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Characteristics of Monomicrobial and Polymicrobial Ventilator Associated Pneumonia in a Tertiary Care Hospital

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Abstract
Background: *Ventilator associated pneumonia (VAP) occurs after 48 hours in mechanically ventilated patients. They are a significant cause of morbidity and mortality.*
Materials and Methods: *100 patients were selected for the study. The details of the patients were collected. The tracheal aspirates were processed and the pathogens identified using standard protocol. Antimicrobial sensitivity testing was done.*
Results: *The incidence of VAP was 36% .The incidence of monomicrobial and polymicrobial VAP was 55.56% and 44.44%. Acinetobacter baumanii was isolated most commonly in both types of VAP. More than 80% of isolates were multidrug resistant. There was prolonged duration of mechanical ventilation and hospital stay in VAP patients.*
Conclusion: *Proper preventive measures should be undertaken to reduce the rates of nosocomial pneumonia by multidisciplinary approach.*
Keywords: *Ventilator associated pneumonia, Monomicrobial, Polymicrobial, Acinetobacter.*

Introduction

Ventilator associated pneumonia (VAP) is defined as nosocomial pneumonia that develops in intubated patients after 48 hours. It is classified into Early onset (onset of VAP within 4 days) and Late onset VAP (onset after 4 days)[1]. The incidence varies from 3.5 to 46 infections/1000 MV days[2]. There are many criteria for the diagnosis of VAP but the most commonly used is the modified Clinical pulmonary infection score. It is characterised by fever, purulent tracheal secretions, leucocytosis, gas exchange degradation and newly formed or changing infiltrates on X ray of chest. A score of more than 6 predicts the development of VAP[3]. VAP prolongs the duration of mechanical ventilation and also Intensive care unit stay and hospital stay. Early onset VAP is usually caused by drug sensitive pathogens like Methicillin sensitive *Staphylococcus aureus, Streptococcus pneumoniae,* while late onset VAP is caused by drug resistant pathogens as *Acinetobacter baumannii,*

Pseudomonas aeruginosa, Methicillin resistant *Staphylococcus aureus*, ESBL producing *Escherichia coli, Klebsiella pneumoniae*[4]. The isolates can be monomicrobial or polymicrobial. The knowledge of the microbial etiology with antibiotic sensitivity pattern is necessary for the proper treatment of VAP. This article provides an insight into the various characteristics of monomicrobial VAP and polymicrobial VAP.

Materials and Methods

Study Design: Prospective study

Study Setting: Patients who underwent ventilation greater than 48 hours in the Respiratory intensive care unit for a period of ten months

Inclusion Criteria

1. Patients who were admitted and underwent mechanical ventilation after two days
2. age >18 years

Exclusion Criteria

Patients having other Respiratory tract infections on admission

Methodology

This prospective study was conducted in the ICU complex of a tertiary care hospital. A total of 100 patients on ventilator were selected for the study after using the inclusion and exclusion criteria.

All the relevant details of the patients like age, sex, diagnosis at the time of admission, date and indication for ventilation, antibiotics given, investigations done, x -ray findings, duration needed by the patient for ventilator support, duration of ICU stay, hospital stay were taken from medical records. The patient was monitored from the date of admission till the discharge date and the outcome was recorded.

VAP was diagnosed on clinical and microbiological basis using the CPIS.VAP was classified as early onset VAP (within 96 hours) and late onset VAP (>96 hours)[3].

Processing of samples

The endotracheal aspirates were collected using the mucous extractor and transported to the laboratory without any delay

A Gram's stain was performed and sample cultured on 5% sheep blood agar, MacConkey agar, Chocolate agar, incubated at 37 ℃ for 24 hours .The isolates were identified using standard protocols.

Monomicrobial and Polymicrobial VAP

When one pathogen was isolated in culture it was termed as monomicrobial and when more than one pathogen was isolated, it was termed as polymicrobial[5].

Antimicrobial sensitivity test

The antimicrobial sensitivity test was done using Mueller Hinton agar by Kirby Bauer disk diffusion method as per CLSI guidelines[6].

Antibiotics tested

Gram positive bacteria

Penicillin (10U), Cefoxitin (30µg), Gentamicin (10 µg), Erythromycin (15 µg), Clindamycin (2 µg), Cotrimoxazole (1.25/23.75), Ciprofloxacin (5 µg), Linezolid (30 µg), Vancomycin (30µg).

