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Original Research Article

Effectiveness of Staff Education on Prevention of Ventilator-Associated Pneumonia and Recent Trends of Antimicrobial Susceptibility of Organism Causing VAP in ICU

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Abstract: **Introduction:** Ventilator-associated pneumonia (VAP) is the most common lethal infection observed in patients who require treatment in intensive care units (ICU). In the present study, we aimed to evaluate the incidence of VAP in a general ICU and hypothesized that the implementation of a specific VAP prevention bundle together with a staff education strategy would be effective in reducing the incidence of VAP. **Methods:** A prospective interventional study design was followed to explore the recent trends in antimicrobial susceptibility of organism causing VAP in the ICU and the use of VAP prevention bundle and staff education to decrease the incidence of VAP. According to the study inclusion criteria, ICU patients were sampled from the population. Clinical and radiological criteria was used to diagnose VAP. The Clinical Pulmonary Infection Score (CPIS) was calculated, and a score greater than 6 was used to verify the diagnosis. Patients who had suspicion of VAP, ET aspirate were sent for microbiological assessment and profile of infective organism was identified. ICU staff nurses were also educated about preventive strategies of VAP and effectiveness of staff nurses education was observed on ICU patients. **Results:** VAP incidence was high in the study setting. Most common organism causing VAP was Acinetobacter Baumanii isolated in 47% cases which was 91.2% extensive drug resistant. However, implementation of a staff education and ventilator bundle had decreased VAP incidence though not proven statically significant (p value .07) **Conclusion:** The execution of a consistent approach to patients care in ICU, including a number of key reduction interventions, may be associated with a significant reduction in VAP.

Keywords: Antimicrobial Susceptibly, Staff Education, VAP bundle, Ventilator Associated Pneumonia.

INTRODUCTION

Critically ill patients in ICU are always at higher risk to develope nosocomial infections (Magill, S.S. *et al.*, 2014; Chawla, R. 2008). This may be because of their underlying diseases or immunosuppressed state as well as several violations of their immune system or lack of asepsis during invasive monitoring and exposure of multiple broad-spectrum antimicrobials (Eggimann, P., & Pittet, D. 2001).Ventilator-associated pneumonia (VAP) is pneumonia arising in a patient who is intubated and on mechanical ventilation for ≧48 hours (Chastre, J., & Fagon, J.Y. 2002). It is the second most common nosocomial infection and is lethal in patients on ventilator (Hunter, J.D. 2012). The risk of developing VAP is most common in first five days on mechanical ventilation and then the risk decreases (Rello, J. *et al.*, 2002). The VAP incidences depends upon the unit, the studied population and the level of antibiotic exposure (Afshari, A. *et al.*, 2012). VAP ranges from 1 to 4 cases per 1000 ventilator days in industrialized countries and incidence up to 13 cases per 1000 ventilator days in developing countries (Tao, L. *et al.*, 2012).

Patients who are intubated and are on mechanical ventilation are 3-10 folds at higher risk of developing hospital acquired pneumonia (Zolfaghari, P.S., & Wyncoll, D.L. 2011). VAP increases the

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mortality and morbidity rate of patients which alsoaffects the hospital stay and cost (Bekaert, M. *et al.*, 2011; Muscedere, J.G. *et al.*, 2012). VAP is usually caused by multidrug resistant pathogens while the rate,pathogens and sensitivity pattern varies between countries,regions and ICUs (World health organisation. 2014; Sader, H.S. *et al.*, 2014). The antibiotics are not effective because of the rise of antibiotic resistance which have created a havoc in management of hospital acquired infections.[14]Indiscriminate use of antibiotics and deficiency of stringent infection control policy are the major contributory factors for the development of resistance.Since there are only few newer antibiotics in pipeline especially for gram negative infections, preventive strategy appears to be a reasonable way to tackle current crisis and controlling and limiting dreadful consequences.Local epidemiological studies can provide data about prevalent pathogen along with constant updation of antimicrobial susceptibility and resistance pattern which is essential for effective clinical management.The center of disease prevention and control (CDC)considers training nursing staff and doctors as a key strategy to reduce VAP incidence (Matteo, B. *et al.*, 2016).

