Relationship between Nursing Procedures and Oxygen Saturation Level of Preterm Infants with Respiratory Distress Syndrome

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Abstract: The present study was conducted to determine the relationship between nursing procedures (Suctioning, change of position, Heel stick) and blood oxygen saturation level, using pulse oximter monitoring. Fifty preterm infants with respiratory distress syndrome were monitored during performing the nursing procedures at the Neonatal Intensive Care Unit, in Maternity University Hospital at EI-Shatby in Alexandria. An assessment sheet was developed for monitoring the oxygen level before, during, and after each of the three nursing procedures. The main results were the preterm neonates with respiratory distress syndrome reacted to nursing care procedures with decrease in oxygen saturation (SPO_2) during different positioning and repositioning, suctioning and heelstick. After the procedures, all preterm neonates returned to pre-procedure average of oxygen saturation except after repositioning from side- lying to supine, from supine to prone position, and after suctioning. The supine position contributed to a slight decrease in oxygenation. Both prone position and suctioning contributed to an increase in oxygenation after the procedures. The main recommendation is that continuous monitoring of oxygen saturation before, during and after performing the nursing procedures is mandatory.

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1. Introduction:

During pregnancy, the fetus grows in the mother's uterus usually for 37 to 42 weeks. Infants born less than 37 weeks are called preterm or premature infants.(1) Those infants are at increased risk of growth problems, developmental delays and complex medical problems. (2)

According to World Health Organization (WHO)2009 data showed that, worldwide more than one million infants die each year because they are born early (or 28% of total newborn death) .The highest preterm delivery rate in the world are found in Africa (11.9%) , followed by North America (United States and Canada). (3) In the U.S.A, the preterm birth rate has risen steadily from 9.4% in 1981, to 10.4% in 2000, to 10.6% in 2005.(3,4) In Canada, there has been a slight increase in preterm birth for 7.5% in 2000, to 7.7 in 2003, to 7.9% in 2004 % , to 10.6 in 2005.(5-7)

Worldwide, in 2005 the preterm birth rate was estimated as 9.6 %-representing about 12.9 million infants.(3) In Alexandria University Hospital, the rate of preterm admission in El-Shatby Neonatal Intensive Care Unit was 74.7% in 2009. Records show that mortality rate of preterm infants has dramatically improved in the neonatal intensive care unit (NICU) from 75.1% in 2002, to 44.8% in 2004, to 35.7 % in 2009. These, records showed that respiratory distress syndrome was the second main reason for admission to the unit (11.4%) during the year 2009.(8)

The tenuous respiratory status of many preterm infants in the neonatal intensive care units places them at high risk from the potential stress of repetitive diagnostic, nursing and therapeutic procedures. These procedures are associated with alteration in physiological responses, which may result in undetected subclinical episodes of hypoxemia or hyperoxemia. (8) Handling during routine nursing care (i.e., vital signs, changing diaper or position, vein puncture for blood draws or feeding, heelsticks, and suction) can result in increased intracranial pressure, episodes of apnea/bradycardia, agitation, and increased or decreased heart rate and blood pressure. (9 - 11)

The development of oxygen saturation measurement techniques provides a tool with which oxygenation may be continuously and non-invasively monitored during nursing care procedures.(11,12) Care should be taken to include oxygen saturation target in daily practice to avoid prolonged or alternating episodes of hypoxia /hyperoxia in infant breathing supplemental oxygen.(13)

The minimum duration of hypoxia that cause brain damage is not known. Until this critical period is determined, hypoxia for any length of time should be avoided. If the infant is unable to recover spontaneously, significant hypoxia can end in assisted ventilation and prolonged intubation. To avoid this risk, the arterial oxygen tension of critically ill preterm infants needs to be maintained at 50-70 mmHg. [14]

In the neonatal intensive care unit (NICU), preterm infants often require support of ventilation and oxygenation through endotracheal intubation and invasive positive-pressure ventilation (IPPV). [15] The presence of an endotracheal tube causes soft-tissue irritation and increased secretions. Intubation can lead to thickening of secretions. Increased or thick secretions add to the risks of endotracheal-tube blockage, lobar collapse, and compromised gas exchange. [16]Suctioning the endotracheal tube in infants with RDS is one of the stressful nursing procedures that should be done if there is secretion, and significantly affects gas exchange and should be kept to a minimum. There are many complications associated with endotracheal suctioning which include hypoxemia, bradycardia, tachycardia, pneumonia, fluctuation in blood and intracranial pressure, localized trauma to the airway, infection and tube dislodgement. [17, 18]

Repositioning of preterm infants is a basic nursing care. [19]It includes supine, prone, side lying, and head up tilted position. Several studies demonstrated variable outcomes affected by different positioning of preterm infants .The American Academy of Pediatrics recommended that the prone position is more appropriate for sick preterm infants because oxygenation is better. [20] Therefore, proper positioning may improve oxygenation and reduce the need for supplemental oxygen and mechanical ventilation. Suitable positioning to maintain normal oxygen saturation is a priority in the nursing care.[21] Preterm infants regularly are subjected to a multitude of diagnostic and therapeutic procedures that are painful but medically necessary. The most frequently performed procedure is heelstick.[22-23] Infants undergoing this procedure experience significant pain manifested by crying, facial expressions, body movements and physiologic changes .[24] Physiological indicators of pain are changes in heart rate, respiratory rate, blood pressure, oxygen saturation (SaO_2), vagal tone, palmar sweating, facial expression and intensity of cry.[25] One reason that heelstick blood collection is painful and distressing is the prolonged squeezing of the heel required to complete the sample.[26]

Many events consistently lead to hypoxemia in preterm infants: as drops in transcutaneous oxygenation $TcPo_2$ during the insertion of an intravenous needle, taking vital signs and pharyngeal suctioning.[27] Daily procedures such as feeding, examination, and diaper changes were sometimes associated with hypoxemia.[12] The physiological and behavioral effects of a supposedly beneficial procedure, a sponge bath, on preterm infant may increase heart rate, cardiac oxygen demand, and decreases in oxygen saturation . [28]

From these facts and clinical observation, changes in nursing care of the preterm infant has taken place faster than their evaluation . Meticulous attention must be given to subtle changes in the infant oxygenation status. So, nursing care should be altered and adapted based on specific observations of each infant's response to care giving. When care is structured to support the individual infant's physiologic stability and neurobehavioral organization, stress is reduced for that infant.[29]Certain routine procedures may be more harmful than beneficial to the infant. There are three routine nursing procedures that may be associated with hypoxemia as suctioning, repositioning and performing heelstick. In the present study procedures are selected because of the frequency with which they are performed in the usual management of preterm infants. The effect of nursing care procedures on the fluctuation of the oxygenation level need to be evaluated. [14]

Aim of the study

The aim of the present study was to determine the relationship between nursing procedures (Suctioning, change of position, Heel stick) and blood oxygen saturation level in preterm infants with respiratory distress syndrome.

2. Materials and methods:

Materials:

Research design: It is a descriptive study.

