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Incidence of VAP in both medical and surgical ICU populations with and without application of Ventilator Bundle Strategy

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Abstract : Ventilator-associated pneumonia (VAP) is a major contributor to morbidity and mortality in the intensive care unit (ICU). Many guidelines developed to deal with this serious condition."The Ventilator Bundle is a series of interventions related to ventilator care that, when implemented together, will achieve significantly better outcomes than when implemented individually."The study included a total of one hundred patients that were intubated and ventilated. Fifty patients were admitted to Al-Hussein University Hospital, they were implemented to ventilator bundle strategy while the remaining fifty patients were admitted to SayedGalal University Hospital; they were not implemented to ventilator bundle**.** Each main group was composed of both medical and surgical patients as 25 patients for each subgroup. Ventilatorbundle included; elevation of patient's head of bed to 30- 45 degrees, daily sedation vacation and daily assessment of readiness toextubation, peptic ulcer disease prophylaxis, Deep vein thrombosis (DVT) prophylaxis and daily oral care with chlorhexidine.Results revealed Incidence of VAP was decreased from 36 % in ventilated patients not subjected to the ventilator bundle strategy to 16 % in patients subjected to the ventilator bundle with both clinical and statistical difference.VAP incidence was decreased from 36 % to 24 % (reduced by 12%)in medical ICU patients in both groups, and decreased from 36 % to 8 % (reduced by 28%) in surgical ICU patients in both groups. **In conclusion** application of Ventilator Bundle Strategy was practical to reduce incidence of VAP in both medical and surgical ICU population.
Keywords : Ventilator bundle, VAP,Pseudomonas aeruginosa, Klebsiella pneumonia, MRSA, mechanical ventilation.

Introduction

Ventilator-associated pneumonia (VAP) refers to pneumonia that develops at least 48 hours after the initiation of mechanical ventilation (1). Ventilator associated penumonia is common in ICUs, affecting 8 to 20% of ICU patients. Mortality rates in patients with VAP range from 20 to 50% and may reach more than 70% when the infection is caused by multi-resistant and invasive pathogens **14.**The clinical diagnosis of VAP has

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traditionally been made by the association of a new or progressive consolidation on chest radiology and at least two of the following variables: fever greater than 38ºC, leukocytosis, leukopenia and purulent secretions**14.**Most recently, the institute of healthcare improvement's (IHI), that focus on improving health care safety has targeted prevention of VAP. The IHI recommends bundling multiple preventive strategies into one package that can be implemented all at once, rather than targeting one preventive strategy at a time **13.**The standard component of IHI's approach is "bundles" of care, defined as "a small, straight forward set of practices generally three to five that, when performed collectively and reliably, have been proven to improve patient outcomes**18.**

Patients and methods

This study was conducted in All ICU units in both El Hussein and SayedGalal university hospitals in the period from November 2015 to June 2016. VAP Bundle programe was explained and all ICU nursing stuff were educated enough for one months until our study was initiated on November 2015.

The current study included on hundred adult medical and surgical patients who were intubated and ventilated in our ICU. Patients were classified into two groups;

Group A; included 50 patients who were admitted to El Hussein Hospital, they were subjected to ventilator bundle protocol.
Group B; included 50 patients who were admitted to SayedGalal Hospital, they were not subjected to ventilator bundle protocol.

Each main group composed of both medical and surgical ICU patients divided as 25 patients for each subgroup.

Exclusion criteria:

Patients were excluded from the study if they had any of the following:

1. Patients died within 72 hrs of intubation.
2. Patients with pulmonary embolism at admission.
3. Patients with gastrointestinal bleed prior to admission.

- Patients were included if they were mechanically ventilated for more than 48 h and were at least 18 years of age.

All patients were subjected to the following:

Full medical history, Full clinical examination (General & local chest examination) daily, routine laboratory investigations regularly including CBC, liver&kidney functions and electrolytes, plain chest and heart X-ray (antero-posterior view) as a part of regular follow up, arterial blood gases analysis regularly, electrocardiography (ECG), CT chest if needed, regular tracheal aspirates and examined by gram stain and culture with sensitivity. Ventilator bundle interventions were donefor all patients in the group A**9.**

The medical management, antibiotic therapy, and weaning from the ventilator were left to the treating physician's decision.

Compliance was assessed twice daily by the ICU team. Ventilator associated pneumonia (VAP) was defined as per the Center of Disease Control (CDC) as a pneumonia that occurs in a patient who was intubated and ventilated at the time of or within 48 h before the onset of the event. Pneumonia was identified using a combination of radiological, clinical, and laboratory criteria. In our study; VAP was clinically diagnosed based on modified CDC criteria **5.** Presence of any two of the following was considered as diagnostic of VAP;

1. Significant heavy growth reported in the culture from tracheal aspirates.
2. Temp.: > 38 c or <35 c.
3. Development of progressive new infiltrate on X-ray.
4. Leucocytosis $\geq 12000c/mm^3$ or leucopenia $\leq 4000c/mm^3$,
5. Ten leucocytes per HPF in gram stain of tracheal aspirates.

VAP rates were calculated based on occurrences per 1000 ventilator days and monitored on a monthly basis throughout the project period.

Incidence of VAP was calculated in the medical and surgical sub-populations who were subjected to VAP bundle. The outcome measures that were analyzed were mean length of stay, mean duration of ventilation, re-intubation rate and mortality rate.

Statistical Analysis of data

Statistical analysis was carried out using the SPSS computer package version 19.0 (SPSS Inc., Chicago, IL, USA). The collected data were statistically managed as follows:

1. For descriptive statistics: the mean ± SD were used for quantitative variables while the number and percentage were used for qualitative variables.
2. For analytic statistics: qualitative variables were compared by Fischer's exact test (FET), and quantitative variables were compared by independent samples t-test while Mann-Whitney -test (for two group comparison) and Wilcoxon Signed Rank test (for comparison within the same group) were used for non parametric statistics when appropriate.
3. The statistical methods were verified, assuming a significant level of $p< 0.05$ and a highly significant level of $p< 0.001$.

Results

Table (1): Age distribution in the studied groups.

Variable	Group A(No = 50) Mean ± SD	Group B(No = 50) Mean ± SD	t test	P Value
Age Min-Max	54.80 ±7.18 35 – 68	52.28 ± 7.25 38 – 66	1.75	0.084

There is no significant difference between both groups in age.

