Ventilator Associated Pneumonia in A Neonatal Intensive Care Unit

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Abstract*:* Ventilator-associated pneumonia (VAP) is the most common nosocomial infection in the intensive care unit and is associated with major morbidity and mortality. Intubation compromises the integrity of the oropharynx and trachea and allows oral and gastric secretions to enter the lower airways. VAP results from the invasion of the lower respiratory tract and parenchyma by microorganisms .Infants mechanically ventilated in neonatal intensive care unit (NICU) are at a particularly high risk of developing VAP because of poor host factors, severe underlying disease, prolonged use of mechanical ventilation, inadequate pulmonary toilet and extensive use of invasive devices and procedure.Difficulties in diagnosis of VAP have led to the development of many diagnostic techniques such as bronchoalveolar lavage, protected specimen brush and quantitative endotracheal aspirates. **Aim:** The current study was done in order to determine the incidence, risk factors and organisms causing nosocomial pneumonia in ventilated patients in neonatal intensive care unit (NICU). **Patients and methods:** This study was conducted on 85 neonates in the neonatal intensive care unit (NICU) of Menoufyia university hospital in the period from April 2012 to January 2013.These neonates were on mechanical ventilation more than 48 hours because of different illness. They were studied for diagnosing VAP based on the combination of criteria defined by centers for disease and control (CDC). They were divided into two groups according to the presence or absence of Vap (diagnosed by CDC and confirmed by non bronchoscopic bronchoalveolar lavage):Group (I), (VAP): It included 47 patients with VAP. Group (II), (Non VAP): It included 38 mechanically ventilated patients without VAP. Both groups were subjected to Full History, Full Clinical examination and laboratory investigations including: Complete blood count (CBC), C-reactive protein (CRP),Liver function tests, Kidney function tests, Blood culture, Chest radiograph done on admission and repeated as required, Arterial blood gases (ABG) monitoring every 12 hours,Monitoring of the ventilator settings, and Non bronchoscopic bronchoalveolar lavage. The **results** of the present study showed that incidence of VAP was (55.3%) significantly higher than non VAP neonates (44.7%). And the incidence density of VAP in this study was 27.9 per one thousands ventilator days. Prematurity, low birth weight, prolonged duration of mechanical ventilation, enteral feeding and invasive manuevers were risk factors for VAP. There was significant difference between the VAP and non VAP in the total leucocytic count, CRP, and hypoalbuminemia. In this study, microorganisms associated with blood stream infection in VAP diagnosed group were, *Staph aureus* (15%), klebsiella (8%), candida (6.5%), pseudomonas (4.2%), *E. coli* (4.2%), while 61.7% of obtained blood cultures in VAP patients were sterile .The results of (NB-BAL) cultures were klebsiella (34%), pseudomonas (25.5%), *Staph aureus* (17%), *E. coli* (17%), candida (6.4%). In our study, nearly most of the studied newborn infants who developed VAP had not the same organism that caused their blood stream infection. **Conclusion**: -The most important risk factors of VAP in our unit included prematurity, low birth weight, prolonged duration of ventilation, enteral feeding, placement of umbilical catheters, chest tubes and central lines.-NB-BAL is a practical diagnostic method in clinically suspected VAP in neonates.- Gram negative organisms comprised the majority of cultures obtained by NB-BAL, klebsiella pneumoniae was the most common identified organism.

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1. Introduction

Ventilator associated pneumonia (VAP) is pneumonia in mechanically ventilated patients in intensive care units that develops later than or at 48 hours (hrs) after the patient has been placed on mechanical ventilation, VAP is the second most common hospital-acquired infection among pediatric and neonatal intensive care unit (NICU) patients. Empirical therapy for VAP accounts approximately 50% of antibiotic use in NICUs. surveillance studies of nosocomial infections in NICU patients indicate that pneumonia comprises 6.8 to 32.3% of nosocomial infections in this setting **(Gauvin *et al.*, 2003)**.