The objective of the present study was to evaluate the incidence of VAP and to assess the effectiveness of series of educational intervention on VAP incidence and outcome of patients and to assess the causative organisms and their antibiotic susceptibility profile.

MATERIAL AND METHODS

This was a prospective intervention study which was conducted in 3 phases

- Phase: 1 Base line period (3 months)
- Phase: 2 Intervention and educational period
- Phase: 3 Post intervention period (3 months)

After taking approval from research and ethical committee of the institute and informed consent taken from enrolled patients respective caring staff nurse this study was conducted in a semi-closed multidisciplinary ICU with a 40 bedded capacity.During the study the nurse to patient ratio was 1:2. The data was collected with personal profile information's and acute physiology and chronic health evaluation (APACHE) II severity scoring of the enrolled patients at the time of admission. The patients who were intubated and were on mechanical ventilation for ≧48 hrs were included in the study. The patients which showed evidence of chest infection prior to intubation, intubated patient re-admitted from another hospital, those who had been treated in an ICU for more than 48 hours during last 90 days and those who stayed less than 48 hours in the ICU were excluded from the study. Patients were monitored in ICU till they were discharged.The study participant were divided into two groups as shown in tab 1.The diagnosis of VAP was made by the ICU consultants based on the radiological and clinical criteria and confirmed by the microbiological examination of ET aspirate (Afshari, A. *et al.*, 2012). Also, the Clinical Pulmonary Infection Score was calculated, and a score greater than 6 was used to verify the diagnosis (Bekaert, M. *et al.*, 2011).

Baseline period-

VAP cases were been recorded on structured performa which included isolation, identification and detection of antibiotic susceptibility pattern of bacteria causing VAP and assessment of infection control policies.

Intervention period- Following interventions were done

- Information education was provided to medical staff and the heads of nursing on the aspects of VAP, hand hygiene,aseptic techniques, isolation precautions,VAP prevention bundle and bio medical waste management.
- VAP prevention checklist including VAP prevention bundle distributed to all the ICU staff.
- Staff were instructed to provide oral care with chlorhexidine implemented twice daily
- Hand hygiene procedure posters were displayed in hand wash area.

Post intervention period- VAP cases were recorded after intervention on the same structured performa which was used in pre-intervention and then both groups were compared.

Sample Collection And Microbiological Methods:

Samples collected were Endotracheal or tracheal tube aspirates from patients on ventilators and BAL samples in sterile universal containers. Samples were collected before antibiotic administration. Endotracheal aspirates were collected by using sterile 12 gauge endotracheal suction catheter. Samples were transported within 15 minutes to microbiology laboratory and processed. The samples which were of poor quality and not representative of lower respiratory tract were excluded. After confirming the quality, the samples were plated on sheep blood agar (SBA), chocolate agar (CA), and Mac Conkey agar (MA) by using 4 mm Nichrome wire loop (Hi-media, Mumbai, India), which holds 0.01 ml of sample. These plates were incubated overnight at 37°C for 48 hrs at 5% CO_2 incubator. Threshold for quantitative cultures was considered as 10^5 CFU/ml. Organisms identification and antimicrobial susceptibility tests were carried out by using an automated system VITEK 2 for amikacin, amoxicillin-clavulanic acid, aztreonam, cefepime, cefotaxime, cefoxitin, ceftazidime, ceftriaxone, ciprofloxacin, gentamicin, imipenem, levofloxacin, meropenem, piperacillin-tazobactam, tobramycin ,trimethoprim-sulfamethoxazole, colistin and for clindamycin, linezolid, vancomycin and teicoplanin for gram positive organisms. *Pseudomonas aeruginosa* ATCC 27853, staphylococcus aureus ATCC

25923, E.coli ATCC 25922 were used as quality control strains. The result of susceptibility testing was interpreted as per CLSI 2015 guidelines (Jean B, P. *et al.*, 2015).

