Effect of Closed Versus Open Suction System on Cardiopulmonary Parameters of Ventilated Neonates

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Abstract: Removal of airway secretion is required in many neonates in the intensive care setting, and the process is most critical with respiratory problems. Clearance of secretions is essential in the mechanically ventilated neonates, because these neonates breathe slowly through an artificial airway. So, accumulation of secretions can lead to airway occlusion, serious physiological abnormalities and even death. Therefore, suctioning is essential for removing secretions and maintaining airway patency. This study aimed to determine the effect of closed versus open suction system on the cardiopulmonary parameters of ventilated neonates. The study was conducted at the Neonatal Intensive Care Unit at El-Shatby Maternity University Hospital in Alexandria. A Convenient sample of 60 neonates was randomly assigned into two groups. Thirty neonates (group A) were suctioned by closed suction system, and the other 30 neonates (group B) were suctioned by open suction system. The results revealed that that the closed suction system was more effective in maintaining the oxygen saturation, capillary refill and has less negative impact on the occurrence of cardiac arrhythmia as cardiopulmonary parameters. Other physiological parameters were also better maintained with closed than open suction system.

[Gehan M. Khamis, Omnia G.Waziry, Abdel-Halim A. Badr-El-Din, Magda M. El- Sayed. **Effect of Closed Versus Open Suction System on Cardiopulmonary Parameters of Ventilated Neonates.** Journal of American Science 2011;7(4):525-534]. (ISSN: 1545-1003). http://www.americanscience.org.

Keywords: suction systems, cardiopulmonary, ventilated neonates, airway patency.

1. Introduction

Immediately after birth, the neonate faces enormous tasks of homeostasis and adaptation to extrauterine life. These tasks include the change from fet.al to extrauterine circulation, establishment of respiration, temperature regulation, digestion, and elimination (Ashwill et.al 2002).The major function of the respiratory system is to provide oxygen for metabolism and to remove carbon dioxide. Without an adequate exchange of oxygen and carbon dioxide, the metabolic demands of tissues would remain unfulfilled and body systems would rapidly fail. When oxygenation and ventilation are inadequate mechanical ventilation may be used (William et.al 2000 & Newmarch 2006).

Mechanical ventilators are devices that can create a flow of gas into and out of the lungs by the manipulation of airway pressures. The main goal of the ventilator may be achieved by improving alveolar ventilation, arterial oxygenation, increasing lung volume and reducing work of breathing (William et.al 2000). Mechanical ventilation is the mainstay of management of a variety of conditions affecting the neonate. However, there are a number of documented complications associated with this procedure, which include hypoxemia, bradycardia and increase in secretion formation in the lower tracheobronchial tree (Pritchard et.al 2003), Morton et.al 2005 &Newberry, 2005).Therefore, Suctioning becomes paramount for removing secretions and maintaining patency which is the major goal of respiratory care to ensure adequate alveolar ventilation (Morton et.al 2005)

Endotracheal suctioning (ES) is usually performed through open suction system (OSS) where the patient is disconnected from the ventilator and the suction catheter is introduced into the endotracheal tube.(Maggiore et.al 2002 & Urden et.al 2004). Although tracheal suctioning is frequently performed to clear airway secretion, it is associated with a number of complications including disturbance in cardiac rhythm, hypoxemia and tissue hypoxia, infection, and development of ventilator associated pneumonia (VAP) (Almgren et.al 2004 , Baun et.al 2005, Jongerden et.al 2007 & El Masry et.al 2005).

An advanced suctioning technique namely closed suction system (CSS) has been introduced into clinical practices with the aim of preventing or reducing the undesirable side effects of OSS. (Tan et.al 2005), Gulielminotti et.al 1998& Zahran, 2001) Closed endtracheal suction is performed with the use of specially designed endotracheal tube included in the ventilatory circuit, where the suction catheter is usually introduced into airway without disconnecting the patient from the ventilator. The risk of complications may therefore be reduced by minimizing the interference with ventilation during the procedure. (Thelan et.al 1998 & Cereda et.al 2001) In a study done by Tan et.al. (2004) to compare between OSS and CSS, they reported that CSS was associated with more hemodynamic stability, and even eliminated suction related complications (Tan et.al 2005). In another study done by El Masry et.al (2005), who conducted a study about the impact of CSS on mechanical ventilator performance, they concluded that positive end expiratory pressure (PEEP) markedly decreased with increased peak flow and respiratory rate when the patient was suctioned with OSS while CSS doesn't cause mechanical ventilator malfunction (El Masry et.al 2005).

