Epidemiology of Ventilator Associated Pneumonia in Hospital SurgeryIntensive Care Units of Ain Shams University Hospital

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Abstract

Background: Ventilator-associated pneumonia (VAP) is the most common intensive care unit acquired infection, and it is associated withincrease in hospitalization, health care cost and mortality. It classified into early onset or late onset. **Objectives:** measure the incidence rate and risk factors of VAP, measure the VAP impact on length of stay in ICU and duration ofmechanical ventilation and to measure adherence to IHI (institute of health improvement) ventilator bundle. **Methods**: A prospective study conducted at surgery hospital ICUs.All ventilated patients who didn't developed chest infections after 48h of mechanical ventilation are followed until discharge from ICU. **Results**: 56.2% of the study population wasmales; the mean age was 43.2± 15.6. Incidence density was 38.3per 1000 ventilation day. Early onset VAP was 47.5% and late onset VAP was 52.5%. The independent risk factors of VAP infection are age ≥ 60 years, duration of mechanical ventilation, smoking, chest diseases, insertion of IV cannula and APACHE II score.Crude mortality rate was 42.1%. VAP infection has a significant impact on both the length of stay in ICU and duration of mechanical ventilation.VAP cases have lower adherence to all IHI ventilator bundle elements and the overall compliance was 71± 22.8 in VAP cases versus 80.7±16.0 in non VAP. Gram negative MDRs bacteria were isolated in 84.3% of VAP cases.The commonest isolated bacteria wasAcintobacter(33.9%).**Conclusion:**VAP is a serious ICU acquired infection with significant impact and required effective preventive action.

Keywords: *VAP, incidence rate, impact, bundle adherence*

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Introduction

Ventilator-associated pneumonia (VAP) is the most common hospital acquired infection in the intensive care unit, and it is associated with prolonged hospitalization, increased health care costs, and high attributable mortality.[1]

VAP is defined by the Center for Disease Control and Prevention (CDC) as pneumonia in persons who had a device to assist or control respiration continuously through a tracheotomy or by end tracheal intubation within the 48-hour before the onset of the infection[2]. It is commonly classified as either early onset (occurring within 96 hours of start of mechanical ventilation) or late onset (occurring more than 96 hours after start of mechanical ventilation)[3].VAP is a significant hospital acquired infection affecting up to one third of patients requiring mechanical ventilation, and is associated with significant attributable morbidity and mortality[4]. A study conducted at the surgery ICU of Ain Shams university hospitals showed that among the ventilated patients who

developed VAP, 41% was early onset VAP and late onset was 59%[5].Also, VAP iseconomically important hospital-acquired infection complicating the course of patients receiving mechanical ventilation and associated with an increase in over $40,000 in mean hospital charges per patient[6].In a study conducted at ICU of a tertiary hospital in India 37% of patients developed VAP during the ICU stay[7]. Another study conducted in Iran owed that the incidence of VAP varies from 15.4% to 32.2% [8]. Patients in ICU especially who are ventilated have multiple factors that increase the risk for development of VAPcould be classified into host factors as (Age, gender and present of chronic diseases as diabetes mellitus) and intervention factors as (patient position , invasive procedure and antibiotics use)[9] . Diagnosing VAP is difficult in ICU patients with multi-organ failure. In addition, differentiating lower respiratory tract infection from colonization can be a difficult task in patients requiring mechanical ventilation [10]. In addition, lack of a gold standard for the diagnosis is a major culprit of poor outcome of VAP[7]. Reducing mortality due to ventilator-associated pneumonia requires an organized process that guarantees early recognition of pneumonia and consistent application of the best evidence-based practices. The Ventilator Bundle is a series of interventions related to ventilator care that, when implemented together, will achieve significantly better outcomes than when it implemented individually. There are many types of bundle which have different components and also, different effect in reducing the incidence of VAP. One of these bundles is the institute of healthcare improvement (IHI) Ventilator Bundle

Elements of IHI ventilator bundle include Elevation of the Head of the Bed, Daily "Sedation Vacations" and Assessment of Readiness to extubate, Peptic Ulcer Disease Prophylaxis, Deep Venous Thrombosis Prophylaxis and Daily Oral Care with Chlorhexidine

