

A Multiple One Day Prevalence Study on Ventilator Associated Pneumonia in ICU

***A Study Of The National Audit On Adult
Intensive Care Units (NAICU)
Ministry of Health***

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Introduction

Nosocomial infections in the critically ill are of great concern as it prolongs ICU stay thereby increasing health cost and increases morbidity and mortality. A large international prevalence study in over 1000 intensive care units in Europe showed that pneumonia accounted for more than half of the infections in the critically ill patients.(1)

Ventilator Associated Pneumonia or VAP refers to pneumonia that develops in patients 48 hours after endotracheal intubation and mechanical ventilation. The mortality rate for VAP ranges from 24 to 50% and can reach 76% in certain specific settings or when lung infection is caused by high-risk pathogens.

A multiple-one day prevalence study was thus conducted to look at the prevalence and factors contributing to VAP as well as some ICU practices relating to VAP in 14 Ministry of Health ICUs. This multiple-one day study was conducted in the months of June, July and August 2004 and below is the results of this study. Like any one day prevalence study, it has its limitations and may not reflect the true or actual incidence of VAP.

Results and Discussion

Occurrence of VAP on the study dates

	Study dates/ No. of patients (%)			
VAP	21.6.04	20.7.04	17.8.04	Total
Yes	12 (20.0%)	8 (14.3%)	9 (15.5%)	29 (16.7%)
No	48 (80.0%)	48 (85.7%)	49 (84.5%)	145 (83.3%)

$p = 0.789$

The incidence of VAP in mechanically ventilated patients is high ranging from 7% to 40% or more. (1, 2)

In this study, 29 of 174 patients or 16.7% of patients developed VAP 48 hours after mechanical ventilation.

Prevalence of VAP in the different hospitals

Hospitals	No. of cases ventilated \geq 48hrs	No. of cases with VAP	VAP per 1000 ventilated days	% of VAP
HKL	23	7	23.4	30.4
Selayang	15	4	36.5	26.7
Klang	17	1	4	5.9
Ipoh	8	0	0	0
Alor Star	5	2	44.2	40
Penang	17	2	19.2	11.8
Seremban	9	3	27.7	33.3
Johore Bahru	30	5	11.7	16.7
Kuantan	5	1	42.8	20
Kuala Terengganu	9	2	25.6	22.2
Kota Bahru	12	2	16.2	16.7
Kuching	6	0	0	0
Kota Kinabalu	10	0	0	0
Melaka	8	0	0	0
Total/Average	174	29	16.3	16.7

p = 0.240

The average VAP per 1000 ventilated days is 16.3. Using this as the benchmark, 7 of 14 hospitals or 57.2% were above the average, 3 hospitals or 14.2% were below the average while 4 or 28.6% had no VAP. Being a one-day point prevalence study it may have been possible to have had no episodes of VAP however if a period prevalence study or incidence study was conducted these hospitals would have had patients with VAP

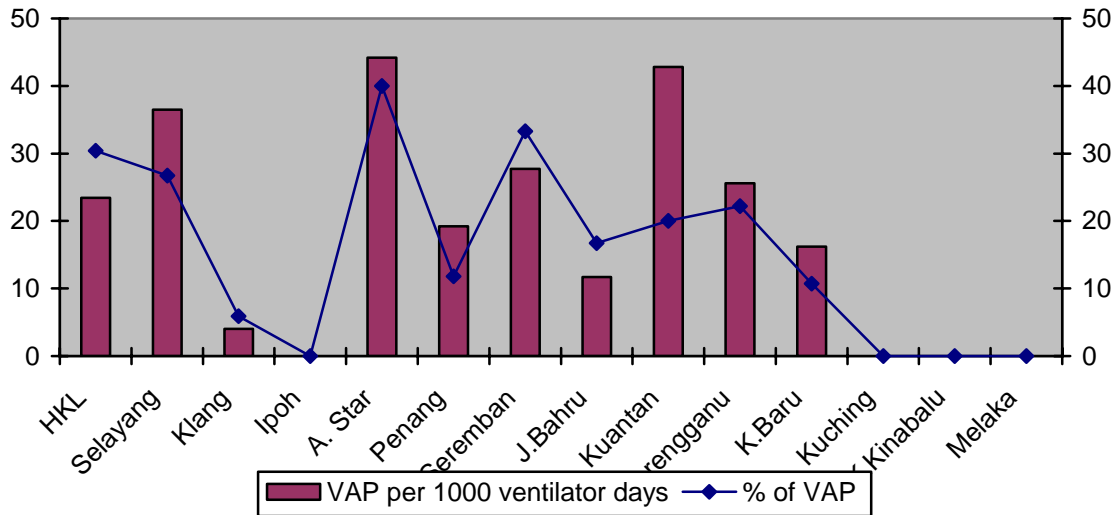


Fig1: Prevalence of VAP

Onset of VAP

Onset of VAP	No. of patients (%)
Early	4 (13.7%)
Late	25 (86.3%)