Setting: The study was conducted at the Neonatal Intensive Care Unit, in Maternity University Hospital at EI-Shatby in Alexandria.

Subjects:

A convenient sample of fifty preterm infants with respiratory distress syndrome who had the following criteria:

- Born at 26 -34 weeks of gestation.
- On mechanical ventilator or continuous positive air way pressure (CPAP).
- Free from any congenital malformation.
- Having normal body temperature and hemoglobin level.
- Having normal oxygen tension before nursing procedure (to exclude hyperoxia)

Tool: It comprised three parts:

Part (I):-

Neonate's biodemographic data such as: name, age, sex, birth weight, gestational age and the type of delivery.

Part (II):-

- Physiological indicators as temperature, heart rate and respiratory rate.
- Temperature of incubator.
- Hemoglobin level.
- If the infants had received surfactant or not.
- Method of oxygen administration such as: tracheal CPAP (Continuous Positive Airway Pressure) or mechanical ventilator.
- Continuous Positive Airway Pressure data included:
  * Fraction of Inspired Oxygen (FiO_2) and Positive End Expiratory Pressure (PEEP).
- Ventilator data included:
  * Mode of ventilator, ventilator category: high or low pressure setting,
  * Duration of stay on ventilator, Peak Inspiratory Pressure (PIP), (PEEP),(FIO_2),Inspiratory Time (Ti), Expiratory Time(Te), Mean Airway Pressure (MAP).
- Arterial blood gas less than 2hrs before procedure which included:
  * PH, Partial pressure of oxygen (PaO_2), Partial pressure of carbon dioxide ($PaCO_2$), Oxygen saturation (SpO_2), Bicarbonate (HCO_3).

Part (III):-

- An assessment sheet for monitoring oxygen saturation level before, during, and after each of the three nursing procedures:
- Change of positioning
  From supine to side, from side to supine, and from supine to prone.
- Endotracheal suctioning.
- Heelstick.

Method:

1. An official approval for conducting the study was obtained from the responsible administrative personnel.
2. The tool was developed by the researcher after thorough review of literatures.
3. The developed tool was validated by five experts in the field in nursing and medical field, modification proposed was implemented and the validity was 0.88.
4. Tool reliability was ascertained where the researcher observed five infants using the assessment sheet for two times with an interval period of 48 hours .The reliability of this tool was 0.82 tested by Cronobach alpha test.
5. A pilot study was done on 5 neonates to test the applicability of the tool; these five neonates were excluded from the sample
6. Each infant was observed by the researcher during the morning and afternoon shifts while the nurse was performing endotracheal suctioning, repositioning, and heelstick.
7. Arterial blood gases were obtained from the neonates by the nurse less than 2 hrs before the procedures.
8. Ventilator data were recorded immediately before each of the three procedures.
9. Temperature, heart rate and respiratory rate were measured 10 minutes before the nursing procedures.
10. Heart rate and oxygen saturation were recorded immediately before the procedure.
11. During baseline monitoring, the infants were not disturbed.
12. Oxygen saturation and heart rate were collected while the infant was receiving the nursing care (Change of positioning - suctioning - heelstick)
13. Oxygen saturation level of every procedure was recorded at 30 seconds before starting, during, and 30 seconds after each procedure until reach to average pre-procedure level.
14. The duration of procedures was recorded.
15. The length of time to return to normal O_2 saturation was measured.
16. The observer didn't interfere with the routine care of the infants. The only request made to the nurse performing the procedure was to allow the infants to return to the pre-procedure oxygen saturation average (88%- 95%) before disturbing again .
17. Several parameters were used to determine the relation of nursing procedures and oxygen saturation. These were (a) desaturation: the incidence of oxygen saturation was less than 88%; (b) high oxygen saturation: the incidence of oxygen saturation was 95% or more;(c) bradycardia : heart rate less than 100 b/m ; (d) tachycardia : heart rate more than 160 b/m.
18. Oxygen saturation was measured by pulse oximeter Nelcor-560 made in Korea or Massimo Rad–9 made in U.S.A with Max –N disposable neonatal sensors .A tiny, lighted probe placed on the infant's hand or foot projects a beam of light through the capillary beds in the tissue .The light beam is converted into an electric signal by a photo detector in the probe that is processed within the module and displayed as both a waveform and a digital value for both the oxygen saturation SpO_2 and the heart rate.

19. The three procedures were performed in the following manner consistent with routine practice in NICU:

A-Suctioning:

a. Tracheal suctioning was performed only when there was a clinical need.

b. The following considerations were followed:

- Suction Catheter was selected according to the endotracheal tube size.
- Negative suction pressure was 40-60 mmHg, it was applied intermittently and only during catheter withdrawal while simultaneously rotating the catheter.
- Hyperoxygenation of the neonates was performed before, and after suction through the ventilator by increasing fraction of inspired oxygen (FiO_2) 10-20% above the baseline.
- The endotracheal tube was disconnected at Y piece from the ventilator.
- The suction catheter was inserted into the endotracheal tube for 10-15 seconds and repeated if needed.
- The attending resident did lung recruitment procedure by the ambu bag 3-5 puffs manually.
- The endotracheal tube was reconnected at Y piece to the ventilator, and gradual decrease of FiO_2 to the pre suction level.
- The oxygen saturation level and heart rate was continuously monitored before, during and after the procedure using a pulse oximeter.

B- Changing positioning:

The paediatric nurse picked up the preterm infant during a calm period one continuous motion from back to one side or from one side to back or from back to prone.

First, the supine position was performed by supporting head, feet and body in the midline by using soft rolls around the infant. A roll under the shoulders was placed to support the newborn's airway and allowed slightly forward flexion of the head.

Second, the prone position was performed by putting the newborn's body prone. The arms should be close to the body with the hands symmetrically close up to the mouth. Flexion of the legs can be encouraged with the knees brought up to the chest, raising the hips slightly. This position was maintained by using a rolled blanket to make a boundary. Position device for prone include a small hip roll to assist in maintaining flexion. Use of a rolled cloth placed under the infant (from top of the head to umbilicus) to provide elevation of the body.

Third, the side lying position was performed by ensuring that the head and trunk should be maintained in neutral alignment. The nurse should use a roll along the infant's back (not touching the back of the head as the infant may be stimulated to push back into it). The legs should be flexed and the upper leg supported in neutral position by the use of roll between the legs.

The oxygen saturation level and heart rate were recorded during and after the procedure using a pulse oximeter.

C- Heel stick:

The nurse warmed the heel for one a minute with a warm washcloth, handled the infant's foot, and appliedmild pressure between thumb and fingers to hold ankle in dorsiflexion , cleaned the heel with alcohol swab. The puncture was made at the outer aspect of the heel with micro lancet. One drop of blood was obtained and a dressing was applied to the heel. The oxygen saturation level and heart rate were recoded before, during, and after the procedure using a pulse oximeter.

