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Effect of Instructional Guidelines on Nurses' Performance Regarding Care of High Risk Neonates Undergoing Surfactant Replacement Therapy

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Abstract: **High risk newborn is defined as a newborn, regardless of gestational age or birth weight, who has a greater-than- average chance of morbidity or mortality, usually because of conditions or circumstances affect on the normal course of events associated with birth and the adjustment to extra uterine existence. Surfactant Replacement Therapy (SRT) is the instillation of surfactant into the trachea of a new born at the risk of developing or already having respiratory distress syndrome (RDS). SRT has become available universally, so neonatal survival improved more in newborn with very low birth weights and associated problems. Aim of the current study was to evaluate the effect of instructional guidelines on nurses' performance regarding care of high risk neonates undergoing surfactant replacement therapy. Design: A quasi experimental design was utilized. Setting: This study was conducted at Neonatal Intensive Care Units (NICUs) at Maternity and Gynecological Hospital affiliated to Ain Shams University Hospitals and El Galaa Teaching Hospital in Cairo. Subjects: A convenience sample of 50 nurses in NICUs and all neonates (30) admitted to NICUs and received SRT during the period of data collection and application of instructional guidelines were included in the current study. Tools: It included; a) a pre-designed questionnaire and b) observation checklist. Results: there was knowledge deficient as well as incompetent practice among the studied nurses regarding RDS and SRT before application of the instructional guidelines. Implementation of the instructional guidelines led to significant improvements in nurses' knowledge and practices regarding care of high risk neonates undergoing surfactant replacement therapy. Conclusion: from the current study findings it can be concluded that, there was knowledge deficient as well as incompetent practice among nurses regarding respiratory distress syndrome and surfactant replacement therapy before application of the instructional guidelines. The research hypothesis is accepted and the implementation of the instructional guidelines led to significant improvements in nurses' knowledge and practices regarding care of high risk neonates undergoing surfactant replacement therapy. Recommendations: In-services educational program should be conducted for all nurses working in NICUs about care of high risk neonates undergoing surfactant replacement therapy with using instructional pamphlet and illustrated booklets.**

Keywords: **Instructional Guidelines, Nurses' performance, High Risk Neonates, Surfactant Replacement Therapy.**

I. INTRODUCTION

Respiratory distress syndrome (RDS) is a common problem in preterm neonates. RDS is caused by surfactant deficiency which is necessary for normal lung function. Surfactant-replacement therapy (SRT) is a life-saving intervention for preterm neonates with RDS characterized by surfactant deficiency. Furthermore, SRT has reduced the mortality and morbidity of the preterm neonates who are at risk of developing RDS ***(Sweet et al., 2017)*** and (***Gharehbaghi et al., 2018).***

Pulmonary surfactant is a multicomponent composed of several phospholipids, neutral lipids, and associated proteins which secreted by the type II epithelial cells within the lung. Its foremost physiologic function is to decrease alveolar surface tension, allow stability to the alveoli, and preserve the alveolar surface free of liquid to facilitate gas exchange. The deficiency or absence of surfactant is one of the hallmark features of RDS, the most common lung disorder among preterm neonates ***(Steven et al., 2009).***

As mentioned by ***Joseph, (2017)***, prematurity accounts for the largest number of admissions to an NICU. The immaturity not only places infants at risk for neonatal complications like RDS, which is utmost in the preterm neonates, but may also predispose the infant to problems that persist into adulthood such as learning disabilities, growth deficiencies and asthma. The administration of exogenous surfactant to preterm neonates with RDS has become an accepted and common therapy in most neonatal centers worldwide. Nursing care of a newborn with RDS is demanding meticulous attention which must be given to subtle changes in the neonates' oxygenation status.

According to ***Polin and Carlo, (2014),*** respiratory failure secondary to surfactant deficiency is a main cause of morbidity and mortality in preterm neonates. SRT significantly reduces mortality and respiratory morbidity for this population. Secondary surfactant deficiency also contributes to acute respiratory morbidity in late-preterm and term neonates with meconium aspiration syndrome, pneumonia/sepsis, and possibly pulmonary hemorrhage; surfactant replacement may be helpful for these infants. On the other hand surfactant administration in preterm neonates with established RDS reduces mortality, decreases the incidence of pulmonary air leak (pneumothoraxes and pulmonary interstitial emphysema), and lowers the risk of chronic lung disease or death at 28 days of age.

Pulmonary surfactant plays an important role in adequate pulmonary function throughout life. The alveoli are covered with a thin film of lung surfactant that decreases the surface tension in the lung, which results in decreased work of breathing thus to confirm constant lung inflation. SRT has been introduced in 1980s, it has confirmed its effect in premature neonates with surfactant deficiency ***(Mazela et al., 2006).***

Surfactant replacement therapy is the instillation of surfactant into the trachea of a newborn at the risk of developing or already having RDS. SRT has become available universally, so neonatal survival improved more in newborn with very low birth weights and associated problems ***Sandesh et al., (2004) and Namasivayam (2005)***. Today, SRT is the most effective and ideal treatment for RDS in preterm neonates in advanced countries. In spite of the many publications on the benefits of SRT, only a few developing countries use surfactant routinely ***(Vidyasagar et al., 2011).***

Two basic strategies for surfactant replacement have emerged: *prophylactic or preventive* treatment, in which surfactant is administered at the time of birth or shortly thereafter to neonates who are at high risk for developing RDS from surfactant deficiency rather than treatment of established RDS; and *rescue or therapeutic* surfactant strategy, in which surfactant is administered after the initiation of mechanical ventilation in neonates with clinically confirmed RDS ***(Walsh et al., 2013) and (Polin and Carlo, 2014).*** Rescue surfactant is most often administered within the first 12 hours after birth; early rescue is defined as surfactant treatment within 1 to 2 hours of birth, and late rescue is defined as surfactant management 2 or more hours after birth ***(Bahadue and Soll, 2012)***.

As stated by ***Walsh et al., (2013),*** surfactant is also efficient in treating neonates with meconium aspiration syndrome (MAS), pulmonary hemorrhage and pneumonia, although the evidence base for their use in these disease processes is much weaker than the primary indication of RDS. Surfactant decreases surface tension, improves lung compliance, and stabilizes lung volumes at a lower trans-pulmonary pressure. Without surfactant, alveoli may never expand or may collapse on expiration and require an excessive amount of force to re-expand on inspiration, leading to the development of severe RDS and air leak syndromes. Surfactant's secondary function is to improve macrophage activity and mucociliary clearance and to decrease inflammation. The incidence of RDS is related more to lung immaturity than to gestational age.