Early onset VAP is defined as patients who have been ventilated for less than 5 days while late onset VAP is defined as patients who have been ventilated for more than and equal to 5 days. 13.7% of patients had early onset VAP while 86.3% had late onset VAP.

Early onset VAP is usually associated with antibiotic sensitive organism while late onset is associated with antibiotic resistant organisms.

Organisms isolated

Organisms isolated	No. of patients (%)
Yes	23 (79.3%)
No	6 (20.7%)

79.3% of patients with VAP had organisms cultured from either the blood or the tracheal aspirate. Currently there is no consensus regarding the best way to diagnose VAP. Hence having a negative culture does not exclude VAP.

Type of organisms cultured from tracheal aspirate

Organisms cultured	Number
Pseudomonas aeruginosa	8 (25.8%)
Acinetobacter sp	15 (48.4%)
Escherichia coli	1 (3.2%)
Klebsiella pneumoniae	2(6.5%)
Stenotrophomonas maltophilia	2 (6.5%)
MRSA	1(3.2%)
Polymicrobial	2(6.5%)

Acinetobacter species is the organism most commonly cultured. 19.4% of organisms cultured were multiresistant organisms. Thus, when starting empirical antibiotics for VAP, it should be based on the local microbial and susceptibility patterns. Inappropriate initial empirical antibiotics have been associated with a significant increase in mortality.(3)

VAP and gender

VAP	Male (%)	Female (%)
Yes	15 (14.3%)	14 (20.3%)
No	90 (85.7%)	55 (79.7%)
Total	105	69

p= 0.294

Although the females had a slightly higher percentage of VAP, this was not significant as shown in the p value.

VAP and trauma

VAP	Trauma	
	Yes	No
Yes	10 (20.4%)	19 (15.2%)
No	39 (79.6%)	106 (84.8%)

p = 0.407

10 of 49 patients or 20% with trauma developed VAP. This was statistically not significant

VAP and Cardiac Arrest

VAP	Cardiac arrest	
	Yes	No
Yes	0	29 (17.4%)
No	7 (100%)	138 (82.6%)

p = 0.227

None of the patients who had a cardiac arrest developed VAP.

VAP and Co morbid disease

VAP	Co morbid	
	Yes	No
Yes	6 (15.4%)	23 (17%)
No	33 (84.6%)	112 (83.0%)

P = 0.807

About 15% of patients with co-morbid disease had VAP. Diabetes mellitus was the most common co-morbid disease associated with VAP.

VAP and steroids

VAP	Steroids	
	Yes	No
Yes	3 (14.3%)	26 (17%)
No	18 (85.7%)	127 (83.0%)

p= 0.755

Patients were considered to be on steroids if they had been on it for a minimum of 2 weeks within one month of ICU admission. 15% of patients on steroids developed VAP and this was not statistically significant

This study did not show a significant difference in the incidence of VAP in the above group of patients. There are independent risk factors that are predictive of VAP and it is important to target these patients with the most effective preventive strategies. Trauma, cardiac arrest, recent corticosteroid therapy and co-morbid diseases such as chronic obstructive airway disease are independent host factors that increase the risk of VAP. (2,4)

VAP and main organ failure

VAP	Organ failure						
	None	Resp ¹	CVS ²	CNS ³	Renal	Hepatic	Haem ⁴
Yes	0	18 (16.4%)	4 (18.2%)	2 (13.3%)	2 (28.6%)	1 (100%)	2 (33.3%)
No	13 (100%)	92 (83.6%)	18 (81.8%)	13 (86.7%)	5 (71.4%)	0	4 (66.7%)

p = 0.139

1. Resp: respiratory 2. CVS: Cardiovascular 3. CNS: Central Nervous System 4. Haem: Haematology

Patients with renal failure and haematological failure had a higher incidence of VAP compared with other organ failure. We are unable to comment on the incidence of VAP in patients with hepatic failure as there was only one patient.