The Pediatric nurse has an important role not only in the management of neonatal airway, but also in preventing complications. She is always responsible for monitoring respiratory status and assessing the need for suctioning secretions, performing suction and evaluating the outcome. In this respect, it can be concluded that nursing care of artificial airway including suctioning of secretion is very important and life saving. (Ashwill et.al 2002 & Williams et.al 2000). She also must be aware of the different methods of suction. Closed suction system is not adequately investigated in Egypt.

Aim of the Study:

The aim of the study is to determine the effect of closed versus open suction system on the cardiopulmonary parameters of ventilated neonates.

2. Material and Methods

Material

Research Design:It is a quasi experimental study.

Setting

The study was conducted at the Neonatal Intensive Care Unit at El-Shatby Maternity University Hospital in Alexandria.

Subjects

A convenient sample of 60 neonates who were mechanically ventilated and free from congenital heart diseases was included in the study. The neonates were randomly assigned into two groups.Thirty neonates (group A) were suctioned by closed suction system, and the other 30 neonates (group B) were suctioned by open suction system.

Tool

Assessment Sheet:

An assessment sheet was developed after thorough review of the related literature. It was comprised of three parts:

Part I:

- **Neonate's data** which included:-
  - Neonate's biodemographic data, such as age, sex, Diagnosis and date of admission.
  - Neonate's birth weight, type of labor, gestational age.
  - Duration of intubation, endotracheal tube size and suction catheter size.

Part II:

- **Ventilator Data** which included:
  Mode of Ventilation, Tidal Volume (Vt), Fraction of Inspired Oxygen (FIO_2), Positive End Expiratory Pressure (PEEP), Peak Inspiratory Pressure (PIP), Inspiratory Time (Ti), Expiratory Time(Te), Inspiratory to Expiratory Ratio (I / E Ratio) and Flow Rate (FR) .

Part III:

- **Cardiopulmonary parameters** which included:-
  Heart rate (HR), Respiratory Rate (RR), Capillary Oxygen Saturation (SPO_2), Capillary refill time, Temperature and Cardiac arrhythmia.

Methods

The data were collected during the period from July 2006 to March 2007.

Methods of Data Collection

1- An official approval for conducting the study was obtained from the responsible administrative personnel.
2- The assessment sheet of the study was developed after thorough review of the related literature.
3- A pilot study was done on 5 neonates to test the applicability of the tool; these five neonates were excluded from the sample.
4- Neonate's data were collected for each neonate in both groups A and B using part (I) of the assessment sheet tool.
5- Ventilator data were obtained immediately before the suction procedure.
6- Physiological parameters were obtained immediately before the suction procedure
7- Cardiopulmonary parameters were obtained through pulse oximetery for both groups before the suction to obtain the baseline data.
8- Tracheal suctioning was performed only when there was a clinical need.
9- The following considerations were followed for both groups:
   A) Suction Catheter was selected according to the endotracheal tube size
   B) Negative suction pressure was 60-80mmHg, it was applied intermittently and only during catheter withdrawal while simultaneously rotating the catheter.
   C) Hyperoxygenation of the neonate was performed before, during and after suction through the ventilator by increasing fraction inspired oxygen (FIO_2) 10-20% above the baseline data.[19]

D) After suction, gradule decrease of FIO_2 to the pre suction level.

10- Suction was carried out after ensuring that the neonate wasn't hypoxic at the time of suction as follows:

11-

For closed suction system (Neonates of Group A)

- The suction catheter was continuously placed between the endotracheal tube and Y piece of the ventilator
- The suction catheter was inserted into the endotreacheal tube ***without disconnection*** from the ventilator for 10-15 seconds and repeated 3 times with hyper oxygenation.

For open suction system (Neonates of Group B)

-The endotracheal tube was ***disconnected*** at Y piece from the ventilator.

-The suction catheter was inserted into the endotreacheal tube for 10- 15 seconds and repeated 3 times with hyper oxygenation.

-The endotracheal tube was reconnected at Y piece to the ventilator.

