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A multimodal interventional strategy for prevention of ventilator associated pneumonia: a study from a tertiary care hospital in South India

Nimisha Sinha, Deepashree R*, Sujatha S R, Badveti Satyasai, Vinay Kumar V, Krishna Karthik M VS

JSS Medical College, JSS Academy of Higher Education & Research, S.S Nagara, Mysuru, Karnataka, India

Corresponding author: Deepashree R, ✉ drdeepu.rajshekar@gmail.com **Orcid Id**: https://orcid.org/0000-0001-9124-1173

JSS Medical College, JSS Academy of Higher Education & Research, S.S Nagara, Mysuru, Karnataka, India

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ABSTRACT

Ventilator associated pneumonia (VAP) is the second most commonly encountered HAI after CAUTI. A robust system in place for prevention of VAP will not only bring down nosocomial mortality significantly but also reduce the burden on the healthcare system, cut the cost of medical expenditure and reduce the length of stay in hospitals. The present interventional study was conducted in adult Medical ICUs of a tertiary care hospital and the study demonstrated a statistically significant improvement in reducing VAE rate following a multimodal educational intervention involving all types of HCWs in the adult medicine ICU of a tertiary care hospital, South India. We observed that the care bundle compliance was considerably low in ICUs. However, intervention approaches, such as the ones employed in this study effectively improved care bundle compliance in our ICUs. Through overall analysis, there was significant reduction of VAE rate in this study and hence, a continuous monitoring system and education of the staff should exist to reduce the incidence of VAP in hospitals and the same strategy can be employed in other areas of hospital as well for prevention of other nosocomial infections like Catheter associated urinary tract infections, central line associated bloodstream infections and so on. The methodology of this study can be extended to the other ICUs including developing customized care bundles for other devices such as urinary catheter and central line in our healthcare facilities and other facilities across the country to obtain a similar improvement in care bundle compliance.

Keywords: Chronic kidney disease, Bio impedance, Volume analysis

INTRODUCTION

As per the World Health Organization's definition, a medical device encompasses any instrument, appliance, implant, software, material, or other related object intended for use in medical applications [1]. Medical devices are used in diverse settings for multifaceted reasons but their utility in intensive care units is unparalleled. Medical devices like ventilators provide an unprecedented opportunity to improve patient care and outcomes [2]. Their usage has revolutionized modern healthcare and significantly reduced the mortality associated with life threatening diseases. However, they bring with them certain banes, like the risk of hospital-acquired infections (HAI) or device associated infections. Some of the common HAIs encountered in hospitals are, catheter associated urinary tract infection (CAUTI), central line associated bloodstream infections (CLABSI) and ventilator associated pneumonia (VAP). After CAUTI, VAP ranks as the second most common HAI. VAP is common in intensive care units, accounting for 8 to 20% of all ICU patients and 27% of mechanically ventilated patients [3, 4]. Thus, a robust system in place for prevention of VAP will not only bring down nosocomial mortality significantly but also reduce the burden on the healthcare system, cut the cost of medical expenditure and reduce the length of stay in hospitals. Adhering to a 'care bundle' approach can do this. A care bundle consists of evidence-based elements to be complied with during insertion and maintenance of devices [5]. This is also evidenced by similar studies done in other

countries including the national project 'ZERO VAP' in Spain, which showed that the application of bundle approach reduced VAP rates significantly and persistently over time [6, 7]. Also, it is implicated in several studies that the hospital immediate environment does play a role in pathogenesis of VAP, but unfortunately there are not many evidenced based study studies in this regard [8-10]. In the present study, we implemented a multimodal interventional strategy, in terms of first assessing the baseline adherence to care bundle practices during the pre-intervention phase (PIP) by direct observation method; conducting educational sessions and setting up visual reminders during the intervention phase and then again assessing the adherence to care bundle practices during the post-intervention phase (POP) by direct observation method along with conducting a survey i.e. knowledge, attitude & practice (KAP) questionnaire analysis in both phases. This was coupled with environmental surveillance during the intervention phase. Care bundle adherence rate was calculated during PIP and POP period; by which we determined the effect of multimodal intervention on care bundle compliance. Our prime purpose was to infer if a multimodal strategy is effective in reducing the rate of VAP, so as to, implement a similar interventional strategy in other locations of the hospital and increase overall care bundle compliance rate to prevent VAP, CLABSI and CAUTI thereby, reducing the burden associated with HAIs. Hence this current study was aimed to strategize a phased out multimodal intervention plan to increase compliance to care bundle practices and create awareness among healthcare workers for prevention of VAP.

