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Original Article

An Observational Study on Ventilator-Associated Pneumonia as a Cause for Nosocomial Infection in Mechanically Ventilated Neonates

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Abstract

Background: Neonatal ventilator associated pneumonia (VAP) is a major hospital-acquired infection in acute care settings, associated with high mortality and poor outcome. **Objectives:** The purpose of this study is to evaluate the frequency of ventilator associated pneumonia, its causative organisms, its risk factors and outcomes at a tertiary care NICU. **Methods:** This is a prospective observational cohort study used Centers for Disease Control (CDC) guidelines for infant's ≤1 year old to diagnose neonatal VAP. All inborn and out-borne neonates who admitted to our NICU from April 2018 to March 2019 were screened for study enrollment and were considered eligible if ventilated for more than 48 hours. They were classified into: Group A: cases with suspected VAP and Group B: cases without VAP. **Results**: Thirty eight out of 140 patients admitted to NICU were VAP with frequency 27.2%. There were significant changes in the vital signs, respiratory manifestation, ventilator settings, radiologic progression and laboratory findings in VAP group. The risk factors were birth weight less than 1500g (P=0.002), prematurity (P< 0.05), duration of ventilation (26.0 ± 11.5 days, P<0.001) and duration of hospital stay (40.3±14.9). Microorganisms associated with bloodstream infection in the VAP-diagnosed group were Klebsiella spp., Staphylococcus aureus, Candida spp. and other Gram negative bacilli (26.3, 5.2, 31.5, and 15.7% respectively). Klebsiella spp. was the most commonly isolated pathogen in non-bronchoscopic bronchoalveolar lavage. In-hospital mortality rates in VAP and non-VAP groups were 65% and 25.5% respectively (P<0.001). **Conclusions:** The frequency of ventilator acquired pneumonia (VAP) in NICU was 27.2%. The most common risk factors of VAP were very low birth weights, prematurity, longer duration of ventilation and duration of hospital stay while Klebsiella spp. was the most common microorganism associated with bloodstream infection.

Key words: Newborn, mechanical ventilation, VAP, risk factors, causative organisms.

Introduction

Neonatal deaths represent the third of the global burden of child mortality [1]. In Egypt, Infections such as pneumonia, meningitis, sepsis/septicemia and other infections account for 28% of deaths during the neonatal period. Survival cannot be achieved without substantial reductions in infection-specific neonatal mortality [2]. Neonatal sepsis is usually classified as early or late onset sepsis. Early sepsis occurs within the first 72 hours of birth and late neonatal sepsis occurs after 72 hours of birth. Early neonatal sepsis is associated with acquisition of microorganism from the mother. Late neonatal sepsis usually occurs due to the lack of aseptic working conditions [3]. The occurrence of late sepsis is considered an important indicator of quality of care. Mechanical ventilation is an essential life-saving therapy for patients with critical illness and respiratory failure. These patients are at high risk for complications and poor outcomes, including death, ventilator-associated pneumonia (VAP), sepsis, pulmonary embolism, barotrauma, and pulmonary edema. Such complications can lead to longer duration of mechanical ventilation, longer stay in the intensive care unit (ICU) and hospital, increased healthcare costs, and increased risk of disability and death [4, 5]. Ventilator associated pneumonia (VAP) is defined as a nosocomial lower airway infection, i.e. pneumonia, in intubated patients with onset after 48 hours or more of invasive mechanical ventilation [6]. VAP is usually caused by airway colonization by potential pathogens. Sources of airway colonization can be the patient's own flora, i.e., bacterial overgrowth in oral secretions, reflux and aspiration of gastric fluid or the patient's environment with its caretakers and equipment [7, 8].