The incidence of VAP-attributable mortality is difficult to quantify due to the possible confounding effect of associated conditions, but VAP is thought to increase the mortality of the underlying disease by about 30%. VAP is also associated with considerable morbidity, including prolonged ICU-length of stay, prolonged mechanical ventilation, and increased costs of hospitalization **(Tejerina *et al.*, 2006).**

Neonates have unique characteristics predisposing them to nosocomial infections. The

immature immune system, the skin and mucous membranes are more permeable and are less effective barriers to infection, abnormal granulocyte migration, and defective phagocytosis in these patients have been demonstrated. Additionally, decreased the activity of complement particularly opsonization and hypogamma-globulinemia **(Pessoa-Silva *et al.*, 2004).**

Low birth weight has been shown to be another risk factor for the development of nosocomial pneumonia. A 41-month surveillance study demonstrated a significant association between a birth weight of less than 1,500 g and a higher rate of nosocomial pneumonia, however, low birth weight may be a marker for an increased duration of mechanical ventilation **(Cordero *et al.*, 2002).**

Although, delayed diagnosis of VAP and subsequent delay in initiating appropriate therapy may be associated with worse outcomes. However, an incorrect diagnosis may lead to unnecessary treatment and subsequent complications related to therapy. Therefore, early, accurate diagnosis is a fundamental in the management of patients with VAP **(Rello *et al.*, 2002).**

Aim of the work:

Is to find the incidence, characteristics and risk factors of ventilator associated pneumonia in critically ill newborn admitted in neonatal intensive care unit.

2. Patients and Methods

This study was conducted on 85 negative non bronchoscopic bronchoalveolar lavage neonates in the neonatal intensive care unit (NICU) of Menoufyia university hospital in the period from April 2012 to October 2012.These neonates were placed on mechanical ventilation more than 48 hours because of different illness. They were studied for diagnosing VAP based on the combination of clinical, radiological, and microbiological criteria defined by centers for disease and control (CDC). They were divided into two groups after placed on ventilation for more than 48 hours according to the presence or absence of Vap(diagnosed by CDC and confirmed by another non bronchoscopic bronchoalveolar lavage):

Group (I), (VAP): It included 47 patients with VAP including 33 males and 14 females, of mean ages 32.9±4.3weeks, of mean duration on mechanical ventilation 26.6±11.5days. **Group (II), (Non VAP):** It included 38 mechanically ventilated patients without VAP, 25 males and 13 females, of mean ages of 35±3.7weeks, these neonates were on mechanical ventilation of mean duration of ventilation 11.1±6.2 days.

The diagnosis of VAP was established using national nosocomial infection surveillance system (NNIS) and centers for disease and control (CDC) (2004) as follow:

-Mechanical ventilation for more than 48 hours.
-Deteriorating gas exchange (Oxygen desaturation, increase ventilation or need for supplemental oxygen).With 3 or more of the following:-
Temperature instability of unknown cause.
-Leukopenia or leukocytosis.
-Change in sputum amount, color, or character.
-Apnea, tachypnea, nasal flaring with retraction of chest wall, or grunting; wheezing, rales, or cough. -Tachycardia (More than 170 beats/minute) or bradycardia (Less than 100 beats/minute).
-With 2 or more serial chest X-rays with one of the following.
1-Onset of progressive and persistent infiltration.
2-Consolidations.
3-Cavitations of pneumatoceles.**(CDC, 2004)**
The diagnosis of Vap was confirmed by non bronchoscopic bronchoalveolar lavage.

Inclusion criteria:- All neonates of Both sexes having medical causes leading to mechanical ventilation of these neonates.
-Negative non bronchoscopic bronchoalveolar lavage on admition
-Negative lung infiltrates in chest x- ray. **Exclusion criteria:-**Age above one month.
-Any patient with surgical problem related to respiratory system.
-Any patient with congenital pneumonia.
-Any patient with meconium aspiration.
-Positive non bronchoscopic bronchoalveolar lavage on admission.
-Positive lung infiltrates in chest x- ray on admission

Methods: All neonates of both groups will be subjected to clinical assessment by:

- Full History Including:

1) Patient data
2) Parents data
3) Perinatal history
4) Present history
5) Family history

- Full Clinical Examination
- Laboratory Investigations Including:

1) Complete blood count (CBC).
2) C-reactive protein (CRP).
3) Liver function tests.
4) Kidney function tests.
5) Blood culture.
6) Arterial blood gases.
7) Non bronchoscopic bronchoalveolar lavage on admission and after 48 hours of mechanical ventilation.

VAP Rate (Incidence density): Was calculated as:(Number of cases with VAP/ Number of ventilator days) x 1000 = VAP rate per 1000 ventilator days. 47/1684 x 1000=27.9 per 1000 ventilator days.