Gram negative bacteria

Ceftazidime (30 µg),Ceftriaxone (30 µg), Cefepime (30µg), Cefoperazone Sulbactam (75/30µg), Piperacillin Tazobactam (100/10 µg), Amikacin (30 µg), Ciprofloxacin (5µg), Cotrimoxazole (1.25/23.75 µg), Imipenem (10 µg), Meropenem (10 µg), Tigecycline(15µg), Colistin (10µg).

Multidrug resistance

Multi drug resistance is defined as resistance to atleast one antimicrobial agent in three or more antimicrobial categories[7].

Results

The total number of patients in the study period were 178. After applying the inclusion and exclusion criteria, the total number of patients were 100 patients, who were selected for the study.

68% of them were males and 32% were females. The highest incidence was seen in the age group of 41-60 years (44%) followed by 61-80 years (38%), 21-40 years (12%) and 81-100 years (6%). The incidence of VAP cases in our study

was found to be 36%.[Figure no:1]. There were 20 episodes of monomicrobial and 16 episodes of poly microbial VAP. The incidence of monomicrobial VAP was 55.56% and polymicrobial VAP was found to be 44.44%. 2 isolates were identified in 15 episodes and 3 isolates in 1 episodes, making it up a total of 33 isolates in polymicrobial VAP [Figure no:2].

72.22% were males and 27.78% were females out of the 36 VAP cases.[Figuree no:3].

The highest incidence was seen in the age group of 41-60 years-38.89%followed by 61-80 years-33.33%, 1-40 years-16.67%,81- 100 years- 11.11%.[Figure no:4].

As seen in Table no: 1, monomicrobial VAP was common in 41-60 years age group but polymicrobial VAP was common in 61-80 years age group.

The most frequently isolated pathogen was *Acinetobacter baumannii*in both monomicrobial and polymicrobial VAP. [Figure no:5]

There were no isolates of *Staphylococcus aureus* in monomicrobial VAP and 2 isolates in polymicrobial VAP . Both of them were Methicillin resistant *Staphylococcus aureus*. [Table no:2]

There were 20 isolates in monomicrobial VAP and 33 isolates in polymicrobial VAP. 2 isolates were Gram positive. So the total number of Gram negative bacterial isolates were 51 (20-monomicrobial type and 31-polymicrobial type) [Table no:3]

Figure No:1

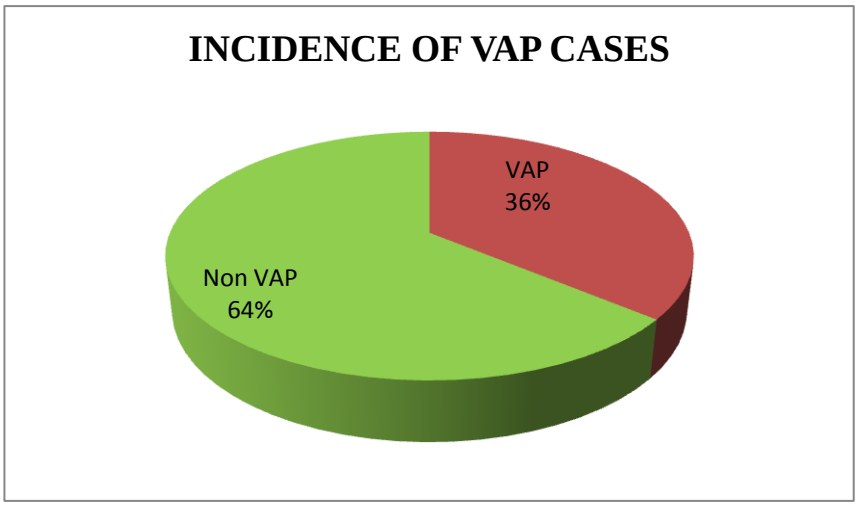
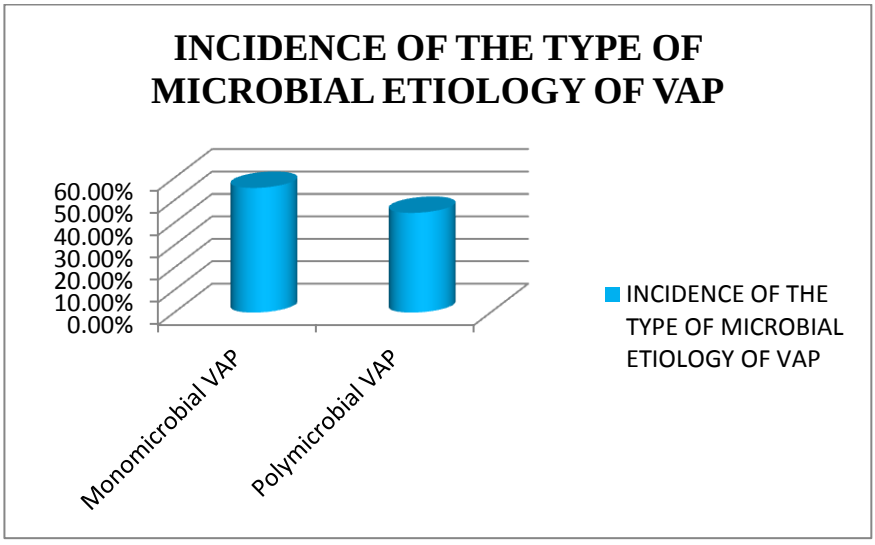