Mechanically ventilated babies face a particular risk because of artificial airways bypass the body's defenses against inhaled pathogens and offer new routes for non-air borne pathogens. Intubation associated lesions of pharynx and trachea lead to bacterial colonization by the deterioration of the swallowing reflex and the ciliary

functions [9].VAP is one of the most frequently diagnosed nosocomial infections [10] and, after suspected early onset sepsis, it is the second most common reason for antibiotic intervention in neonatal intensive care unit (NICU) [11, 12]. VAP incidence can be reduced by infection control measures such as VAP-prevention-bundles [13]. Regarding diagnosis of VAP episode requires a combination of radiological, clinical, and laboratory criteria. However Center for Disease Control and Prevention/ National Nosocomial Infection Surveillance (CDC/NNIS) criteria refers to infants younger than 1 year and do not define specific criteria for the newborn period in term or preterm infants. In spite of this lack of specificity, most studies of VAP performed in NICUs are based on these criteria [14].

Aim of the work: The purpose of this study is to evaluate the frequency of ventilator associated pneumonia, its causative organisms, its risk factors and the outcome at a tertiary care neonatal intensive care unit (NICU).

Methods

Design: This is a prospective, observational cohort surveillance carried out at Assiut University Children Hospital neonatal intensive care unit (NICU) during the period from April 2018 to March 2019 for neonates who needed mechanical ventilation, reviewing data for diagnosis of neonates with ventilation associated pneumonia VAP.

Setting: Assiut University Children Hospital NICU is a level III, part of a university-teaching hospital, receives referrals from the whole Upper Egypt hospitals. It has approximately 1450 case per year, approximately ~ 5 patients per day and it has approximately 450 case needs MV per year.

Patients:

All inborn and out borne neonates who admitted to the our NICU during the period from April 2018 to March 2019 were screened for study enrollment and were considered eligible if ventilated for more than 48 hours. Neonates in our study were classified into two groups:

Group A: cases with suspected VAP and Group B: cases without VAP. Because up to this point we don't know the lab results and microbiology, the diagnosis was based on all of the three items of radiologic signs, clinical signs and symptoms and microbiological findings according to CDC criteria [15].

Neonates ventilated with evidence of neonatal sepsis before ventilation, Neonates with meconium aspiration syndromes and neonatal deaths within 48 hours of NICU admission and/or ventilation were excluded from the study. Medical records comprising charts, daily flow sheets, laboratory and radiographic reports were collected prospectively by the investigators. Neonates with suspected VAP in NICU: were diagnosed as VAP according to: Modified CDC guidelines for infants ≤ 1 year old [5, 6, 13]. The clinical criteria for diagnosis; Worsening gas exchange: desaturations pulse oximetry less than 90%, increase ventilation demand, and at least three of the following:(Temperature instability, Leukopenia (≤4000 WBC/mm3) or leukocytosis (>15,000 WBC/mm3) and left shift, Band forms (>10%), new onset of purulent sputum or change in character of sputum, or increased respiratory secretions, apnea, tachypnea, nasal flaring with retraction of chest wall or nasal flaring with grunting, wheezing, rales, or rhonchi.

All patients will be subjected to full history takin and full clinical examination. Then Monitoring of the ventilator settings, and fraction of inspired oxygen (FiO2) were done. Investigation: Imaging study: (chest x-ray on admission& follow up, ultrasound and CT scan when indicated), complete blood count, capillary blood gases and septic screening (C-reactive protein, blood culture and culture of bronchoalveolar lavage): aspirate for culture (non-quantitative cultures) after the third day then weekly until extubation. Antibiotic sensitivity test was done to all cultures. We tried to compare the results of broncho-alveolar lavage

(BAL) versus blood culture in the diagnosis of VAP according to Cantey JB et al [12], aiming to intensify the role of BAL.

According to results:

1. Full agreement: when the same strain of organism has been isolated from the blood and endotracheal tube aspirate cultures,
2. Partial agreement: when the organisms in the blood were found as one of the multiple isolates from the endotracheal tube,
3. No agreement: when the organism was found in the endotracheal tube aspirate and blood was not the same.

Initial (empirical) therapy is most often begun before a definite causative agent is identified, then continuing therapy is based on culture and sensitivity results and clinical course.