Data analysis:

Data collected were coded and transferred into specially designed formats to be suitable for computer Feeding: the SPSS version 15.0 statistical program was utilized for results .Descriptive measures included : Percentage, mean, standard deviation , "t" test, F-test ,and Chi-square were used for test of significant. Level of significant was 5% level.

3. Results

Table (1) shows the general characteristics of the study subjects. Male constituted 62.0%. Age ranged from 1-17 days with a mean 4.96 ±2.28 days. Moreover, the gestational age of the neonates ranged between 27-34 weeks with a mean 30.04±2.09 weeks. The highest percentage of preterm neonates (84%) had a gestational age less than 33 weeks.

The weight of the neonates ranged from 600-2020 gms with a mean of 1128.78±261.92 gms. More than half of the sample (54%) had a Very low birth weight (VLBW) i.e weighing 1000 to less than 1500 gms, while 20% of the sample had Extremely low birth weight (ELBW) i.e weighing less than 1000 gms .Concerning the type of delivery, 68.0% were delivered by caesarean section, while 32.0% of the preterm neonates had delivered normaly .

Figure I describes the percent of preterm neonates regarding oxygen saturation when repositioning from supine to side. The present result reveals that 96.0% of neonates had normal oxygen saturation (88-94%) before repositioning. During the procedure, it declined to 68.0%. After the procedure, it increased to 80.0% at half a minute, it was kept the same at 2.0 minutes, and then it increased to 84.0% at 5.0 minutes. In the rest of neonates, the percent of those who had oxygen saturation ≥ 95% increased. There were statistically significant differences between the percent of neonates before repositioning and their percent during the procedure, and at half a minute, 2 minutes, and 5 minutes after.(p=0.0021, 0.0159, 0.033, 0.048 respectively)

Figure II illustrates the percent of the preterm neonates regarding oxygen saturation when repositioning from side to supine. It demonstrates that before the procedure, the percent of neonates who had normal oxygen saturation (88-94%) were 96.0%. During the procedure, their percent decreased to 54.0%. After repositioning, the percent of neonates declined to 52.0% at half a minute. This decline was apparent in the percent of neonates who had O_2 saturation< 88%. At 2.0 minutes and 5.0 minutes after the procedure, the percent of neonates increased to 74.0%, 84.0% respectively. This difference in the percent of neonates before repositioning and at 5.0 minutes after the procedure shows either increase in the percent of neonates who had O_2 saturation< 88% , or in the percent of neonates whose O_2 saturation ≥ 95% . There was a statistically significant difference between the percent of neonates before repositioning and their percent during, at half a minute, 2 minutes, and 5 minutes later.(p=0.001, 0.001, 0.036, 0.011 respectively)

Figure III illustrates the percent of the preterm neonates regarding oxygen saturation when repositioned from supine to prone. The figure reveals that 98% of the neonates who had normal oxygen saturation between 88-94% before repositioning declined to 44.0% during repositioning. This decline appears in the percent of neonates who had O_2 saturation< 88%. After the procedure, the percent of neonates increased to 88.0% at half a minute, and then kept nearly the same 86.0% at 2.0 minutes, and then it decreased to 52.0% after 5.0 minutes which is parallel by an increase in the percent of neonates who had oxygen saturation ≥ 95%. There was a statistically significant difference between the percent of neonates before repositioning and their percent during, after half, 2.0, and 5.0 minutes.(p=0.001, 0.039, 0.045, 0.001 respectively)

Figure IV shows the percent of preterm neonates regarding oxygen saturation before, during, and after suctioning. It is clear from the figure that before suctioning, all the neonates (100%) had normal oxygen saturation (88%-94%).During the procedure, their percent decreased to 20.0 %. This decline shows an increase in the percent of neonates who had O_2 saturation< 88% .After the procedure, it was observed that, the oxygen saturation of neonates improved when the percent of neonates increased to 74.0%, and 82.0% at half a minute and at 2.0 minutes respectively. At 5.0 minutes, the percent of neonates decreased to 62.0%. The decrease in percent of neonates is apparent in those who had O_2 saturation ≥95%. There were statistically significant differences between the percent of neonates before and their percent at different periods of suctioning except at 2.0 minutes after. (p=0.0001, 0.0013, 0.002 respectively)

Figure V portrays the percent of preterm neonates regarding oxygen saturation before, during, and after heelstick. It is clear that 100% of neonates had normal oxygen saturation (88-94%) before heelstick. During the procedure, the percent of neonates decreased to 72.0% .This decline is apparent in the percent of neonates who had O_2 saturation< 88%. After the procedure, the percent of neonates increased to 80.0% and 88.0% at half a minute and at 2.0 minutes respectively, and then it decreased to 82.0% at 5.0 minutes which is paralleled by an increase in the percent of neonates who had oxygen saturation ≥ 95%. Statistically significant differences between the percent of neonates before heelstick and their percent during the procedure, at half a minute , at 2.0, and at 5.0 minutes after were observed.(p=0.0032, 0.039, 0.0043, 0.045 respectively)

Table II shows the mean values of oxygen saturation of preterm neonates before, during and after the nursing procedures. It is observed that the mean oxygen saturation value was 91.49± 9.25% before repositioning from supine to side, it decreased to 88.32± 8.65% during the procedure, and to 87.86± 9.65% at half a minute after, then it gradually increased to 91.04 ± 9.25% , to 92.68± 10.6 % at 2 .0 minutes and at 5.0 minutes respectively after repositioning. There was statistically significant difference between mean oxygen saturation before the procedure and each of during, and at half a minute after the procedure (p=0.045, and 0.033 respectively). It is clear from the table that the mean value of oxygen saturation was 92.16± 7.89% before repositioning from side to supine, it decreased to 87.44± 7.25% during the procedure, then it gradually increased to 88.9 ±7.65% , to 89.86± 7.65%,and to 90.48±7.98% after the procedure at half a minute , 2.0 minutes , and 5.0 minutes respectively. There was statistically significant difference between mean oxygen saturation before the procedure and each of during, and half a minute after the procedure (p=0.048, and 0.05 respectively).

It is observed also that the mean value of oxygen saturation when repositioning of neonates from supine to prone was 90.34± 6.98% before repositioning, it decreased to 86.84±6.99% during the procedure, then it increased to 89.38± 8.02%, 92.54 ± 8.06%,and 95.8± 11.3% at half , 2.0, and 5.0 minutes respectively after repositioning. Statistically significant difference was observed between mean value of oxygen saturation before the procedure and each of during the procedure and 5 minutes after repositioning (p=0.047, and 0.021 respectively).

In relation to Endotracheal Tube(ETT) suctioning, the same table shows that the mean value of oxygen saturation was 89.96±7.54% before the procedure, it decreased to 84.86 ± 6.52% during the procedure, then gradually increased to 90.3 ±7.36%, 92.88±7.65%, and 93.62 ±10.6% at half, at 2, and at 5 minutes after suctioning respectively. There was a statistically significant difference between mean value of oxygen saturation before the procedure and each of during the procedure and 5 minutes after repositioning (p=0.041, and 0.048 respectively).