VAP and Respiratory Therapy

VAP	Respiratory therapy			
	None	IPPV ¹	NIPPV ²	O ₂ therapy
Yes	0	24 (18.2%)	1 (50%)	4 (10.3%)
No	1	108 (81.8%)	1 (50%)	35 (89.7%)

p = 0.370 p= 0.206 p=0.216

1. IPPV: Intermittent Positive pressure ventilation

2 NIPPV: Non Invasive Positive pressure Ventilation.

18% of patients who were ventilated developed VAP patients, this was statistically not significant. Mechanically ventilated patients are associated with a 3-fold higher risk of VAP than non ventilated patients. (2) Noninvasive ventilation should therefore reduce the risk of VAP.

VAP and ICU mortality

VAP	Alive	Died	Total
Yes	14 (53.8%)	12(46.2%)	26
No	100(73.0%)	37(27%)	137

p= 0.051

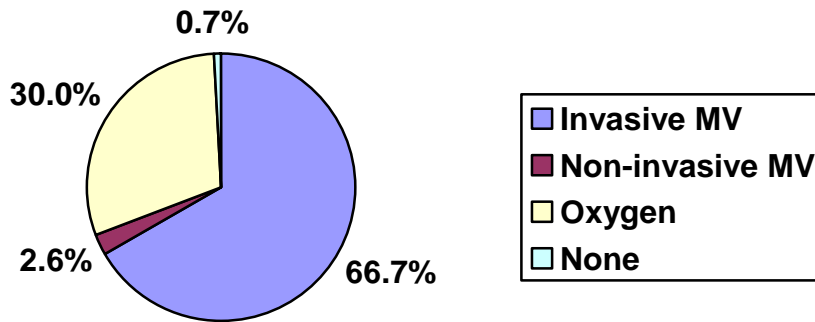
The mortality of patients with VAP was 46.2%. We are unable to comment as to whether attributable mortality of these patients was due to VAP or other causes.

Review of certain ICU practices related to VAP

There are some evidence based reviews and studies that show that certain practices such as position of the patient, method of intubation is associated with a decrease incidence of VAP while other practices such as frequency of change of ventilator tubings show no difference in the incidence of VAP.

Below is a review of certain ICU practices related to VAP in the different hospitals.

Respiratory therapy



* MV: mechanical ventilation * O₂ via mask includes ventimask/trachymask

Invasive mechanical ventilation is an independent risk factor to the development of VAP.(2) Although the cumulative risk increased over time, the daily hazard risk decrease after day 5 (3.3% at day 5, 2.3% at day 10 and 1.3% at day15) (4). Noninvasive ventilation has associated with a decrease incidence of VAP.

As shown in the chart, majority of patients requiring respiratory therapy in ICU were mechanically ventilated while only 2.6% of patients were non-invasively ventilated. Noninvasive ventilation has been shown to be effective in patients with cardiogenic pulmonary oedema and COAD. It has also been shown to be successful in weaning and thus standards for the use of noninvasive ventilation should be established.

Method of intubation

Method of intubation	No. of patients(%)
Nasal	1 (0.5%)
Oral	150 (81.5%)
Tracheostomy	33 (18%)

Almost all patients are intubated orally. 18% of patients have a tracheostomy probably due to a poor GCS or prolonged ventilation with difficult/slow weaning. Nasal intubation is known to increase the risk of sinusitis and may predispose the patient to VAP.(5,6) Therefore it is no longer advocated as a method of intubation in critically ill patients

Intracuff pressure monitoring

Intracuff pressure monitoring	No. of patients (%)
Yes	141 (77.5%)
No	41 (22.5%)

The pathogenesis of VAP is aspiration of the oropharyngeal secretions. Measuring the intracuff pressure of endotracheal tubes is mandatory to prevent this. This study shows that only 77.5% of patients had their cuff pressure monitored. Intracuff pressure monitoring needs to be strictly enforced.