Statistical analysis

The frequency was calculated by dividing the number of VAP cases by the total number of admission during the period of study. The data were tested for normality using the Kolmogorov-Smirnov test and for homogeneity variances prior to further statistical analysis. Categorical variables were described by number and percent (N, %), where continuous variables described by mean and standard deviation (Mean, SD). Chi-square test used to compare between categorical variables where compare between continuous variables by t-test (One Way ANOVA). A two-tailed $p < 0.05$ was considered statistically significant. All analyses were performed with the IBM SPSS 20.0 software.

Ethics approval and consent to participate: The aim of the study was explained to each parents of the child before the beginning of the process. A written consent was obtained from those who welcomed to participate in the study. Privacy and confidentiality of all data were assured. This study was approved by" the Committee of Medical Ethics "of Faculty of Medicine Assiut University. An informed written consent

was obtained from all parents' participants included in the study.

Details of the clinical trial registry

Name: NCT

Registration Number: NCT03310840

Date of Registration: 16th of October 2017. Date of participant enrollment: 1st of April. URL: https:// clinicaltrials.gov/ct2/ show/ NCT 03310840

Results

During the study period, one hundred forty (140) neonates met the study criteria and were consented and enrolled. Neonates in our study were classified into two groups; Group A (cases with confirmed VAP) were 38 patients and Group B: (cases without VAP) were 102 cases, from those 16 cases met the clinical criteria only and 86 didn't meet the clinical criteria. Group A: cases with confirmed VAP, (met the clinical, radiographic and laboratory criteria) included 38 patients of an age range 1 to 28 days. There were 40 episodes of clinical VAP (Two patients had 2 episodes of VAP and the other patients had only one episode) in 38 patients as shown in figure (1). The prevalence was 27.2%. According to distribution cases per month, the prevalence of VAP increased in August during the studied year as shown in figure (2).

The VAP and non-VAP groups differed significantly with respect to gestational age and weight, according to demographic data as showed in table (1). The very low birth weight less 1500g ($P<0.001$) and prematurity (28-32wks) ($P< 0.05$) were significantly increased among VAP group than non VAP group, while there were no significant differences as regard to sex or mode of delivery as shown in table (1). The causes of connection to mechanical ventilator in the VAP group were 16 cases respiratory causes (RDS and respiratory tract anomalies), 8 cases congenital heart disease, 2 cases metabolic, 4 cases surgical causes and 8 cases due to neurological causes.

There were significant differences between VAP and non VAP groups concerning the clinical findings, ventilation parameters, radiological and laboratory investigations as shown in tables (2, 3). The most significant clinical findings with VAP were changes in temperature (either hypothermia or hyperthermia or fluctuation in temperature) heart rate (tachycardia or bradycardia), respiratory rate (tachypnea or apnea), skin color (pallor or cyanosis) and respiratory manifestation (worsening of breathing, auscultatory findings, change in the character of sputum and increase respiratory secretions). There were also significant changes in the ventilator settings with the VAP group with increase in the oxygen requirement and ventilation demands. There were significant radiological findings with the VAP group as progression of infiltration and consolidation. There were significant blood gases changes with the VAP group in the form of increase in the partial pressure of arterial carbon dioxide PaCO2. There were significant increases in the total leucocyte count (TLC) and C-reactive protein (CRP) in the VAP group. The characteristics and risk factors of the VAP and non-VAP subjects are compared in table (4). The significant risk factors were central venous line in16 cases (42.1%) ($P< 0.05$), reintubation in 22 cases (57.8%) $P<0.001$) and sedative use in 16 cases (42%) ($P<0.05$). The microorganisms associated with bloodstream infection in the VAP diagnosed group were Klebsiella spp. (31.5%), S. aureus (26.3%), Candida spp. (2.5%), Other Gram negative bacilli (15.7%) while 21% of obtained blood cultures in VAP patients were sterile as shown in table (5).The NB-BAL cultures revealed the presence of Klebsiella spp. (42.5%) whereas Candida spp. (4.7%) was the least common as shown in table (5). Microorganisms isolated from blood were compared with that isolated from BAL. According to results:

1. Full agreement: only in 22 cases (57.8%).

2. Partial agreement: in 10 cases (26.3%).
3. No agreement: this was in 6 cases only (15.7%).

In this study, it was noticed that combination of more than one antibiotic to cover both gram negative and positive bacteria was used in (100%) of studied neonates based on a local antibiogram.