Prophylactic replacement of natural surfactant has proven to reduce the risk of air leak syndromes such as pneumothorax and pulmonary infiltrate with eosinophilia (PIE), decrease in the incidence of infant mortality and the risk of bronchopulmonary dysplasia (BPD). Also, it reduces death and improves oxygenation as demonstrated by improved alveolar-arterial oxygen difference, Arterial/alveolar oxygen ratio and decreased FIO2 requirements. Moreover it promotes ventilation as demonstrated by decreased mean airway pressures (MAP) and improves ventilator efficiency index. Incidence of infants surviving to go home is significantly higher with prophylactic or preventive SRT than with rescue or therapeutic SRT ***(Lawson., 2009)***.

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The neonatal nurse has a unique opportunity of closely observing and providing care for the neonates after delivery. Nurses play an important role in caring for newborn who receive SRT in the NICU. The care of the neonates before, during and after SRT is unique to this treatment modality. It is important for nurses to have a working knowledge of the specific care needs of neonates treated with surfactant ***(Joseph, 2017)***.

Nursing care focus on close monitoring of all neonates who are intubated and mechanically ventilated. First of all, the nurse will monitor increasing oxygen and pressure requirements based on falling oxygen saturations and poor blood gas readings. Hypotension may also be noted. The endotracheal tube should be kept in the proper position, above the level of the carina. The nurse should closely monitor oxygen saturations and blood gases levels so that ventilator changes can be made promptly. The nurse must be acquainted with the equipment and maintain a high level of vigilance ***(Greenough, 2008)***.

As mentioned by ***Nouraeyan et al., (2014)***, if the newborn undergoing SRT, the neonatal nurse should perform a baseline newborn assessment including vital signs: heart rate, oxygen saturation (SpO2), blood pressure, respiratory assessment as respiratory rate, ventilator pressures, tidal volumes and transcutaneous *P*CO2 (TcPCO2) beside chest assessment as air entry, respiratory sounds, symmetrical chest expansion and chest secretions. Also, the nurse should assess the newborn's status if awake, asleep or sedated. On the other hand the neonatologist should review chest x-ray to assess endotracheal tube (ETT) position and lung volume.

A chest x-ray should be taken to evaluate appropriate endotracheal tube placement. Once tube placement is confirmed, the length of the tube in relation to the infant's lip should be documented so that proper location can be checked every shift. When evaluating position by auscultating breath sounds, the caregiver should hear a slight air leak around the tube. Gas flow through the ventilator should be warmed and humidified appropriately. The nurse plays a major role in preventing airway damage from suctioning. Prior to suctioning, the nurse should select the appropriately sized suction catheter and know the exact measurement of the endotracheal tube. The suction catheter should not be passed beyond the length of the endotracheal tube. No more than 50–80 cmH2O pressure should be used when applying suction for five seconds. The frequency of suctioning should be individualized, based on the newborn's breath sounds, respiratory status, and clinical condition. Oxygen saturation and clinical status should be closely monitored while weaning the newborn to appropriate ventilator settings ***(Fraser, 2013).***

According to ***Edeltraud and Cynthia (2006)***, there is no doubt that education leading to the desired change in behavior. Structured teaching program is an important aspect to communicate knowledge in order to prevent the morbidity due to respiratory distress.

Prevention of infection is a major challenge to the NICU team. The endotracheal tube is preventing the cilia in the airway from clearing airway debris and potentially pathogenic bacteria or viruses. As a result, infection may develop, leading to the previously described airway lesions. Maintaining clean technique during intubation and endotracheal suctioning is important. If infection is suspected, antibiotics should be initiated and modified to specific organisms. The nurse should assist the parents in understanding the diagnosis and possible treatment by giving them pamphlets and arranging meetings with the ophthalmologist and neonatologist. Nurses play a key role in recognizing early signs of potential complications and alerting the neonatal team. Support of the family through this stressful time is important ***(Fraser, 2013).***

Significance of the study

Preterm neonates form a pediatric priority because they have less chance of survival than term babies. Prematurity accounts for the largest number of admissions to NICUs. Preterm neonates are particularly vulnerable to complications due to impaired respiration, difficulty in feeding, poor body temperature regulation and high risk of infection. Neonatal Respiratory Distress Syndrome (RDS) is a common complication seen in preterm neonates ***(Joseph, 2017).*** RDS in neonates constituted 52.9% of total admission to NICU. Hyaline membrane disease represented 45.8% of RD cases. RDS is one of the important causes of admission to the NICU ***(Abou-Faddan and Abdelaziz, 2017).***

Infant mortality and morbidity from preterm birth can be reduced through interventions delivered to the mother before or during pregnancy, and to the preterm infant after birth. ***(Escobar et al., 2006) and (Wang et al., 2004).***Surfactant-replacement therapy is a life-saving treatment for preterm infants with RDS ***(Joseph, 2017).*** Exogenous surfactant replacement has been established as an appropriate preventive and treatment therapy for prematurity-related surfactant deficiency ***(AAP, 1999).***

According to ***Fraser (2013)***, nursing care of the ventilated premature neonates requires careful monitoring for signs of a Patent Ductus Arteriosus (PDA) especially after administration of surfactant. Prevention of airway injury should be a priority for nurses caring for any mechanically ventilated newborn. An endotracheal tube of the correct size should be used. Following intubation, the tube should be stabilized to prevent excessive movement and accidental extubation.

Aim of the Study

The aim of this study was to evaluate the effect of instructional guidelines on nurses' performance regarding care of preterm neonates undergoing surfactant replacement therapy. This aim was achieved through:

- Assessing knowledge of nurses working in NICUs regarding surfactant replacement therapy.
- Assessing practice of nurses working in NICUs regarding surfactant replacement therapy.
- Designing and implementing instructional guidelines for nurses working in NICUs regarding care of high risk neonates undergoing surfactant replacement therapy.
- Evaluating the effect of instructional guidelines on nurses' performance regarding care of high risk neonates undergoing surfactant replacement therapy.

Research hypothesis

Implementation of instructional guidelines has a positive effect on nurses' knowledge and practices regarding care of high risk neonates undergoing surfactant replacement therapy

Research Questions

- What is the level of nurses' knowledge regarding surfactant replacement therapy?
- What is the level of nurses' practice regarding surfactant replacement therapy?
- Is there is an effect of instructional guidelines on nurses' knowledge and practice regarding care of high risk neonates undergoing surfactant replacement therapy?

II. SUBJECTS AND METHODS

Research design:

A quasi-experimental research design was utilized in the current study.