11- Ventilator parameters were obtained for each neonate of both groups A and B immediately after suctioning procedure and 10 minutes later.

12- Physiological and cardiopulmonary parameters were obtained immediately and after 10 minutes of suctioning for each neonate in both groups.

13- Heart rate, SPO_2 and cardiac rhythm were monitored by using a pulse oximeter and capillary refill was done by pressing the neonate's forehead.

Statistical Analysis:

After data were collected, they were coded and transferred into specially designed formats so as to be suitable for computer feeding. Following data entry, checking and verification processes were carried out to avoid errors during the data entry. Frequency analysis, cross tabulation and manual revision were all used to detect any errors. The **SPSS (**version 12**)** statistical program was utilized for both data presentation and statistical analysis of the results.

The following statistical measures were used:

1- Descriptive measures included: Percentage, mean, standard deviation.
2- Fisher exact test, Z test, ANOVA test, was used for test of significance.
3- The level of significance selected for this study was P less than 0.05

3. Results

Table (1) illustrates biodemographic characteristics of the neonates in relation to age, sex, birth weight and gestational age. It was found that slightly more than half of the neonates who were suctioned by the closed system (53.5%) and 70% of the neonates who were suctioned by the open system were less than one week of age. Moreover, the mean ages of closed and open suction groups were 9.73 ± 8.88 and 7.63±10.25days respectively. Males constituted 60% of neonates of closed suction group and 50% for those who had open suction. It is observed from the table that 43.30% of neonates of both closed and open suction groups were very low birth weight i.e. weight < 1500 gm with the mean birth weights for both closed and open suction groups were 1578.33±718.077 and 1597.83± 635.219 gm respectively. Slightly more than three quarters of neonates of closed suction group (76.70%) and 83.30% of the open suction group were preterm i.e. gestational age less than 37 weeks.

Characteristics of the neonates regarding type of labor, duration of intubation, tracheal tube and suction catheter size are presented in table (II). Sixty percent of the closed suction group and slightly more than three quarters of the open suction group (76.7%) were delivered by cesarean section.

Concerning the duration of intubation, 43.30% of the closed suction neonates and 73.30% of open suction neonates were on mechanical ventilator for a period of less than one week. Furthermore, fifty percent of both closed and open suction neonates had endotracheal tube size 3 French. All neonates of closed suction group (100%) and the majority of open suction group (83.30%) were suctioned with catheter size of 6 French.

Table (III) shows distribution of neonates according to their diagnosis for closed and open suction groups. It was clear from the table that most of the neonates of both groups had hyaline membrane disease (80% and 96.7% respectively). Two thirds of the neonates of closed suction group (66.7%) and 70% of the neonates of open suction group had pneumonia.

Table (IV) clarifies the comparison of chest assessment between closed and open suction groups. It was clear from the table that immediately after suction, only 40% of neonates of closed suction group had crackles compared to 63.3% of open suction group. Ten minutes after suction, only one neonate of closed suction group had crackles (3.3%) compared to 70% of neonates of open suction group and the difference was statistically significant. (P=0.000)

Regarding wheezes, it was observed that 43.3% of the neonates of closed suction group had wheezes before suction which declined to 10% only immediately after suction. On the other hand, 33.3% of the neonates of open suction group who had wheeze before suction declined to 23.3%. Ten minutes after suction, further decrease was found in closed suction group as 6.7% only had wheezes, while in the open suction group wheezes increased again to 26.7%. Statistical significant difference was found between both groups 10 minutes after suction.

Table (V) compares between closed and open suction groups of neonates according to their physiological parameters. As the table shows, 60% of the neonates of the closed suction group who had heart rate within the normal range before suction(120-140) increased to 76.6% immediately after suction while, the 26.7% of the neonates of open suction group who had heart rate within normal range showed slight increase (33.3%) immediately after suction .Ten minutes after suction, further increase in the percentage was found among the closed suction group (83.3%) while, the other group showed slight decline (23.3%).

The frequency of bradycardia remained the same in the closed suction group, where only one neonate had bradycardia either immediately after suction or 10 minutes later (3.30%),while the incidence of bradycardia increased among the neonates of open suction group from 3.30% to 26.70% immediately after suction and 60% ten minutes after suction. Statistically significant difference was found between both groups immediately after suction (P=0.006).