Figure No:2



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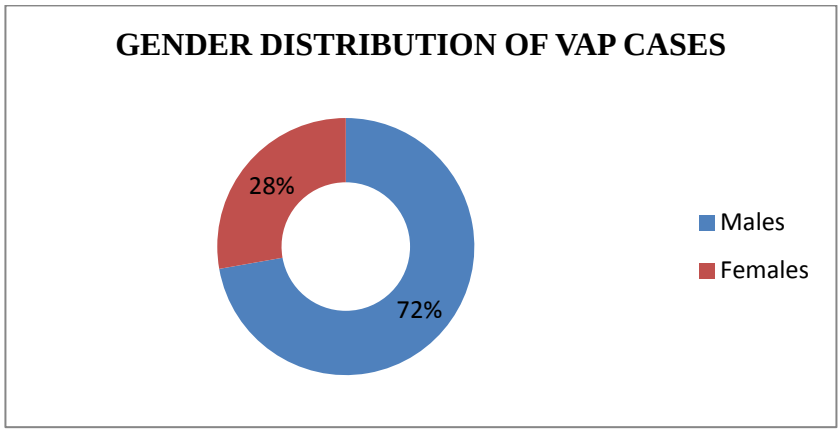

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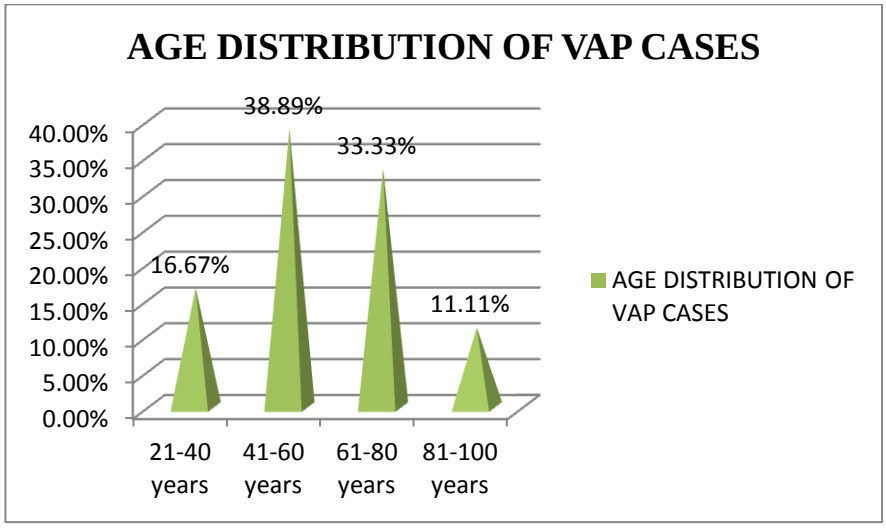

