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Incidence of ventilator associated pneumonia and its risk factors

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Abstract

Hospitals are intended to heal the sick; but they are also sources of infection. Ironically, the advances in medicine are partly responsible for the fact that today; hospital infections are the leading cause of death worldwide. Newer technology and latest surgical and medical diagnostic methods and treatment procedures have increased the number of invasive techniques leading to higher chances of nosocomial infection. Pneumonia is the leading cause of death due to nosocomial infections. Intubation & mechanical ventilation greatly increases the risk for ventilator-associated pneumonia (VAP). In developing country like India, such hospital-acquired infections have a significant impact on patient's morbidity, mortality, hospital stay and on financial concerns of the patient, hospital and community. The present investigation was aimed to determine the incidence of ventilator associated pneumonia in the neurosurgery intensive care unit of a tertiary care centre and to determine the risk factors of ventilator associated pneumonia. A total of 30 samples belonging to the age group of 15 to 75 years who where on mechanical ventilator for more than 48 hours in the neurosurgery intensive care unit of a tertiary care centre were selected using convenience sampling. The incidence of VAP was estimated to be 30%. The risk factors identified for the development of VAP was found to be combined head and cervical spine injury (P=0.001), associated injuries (P=0.035), additional surgeries (P=0.025), nasogastric feeding (P=0.001), intake of immuno suppressive drugs (P=0.004), pre operative antibiotics (p=0.000) and duration of mechanical ventilation >5 days (P=0.000). The mortality among patients with VAP was found to be higher than patients without VAP (88.9% than non VAP patients).

Key words: Ventilator-associated pneumonia, nosocomial infection, risk factors

Introduction

Nosocomial infections, even in this modern era of antibiotics, continue to remain an important and formidable consequence of hospitalization. New technology and latest surgical and medical diagnostic methods and treatment procedures have increased the number of invasive techniques leading to higher chances of nosocomial infection.

Nosocomial infections have a significant impact on patient's mortality, morbidity, hospital stay and on the financial concerns of patients, hospital and community. The National Nosocomial Infection Surveillance System database compiled by the CDC shows that 3.5% of patients leave hospital after having acquired infection, depending on the cause, hospital size and multiple other factors (NNIS 2006). The 3 most common invasive device related infections are central line associated blood stream infection (BSI), ventilator associated pneumonia (VAP) and Foley's catheter associated urinary tract infection. These infections occur most commonly in those who are cared in intensive care units (CDC, 2006).

Device associated nosocomial infection rate in Intensive Care Units of the university affiliated hospital in Greece demonstrated 12.1 infections per 1,000 device days for BSI and ventilator associated pneumonia to be 12.5 infections per 1,000 device days (Sofia, Dima and Evangelos,

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2007). Nosocomial infections are notorious for the manner in which they complicate the course of the original illness, increase costs of hospital stay and delay recovery 10 to 30 percent of patients admitted to hospitals & nursing homes in India acquire nosocomial infection as against 5% in the west and a very large number of Indians are every year under the threat of nosocomial infection. Here hospital acquired infections kill more people than any other form of accidental death (Yohan & Mishra ,2006).The invariable outcome is antibiotic intake costing between Rs.3000 to Rs 5000 a day (1.2 – 1.5 lakhs over & above the actual treatment cost) prolonged hospital stay & loss of work, which affects the health of the economy too (WHO 2005). However infection control in the hospitals is far from encouraging. So, the present investigation was aimed to determine the incidence of ventilator associated pneumonia in the neurosurgery intensive care unit of a tertiary care centre and to determine the risk factors of ventilator associated pneumonia**.**

Materials and methods

Research Approach

A descriptive approach was used to accomplish the objectives

Research Design

The design adopted for the present study was descriptive survey

Sample

A total of 30 samples, both male & female patients who were selected on the basis of selection criteria.

Sampling technique

In this study, convenience sampling technique was adopted.

Criteria for sample selection

This study, the following criteria were set to include the samples in the study.

1. Patients who were admitted in the Neurosurgery intensive care unit and those who required mechanical ventilation for more than 48 hours.

