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INICC Bundle to Prevent Health Care Pneumonia in Intensive Care Units: An International Perspective.

Purpose

Previously published guidelines are available that provide comprehensive recommendations for detecting and preventing healthcare-associated infections, especially in the USA. The intent of this document is to highlight practical recommendations in a concise format designed to assist acute care hospitals worldwide in implementing and prioritizing their health care associated pneumonia prevention efforts.

Ventilator-associated pneumonia Background

VAP pneumonia Rates Internationally.

Ventilator-associated pneumonia (VAP) has been considered to be the most serious healthcare-associated infection (HAI), and it was reported to be the leading cause of morbidity and mortality for device-associated infections (DAI), particularly, in the intensive care unit (ICU) setting.[1,2] Additionally, in a large body of scientific literature, VAPs are among the commonest type of DAI, resulting in a substantial increase in hospital costs and length of stay (LOS).[1-3]

The scope of the burden posed by VAP internationally, however, has not been systematically addressed.[1] Although surveillance has been reported as an effective tool for the reduction of VAP in the USA and Europe,[4] the importance of surveillance for measuring ICU patient infection risks, outcomes and processes internationally remains many times under-recognized.[1,5] As a countervailing strategy, in 2002 the International Nosocomial Infection Control Consortium (INICC) developed an outcome and process surveillance program specifically designed for ICUs internationally.[6-8]

Through the implementation of the INICC program, it was demonstrated that there was a notable difference in the VAP rates between the ICUs of hospitals from the industrialized world and those internationally, with rates ranging from 3 to 5 times higher in the latter ones. [9-18]

The prevalence of HAI internationally was found to at least double the rates published by the European Centre for Disease Prevention and Control,[19] and triple those found in the USA.[20]

In the case of DAIs, the rate of device use was found to be analogous or even lower to the one reported of U.S. ICUs by the National Nosocomial Infection Surveillance System (NNIS)/ National Healthcare Safety Network (NHSN) System;[21] however, pooled mean rates identified in ICUs internationally by the International Nosocomial Infection Control Consortium (INICC) were found to be exceedingly higher than those reported from U.S.'s ICUs by the NHSN. [5,17,21,22]

Meta-analyses and systematic reviews on HAI have been scant internationally. Furthermore, such analyzes could not retrieve enough data from some regions and many countries were not even represented.[23] The systematic review and meta-analysis on the burden of endemic HAI internationally by Allegranzi *et al* concluded that HAI prevalence was significantly higher in low and middle low-income countries compared to USA and Germany. The incidence density of DAI in critically ill patients was found to be from two- to 19-fold higher than those reported from the USA and Germany.[23]

In a systematic review by Arabi *et al* on VAP in adults internationally, from 1966 to 2007, the rates of VAP were higher overall than NHSN benchmark rates, and ranged from 10 to 41.7 per 1000 ventilator-days. The review found that the crude mortality attributable to VAP ranged from 16% to 94%.[1]

By applying INICC methodology, the following VAP rates per 1000 mechanical ventilator (MV)-days were collected and found: 46.3 in Argentina;[24] 20.9 in Brazil;[25] 20.8 in China;[26] 10.1 in Colombia;[13] 52.5 in Cuba;[27] 73.4 in Egypt;[28] 12.1 in a PICU[29] and 9.9 in a NICUs in El Salvador;[29] 10.4 in India;[30] 21.8 in Mexico;[31] 43.2 in Morocco;[32] 31.3 in Peru;[9] 16.7 in an adult ICU in Philippines,[33] and is 12.8 in a Pediatric ICU;[33] 18.2 in Poland;[34] 26.5 in Turkey;[35] and 8.1 in Lebanon;[36] in the INICC international report from 8 countries the VAP rate is 24.1;[37] in the INICC international report from 18 countries it is 19.5;[38] in the INICC international report from 25 countries it is 13.6;[6] in the INICC international report from 36 countries it is 15.8;[39] and in the INICC report of Neonatal ICUs of 15 countries the VAP rate is 9.7.[40]

VAP Mortality, Extra Length of Stay, and Extra Cost Internationally.