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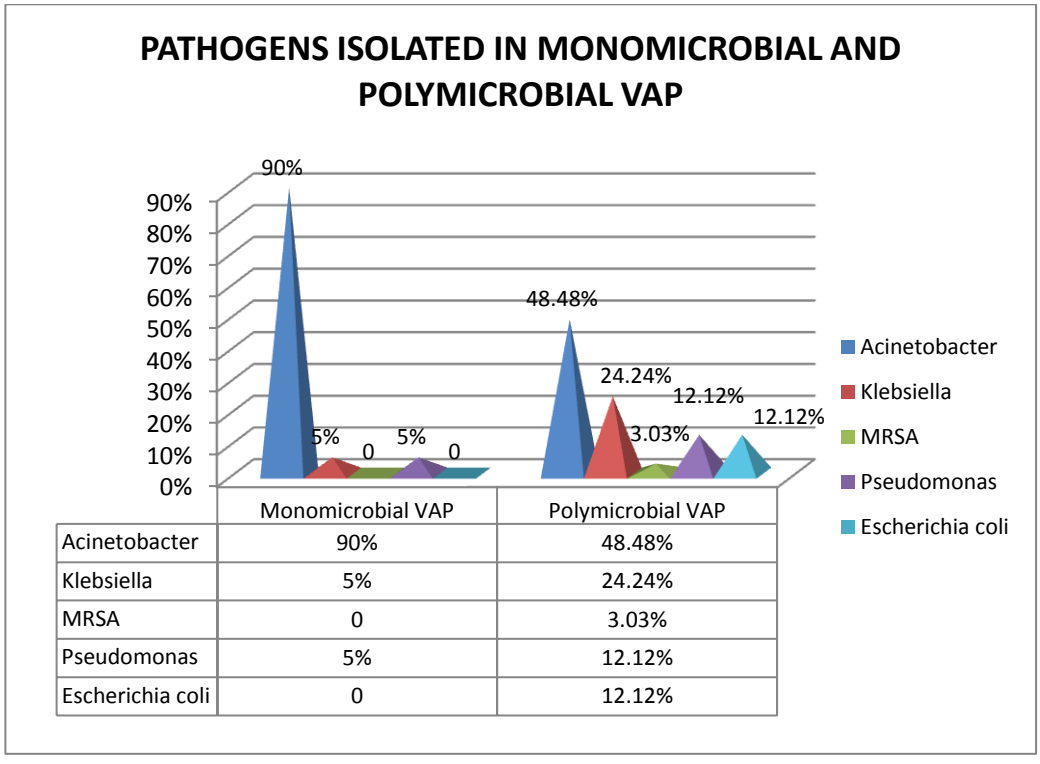

	Monomicrobial VAP	Polymicrobial VAP
Acinetobacter	90%	48.48%
Klebsiella	5%	24.24%
MRSA	0	3.03%
Pseudomonas	5%	12.12%
Escherichia coli	0	12.12%

Table No:1 Characteristics of Monomicrobial and Polymicrobial Vap

PARAMETERS		MONOMICROBIAL VAP (N=20)	POLYMICROBIAL VAP (N=16)
Gender	MALE	75%	68.75%
	FEMALE	25%	31.25%
Age	21-40 YEARS	15%	18.75%
	41-60 YEARS	45%	31.25%
	61-80 YEARS	30%	37.5%
	81-100 YEARS	10%	12.5%
Diagnosis	Central nervous system disorders	20%	43.75%
	Kidney disorders	10%	12.5%
	Coronary artery disease	10%	-
	Multisystem system involvment	50%	25%
	Others	10%	18.75%
Comorbidities	Diabetes	30%	18.75%
	Hypertension	25%	25%
	Both DM and HT	30%	25%
	None	15%	31.25%
Type of VAP	Early onset VAP	30% 6	31.25% 5
	Late onset VAP	70% 14	68.75% 11
Pathogens isolated	Acinetobacter	80 % 16	45.45 % 15
	Klebsiella	10 % 2	24.24% 8
	Pseudomonas	10 % 2	12.12% 4
	MRSA	-	6.06 % 2
	Escherichia coli	-	12.12% 4
Effects	Ventilator days	9.75 ±4.04 days	12.4± 5.92 days
	Hospital days	18.56 ± 13.83 days	21 ± 9.7 days
Outcome	Death	25 %	43.75%

Table No:2 Antibiotic Resistance in Staphylococcus Aureus

ANTIBIOTICS	RESISTANCE %
Penicillin (10U)	100%
Cefoxitin (30µg)	100%
Gentamicin (10 µg)	100%
Erythromycin (15 µg)	100%
Clindamycin (2 µg)	100%
Cotrimoxazole (1.25/23.75µg)	100%
Ciprofloxacin (5 µg)	100%
Linezolid (30 µg)	0
Vancomycin (30µg)	0