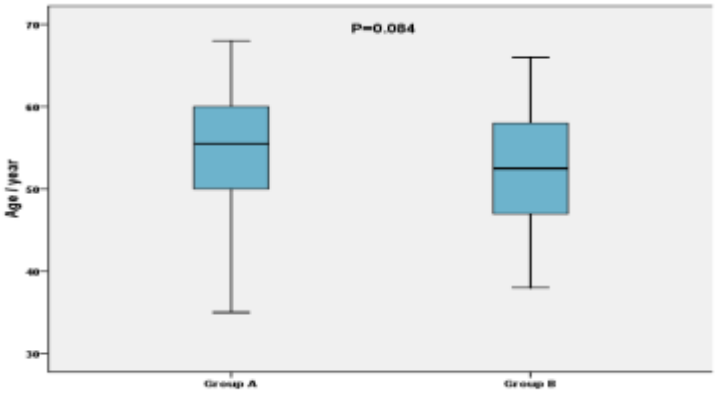

Figure (1): Age distribution in the studied groups.

Table (2): Co-morbid conditions in the studied groups.

Co-morbid conditions	Group A (No = 50) (%)	Group B (No = 50) (%)	FET	P Value
DM	23 (46.0 %)	25 (50.0 %)	0.16	0.841
RF	4 (8.0 %)	5 (10.0 %)	0.12	1.000
LC	2 (4.0 %)	1 (2.0 %)	0.34	1.000
HF	4 (8.0 %)	6 (12.0 %)	0.44	0.741
Malignancy	8 (16.0 %)	7 (14.0 %)	0.08	1.000

There is no significant difference between both groups regarding theprevalence of co morbid conditions.

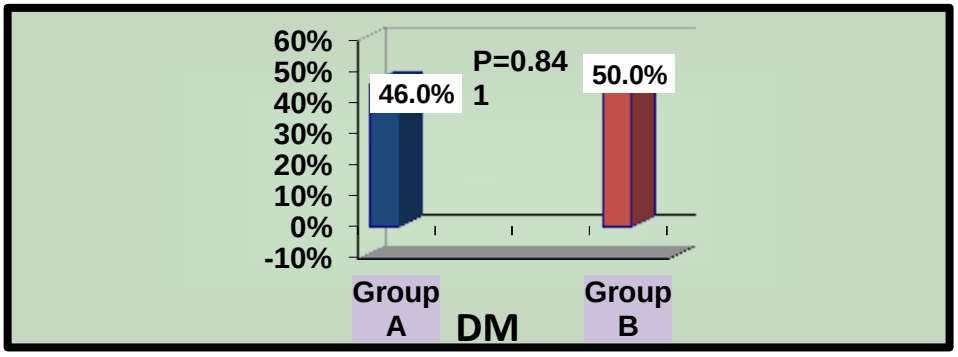

Figure (2): Prevalence of DM in the studied groups.

Table (3): Complete blood picture in the studied groups.

CBC	Group A (No = 50) Mean ± SD	Group B (No = 50) Mean ± SD	t test	P Value
WBC Min-Max	9.57 ± 4.83 2.8 – 19	9.92 ± 4.46 2.9 – 18	0.37	0.711
Hematocrit Min-Max	37.06 ± 5.46 27 – 49	36.64 ± 4.57 28 – 47	0.42	0.678
Platelets Min-Max	230.28 ± 79.65 110 – 390	210.82 ± 72.75 117 – 350	1.28	0.205

There is no significant difference between both groups in CBC.

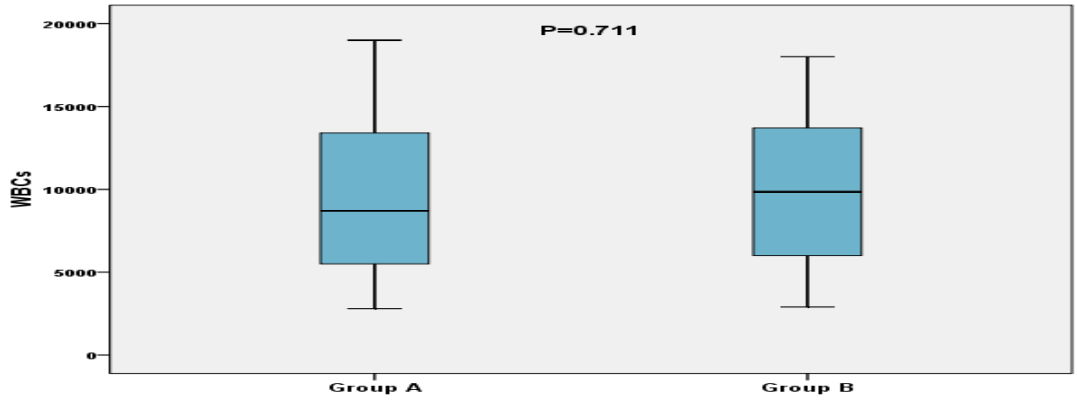

Figure (3): WBCs in the studied groups.

Table (4): Haemodynamics in the studied groups.

Haemodynamics	Group A (No = 50) Mean ± SD	Group B (No = 50) Mean ± SD	t test	P Value
MBP Min-Max	82.84 ± 11.83 65 – 105	82.40 ± 13.04 60 – 105	0.18	0.860
Pulse Min-Max	107.02 ± 17.93 85 – 139	104.34 ± 11.55 88 – 136	0.89	0.376
Respiratory rate Min-Max	30.14 ± 3.19 24 – 37	31.40 ± 3.73 26 – 40	1.82	0.072

There is no significant difference between both groups in hemodynamic.

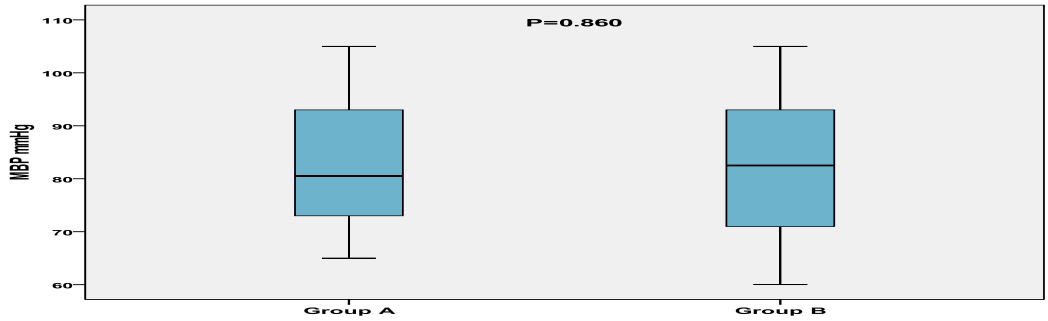

Figure (4): Mean blood pressure in the studied groups.