Subject:

- A convenience sample of 50 nurses was participated in the current study.
- All neonates (30) admitted to NICUs and received surfactant replacement therapy during the period of data collection and application of instructional guidelines

Setting:-

This study was conducted at Neonatal Intensive Care Units (NICUs) at Maternity and Gynecological Hospital affiliated to Ain Shams University Hospitals and El Galaa Teaching Hospital in Cairo, where these settings have being a highest capacity of high risk neonates with reasonable number receiving SRT in each setting.

Tools of Data Collection

Data were collected through using the following tools:

I. Pre-designed Questionnaire :

It was designed by the researchers based on updated related literatures to assess the studied nurses' knowledge regarding surfactant replacement therapy, it consisted of two parts:

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Part (1): Characteristics of the studied subjects including: A. Characteristics of the studied nurses as age, gender, previous attendance of training courses about care of high risk neonates with RDS and surfactant replacement therapy or not. **B.** Characteristics of the studied neonates as gender, birth weight, length, gestational age and diagnosis. These data were collected from neonates' medical record.

Part (2): Questions regarding respiratory distress syndrome (RDS) to assess nurses' knowledge regarding RDS as definition, etiology, pathophysiology, clinical pictures, nursing care and complications of. As well as nurses' knowledge regarding surfactant replacement therapy (SRT) included definition, origin and function of surfactant in human body, indications of SRT, sources of exogenous surfactant, route of administration, nursing intervention pre, during and after SRT and its complications. Time consumed to fill in the questionnaire by nurses was 20-30 minutes.

Scoring system of nurses' knowledge. According to the answers obtained from the studied nurses, a scoring system was followed to obtain the outcome of their knowledge. Where 2 grades was given for completely correct answer, 1 grade for incompletely correct answer, and 0 grade for unknown or wrong answer. The total number of questions was 32 questions and the total score of 64 grades was given for total knowledge (equal 100%).

The studied nurses' answers were checked using a model key answer and accordingly, their knowledge were classified into; satisfactory knowledge, 50 grads or more (≥ 80%) and unsatisfactory knowledge, less than 50 grads (<80 %).

Content validity:

The tools of data collection were developed by the researchers after extensive review of relevant recent literature. Tools were evaluated by a panel of five experts in the field of neonatal nursing to test the content validity. Some modifications for the tools were done according to the panel judgment on appropriateness of content, clarity of sentences, and sequence of items.

Reliability test was done using Cronbach's test was done to be accepted reliability on ≤ .78.

II. Observational checklists:

The observational checklists were adapted from the ***(Polin and Carlo, 2014), (Sweet etal., 2017), (El Shahed et al., 2017) and (Centers for Disease Control and Prevention, 2017).*** Simple modifications were done by the researchers in the checklists to suit the nature of the study. It was used to assess the nursing care for the high risk neonates undergoing surfactant replacement therapy. It included the procedures of hand washing, vital signs assessment, respiratory hygiene, total parenteral nutrition, capillary blood sampling, venous blood sampling, nursing care of endotracheal tube insertion, nursing care for neonates before, during, and after connection and weaning from mechanical ventilation and surfactant replacement therapy.

Time consumed for assessing each procedure during actual work of the studied nurses was 3-15 minutes. The total number of procedures was 9, each procedure scored from five (5) to ten (10) according to total number of steps for each procedure that made a total score of 100 grades (equal 100%) for all procedures. For each step of nurses' performance was classified into either correctly done (1), for incorrectly or not done (0). Accordingly, the scoring system of studied nurses actual practices was classified into either competent practices ≥ 80 grads (scored 80% and more) or incompetent practices < 80 grads (scored less than 80 %).

Exploratory Phase

A. Pilot study

A pilot study was carried out on 10% of the studied subjects, involved 5 nurses and 3 of high risk neonates undergoing surfactant replacement therapy for the purpose of testing the tools, to determine its clarity, applicability, objectivity, time required to fill in each tool and feasibility of conducting the study. Some modifications were carried out as revealed from the findings of the pilot study to develop final form of the study tools and the subjects included in the pilot study were excluded later from the study sample.

B. Procedure technique : It achieved in 4 weeks for each group entailed from 4-6 nurses in each setting including one week for pretest followed by two weeks for implementation of the instructional guidelines (one week for theoretical part and another week for practical part) followed by one week for posttest.

I. Assessment Phase:

Data collection procedure:

Field work

An official approval was obtained from authorized personnel of the study settings where a clear explanation was given about the nature, importance, phases and expected outcomes of the study. The field work was carried out from the beginning of July 2018 to the end of December 2018 (6-months for data collection and guidelines implementation). The researchers were available at the study settings by rotation, two days per week during morning shift where it is the time of basic and routine nursing procedures and implementing the procedures required for selected neonates.

As a preface for the practical part of the instructional guidelines implementation, 2 days before beginning of the study in NICUs the researchers conducted an initial visit for NICUs and introduced themselves to the head nurse of each unit, explained the purpose of the visit and gave simple explanation about the nature of the study, its expected outcomes. Also, the researchers carried out an assessment for all the PT neonates as regards progress, changes, the attached devices and treatment used for each case to select the study subjects fulfilling the study criteria.

Data were collected from the studied nurses individually or in groups that entail 2-3 nurses according to their readiness and nature of work circumstance inside the NICUs. The questionnaire was filled in by the studied nurses in the presence of the researchers to clarify any queries from the nurses related to the questionnaire form. While their performance was assessed during their actual care provided for neonates undergoing SRT using observational checklists.

II. Implementation phase

Each researcher was available 2 days/ week in the morning shift, and allocated two sessions to cover the theoretical part and four sessions for practical procedures as regards care of high risk neonates undergoing SRT. For the application each session took 45-60 minutes for theoretical session or demonstration and re-demonstration according to the nurses' readiness. The instructional guidelines were applied using illustrated Arabic booklet that involved clear instructions to improve nurses' knowledge and practice regarding SRT for neonates.

The researchers were handling four to six nurses in each setting per month. Methods of teaching were through using teaching sessions, group discussion, demonstration and re-demonstration, as well as guiding booklet with colored pictures; video film and power point presentation using researchers' laptops. Real objects as small manikin mimics 26 weeks preterm neonates, ambubag, neonatal endotracheal tube, suction catheter, sterile gloves, 10 ml sterile syringe and suspension vial mimics "Survanta" vial etc… were used as instructional media in the practical sessions. Learning activities are done inside the nurses room affiliated to the NICUs after the morning care and during the sleeping time of high risk neonates.

Intervention program construction involved the following:

I. *Setting the Objectives:*

The general objective of the intervention program was to promote the nurses' performance regarding care of high risk neonates undergoing surfactant replacement therapy, by providing the nurses with the correct knowledge and competent skills.