Regarding the temperature, it was observed from the table that 16.37% of neonates of both closed and open suction groups had temperature below normal range (<35 ^{0}C) before suction. Immediately after suction, this percent of neonates decreased among the closed suction group to 13.30 %, while, the percentage increased to 26.70% for neonates of open suction group. Ten minutes after suction, further increase was found among the neonates of open suction group (46.70%) while, 16.70% of the neonates of closed suction group returned to the temperature baseline reading. Statistical significant difference was found between both groups 10 minutes after suction (P=0.02).

Table (VI) illustrates the comparison between closed and open suction neonate's groups in relation to cardiopulmonary parameters. As the table clarifies, the neonates who received closed suction showed more improvement in their oxygen saturation level immediately after suction and after 10 minutes of suction than those who received open suction. The 10% of neonates of closed suction group who had oxygen saturation ≥95 before suction increased to 46.70% immediately after suction compared to the 30% of the neonates of open suction group who had their percentage decreased to only 3.3% immediately after suction.Ten minutes after suction, further improvement in oxygen saturation was observed among the neonates of closed suction group where 73.30% had oxygen saturation ≥95% compared to 36.70% of the neonates of open suction group who had oxygen saturation ≥95%. Statistical significant differences were found between both groups immediately after suction (P = 0.000) and after 10 min (P= 0.014) as shown in (Table XII).

Concerning the capillary refill, it was clear from the table that the 70% of the neonates of the closed suction group who had capillary refill 1-2 second before suction increased to 96.70% immediately after suction .Among the open suction group, 86.7% had a capillary refill 1-2 second but this percent declined to 60% immediately after suction. Ten minutes after suction, all neonates of closed suction group had capillary refill 1-2 second (100%) compared to 83.30% of the open suction group. The differences among both groups before suction, immediately after suction and 10 minutes after suction were statistically significant. (P = 0.003, 0.000 and 0.015 respectively).

It is revealed from (Table VI) that, the frequency of cardiac arrhythmia improved in the neonates of closed suction group than the neonates in the open suction group. The 50% of the neonates of closed suction group who had cardiac arrhythmia before suction declined to 23.3% immediately after suction and 13.3% after 10 minutes. While the 43.3% of the neonates of open suction group who had cardiac arrhythmia before suction increased to 70% immediately after suction and 53.3% ten min after suction. The differences were statistically significant between both groups immediately and 10 minutes after suction. (P= 0.000 and 0.001 respectively).

4. Discussions

A large number of premature neonates require prolonged ventilatory support. There are a number of reasons for neonatal mechanical ventilation including hyaline membrane disease, pneumonia, respiratory failure and apnea. Mechanical ventilation will improve ventilation and perfusion of the neonates and support pulmonary gas exchange. In order to provide ventilatory support an artificial airway must be inserted. This airway can be established in one of two ways, either with an endotreacheal tube or through a tracheotomy tube. Regardless of which method is used, the neonate's upper airway is bypassed, thus reducing the neonate's ability to clear secretions spontaneously. Additionally, the presence of the tube may lead to an increase in sputum production. For these reasons neonates with an artificial airway in place will require airway suctioning (Curley, 2001&Hockenberry et.al 2005).

The biological characteristics of the present study reflected that the majority of the studied neonates in both groups had hyaline membrane disease. This result may be related to the gestational age where the majority of neonates were preterm (Table I, Table III). This finding is supported by many researchers who reported that hyaline membrane disease usually occurs in neonates less than 35 weeks of gestation. It represents a major problem in neonatal intensive care units and is considered the primary cause of mortality (Ashwill et.al 2002, Curley, 2001& Hockenberry et.al 2005).

Suctioning is the most frequently performed nursing procedure in NICUs. The practice of endotracheal suctioning (ES) of ventilated neonates is necessary for removing secretions to prevent obstruction of endotreacheal tube and lower airway. This procedure is essential but potentially hazardous because it creates a large variety of heart and lung interferences (Lindgren, 2007, Greenough, 1999, Gould, 1996, Shelly, 1999, Lasocki et.al 2006).