Table (5): Arterial blood gases in the studied groups.

Variable	Sepsis Related ARDS (No = 40) Group A Mean ± SD	Non-Sepsis Related ARDS (No = 20) Group B Mean ± SD	Z test	P Value
PH Min-Max	7.27 ± 0.04 7.22 – 7.34	7.29 ± 0.03 7.24 – 7.33	0.70	0.484
PaCo2 Min-Max	47.32 ± 11.44 28 – 66	44.50 ± 11.18 27 – 63	0.90	0.367
HCO3 Min-Max	24.08 ± 6.47 12 – 36	23.85 ± 8.93 10 – 39	0.20	0.838
PaO2 Min-Max	64.70 ± 9.99 48 – 81	62.00 ± 8.98 49 – 79	0.99	0.319
O2 Sat. Min-Max	89.91 ± 2.45 86 – 94.5	89.21 ± 1.87 86.2 – 93	1.03	0.304

There is no significant difference between both groups in ABG.

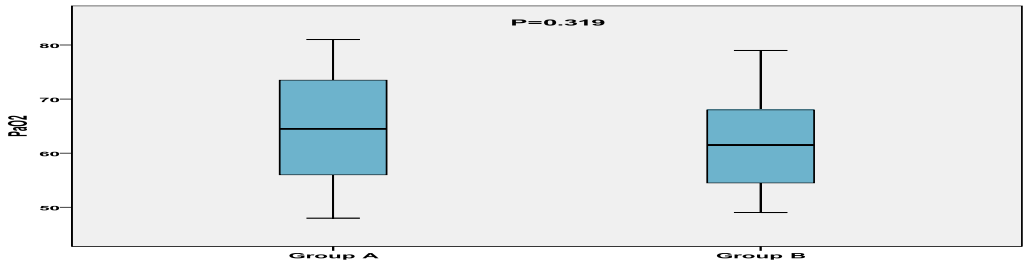

Figure (5): Arterial blood gases in the studied groups.

Table (6): Incidence of VAP in both studied groups

Variable	Group A No= 50 No (%)	Group B No = 50 No (%)	FET	P-value
Incidence of VAP	8 (16.0 %)	18 (36.0 %)	5.19	**0.039**

Incidence of VAP in group (A) was 16 % compared to 36 % ingroup (B) with significant difference.

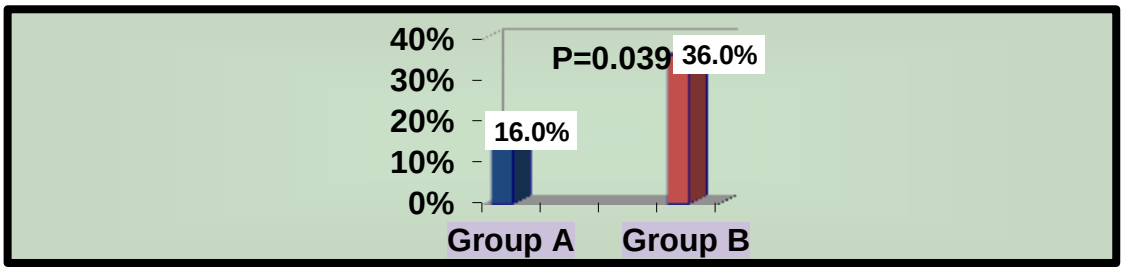

Figure (6): Incidence of VAP in both studied groups

Table (7): Incidence of VAP in both studied groups calculated as No. of cases/1000 ventilator days.

Variable	Group A No= 50	Group B No = 50	FET	P-value
Incidence of VAP No. of cases/1000 Ventilator days	14/1000	30/1000	10.39	**0.002**

Incidence of VAP in group (A) was 14/1000 ventilator days compared to 30/1000 ventilator days in group (B) with significant difference

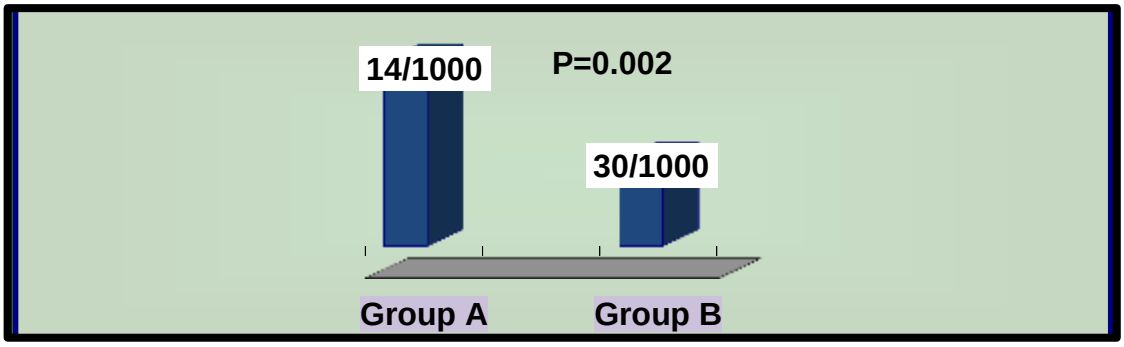

Figure (7): Incidence of VAP in both studied groups calculated as No. of cases/1000 ventilator days.

Table (8): Duration of MV in both studied groups.

Variable	Group A No= 50 Mean ± SD	Group B No = 50 Mean ± SD	t test	P-value
Duration of MV (in days) Min-Max	12.92 ± 4.54 4 – 21	17.00 ± 4.66 8 – 24	4.43	< **0.001**

There is significant decrease in duration of MV in group A than in group B.