STATISTICAL ANALYSIS

Categorical variables were recorded as frequencies and proportion while continuos variables were recorded as mean(standard variation).All the variables were first tested for normal distribution.Independent t test was applied on group means of continues variables and chisquare($\chi 2$) test was used to compare categorical variables.p value of less than .05 was considered statistically significant.Data was analyzed using statistical package for the social science (SPSS) Version 20.

RESULTS

During the 6 months study 1489 patients were admitted in ICU .Out of which 356 patients met the inclusion criteria.(fig 1)

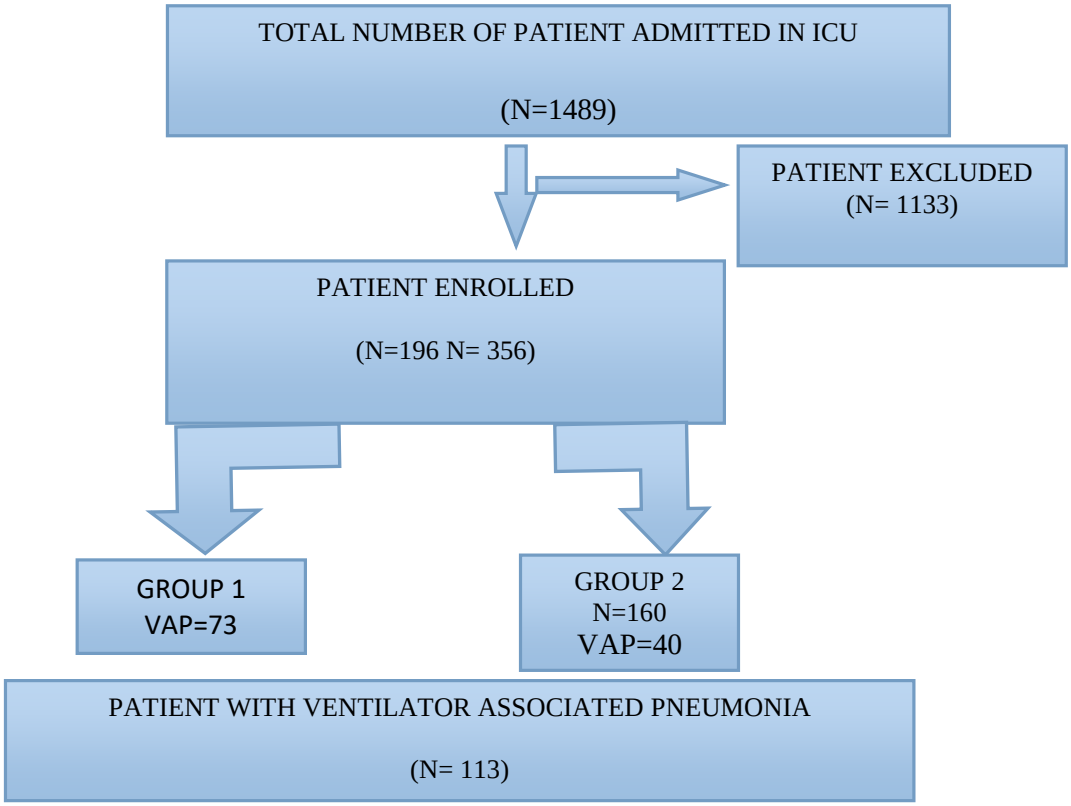


FIG1: summary of patients sample

Group distribution of patients is shown in tab 1

TAB 1: Group distribution of patients

GROUP 1	GROUP 2
patients in pre-intervention period	patients in post intervention period

Result showed 73 out of 196 fulfilled the criteria of VAP in group 1 while 40 out of 160 fulfilled the criteria of VAP in group 2.Age, sex and severity of illness as calculated by APACHE at admission were similar before and after admission as shown in tab 2.Sepsis with multi-organ dysfunction system prior to VAP was most common diagnosis at admission in pre intervention group as shown in tab 2 and there was no difference in two group based on early (<5 days) versus lateVAP(≧5 days).