Applying IHI's ventilator bundle in the care of ventilated patients can markedly reduce the incidence of VAP an average 45% reduction in the incidence of AP was observed in the ICUs that applied the IHI ventilator bundle[11].Surveillance for HAI is one of the major activities of the infection control program. Availability of accurate data is mandatory for prevention and control of different HAI including VAP and required for evaluation of patient safety and quality health care in health care setting. This study was carried out to help in reducing the VAP rate among the ventilated patients in surgery hospital ICU Ain Shams University hospital through determiningthe magnitude,risk factors and impact of the VAP and the degree of adherence to IHI ventilator bundle.Study objectives were to measure the incidence rate of VAP among the ventilated patients in surgery hospital ICUAin Shams University hospital, to identify the risk factors of VAP, to measure the VAP impact on length of stay in ICU and duration of mechanical ventilation and to measure the degree of adherence to IHI (institute of health improvement) ventilator bundle.

Participants and methods:

Study design: A prospective study was carried out to measure the incidence of the ventilator-associated pneumonia among ventilated patients in surgery intensive care units in Ain Shams University Hospitals

Study setting: Surgery intensive care units in Ain Shams University Hospital (Causality, general surgery and neurosurgery ICU),which receive patients who need intensive care from the different general surgery departments and causality

Study participants: All ventilated patient admitted to surgery hospital ICUs were followed up since put on ventilator until

discharged from the intensive care units. They are divided into two groups (cases and non-cases) to find out the risk factors of the ventilator associated pneumonia.

Exclusion criteria included patient admitted with respiratory infections from the community or transferred from other hospital, patients who developed respiratory infections or died within (48 hours) after ventilation and patients less than 15 years old as APCHE II score is not valid below this age.

Sample size justification: Sample size was estimated to be 240 patients using EPi info 7 statistical package using α error= 0.05, power 80%. Total numbers of ICU patients according to the hospital records of 2011 there are (1118 patients) were admitted to general surgery ICUs half of them were ventilated.Expected rate of the pneumonia among ventilated patients was revealed from other studies to be (37%). Percentage of unexposed patients to risk factor (patient position) with the outcome (VAP), was 27.14% and the relative risk was 2.22.[7]

Tools of the study: A worksheet was used for data collection about the following items: Patients characteristics, clinical data and patients'co-morbidities (risk factors), date of ventilation and date of discharge from the ICU, length of stay in ICU, duration of mechanical ventilation and degree of adherence to IHI ventilator bundle.

Criteria used for diagnosis of VAP (based on (CDC/NHSN Ventilator-Associated Pneumonia Definition, 2013) was also included.

Study duration: 14 months(DEC.2013 to Jan2015)

Statistical analysis: Analysis was done by using SPSS (Statistical Package for Social Science) version 18 statistical package. Descriptive analysis was done in the form of averages, range and SD.Analytical analysis was done by using tests of significance Parametric tests (t test, ANOVA and chi-squared test) and Non-parametric tests(Mann-whitney and Kruskal Wallis test). Multivariate logistic regression was performed to identify independent risk factors of VAP. Differences was considered significant at p value less than or equal to 0.05

Ethical consideration: Approval from the Ain Shams University Ethical Review Committee, the heads of surgery departments and heads of nurses in different ICUs was obtained before the study beginning.

Results and discussion

During the study duration 240 patients were enrolled they divided into two groups 80 patients with VAP (33.3% and 160 patients without(66.7%).

About fifty seven percent (57.5%) of VAP cases were males versus (55.6%)(p=0.07) in non VAP group and the mean age was 45±15.5 in VAP cases versus 44.3±15.3 in non VAP (p=0.7).This is similar to study conducted by Al-Bagouryand her colleagues 2015 in El-Demerdash hospital as males represented (55.6%) of the studied population and the mean age was 38.2 year. This could be explained by that both studies conducted at the same place. Obesity was prevalent in both groups as (43.8%) of VAP cases was obese VS (48.8%)in non VAP group (p=0.1). This could be explained as obesity is a common public health problem nowadays and usually associated with other co-morbidities which need hospital admission.15% of VAP cases were exposed to re-intubation versus 12.5%innon VAP group (p=0.6). This is similar to Badwi and his colleagues 2012 as 18% of cases were exposed to re-intubation. APACHE II score was higher inVAP cases than non VAP. Themean score was 18.9±4.2 in VAP group versus 17.2± 6.5 in non VAP group (p=0.03). This could be explained by the high APACHE score that is associated with low physiological conditions(Table 1).

