocol. This finding indicated an improvement in the studied nurses' level of knowledge after implementing the nursing protocol. The improvement of the studied nurses' level of knowledge about nursing care provided to preterm infants indicated the effectiveness of protocol implementation. This finding may be due to the young age of the studied nurses lead to an increase in their ability and readiness to acquire new information. Besides, decreasing years of experience leads to an increase in their needs for improvement in their level of knowledge. These findings are supporting the first research hypothesis.

Regarding nurses' total practice regarding nasal CPAP, the present study reveals that around two-thirds of the studied nurses had competent level after nursing protocol implementation compared with only one-tenth of them had competent level pre-nursing protocol implementation. This finding may be due to the applicable educational program that leads to an improvement in their level of practice. This finding supported by *Kaur and Charan (2018)* in a study about "A study to assess the effectiveness of STP on knowledge and practice regarding ABGs among ICU nurses in Selected Hospitals at Jalandhar, Punjab," who showed that most nurses had a good score on practice, and there was a significant difference between pretest and post-test scores.

Moreover, *Safwat and Khorais (2018)*, in their study entitled "Effectiveness of a computer-based learning module on Arterial Blood Gas interpretation among staff nurses in critical care units," found that there were highly

significant differences between pre-and post-tests, related to the practical skills of the studied nurses concerning ABG interpretation.

Regarding the total mean score of Neonatal Skin Condition Score (NSCS) scale in the control and study group of preterm infants in the 1st, second and third weeks after connection to nasal CPAP, the current study clarified that there was a statistically significant difference between control and study groups regarding their total score in the first, second and third week. From the researchers' point of view, the current study results showed that the nursing protocol regarding nasal skin breakdown for preterm infants receiving continuous positive airway pressure could improve nasal skin integrity more effectively compared to conventional routine care.

These results supported by *Jabraeili et al. (2017)* in a study about "The efficacy of a protocolized nursing care on nasal skin breakdown in preterm neonates receiving Nasal Continuous Positive Airway Pressure," who found that nasal skin integrity of preterm infants receiving nasal CPAP monitored for ten days from the first day of NCPAP placement. After placement of nasal CPAP interface, fragile nasal skin of preterm infants started to be damaged over time in both study and control groups, but the severity of skin damage was not similar in both groups. These findings are supporting the second research hypothesis.

## 7. Conclusion

Based on the present study results, it can be concluded that the research hypotheses were accepted. The majority of the studied nurses had a good level of knowledge and competent level of practice after implementing the care protocol compared to before implementation with highly statistically significant improvement. Additionally, there was a statistically significant difference between control and study groups preterm infants regarding their total score of neonatal skin condition score (NSCS) scale in the first, second, and third weeks.

## 8. Recommendations

Based on the results of the present study, the following recommendations can be suggested:

- Conducting periodical orientation programs for nurses in NICUs with continuous regular updating of knowledge and practice regarding nasal skin breakdown for preterm infants undergoing continuous positive airway pressure (CPAP).
- Emphasizing the importance of applying nursing protocol for nurses caring for preterm infants reduces nasal skin breakdown during CPAP ventilation, which is an effective and safe non-invasive intervention in all NICUs as a standard of care for all preterm infants.
- Further studies are suggested regarding implementing a nursing protocol for different health statuses for preterm infants in different health care settings.

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