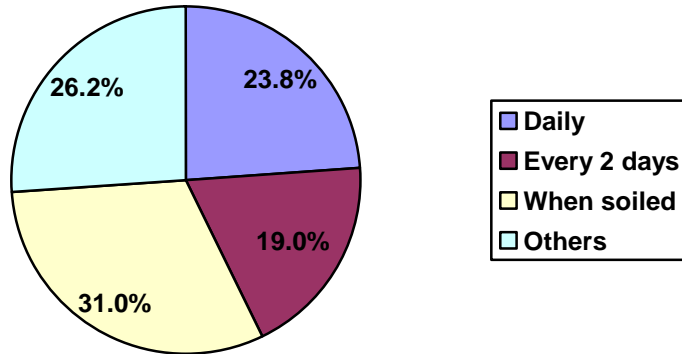
Humidification device

Humidification device	No. of patients (%)
HME	79 (42.9%)
Heated water bath	101 (54.9%)
Bubble through	4 (2.2%)

HME: Heat and moisture exchanger

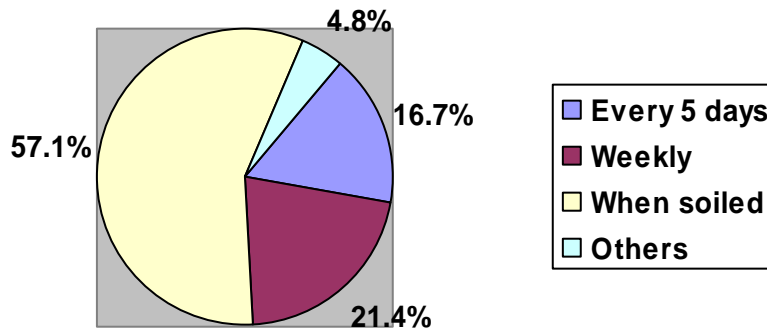
The percentage of patients using heated water bath as the humidification device is slightly higher than HME. HMEs are associated with either a similar or lower VAP rates than heated humidifiers. (7) Currently there is no recommendation as to the humidification device which would decrease the incidence of VAP as there is some discordance between trials.

Practice of HME changes



Most ICUs change the HME daily and when soiled with secretions or blood.

Practice of ventilator circuit change



Most ICUs change the ventilator circuits once every 5 days or weekly and when soiled. There is no benefit of routinely changing ventilator-circuit tubings except when there is overt soiling.(8) What is more beneficial is routine drainage and careful disposal of condensates that accumulate in the tubing. (9)

Bronchodilator therapy

Type of bronchodilator	No. of patients (%)
Nebuliser	85 (55.5%)
MDI	63 (41.2%)
Both	5 (3.3%)

MDI: Metered dose inhaler

More than 50% of patients received nebuliser for bronchodilatation while ventilated.

Practice of bronchodilator therapy

Bronchodilator therapy	No. of ICUs (%)
Nebuliser	14 (33.3%)
MDI	10 (23.8%)
Both	18 (42.9%)

Currently most ICUs use both nebuliser and MDI for bronchodilator therapy. Patients may receive MDI while ventilated but once extubated they may be switched over to the nebuliser due to incorrect usage. This could be the reason to both being used in the ICUs. Nebulisers have been associated with outbreaks of infections and hence MDIs are recommended. (10 - 12)

Semi-recumbent position

Semi-recumbent position	No. of patients (%)
Yes	251 (91.9%)
No	22 (8.1%)

Semi-recumbent position with the head-up between 30° – 45° prevents gastroesophageal reflux and aspiration of orogastric secretions and thus the development of VAP. It is one of the most simple, cost-free and low risk approach way of preventing VAP. Barring any contraindications to semi-recumbent position, all patients should be propped up. (13)

As seen from this study, most patients are being put in this position. The 8.1% who are not in this position could be because it was contraindicated.

Enteral feeding

Enteral feeding	No. of patients (%)
Yes	174 (63.7%)
No	99 (36.3%)

Enteral feeding has not been consistently shown to decrease the incidence of VAP though it has many other beneficial effects.

Only 63.7% were being enterally fed on the study days. The reasons as to why the rest of the patients are not fed could be due to GI surgery, severely septic with septic shock or inability to tolerate feeds.

Method of feeding

Feeding	No. of patients (%)
Intermittent	51 (29.5%)
Continuous	122 (70.5%)

No method of enteral feeding has been shown to significantly decrease the incidence of VAP.(14) However patients show better tolerance to continuous feeding when compared to bolus feeding with smaller volume of gastric aspirates Continuous feeding has also been shown to achieve the goals of feeding faster.