From the available literature, it is highly visible that the adverse consequences of device-associated healthcare-associated infections (DA-HAIs) internationally —that is, attributable mortality,[2,3,6,9,10,12,13,17,32,41-51] prolonged length of stay, [2,3,6,9,10,12,41-46,48-52] extra hospital costs,[3,41,44] and increased bacterial resistance[25,30,32,38,52-59]—are more

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far-reaching in terms of severity than in the USA and Germany.

A Retrospective matched cohort study using data from a large US inpatient database was conducted to evaluate cost of VAP. Cases of VAP were matched on duration of mechanical ventilation, severity of illness on admission (predicted mortality), type of admission (medical, surgical, trauma), and age with up to three control subjects. Mortality, resource utilization, and billed hospital charges were then compared between cases and control subjects. Of the 9,080 patients meeting study entry criteria, VAP developed in 842 patients (9.3%). Patients with VAP were matched with 2,243 control subjects without VAP. Nevertheless, patients with VAP had a significantly longer duration of mechanical ventilation (14.3 +/- 15.5 days vs 4.7 +/- 7.0 days, p < 0.001), ICU stay (11.7 +/- 11.0 days vs 5.6 +/- 6.1 days, p < 0.001), and hospital stay (25.5 +/- 22.8 days vs 14.0 +/- 14.6 days, p < 0.001). Development of VAP was also associated with an increase of > $40,000 in mean hospital charges per patient ($104,983 +/- $91,080 vs $63,689 +/- $75,030, p < 0.001).[60]

A 2012 published retrospective matched cohort study using US data from the Premier research database showed that mean hospitalization costs were $99,598 for patients with VAP and $59,770 for patients without VAP (*P* < .0001), resulting in an absolute difference of $39,828. Just pharmacy, prescribed drugs, ventilator in ICU, respiratory therapy and chest x-rays expenses resulted in an absolute difference of $10,889 in extra mean costs for patients with VAP versus patients without VAP.[61]

A 5-year prospective matched cohort study was undertaken at 6 ICUs of three hospitals members of INICC in Aergentina. Three hundred and seven patients with VAP (exposed) and 307 patients without VAP (unexposed) were matched for hospital, ICU, period, LOS more than seven days, gender, age, and average severity of illness score (ASIS). The mean extra LOS for 307 cases (compared to the controls) was 8.95 days, the mean extra antibiotic defined daily doses (DDD) was 15, the mean extra antibiotic cost was $996, the mean extra total cost was $2,255, and the extra mortality was 30.3%.[62] Nevertheless, the extended suffering of patients and their relatives cannot be estimated in terms of economic costs only. Mortality due to ventilator-associated pneumonia (VAP) has been found by Rosenthal to be as high as 56,7%.[32]

In a prospective case control study conducted in Turkey, data were collected from 25 intensive care unit (ICU) beds. A total of 162 ICU patients who required mechanical ventilation were assessed. Of these, 81 patients were diagnosed with VAP and the other 81 were controls (without VAP). Risk of mortality was analyzed and total cost of care was recorded. Age, sex and underlying disease were similar between the groups. The mean length of stay (LOS) in the ICUs in the VAP cases (15.7+/-9.1 days) exceeded that of the controls (4.9+/-4.9 days) (p 0.0001), and the additional LOS attributable to VAP was estimated at 10.8 days. In the VAP group, 25 patients had early-onset VAP, and the other 56 patients had late-onset VAP. Mortality rates were higher in VAP patients (32%) than controls (19.7%) p 0.05). Total costs were USD 8602.7+/-5045.5 in the VAP group and USD 2621.9+/-2053.3 in controls. The additional cost for VAP was found to be USD 5980 per patient.[63]

In a study performed in hospitals members of INICC in 10 developing countries to estimate extra LOS and mortality in an intensive care unit (ICU) due to a VAP, a cohort of 69,248 admissions were followed for 283,069 days in ICUs. Data were arranged according to a multi-state format. Extra LOS and increased risk of death were estimated independently in each country, and their results were combined using a random effects meta-analysis. The findings of the analysis showed that a VAP prolonged LOS by an average of 2.03 days (95% CI: 1.52, 2.54 days), and increased the risk of death by 14% (95% CI: 2, 27%). [64]

All above described studies demonstrated that VAP is being associated with a statistically significant resource utilization burden, which underscores the need for cost-effective interventions to minimize the occurrence of this complication.