2. Patients who were free of respiratory tract infection at the time of surgery.

3. Patients of age between 15 and 75 years.

Tool I: General assessment profile

a) Demographic data: This consisted of information regarding patient's age & sex.

b) Clinical data: This included information regarding clinical diagnosis, nature of airway, co-morbid illness, presence of nasogastric feeding, type of peptic ulcer disease prophylaxis, treatment with immunosuppressive drug and presence of pre operative antibiotics**.**

Tool II: Investigation report

a). Report of chest X -ray

b).Report of endo tracheal aspirate culture (both qualitative & quantitative)

Tool III: Check list for clinical assessment of ventilator associated pneumonia:

This included the assessment of following parameters- fever ($>37.8 \circ C$), hypothermia ($<36 \circ C$), leucocytosis ($>12,000/mm^3$), leucopenia$<4000/mm^3$), new onset of purulent tracheal secretion and rales /bronchial breath sounds.

Data collection process

The investigator selected patients according to the inclusion criteria. The patients /their relatives were given explanation regarding the purpose of the study and informed consent was taken before the study.

Demographic data and clinical data were collected pre operatively from the neurosurgical patients who were admitted in the general wards and trauma care unit of using the assessment format .Patients were assessed clinically and radiologically to exclude pre existing respiratory tract infection. Post operatively, same patients were assessed in the neurosurgery intensive care unit for the clinical and radiological evidence for the development of ventilator associated pneumonia starting after 48 hours of mechanical ventilation till 2 days after extubation with the help of assessment format.

Results

Findings related to general assessment of the patients - demographic and clinical data

a) Demographic characteristics

Table 1. Frequency distribution and percentage of patients according demographic characteristics age and sex (*n*=30)

Demographic data	f	%
Age in years		
20-30	7	23.3
31-40	3	10
41-50	8	26.7
51-60	9	30
61-70	3	10
Sex		
Male	20	66.7
Female	10	33.3

The data presented in table 2 show that 10 % of patients belong to age group 61-70 years, 30% of patients belong to age group of 51-60 years followed by 41-50 years (26.7%),31-40 years (10 %) & 20 -30 years(23.3 %). It was observed that majority of patients i.e., 66.7% were males.

b) Clinical data

Table 2. Frequency distribution and percentage of patients according to clinical data (*n*=30**)**

Clinical data	f	%
Diagnosis		
Head injury	18	60
Intra cranial space occupying lesion	6	20
Intracerebral hemorrhage	2	6.7
Head and cervical spine injury	4	13.3
Co-morbid illness		
Bronchial asthma	1	3.33
Chronic obstructive pulmonary disease	1	3.33
Diabetes mellitus	2	6.66
Hypertension	3	10
Associated injuries	4	13.33
Additional surgery	2	6.66
Nasogastric feeding		
Present	13	43.3
Absent	17	56.7
Treatment with immuno suppressive drug		
Present	9	70
Absent	21	30
Administration of pre-operative antibiotics		
Present	12	40
Absent	18	60
Peptic ulcer prophylaxis		
H2 receptor antagonist	17	56.7
Mucosal barrier fortifiers	0	0
Proton pump inhibitors	5	16.66
None	8	26.66
Duration of ventilation (days)		
2-5	20	66.66
6-10	10	33.33
Mortality status		
Survivors	18	60
Non survivors	12	40

The data presented in table 3 reveal that 60% of patients had head injury. 20%, 13.3% & 6.7% were diagnosed to have intracranial space occupying lesion, combined head and cervical spine injury & intra cerebral hemorrhage respectively. It was observed that 13.3% of patients suffered associated injuries, 10% had history of hypertension, 6.66% underwent additional surgery and 6.66% had diabetes mellitus. Bronchial asthma and chronic obstructive pulmonary disease was present in 3.33% of patients.

It was noted that nasogastric feeding was present among 43.3% of patients. 70% of patients were on immunosuppressive drug & 40 % on pre-operative antibiotics. 56.7% of patients received H_2 receptor blocker while proton pump inhibitor was present for 16.66 % of patients. 66.66% of total patients were on mechanical ventilator for a period of 2-5 days while 33.33% of patients were ventilated for time duration of 6-10 days. 40 % who were on mechanical ventilator expired during the study period while 60 % of patients survived.