3. Results:

Our results were presented in 6 tables:

Table (1) Comparison between the studied groups as regarding their gestational age, weight in kg, duration in NICU(days),and duration on M.V (days).

Variables	VAP N=47 55.2%	NON-VAP N=38 44.8%	t	*P*
GA (weeks)	32.9±4.3	35±3.7	-3.9	<0.001**
Weight in kg	2.1±0.7	2.9±1	-4.2	<0.001**
Duration in NICU(days)	40.3±14.9	21.4±14.2	5.9	<0.001**
Durationon M.V(days)	26.6±11.5	11.1±6.2	7.4	<0.001**

There was asignificant difference between the two groups regarding their gestational age, weight in kg, duration in NICU(days),and duration on M.V (days).

Table (2)Comparison between the studied groups regarding medications

Medication	VAP		NON-VAP		X2	*P*
	N	%	N	%		
Inotrops	35	74.5	20	52.6	4.3	<0.05*
Antacids	17	36.2	13	34.2	0.03	NS
Corticosteroid	33	70.2	9	23.7	18.1	<0.001**
Surfactant	9	19.1	7	18.4	0.007	NS

This table shows significant difference between VAP and non VAP groups as regarding the use of inotropes and corticosteroid and no significant difference as regarding the use of antacids, surfactant.

Table (3)Comparison between the studied groups regarding feeding

Feeding	VAP		NON-VAP		X^2	*P*
	N	%	N	%		
Enteral feeding	38	80.5	24	63.1	4.6	<0.05*
Total parenteral nutrition (TPN)	11	23.4	14	36.9	1.8	NS
Invasive maneuvers:						
Chest tubes	28	59.5	6	15.8	10.2	<0.001**
UVC	36	76.6	19	50	6.5	<0.05*

This table shows significant differences as regarding enteral feeding and no significant difference regarding TPN.
This table shows significant differences as regarding invasive maneuvers (Chest tubes, UVC).

Table (4)Comparison between the studied groups regarding laboratory investigation

Laboratory investigation	VAP	NON-VAP	T	*P*
TLC	19.4±6.2	12.4±4.2	3.3	<0.001**
HB	12.3±2.3	12.6±2.9	-0.6	NS
PLT	249.5±170.3	201.5±150.2	1.3	NS
CRP	54.5 ± 40.57	28.0 ± 41.92	1.18	0.05*
UREA	47.2±27.3	51.9±37.2	-1.01	NS
CREAT	0.6±0.3	0.8±0.4	1.4	NS
SGPT	30.8±24.6	27.5±16.3	0.5	NS
S. albumin	3.1±0.2	3.8±0.6	-2.2	<0.05*

This table shows significant differences between VAP and Non-VAP groups as regarding total leukocytic count, CRP and S.albumin level and shows no significant difference between two groups as regard (Hb, PLT, urea, creatinin and SGPT).

Table (5)Comparison between the studied groups regarding blood culture results

Blood culture	VAP		NON VAP		X^2	*P*
	N	%	N	%		
Sterile	29	61.7	32	84.5	3.7	<0.05*
Klepsiela	4	8.5	2	5.2	0.7	NS
Staph	7	15	2	5.2	0.2	NS
Pseudo	2	4.2	0	0	YATES 2.1	NS
E-coli	2	4.2	1	2.6	0.05	NS
Candida	3	6.4	1	2.6	0.4	NS

This table shows significant differences between VAP and Non-VAP groups as regarding sterile blood cultures and no significant difference with organisms (Klebsiela and Staphylococcus, pseudomonas, *E. coli* and candida).

Table (6) cross relation between blood culture results and NB-BAL results in VAP and non VAP group:

			NB-BAL fluid culture						Total
			STERILE	KLEBS	STAPH	PSEUDO	E.COLI	CAND	
BLOOD	STERILE	Count	31	10	4	8	5	3	61
		%	81.6%	62.5%	50.0%	66.7%	62.5%	100.0%	71.8%
	KLEBS	Count	2	2	0	1	1	0	6
		%	5.3%	12.5%	0.0%	8.3%	12.5%	0.0%	7.1%
	STAPH	Count	3	2	1	3	0	0	9
		%	7.9%	12.5%	12.5%	25.0%	0.0%	0.0%	10.6%
	PSEUDO	Count	0	1	1	0	0	0	2
		%	0.0%	6.2%	12.5%	0.0%	0.0%	0.0%	2.4%
	E.COLI	Count	1	0	0	0	2	0	3
		%	2.6%	0.0%	0.0%	0.0%	25.0%	0.0%	3.5%
	CAND	Count	1	1	2	0	0	0	4
		%	2.6%	6.2%	25.0%	0.0%	0.0%	0.0%	4.7%
Total		Count	38	16	8	12	8	3	85
		%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

This table shows that nearly no similarity in the type of organisms cultivated from either blood or NB-BAL.