The second line antibiotics used in the current study in (21%) of neonates as empirical therapy had not changed. In (50%) of neonates, the first antibiotic was changed to another agent based on the results of culture and sensitivity, while in (29%) of neonates the first agent was changed without waiting results of culture and sensitivity. This may be attributed to associated clinical deterioration.

The outcomes compared between the VAP and non-VAP groups are shown in table (6). There were significant longer duration of ventilation (26.0 ± 11.5 days, P<0.001) and duration of hospital stay (40.3±14.9) with the VAP group, adding the in-hospital mortality rates in the VAP and non-VAP groups were 65% and 25.5% respectively (P<0.001). Associated complications among the studied cases of group A, Disseminated intravascular coagulopathy (DIC) in 14 cases (36.8%), intra-ventricular hemorrhage (IVH) in 4 cases (10.5%) and pneumothorax in 3 cases (7.8%).

Discussion

In this study, the frequency of VAP was 27.2%. This result was in agreement with Hooven et al [5], who showed that VAP accounts for up to 30% of nosocomial infections in neonatal intensive care unit (NICU) patients but this was against Goerens et al [13]. This difference may be attributed to the big difference in reported VAP rate which was observed among different studies as the confirmation of neonatal VAP is a difficult subject, resulting in a great variance between suspected and confirmed episodes.

This study included 38 neonates with confirmed VAP who were males 65%

(n=25) and females 35% (n=13). Thirty of them (79%) had positive blood cultures and eight of them (21%) had no growth in blood culture. In this study the majority of studied neonates (68%) were below 2500 gm. Also the mean birth weight of the VAP group was significantly lower than that of the non-VAP group (P = 0.05). This result was similar to the results obtained by Spitzer et al [16], who reported in a cross-sectional study that VAP rates were highest in neonates with 1-1.5 kg birth weight categories.

The mean gestational age of infants diagnosed with VAP was significantly lower than that of the non-VAP group. This result was similar to the results obtained by Khattab et al [17]. Meanwhile, there were no significant differences as regards to sex or mode of delivery.

The most significant clinical findings with VAP were changes in temperature (either hypothermia or hyperthermia or fluctuation in temperature), heart rate (tachycardia or bradycardia), respiratory rate (tachypnea or apnea), skin colour (pallor or dusky) and respiratory manifestation (worsening of breathing, auscultatory findings, change in the character of sputum and increase respiratory secretions). There were also significant changes in the ventilator settings with the VAP group with increase in the oxygen requirement and ventilation demands.

There were significant radiological findings with the VAP group as progression of infiltration and consolidation. We still depend on the x-ray findings as we don't make lung ultrasound as a routine for diagnosis of VAP.

There were significant blood gases changes with the VAP group in the form of increase in the partial pressure of arterial carbon dioxide PaCO2. There were significant increases in the total leucocytic count (TLC) and C-reactive protein (CRP) in VAP group. These

results were in agreement with other studies [17, 18].

The analysis of the risk factors revealed that sedative medication use (P<0.05) and CVL (P<0.05), re-intubation (P <0.001) were significant independent risk factors associated with the development of VAP. This result was similar to the results obtained by Thatrimontrichai et al [10], who reported that sedatives are given in cases of patient-ventilator dys-synchrony; however, they should be avoided if possible, as a significant risk factor and sedative medications have also been shown to alter cellular function and other mediators of the immune system, which possess a significant immunosuppressive effect associated with VAP.

This study showed a significant defect in the infection control measures practices. Change machine circuit was done only in (47.3%) of cases, mouth wash was done in (31.5%) of cases, closed suction was not used because it was not available at our unit according to guidelines of infection control unit [19].