Table No: 3 Antibiotic Resistance In Gram Negative Bacteria

ANTIBIOTICS	MONOMICROBIAL VAP		POLYMICROBIAL VAP	
	N=20	%	N=31	%
Ceftazidime (30µg)	13	65%	24	77.42 %
Ceftriaxone (30µg)	12	60 %	23	74.19%
Cefepime (30µg)	12	60%	21	67.74 %
Cefoperazone Sulbactam (75/30µg)	13	65 %	22	70.97 %
Piperacillin Tazobactam (100/10 µg),	13	65 %	22	70.97 %
Amikacin (30µg)	16	80%	25	80.65 %
Ciprofloxacin (5µg)	16	80%	26	83.87 %
Cotrimoxazole (1.25/23.75 µg)	16	80%	25	80.65 %
Imipenem (10 µg)	6	30%	18	58.06%
Meropenem (10 µg)	6	30%	17	54.84 %
Tigecycline (15µg)	3	15 %	7	22.58 %
Colistin (10µg)	0	0	0	0

Discussion

Ventilator associated pneumonia is a type of nosocomial pneumonia that occurs in intubated patients. Their incidence varies according to the study group, hospital and the type of intensive care unit. The study of VAP is important because it leads to increased mortality, increases the duration of stay in the hospital and also imposes additional health costs.

Demographic characteristics of the study group

The total number of RICU admissions in the study period was 178. After using the inclusion and exclusion criteria, the total number of patients were 100, who were selected for the study. 68% of them were males and 32% were females.

The highest incidence was seen in the age group of 41-60 years (44%) followed by 61-80 years (38%), 21-40 years (12%) and 81-100 years(6%).

Incidence of Ventilator associated pneumonia

The incidence of VAP was found to be 36% [Figure no:1]. *Kumari et al.* reported an incidence of 37% which is closeto our study[8].

John et al. reported an incidence of 14.85% in their study which is very low compared to our study[9]. The high incidence may be due to the increased number of old patients with multi organ involvement and co morbidities.

Incidence of monomicrobial VAP and polymicrobial VAP

The incidence of monomicrobial VAP was 55.56% and polymicrobial VAP was found to be 44.44% in our study.[Figure no:2]. 55.40% of patients had poly-microbial VAP and 44.59% had monomicrobialetiology in a study by *Patil et al.*[12]. 60% had monobacterial and 40% had polybacterial infections in a study by *Rashmi et al.,* which is similar to our study[10].

86.54% were monomicrobial and 13.46% were polymicrobial by *Golia et al.*[14].

92.59% of the BAL fluid samples contained poly microbial infections and Mono microbial infections were diagnosed in 7.41% in a study by *Hejazil et al.*[16].

The percent of Late onset VAP was more compared to early onset VAP in both monomicrobial (70%) and polymicrobial VAP (68.75%)

Gender distribution of VAP cases

Out of the 100 patients, 62.22% were males and 27.78% were females. [Figure no:3]

63.3% were males and 36.7% were females in a study by *Rashmi et al.*[10]. Similar male preponderance was also noted in similar studies by *Rit et al.,* and *Patil et al.*[11,12]

Age distribution of VAP cases

The highest incidence was seen in the age group of 41-60 years-38.89% 61-80 years-33.33% followed by 21-40 years-16.67% and 81- 100 years- 11.11% [Figure no:4]. As seen in Table no:1, monomicrobial VAP was common in 41-60 years age group but polymicrobial VAP was common in 61-80 years age group. This is similar to a study by *Rashmi et al.,* who reported maximum number of cases in the age group of 51- 60 years[10].

The incidence of VAP was highest in patients more than 50 years of age by *Ranjan et al.,* and *Golia et al.*[13,14]. In old age there was decreased elasticity of the lungs with depressed immunological defenses which predisposed them to lung infections [15].

Association of comorbidities with VAP cases

30% of diabetics in monomicrobial and 18.75% in polymicrobial VAP were prone to VAP, but 50% of hypertensive patients (25% in monomicrobial and 25% in polymicrobial VAP) were susceptible. 55% of patients had both hypertension and diabetes. [Table no:1]

A study by *Chang et al.,* demonstrated that 42.1% of hypertension patients and 28.1% of diabetic patients were prone to VAP and also found that diabetes is an independent risk factor for the development of VAP[17]. The most frequent

comorbidity was hypertension 34.0%, in a study by *Ali HS et al.*[18]. The diabetic patients are more prone to critical illness beacuse of alteration of lung defenses by *Darveshi et al*[19].