Findings of investigation in the patients - chest X-ray, endo tracheal aspirate culture

Table 3. Frequency distribution and percentage of patients according to the findings of investigation-chest X ray, endotracheal aspirate culture (*n*=30)

Investigation	f	%
Chest X-ray		
New infiltrates	8	26.7
Consolidation	1	3.3
Cavitations	0	0
Normal	21	70
Endo tracheal aspirate culture		
Positive	26	86.7
Negative	4	13.3
Quantitative culture of endotracheal aspirate		
$>10^5$ cfu/ml	9	30
$<10^5$ cfu/ml	21	70
Pathogens grown in endotracheal aspirate culture		
Pseudomonas	6	20
Klebsiella	10	33.3
Staphylococcus	1	3.3
E coli	5	16.7
Pseudomonas,& Klebsiella	1	3.3
Pseudomonas & E coli	2	6.7
Klebsiella, & Staphylococcus	1	3.3
No growth	4	13.3

The data presented in table 3 reveal that, 26.7% of patients developed new filtrates and 3.3% had consolidation while on mechanical ventilator but none of the patients developed cavitations.86.7%of patients were tested positive for endotracheal aspirate culture(ETA) and 30% of patients met the threshold value of ETA aspirate i.e. $>10^5$ cfu/ml. The most frequently isolated organism were Klebsiella (33.3%) followed by Pseudomonas (20%),E coli (16.7%) and Staphylococcus (3.3%). 13.3% of patients had polymicrobial growth with Pseudomonas and E. coli (6.7%)while 3.3% of the patients demonstrated infection by Pseudomonas and Klebsiella and Klebsiella and Staphylococcus.

Table 4. Frequency distribution and percentage of patients according to CDC criteria for diagnosis of ventilator associated pneumonia (*n=30)*

Clinical assessment	f	%
Fever (>38^{0}C)		
Present	13	43.3
Absent	7	23.3
Hypothermia (<35^0 C)		
Present	0	0
Absent	30	100
Lecucocytosis		
Present	9	30
Absent	21	70
Leucopenia		
Present	0	0
Absent	30	100
Purulent secretion		
Present	20	66.7
Absent	10	33.3

Incidence of ventilator associated pneumonia

Table 5. Frequency distribution and percentage of patients according to incidence of ventilator associated pneumonia (*n=30)*

Ventilator associated pneumonia	f	%
Present	9	30
Absent	21	70

Fig: 1 Pie diagram representing the incidence of ventilator associated pneumonia
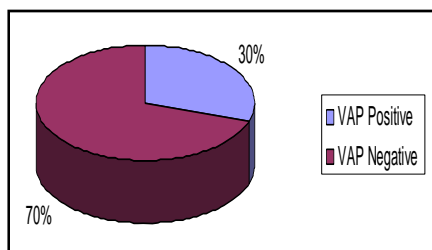

Table 5 and figure 1 depicts that 30% of patients developed ventilator associated pneumonia.

Table 6 and figure 2 reveals that among patients with VAP, equal percentage (44.4%) had head injury and combined head & cervical spine injury. Intracranial space occupying lesion was present in 11.1 % of patients with VAP.66.7 % of patients without VAP had head injury while 28.6 % & 4.8 % had intracranial space occupying lesion & intracranial hemorrhage respectively. None had combined head & cervical spine injury.

In order to determine the association between diagnosis and incidence of VAP, chi-square was computed. It was found that, the obtained chi square value for head injury, intracranial space occupying lesion and intracerebral hemorrhage was not significant (p>0.05), but it was observed that, the chi square value computed for combined head and cervical spine injury was statistically significant at 0.01 level.

Findings related to the association between clinical data – Co-morbid illness & incidence of VAP.

The data shown in Table 7 reveal that, among patients with VAP, equal percentage of patients (11.1 1%) had bronchial asthma, diabetes mellitus & hyper tension. Associated injury was present in 3.33 % of patients & 22.2 % underwent additional surgery. None had history of chronic obstructive pulmonary disease. Among patients without VAP, equal percentage (4.76%) had chronic obstructive pulmonary disease, diabetes mellitus & associated injuries. Hypertension was reported in 9.52 % of patients without VAP & none had bronchial asthma or underwent additional surgery. In order to determine the association between co morbid illness and incidence of VAP, chi square test of significance was computed. It was found that the obtained chi square value for bronchial asthma, chronic obstructive pulmonary disease, diabetes mellitus and hypertension is not significant(p>0.05).It was found that the chi square computed for associated injuries and additional surgery was statistically significant at 0.05 level. The risk ratio for associated injury is established by computing Odd's ratio. It was found that, patients with associated injuries are 10 times more prone to develop VAP than patients who have not suffered associated injuries.