TAB 2 Baseline chaterstics of diagnosed VAP cases (n=113) before and after intervention period

	INDEX		BEFORE INTERVENTION (N=70)	AFTER INTERVENTION (N=43)	p
1.	SEX Male female		 47(67.1%) 23(32.9%)	 32(74.4%) 11(25.6%)	.41
2.	AGE Mean(yrs) (median) Range(yrs)		 48 50 12-96	 51 55 18-86	
3.	Age groups(yrs) 0-10 10-19 20-29 30-39 40-49 50-59 60-69 70-79 ≧80		 5(7.1%) 8(11.4%) 8(11.4%) 11(15.71%) 12(17.14%) 17(24.28%) 4(5.71%) 5(7.1%)	 1(2.32%) 6(13.95%) 7(16.27%) 7(16.27%) 4(9.3%) 8(18.6%) 6(13.9%) 4(9.3%)	.59
3.	APACHE 2 mean(SD)		21.49(6.48)	23.16(7.17)	.20
4.	CAUSE OF ADMISSION Respiratory Neurological Neurotrauma Sepsis Chronic liver disease Blunt trauma Pancreatitis Poisoning		 2(2.85%) 7(10%) 14(20%) 35(50%) 6(8.57%) 0(0%) 3(4.28%) 3(4.28%)	 3(6.97%) 12(27.9%) 13(30.23% 9(20.9%) 3(6.97%) 2(4.65%) 1(2.32%) 0(0%)	.010
5.	Duration of ventillation	<5 days(early onset	43(61.4%)	32(74.4%)	0.21
		≧5 days(late onset)	27(38.6%)	11(25.6%)	

Total number of VAP cases in pre-intervention group were 70 with VAP density(incidence of VAP per 100 patients) of 35.71and 43 in post intervention group with VAP density of 26.8.Though there was reduction in VAP cases in post intervention group but it was not statistically proved significant difference(p=.07).Mean number of mechanical ventilation and ICU stay was similar in both the groups.Mortality was same in both the groups as shown in tab 3.

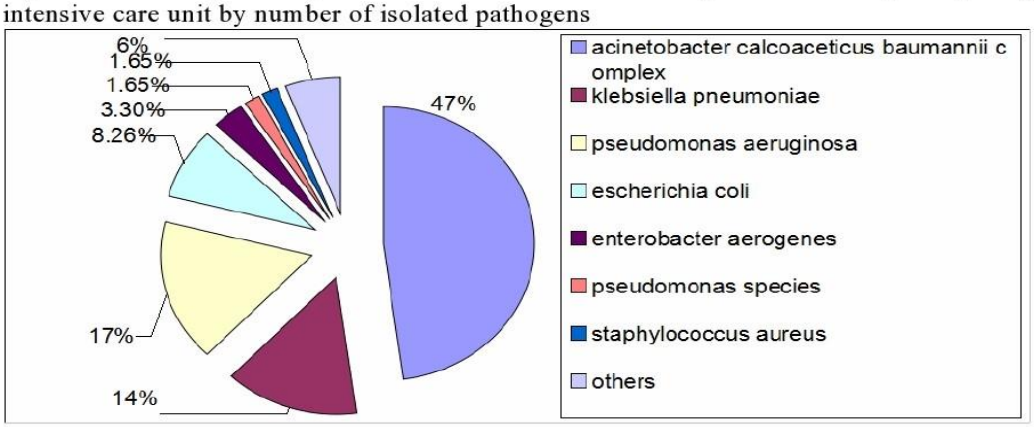
TAB 3: Outcome of patients with ventilator associated pneumonia before and after intervention

OUTCOME MEASURE	**BEFORE INTERVENTION**	**AFTER INTERVENTION**	**p**
No. Of VAP cases	70	43	
Days of mechanical ventilation, mean (SD)	9.41(13.68)	9.18(8.59)	0.92
VAP incidence(per 100 patients)	35.71	26.87	.07
Days in intensive care unit, mean (SD)	11.43(13.95)	11.27(10.54)	0.95
OUTCOME Improved Expired LAMA*	 33(47.1%) 20(28.57%) 17(24.2%))	 20(46.5%) 11(25.58%) 12(27.9%)	0.89