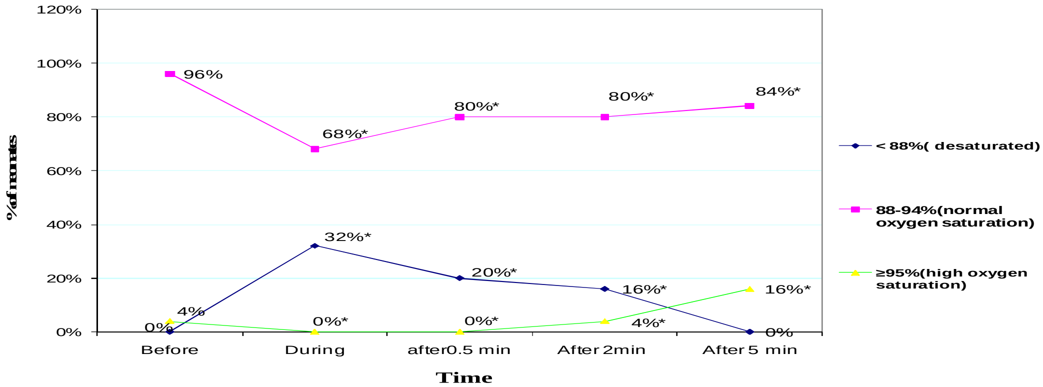
Concerning the heelstick, the mean value of oxygen saturation before the procedure was 92.26±6.98%, it declined to 85.65± 7.41% during the procedure, then it increased to 88.1±5.11%, 92.86±8.04%, and 92.96± 9.65 % at half a minute, 2 minutes and 5 minutes after the procedure. There was a statistically significant difference between mean value of oxygen saturation before the procedure and each of during the procedure and at half a minute after repositioning (p=0.036, and 0.046 respectively).While no statistically significant differences were found between mean oxygen saturation before and during the different nursing procedures.

Table (1): Percent distribution of the preterm neonates according to biodemoographic data.

Biodemographic Characteristics	N	%
Sex		
Male	31	62.0
Female	19	38.0
Age (days)		
• 1-	28	56.0
• 5-	15	30.0
• 9-	5	10.0
• 13-17	2	4.0
Range	1-17 days	
Mean±S.D.	4.96 ±2.28	
Gestational age(weeks)		
• 27-	12	24.0
• 30-	30	60.0
• 33-34	8	16.0
Range	27 – 34 weeks	
Mean±S.D.	30.04±2.09	
Weight (gm)		
• ELBW <1000 -	10	20
• VLBW 1000 -	27	54
• LBW 1500-2020	13	26
Range	600 – 2020 gm	
Mean ± S.D.	1128.78 ±261.92	
Type of delivery		
• Caesarean section	34	68.0
• Normal vaginal delivery	16	32.0
Total	50	100.0

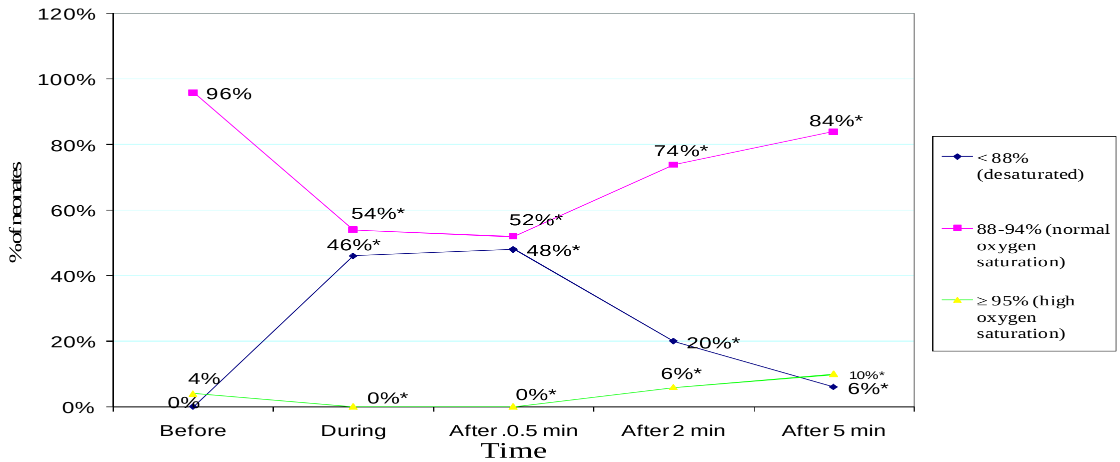
- Extremely low birth weight (ELBW): weighing less than 1000 gms.
- Very low birth weight (VLBW): weighing 1000 to less than 1500 gms.
- Low birth weight LBW: weighing less than 2500 gms

Figure (I): Percent Distribution of preterm neonates regarding oxygen saturation before , during and after repositioning from supine to side



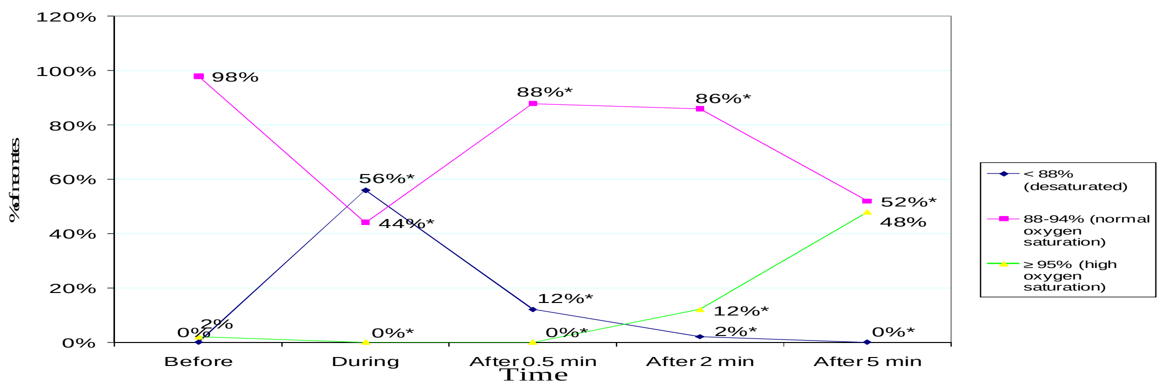
*Statistically significant at P ≤ 0.05

Figure (II): Percent Distribution of preterm neonates regarding oxygen saturation level before, during and after repositioning from side to supine