A. Setting specific objectives of the intervention program included the following:

1. Discuss causes and degrees of RDS.
2. Mention clinical manifestations of RDS.
3. Enumerate medical management of RDS.
4. Mention origin and function of surfactant in the human lung.
5. Clarify indications of SRT.
6. Discuss technique of surfactant delivery.

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7. Discuss nursing intervention before, during and after SRT
8. Apply respiratory hygiene for newborn undergoing SRT
9. Discuss complications of SRT.

Content of the Program: According to the previously mentioned objectives, **theoretical content of the program were included:** causes and types of RDS, clinical manifestations of RDS, medical management of RDS, indications of SRT, technique of surfactant delivery, nursing intervention before, during and after SRT, respiratory hygiene for newborn undergoing SRT and complications of SRT.

Practical content of the program were included: hand washing, vital signs assessment, respiratory hygiene (ETT, oral and nasal suction, total parenteral nutrition (TPN) administration, capillary blood sampling, venous blood sampling, nursing care of endotracheal tube insertion (before, during and after), nursing care for neonates with mechanical ventilation and nursing role before, during and after surfactant replacement therapy.

Evaluation Phase: for each group the researchers allocated one week to evaluate the outcome of the instructional guidelines on nurses' knowledge and practices regarding care of high risk neonates undergoing surfactant replacement therapy. Nurses are assessed for all practical part during their actual care of the studied neonates. The researchers using the same study tools of assessment phase immediately after instructional guidelines implementation (posttest).

8. Statistical design:-

Data were collected, organized, revised, coded, tabulated and analyzed by using the Statistical Package for Social Science (SPSS) version 20. Numerical data were presented as number, percentage, mean and standard deviations. The comparison between quantitative data pre and post application of the instructional guidelines was done by using **t test**. The p-value was considered significant as the following: $P > 0.05$ (Non-significant), $P < 0.05$ (Significant) and $P < 0.01$ (Highly-significant).

9. Ethical consideration:-

Each studied nurse had the freedom to participate or refrain to participate in the study. Also, nurses had the right to withdraw at any time from the study. The study had not any negative effect on the studied neonates. The researchers were ensuring complete privacy and confidentially.

III. RESULTS

Table (1): Distribution of the Studied High Risk Neonates According to Their Characteristics.

High risk neonates' Characteristics	Studied Neonates [No. = 30 (100%)]	
	No.	%
Gestational age (Weeks)		
< 26	1	3.3
26 - < 30	15	50.0
30 - < 34	14	46.7
$\bar{X} \pm SD$	29.78 ± 2.98	
Birth weight (Grams)		
< 1000	5	16.7
1000 - < 1500	18	60
1500 - < 2000	7	23.3
$\bar{X} \pm SD$	1388.80 ± 323.52	
Hospital stay (Days)		
< 30	12	40
30 - < 45	10	33.3
45 - ≤60	8	26.7

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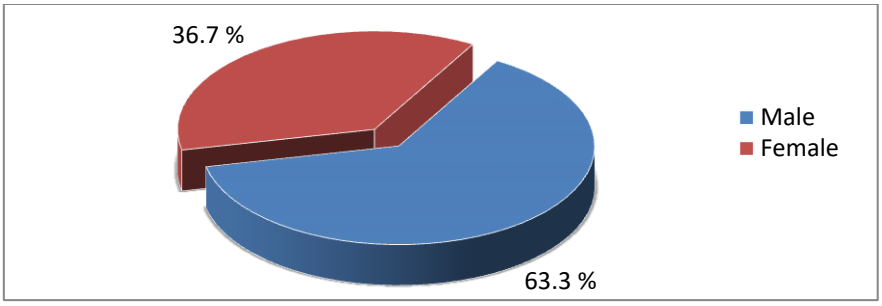
$\bar{X} \pm SD$	46.14 ± 20.73	
Presence of congenital anomalies		
Yes	6	20
No	24	80

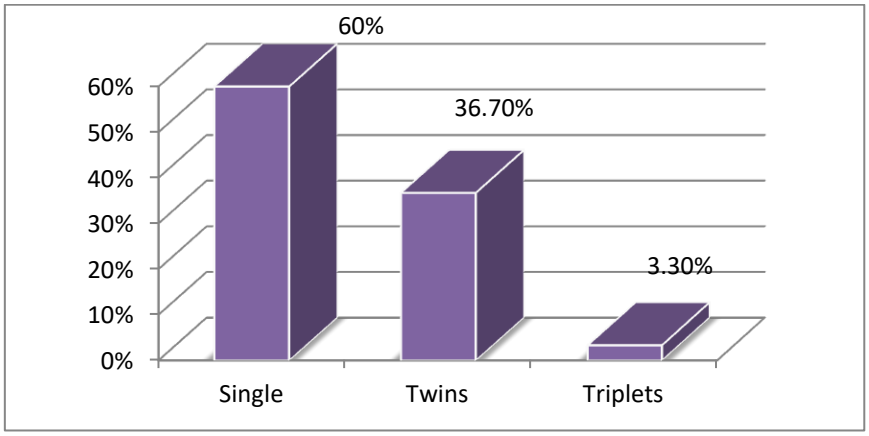
As observed from table 1, half (50%) of the studied neonates' their gestational age was ranging from 26 to less than 30 weeks and their mean gestational age was 29.78 ± 2.98 weeks. Also, their mean birth weight was 1388.80 ± 323.52 grams and mean days of hospital stay was 46.14 ± 20.73 day, and one fifth (20.0%) of them had congenital anomalies.

Figure (1): Distribution of the Studied High Risk Neonates According to Their Gender



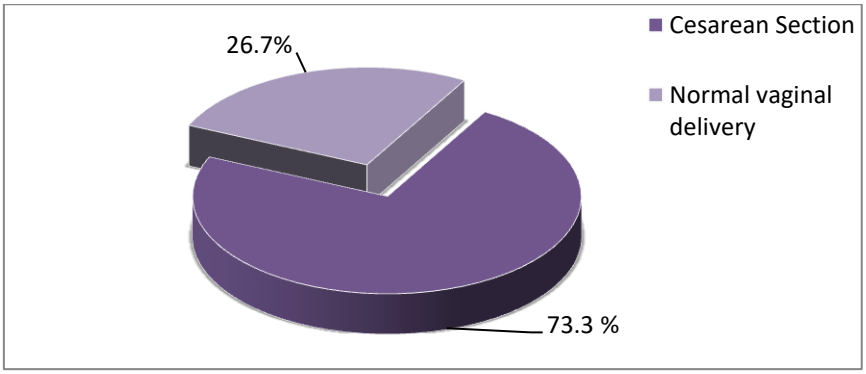
As clarified from figure (1), nearly two thirds (63.3 %) of the studied high risk neonates were males.