*left against medical advise

Most common organism causing VAP was Acinetobacter baumanii which was seen in 47% cases .Other organisms isolated are shown in fig 2.Most of the organisms isolated were multidrug resistant.Acinetobacter Baumanii was 91.2% extensively drug resistant(XDR),Pseudomonas was 65% XDR ,Klebsella was 88.2% XDR,E.coli was 30% XDR and Staph aureus and Enterococcus isolated were also resistant to antibiotics.

Fig 2 : Microorganism profile of ventilator associated pneumonia in participating intensive care unit by number of isolated pathogens



DISCUSSION

Hospital-acquired pneumonia continues to be challenging issue among health care workers. Among critically ill patients in ICU, pneumonia is one of the most common hospital-acquired infections.Most common pathogenesis of VAP is due to bacterial colonization of the oral cavity and aspiration of contaminated secretions into the lower respiratory tract (Livingston, D.H. 2000). The artificial airway of the ventilator or the endotracheal (ET) tube can transmit microorganisms to the lungs.So most important risk for development of VAP is intubation itself (Zolfaghari, P.S., & Wyncoll, D.L. 2011).

VAP has a potential to be prevented (Mathews, P.J., & Mathews, L.M. 2000). Interventions to prevent VAP should begin at the time of intubation and has to be continued until extubation.Most of the preventive measures are a part of routine nursing care (Augustyn, B. 2009). VAP prevention bundle is bundle of activity to prevent VAP and it is effective in reducing VAP incidence as shown by various studies (Eom, J. S. *et al.*, 2014; Shitrit, P. *et al.*, 2015; Lim, K. P. *et al.*, 2015; Resar, R. *et al.*, 2005; & Wip, C., & Napolitano, L. 2009). The occurrence of nosocomial infections is directly related to the adequacy of staff.So an intervention program for prevention and education on VAP was initiated for the first time in our ICU.

This study demonstrated reduction in the incidence of VAP after implementation of the intervention though not statistically significant which was in agreement with studies conducted in various countries :in Brazil (Marra, A.R. *et al.*, 2009), in Shanghai (Afshari, A. *et al.*, 2012), in USA (Bird, D. *et al.*, 2010), Italy (Prospero, E. *et al.*, 2008), Saudi Arabia (Al-Dorzi, H.M. *et al.*, 2012; Al-Tawfiq, J.A., & Abed, M.S. 2010), Egypt (Magda, M. *et al.*, 2017; Abdel-Latif, W., & Erfan, D. 2013) and Hungary *et al.*, (2016). In this study however there was no reduction in duration of mechanical ventilation, ICU stay or mortality similar to the study by Raquilly A *et al.*, (2015).

Nurse education plays a vital role in prevention of VAP. Nursing education improves hand hygiene of nurses, and compliance to VAP bundle as shown by Lambert ML *et al.*, (2013). Maria Parisi *et al.*, also showed the significance of use of VAP bundle and staff education for reduction of VAP incidence (Parisi, M. *et al.*, 2016). Regular monitoring and continuous education of medical and nursing staff is required to effectively prevent VAP.

Most common organism causing VAP in our study was Acinetobacter Baumanii.which was same in pre and post intervention period.This pathogen can thrive in the hospital environment due to its survival abilities and has the ability to develop resistance to a wide range of antimicrobial agents including Carbapenem,thus limiting the choice of treatment..Literature suggests that VAP caused by Acinetobacter species does not effects the prognosis,mortality or eradication of VAP as compared to other species (Di Bonito, M. *et al.*, 2012) but it is associated with prolong intubation and mechanical ventilation (El-Saed, A. *et al.*, 2013) and hemodynamic impairment which predicts poor outcome (Chaari, A. *et al.*, 2013).In our study baumanii was 91.2% resistant to meropenem and imipenem,Pseudomonas was 65% resistant to imipenem and 70% to meropenem, Klebsella was 91% resistant to carbapenems while E. coli was 30% resistant to imipenem and 40% to meropenem.The frequency of multi-drug-resistant (MDR) pathogenesis on rise dramatically in recent years (Kollef, M. H. *et al.*, 2012) which seriously limit the clinical utility of beta-lactams (Harbarth, S. *et al.*, 2007).