Figure(1)Shows that 33.3% of ventilated patient developed VAP infection the incidence density was 38.3/1000ventilation day there is no statistical significance change in VAP rate during the study duration as Chi-square for trend was 0.004(p 0.94). This is similar to Gandani et al 2010[7] and kamel et al 2014[13] as(37%) and (34%) of admitted patients developed VAP respectively and lower than the incidence in a study conducted by Badawi and his colleagues 2015[12] as (60%)of patient admitted to chest ICU developed VAP this higher incidence could be explained by that all studied patients have Chronic Obstructive Pulmonary Diseases (COPD) which increased the risk of VAP.

VAP cases have higher co-morbid conditions and risk factors during ICU admission than non VAP as (43.8%) of VAP cases were smoker vs (30%) in non VAP group (p=0.03). (23.7%) of VAP cases have chest diseases vs (7.5%) in non VAP group (p<0.001),(88.8%) of VAP cases have central line vs (47.5%) in non VAP group (p<0.001). (80%) of VAP cases exposed to surgical intervention vs (63.3%) in the other group (p=0.008). Crude mortality rate was higher in VAP cases than non VAP (57.3%) vs (34.4%) respectively (p=0.005).This is similar to the finding ofAl-Bagouryand her colleagues 2010[5] and Huang WY, et al, 2012[14] as they found that VAP cases have higher co-morbidities and exposure to invasive procedures during ICU admission than controls(Table 2).

VAP cases stay more time in ICU than patients without VAP as the median(IQR)length of stay in ICU for VAP cases was 15.5 days (11.5) vs 6 days (3) in patients without VAP(p<0.001) and extra length of stay in ICU was (9.5).This is similar toNseir et al 2005[15]as the extra length of stay due to VAP infection was 9 days. VAP cases stay more time on ventilator than patients without VAP as the median (IQR) length of mechanical ventilation for VAP cases was 12 days(10) VS 5 days (3) in patients without VAP(p<0.01) and extra duration of mechanical ventilation was (7). This is similar to results of a study conducted by Gadani and his colleagues 2010[7] as the extra duration of mechanical ventilation was 7 days (Table 3).

Figure (2) shows that 47.5% of VAP cases was early onset (first 96h of mechanical ventilation) and 52.5% was late onset (after 96 hours of mechanical ventilation) .This is similar to the finding in the study conducted by Jordi et al 2002[16] as 45.2% of VAP was early onset and Badawi and his colleagues 2015[12] as early onset was 41% and late onset was 59%.

In figure 3,Multi-drug resistance gram negative bacteria caused 84.7% of VAP infection, the commonest isolated gram negative bacteria was multi drug resistance Acintobacterspp (33.9%) followed by Klebsillaspp(32.3%) then Pseudomonas aeruginosa(12.9%) and the commonest gram positive isolated bacteria was MRSA (13.6%). This is similar to Leblebicioglu 2007[17] as gram negative isolated from 71% of VAP cases and the commonest one was Acintobacterspp(29%) and Predo et al 2009[18] as the commonest isolated bacteria from VAP cases was Acintobacterspp(28%).

In table (4) VAP cases showed lower mean adherence to IHI ventilatorbundle elements than Non VAP cases and this difference was statistically significance. The lowest adherence in the cases was in element (5); daily oral care with Chlohexidinewithmean± SD (21.1± 41.1) vs (60±49) in non VAP cases (p=0.001), then element (2); daily assessment of readiness to extubate as it has a mean±SD (62.7±25.3) vs (70.4± 28.9) in non VAP cases (p=0.04), element (3) PUD prophylaxis as it has mean±SD (93.7±14.8) Vs (98±8.5) in non VAP cases (p=0.005) and the overall

compliance has mean +SD (71.8±22.8) vs (80.7±16.01) in non VAP cases (p=0.002). This low adherence to IHI ventilator bundle reflects the effect of bundle in prevention of VAP infection.

Table (5) shows that the six independent risk factors for VAP using the logistic regression model are (age≥60 year, duration of MV, smoking, chest infection, IV cannula insertion and APACHE II). This is in agree with a study conducted by Kolleff and his colleagues 1993, as age and duration of MV were risk factors of VAP infection.Al Bagoury and her colleagues 2010[5] and Eleni et al 2003[20]reported that duration of mechanical ventilation and chest infection were risk factors of VAP infection and Badwi et al 2015[12]added that old age , chest diseases and smoking were risk factors of VAP.