Antibiotic Usage and Bacterial Resistance Internationally.

The relationship of antibiotic use and the emergence of antibiotic-resistant HAI is an issue that epidemiologists and hospital authorities internationally must be aware of. In INICC's ICUs, antimicrobial resistance rates found for *Staphylococcus aureus* isolates as resistant to methicillin (MRSA), *enterobacteria* resistant to ceftazidime (extended-spectrum beta-lactamase producers), and *Pseudomonas aeruginosa* as resistant to fluoroquinolones, were far higher than NHSN ICUs' rates.[65] Nonetheless, the rates found in the INICC's ICUs for *enterococcal* isolates as resistant to vancomycin were much lower than NHSN ICUs' rates.[32,53,65]

VAP Rates in Neonatal ICUs Internationally.

In several studies, researchers have highlighted the extreme vulnerability of neonates hospitalized in neonatal intensive care units (NICUs) to mortality attributable to DA-HAI, with rates ranging from 24% in the pre-surfactant era to 11% in the post-surfactant era in the developed countries.[66-69] However, within the context of developing countries, access to knowledge regarding DA-HAI is scarce, and there is an insufficient recognition of the importance of surveillance for measuring the infection risks, outcomes and processes concerning the neonatal patient hospitalized in the NICU.[29,70-72] In this respect, a recent study was performed to evaluate the impact of country socioeconomic status and hospital type on device-associated healthcare-associated infections (DA-HAIs) in 30 neonatal intensive care units (NICUs), from hospitals members of INICC in 15 developing countries. Its findings revealed that ventilator-associated-pneumonia (VAP) rates in patients hospitalized in NICUs from academic hospitals were significantly higher than rates found in private or public hospitals.[49]

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Strategies for VAP Rate Reduction Internationally.

According to a review by Arabi *et al* on VAP in adults internationally, a small number of VAP intervention studies were performed, which found that staff education programs, implementation of hand hygiene, and VAP prevention guidelines, and implementation of sedation protocol were related to a significant reduction in VAP rates.[1]

Since 1998, INICC has conducted several studies internationally with the focus on the reduction of VAP rates by applying similar methodology. The aim of these studies was to analyze the effect of the INICC multidimensional infection prevention model on the reduction of VAP in hospitalized patients. It was a prospective active surveillance before-after study to assess the impact of a multi-dimensional prevention model on the VAP rate. The study was divided into two phases. During phase 1, the infection control team at each ICU conducted active prospective surveillance of VAP by applying the definitions of the Centers for Disease Control and Prevention (CDC) National Health Safety Network (NHSN), and the methodology of INICC. During phase 2, the prevention model for VAP was implemented at each ICU, in addition to the active surveillance. The INICC VAP prevention model included the following measures: 1- bundle of infection control interventions, 2- education, 3- outcome surveillance, 4- process surveillance, 5- feedback of VAP rates, and 6- performance feedback of infection control practices. The VAP rates obtained in phase 1 were compared to the rates obtained in phase 2.

The study conducted by INICC in China,[73] from January 2005 to July 2009, recorded data from 16,429 patients hospitalized in 3 ICUs, for a total of 74,116 ICU bed days. The VAP baseline rate was 24.1 per 1000 ventilator-days. During phase 2, the VAP rate significantly decreased to 5.7 per 1000 ventilator-days in 2009 (2009 vs. 2005: relative risk, 0.31; 95% confidence interval, 0.16-0.36; P = .0001), amounting to a 79% cumulative VAP rate reduction.[73]