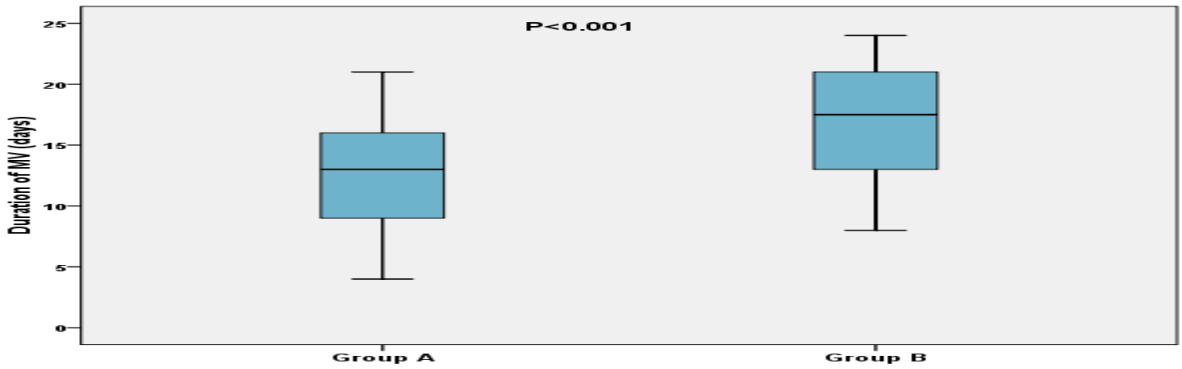

Figure (8): Duration of MV in both studied groups.

Table (9): ICU long of stay in both studied groups.

Variable	Group A No= 50 Mean ± SD	Group B No = 50 Mean ± SD	t test	P-value
ICU LOS (in days) Min-Max	13.90 ± 4.55 6 – 22	18.82 ± 5.48 9 – 27	4.88	< **0.001**

There is significant decrease in ICU stay days in group A than in group B.

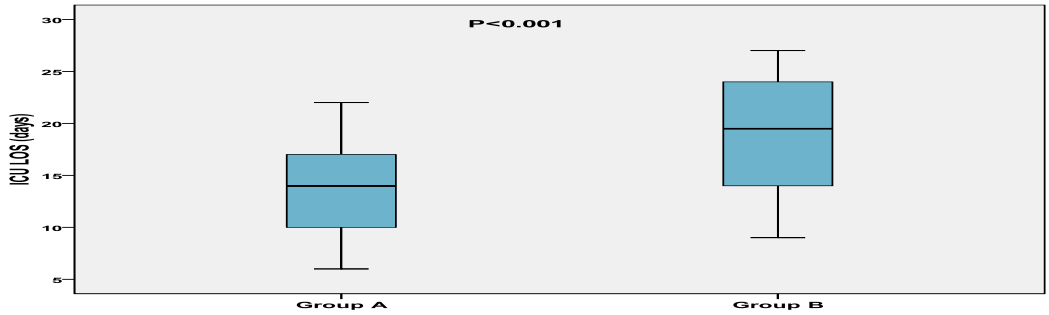

Figure (9): ICU long of stay in both studied groups.

Table (10): Re-intubation rate in both studied groups.

Variable	Group A No= 50 No (%)	Group B No = 50 No (%)	FET	P-value
Re-intubation rate	1 (2.0 %)	8 (16.0 %)	5.98	**0.031**

There is significant decrease in ICU stay days in group A than in group B.

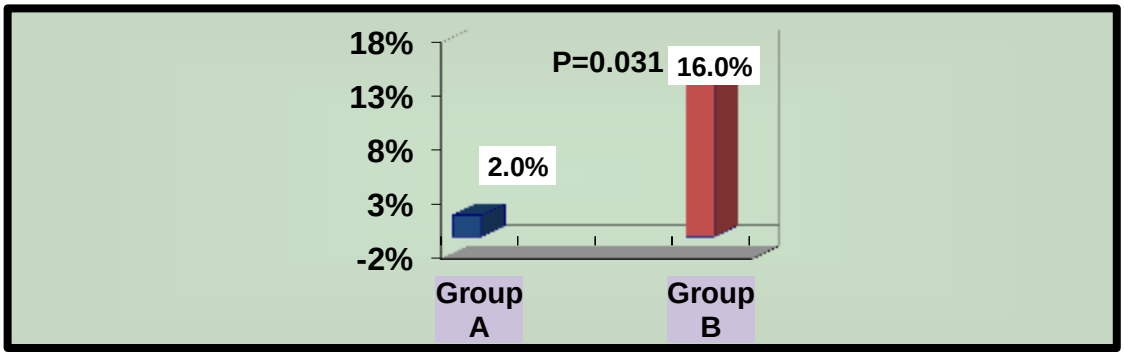

Figure (10): Re-intubation rate in both studied groups.

Table (11): Mortality rate in both studied groups.

Variable	Group A No= 50 No (%)	Group B No = 50 No (%)	FET	P-value
Mortality rate	6 (12.0 %)	15 (30.0 %)	4.88	**0.048**

Mortality rate in group A was 12 % compared to 30 % in group Bwith significant difference.

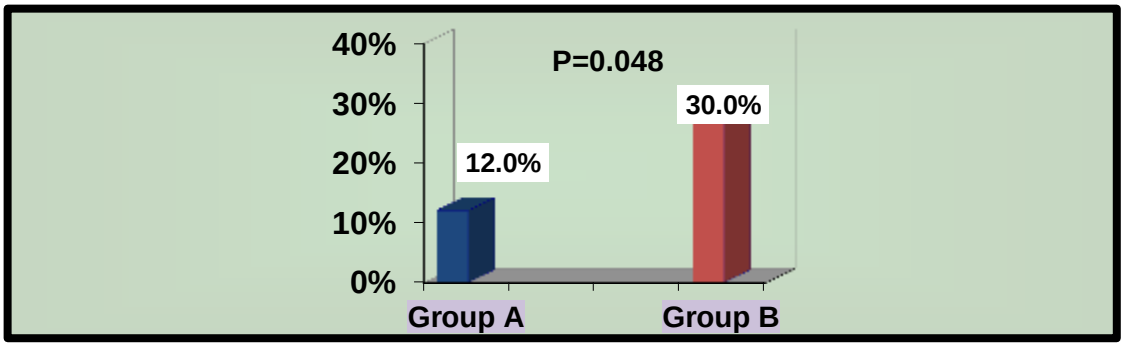

Figure (11): Mortality rate in both studied groups.

Table (12): Comparison between medical ICU patients in both groups.