Closed suction system has been available for several years; however, its use in neonates is limited. Protocols for ES of the neonate are inconsistent throughout and within neonatal intensive care units. Although, a recent neonatal systematic review concludes that there is insufficient evidence to support the practice of CSS, yet, a number of studies have examined the use of CSS to maintain PEEP and minimize the decreased arterial oxygenation that accompanies OSS. Unfortunately, most of these studies have reported the effects of CSS on respiratory variables only and have not examined the effects of both systems on the cardiovascular parameters(Subirana ,2004 , Maggiore et.al 2003&Morrow et.al 2006).Thus, the current study was conducted to compare the effect of closed versus open suction system on the cardiopulmonary parameters of ventilated neonates.

Craig (2002) ascertained the importance of neonatal chest assessment for checking the abnormal sounds that are considered the main criteria for obstructed airway (Craig, 2002) .The findings of the current study revealed that the majority of both groups had adventitious sounds before suction which include crepitations, rhonchi and wheezes (Table IV). These adventitious sounds could be explained by the increased secretions in neonate's airway. These adventitious sounds are considered as appropriate indicators for suctioning. Another explanation for the presence of adventitious sounds may be related to the original disease that required intubation and initiation of ventilation.

Also, the result of this study reflected that there were statistical significant differences between the closed suction group and open suction group regarding the crepitation and wheezes 10 minutes after suction (Table IV). These findings could be interpreted in the light of the fact that CSS is more adequate in removing secretions that may obstruct the airway more than the OSS. These findings are contradicted by Urden et.al (2004) who reported that CSS inadequately removed secretions, and further investigation is required to settle this issue (Urden et.al 2004).

The result of the present study revealed that, the incidence of bradycardia was not increased in closed suction group either immediately after or 10 minutes after suction (Table V). This result is similar to the finding of Wilinska et.al (2005). This finding could be justified by the fact that CSS permits spontaneous lung inflation and continuous oxygen flow during the suction procedure thus may prevent a reflexive bradycardia. On the other hand, many authors reported that bradycardia is associated with open suction system (Galvin, 1997, Lee, 2001, Corderro et.al 2002, Johnson et.al 1994&Scanlon et.al 2004)

This result was consistent with the result of the current study as the open suction technique increased the incidence of bradycardia among the neonates immediately after and 10 minutes after suction (Table V). This finding could be explained by the fact that bradycardia may arise due to vagal triggering by simulation from the suction catheter (Zahran, 2001). On the Contrary, Deppee et.al (1994), who conducted a study about costs and physiologic consequences of closed versus open endotreacheal suctioning, reported that both methods of suction increased the mean heart rate immediately after suction and 30 seconds after suction, and that OSS was associated with significantly higher mean heart rate than closed method(Deppee et.al 1994).

The present study revealed that, the closed suction group showed a significant increase in capillary oxygen saturation (SPO_2) immediately after suction and further increase was observed 10 minutes later (Table VI). On the contrary, the open suction group showed a significant decrease in SPO_2 immediately after suction and then increased after 10 minutes. The results also revealed that the increase in oxygen saturation was higher in closed suction group than the open suction one (Table VI). These findings could be interpreted in the light of the fact that CSS could reduce the oxygen desaturation where the neonate was not disconnected from the ventilator which is one of the steps in OSS (Glass et.al 1999, Paul-Allen, 2000& Zeitoun, 2003) Furthermore, Hooser (2002), added that during the OSS, the gas drawn from the lungs was replaced by air drawn from the atmosphere through the space left around the catheter which inturn decreases the oxygen saturation during the OSS. (Hosser,2002).Weilte and Bettstetter (1994) also reported that although oxygen saturation increased significantly after suction in both OSS and CSS, yet it was higher in CSS(Weitle,1994).This could be explained by the increase of SPO_2 as a positive effect of pre oxygenation before ES. In addition the SPO_2 was less marked in the OSS because the fraction of inspired oxygen was abruptly reduced after disconnection as well as simultaneously positive pressure ventilation and PEEP were lost (Sole et.al 2002).

The result of the current study also revealed that CSS was more effective in preventing post suctioning hypoxia (decrease oxygen saturation less than 95%**)** rather than OSS. These results are in agreement with the results reported by Prendiville et.al (2002)(Prendiville et.al 2002). Craig (2002) who did a survey about neonatal suction techniques performed by registered nurses in Marshall reported that hypoxia may be related to three causes. Firstly, the process of mechanical suction removes gases from the airways along with secretion. The second reason could be justified by the large percentage of ventilated neonates who suffer from pulmonary diseases or premature lung development and are ventilator dependant to maintain adequate oxygenation. Finally, any disruptions of ventilator cycle such as removing the neonates from the ventilator to perform open endotracheal suctioning can also lead to transient hypoxia (Craig, 2002).In addition, Salvator et.al (2003) mentioned that, the changes of oxygen saturation which are induced by suctioning may be due to the ventilation and perfusion ratio modification that could explain transient impairment in oxygen saturation (Salvator et.al 2003).