Majority of patients were continuously fed while 29.5% of patients were given bolus feeding. The reasons for this could be unavailability of pumps for continuous feeding or patients being discharged to the ward.

Volume of gastric aspirate

Volume of gastric aspirate(mls)	No. of patients (%)
< 50	228 (86.7%)
50 - 100	17 (6.5%)
101-150	8 (3.0%)
>150	10 (3.8%)

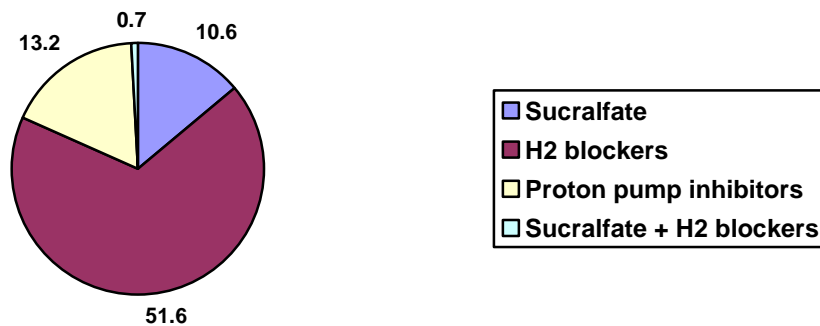
Large gastric volume aspirates may increase the incidence of gastroesophageal reflux, aspiration and VAP. More than 80% of patients have low gastric volume aspirates and this could be because they are being continuously fed.(15)

Stress ulcer prophylaxis

Stress ulcer prophylaxis	No. of patients (%)
Yes	209 (77.6%)
No	64 (23.4%)

Gastrointestinal bleeding in the critically ill is associated with significant morbidity and mortality. Ranitidine an H-2 blocker has been shown to decrease the incidence of significant bleeding. The largest RCT by Cook et al also showed that there was no increase in the incidence of VAP with the use of stress ulcer prophylaxis.(16)

Type of stress ulcer prophylaxis



Most clinicians use H2 blockers for stress ulcer prophylaxis. A current survey in the US show that the use of proton pump inhibitors in critically ill patients has increased over the years.(17) However there has been no study showing its superiority over ranitidine for stress ulcer prophylaxis though theoretically, tolerance develops on the third day with ranitidine while proton pump inhibitors suppress gastric acid irreversibly.

Continuous intravenous sedation

Continuous iv sedation	No. of patients (%)
Yes	108 (39.9%)
No	163 (60.1%)

Continuous intravenous sedation has been shown to be an independent risk factor for the development of VAP.(3) About 40% of patients were given continuous sedation.

Cohorting of patients

Cohorting of patients	No. of ICUs
Yes	12 (85.7%)
No	2 (14.3)

Availability of isolation rooms

Isolation rooms	No. of ICUs
Yes	10 (71.4%)
No	4 (28.6%)

Precautions of pathogen transmission from patient to patient includes isolation and cohorting.(11) Of the 4 ICUs that did not have isolation rooms, 2 practiced cohorting of infected patients while the other 2 did not. Cohorting is an easy and cost-free way of preventing cross contamination between patients. 85% of ICUs practice cohorting of infected patients.

Resources and Workload

Nurse patient ratio

Participating Hospital	Nurse: patient ratio		
	AM	PM	Night
HKL	1 : 0.98	1 : 0.92	1 : 1.5
Selayang	1 : 0.81	1 : 0.85	1 : 1.05
Klang	1 : 0.69	1 : 0.70	1 : 0.95
Ipoh	1 : 0.71	1 : 0.80	1 : 1.33
Alor Star	1 : 0.93	1 : 0.87	1 : 1.08
Penang	1 : 0.89	1 : 0.84	1 : 1.17
Seremban	1 : 1.22	1 : 1.33	1 : 1.83
Johore Bahru	1 : 0.9	1 : 0.92	1 : 1.5
Kuantan	1 : 0.66	1 : 0.72	1 : 1.08
Kuala Terengganu	1 : 0.64	1 : 0.85	1 : 0.92
Kota Bahru	1 : 1.27	1 : 1.19	1 : 1.27
Kuching	1 : 0.44	1 : 0.5	1 : 0.63
Kota Kinabalu	1 : 1.30	1 : 1.2	1 : 1.20
Melaka	1 : 1.02	1 : 1.08	1 : 0.93
Average	1 : 0.89	1 : 0.91	1 : 1.2

The staffing ratio of one-to-one nursing during the morning and afternoon shifts was achieved but not during the night. Inadequate staffing is associated with an increase incidence of nosocomial infections in the ICU. (18, 19)

Nurse: patient ratio and VAP

Nurse: patient ratio	VAP per 1000 ventilator days
< 1:1	21.5
≥ 1.1	13.2

P = 0.358

In this study, nursing patient ratio of more than 1:1 was not associated with an increase incidence of VAP.