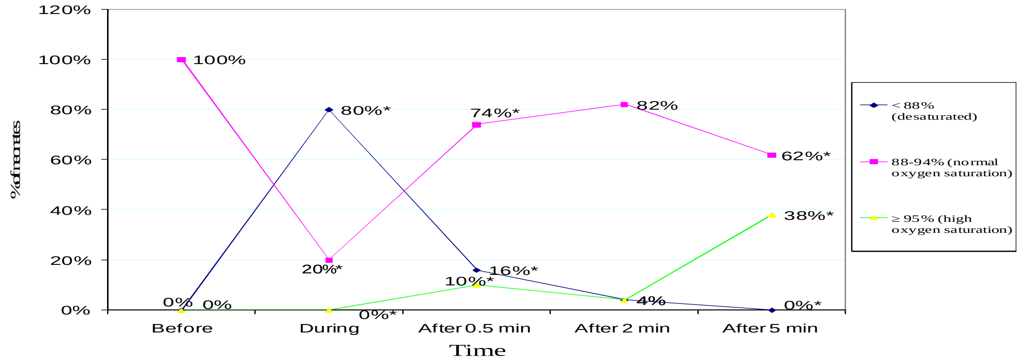
*Statistically significant at P ≤ 0.05

Figure (III): Percent distribution of preterm neonates regarding oxygen saturation before , during and after repositioning from supine to prone



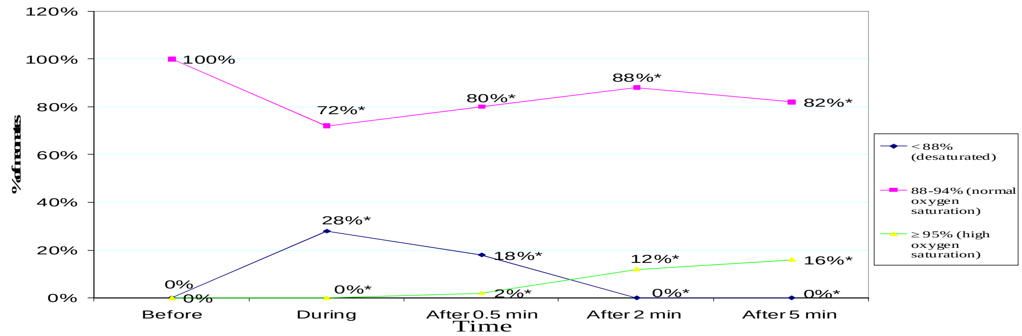
*Statistically significant at P ≤ 0.05

Figure (IV): Percent Distribution of preterm neonates regarding oxygen saturation before, during and after suctioning



*Statistically significant at P ≤ 0.05

Figure (V): Percent distribution of preterm neonates regarding oxygen saturation before, during and after heelstick



*Statistically significant at P ≤ 0.05

Table (II): Comparison of preterm neonates' mean oxygen saturation before, during and after nursing procedures

Nursing procedures	Oxygen saturation of preterm neonates				
	Before	During	After the procedures		
			0.5 min. after the procedure	2.0 min. after the procedure	5.0 min. after the procedure
(I)Reposition (1)From Supine to Side	91.49±9.25	88.32±8.65	87.86±9.65	91.04±9.25	92.68±10.6
t-test		1.89	2.11	0.48	0.62
P		0.045*	0.033*	0.62	0.45
(2)From Side to Supine	92.16±7.89	87.44±7.25	88.9±7.65	89.86±7.65	90.48±7.98
t-test		1.82	1.79	1.62	1.089
P		0.048*	0.05*	0.069	0.244
(3)From Supine to prone	90.34±6.98	86.84±6.99	89.38±8.02	92.54±8.06	95.8±11.3
t-test		1.89	1.54	0.98	2.32
P		0.047*	0.086	0.21	0.021*
(II)Endotracheal Suctioning	89.96±7.54	84.86±6.52	90.3±7.36	92.88±7.65	93.62±10.6
t-test		1.89	0.84	1.25	1.98
P		0.041*	0.46	0.098	0.048-*
(III)Heelstick	92.26±6.98	85.65±7.41	88.1±5.11	92.86±8.04	92.96±9.65
t-test		2.01	1.85	0.35	0.38
P		0.036*	0.046*	0.65	0.71
ANOVA p	2.65 0.108	3.04 0.099	1.65 0.28	0.85 0.39	1.25 0.27

*Statistically significant at P ≤ 0.05

4. Discussion:

The fetus is brought into a world for which he is not physiologically prepared which constitutes an obstacle to normal development. Preterm infants are at high risk for chronic lung disease, intraventricular hemorrhage, retinopathy of prematurity and necrotizing entrocolitis. Moreover, possible insults to the preterm neonates during the time she/he is in the intensive care unit are exposure to stress and pain caused by medical and nursing procedures. [30,31]

In caring for the preterm neonates with respiratory distress syndrome, one of the aims of therapeutic intervention is to maintain optimal oxygenation. Therefore; the fragile preterm infants might need mechanical ventilator support .The appropriate use of oxygen in the preterm infant has been the source of concern and study for more than half a century. Oxygen therapy has been causally linked to adverse neonatal outcomes including retinopathy of prematurity and chronic lung disease due to prolonged exposure to high oxygen tensions.

Lowering oxygen saturation targets in preterm infants in the first few weeks of life has been shown to reduce the incidence of certain complications; however prolonged periods of hypoxemia may result in poor growth, cardiopulmonary complications of chronic lung disease, neurodevelopmental disabilities, or increased mortality. [32]

Preterm infants who require extended mechanical ventilator support are at high risk of the potential stress of repetitive diagnostic, nursing and therapeutic procedures. Routine nursing care (i.e., vital signs, changing diaper or position, vein puncture for blood draws, feeding, heelstick, suction, and physical or neurological examination) may result in unnoticed subclinical episodes of hypoxemia or hyperoxemia. These episodes could be detected by arterial oxygen saturation (SpO_2) monitoring by pulse oximetry. Newborn intensive care unit personnel respond to high / low Spo_2 alarms but any delay of response can prolong exposure to unnecessary high concentration of supplemental oxygen or periods of hypoxemia that may increase the risk for its complications. [10, 33, 34]

As regards positioning of preterm neonates from supine to side-lying, the finding of the present study showed that a statistically significant fall in oxygen saturation was observed during the procedure, then after the procedure there was a gradual slight increase in oxygen saturation that did not reach significance . In accordance to the current finding, Yottiem et al (2004) stated that infants with side lying position had higher mean oxygen saturation than infants with regular position.[32] Furthermore, the neonatology clinical guidelines (2006) recommended that side-lying position can be used to treat unilateral lung disease, with better oxygenation being achieved by positioning the 'good ' lung uppermost. This also supports a better oxygenation. [34]

The present results revealed a significant decrease of oxygen saturation during repositioning from side to supine and short period after the procedure. Within the five minutes observation period the supine position was associated with a slight reduction in oxygen saturation and 6% of infants did not reach the pre-procedure average of oxygen saturation. Such findings raise the doubts about the benefit of supine position .It could be justified that in the supine position the abdominal organs tend to be forced by gravity against the diaphragm. This makes it difficult for the diaphragm to contract and for the newborn to breathe. [35]The present results are supported by Dimitriou et al (2002) and Woragidpoonpol (2001) who reported that the supine position was associated with lower oxygen saturation than the prone**.**[36, 37]