Figure (2): Distribution of the Studied High Risk Neonates According to Their Number of Gestation



As noticed from figure (2), three fifths (60 %) of the studied high risk neonates were singles. While more than one third (36.7 %) of them were twins.

Figure (3): Distribution of the Studied High Risk Neonates According to Their Method of Delivery.



As observed from figure (3), approximately three quarters (73.3%) of studied neonates were delivered by cesarean section.

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Table (2): Distribution of the Studied Nurses According to Their Characteristics

Nurses' Characteristics	Studied Nurses [No. = 50 (100%)]	
	No.	%
Age (Years)		
< 20	2	4.0
20 - < 25	23	46.0
25 - < 30	9	18.0
≥ 30	16	32.0
$\bar{X} \pm SD$	27.28 ± 6.69	
Level of education		
Secondary School of Nursing	27	54.0
Technical Institute of Nursing	17	34.0
Bachelor's Degree in Nursing	6	12
Years of experience (Years)		
1-<5	38	76.0
5-<10	4	8.0
10-<15	4	8.0
≥15	4	8.0
$\bar{X} \pm SD$	4.90 ± 5.7	
Attendance of training courses about SRT		
Yes	15	30.0
No	35	70.0

It was observed from **table (2)** that, nearly half (46.0%) of studied nurses their age was ranging from 20 to less than 25 years while, the minority (4.0%) of them was in the age group less than 20 years with mean age 27.28 ± 6.69 year. Regarding nurses' educational level, the current study revealed that, more than half (54.0%) of nurses were secondary school graduates of nursing. While, the minority (12.0%) of them were graduates Bachelor of Nursing. Concerning the years of experience, the current study showed that, more than three quarters (76%) of studied nurses were had 1 to less than 5 years of experience with mean years of experience 4.90 ± 5.7 years. In addition, more than two thirds (70.0%) of them didn't receive any training courses about surfactant replacement therapy.

Table (3): Mean Scores of Nurses' Knowledge Regarding Respiratory Distress Syndrome Pre/Post Instructional Guidelines Application

Items of Nurses' Knowledge	Studied Nurses [No. = 50 (100%)] $\bar{X} \pm SD$	Paired t-test	P- value
Definition of RDS			
- Pre	2.04 ±0.88	-10.985	0.000*
- Post	3.12 ±0.72		
Causes of RDS			
- Pre	1.80 ± 0.78	-12.338	0.000*
- Post	3.38 ± 0.60		
Signs of RDS			
- Pre	1.74 ± 0.80	-16.848	0.000*
- Post	3.78 ± 0.42		
Treatment of RDS			
- Pre	1.64 ± 0.75	-15.355	0.000*
- Post	3.60 ± 0.61		

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Nursing Intervention for newborn with RDS - Pre - Post	 2.22 ± 0.79 3.56 ± 0.71	-9.092	0.000*
Complications of RDS - Pre - Post	 1.82 ± 0.85 3.38 ± 0.78	-10.885	0.000*
Total Mean Scores of Nurses' Knowledge. - Pre - Post	 11.28 ± 3.56 20.82 ± 2.35	-21.410	0.000*

P < 0. 001 (*Highly Statistical Significant Difference)

Table 3 indicated that, there was a significant improvement in total nurses' knowledge regarding respiratory distress syndrome (RDS) post instructional guidelines application with highly statistical significant difference (P, = 0.000) with a clear improvement in nurses' knowledge regarding all elements of RDS including definition, causes, signs, treatment, nursing intervention and complications compared to pre instructional guidelines application that reflected the positive effect of guidelines application.

Table (4) Mean Scores of Nurses' Knowledge Regarding Concept of Surfactant Pre/Post Application (N= 50)

Items of Nurses' Knowledge	Studied Nurses [No. = 50 (100%)] $\bar{X} \pm SD$	Paired t-test	P- value
Definition of Surfactant - Pre - Post	 1.64 ± 0.66 3.86 ± 0.35	-20.554	 0.000*
Origin of Surfactant in the Human Body - Pre - Post	 0.92 ± 0.67 3.44 ± 0.64	-19.605	0.000*
Benefit of Surfactant for the Human Lung - Pre - Post	 1.38 ± 0.64 3.66 ± 0.69	-15.638	0.000*
Total Mean Score of Mothers' knowledge - Pre - Post	 3.90 ± 1.42 10.96 ± 1.07	-26.737	0.000*

P < 0. 001 (*Highly Statistical Significant Difference)

As noticed from table 4 there was a significant improvement in the total nurses' knowledge regarding concept of surfactant post instructional guidelines application that indicated highly statistical significant difference with t = -26.737, P= 0.000.

Table (5) Mean Scores of Nurses' Knowledge Regarding Surfactant Replacement Therapy Pre/Post Application (N= 50)

Items of Nurses' Knowledge	Studied Nurses [No. = 50 (100%)] $\bar{X} \pm SD$	Paired t-test	P- value
Definition of SRT. - Pre	1.56 ± 0.73 3.60 ± 0.61	-14.901	0.000*

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- Post			
Types of SRT. - Pre - Post	0.82 ± 0.69 3.44 ± 0.61	-23.764	0.000*
Indications of SRT. - Pre - Post	1.42 ± 0.67 3.50 ± 0.79	-16.344	0.000*
Nursing Role before SRT. - Pre - Post	1.36 ± 0.60 3.22 ± 0.79	-13.286	0.000*
Nursing Role during SRT. - Pre - Post	1.54 ± 0.61 3.06 ± 0.91	-9.227	0.000*
Nursing Role after SRT. - Pre - Post	1.72 ± 0.76 3.56 ± 0.61	-13.934	0.000*
Complications of SRT. - Pre - Post	0.96 ± 0.95 3.04 ± 0.97	-13.109	0.000*
Total Mean Score of Nurses' knowledge - Pre - Post	9.38 ± 3.22 23.42 ± 3.45	-21.977	0.000*

P < 0. 001 (*Highly Statistical Significant Difference)

As noticed from table 5, there is a clear improvement of the nurses' knowledge regarding all elements of SRT post instructional guidelines application compared to pre application that reflected highly statistical significance difference (t = -21.977, P, = 0.000).