There is enough evidence to indicate that VAP is preventable. It has a large impact on outcome of critically ill patients. Nurses play a key role in preventing VAP and most of the interventions are the part of routine nursing care. So education should focus on the risk factors for VAP and its preventive measures. In order to further decrease the incidence of VAP, infection control protocols and monitoring tools for compliance must be developed. VAP is not a new diagnosis, but because it is usually caused by MDR bacteria so education and research on the prevention of this life-threatening problem,are still ongoing.

Limitation

Intervention period was small and compliance to the preventive measures was not monitored. Numerous studies indicate that vigorous and repeated training of nursing staff is required and compliance to the preventive measures has to be monitored for the effective results (Augustyn, B. 2009; Rosenthal, V.D. *et al.*, 2006).

CONCLUSION

In conclusion this study confirms that VAP occurs frequently and increases morbidity of critically ill patient. VAP is usually caused by MDR bacteria.Nurses are the first line of defense in preventing VAP.Education of health care workers and nurses plays a key role in the management of patients with VAP.

REFERENCES

1. Magill, S.S., Edwards, J.R., Bamberg, W., Beldavs, Z.G., Dumyati, G., Kainer, M.A., *et al (*2014). Multistate point-prevalence survey of healthcare-associated infections. N Engl J Med, 370, 1198–208.
2. Chawla, R. (2008). Epidemiology, etiology, and diagnosis of hospital-acquired pneumonia and ventilator-associated pneumonia in Asian countries. Am J Infect Cont, 36 Suppl 4, S93-100.
3. Eggimann, P., & Pittet, D. (2001). Infection control in the ICU. *Chest*,120, 2059-2059.
4. Chastre, J., & Fagon, J.Y. (2002). Ventilator-associated pneumonia. Am J Respir Crit Care Med, 165, 867-903.
5. Hunter, J.D. (2012). Ventilator associated pneumonia. BMJ, 344, e3325.
6. Rello, J., Ollendorf, D., Oster, G., Vera-Llonch, M., Bellm, L., Redman, R., *et* al (2002). VAP Outcomes Scientific Advisory Group: Epidemiology and outcomes of ventilator-associated pneumonia in a large US database. Chest, 122, 2115–21.
7. Afshari, A., Pagani, L., & Harbarth, S. (2012). Year in review 2011: Critical care – infection. Crit Care, 16, 242–7.
8. Tao, L., Hu, B., Rosenthal, V. D., Zhang, Y., Gao, X., & He, L. (2012). Impact of a multidimensional approach on ventilator-associated pneumonia rates in a hospital of Shanghai: findings of the International Nosocomial Infection Control Consortium. *Journal of critical care*, *27*(5), 440-446.
9. Zolfaghari, P.S., & Wyncoll, D.L. (2011). The tracheal tube: gateway to ventilator associated pneumonia. Crit Care, 15, 310–7.
10. Bekaert, M., Timsit, J. F., Vansteelandt, S., Depuydt, P., Vésin, A., Garrouste-Orgeas, M., ... & Benoit, D. (2011). Attributable mortality of ventilator-associated pneumonia: a reappraisal using causal analysis. *American journal of respiratory and critical care medicine*, *184*(10), 1133-1139.
11. Muscedere, J.G., Day, A., & Heyland, D.K. (2012). Mortality, attributable mortality, and clinical events as end points for clinical trials of ventilator-associated pneumonia and hospital-acquired pneumonia. Clin Infect Dis, 51 Suppl 1,120–5.
12. World health organisation. (2014). Antimicrobial resistance:Global report on surveillance.
13. Sader, H.S., Farrell, D.J., Flamm, R.K., & Jones, R.N. (2014). Antimicrobial susceptibility of Gram-negative organisms isolated from patients hospitalised with pneumonia in US and European hospitals: results from the SENTRY Antimicrobial Surveillance Program, 2009–2012. Int J Antimicrob Agents, 43,328–34.
14. Matteo, B., Tobias, W., Richard, G., & Wunderink (2016). Treatment of Gram-negative pneumonia in the critical care setting: is the beta-lactam antibiotic backbone broken beyond repair? Critical Care, 20, 19.
15. Jam Gatell, M. R., Santé Roig, M., Hernandez Vian, O., Carrillo Santin, E., Turegano Duaso, C., Fernandez Moreno, I., & Valles Daunis, J. (2012). Assessment of a training programme for the prevention of ventilator-associated pneumonia. Nursing in critical care, 17(6), 285-292.
16. Zil berberg, M.D., & Shorr, A.F. (2010). Ventilator-associated pneumonia: the clinical pulmonary infection score as a surrogate for diagnostics and outcome. Clin Infect Dis, 51Supp 1, 131–5.
17. Jean B, P. et al (2015) .Performance Standards of Antimicrobial Susceptibility Testing.Clinical and laboratory standard institutes Jan; 35 suppl 25: M 100-S20.
18. Livingston, D.H. (2000). Prevention of ventilator associated pneumonia. Am J Surg, 179, 12-7.
19. Mathews, P.J., & Mathews, L.M. (2000). Reducing the risks of ventilator- associated infections. Dimens Crit Care Nurs, 19, 17-21.
20. Augustyn, B. (2009). Ventilator-associated pneumonia: Risk factors and prevention. Crit Care Nurse, 27, 32–39.
21. Eom, J. S., Lee, M. S., Chun, H. K., Choi, H. J., Jung, S. Y., Kim, Y. S., ... & Park, S. Y. (2014). The impact of a ventilator bundle on preventing ventilator-associated pneumonia: a multicenter