MATERIALS AND METHODS

This interventional study was carried out for a period of two months (August-September, 2022) in the Adult Medicine Intensive Care Unit of a tertiary care hospital situated in Mysore and is done in 3 phases- Pre-intervention phase (PIP) lasting 3 weeks, Intervention phase lasting 2 weeks and Post intervention phase (POP) lasting 3 weeks. Institutional ethics committee approval was obtained before initiation of the study (JSSMC/IEC/050722/23NCT/2022-23).

All ventilated patients in the medicine ICU during the study period were included as a part of the study. Finally, 75 ventilated patients in the PIP and 64 ventilated patients in the POP were observed and their data was recorded through a structured checklist. Data was collected by direct observation method for 30-45 minutes daily. Apart from the care bundle audit, a KAP (knowledge, attitude, practice) survey was conducted on 54 healthcare workers in the PIP and 54 healthcare workers in the POP using Google forms and results were derived. During the intervention phase which lasted 2 weeks, educational classes were conducted by the HIC team addressing all HCWs in the medicine ICU regarding care bundle practices. The session was reinforced in terms of visual reminders by displaying posters in the ICU. Simultaneously, during the study period, environmental surveillance was also conducted so as to compare to pathogens isolated from VAP cases which helped us revisit the hospital disinfection policy in the location.

Table 1: Formulas used for calculations

Type of measure	Formula applied
Location-specific compliance to the care bundle	(Number of patients with device where the all components of care bundle are followed /Total number of patients on device) * 100
Compliance to the individual specific components of care bundle	(Number of patients with device where Specific component bundle are followed/ Total number of patients on device) * 100
VAE rate	(Number of VAE cases/ Total ventilator days) *1000

The data recorded was codified to maintain patient confidentiality and was available only to the researchers. Institutional ethical committee clearance was obtained before commencement of the study. All the data generated in the study was entered in MS Excel and analyzed using SPSS software version 22. Descriptive analysis of the data was done and effectiveness of intervention was found using Mc Nemar's chi square test. P value less than 0.05 was considered statistically significant.

RESULTS

During the study period, data was collected from a total of 26 patients (76 ventilator days) in the pre-intervention phase and 28 patients (64 ventilator days) in the post intervention phase, the period of data collection being 3 weeks in both phases. Since, some of the patients were ventilated for multiple days (represented as ventilator days), their demographic data was repeated. So, we considered their data only once and results were calculated accordingly. In the pre-intervention phase, the mean age of the ventilated patients was 59 years with a SD (SD) of 12.7279 years shown in Table 2**.** While in the post-, the mean age of the ventilated patients was 58 years with a standard deviation (SD) of 11.3137 years. 80% of the patients in our study were males and 20% were females in the PIP and in the POP, 57.14% of the patients were male and 42.86% of the patients were female. The primary diagnosis was chronic kidney disease (CKD) for 24% cases, Fever under evaluation for 16% cases and Acute Kidney Injury (AKI) for 12% cases in the pre-intervention phase.

In the POP, the primary diagnosis was Chronic Kidney Disease (CKD) for 39.28% cases, Acute Kidney Injury (AKI) for 17.86% cases and sepsis for 10.71% cases. In the pre-intervention phase, while 48% (n=12) patients had no comorbidities, Type II Diabetes Mellitus was one of the common comorbidity present in 36% (9) patients, 12% (n=3) patients had both Type II Diabetes Mellitus and Hypertension and Hypertension alone was present in 4% (n=1) patients.

In the POP, while 28.57% (n=8) patients had no comorbidities, Type II Diabetes Mellitus alone was the most common comorbidity, present in 46.43% (13) patients, 17.86% (n=5) patients

had both Type II Diabetes Mellitus and Hypertension and Hypertension alone was present in 7.14% (n=2) patients.

The total number of days of ventilation was 82, with a mean of 8.5 days and a SD of 4.95 days in the PIP shown in Table 3. The total number of days of ventilation was 66, with a mean of 7 days and a SD of 1.414 days in the POP phase shown in Table 4. The compliance to specific components of the care bundle in the PIP and POP has been depicted in Table 5. For the purpose of care bundle audit, data from all 75 patients in the PIP and 64 patients in the POP has been considered as the same patient being ventilated for multiple days doesn't change the outcome of the result. The compliance to the practice of head end elevation to 30°-45° was 100% in both the PIP and POP. Adherence to hand hygiene was recorded to be 29.33% in the PIP and 93.75% in the POP. Daily oral care with 2% chlorhexidine gluconate was at 74.66% in the pre intervention phase and 93.75% in the POP. Assessment of the need of peptic ulcer disease prophylaxis was 60% in the PIP and 92.18% in the POP. Assessment of the need for deep vein thrombosis prophylaxis was 34.67% in the pre intervention phase and 85.93% in the POP.