Table (6): Total Mean Scores of Nurses' Knowledge Regarding Respiratory Distress Syndrome and Surfactant Replacement Therapy Pre/Post Application (N= 50)

Nurses' Knowledge	Studied Nurses No. = 50 $\bar{X} \pm SD$	Paired t-test	P- value
Total Mean Score of Nurses' Knowledge. - Pre - Post	24.56 ± 4.07 55. 20 ± 6.74	-18.362	0.000*

P < 0. 001 (*Highly Statistical Significant Difference)

As revealed from table 6, there is a clear improvement in the total nurses' knowledge post instructional guidelines application as regards RDS and SRT. The total mean score of nurses' knowledge was 24.56 ± 4.07 pre guidelines application compared to 55. 20 ± 6.74 post application that indicates highly statistical significant difference (t test = -18.362 with p = 0.000).

Table (7): Mean Scores of Nurses' Practices Regarding Care of Neonates with Respiratory Distress Syndrome Pre/Post Application (N= 50)

Nurses' Practices	Studied Nurses [No. = 50 (100%)] $\bar{X} \pm SD$	Paired t-test	P- value
Hand washing. - Pre	2.46 ± 0.84 4.56 ± 0.58	-14.080	0.000*

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- Post			
Vital signs assessment - Pre - Post	10.86 ± 1.92 13.94 ± 0.89	-9.424	0.000*
Respiratory hygiene - Pre - Post	9.62 ± 1.56 13.40 ± 1.29	-14.858	0.000*
Care for endotracheal tube insertion - Pre - Post	6.20 ± 1.49 8.64 ± 1.03	-9.200	0.000*
Capillary blood sampling - Pre - Post	6.24 ± 1.57 8.70 ± 1.23	-8.022	0.000*
Nursing Care for Neonates on Mechanical Ventilation. - Pre - Post	7.30 ± 2.32 13.28 ± 1.11	-16.625	0.000*
Total Mean Score of Nurses' Practices. - Pre - Post	42.68 ± 7.13 62.52 ± 4.56	-15.805	0.000*

P < 0. 001 (*Highly Statistical Significant Difference)

Table 7 represents that, there was an obvious improvement in total nurses ' practices regarding respiratory distress syndrome post instructional guidelines application compared to pre application that indicated highly statistical significance difference (t = -15.805. P, = 0.000).

Table (8): Mean Scores of Nurses' Practices Regarding Care of Neonates undergoing Surfactant Replacement Therapy Pre/Post Application (N= 50)

Nurses' Practices	Studied Nurses [No. = 50 (100%)] $\bar{X} \pm SD$	Paired t-test	P- value
Nursing Care before Surfactant Replacement Therapy. - Pre - Post	2.36 ± 0.85 3.88 ± 0.72	-10.193	0.000*
Nursing Care during Surfactant Replacement Therapy. - Pre - Post	1.66 ± 0.87 4.20 ± 0.70	-17.706	0.000*
Nursing Care after Surfactant Replacement Therapy. - Pre - Post	1.82 ± 0.94 4.38 ± 0.64	-16.593	0.000*
Total Mean Score of Mothers' Practices. - Pre - Post	5.84 ± 2.28 12.50 ± 1.61	-20.091	0.000*

P < 0. 001 (*Highly Statistical Significant Difference)

As noticed from table 8, there was a clear improvement in nurses' practices regarding care of neonates with SRT post instructional guidelines application (12.50 ± 1.61) compared to pre application (5.84 ± 2.28) which reflected highly statistical significance difference (P=0.000).

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Table (9): Mean Scores of Nurses' Practices Regarding Total Parenteral Nutrition and Venous Blood Sampling for High Risk Neonates Undergoing Surfactant Replacement Therapy Pre/Post Application (N= 50)

Nurses' Practices	Studied Nurses [No. = 50 (100%)] $\bar{X} \pm SD$	Paired t-test	P- value
Total Parenteral Nutrition - Pre - Post	2.74 ± 0.97 4.62 ± 0.49	-13.256	0.000*
Venous blood sampling - Pre - Post	5.96 ± 1.32 8.56 ± 1.05	-13.877	0.000*
Total mean score of nurses' Practices. Pre Post	8.70 ± 2.11 13.18 ± 1.30	-14.867	0.000*

P < 0. 001 (*Highly Statistical Significant Difference)

Table 9 revealed that, there is an obvious improvement in total nurses' practice regarding total parenteral nutrition and venous blood sampling for high risk neonates undergoing SRT with total mean score 13.18 ± 1.30 post instructional guidelines application compared to 8.70 ± 2.11 that reflected significant improvement with highly statistical significance difference (t = -14.867, P, = 0.000).

Table (10): Total Mean Scores of Nurses' Practices Regarding High Risk Neonates Undergoing Surfactant Replacement Therapy Pre/Post Application (N= 50)

Nurses' Practices	Studied Nurses No. = 50 $\bar{X} \pm SD$	Paired t-test	P- value
Total Mean Score of nurses' Practices. - Pre - Post	57.22 ± 7.08 88.2 ± 5.99	-28.274	0.000*

P < 0. 001 (*Highly Statistical Significant Difference)

As revealed from table 10, there is a clear improvement in the total nurses' practices post instructional guidelines application as regards care of high risk neonates undergoing SRT. The total mean score of nurses' practices was 57.22 ± 7.08 pre guidelines application compared to 88.2 ± 5.99post application that indicates highly statistical significant difference (t test = -28.274with p = 0.000).

IV. DISCUSSION

The nurse is one of the specialists responsible for implementing care directed to promote physical, emotional and social development of neonates in NICUs. The NICU establishes a therapeutic environment proper for treatment of the newborn (NB) in a serious condition. The fragility of those neonates increasing application of high-risk procedures and the low tolerance to medication errors are some of the concerns of nursing experts working in the NICU ***(Montanholi et al., 2011)***.

According to ***Torres et al., (2016)***, promoting care in the NICU requires nurses´ knowledge and responsibility. Care should be permeated by technology, especially for high risk neonates. Also, the competence, information integrations, construction judgments and priorities setting are essential to the nurse, providing a homeostatic condition in both the biological and the psychological care.

Neonatal RDS, also known as Hyaline Membrane Disease (HMD) may occur if the lungs aren't fully developed in the preterm newborn that causes a primary insufficiency of surfactant and a reduced alveolar surface area available for gas exchange ***(Yousuf and Abbas, 2014)***. Surfactant is a substance produced in the lungs which lines the alveoli and prevents them from collapsing, it is not normally secreted in sufficient quantities until nearly the 29-30th week of gestation and as a result most preterm infants born before this gestation will be surfactant deficient ***(Johnson et al., 2014).***

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Concerning the characteristics of the studied neonates **(table 1)**, the current study findings displayed that, half of the studied neonates their gestational age (GA) was ranging from 26 to less than 30 weeks with mean GA 29.78 ± 2.98 weeks and more than three fifths of them were male **(figure 1)**. These findings were parallel with findings of ***Hameed, (2016),*** who proved in a similar study that, mean GA of the studied neonates was 29.7 ± 4.5 weeks and nearly three fifths of them were males.