Distributions of the microorganisms isolated from blood cultures in this study were as follows: The most common isolates were Klebsiella spp presented in 12 cases (31.5%) followed by Staph. aureus presented in 10 cases (26.3%), other Gram negative (G-ve) bacilli was present in 6 (15.7%) and Fungi in 2(5.2%) neonates . The microorganisms isolated from endotracheal aspirate cultures include Klebsiella spp, Acinetobacter spp as the most common organisms. This is consistent with the results of previous Egyptian study by Badret al [18] found that the most frequently isolated organisms were Klebsiella Spp.

Regarding the outcome of the current study, increase duration of ventilation mean±SD (26.0 ± 11.5) in days, duration of hospital stay mean±SD (40.3±14.9) in days and median range (4-34) days were significant risk factors (P <0.001).

Also Prolonged duration of NICU admission have been reported to be associated with an increased exposure to invasive procedures, other devices such as nebulizers, humidifiers and ventilator circuits and this is in agreement with Lee et al [14].

In this study, twenty five (65%) neonates died and only 13 (35%) neonates were survived. This high mortality rate may be explained by the commonest organisms for nosocomial infection in this study which were Gram-negative rods often associated with antibiotic resistance, rapid clinical deterioration and is commonly associated with shock and cardiovascular collapse as described by Peters et al [11].

There were limitations to this study: The most important one is that it is not an interventional study with a control group aiming to prove the causative benefit of the implemented changes and the small sized sample (the study included only 140 neonates).

Conclusions

We found that the frequency of ventilator acquired pneumonia (VAP) in NICU was 27%. With the most common risk factors of VAP were very low birth weights, prematurity, longer duration of ventilation and duration of hospital stay. The microorganisms associated with bloodstream infection in the VAP-diagnosed group were Klebsiella spp., Staph aureus and others Gram negative bacilli while Klebsiella spp. was the most commonly isolated pathogen in non-bronchoscopic broncho-alveolar lavage. We have to ensure the importance of guidelines for antimicrobial use and infection control measures that may lead to an effective decrease in VAP incidence. Lastly we encourage the policy for early-extubation, and the use of NCPAP which might be helpful too.

List of Abbreviations

BAL: bronchoalveolar lavage

CDC/NNIS: Centers for Disease Control and Prevention/ National Nosocomial Infection Surveillance

CRP: C-reactive protein

CVL: central venous line

Gram negative: G-ve

ICU: intensive care unit

NCPAP: nasal continuous positive airway pressure

NICU: Neonatal Intensive Care Unit

PaCO2: partial pressure of arterial carbon dioxide

Species: spp.

Staph. Aureus: Staphylococcus aureus

TLC: total leucocytic count

VAP: Ventilator-associated pneumonia

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Author's contributions

AA performed the study design and revised the whole work. A M Revised the data collection, recording of the results and the interpretation of results, and helped to draft the manuscript. AF Data collection and recording analyzed, and interpreted the data and performed the statistical analysis, and wrote the manuscript. All authors have read and approved the final manuscript.

Conflict of interest

Authors declare they have no conflict of interest

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Table (1): Demographic data of the studied groups.

Variable	Item	Group A VAP (N = 38) (27.2%)	Group B Non-VAP (N = 102) (72.8%)	t	P- value
Gestational age (weeks)	Full term(37-41)	11(28.9%)	16(15.6%)	.019	< 0.05
	Late preterm(33-36)	12(31.5%)	32(31.3%)		NS
	Preterm(28-32)	15(39.5%)	52(50.9%)		< 0.05
	Post term(≥42)	0	2(1.96%)		NS
Sex	Male	25(65.7%)	72(70.5%)	0.1	NS
	Female	13(34.2%)	30(29.5%)		NS
Birth weight (gm.)	Normal (2500-3999 gm.)	12(31.5%)	28(27.4%)	1.2	NS
	LBW(<2500 gm)	15(39.4%)	68(84.3%)		< 0.05
	VLBW(<1500gm)	11(28.9%)	6(5.88%)		< 0.001
Maternal condition	No Risk	16(42.1%)	44(43.1%)		NS
	PROM	8(21%)	20(19.6%)	.014	NS
	Gestational DM	4(10.5%)	12(11.7%)		NS
	Pre-clampsia	4(10.5%)	10(9.8%)		NS
	Multiple gestation	6(15.7%)	16(15.5)		NS
Type of delivery	VD	4(10%)	6 (5%)	0. 5	NS
	CS	34(90%)	96(95%)		NS