study. *American journal of infection control*, *42*(1), 34-37.

22. Shitrit, P., Meirson, M., Mendelson, G., & Chowers, M. (2015). Intervention to reduce ventilator-associated pneumonia in individuals on long-term ventilation by introducing a customized bundle. J Am Geriatr Soc, 63, 2089–93.
23. Lim, K. P., Kuo, S. W., Ko, W. J., Sheng, W. H., Chang, Y. Y., Hong, M. C., ... & Chang, S. C. (2015). Efficacy of ventilator-associated pneumonia care bundle for prevention of ventilator-associated pneumonia in the surgical intensive care units of a medical center. Journal of Microbiology, Immunology and Infection, 48(3), 316-321.
24. Resar, R., Pronovost, P., Haraden, C., Simmonds, T., Rainey, T., & Nolan, T. (2005). Using a bundle approach to improve ventilator care processes and reduce ventilator-associated pneumonia. Jt Comm J Qual Patient Saf, 31, 243–8.
25. Wip, C., & Napolitano, L. (2009). Bundles to prevent ventilator-associated pneumonia: How valuable are they? Curr Opin Infect Dis, 22, 159–66.
26. Marra, A.R., Cal, R.G.R., Silva, C.V., Caserta, R.A., Paes, Â.T., Moura, D.F, *et al (*2009). Successful prevention of ventilator-associated pneumonia in an intensive care setting. American journal of infection control, 37, 619-25.
27. Bird, D., Zambuto, A., O'Donnell, C., Silva, J., Korn, C., Burke, R., ... & Agarwal, S. (2010). Adherence to ventilator-associated pneumonia bundle and incidence of ventilator-associated pneumonia in the surgical intensive care unit. *Archives of surgery*, *145*(5), 465-470.
28. Prospero, E., Bacelli, S., Barbadoro, P., Nataloni, S., D'Errico, M.M., & Pelaia P. (2008).Improvement of the ventilator associated pneumonia rate with infection control practices in an Italian ICU. Minerva anestesiologica, 74, 537-41.
29. Al-Dorzi, H.M., El-Saed, A., Rishu, A.H., Balkhy, H.H., Memish, Z.A., & Arabi, Y.M. (2012). The results of a 6-year epidemiologic surveillance for ventilator associated pneumonia at a tertiary care intensive care unit in Saudi Arabia. American journal of infection control, 40, 794-9.
30. Al-Tawfiq, J.A., & Abed, M.S. (2010). Decreasing ventilator-associated pneumonia in adult intensive care units using the Institute for Healthcare Improvement bundle. American journal of infection control, 38, 552-6.
31. Magda, M., Azzab, R. H., El-Sokkary, Mohamed, M., Tawfeek., & Manar, G. G. (2017). Prevention of Ventilator Associated Pneumonia in an Emergency Intensive Care Unit: An Intervention Study.Egyptian Journal of Medical Microbiology, 26, 83-94.