In the current study, although repositioning from supine to prone resulted in a transient fall in oxygen saturation during the procedure, yet the prone position was associated with improvement in oxygen saturation after the procedure.It could be justified that when the infant is placed in the prone, stability of the chest wall is enhanced, particularly during inspiration. This fixation of chest wall allows for an increased thoracic volume when needed without additional work of breathing. This occurs because additional muscles of inspiration are not needed to overcome diaphragmatic contraction. [38,39]

In the same context, Bhat et al (2003) found that oxygenation was better in the prone posture than in the supine posture. The researchers explained that prone placement might contribute to better SpO_2 and lower respiratory resistance, which is attributed to a more stable rib cage.[40]Similarly, Ammari et al (2009) observed an increase in oxygenation when the infants were turned from supine to prone. [41]This is in agreement with Poets et al (2007), Picheansthian and Woragidpoolpol (2003) who reported that infants who are born prematurely exhibit less apnoea and intermittent hypoxia have better thoracoabdominal synchrony, higher lung volumes and better oxygenation when nursed in the prone position. [42, 43]According to Chang et al (2002) the prone position produced fewer episodes of desaturation and lesser levels of activity. [44]

The findings of the present study revealed that the incidence of desaturation increased during repositioning from supine to side, from side to supine, and from supine to prone .It could be explained that motion results in disruption of the calmed infant when picked up and turned from one position to another. This explanation is in accordance with Claure and Bancalari (2009), Esquer et al (2007), and Bolivar et al (1995) who found that the episodes of hypoxemia have been associated with increased activity of preterm infants.[45-47]The current result is also in agreement with Browne(2000), and Evans(1991) who stated that preterm infants who required assisted ventilation are susceptible to oxygen desaturation because of physiological instability and vulnerability to handling.[48,49] Mourdoch and Darlow (1984) studied handling during neonatal intensive care and mentioned that nursing care like alteration of position was associated with reduction of trascutaneous oxygenation.[50]

The present result revealed no significant difference in mean oxygen saturation between side-lying, supine, and prone position. The findings are congruent with the results of Bozynski et al (1988) who found no significant difference in the median of $TcPaO_2$ value between the lateral positioning and supine position, when examining the effect of side lying versus supine on transcutaneous oxygen saturation $TcPaO_2$ of 18 mechanically ventilated neonates .[51] Crane et al (1990) mentioned that there was no significant difference in oxygen saturation between supine and side-lying position. [52] Elder et al (2005) who also reported that there was no significant difference in oxygen saturation between supine and prone position. [53]The results of the present research are in line with a systemic review done by Balaguer et al (2006) who reported that no evidence concerning whether particular body positions during mechanical ventilation of the neonate are effective in producing sustained and clinically relevant improvements , prone position was found to slightly improve oxygenation.[54]

The practice of endotracheal suctioning (ETT) of ventilated preterm neonates is necessary for removing secretions to prevent obstruction of endotracheal tube.[55,56] The present results show that a statistically significant decrease in oxygen saturation was present in 80% of infants during open endotracheal suctioning .One explanation for the decline in oxygenation during suctioning may be the interruption of the infant's airway by suction catheter as this procedure necessitated the disconnection of the infants from the ventilator and disturbance in oxygen delivery. Another explanation is that, suctioning involved some degree of repositioning of the head and torso, so the effect of the two procedures may have been compounded. [15] Seckel (2008) and Jondgreden et al (2007) added that during open endotracheal suctioning, there was a drop in airway pressure, loss of lung volume and decreased in oxygen saturation. [57,58] In addition, Lindgren (2007) also reported that disconnection of breathing apparatus and negative pressure application during suctioning result in atelectasis, pulmonary shunting and venous return producing hypoxemia and lung compliance change. [59]In addition , Hooser (2002) mentioned that during open suctioning the gas drawn from the lung was replaced by air drawn from the atmosphere through the space left around the catheter which decreases the oxygen saturation .[60]

The finding of the current study are congruent with Hoellering et al (2008), Kalyn et al (2003) and Slevin et al (1998) who mentioned that open ETT suctioning could contribute to disturbance in ventilation, leading to greater degree of hypoxemia. [61-63]After performing of endotracheal suctioning, the present result shows an increase in oxygen saturation up to 5 minutes. This may be due to removal of secretions that partially obstructed the endotracheal tube. It can also be interpreted by the fact that hyperoxygenation before and after ETT suctioning may have a positive effect in increasing oxygen saturation.

Heelstick is one of the most common painful invasive procedures in NICU .It is the conventional method of blood sampling in neonates for screening tests or measurements of serum bilirubin or glucose or blood gas. Sick preterm infants admitted to neonatal intensive care units (NICUs) are exposed to this procedure repeatedly as part of their routine care. Painful procedures are harmful to the infant's physiological stability and ability to self regulate. [64, 65]

The result of current study shows a significant transient decrease of oxygen saturation during squeezing the heel and a short period after the procedure, and then it returned quickly to the baseline oxygen saturation . The result can also be attributed to the fact that decreased oxygen saturation is one of the physiological cues that might indicate pain and distress. The finding is congruent with Newnham et al (2009) who reported that heel prick was associated with hypoxemic episodes. [66]The current study is in agreement with Cong et al (2009) who examined the effect of kangaroo care on heelstick pain. They found that oxygen saturation was lower during heelstick than another phases in kangaroo group and in incubator heel group, supporting evidence that heelstick is a stressful event. [67] Hummel and Van (2006) and Walden & Gibbins (2008) explored that brief, acute noxious stimuli result in decreasing in oxygen saturation during the pain. [68, 69] On the contrary, Herrington et al (2007) found that no significant differences were noted in oxygen saturation in any phases of heelstick procedure. [70] Norris et al (1981) also concluded that transcutaneous oxygen saturation did not differ significantly during heelstick procedure. [15]

5. Conclusion

Based on the findings of the present study, it is concluded that preterm neonates with respiratory distress syndrome reacted to nursing care procedures with decrease in oxygen saturation (SPO_2) during repositioning from supine to side- lying, from side-lying to supine, and from supine to prone position as well as during suctioning, and during heelstick. After the procedures, all preterm neonates returned to pre-procedure average of oxygen saturation except after repositioning from side- lying to supine, from supine to prone position, and after suctioning. The supine position contributed to a slight decrease in oxygenation. Both prone position and suctioning contributed to an increase in oxygenation after the procedures.

Recommendations

Individual neonates show varied response to nursing intervention especially preterm infants, therefore continuous monitoring of oxygen saturation is mandatory before, during and after performing the nursing procedures because an infant's status can change rapidly.

The need for caution among nurses and other professionals in delivery of care to this vulnerable infant is warranted. In planning care for preterm infant with RDS, the infant's response to procedures should be predicted consideration should be given to the benefits of the procedure in relation to its risk.

Routine intensive care should be altered and adapted based on specific observations of each infant's response to the care given and avoid prolonged exposure to unnecessary high concentration of supplemental oxygen or periods of hypoxemia that may increase the risk for their complications.