NICU; Neonatal intensive care unit, VAP; ventilator-associated pneumonia, VLBW ; Very Low Birth Weight, LBW; PROM , Premature Rupture Of Membranes ;DM,, Diabetes Mellitus ;VD, Vaginal Delivery ; CS ,Caesarean Section; Low Birth Weight. $P \geq 0.05$, NS; $P < 0.05$, significant difference; $P < 0.001$, highly significant**.**

Table (2): Comparison between clinical and radiological findings in the studied cases

Variables	Item	Group A VAP (n=38) N&%	Group B Non VAP (n=102) N&%	P value
Temperature	▪ Normal	4(10.5%)	54(52.9%)	< 0.001
	▪ Hypothermia	18(47.3%)	36(35.2%)	< 0.05
	▪ Hyperthermia	14(36.8%)	12(11.7%)	< 0.05
	▪ Fluctuation of Temp	28(73.6%)	44(43.1%)	< 0.001
RR	▪ Normal	0	28(27.4%)	< 0.05
	▪ Tachypnea	30(78.9%)	58 (56.8%)	< 0.05
	▪ Apnea	8(21.1%)	16(15.6%)	< 0.05
Heart rate	▪ Normal	8(21%)	74(72.5%)	<0.001
	▪ Tachycardia	18(47.3%)	8(7.8%)	<0.05
	▪ Bradycardia	12(31.5%)	20(19.6%)	<0.05
Skin	▪ Pallor	10(26.3%)	15(15.7%)	< 0.05
	▪ Ecchymosis	7(18.4%)	10(10.5%)	NS
	▪ Jaundice	10(26.3%)	31(31.5%)	< 0.05
	▪ Cyanosis	14(36.8%)	6(7.8%)	< 0.05
Respiratory system	▪ Worsen act of breathing	28(73.6%)	10(10.5%)	< 0.001
	▪ Auscultatory chest finding	32(84.2%)	34(36.8%)	< 0.05
	▪ Change of character of sputum	28(73.6%)	20(21%)	< 0.001
	▪ Increase respiratory secretion	36(94.7%)	10(10.5%)	< 0.001
Mechanical ventilation setting(MV)	▪ Increase oxygen required	38(100%)	22(21.5%)	<0.001
	▪ Increase ventilation demand	28(75%)	18(17.6%)	<0.001
Radiological finding	▪ Progression of infiltration	28(73.6%)	0	<0.001
	▪ Consolidation	10(26.3%)	0	<0.001

VAP, ventilator-associated pneumonia; MV, mechanical ventilation ;RR ,Respiratory Rate;, $P \geq 0.05$, NS; $P < 0.05$, significant difference; $P < 0.001$, highly significant. TLC (total leucocytic count), CRP(C-reactive protein), and PaCO2(Partial pressure of arterial carbon dioxide)

Table (3): Comparison between the laboratory findings in the studied cases

Variables	Group A VAP (N = 38)	Group B Non-VAP(N = 102)	t	P- value
Capillary BG [mean ± SD]				
• PaCO2 (mmHg)	51.2±9.6	43.8±10.6	2.68	< 0.05
CBC				
• HB (g%) [mean ±SD]	12.3±2.3	14.6±2.9	-2.6	NS
• TLC [mean ± SD]	19.2±6.2	12.4±4.2	3.3	< 0.001
• PLT [mean ± SD	249.5±170.3	201.5±150.2	1.3	< 0.001
CRP				
• [mean ± SD]	54.5±40.47	28.0 ± 41.92	1.18	< 0.05
• Positive result	32(84.2)	14(13.7)	19.4	< 0.05

VAP, ventilator-associated pneumonia; MV, mechanical ventilation ;RR ,Respiratory Rate;, $P \geq 0.05$, NS; $P < 0.05$, significant difference; $P < 0.001$, highly significant.; TLC (total leucocytic count), CRP: (C-reactive protein), and PaCO2 (Partial pressure of arterial carbon dioxide)

Table (4): Risk factors among the studied groups.