The study conducted by INICC in Adult ICUs,[74] showed that in 44 AICUs, from 38 hospitals members of the International Nosocomial Infection Control Consortium (INICC), from 31 cities of the following 14 developing countries: Argentina, Brazil, China, Colombia, Costa Rica, Cuba, India, Lebanon, Macedonia, Mexico, Morocco, Panama, Peru, and Turkey. During Phase 1, we recorded 10,292 mechanical ventilator (MV) days, and during Phase 2, with the implementation of the multi-faceted prevention model, we recorded 127,374 MV days. The rate of VAP was 22.0 per 1000 MV days during Phase 1, and 17.2 per 1000 MV days during Phase 2. The adjusted model of linear trend shows a 55.83% reduction of the rate of VAP at the end of the study period; that is, the VAP rate is 55.83% lower than it was at the beginning of the study.[74]

The study conducted by INICC in Pediatric ICUs,[75] showed that during the baseline period, we recorded 5,212 mechanical ventilator (MV) days, and during the implementation of the bundle of interventions, we recorded 9,894 MV days. VAP rate during baseline period was 11.7, and during intervention period, it was 8.1 per 1000 MV days (RR; 0.69; 95% CI 0.5-0.96; P 0.02), which showed a 31% VAP rate reduction.[75]

The study conducted by INICC in Neonatal ICUs,[76] showed that during Phase 1, 3,153 mechanical ventilator (MV) days we recorded, and during Phase 2, with the implementation of the bundle of interventions, we recorded 15,981 MV days. VAP rate during Phase 1 period was 17.8, and during Phase 2 period was 12.0 per 1000 MV days (RR; 0.67; 95% CI 0.50-0.91; P 0.001), showing a 33% VAP rate reduction.[76]

Our results demonstrate that the implementation of the INICC multidimensional infection control program was associated with a significant VAP rate reduction in adult, pediatric and neonatal ICUs internationally.[73-76]

Conclusion

These findings are a clear indication of the influence that economics, as a surrogate of available medical supplies, outdated technology, and scarce human resources availability, have on developing countries, and of the close relation between hospital type and limited access to health care resources. In public and academic hospitals, the limitated resources in terms of adequate number of trained and specialized staff, budget, medical supplies and hospital administrative support is markedly more serious than in private hospitals, as the public hospital are more dependent on the socio-economic category of the country concerning the budget allocation. Limited-resource countries are confronted with aspects that transcend clinical findings and good delivery of healthcare practices; the harsher reality suffered by patients hospitalized in the ICUs of developing countries lies outside the scope of the hospital itself, and reflects the country's social and political situation, poor living conditions, difficult or differentiated access to labor market and precarious labor conditions, diversity of cultural values, unequal allocation of assets among population resulting in unsatisfied basic needs, including sanitary infrastructure and limited access to the education and health system. As long as these conditions prevail, healthcare workers from developing countries are urged to focus their best efforts on improving healthcare and clinical practices, and disseminating their successful achievements, so as to be able to counteract the many social factors that cannot be directly controlled by clinical practices alone.[77] Also the findings of these reviews and meta-analyses evidence the urgent need to improve surveillance, infection control practices, update outdated technology, and to increase the number of intervention studies to reduce these high DA-HAI rates internationally. Therefore, additional epidemiological studies are to be performed to develop more definitive approaches for DA-HAI prevention in the form of practical, cost-effective technological measures that are feasible to implement internationally. Finally, INICC results demonstrate that the implementation of the INICC multidimensional infection control program was associated with a significant VAP rate reduction in adult, pediatric and neonatal ICUs internationally.

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INICC Methodology

The INICC Surveillance Program includes two components: outcome surveillance (VAP rates and consequences) and process surveillance (adherence to hand hygiene and other basic preventive infection control practices).[7]

The investigators at the participating hospitals were required to perform outcome and process surveillance by completing forms, which were then sent for their monthly analysis to the INICC office in Buenos Aires.[7]

Outcome Surveillance

The INICC Surveillance Program is focused on the methods and definitions for DAI developed by the U.S. Centers for Disease Control and Prevention (CDC) for the National Nosocomial Infection Surveillance System (NNIS)/ National Health Safety Network (NHSN) program.[78,79] However, the INICC methods have taken into consideration the different socioeconomic status and specific limitations of limited-resource countries, and were adapted for their application in this setting.[7] Outcome surveillance includes rates VAP per 1000 device-days; microorganism profile, bacterial resistance, length of stay, and mortality in their ICUs.