The documentation of the readiness of the patient to be removed from invasive mode of ventilation was 80% in the PIP and 93.75% in the POP. Overall Location specific compliance rate to the care bundle was 16% in the PIP and rose to 71.87% in the POP were shown in Table 6. Ventilator associated events Rate was calculated to be 3.7 per 1000 device days in the previous intervention phase and 2.4 per 1000 device days in the POP Table 7. Healthcare workers (HCWs) managing the adult medicine ICU were asked to fill a Google-form based Knowledge, Attitude and Practice (KAP) based questionnaire. We got responses from 54 HCWs in the pre intervention phase. After conducting the intended interventions, the same 54 HCWs were contacted and were asked to fill the questionnaire again. Out of the 54 HCWs whose responses were analyzed, 22.22% were made and 77.78% were female. The mean age of the HCWs was 27.5 years with a SD of 9.192. The mean years of experience was 2 years with a SD of 2.83. Among the HCWs, 7.40% were consultants, 75% being male consultants and 25% being female consultants. The mean age of this group was 45 years with a SD of 4.24 and the mean years of experience was 13 years with a SD of 7.07. Nurses constituted 40.74% of HCWs, 13.64% being males and 86.36% being females. The mean age was 30.5 years with a SD of 4.95 and the average years of experience was 2.5 years with a SD of 2.12. 14.81% of the HCWs were Post graduates, 37.5% being male and 62.5% being female. The mean age was 25 years with a S.D. of 0 and the average years of experience was 2.5 years with a SD of 0.71. Interns constituted 12.96% of the HCWs, 57.14% being male and 42.86% being female. The mean age was 23.5 years with a SD of 0.707 and the average years of experience was 0. 15.81% of the HCWs were housekeeping staff, 62.5% of which were males and 37.5% were females. The mean age was 34 with a S.D. of 7.07, their average years of experience being 4 years with a S.D. of 2.83. Students constituted 9.26% of the HCWs, 40% being males and 60% being females. The mean age was 21. Demographic results of HCW's participated in the study were depicted in Table 8**.** The results of KAP analysis were depicted in Table 8**.** From the attitude and practice-based questions, we inferred that only 44% HWs were satisfied with the current prevention measures for VAP being followed at the hospital while 56% of the HCWs were not. When asked as to why they don't perform hand hygiene, forgetfulness and lack of motivation constituted the major chunk of the responses at 77.78% and 18.52% respectively. Inadequate availability of hand rub products was the response in 3.07% cases.

68.52% concluded that educational sessions would help them adhere to care bundle practices followed by seeing higher ups perform hand hygiene at 18.52%, visual reminders like posters at 9.26% and providing pocket hand rub at 3.07% Table 9**.** In this study we also tried to correlate between the environmental isolates obtained by microbiologically screening immediate environment of the patients and comparing with the organism isolated in endotracheal aspirates of microbiological culture. We found that *Pseudomonas* spp, *Acinetobacter* spp, *Klebsiella pneumonia*, *E. coli* and *Serratia marscences* were the predominant microorganisms isolated from the endotracheal aspirates of the patients. In environmental surveillance we isolated predominant gram-positive aerobic spore bearers and coagulase negative *Sstaphylococcus*.

Table 2: Number of days of ventilation in pre-intervention phase where, m= number of days on ventilator, n= number of patients, p= total ventilator days and S.D. = standard deviation.

Number of patients (n)	Number of days on ventilator (m)	Total ventilator days (p=n x m)	Mean	SD
5	1	5	8.5	4.95
7	2	14		
7	3	21		
2	4	8		
1	5	5		
1	8	8		
1	9	9		
1	12	12		

Table 3: Number of days of ventilation in post intervention phase where, m= number of days on ventilator, n= number of patients, p= total ventilator days and S.D. = standard deviation.