It can be concluded from the present study that, oxygenation was better in CSS group than OSS. This result is inline with Hooser (2002), who reported that the most recent Society for Critical Care Medicine (SCCM) standard for care of patients with acute respiratory failure on mechanical ventilatory support call for using a sterile suction technique and maintenance of the patient's oxygen saturation above 90%. Thus, CSS is preferred in the achievement of SCCM standards (Hooser, 2002).

It was noted from the current finding that cardiac dysrhythmia occurred after OSS with statistical significant decline in CSS group (Table VI). This result is similar to the results of Lee and Wilkins (2001) who reported that there was a significantly higher incidence of arrhythmia among the neonate of open suction group compared to those of closed suction group(Lee,2001).The occurrence of dysrhythmia may be due to the decrease of SPO_2, in addition to the vagal stimulation. Also, it is documented by research evidence, that venous and arterial oxygen saturation remain significantly higher and subsequently there are less cardiac arrhythmias because the ventilatory circuit is not disconnected (Rmanini, 1994).

Concerning the capillary refill, the results of the present study reflected that there were statistical significant differences between the open and closed suction groups immediately after suction and 10 minutes after suction (Table VI). The closed suction group showed more improvement in capillary refill than Open suction group. This result may be related to the hypoxia that occurred during the open suction group. Furthermore, change in intrathoracic pressure during suctioning may impede venous return, resulting in reducing ventricular preload and often cardiac output leading to hypotension (Singer, 1994).

5. Conclusion

Based on the findings of the present study, it is concluded that the closed suction system was more effective on the oxygen saturation, capillary refill and cardiac arrhythmia as cardiopulmonary parameters and on the physiological parameters than the opened suction system. The closed suction system maintains the PEEP during the suction compared to the open suction system which changes the PEEP of neonates.

Recommendations

Based on the previous findings and conclusion drown from the current study, the following recommendations are suggested:

- The neonatal intensive care units should include updated polices related to closed suction system.
- The pediatric Intensive care nurse managers should be responsible for developing standard for closed suction technique in neonatal intensive care units.
- The closed suction catheter should be available in neonatal intensive care units for ventilated neonates.

Table (I): Biodemographic Characteristics of the Neonates

Biological Characteristics	Closed suction n=30		Open suction n=30	
	No	%	No	%
1- Age				
• < 7	16	53.3	21	70
• 7-	5	16.6	3	10
• 14 -	1	3.3	2	6.6
• 21 –	8	26.6	2	6.6
• 28	0	0	2	6.6
Total	30	99.8	30	99.8
Mean ± S. D	9.73±8.88		7.63±10.25	
2- Sex				
• Male	18	60	15	50
• Female	12	40	15	50
Total	30	100	30	100
3-Birth Weight /gm				
• Very low birth weight	13	43.30	13	43.30
• Low birth weight	12	40	14	46.70
• Normal birth weight	5	16.70	3	10
Total	30	100	30	100
Mean ± S. D	1578.3±718.07		1597.8±635.21	
4-Gestational age				
• Preterm	23	76.70	25	83.30
• Term	7	23.30	5	16.70
Total	30	100	30	100
Mean ± S. D	32.63±4.34		32.77±3.81	

Table (II): Characteristics of the Neonates Regarding Type of Labor, Duration of Intubation, Endotreacheal Tube and Suction Catheter Size

Characteristics	Closed suction n=30		Open suction n=30	
	N0	%	N0	%
Type of labor				
• Normal delivery	12	40	7	23.3
• Cesarean section	18	60	23	76.7
Total	30	100	30	100
Duration of intubation				
• < 1 week	13	43.30	22	73.30
• 1 week -	4	13.30	2	6.70
• 2 weeks -	3	10	4	13.30
• 3 weeks -	8	26.70	2	6.70
• 4 weeks	2	6.70	0	0
Total	30	100	30	100
Endotreacheal tube size(French)				
• 2.5 Fr	5	16.6	4	13.3
• 3 Fr	15	50	15	50
• 3.5 Fr	10	33.3	11	36.3
Total	30	99.9	30	99.9
Suction catheter size(French)				
• 6 Fr	30	100	25	83.30
• 8 Fr	0	0	5	16.70
Total	30	100	30	100