4.Discussion:

The incidence density of VAP in this study (27.9 /1000 ventilator days) is near the results of **(Yuan *et al.*, 2007)** in China who studied 92 neonates and the incidence density was 28.3/1000 ventilator days but lower than the result of **(Petdachai *et al.*, 2004)** in Thailand, He studied 170 infants aged less than 30 days who required mechanical ventilation for longer than 48hrs and VAP incidence density was 70.3 per 1,000 ventilator days, **(Afify *et al.*, 2012)** in Saudi Arabia, who studied 57 neonates and the result was 57.8 per 1,000 ventilator days and **(Tripathi *et al.*, 2010)** in India who studied 98 neonates and the incidence density was 37.2/1000 ventilator days. This variation is due to difference in diagnostic criteria used, aseptic precautions in neonatal intensive care unit and variable sensitivity and specificity of diagnostic tests **(Tripathi *et al.*, 2010)**. In comparison, the CDC national healthcare safety network (NHSN) hospitals report a mean VAP rate in multicenter study from 16 USA NICUs reported a mean VAP rate of 14.8/1000 ventilator days. In Canada, reported VAP ranged from 9.4/1000 ventilator days; in France, 24/1000 ventilator days; in Germany, 35/1000 ventilator days and 46/1000 ventilator days in Italy **(Edwards *et al.*, 2007)**. Thus, even in the developed countries, considerable inter-country variation exists, but it appears that in several developing countries, VAP rates are higher than the reported rates from the USA, Canada, and some European countries **(Raza *et al.*, 2004)**.

Weighing our results against data from other developing countries, we observed an incidence of VAP was 47% in Lebanon **(Kanafani *et al.*, 2003)**, 38.1% in Jordan **(Khuri-Bulos *et al.*, 1999)** and 25.2% in Saudi Arabia **(Memish *et al.*, 2000)**.

The incidence of VAP in our study newborn was 55.3% while the incidence of VAP in newborn infants, as estimated by the national nosocomial infections surveillance study (NNIS) is 20% **(Apisarnthanarak *et al.*, 2003)**.

In our study the mean gestational age of infants diagnosed as VAP was (33.3±3.9) wks which was significantly lower than of the non VAP group (36.2±3.5) wks, this result was agree with many studies that reported that VAP rates had significantly increased with decreasing gestational age **(Foglia *et al.*, 2007** and **Petdachai, 2004)** and it was not consistent with **(Afjeh *et al.*, 2012)** who reported that VAP rates had no relation with decreasing gestational age. But **(Donn- SM and Sinha SK 2006)** explained that VAP more common with decreasing gestational age by, in preterm newborn, the airways are narrower in diameter and result in a higher resistance to the flow. **Rello and Diaz, 2003** explained that by increasing airway compliance increases the propensity for airway collapse or distension expiration. And also Levels of IgG are lower in premature newborns, as maternal levels have not be transported to the infant as maternal immunoglobulin G (IgG) is transported to the fetus in the second and last trimesters of pregnancy, and fetal IgG levels reach maternal levels by term.

The mean birth weight of the VAP group in our study was 2.1±0.7 kg which was also significantly lower than the non VAP group 2.9 ±1 kg. This result was near to the results obtained by **(Afify *et al.*, 2012)** who reported that the mean birth weight in the group diagnosed as VAP was 1.5±0.8 kg whereas, in the non VAP was 2.6±0.38 kg **(Tripathi *et al.*, 2010)** who reported that very low birth weight (<1.5) kg is significantly associated with

vap.on the other hand some studies was against our study like **(Afjeh *et al.*, 2012)** who reported that body weight not related to the occurrence of VAP. However low birth weight increase length of stay on MV so more vulnerable to VAP **(Cordero *et al.*, 2002)**.