Table 6. Frequency distribution, percentage, chi square value and 'p' value of clinical data –clinical diagnosis of patients and incidence of VAP (*n*=30)

Clinical data: Diagnosis	With VAP		Without VAP		df	χ^2	'p' value
	f	%	f	%			
Head injury	4	44.4	14	66.7	1	1.591	0.207
Intracranial space occupying lesion	0	0	6	28.6	1	0.408	0.523
Intracerebral hemorrhage	1	11.1	1	4.8	1	0.408	0.523
Head and cervical spine injury	4	44.4	0	0	1	10.769	0.001**

** Significant at 0.01 level.

Fig 2: Bar diagram representing clinical data –diagnosis of the patients and incidence of VAP.
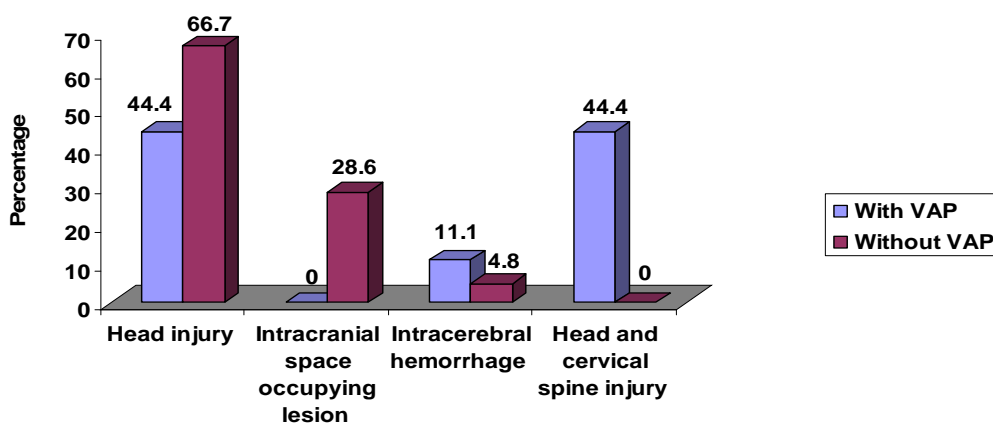

Table 7. Frequency distribution, percentage, chi square value and 'p' value of clinical data - co morbid illness & incidence of VAP (*n=30*)

Clinical data : Co-morbid illness	With VAP		Without VAP		df	χ^2	'p' value
	f	%	f	%			
Bronchial asthma	1	11.1	0	0	1	2.414	0.120
Chronic obstructive pulmonary disease	0	0	1	4.76	1	0.443	0.506
Diabetes mellitus	1	11.1	1	4.76	1	0.408	0.523
Hypertension	1	11.1	2	9.52	1	0.018	0.894
Associated injuries	3	33.3	1	4.76	1	4.451	0.035*
Additional surgery	2	22.22	0	0	1	5	0.025*

* Significant at 0.05 level.

Table 8. Frequency distribution, percentage, chi square value and 'p' value of clinical data - presence of nasogastric feeding in the patients & incidence of VAP (*n=30*)

Clinical data: Nasogastric feeding	With VAP		Without VAP		df	χ^2	'p' value
	f	%	f	%			
Present	8	88.9	5	23.8	1	10.866	0.001***
Absent	1	11.1	16	76.2			

*** Significant at 0.001 level.

Table 9. Frequency distribution, percentage, chi square value and 'p' value of intake of immuno suppressive drug & incidence of VAP (*n=30*)

Clinical data : Immuno suppressive drug	With VAP		Without VAP		df	χ^2	'P' value
	f	%	f	%			
Present	6	66.7	3	14.3	1	8.231	0.004**
Absent	3	33.3	18	85.7			

** Significant at 0.01 level.

Findings related to the association between clinical data –nasogastric feeding in the patients & incidence of VAP.

In order to determine association between clinical data –nature of feeding and incidence of VAP, chi square test of significance was computed.

Table 8 points out that 88.9% patients who developed VAP was on nasogastric feeding, while patients who were free of VAP, 76.2% was not having nasogastric feeding.

In order to determine association between clinical data –nasogastric feeding and incidence of VAP, chi square test of significance was computed. It was found that the obtained chi square value significant at 0.001 level. The risk ratio for associated injury is established by computing Odd's ratio. It was found that, patients on nasogastric feeding are 25 times more prone to develop VAP than patients without nasogastric feeding.