Table (III): Distribution of Neonates of Closed and Open Suction Groups According to their Diagnosis

Diagnosis*	Closed group n=30		Open group n=30		Total n=60	
	No	%	No	%	No	%
-Hyaline membrane disease	24	80	29	96.7	53	88.3
-Neonatal sepsis	9	30	6	20	15	25
-pneumonia	20	66.7	21	70	41	68.3
-Pneumothorax	4	13.3	2	6.7	6	10

*Some neonates have more than one diagnosis.

Table (IV): Comparison of Chest Assessment between Closed and Opened Suction Groups of Neonates

Chest Sound	Before suction n=30					Immediately after suction n=30					Ten min After suction n=30				
	Closed		Open		Z Test	Closed		Open		Z Test	Closed		Open		Z Test
	N	%	N	%		N	%	N	%		N	%	N	%	
Crackles	30	100	27	90	0.07	12	40	19	63.3	0.06	1	3.3	21	70	0.000*
Rhonchi	6	20	6	20	1.00	5	16.7	5	16.7	1.00	5	16.7	5	16.7	1.00
Wheezes	13	43.3	10	3.3	0.42	3	10	7	23.3	0.16	2	6.7	8	26.7	0.03*

* Statistically significant at <0.05

Table (V): Comparison between Closed and Opened Suction Groups of Neonates Regarding Physiological Parameters

parameters	Before n=30					Immediately after suction n=30					Ten min after suction n=30				
	Closed		Open		FET	Closed		Open		FET	Closed		Open		FET
	No	%	No	%		No	%	No	%		No	%	No	%	
Heart rate :(b/m)															
• <120	1	3.30	1	3.30		1	3.30	8	26.70		1	3.30	18	60	
• 120-140	18	60	8	26.70	0.775	23	76.7	10	33.30	0.006*	25	83.30	7	23.30	0.10
• >140	11	36.70	21	70		6	20	12	40		4	13.30	5	16.70	
respiratory rate: (c/m)															
• <30	7	23.30	4	13.30		7	23.30	4	13.30		7	23.30	5	16.70	
• 30-50	16	53.30	17	56	0.683	16	53.30	17	56.70	0.683	16	53.30	15	50	0.61
• >50	7	23.30	9	30		7	23.30	9	30		7	23.30	10	33.30	
Temperature:(^{0}C)															
• < 36.5	5	16.70	5	16.70		4	13.30	8	26.70		5	16.70	14	46.70	
• 36.5-37.5	22	73.3	19	63.30	0.624	23	76.70	17	56.70	0.271	22	73.30	12	40	0.02*
• >37.5	3	10	9	20		3	10	5	16.70		3	10	4	13.30	

FET=Fisher's Exact Test.
*Significant at P>0.05

Table (VI): Comparison between Closed and Opened suction groups of Neonates regarding Cardiopulmonary Parameters

Parameters	Before suction n=30					Immediately after suction n=30					Ten min After suction n=30				
	Closed		Open		FET	Closed		Open		FET	Closed		Open		FET
	No	%	No	%		No	%	No	%		No	%	No	%	
-Oxygen saturation (%)															
• 75-84	8	26.70	8	26.70		1	3.30	14	46.70		0	0	4	13.30	
• 85-94	19	63.30	15	50	0.251	15	50	15	50	0.000*	8	26.70	15	50	*0.014
• ≥95	3	10	9	30		14	46.70	1	3.30		22	73.30	11	36.70	
-Capillary refill															
• 1-2 sec	21	70	26	86.70	0.003*	29	96.70	18	60	0.000*	30	100	25	83.30	0.015*
• >2 sec	9	30	4	13.30		1	3.30	12	40		0	0	5	16.70	
-Cardiac arrhythmia	15	50	13	43.3	0.607	7	23.3	21	70	0.000*	4	13.3	16	53.3	0.001*

FET=Fisher's Exact Test.

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3/3/2011