Number of patients (n)	Number of days on ventilator (m)	Total ventilator days (p=m x n)	Mean	SD
8	1	8	7	1.414
13	2	26		
2	3	6		
5	4	20		
1	6	6		

Table 4: Comparison between the specific care bundle component adherence in the pre intervention and post intervention phase where n= number of patients in the pre intervention phase and m= number of patients in the post intervention phase, CHG= chlorhexidine gluconate, PUD= peptic ulcer disease and DVT= deep vein thrombosis.

Ventilator Care Bundle Audit		
Components	Pre-intervention phase % (n) Total n=75	Post-intervention phase % (m) Total m=64
Head end elevation	100% (75)	100% (64)
Adherence to hand hygiene.	29.33% (22)	93.75% (60)
Daily oral care (CHG 2%).	74.66% (56)	93.75% (60)
Need of PUD prophylaxis assessed	60% (45)	92.18% (59)
Need of DVT prophylaxis assessed	34.67% (26)	85.93% (55)
Assessment of readiness to remove documented	80% (60)	93.75% (60)

Table 5: Table showing Location specific compliance to the care bundle

Phase	Overall location specific compliance to the care bundle (%)
Pre intervention phase	16%
Post intervention phase	71.87%

Table 6: Table showing Ventilator Associated Events Rate in the pre intervention and post intervention phase in %, where VAE Rate= Ventilator Associated Events Rate.

VAE Rate(per 1000 device days)	Pre intervention phase	Post intervention phase
	3.7	2.4

Table 7: Demographic details of healthcare workers in the ICU who participated in the KAP analysis. HCW= healthcare worker, n= number of patients, S.D. = standard deviation.

Group	Number (n)	Sex in %		Age (in years)	Years of experience
		M	F		
All HCWs	100% (54)	22.22% (12)	77.78% (42)	Mean= 27.5 S.D.= 9.192	Mean= 2 S.D.= 2.83
Consultants	7.40% (4)	75% (3)	25% (1)	Mean= 45 S.D.=4.24	Mean= 13 S.D.= 7.07
Nurses	40.74% (22)	13.64% (3)	86.36% (19)	Mean= 30.5 S.D.= 4.95	Mean= 2.5 S.D.= 2.12
Post graduates	14.81% (8)	37.5% (3)	62.5% (5)	Mean=25 S.D.=0	Mean= 2.5 S.D.= 0.71
Interns	12.96% (7)	57.14% (4)	42.86% (3)	Mean=23.5 S.D.= 0.707	Mean= 0 S.D.= 0
Housekeeping	14.81% (8)	62.5% (5)	37.5% (3)	Mean=34 S.D.= 7.07	Mean= 4 S.D.= 2.83
Students	9.26% (5)	40% (2)	60% (3)	Mean=21 S.D.= 0	Mean= 0 S.D.= 0

Table 8: Pre intervention and post intervention comparison of responses of questions based on knowledge obtained during KAP analysis, where VAP= Ventilator associated pneumonia and WHO= World Health Organization.

Knowledge Based Questions	Responses	
	Pre intervention phase (n=54)	Post intervention phase (=54)
Are you aware of the care bundle concept in prevention of ventilator associated pneumonia?	Correct responses: 74.07% (40) Incorrect responses: 25.93% (14)	Correct responses: 98% (53) Incorrect responses: 2% (1)
Are you aware of multiple components of VAP care bundle practice?	Correct responses: 59.26% (32) Incorrect responses: 40.74% (22)	Correct responses:98% (53) Incorrect responses:2% (1)
Which is the most common route of transmission of resistant bugs in hospital setting?	Correct responses: 46.30% (25) Incorrect responses:53.7% (29)	Correct responses: 92.6% (50) Incorrect responses: 7.4% (4)
Are you aware of WHO-assigned My 5 moments of hand hygiene?	Correct responses: 42.59% (13) Incorrect responses: 57.41% (31)	Correct responses: 85.19% (46) Incorrect responses: 14.81%(8)
According to WHO, what is the minimum duration for which hand rub has to be performed?	Correct responses:29.63% (16) Incorrect responses: 70.37% (38)	Correct responses: 85.18% (46) Incorrect responses: 14.82% (8)
Do you practice the concept of head end elevation (30°- 45° angle) of ventilated patients?	Correct responses: 88.89% (48) Incorrect responses: 11.11% (6)	Correct responses: 100% (54) Incorrect responses: 0% (0)
What is your current practice with regard to daily oral care for all ventilated patients?	Correct responses: 62.96% (34) Incorrect responses: 37.04% (20)	Correct responses: 79.63% (43) Incorrect responses: 20.37% (11)
Is it a routine practice to assess readiness to wean / removal of device on daily clinical rounds?	Correct responses: 88.89% (48) No: 11.11% (6)	Correct responses: 96.74% (52) Incorrect responses: 3.70% (2)

Table 9: Pre intervention and post intervention comparison of responses of questions based on attitude and practice obtained during KAP analysis, where VAP= Ventilator associated pneumonia.