In relation to the mean birth weight, the current study findings showed that, the mean birth weight of the studied neonates was 1388.80 ± 323.52 gm. This finding was consistent with ***Abdel Maksoud and Saleh (2015),*** who declared in their similar study that, mean birth weight of the studied group was 1324±143 gm.

In the same context, ***Condò et al., (2016),*** proved in a similar study that, birth weight, mode of delivery and pathological pregnancy were the chief factors associated with RDS. Neonates weighing 1000-1499 grams were at higher risk of RDS in comparison to those weighing 1500-2499 in all GA groups.

Regarding the multiple gestations **(figure 2)**, the current study findings revealed that, nearly two fifths of the studied neonates were twins, while single delivery was observed in three fifths of them. In the same context, ***Hacking (2001)*** stated that, in twins gestation, the second twin is usually at larger risk of emerging RDS. This risk of developing RDS in the second twin rises with gestation and is most significant after 29 weeks. This increased risk is due to delayed maturation of the lungs or an increased risk of hypoxia/acidosis in the second twin.

On the other hand ***Ventolini et al., (2008),*** mentioned that, in prematurity the greatest risk factor for RDS is low gestational age and the development of the syndrome begins with the impaired synthesis of surfactant associated with prematurity. About half of preemies before 30 weeks' gestation are developing RDS and the incidence declines with progressing gestational age, about three fifths to four fifths of preemies born at 26–28 weeks, to about 15–30% of those born at 32–36 weeks. So RDS is the consequence of both surfactant insufficiency and structural immaturity of the lungs.

As regards the type of delivery **(figure 2)**, findings of the current study proved that, most of the studied neonates were delivered through cesarean section (CS). This finding was parallel with ***Gerten et al., (2005)***, who stated that, at any given GA the prevalence of RDS is larger for neonates born by CS, especially without conventional labor, than for those born by vaginal delivery. On the same line, ***Zanardo et al., (2004***), clarified that, the blend of elective CS and delivery before term significantly rises the risk of RDS related to mixture of delayed removal of fetal lung fluid and a lack of cortisol response associated with natural labor.

Regarding the characteristics of the studied nurses **(table 2)**, findings of the current study clarified that, nearly half of the studied nurses' age ranging between twenty to less than twenty five years and more than half of them were secondary school graduates of nursing. Also, almost three quarters of the studied nurses had years of experience ranging from one to less than five years with mean years of experience 4.90±5.7 years. This may be due to the fact that, the secondary schools of nursing provide the health agencies with large numbers of graduated diploma nurses than faculties of nursing and technical institutes of nursing.

Concerning the studied nurses' knowledge as regards RDS **(table 3)**, findings of the present study indicated that there was significant improvement in all items of nurses' knowledge post implementation of the instructional guidelines compared to pre implementation regarding definition, causes, signs, treatment, nursing intervention and complications of RDS. These differences showed also a statistically significant improvement in the total nurses' knowledge post implementation of instructional guidelines. This improvement in nurses' knowledge justified the research hypothesis, and attributed it to the fact that the instructional guidelines were planned after assessment of nurses' identified knowledge gaps and needs and they were willing to get more information to be equipped with enough recent knowledge to provide quality nursing care and prevent complications. From the researchers' point of view this highlights the importance for conducting periodic in-services educational program about care of high risk neonates especially whose suffering RDS or undergoing SRT.

In the same line, ***Timmons, (2008) and Hay, et al,(2009),*** mentioned that, nurses have a key role in the care of high risk and preterm infants with RDS for reduction of neonatal mortality and morbidity. Nursing intervention for newborn with RDS through ET intubation, maintain mechanical ventilation as indicated, monitor oxygen concentration, continuous monitoring of the SaO2 and observe the newborn's response to oxygen. Suctioning as needed because the gag reflex is weak and cough is ineffective. Furthermore, promoting adequate nutrition and hydration is important.

In relation to nurses' knowledge regarding concept of surfactant **(table 4)** findings of the present study revealed that, there was statistically significant difference pre/post implementation of instructional guidelines regarding the nurses' knowledge of surfactant with improvement of all knowledge items post implementation compared to pre implementation. This finding was corresponding with **Joseph, (2017),** who reported in a similar study that, majority of the studied subjects had moderately adequate knowledge and approximately two fifths had inadequate knowledge on surfactant therapy preprogram. While, in the post-test, most (98.3%) of them had adequate knowledge regarding surfactant.

Also, the present study showed the positive effect of the instructional guidelines regarding nurses knowledge about surfactant replacement therapy (SRT) **(table 5)**, with improvement of all items of knowledge including definition, types, indications, nursing intervention and complications of SRT. These findings were concordant with findings of ***Elsayed and El-Nagger, (2013)***, who proved in their similar study that, nearly three fifths of the studied nurses had unsatisfactory knowledge about function of surfactant, while about three quarters of them had unsatisfactory knowledge about nursing intervention for neonatal RDS and nursing intervention during SRT respectively and they added in their recommendations that nurses working in the NICUs need periodic in service training programs to improve their knowledge and performance regarding care of neonates with RDS.

From the researchers' point of view there was decrease in nurses' knowledge in the present study before implementation of the instructional guidelines due to the fact that, more than half of the studied nurses were secondary school graduates of nursing and SRT is not included as a teaching subject in their curriculum before graduation. Also, work overload, insufficient in-services educational program regarding the previously mentioned subject together with inaccessibility or lack of provision of educational books, booklets, leaflets and manuals suite to the intellectual level of nurses with lack of time for reading led to lack of knowledge among nurses which obviously improved after implementation of the instructional guidelines due to easy language of the guidelines content, relevance of the discussed items with repetition and discussion of the items besides the distribution of guidelines booklet designed by the researchers. So that it is necessary to use appropriate continues educational program with more frequent sessions to sustain their impact.

These findings were supported by ***Dharmapuri et al., (2011),*** who stated in their similar study that, units expecting to use SRT must be well prepared with trained and knowledgeable medical and nursing staff and a respiratory therapist. SRT should be performed by a physician or other qualified personnel such as a nurse. It is essential to have medical and nursing staff trained in caring for neonates managed with SRT.

According to ***Rolim and Cardoso, (2006)***, improvement of care in the NICU requires nurses´ knowledge and responsibility. Care should be implemented by technology, especially for high risk neonates. ***Silva and Vieira (2008),*** added that it is important to evaluate the quality of nursing care in NICU. This quality is based on the planning and organization of the service, following principles set out in documents governing this hospital service.