Variable	Medical ICU patients (in group A) No= 25	Medical ICU patients (in group B) No= 25	FET or Z test	P-value
Incidence of VAP	6 (24.0 %)	9 (36.0 %)	0.86	0.538
Duration of MV Min-Max	14.72 ± 4.38 7 – 21	14.80 ± 3.89 8 – 22	0.05	0.961
ICU LOS Min-Max	15.72 ± 2.82 10 – 20	15.40 ± 3.19 9 – 21	0.34	0.733
Re-intubation rate	1 (4.0 %)	5 (20.0 %)	3.03	0.189
Mortality rate	5 (20.0 %)	8 (32.0 %)	0.94	0.520

There is no significant difference between medical ICU patients inboth groups in both VAP incidence and clinical outcome.

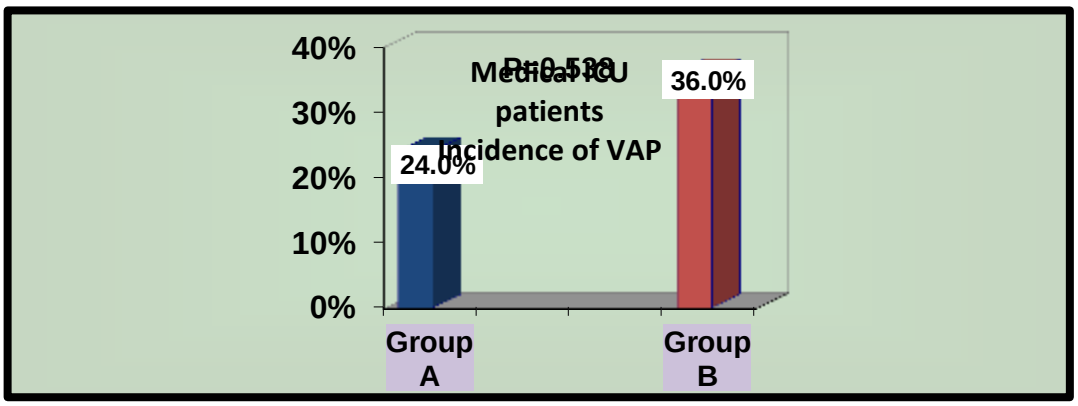

Figure (12): Comparison between medical ICU patients inboth groups in incidence of VAP

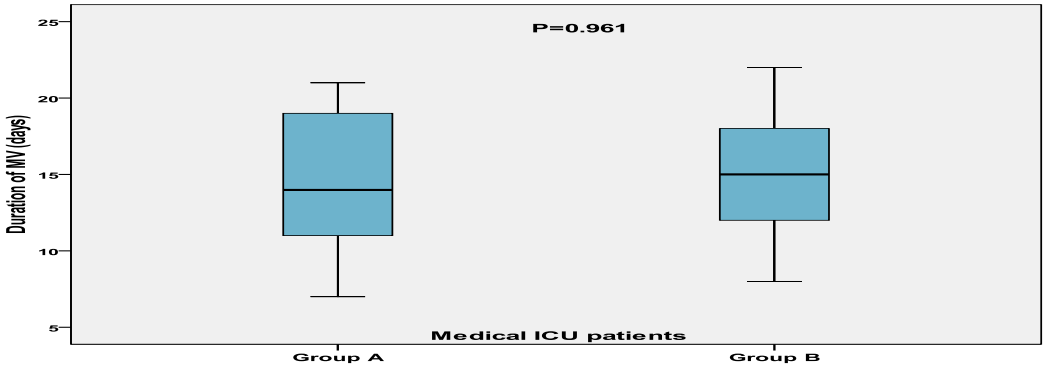

Figure (13): Comparison between medical ICU patients induration of MV.

Table (13): Comparison between surgical ICU patients in both groups.

Variable	Surgical ICU patients (in group A) No= 25	Surgical ICU patients (in group B) No= 25	FET or Z test	P-value
Incidence of VAP	2 (8.0 %)	9 (36.0 %)	5.71	**0.037**
Duration of MV Min-Max	10.48 ± 3.59 4 – 17	16.16 ± 4.34 8 – 24	4.10	< **0.001**
ICU LOS Min-Max	14.24 ± 4.43 6 – 22	18.92 ± 4.67 10 – 27	3.19	**0.001**
Re-intubation rate	0 (0.0 %)	3 (12.0 %)	3.19	0.235
Mortality rate	1 (4.0 %)	7 (28.0 %)	5.36	**0.049**

There is significant decrease in incidence of VAP, duration of MV, ICU LOS and mortality rate in surgical ICU patients in group A than corresponding patients in group B, while there was no difference in the re-intubation rate.

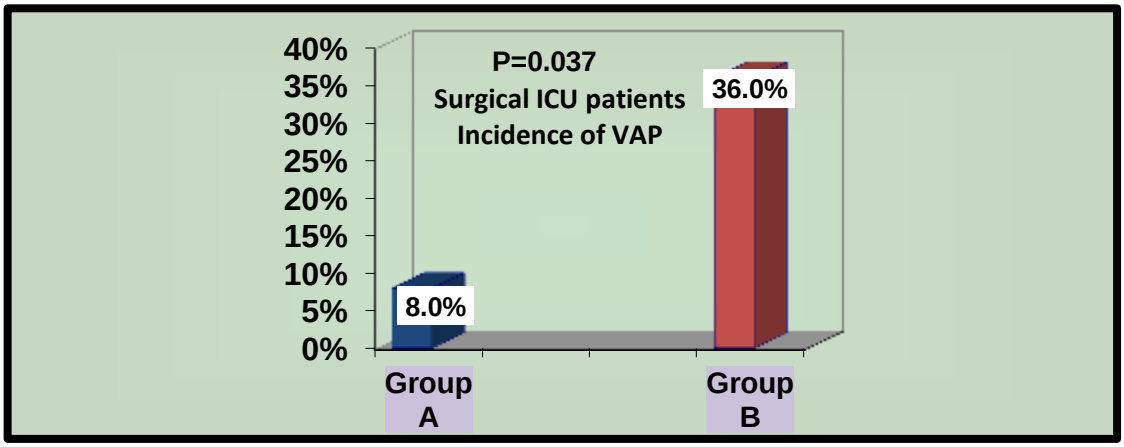

Figure (14): Comparison between surgical ICU patients in both groups in incidence of VAP.