Findings related to the association between clinical data – intake of immuno suppressive drug patients & incidence of VAP.

In order to determine the association between intake of immuno suppressive drug and incidence of VAP, chi square test of significance was computed. Table 9, reveal that all patients (100%) of patients who developed VAP had immuno suppressive drug whereas only 14.3% of patients without VAP had immuno suppressive drug.

In order to determine the association between intake of immuno suppressive drug and incidence of VAP, chi square test of significance was computed .It was found that chi square computed for presence of immunosuppressive drug was significant at 0.001.The risk ratio for the intake of immunosuppressive drug is established by computing Odd's ratio. It is found that patients on immunosuppressive drug are 12 times at risk of developing VAP than patients who are not on immunosuppressive drugs.

Findings related to the association between clinical data- presence of pre-operative antibiotics in the patients & incidence of VAP.

In order to determine association between intake of pre operative antibiotics and incidence of

VAP, chi square test of significance was computed. Data presented in the Table 10 shows that 88.9 patient's % of VAP who developed VAP were on preoperative antibiotics while only 19% of patients without VAP had preoperative antibiotics.

In order to determine association between intake of pre operative antibiotics and incidence of VAP, chi square test of significance was computed. It was found that the obtained chi square value was significant at 0.001. it is interpreted that there is association between selected clinical data - preoperative antibiotics intake and incidence of VAP. The risk ratio for the intake of pre operative antibiotics is established by computing the Odd's ratio. It is found that, patient patients on pre operative antibiotics are 34 times more prone to develop VAP than patients who are not on pre operative antibiotics.

Findings related to the association between clinical data -peptic ulcer prophylaxis in the patients & incidence of VAP. In order to determine association between peptic ulcer prophylaxis and incidence of VAP, chi square test of significance was computed.

The presented in the table 11 depicts that 77.8 5 % & 22.2 % of patients with VAP had H_2 receptor antagonist & proton pump inhibitor respectively for peptic ulcer prophylaxis. While, 47.6 % & 14.28 & of patients without VAP had H_2 receptor blocker & proton pump inhibitor for peptic ulcer prophylaxis. In order to determine association between peptic ulcer prophylaxis and incidence of VAP, chi square test of significance was computed. It was found that the obtained chi square value was not significant at 0.05 level.

Findings related to the association between clinical data - duration of mechanical ventilation & incidence of VAP.

In order to determine the association between duration of mechanical ventilation and incidence of VAP, chi square test of significance was computed

From table 12, it can be noted that all patients (100%) who developed VAP were ventilated for time duration of 6-10 days but among patients who did not develop VAP, only 4.76% were ventilated for the same duration.

Table 10. Frequency distribution, percentage, chi square value and 'p' value of clinical data- presence of pre-operative antibiotics in the patients & incidence of VAP.

Clinical data: Pre operative antibiotics	With VAP		Without VAP		df	χ^2	'p' value
	f	%	f	%			
Present	8	88.9	4	19	1		
Absent	1	11.1	17	81		12.804	0.000***

*** Significant at 0.001 level.

Table 11. Frequency distribution, percentage, chi square value and 'p' value of presence of peptic ulcer prophylaxis in the patients & incidence of VAP (*n*=30)

Clinical data	With VAP		Without VAP		df	χ^2	'p' value
	f	%	f	%			
H$_2$ receptor antagonist							
Present	7	77.8	10	47.6	1	2.334	0.127
Proton pump inhibitors							
Present	2	22.2	3	14.28	1	0.29	0.59

Table 12. Frequency distribution, percentage, chi square value and 'p'value of clinical data - duration of mechanical ventilation & incidence of VAP & incidence of VAP.

Clinical data: Duration of mechanical ventilation (days)	With VAP		Without VAP		df	χ^2	'p' value
	f	%	f	%			
2-5	0	0	20	95.33			
6-10	9	100	1	4.76	1	26.825	0.000***

*** Significant at 0.001 level.

Table 13. Frequency distribution, percentage, chi square value and 'p' value of mortality of patients & incidence of VAP.

Morality	With VAP		Without VAP		df	χ^2	'p' value
	f	%	f	%			
Death							
Present	8	88.9	4	19	1	12.804	0.000***
Absent	1	11.1	17	81			

***Significant at 0.001 level

It was noted that, among the patients who developed VAP, 77.77 %had late onset pneumonia (after 5 of mechanical ventilation) & 22.2 % had early onset pneumonia (within 5 days of mechanical ventilation).