In the same context ***Verklan and Walden, (2010***), mentioned that the nurses are usually in the first line of defense to keep neonates' safety, which helps them discover matters that influence neonates' safety closely and directly. Consequently discovering and relieving the source of damage is critical to offering safe care. Furthermore, nurses play a major role in meeting neonates' safety-related requirements. A Considerable reduction in mistakes and upgrading of nurses' performance at the NICU is realized when NICU nurses understand and recognize the related reasons and then implement evidence-based interventions.

Concerning nurses' practices regarding care of high risk neonates with RDS pre and post application of instructional guidelines **(table 7)**, findings of the current study displayed that, there was an improvement in the nurses practices post application compared to pre application with highly statistical significance difference (P= 0.000). From the researchers observation and assessment of nurses' practice in actual situation regarding hand washing, most of nurses weren't practicing hand washing to elbow at the beginning of the shift or before and after preparing/giving medications or after the removal of gloves . They also sometimes were omitting rubbing fingers during hand washing. Also they were using disinfectant solutions instead hand washing most of times. Also, some of nurses were get contaminated hands after hand washing and before contact of the patient with staff body parts, using mobile phones, handling patient's file or observation sheet.

These findings were parallel with ***Jabbar et al., (2017),*** who proved in their recent study that most of the nurses' perception is weak regarding the effectiveness of the hand washing to avoid the infections. Also they stated that, nurses find it difficult to clean the hands while working in their units.

In the same context ***Mu'taz et al., (2016),*** mentioned that, hand hygiene is the main measure to decrease the infection among neonates. Hand hygiene is an easy and simple procedure and its omission can enhance the morbidity and mortality rates in neonates. However, infections are the major source of death in neonates. The solution to this challenge is to promote hand hygiene compliance among the nurses and the health care staff.

Moreover, ***Hemati, (2016)***, added that, the nurse is the first step for attaining desired therapeutic outcomes at the NICU. The nurses should perform healthcare practices with reference to a wide range of complete healthcare standards. Because nurses play a significant role in newborn healthcare, quality of their practice is critical for the recovery of newborns.

In relation to the nurses' practice in respiratory hygiene **(table 7)**, the researchers observed that, most of nurses were performing endotracheal tube (ETT) suctioning as a routine procedure and did not assess the respiratory condition of the neonates prior suctioning and did not recognize clinical signs indicating the need for suction. This finding was inconsistent with ***Janes, (2012)***, who recommended that, suction of the ETT should not be considered a routine procedure and nurses should assess the neonates' clinical condition and abnormal signs as oxygen desaturation, bradycardia or audible crackles on auscultation to determine the need for suction.

Regarding nursing care of the neonates on mechanical ventilator **(table 7)**, there was an improvement in nurses practice post implementation of the guidelines compared to pre implementation with highly statistical significance difference. From the researchers' observation for nurses during actual care, nurses usually omitting to ensure sterile water level in the humidifier of the ventilator to facilitate adequate humidification and avoid trauma to the airway. Moreover, they sometimes did not emptying sloshing water in the ventilator or nebulizer tubing. In the same context ***Daco, (2011)***, stated that nurses should promote adequacy of humidification for neonates on mechanical ventilator to avoid trauma to the airway. Also, ***Tazeen et al., (2011) and Garland, (2014)***, mentioned that, tracheal suctioning is mandatory for neonates to ensure good ventilation and oxygenation. But, repeated suctioning procedure increases the risk of colonization of the respiratory tract and potentially trauma that predisposes to infection.

As regards nurses' practice regarding SRT **(table 8)**, findings of the current study revealed statistically significant difference pre/post implementation of instructional guidelines regarding nurses' practices before, during and after SRT. From the researchers' observation nurses were not perform their exact role in SRT. This may be due to their incompetent practices which attributed to lack of experience regarding SRT, shortage of lectures and educational program regarding SRT.

These findings were not compatible with ***Nouraeyan et al.,(2014)***, who recommended that, during surfactant administration procedure, the nurse should keep newborn in the horizontal position. Vital signs and ventilator parameters should be monitored during surfactant delivery. The ETT should not be suctioned for following 2 hrs unless signs of significant airway obstruction occur. Post surfactant administration, the registered nurse should record vital signs immediately after administration is completed and every 10 min for the next hour and should record ventilator parameters every next hour.

Considering nurses practice as regards total parenteral nutrition (TPN) and venous blood sampling **(table 9)**, findings of the present study displayed that, there was a clear improvement in nurses' practice regarding the previously mentioned items with statistically significant difference pre/post implementation of instructional guidelines. From the researchers' observation nurses' practical mistakes were in the form of, didn't prepare equipment properly, didn't wearing gloves during venous blood sampling and stated that wearing gloves hindering them from palpation of vein didn't transport the sample quickly and usually there were more than three or four trail for venous blood sampling. Also, fluid extravasation during TPN was a common problem due to displacement of intravenous cannula. These malpractices resulted from negligence of nurses, their heavy workload, increased rate of neonatal admission, increased working hours and reduced nursing staff. Findings of the current study agree with ***Lippi and Guidi (2007) and Goswam et al. (2010)*** who found that, more than half of the participants in blood sampling withdrawal had incompetent practice.

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Concerning total nurses' practices **(table 10)**, regarding high risk neonates undergoing SRT pre/post guidelines application, it was observed that, there was a clear improvement in total nurses practice. Findings of the present study revealed that there was a statistically significant improvement post guidelines implementation. This improvement justified the research hypothesis and reflected the importance of the instructional guidelines which helped the nurses to improve their practices to care for neonates undergoing SRT.

V. CONCLUSION

Based on the findings of the current study, it can be concluded that, there was knowledge deficient as well as incompetent practice among nurses regarding respiratory distress syndrome and surfactant replacement therapy before application of the instructional guidelines. The research hypothesis is accepted and the implementation of the instructional guidelines led to significant improvements in nurses' knowledge and practices regarding care of high risk neonates undergoing surfactant replacement therapy.

VI. RECOMMENDATIONS

Based on the results and conclusion of the current study, the following recommendations were suggested:

- In-services educational program should be conducted for all nurses working in NICUs about care of high risk neonates undergoing surfactant replacement therapy.
- Instructional pamphlet and illustrated booklets about surfactant replacement therapy should be designed and provided for all nurses in all NICUs.
- Periodical follow-up for the level of knowledge and practices of all nurses regarding care of high risk neonates with respiratory distress syndrome and undergoing surfactant replacement therapy.

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