Limitations of study: Absent of electronic records for patients during their ICU admission. The results of this study can't be generalized to other heath facilities like general hospitals as the studied sample was restricted to a university hospital

Conclusion:

VAP is a serious ICU acquired infection with a significant impact on mortality, length of stay and duration of mechanical ventilation in the surgery ICUs at Ain-Shams university hospitals. Adherence to ventilator bundle like IHI bundle associated with significant reducing in the VAP incidence

Recommendations: Providing the required resources for practicing infection controlespecially in high risk areas like ICU as (materials, training courses and up-to-date techniques). Applying programs for infection control included all stages of patient treatment from admission until discharge these programs must beMulti-model program incorporating staff education, process measurement, outcome measurement, feedback to staff and organizational changes recommended by standard organization like CDC. Continuous surveillance by using standard methods for data collection and training medical staff (doctors and nurse) on using it should be set.Application of preventive measures for VAP infection like IHI ventilator bundle is mandatory.

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Table (1): Patients Characteristics and Clinical Data

Patients characteristics and clinical data		Cases of VAP N=80 N(%)	Non VAP cases N=160 N(%)	Test of significance	P value
Gender	Male	46 (57.5)	89(55.6)	0.78¥	0.07
	Female	34(42.5)	71(44.4)		
Age (ys) Mean± SD		45.2+15.5	44.3+ 15.3	0.38¥¥	0.7
BMI	Underweight	2(2.5)	0(0)	2.6¥	0.1
	Normal	17(21.3)	23(14.4)		
	overweight	26(32.5)	59(36.9)		
	Obese	35(43.8)	78(48.8)		
Re-intubation		12(15)	20(12.5)	2.8	0.6
APACHE II (Mean±SD)		18.9+4.2	17.2+ 6.5	2.14¥¥	0.03*

¥significant difference since p<0.05

Table(2): Patients Co-Morbidities, Risk Factors during ICU Admission and Mortality Rate

Patients co-morbidities/risk factors and mortality		Cases of VAP N=80 N(%)	Non VAP cases N=160 N(%)	Test of significance	P value
Smoking		35(43.8)	48(30)	4.45	0.03*
diabetics mellitus		23(28.8)	54(34.2)	0.71	0.39
Hypertension		23(29.1)	38(23.8)	0.8	0.37
Chest diseases		19(23.8)	12(7.5)	12.5	<0.001*
Cardiac diseases		20(25)	34(21.3)	0.43	0.51
Antibiotic use	prophylactic	0(0)	125(78)	132	<0.001*
	therapeutic	80(100)	35(22)		
Central line		71(88.8)	76(47.5)	38.2	<0.001*
IV cannula		20(25)	114(71.3)	46.3	<0.001*
Surgical intervention		64(80)	101(63.1)	7.06	0.008*
Urinary catheter		78(97.5)	155(98.3)	4.01	0.04*
Crude mortality rate		46(57.5)	55(34.4)	12.9	0.005*

* significant difference since p<0.05

Table (3): Comparison between VP Cases and Non VAP Cases regarding Length of Stay in ICU and MV

LOS and duration of MV	VAP cases (N=80)	Non VAP (N=160)	Test of sig (Mann whitney)	p value
length of stay in ICU median (IQR)	15.5(11.5)	6(3)	9.5	<0.001*
length of stay on MV median (IQR)	12(10)	5(3)	2.5	0.01*