32. Abdel-Latif, W., & Erfan, D. (2013). The impact of improvement project on ventilator associated pneumonia incidence rate at Nasser institute intensive care unit in Cairo. Egyptian journal of medical laboratory sciences, 22, 205-20.
33. Mogyoródi, B., Dunai, E., Gal, J., & Ivanyi, Z. (2016). Ventilator-associated pneumonia and the importance of education of ICU nurses on prevention–Preliminary results. *Interventional Medicine and Applied Science*, *8*(4), 147-151.
34. Roquilly, A., Marret, E., Abraham, E., & Asehnoune, K. (2015). Pneumonia prevention to decrease mortality in intensive care unit: a systematic review and meta- analysis. Clin Infect Dis, *60, 64*-75.
35. Lambert, M. L., Palomar, M., Agodi, A., Hiesmayr, M., Lepape, A., Ingenbleek, A., ... & Frank, U. (2013). Prevention of ventilator-associated pneumonia in intensive care units: an international online survey. *Antimicrobial resistance and infection control*, *2*(1), 9.
36. Parisi, M., Gerovasili, V., Dimopoulos, S., Kampisiouli, E., Goga, C., Perivolioti, E., ... & Nanas, S. (2016). Use of ventilator bundle and staff education to decrease ventilator-associated pneumonia in intensive care patients. *Critical Care Nurse*, *36*(5), e1-e7.
37. Di Bonito, M., Caiazzo, S., Iannazzone, M., Miccichè, V., De Marco, G., De Robertis, E., ... & Piazza, O. (2012). Prognostic differences between VAP from Acinetobacter baumanii and VAP from other microorganisms. *Translational Medicine@ UniSa*, *3*, 15.
38. El-Saed, A., Balkhy, H.H., Al-Dorzi, H.M., Khan, R., Rishu, A.H., & Arabi, Y.M. (2013). Acinetobacter is the most common pathogen associated with late-onset and recurrent ventilator-associated pneumonia in an adult intensive care unit in Saudi Arabia. Int J Infect Dis, *17, 696*-701.
39. Chaari, A., Mnif, B., Bahloul, M., Mahjoubi, F., Chtara, K., Turki, O., ... & Bouaziz, M. (2013). Acinetobacter baumannii ventilator-associated pneumonia: epidemiology, clinical characteristics, and prognosis factors. *International Journal of Infectious Diseases*, *17*(12), e1225-e1228.
40. Kollef, M. H., Chastre, J., Clavel, M., Restrepo, M. I., Michiels, B., Kaniga, K., ... & Redman, R. (2012). A randomized trial of 7-day doripenem versus 10-day imipenem-cilastatin for ventilator-associated pneumonia. *Critical Care*, *16*(6), R218.
41. Harbarth, S., Nobre, V., & Pittet, D. (2007). Does antibiotic selection impact patient outcome? Clin Infect Dis, 44, 87–93.
42. Rosenthal, V.D., Guzman, S., & Crnich, C. (2006). Impact of an infection control program on rates of ventilator-associated pneumonia in intensive care units in 2 Argentinean hospitals. American journal of infection control, 34, 58-63.