Neonatal intensive care units should include updated policies related to oxygen therapy, repositioning, suctioning, heelstick and other nursing care procedures for preterm neonates.

Care protocols for preterm neonates should incorporate a principle of minimizing the number of disruptions in care as much as possible and avoid sudden interruption.

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6. References:

1. Robert M. Fetal and Neonatal Medicine. In: Behrman RD, Kliegman RM. Nelson Essential of Pediatric. 4th ed. Philadelphia: W.B. Saunders Co. 2002; 214-5.
2. Ricci SS. Essential of Maternity, Newborn, and Women's health Nursing. Philadelphia: Lippincott Co. 2007; 644.
3. Beck S, Wojdyla D, Say L, Betran AP, Merialdi M. WHO Systemic Review on Maternal mortality and morbidity: The global burden of preterm birth 2009. The Bulletin of the World Health Organization. available at http://www.eurekalert.org/pub.../2009.../modfgdt100209.phd
4. Hamilton BE, Martin JA, Ventura SJ. Births: Preliminary data for 2007. National vital statistics reports 2009; 57(12):1-5. Available at http://*www.cdc.gov/nchs/data/nvsr/nvsr57/nvsr5712.pdf*
5. Henrik, Hagberg. Preterm birth and Perinatal morbidity and mortality: Incidence of Preterm birth in different countries. Subgroups of preterm birth. Available at http://*www.kbh.uu.se/pdf/Quiip/Preterm-Birth.pdf*
6. MacDorman MF, Mathews TJ. Recent Trends in Infant Mortality in the United States. NCHS data brief, no 9. Hyattsville, MD: National Center for Health Statistics. 2008. Available at http://*www.cdc.gov/nchs/data/databriefs/db09.htm*.
7. Rate of preterm birth (percent of live birth) ,Canada,2002-2004 source : public health Agency of Canada using statistics Canada, Canadian vital statistics, birth database available at http://www.phcspc.gc.ca/publicat/2007/Ibrd.
8. Un-published Statistical Records of Neonatal Department, Children University Hospital at El-Shatby in Alexandria, 2009.
9. Danford D, Miske S, Headly J, Nelson R. Effect of routine Care procedures on transcutaneous oxygen in neonates: a quantitative approach. Journal of Archives of disease in childhood 1983; 85:20-30.
10. Peters K. Does routine nursing care complicate the physiologic status of the premature neonate with respiratory distress syndrome? .Journal of Perinatal Neonatal Nurse 1992; 9:67.
11. Gagnon R, Leung A, Macnab A. Variations in regional cerebral blood volume in neonates associated with nursery events. Journal of American Perinatology1999; 16:7.
12. Gonsalves S, Mercer J .Physiological correlates of painful stimulation in preterm infants. Clinical Journal of Pain 1993; 9(2):88-93.
13. Long J, Philip A, Lucey J .Excessive handling as a cause of hypoxemia .Journal of Pediatrics 1980; 65(2):203-7.
14. Claure N. Automated Regulation of inspired oxygen in preterm infants: Oxygenation stability and clinical

workload. Journal of Anesthesia and Analgesia 2007; 105(6):537-41.
15. Norris S, Campebll, Brenerl S. Nursing procedures and alteration in transcutaneous oxygen tension in premature infants. Journal of Nursing Research 1981; (4): 330-6.
16. Demaray W. Suction for Intubated Patients. RT. For Decision Makers in Respiratory Care June/July 2002.Available at http://www.rtmagazine.com/issues/articles/2002-0606.asp.
17. Woodgate PG, Flenady V. Tracheal suctioning without disconnection in intubated ventilated neonates. Cochrane Database Systematic Reviews 2001; 4:1-14.
18. Rennie J, Morley CJ, Sinha S, King M, Danielian p. Guidelines for good practice in the management of neonatal respiratory distress syndrome .1998. Available at http://www.bapm.org/documents/publications/rds
19. Morrow B, Futter M,and Argent A. Effect of endotracheal suctioning on lung dynamic in mechanically –ventilated pediatric patients . Australian Journal of Physiotherapy 2006; 52:121.
20. Heimler R, Langlois J, Hodel D. Effect of positioning on breathing pattern of preterm infants. Journal of Archives Disease in Childhood 1992; 67(3):312-4.
21. American Academy of pediatrics Task Force on Infant and SIDS. Positioning and sudden infant death syndrome (SIDS): update. Journal of Pediatrics 1996; 98 (6 Pt 1):1216-8.
22. American Academy of pediatrics Task Force on Infant and SIDS. Changing concepts of sudden infant death syndrome: implication for infant sleeping environment and sleep position. Journal of Pediatrics 2000; 105: 650-6.
23. James A. Lemons, William P, and Hugh M. Prevention and Management of Pain and Stress in the Neonate. Journal of Pediatrics 2000; 105(2):454-61.
24. Abu-Saad H, Bours G, Stevens B, Hamers J. Assessment of pain in neonates. Journal of Semin Perinatol 1998; 22:402-16.
25. Gibbins F, Maddallena P, Moulsdale W. Pain assessment and pharmacological management for infant with NEC: a retrospective chart audit. Neonatal Net Work 2006;25(5):339-45.Available at http://www.ncbi.nlm.nih.gov/pubmed/16989133
26. Gibbins F, Stevens B. The influence of gestational age on the efficacy and short term safety of sucrose for procedural pain relief .Advances in Neonatal Care 2003; 4(3):126-40.
27. Folk L. Capillary Heelstick Blood Sampling .In: MacDonald M, Ramasethu J, Seigafuse S. Atlas of Procedures in Neonatology, 4th ed. Philadelphia: Lippincott Williams & Wilkins Co. 2007; pp. 93-6 .
28. Peters K. Bathing Premature Infants: Physiological and Behavioral Consequences. American Journal of Critical Care 1998; 7:90-100.
29. Goubet N. Effects of repeated heelsticks on premature newborn. Doctorate Dissertation, Massachusetts Amherst University, 1998; 12-3
30. Datta P.Pediatric Nursing.New Delhi: Jaypee Brothers Co. 2007; 105-6 .
31. Greenspan J, Goldsmith J .Oxygen therapy in preterm infants: Hitting the target .Journal of Pediatrics 2006; 118:1740-1.
32. Yottiem P, Tilokskulchai F, Vitchisukon K, Kolatat T. The effect of position in premature infants with assisted ventilation. Asian Journal of Nursing Studies 2004; 7(3):36-42.
33. Claure N. Automated Regulation of Inspired Oxygen in Preterm Infants: Oxygenation Stability and Clinician Workload. International Anesthesia Research Society 2007; 105(6): S37.
34. Neonatology Clinical Guidelines. Metabolic management. 2006. Available at http://www.kemh.health.wa.gov.au/services/nccu/guidelines/documents/7467.pdf
35. James J, Baker C, Swain H, Principles of Science for Nurses. Australia: Blackwell Co., 2002; pp.148.
36. Dimitriou G, Greenough A, Pink L, Mc Ghce A. Effect of posture on oxygenation and respiratory muscles strength in convalescent infant. Journal of Arch Dis Child 2002 ; 86: 147-50.
37. Woragidpoonpol P . The effect of positioning on the oxygenation and sleep state in preterm infants. Journal of Chiang Mai Med Bull 2001; 40(2):53-60.
38. Bowling S, McEvory C, Cozum E. Prone position improves functional residual capacity: respiratory compliance (CRSl) and oxygenation in intubated preterm infants less than 1259 grams. American Journal of Respiratory Critical Care Medicine 1998; 157:A373.
39. Mendoza IC, RobertsIL, Cook LN. Postural effects on pulmonary function and heart rate of preterm infants with lung disease. Journal of Pediatrics 1991; 118:445-8.
40. Bhat RY, Leipälä JA, Singh NR, Rafferty GF, Hannam S, Greenough A. Effect of posture on oxygenation, lung volume, and respiratory mechanics in premature infants studied before discharge. Journal of Pediatrics 2003; 112 (1 Pt 1):29-32.
41. Ammari A, Schulze K, Kist K, Kashyap S, Fifer W. Effects of body position on thermal, cardiorespiratory and metabolic activity in low birth weight infants. Early Human Development 2009 .Available at http://www.ScienceDirect.
42. Poets C, Bodman A . Placing preterm infants for sleep: first prone, then supine. Journal of Arch Dis Child Fetal Neonatal Ed 2007; 92: F331- 2.
43. Picheansathian W, Woragidpoolpol P. A systemic review of positioning of preterm infants for optimal