In our study the mean duration of NICU stay in VAP patients was 40.3±14.9 days while the mean duration of NICU stay in non VAP patients was 21.4±14.2 days. This agree with **(Afify et al., 2012)** who reported that prolonged duration of NICU admission was a significant risk factor for VAP because it increases the risk of infection and exposure to poor infection control measures as hand washing, and it was near the results of **(Tripathi et al., 2010)** who reported that the mean duration of NICU stay in VAP patients was 32.7±34.7 days in his study and the mean duration of NICU stay in non VAP patients was 19.7±23.9 days.

In the current study, infants with VAP tend to receive mechanical ventilation for a duration of 26.6±11.5 days while those without VAP of duration 11.1±6.2 days. This agree with the results of many studies like **(Tripathi *et al.*, 2010)** who reported that the mean duration of MV in infants with VAP in his study was (12.5±0.9) days and the mean duration of MV in infants without VAP was (5.4±0.8) days,**(Koksal *et al.*, 2006)** mentioned that prolonged duration of ventilation generally increases the risk of infection due to the exposure to other devices including nebulizers, humidifiers, and ventilator circuits that are proven to be an important source and media for microorganisms and **(Apisarnthanarak *et al.*, 2003)** who mentioned in his study that the risk of VAP increased by 11% for every additional ventilator week**.**

In our study inotropes were significantly used more in VAP group in order to normalize their blood pressure. This agree with **(Fischer *et al.*, 2000)** who found that inotropic support was significantly more required in the VAP group. Also, in our study, corticosteroids were significantly associated with VAP group rather than non VAP, this agree with **(Foglia *et al.*, 2007)** who mentioned that corticosteroids were associated with the development of VAP as corticosteroids are immunosuppressants and increase the incidence of sepsis**(Pawar *et al.*, 2003)**.

In our study there is no significant difference between VAP and non VAP neonates as regarding antacids therapy. This agree with **(George *et al.*, 2000)** and **(Afify *et al.*, 2012)** namely that the use of antacids or H2 antagonists did not increase the risk of VAP, but disagree with **(Carlos *et al.*, 2009)** who explained this by the fact that administration of antacids results in elevations in the stomach's pH, therefore increasing colonization with pathogenic bacteria in close proximity to the respiratory tract. Conversely, **(Bonten *et al.*, 1995**) showed that antacid use is not critical for VAP development in neonates and **(Benítez and Ricart, 2005)** showed that oropharyngeal colonization by flora in oral cavities and contaminated secretions into the lung are the primary causes of VAP in neonates, thus the contamination of the lower airway is associated with acid regurgitation. However, confirming this pathogenesis was challenging in this study because of the difficulty in detecting episodes of aspiration during nursing care, additionally, antacids can decrease the degree of gastroesophageal reflux. Thus, the role of antacids in neonates with VAP remains controversial.

Also, surfactant was not significant with VAP patients in our study. This was inconsistent with **(Afify *et al.*, 2012)**. This may be due to low rate of administration of surfactant because of high cost and different protocols of treatment in our NICUs. Also administration of surfactant done under complete aseptic conditions.

This study shows that there were significant differences between VAP and non VAP patients as regard enteral feeding. Many previous studies detected that enteral nutrition are risk factors for VAP as they may increase the risk of gastric distention, colonization with gram-negative microorganisms to multiply in the stomach, and consequently lead to an increased rate of neonatal pneumonia (NP). Though, to reduce the risk of NP, it is important to avoid unnecessary enteral nutrition **(Memish *et al.*, 2000)**.This was not in agreement with (**Berthelot *et al.*, 2001)** who mentioned that accurate evaluation of nutritional status and early initiation of enteral feeding is important in NICU patients and can aid to preserve the gastrointestinal epithelium and prevent bacterial colonization.

This study shows that there was significant greater number of VAP babies with UVC (76.6%) compared to non VAP patients (50%). **(Van der kooi *et al.*, 2007)**, reported in a study that the placement of central venous catheters (CVCs) was the major risk for acquiring VAP as they are considered an important source of blood stream infection in the immunocompromised ventilated babies, Whereas **(Apisarnthanarak *et al.*, 2003)** reported that the presence of these catheters might be a marker for the severity of illness.

As regard other invasive devices like intercostal tube in babies suffering from pneumthorax, this study reported that it has significant relation with VAP (43.9%) compared to non VAP patients (15.8%). **(Bailey, 2000)** stated that specifically, pain, vascular injury, improper

positioning of the tube, inadvertent tube removal, post removal complications, longer hospital stays, empyema and pneumonia have been reported in up to 30% of cases.