Attitude and Practice based questions	Responses
Are you satisfied with the prevention measures followed for VAP?	A. Yes: 54% (29) B. No: 46% (25)
Which of the following aspects will motivate you to adhere to care bundle practices better?	A. Visual reminders like posters 9.26% (5) B. Seeing your higher orders perform hand hygiene 18.52% (10) C. Educational sessions 68.52% (37) D. Providing pocket hand rubs 3.07% (2)
What makes you not perform hand hygiene when required?	A. Inadequate availability of hand rub products 3.07% (2) B. Forgetfulness 77.78% (42) C. Lack of motivation 18.52% (10) D. Allergy to hand rub product 0% (0)

DISCUSSION

A hospital, if compared to a temple, the Intensive Care Unit (ICU), undoubtedly, becomes its inner sanctum. Only the most serious patients battling life threatening conditions and requiring constant supervision are admitted in ICUs. ICUs are equipped with ventilators which are essential lifesaving medical devices. But every virtue has its vice. Although ventilators are an irreplaceable element of ICUs, the risk of nosocomial infection i.e. Ventilator Associated Pneumonia (VAP) associated with them cannot be overlooked. The outcomes associated with VAP are often dreaded and create a double burden not only on the patients, who have to combat VAP along with their primary disease, but also on healthcare workers who have to manage these patients. Hence, we came up with a comprehensive study to see if a multimodal intervention strategy could prevent VAP. Data was collected from 26 patients (76 ventilator days) in the PIP and 28 patients (64 ventilator days) in the POP. The VAE rate per 1000 days was 3.7 in the PIP and 2.4 per 1000 days in the POP i.e. after the interventions, the VAE rate reduced. In the PIP, the mean age of the ventilated patients was 59 years with a SD of 12.7279 years while in the POP, the mean age of the ventilated patients was 58 years with a SD of 11.3137 years.

80% of the patients were male and 20% of the patients were female in the PIP. In contrast, in the POP, 57.14% of the patients were male and 42.86% of the patients were female. Studies have shown that males account for the majority of VAP cases and this was reiterated in our study as the VAE rate decreased in the POP when females constituted a higher portion of the study population compared to the PIP [11, 12].

The most common primary diagnosis of the ventilated patients was chronic kidney disease (CKD), both in the PIP and POP at 24% and 39.28% respectively. Other primary diagnoses encountered in the patients have been highlighted in the results section. When it came to the presence of comorbid conditions in the patients, in our study, 52% patients in the PIP and 71.43% patients had comorbidities like Diabetes mellitus and hypertension. Diabetes mellitus alone remained the highest encountered co-morbidity at 36% and 46.43% in the PIP and POP respectively.

This is in line with a study, which found that chronic diseases might be a risk factor for VAP, including coronary disease, diabetes, respiratory diseases, chronic renal failure, and Hashimoto's thyroiditis [3]. A study showed that the incidence of VAP increased from 5% in patients with 1 day of mechanical ventilation to 65% in patients with 30 days of mechanical ventilation in its study population i.e. increased duration of ventilation is a risk factor for VAP [4]. In our study, the total number of days of ventilation was 82, with a mean of 8.5 days and a SD of 4.95 days in the PIP and 66, with a mean of 7 days and a SD of 1.414 days in the POP which is in conjunction with a higher VAE rate of 3.7 in the PIP as compared to 2.4 in the POP, thus, corroborating the above-mentioned study.