* significant difference since p<0.05

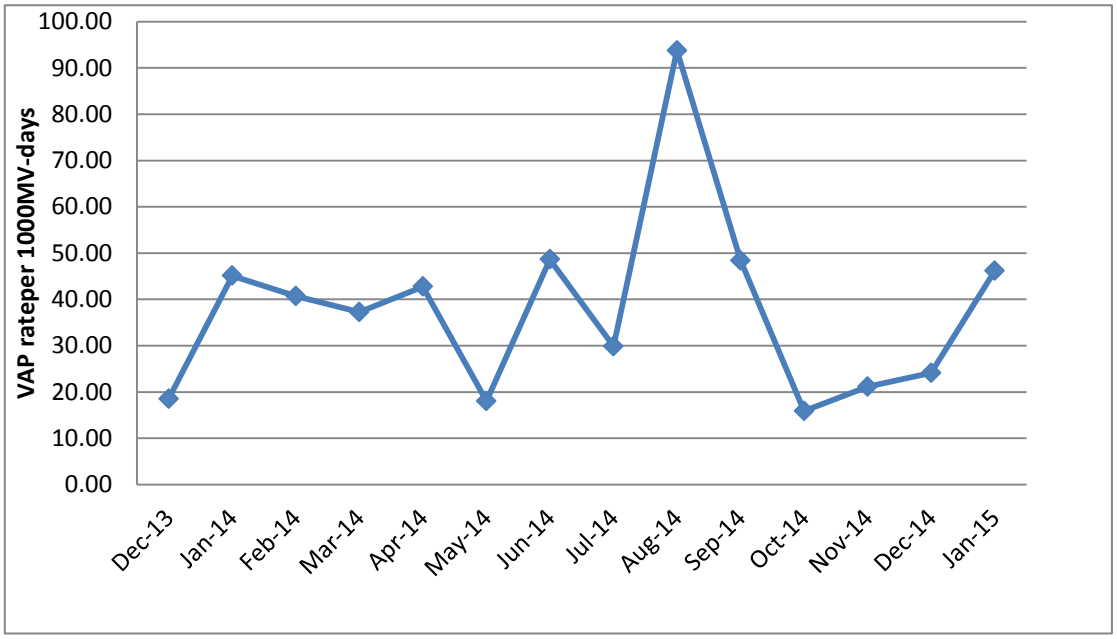
Table (4):Comparison between VAP Cases and Non VAP Cases regarding Mean Adherence to IHI Bundle

	VAP Cases Mean±SD	Non VAP cases Mean±SD	Test of sign (t test)	P value
1. Raise head of the bed 30^{o}	87.9 ±23.6	88.9 ±27.1	0.28	0.77
2. Daily assessment of readiness to extubate	62.7 ±25.3	70.4 ±28.9	2.05	0.04*
3. PUD prophylaxis	93.7 ±14.8	98 ±8.5	2.86	0.005*
4. DVT prophylaxis	93.7 ±25.2	86.1 ±28.5	0.95	0.34
5. Daily oral care with chlohexidine	21.2 ±41.1	60 ±49.1	6.06	<0.001*
Overall compliance	71.8 ±22.8	80.7 ±16.07	3.48	0.002*

* significant difference since p<0.05

Table (5): Multivariate Logistic Regression Analysis for Predictors of VAP.

	B	OR	95% CI		Wald	P value
			Lower	Upper		
Age ≥ 60	0.99	0.37	0.13	1.05	3.48	0.05*
Gender	0.18	1.20	0.40	3.60	0.11	0.74
Duration of MV	0.32	1.37	1.23	1.53	31.86	<0.001*
Re -intubation	0.16	0.86	0.28	2.64	0.07	0.78
Smoking	1.32	3.75	1.22	11.57	5.28	0.02*
Chest diseases	1.56	4.74	1.41	15.94	6.31	0.01*
Hypertension	0.43	1.54	0.58	4.07	0.74	0.38
Central line insertion	0.26	1.29	0.41	4.06	0.19	0.66
IV cannula insertion	1.70	0.18	0.06	0.57	8.56	0.003*
Surgical intervention	0.63	1.88	0.67	5.27	1.45	0.228
APACHEII	0.09	1.09	1.01	1.18	4.72	0.03*
Coma (GCS<9)	0.02	0.98	0.86	1.12	0.08	0.785
Compliance to IHI bundle items	0.01	1.00	0.97	1.03	0.01	0.926