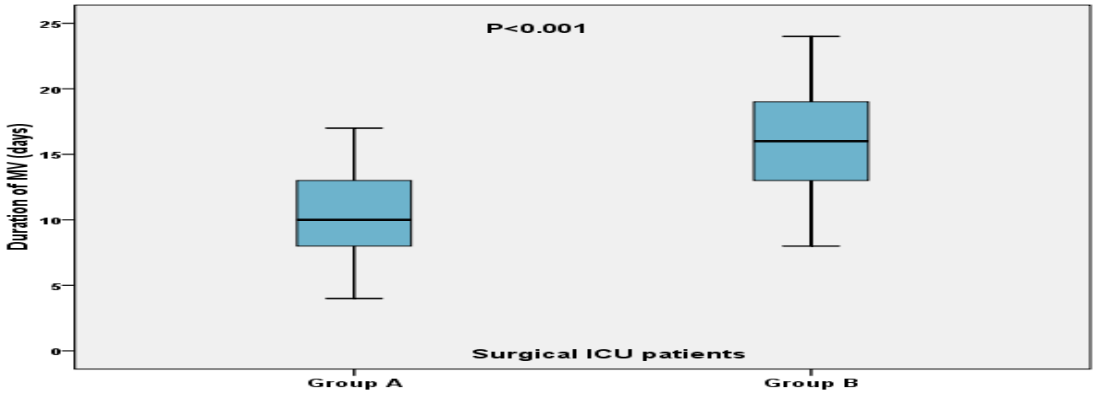

Figure (15): Comparison between surgical ICU patients in both groups in duration of MV.

Table (14): Comparison between medical and surgical ICUpatients in group A.

Variable	Medical ICU patients (in group A) No= 25	Surgical ICU patients (in group A) No= 25	FET or Z test	P-value
Age Min-Max	53.48 ± 8.38 42 – 68	48.04 ± 7.38 35 – 58	1.99	**0.047**
Male sex	17 (68.0 %)	15 (60.0 %)	0.35	0.769
Female sex	8 (32.0 %)	10 (40.0 %)		
Incidence of VAP	6 (24.0 %)	2 (8.0 %)	2.38	0.247
Duration of MV Min-Max	13.04 ± 4.17 7 – 21	10.0 ± 3.96 4 – 17	2.29	**0.022**
ICU LOS Min-Max	14.56 ± 2.8 10 – 20	12.28 ± 5.0 6 – 22	2.05	**0.040**
Re-intubation rate	1 (4.0 %)	0 (0.0 %)	1.02	1.000
Mortality rate	5 (20.0 %)	1 (4.0 %)	3.03	0.189

There is a significant decrease in age, duration of MV and ICU LOS in surgical patients than in medical patients in group A, while there is no difference regarding the sex distribution, incidence of VAP, re-intubation rate and mortality rate

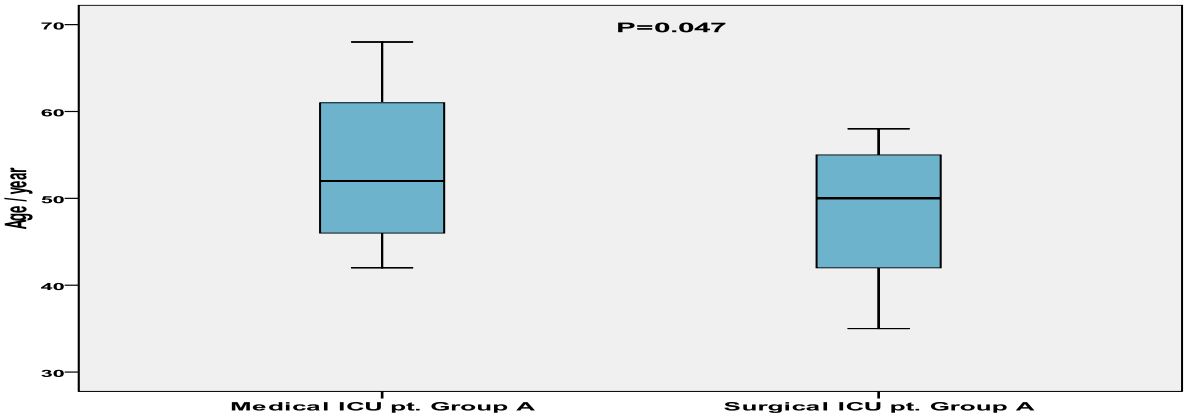

Figure (16): Comparison between medical and surgical ICUpatients in group A in age.

Figure (17): Comparison between medical and surgical ICUpatients in group A in duration of MV.

Table (15): Causative organisms of VAP

Variable	Group A No= 50 (%)	Group B No= 50 (%)	FET	P-value
Pseudomonas aeruginosa	14 (28.0 %)	15 (30.0 %)	0.05	1.000
Klebsiellapneumoniae	13 (26.0 %)	14 (28.0 %)	0.05	1.000
Penicillin sensitive Staph.	5 (10.0 %)	3 (6.0 %)	0.54	0.715
MRSA	4 (8.0 %)	4 (8.0 %)	0	1.000
Proteus	2 (4.0 %)	2 (4.0 %)	0	1.000
Acinetobacterbaumannii	0 (0.0 %)	1 (2.0 %)	1.01	1.000
E. Coli	3 (6.0 %)	4 (8.0 %)	0.15	1.000
Candida	1 (2.0 %)	2 (4.0 %)	0.34	1.000
Mixed organisms	8 (16.0 %)	5 (10.0 %)	0.79	0.554

Pseudomonas aeruginosa, Klebsiella pneumonia were the most common organisms of VAP followed by Penicillin Sensitive Staph, MRSA and E.Coli