Several studies implicate hand hygiene as a major preventive measure for VAP, however, a recent study showed that hand hygiene has no impact on VAP incidence, duration of MV, or mortality [13]. In our study, adherence to hand hygiene was found to be at 29.33% in the PIP and 93.75% in the POP, associated with a decreased VAE rate in the post intervention phase. Head end elevation to 30°-45° is a common practice thought to lower risk of VAP In our study, the compliance to head end elevation was at 100% in both phases. Daily oral care with chlorhexidine is a controversial topic, some studies suggesting an increased mortality rate with this practice [14, 15]. In our study, daily oral care with chlorhexidine was at 74.66% in the pre-intervention phase and at 93.75% in the POP. In our study, Peptic Ulcer Disease prophylaxis (PUD) was 60% in the PIP and 92.18% in the POP. DVT prophylaxis was at 34.67% and 92.18% in the PIP and POP respectively. Peptic Ulcer Disease prophylaxis, although routinely practiced as a part of VAP care bundle, is associated with either no effect or an increased risk of VAP [16]. Similarly, DVT prophylaxis is not found to directly impact VAP rates [17]. Hence, more extensive studies are required to study their provision in the VAP care bundle.

The removal of patients from ventilators as soon as possible is often cited as the most important factor for prevention of VAP [18, 19]. In our study, the readiness to be removed from ventilators was documented as 80% in the PIP and 93.75% in the post intervention phase, which corroborates the above-mentioned studies through a decline in the VAE rate in the POP compared to PIP.

Compliance to a care bundle as a whole, compared to specific components, is of more value as is evidenced by multiple studies [20-22].

This is very strongly corroborated by our results, which showed that location specific compliance to all components of the care bundle increased from 16% to 71.87%. This was parallel to a fall in the VAE rate from 3.7/1000 device days to 2.4/1000 device days after intervention.

Studies have shown that the knowledge of evidence-based strategies for preventing VAP was low among most healthcare workers in the ICU and when present, that knowledge was not consistently or uniformly implemented. Hence, we planned a 2-week intervention period wherein we conducted educational sessions for HCWs and set up visual reminders in the form of posters in the ICU.

Along with a care bundle audit, we performed a Knowledge, Attitude, Practice (KAP) analysis on the healthcare workers of the ICU. This was done to assess if our interventions increased awareness among HCWs and increased their adherence to care bundle packages.

A study reported that a 2-hour educational material

significantly enhanced nurses' knowledge towards prevention of VAP [20]. In contrast, Aloush SM, in his study, concluded that unless other confounding factors, such as their workload, are controlled, there will be no enhancement in nurses' compliance.

In the present study, we analyzed the data from 54 HCWs each in both the PIP and POP, 7.40% of whom were consultants, 40.74% were nurses, 14.81% were post graduates, 12.96% were interns, 14.81% were housekeeping staff and 9.26% were students. 77.78% of all HCWs were females and the rest 22.22% were males. The mean age was 27.5 years with a SD of 9.192 and the average years of experience were 2 years with a SD of 2.83 years.

The correct responses for knowledge-based questions generalized increment indicates that our interventions were successful in creating awareness among healthcare workers regarding VAP. From the attitude and practice-based questions, we inferred that 56% of the HCWs were not satisfied with the current prevention measures for VAP being followed at the hospital. When asked as to why they don't perform hand hygiene, forgetfulness and lack of motivation constituted the major chunk of the responses at 77.78% and 18.52% respectively.

68.52% concluded that educational sessions would help them adhere to care bundle practices followed by seeing higher ups perform hand hygiene at 18.52%, visual reminders like posters at 9.26% and providing pocket hand rub at 3.07%. Some studies suggest that the ICU environment was observed to be the potential reservoir for VAP pathogens like *Pseudomonas aeruginosa* and *Acinetobacter baumannii*. However, there are very few extensive studies in this regard [8-10]. We also performed surface surveillance cultures and compared it with the pathogens isolated from VAP cases which showed that there was no correlation among them. Hospital disinfection policy plays a major role in keeping the immediate surroundings of patients safe and as we isolated only environmental contaminants in surface cultures the existing disinfection policy can be continued.

CONCLUSION

The acquisition of nosocomial infections in the ICU may result in significant increase in length of ICU stay. Knowledge regarding the frequency of VAP, the correlated risk factors, and the usual pathogens causing VAP is essential for devising effective preventive measures. This, in turn, can lead to a decline in mortality and morbidity rates, along with a reduction in the duration of treatment and hospital stay associated with VAP.

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Limitations of the study

The limitation is that this is a short term study and the data obtained may be inadequate to come to definitive conclusion but on overall analysis, there was significant reduction of VAE rate in the study and hence, a continuous monitoring system and education of the staff should exist to reduce the incidence of VAP in hospitals and the same strategy can be employed in other areas of hospital as well for prevention of other nosocomial infections like Catheter associated urinary tract infections, central line associated bloodstream infections and so on.

Conflicts of interest: Authors declare no conflict of interest.

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