Variables	**Group A VAP**	**Group B Non-VAP**	**P- value**
Invasive procedure: after MV			
▪ **Central Venus line**	16(42.1%)	28(27.4%)	< 0.05
▪ **Peripheral line**	26(57.8%)	78(76.4%)	NS
▪ **Reintubation**	22(57.8%)	16(15.6%)	< 0.001
Medication:			
▪ **Surfactant**	4(10.5%)	16(15.6%)	NS
▪ **TPN**	32(84.2%)	88(86.2%)	NS
▪ **Sedative use**	16(42%)	20(19.6%)	< 0.05
Infection control measures:			
▪ **Closed suction**	Not done	Not done	NS
▪ **Mouth wash**	12(31.5%)	40(40%)	NS
▪ **Change machine circuit**	18(47.3%)	36(35.2%)	NS

MV, mechanical ventilation; NICU, neonatal intensive care unit; RDS, respiratory distress syndrome; VAP, ventilator-associated pneumonia; $P \geq 0.05$, NS; $P < 0.05$, significant difference ; $P < 0.001$, highly significant.

Table (5): Microorganisms isolated from blood cultures and BAL in group A.

Causative organism	**No. of cases**	**Percent %**
• No growth	8	21%
• Klebsiella Spp.	12	31.5%
• Staph. Aureus	10	26.3%
• Others Gram negative bacilli	6	15.7%
• Fungi	2	5.2%
• Total	38	100.00
Microorganisms isolated from BAL of the studied cases		
• Klebsiella Spp.	17	42.5%
• Gram negative bacilli	12	30%
• Staph epidermis	9	22.5%
• Fungi	2	5%
• Total	40 episode	100%

Table (6): The outcome in the studied groups.

Variable	**Group A VAP**	**Group B Non VAP**	**t**	**P value**
Duration of ventilation Mean ±SD(in days)	26.0 ± 11.5	11.1±6.2	7.4	<0.001**
Duration of hospital stay				
• **Mean ±SD(in days)**	40.3±14.9	21.4±14.2	5.9	< 0.05
• **Median (range)**	(4- 34)	(2-23)		
In-hospital Survival (%)	13(34.2%)	76(74.5%)	-1.2	< 0.001
In-hospital mortality (%)	25(65.7%)	26(25.5%)	6.5	<0.001**