Distribution of VAP cases by diagnosis

38.89% of patients had multisystem involvement (50% in monomicrobial VAP and 25% in polymicrobial VAP) and 30.56% of patients had central nervous system disorders (20% in monomicrobial and 43.75% in polymicrobial VAP) followed by 11.11% with kidney disorders, 5.56 % with coronary artery diseases and 13.89 % were admitted with miscellaneous causes (poisoning, raod traffic accident, liver disorders and carcinoma of various organs).[Table no:1]

The most frequent cause of ICU admission was polytrauma 36.8% by *Ali HS et al* [18].

Higher incidence of VAP occurred in poisoning, post laparotomy and COPD in a study by *Ranjit et al.*[20]. In a a study by *Mohanty et al.*, the maximum number of cases were Cerebrovascular accident and sepsis[21]. In central nervous system disorders, there is depression of the swallowing reflex leading to pulmonary aspiration and pneumonia[22].

Pathogens isolated from VAP cases

There were 20 monomicrobial VAP and 16 polymicrobial VAP cases. Among polymicrobial VAP, 15 had 2 isolates and 1 had 3 isolates, yielding a total of 53 isolates. There were only 2 Staphylococcus aureus isolates in polymicrobial VAP. And the 2 isolates were MRSA. The 96.23% were Gram negative bacteria. The predominant isolate in both types of VAP was *Acinetobacter baumannii* (80% in monomicrobial VAP and 45.45% in poly microbial VAP) followed by *Klebsiella pneumoniae*-34.24%, *Pseudomonas aeruginosa*-22.12%, *Escherichia coli*-12.12%, *Staphylococcus aureus*-6.06%. [Figure no:5]

But a study by *Golia et al*. and *Gadani et al.*, showed that Pseudomonas was the predominant isolate. While Klebsiella was the predominant organism in astudy by *Patil et al.* [14,23].

Acinetobacter spp. accounted for 34.28% of VAP cases followed by *Pseudomonas aeruginosa* which was responsible for 25.71% cases. in astudy by *Ranjan et al.*[13].

Acinetobacter baumannii is increasingly involed in health care associated infections such as urinary tract infections, blood stream infections, ventilator associated pneumonia. The risk factors include prolonged hospitalisation, mechanical ventilation, immunocompromised status and the use of invasive procedures. This bacteria also has the capacity to gain resistance to many drugs which make it a dreaded pathogen[24].

Multi drug resistance in VAP isolates

More than 80% of isolates were multidrug resistant in both monomicrobial and polymicrobial VAP. Maximum resistance was observed to Amikacin, Cotrimoxazola and Ciprofloxacin in both monomicrobial and poly microbial VAP. Even among Carbapenems which are considered to be second line drugs, 30% resistance to Imipenem and Meropenem in Monomicrobial type and 58.06% resistance to Imipenem and 54.84% resistance to Meropenem was observed in polymicrobial type of VAP.

Colistin resistance in VAP isolates have been reported in literature [25,26]. But in our study all the isolates were sensitive to Colistin.

Outcome of VAP

VAP definitely leads to increased duration of mechanical ventilation. The Ventilator days in monomicrobial VAP was found to be 9.75 ±4.04 days and 12.4± 5.92 days in polymicrobial VAP.

The hospital stay was 18.56 ± 13.83 days in monomicrobial VAP and 21 ± 9.7 days in polymicrobial VAP.

In a study by *Ranjit et al.*,the VAP patients had longer duration of mechanical ventilation (18.88±7.7 days) and stay (29±17.8 days)[20]

A study by *Mohanty et al.*, also reported longer duration of mechanical ventilation and hospital stay in VAP patients[21].

The mortality rate was found to be 25% in mono microbial VAP and 43.75% in polymicrobial VAP. In a study by *Mallick et al.*, the overall mortality rate i was 44%[27].

Conclusion

In the present study , incidence of monomicrobial and polymivrobial VAP was found to be 55.56% and 44.44% respectively. *Acinetobacter baumannii* was the frequently isolated organsim in both types of VAP. More than 80% multidrug resistance was documented to the Gram negative bacterial isolates.

VAP is a nosocomial infection which has significant effects on the patients such as increased length of stay and imposes added financial burden. Early treatment of VAP is essential to prevent the morbidity associated with it. So the knowledge of the pathogens causing VAP is important. VAP caused by polymicrobial etiology tend to have more dangerous outcomes. So the proper implementation of prevention measures is crucial. Implementation of the VAP prevention bundle along with health education of the nursing staff about personal hygiene and surveillance of the ICU periodically, antimicrobial resistance tracking will reduce the VAP rates in the ICU.

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