In order to determine the association between duration of mechanical ventilation and incidence of VAP, chi square test of significance was computed. It was found that the obtained chi square value was significant at 0.001.

Findings related to the association between mortality & incidence of VAP.

In order to determine association between mortality of patients &incidence of VAP, chi square test of significance was computed.

The data presented in table 13 reveal that, mortality of patients with VAP was 88.9% while it was only 19% in patients without VAP. In order to determine the association between incidence of VAP and mortality, chi square value was computed. It was found that the obtained chi square value was significant at 0.001. On computation of risk ratio, it was found that mortality is 34 times higher among patients with VAP than patients without VAP.

The incidence of ventilator associated pneumonia was estimated to be 30%. Head injury together with cervical spine injury was found to be an independent risk factor for VAP development in the present study. Associated injuries and additional surgery were found to be risk factor for the development of VAP and it was also found that patients with associated injuries are 10 times more prone to develop VAP than non VAP patients in the present study. 66.7% of patients

who developed VAP were on immuno suppressive drug while only 14.3 % patients who were free of VAP were on immunosuppressive drugs. Present study revealed that immunosuppressive drug intake was found to be a significant factor for the development of VAP, & the risk is 12 times more when compared to patients who were not on immunosuppressant. Pre-operative antibiotics were present in 88.9% of VAP patients & 19% of non VAP patients had pre-operative antibiotics. Significant relationship between pre-operative antibiotics & incidence of VAP was found out in the present study. The risk of VAP in patients receiving pre-operative antibiotics found to be 34 times more than patients who were not on pre-operative antibiotics. 100%of patients who developed VAP were on mechanical ventilator for time duration of 6-10 days. It was found that there is significant relationship between duration of mechanical ventilation and incidence of VAP. Mortality among patients with VAP was 88.9% while it was 19% in patients without VAP. In the present study, it was found that VAP had significant association with the mortality (OR-34 times higher in VAP patients than patients without VAP).

Discussion

David *et al.* (2004) in their study on ventilator associated pneumonia in traumatic brain injury reported that the incidence rate was 42%. The incidence density of VAP was reported to be 28.6% in the neurosurgery intensive care unit of University Hospital Athens (Apostolopouloc, 2005). In the present study the incidence of ventilator associated pneumonia was estimated to be 30 %.and this finding is consistent with the previous investigators. Every patient who is intubated and receiving ventilatory support is at risk for VAP. Risk factor identification is a critical step in the prevention of ventilator associated pneumonia. Risk factors as identified by Tejada & Bello (2003) in critically ill trauma patients were nasogastric feeding, prolonged mechanical ventilation (>1 day), use of H_2 receptor antagonist, muscle relaxants, corticosteroids, barbiturates, craniotomy, intense sedation. In the present study, the risk factor that demonstrated significant association with incidence of VAP were combined head and cervical injury (P =

0.001) ,poly trauma (P = 0.035), additional surgery (P = 0.025), nasogastric feeding (P = 0.001), corticosteroids (P = 0.004), pre- operative antibiotics (P = 0.000) ,duration of mechanical ventilation >5 days (P = 0.000). Similarly Hugues, Oliver, Benoit, Serge and Gilles (2006) identified that ICU admitting diagnosis, administration of antibiotics prior to ventilation, use of steroids invariably resulted in VAP development. Yet another study by David et al (2004) high lighted that poly trauma (risk ratio 1.7) & prolonged (>24 hours) antibiotic treatment independently predicted late onset pneumonia (OR, 9.2).

Conclusion

Despite rapid technological and treatment advances in medicine, nosocomial infection rates remain elusive. VAP is a multifaceted process and will require innovative and comprehensive approaches to all possible aspects of prevention. It has been estimated that up to one-third of VAP could be prevented by improved infection control practice Prevention outcomes are directly related to reducing the risk. When the actual treatment cost of VAP is considered,the cost effective method is to prevent VAP using guideline. Prevention involves planting a tree, nurturing it, pruning it and watching it grow and spread seeds for more trees. Investing in prevention can pay great dividends in terms of improved quality of life, morbidity and mortality. Spreading the seeds of prevention into long term care and rehabilitation facilities is also vitally needed.

Acknowledgement

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