In our present study there were significant differences between VAP and non VAP patients regarding CRP titre and total leucocytic count.This were in agreement with **(Povoa *et al.*, 2005)** who mentioned that decreases in CRP levels precede clinical improvement, whereas, conversely, failure of CRP levels to fall suggests infectious complication or ineffective or inappropriate treatment.

Hypoalbuminemia which is considered as an indicator of poor nutritional status was a significant risk factor to develop VAP in our study. This came in agreement with **(Alp and Voss,2006)** who mentioned that in critical illness there is a reduction in the production of albumin, due to favored hepatic production of acute phase proteins such as globulins, fibrinogen and haptoglobin. The inflammatory cascade in many patients leads to a common pathway, causing a generalized increase in vascular permeability ("capillary leak syndrome"). This leads to leakage of protein rich fluid into the interstitium. This appears to be the primary cause of decreased serum albumin in sepsis.

As regarding other laboratory investigations (Hemoglobin, platelets, urea, creatinine, SGPT) no significant difference between VAP and non VAP, this agree with **(Afify *et al.*, 2012)**.

As regarding Capillary blood gases results between VAP and non VAP patients, we couldn't elicit significant difference except for PaCO2, PaO2 and O2 saturation. These results were the same obtained by **(Babcock *et al.*, 2004)**.

In this study, microorganisms associated with blood stream infection in VAP diagnosed group were, *Staph aureus* (15%), Klebsiella (8%), Candida (6.5%), Pseudomonas (4.2%), *E-coli* (4.2%), while 61.7% of obtained blood cultures in VAP patients were sterile. This result may be explained by our studied newborns enrolled in this study were already under antibiotics therapy. Staphylococcus was predominant organism in BSI in our study, this was against **(Tawfik *et al.*, 2009)** who reported that Klebsiella was predominant organism in BSI, this may be due to defect in infection control measures especially hand hygiene at the time of intake the samples

The results of (NB-BAL) cultures were Klebsiella (34%), Pseudomonas (25.5%), *Staph aureus* (17%), *E-coli* (17%), Candida (6.4%). *Klebsiella pneumoniae* was the most common isolated pathogen in the ETA. This is similar to **(Tripathi *et al.*, 2010)** in India as the most common bacterial isolate from ETA was Klebsiella spp (32.87%) and **(Apisarnthanarak, 2003)** in Thailand who studied 67 mechanically ventilated infants and had positive ETA growth in 19 cases, reported the most commonly isolates included Klebsiella spp. (38.4%), *Pseudomonas aeruginosa* (23%) and *Staphylococcus aureus* (23%).

The results of (NB-BAL) cultures reported that gram negative bacteria were isolated from the majority of babies (76.5%), with klebsiella predominating the positive cultures (34%). On the other hand gram positive infection comprised 17% of the total cultures with *Staph aureus* predominating, while Candida was positive in 6.4% of samples examined. Our results were similar to **Apisarnthanarak *et al.* (2003), Petdachai *et al.* (2004)**, **Koksal *et al.* (2006) and Tawfik *et al.* (2009),** who mentioned that predominance of gram negative infection in their units. However, the reported species isolated differed from a study to another. This can be explained by the fact that the distribution of microorganisms differs from a NICU to another and also, differs within same place from one period of time to another. **Tawfik *et al.* (2009)** reported that klebsiella was the most predominating causative agent. **Koksal *et al.* (2006)** mentioned that Acintobacter was the most predominating causative agent, whereas **Apisarnthanarak *et al.* (2003) and Petdachai *et al.* (2004)**, and**,** reported that pseudomonas was the most common organism isolated.

In our study, nearly most of the studied newborn infants who developed VAP had not the same organism that caused their blood stream infection. This was in agreement with **(Apisarnthanarak *et al.*, 2003**) and **(Yuan *et al.*, 2007)**.

Conclusion:

1-The most important risk factors of VAP in our unit included prematurity, low birth weight, prolonged duration of ventilation, enteral feeding, placement of umbilical catheters, chest tubes and central lines in addition to the use of some drugs as inotropes and corticosteroids**.**

2- NB-BAL is a practical diagnostic method in clinically suspected VAP in neonates. It can be easily, without side effects and repeatedly performed to help clinicians in decision making regarding antibiotic use.

3-Gram negative organisms comprised the majority of cultures obtained by NB-BAL, klebsiella pneumoniae was the most common identified organism.

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