* significant difference since p<0.05 - **Chi-square for trend 0.004 p =0.94**

Figure (1):Incidence Rate of VAP among the Studied Group

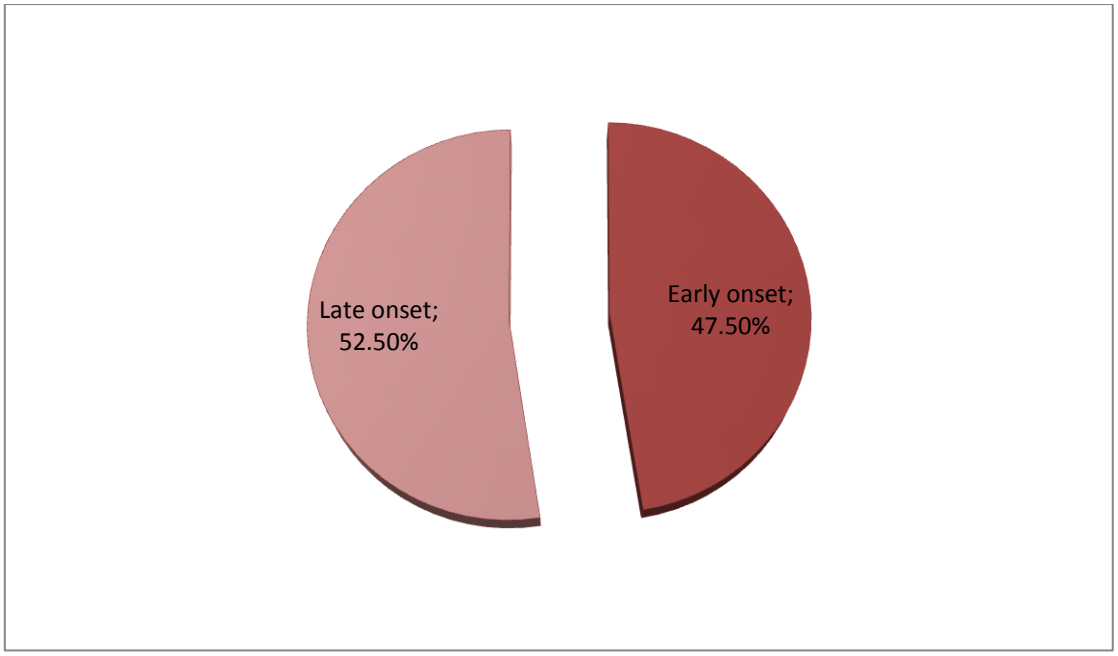


Figure (2): Types of VAP Infection among the Studied Group

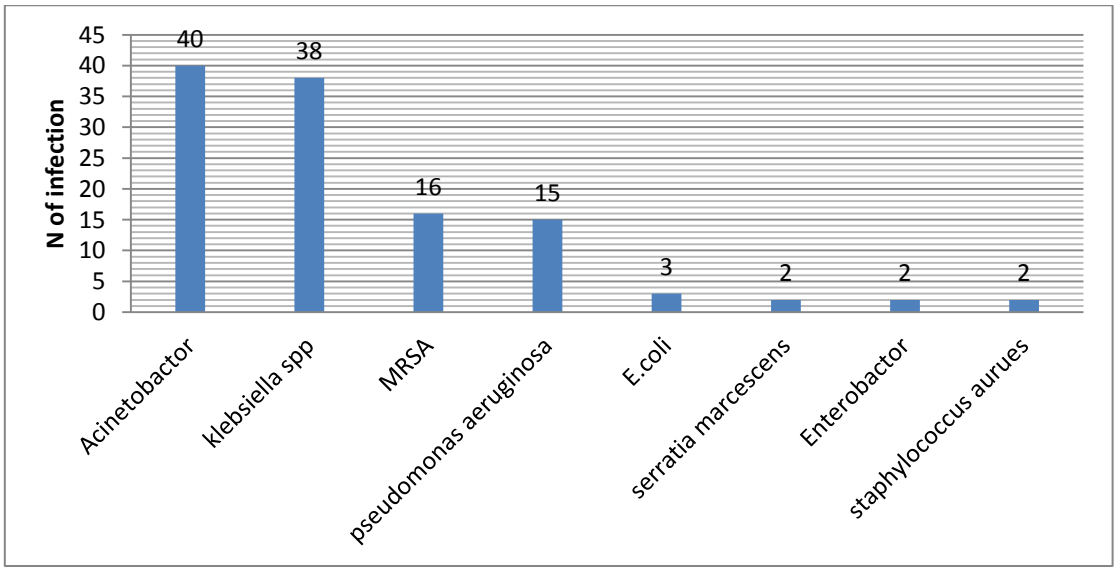


Figure (3): Number of Infection Episodes by Isolated Micro-Organism