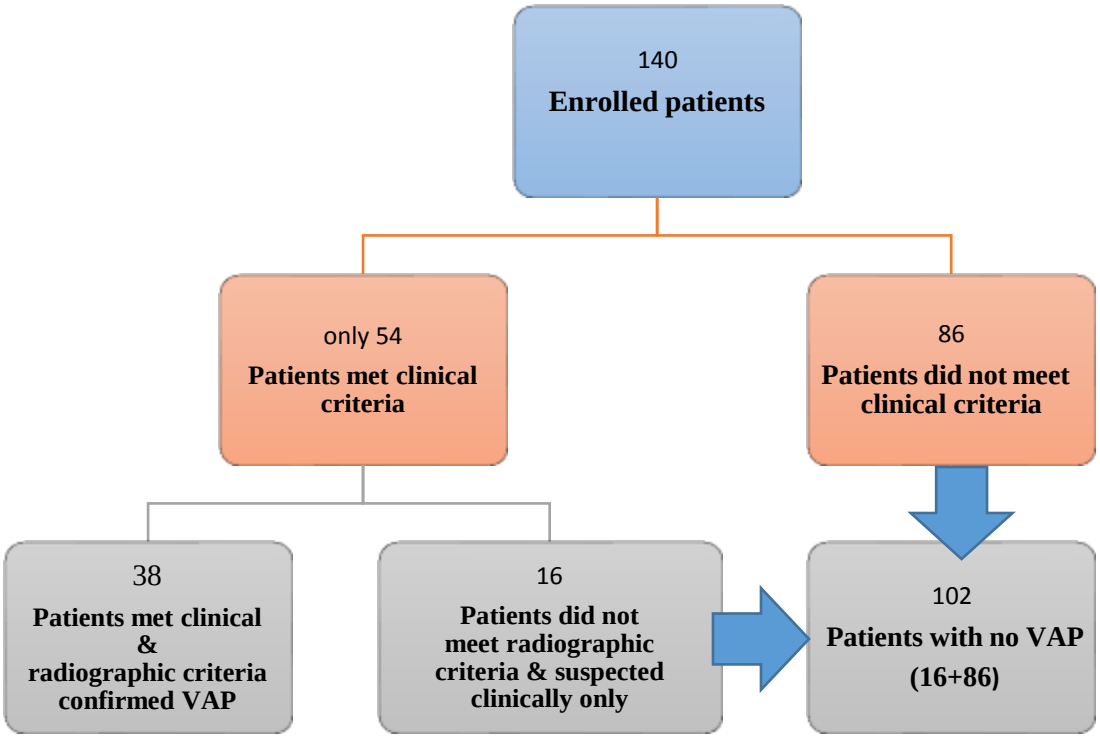

Figure (1) Participants enrolled in the study

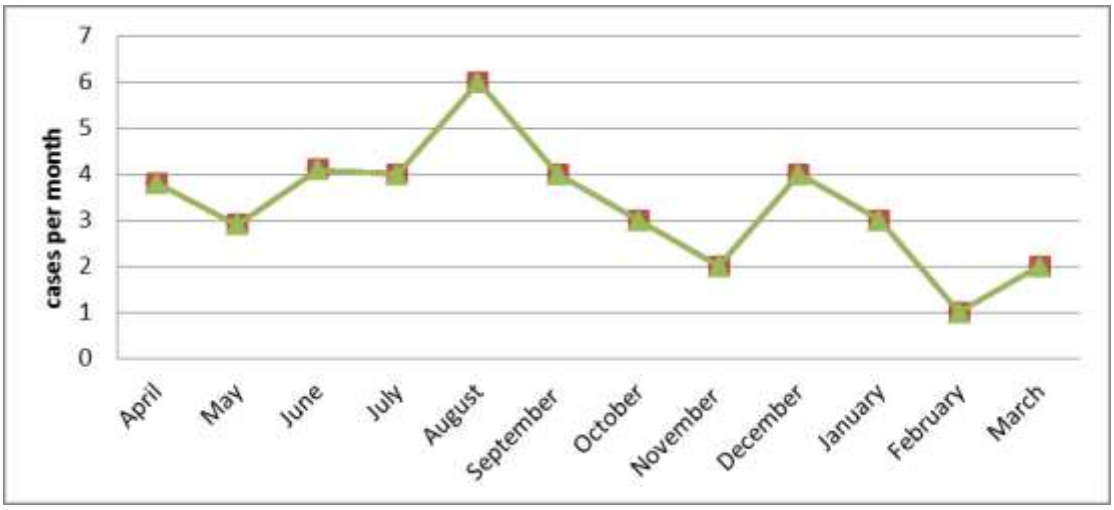

Figure (2) Prevalence of VAP all over the year

Citation: Abdel Rahman F. Abdel Azem Gohr, Azza A. El Tayeb and Amira M. Shalaby. An Observational Study on Ventilator-Associated Pneumonia as a Cause for Nosocomial Infection in Mechanically Ventilated Neonates Annals of Neonatology Journal. 2021, 3(1): 144-164 doi: 10.21608/ANJ.2021.56811.1019