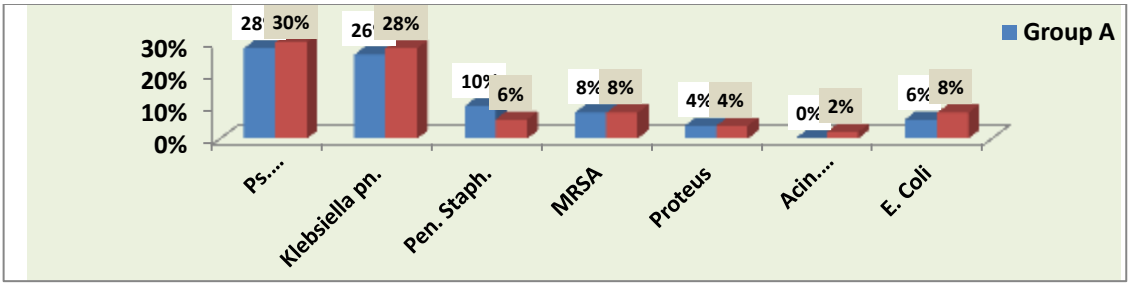

Figure (18): Causative organisms of VAP

Discussion

Ventilator-associated pneumonia (VAP) is among the most common infections in patients requiring endotracheal tubes with mechanical ventilation. It has been reported to occur in 9% to 27% of all intubated patients **2.** VAP is associated with increased hospital costs **16.**a greater number of days in the intensive care unit (ICU), longer duration of mechanical ventilation, and higher mortality **3.** The overall rate of ventilator-associated pneumonia (VAP) was 13.6 per 1000 ventilator days according to International Nosocomial Infection Control Consortium (INICC) report data summary for 2003-2008 compared to 3.3 per 1000 ventilator-days in the US National Healthcare SafetyNetwork (NHSN; formerly the National Nosocomial Infection Surveillance system (NNIS)**15.**

Because multiple factors contribute to the high risk of ventilator associated pneumonia, a multi‑strategy approach is required to prevent such infections. The Institute of Health Improvement (IHI) has developed a ventilator bundle that incorporates several strategies to prevent morbidity associated with the ventilator. The IHI ventilator bundle has been broadly adopted by many hospitals as part of the effort to reduce VAP. The use of VAP bundle has been reported to decrease the incidence of VAP in the intensive care units (ICUs) in few studies **6.**

The present study was established to detect the role of ventilator bundle strategy to prevent VAP and its impact on clinical outcome.

The study included one hundred patients; all were intubated and mechanically ventilated. Fifty patients (group A) were implemented to ventilator bundle protocol after education of nursing stuff. The other fifty patients (group B) considered to be control group, not implemented to ventilator bundle. Both groups were followed up to detect the incidence of VAP and if the ventilator bundle application had an impact on the clinical outcome.

In the present study, we revealed no difference between both groups regarding the prevalence of co-morbid conditions **(table 3).** Really, co-morbidities appear to be more common among medical ICU than in surgical ICU patients, but in this situation, we are comparing two groups in which each composed of a mixture of both medical and surgical patients. Most studies that were interested in the ventilator bundle, did not intend to co-morbidities as a variable that could affect the incidence and fate of VAP altogether with ventilator bundle. **1** is one of the few studies that considered comorbidities and explained the cause of mechanical ventilation, however, they did not reveal any difference in the prevalence of co-morbidities among all 6 groups of their study.

Comparing laboratory findings between two groups, there was no any significant difference in hematocrit, leucocytes, and platelets and all arterial blood gases components including PH. Pao2, Paco2, HCO3 and O2 saturation **(tables 3, 5)**.**10** ; revealed no significant difference in complete blood picture, ABG and serum Na, and K between the two groups of his study. Also, **1**; in their study, revealed no significant difference in CBC, ESR, CRP, liver enzymes and serum creatinine.

Hemodynamics including the mean blood pressure, heart rate and respiratory rate were similar in both groups in our study without significant difference **(table 4)**. **10**; added APACHE score to compare the clinical status between studied groups, which may be more reliable in comparison than hemodynamics only. However, he did not reveal any difference whether in hemodynamics or APACHE score between both groups, results that agree with our study.

In the present study, we revealed that the incidence of VAP was decreased from 36 % in ventilated patients not subjected to the ventilator bundle strategy to 16 % in patients subjected to the ventilator bundle with both clinical and statistical difference **(table 6)**. In other words, the incidence of VAP was significantly decreased from 30 per 1000 ventilator days to 14 per 1000 ventilator days **(table 7).** Comparing the incidence of VAP in medical and surgical ICU patients in both groups, VAP incidence was decreased from 36 % to 24 % (reduced by 12%)in medical ICU patients in both groups, and decreased from 36 % to 8 % (reduced by 28%) in surgical ICU patients in both groups. Regarding the causative organisms of VAP in the present study, Pseudomonas aeruginosa, Klebsiella pneumonia were the most common organisms of VAP followed by Penicillin Sensitive Staph, MRSA and E.Coli**(table 15).**

Ventilator bundle not only affected the incidence of VAP, but also, had an impact on the clinical outcome. In the present study, the mean duration of mechanical ventilation and ICU stay days were significantly decreased in patients subjected to ventilator bundle than in patients of the other group. Also, the rate of re-intubation was less in patients implemented to the ventilator bundle. Regarding the mortality rate, it significantly decreased from 30 % in patients not subjected to ventilator bundle to 12 % in patients implemented to the bundle **(tables 8, 9, 10, 11) 10** obtained similar results; he reported a mortality rate of 15 % in patients implemented to the ventilator bundle compared to 23 % in patients not subjected to the bundle. The re-intubation rate was decreased from 26% in patients not subjected to the ventilator bundle to 16% in the other group. Also, the mean duration of mechanical ventilation and ICU stay days were significantly decreased in patients implemented to the ventilator bundle.

In the study of **1** despite of decrease in VAP incidence in the patients that implemented to oral cleaning by chlorohexidine, as a part of the ventilator bundle, the duration of mechanical ventilation and ICU stay days were similar between all groups, results that disagree with our study. This may be simply explained by their involvement of only on component of the ventilator bundle, neglecting remaining and important measures that could reduce the incidence of VAP like head elevation and daily sedation vacation.

Studies have shown that the risk of VAP increases with the increase in the duration of mechanical ventilation **8.** Also, the organisms responsible are multiresistant and require a higher broad spectrum antibiotic for at least 2 weeks for cure. Thus this results in longer length of stay and prolonged use ventilator support. There is always a threat to the other patients of getting this infection as a result of cross contamination through the hands of the health care workers. Thus it results in increase in the burden to the health care costs and the ICU resources **16.** This means that providing of ventilator bundle decreases duration of mechanical ventilation that itself decrease the chance for development of VAP.