physiological development .2003. Available at http://www.joannabriggs.edu.eu/protocols/position.
44. Chang YJ, Anderson GC, Dowling D, Lin CH .Decreased activity and oxygen desaturation in prone ventilated preterm infants during the first postnatal week. Journal of Heart Lung 2002; 31(1):34-2.
45. Claure N, Bancalari E. Automated respiratory support in newborn infants. Journal of Seminars in Fetal and Neonatal Medicine 2009; 14(1): 35-41.
46. Esquer, N. Claure C. D'Ugard , Bancalari E . The role of abdominal muscle activity on the duration and severity of hypoxemia episodes in mechanically ventilated preterm infants. Journal of Neonatology 2007; 92: 182– 6.
47. Bolivar J, Gerhardt T, Gonzalez A .Mechanisms for episodes of hypoxemia in preterm infants undergoing mechanical ventilation, Journal of Pediatrics 1995; 127: 767–73.
48. Browne J. Developmental Care -Considerations for Touch and Massage in the Neonatal Intensive Care Unit. Neonatal Network 2000; 19 (1). Available at http://www.preemie-l.org/massage.html
49. Evans JC. Incidence of hypoxemia associated with care giving in premature infants. Neonatal Network 1991;10(2): 17 -24
50. Murdoch D, Darlow B. Handling during neonatal intensive care. Journal of Archives of Disease in Childhood 1984; 59: 957- 61.
51. Bozynski ME, Naglie RA, Nicks JJ, Burpee B, Johnson RV. Lateral positioning of the stable ventilated very-low-birth-weight infant. Effect on transcutaneous oxygen and carbon dioxide. American Journal of Diseases of Children 1988; 142(2):200-2.
52. Crane LD, Snyder JE, Knight P, Philips JB, Cassady G. Effects of position changes on transcutaneous carbon dioxide tension in neonates with respiratory distress. Journal of Perinatology 1990; 10:35-7.
53. Elder DE, Campbell AJ, Doherty DA. Prone or supine for infants with chronic lung disease at neonatal discharge?. Journal of Paediatrics Child Health .2005; 41: 189-5
54. Balaguer A, Escribano J, Roqué M. Infant position in neonates receiving mechanical ventilation. Cochrane Database Syst Rev 2006 ;(4):CD003668.
55. Siempos K, Vardakas M, Falagas E. Closed Tracheal Suction Systems for Prevention of Ventilator-associated Pneumonia. British Journal of Anaesthesia 2008;100(3):299-306
56. Wong S, Guillermo S,Kacmareck R ,Hess D . A bench evaluation of alveolar pressure changes during endotracheal suction. Journal of Respir Care 2002; 45(10):1070.
57. Seckel M. Does the use of a closed suction system help to prevent ventilator-associated pneumonia? Journal of Critical Care Nurse 2008; 28: 65-6.
58. Jongerden IP, Rovers MM, Grypdonck MH. Open and closed endotracheal suction systems mechanically ventilated intensive care patients: a meta-analysis. Journal of Critical Care Medicine 2007; 35:260–70.
59. Lindgren S. Open and closed suctioning experimental and human studies. Göteborg University 2007 ***Available at*** http://www. gupea.ub .gu.se/ dspace/ bitstream/ .../Ram% 20Sophie%20Lindgren.pdf
60. Hooser TV. Airway clearance with closed system suctioning. American Association of Critical Care Nurses. Columbia: 2002; 1-12.
61. Hoellering AB , Copnell B , Dargaville PA. Lung volume and cardiorespiratory changes during open and closed endotracheal suction in ventilated newborn infants. Journal of Arch Dis Child Fetal Neonatal Ed 2008; 93(6):F436-41.
62. Kalyn A, Blatz S, Feuerstake SR, Paes B. Closed Suctioning of Intubated Neonates Maintains Better Physiologic Stability: A Randomized Trial. Journal of Perinatology 2003; 23:218–22.
63. Slevin M, Daly L, Murphy J. Preterm infants stress responses to an invasive NICU event: Endotracheal suctioning. Journal of Reproductive and Infant Psychology 1998; 16(4): 285 – 92.
64. Shah V, Ohlsson A. Vein puncture versus heel lance for blood sampling in term neonates. A Cochrane review in The Cochrane Library, Issue 4, 2007.Available at http://www.thecochranelibrary.com
65. Johnston C , Filion F, Campbell M, Goulet C, Bell L. Kangaroo mother care diminishes pain from heel lance in very preterm neonates. BMC Pediatrics 2008; 8(13)Available at www.pubmedcentral.nih.gov/articlerender.fcgi?artid =2383886
66. Newnham C , Inder T, Milgrom J . Measuring preterm cumulative stressors within the NICU: The neonatal infant stressor scale. Journal of Early Human Development 2009. Available at http://www.ScienceDirect
67. Cong X, Ludington-Hoe S, McCain G. Kangaroo Care modifies preterm infant heart rate variability in response to heel stick pain: Pilot study. Journal of Early Human Development 2009. Available at http://www.ScienceDirect
68. Hummel P, Van D. Pain assessment: Current status and challenges.Journal of Seminars in Fetal and Neonatal Medicine 2006; 11:237-45.
69. Walden M, Gibbins S .Pain assessment and Pain management Guidelines for practice 2nd ed .2008 .Available at http://www.NANN.org
70. Herrington C. Reducing pain of heelstick in premature infants with gentale humen touch .Doctorate Dissertation, MSU College of Nursing, University of Wayne State, 2007; 39-40.

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