Bed Occupancy Rate

Hospital	Functional beds	Average BOR	Average % of patients on MV*
HKL	17	88.2	37.8
Selayang	10	73.3	82.7
Klang	6	100	66.6
Ipoh	6	66.7	91.7
Alor Star	7	61.9	53.3
Penang	8	87.5	87.5
Seremban	4	91.7	61.1
Johore Bahru	16	93.8	77.7
Kuantan	6	72.7	68.9
Kuala Terengganu	5	73.3	61.1
Kota Bahru	7	90.5	74.3
Kuching	7	57.1	60.6
Kota Kinabalu	7	80.9	53.2
Melaka	6	77.7	100
Total/Average	112	79.6	69.8

MV: mechanical ventilation

The average bed occupancy rate or BOR on the three study days was 79.6 with about 70% of patients being mechanically ventilated. BOR in the MOH hospitals are calculated on mid-night count and not on admission through-put which would then have been higher. The recommended mean BOR is 70- 75%

Bed Occupancy Rate and VAP

BOR	VAP per 1000 ventilator days
< 80	21.3
≥ 80	14.6

p = 0.460

Again this study did not show any significant difference between bed occupancy rate and VAP.

SUMMARY

The main results of this multiple-one day prevalence study of the 14 state hospitals are summarized below.

1. Occurrence of VAP

- 1.1 The occurrence of VAP was 16.3 per 1000 ventilator days or 16.3%
- 1.2 18% of patients who were mechanically ventilated developed VAP
- 1.3 31% of patients developed early onset VAP while 69% developed late onset VAP
- 1.4 The commonest organism cultured was Acinetobacter species
- 1.5 Patients with renal and haematological failure had a higher incidence of VAP

2. ICU practices related to VAP

- 2.1 About two-thirds(66.7%) of patients were mechanically ventilated while only 2.6% were non-invasively ventilated
- 2.2 More than 80% of patients were intubated orally with another 18% being ventilated via a tracheostomy.
- 2.3 A little more than two-thirds (77.5%) of patients had the endotracheal tube cuff monitored.
- 2.4 Most ICUs change the HMEs daily and when soiled with secretions or blood
- 2.5 More than half the ICUs changed the Ventilator circuits were changed only when soiled
- 2.6 About 43% of ICUs use both the MDI and nebuliser for bronchodilatation
- 2.7 More than 90% of patients were nursed in the semi-recumbent position.
- 2.8 A little bit more than two-thirds of patients were enterally fed with 70% being fed continuously.
- 2.9 77% of patients received stress ulcer prophylaxis with about half receiving H2 blockers as the prophylaxis

2.10 About 40% of patients received continuous intravenous sedation

2.11 Cohorting of patients was practiced by 85% of ICUs

3. Resources and Workload

3.1 The nurse-patient ratio of 1:1 was achieved during the morning and afternoon shift only.

3.2 The average bed occupancy rate was 79.6

RECOMMENDATIONS

1. Improve nosocomial infection control measures

It is imperative to ensure infection control measures are strictly adhered to in the intensive care unit as nosocomial infections is known to increase length of stay as well as morbidity and mortality

2. “Closed” system ICU

In a closed ICU system, clinicians are responsible for the clinical management of the patient. There would be consistency in the prevention, diagnosis and management of patients with VAP. More clinicians should be trained in intensive care so that more ICUs can practice a closed system.

3. Education

Ongoing education for all health care workers to instill awareness on the importance of infection control measures.

4. Evidence based practices

Clinicians working in the ICU should be aware and implement evidence based practices in the prevention of VAP.

5. Isolation rooms

Isolation prevents cross contamination of infected patients. ICUs should have more isolation rooms to practice this.

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