In the present study; each main group included on medical and surgical patients, when we compared the clinical outcome in both surgical and medical patients in both groups, we obtained significant results. For medical ICU patients, the mean duration of mechanical ventilation, ICU stay days, the rate of re- intubation and the mortality rate, all were lower in patients subjected to ventilator bundle than in patients not subjected to the bundle but not statistically significant. However; in the surgical ICU, the mean duration of mechanical ventilation, ICU stay days, the rate of re- intubation and the mortality rate, all were significantly lower in patients subjected to ventilator bundle than in patients not subjected to the bundle **(tables 12, 13, 14) 10** obtained similar results, in which the group of medical ICU intubated patients had increased VAP incidence with poorer clinical outcome than in surgical patients.

The higher rate of VAP in medical subgroup after the bundle was implemented could be attributed to higher mean age of this population as the age and other co-morbidities are independent risk factors for the development of VAP in critically ill patients**3**Another factor that helps in decreasing the rate of VAP in surgical subgroup was a lower re-intubation rate which may be a reason for limiting aspiration pneumonia and infection. Furthermore the pathogenesis of VAP commences in most cases with the bacteria entering the trachea during initial intubation, during subsequent re-intubations as this was studied by **17** when they reviewed more than one hundred surgery and trauma patients who underwent BAL within 48 h of intubation. They found that 90% of specimens had some growth and 58% had at least 104 colony forming units/ml. Patients subsequently diagnosed with VAP often grew the same organisms as they were present on the initial BAL.

Conclusion

Application of Ventilator Bundle Strategy was practical to reduce incidence of VAP in both medical and surgical ICU population.

It reduced the mean duration of mechanical ventilation and ICU stay days in both medical and surgical ICU populations. Implementing of ventilator bundle had reduced mortality rate in both medical and surgical populations.

The effectiveness of ventilator bundle in prevention of VAP and improving the clinical outcome was more evident in surgical ICU than in medical ICU patients.

Recommendations

Ventilator Bundle should be generalized to be applied on large number of ICU populations; hence, obtained results could be more reliable and evident.

Compliance to ventilator bundle components should be always assessed before judging on the reliability of ventilator bundle application results.

References

1. Abbas Hussein, AsgharKhalifahzaden, Ahmed Parizade(2016).The effects of an oral care practice on incidence of pneumonia in ventilated patients in ICUs of selectedhospitals in Isfahan 2010. Iranian journal of nursing and midwiferyresearch (17) 3, 216.
2. American Thoracic Society; Infectious disease society of America(2005).Guidelines for the management of adults with hospital –acquired, ventilator associated, and health care associated pneumonia. Am J RespirCrit Care Med, Vol 171, No 4, pp.388-416.
3. Bekaert M, Timsit JF, Vansteelandt S, Depuydt P, VésinA,Garrouste-Orgeas M, et al. (2011): Attributable mortality of ventilator- associated pneumonia: A reappraisal using causal analysis. Am J RespirCrit Care Med;184:1133-9.
4. Bukhari S. Z., Hussain W. M., Banjar A. A., Fatani M. I., et al., (2012): Application of ventilator care bundle and its impact on ventilator associated pneumonia incidence rate in the adult intensive care unit. Saudi Med J; 33 (3): 278-283.
5. CDC. Ventilator associated pneumonia (VAP) events (2011): In: CDC, ed. Device associated events. Atlanta, GA: CDC; 2011: 6–1:6–14.
6. Cocanour CS, Peninger M, Domonoske BD, Li T, Wright B, Valdivia A, et al. (2006); Decreasing ventilator-associated pneumonia in a trauma ICU. J Trauma;61:122.
7. Ho KM ,Chavan S , Pilcher D (2011): Omission of early thromboprophylaxis and mortality in critically ill patients: a multicenter registry study . Chest; 140: 1436 – 1446.
8. Ibrahim, E.H., Tracy, L. and Hill, C. et al (2001) The occurrence of ventilator-associated pneumonia in a community hospital: risk factors and clinical outcomes. Chest, Vol 120, No 2, pp. 555–561.
9. Institute for Helathcare improvement (2015).Getting started kit :Ventilatory bundle for prevention of ventilator associated pneumonia. Available at http://www.ihi.org/ IHI/programms/CAMPAIGN [accessed, February 3, 2015].
10. Kamel, 2013; Compliancewith VAP bundle implementation and itseffectiveness on surgical and medicalsub- population in adult ICU. Critical Care Medicine, CairoUniversity, Egypt .The Egyptian Society of ChestDiseases and Tuberculosis.
11. Lin PC, Chang CH, Hsu PI, et al. (2010): The efficacy and safety of proton pump inhibitor vs histamine2 receptor antagonist for stress ulcer bleeding prophylaxis among critical care patients. CritCrit Care Med; 38: 1197 – 1205.
12. Niel-Weise BS ,Gastmeier P , Kola A , et al. (2011): An evidence-based recommendation on bed head elevation for mechanically ventilated patients. Crit Care; 15: R111.
13. 13-Reasar, F.R., Pronovastp, H.C. and Simmonds, T. et al (2005) Using a bundle approach to improve ventilator care processes and reduce ventilator-associated pneumonia. JT comm. J qual patient saf, Vol 31, pp.243-221.
14. Reo-Neto, A., Youssef, N.C. and Tuche, F. et al (2008)Diagnosis of Ventilator associated pneumonia: a systematic review of literature.Crit Care Med, Vol 12, No 2, pp. 1-14.
15. Rosenthal VD, Maki DG, Jamulitrat S, Medeiros EA, Todi SK, Gomez DY, et al (2010); International Nosocomial Infection Control Consortium (INICC) report, data summary for 2003-2008, issued June 2009. Am J Infect Control;38:95-104.
16. Warren DK, Shukla SJ, Olsen MA, Kollef MH, Hollenbeak CS, Cox MJ,et al (2003); Outcome and attributable cost of ventilator-associated pneumoniaamong intensive care unit patients in a suburban medical center. CritCare Med;31:1312-7.
17. W.L. Wahl, C. Zalewski, M.R. Hemmila, (2011); Pneumonia in thesurgical intensive care unit: is every one preventable?, Surgery 150 665–672.
18. Zilberberg, M.D., Shorr, A.F. and Kollef, M.H. et al (2009) Implementing quality improvements in the intensive care unit: ventilator bundle as an example. Crit Care Med, Vol 37, No 1, Jan, pp.305-309.

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