Process surveillance

Preventive strategies in INICC member hospitals are based on simple, inexpensive, evidence-based measures, which include outcome surveillance, process surveillance, education and performance feedback of outcome surveillance and process surveillance.[7]

Process surveillance is designed to monitor compliance with easily measurable, key infection control measures. It includes the surveillance of compliance rates for hand hygiene practices and some specific infection control measures for the prevention of VAP.[77,80-82]

Hand-hygiene (HH) compliance by healthcare workers (HCWs) is determined by measuring the frequency of HH performances when clearly indicated, and such practices are monitored by the hospital's ICP during randomly selected 1-hour observation periods, 3 times a week. Although HCWs know that HH practices are regularly monitored, they are not actually aware of the precise moment in which observations are taking place.[7]

ICPs were trained to detect HH compliance and record HH opportunities and compliance through direct observation. The INICC direct observation comprises the "Five Moments for Hand Hygiene," as recommended by the World Health Organization (WHO). The "Five Moments" were designed on the basis of the evidence concerning DAI prevention and control, and include the monitoring of the following moments: (1) before patient contact, (2) before an aseptic task, (3) after body fluid exposure risk, (4) after patient contact, and (5) after contact with patient surroundings.[83]

Training and Validation

Investigators are self-trained by means of a manual and training tool that describe how to perform surveillance and complete surveillance forms. Investigators have continuous e-mail and telephone access to a support team at the INICC Central Office in Buenos Aires, Argentina, which is in charge of responding to all queries within 24 hours. The INICC Chairman further reviews all queries and responses.

Surveillance forms for individual patients allow internal and external validation, because they include every clinical and microbiological criterion for each type of DAI, such as temperature, blood pressure, use if invasive devices, cultures taken, culture results, antibiotic use. Surveillance also includes a form where positive cultures are registered and matched with patients' forms.

On a monthly basis, participating hospitals submit the completed surveillance forms to the INICC Central Office, where the validity of each case was checked and the recorded signs and symptoms of infection and the results of laboratory studies, radiographic studies, and cultures were scrutinized to assure that the NNIS System criteria for device-associated infection were fulfilled.

The ICT member who reviewed the forms completed at the participating AICU was able to verify that criteria for infection had been met accurately in each case. Additionally, the original patient data forms were further validated at the INICC Central Office, before data on the reported infection were entered into the INICC's database. To that end, queries were submitted from INICC office in Buenos Aires to the ICT teams at each hospital, challenging those cases with suspected VAP, and data were uploaded after receiving the reply from hospital teams. Finally, the INICC team performed consistency analyses of database, such as age, gender, dates, among other data, and reviews of medical records that compared data registered in forms and data in medical records.

Performance Feedback

The concept of using performance feedback of outcome surveillance and process surveillance as a valuable control measure in limited-resource hospitals was based on its effectiveness as proved in previous INICC studies.[77,80-82,84,85]

The INICC Central Office team prepared and sent monthly chart reports to each participating hospital that detailed their rates of VAP, microbiology profile, and rates of adherence to hand hygiene, among other infection related data. The participating ICU staff received feedback on their performance at monthly meetings, by means of the review of said charts, which were posted in a prominent location in the ICU.

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Bundle Background

Within the INICC program, the infection prevention bundle was mainly based on the guidelines published by the Society for Health Care Epidemiology of America (SHEA) and the Infectious Diseases Society of America (IDSA), which describe evidence-based interventions and recommendations for VAP prevention in the ICU.[86] These guidelines provide feasible and cost-effective infection control measures, relatively applicable internationally. In addition, the INICC prevention bundle also followed the recommendation by the Institute of Healthcare Improvement (IHI) that a ventilator bundle be implemented at every ICU to reduce the incidence of VAP to zero, which was part of the 5 Million Lives campaign, endorsed by leading US agencies and professional societies.[87] Within the international context, outcome and process surveillance, integrated in an intervention bundle with performance feedback of infection control practices, has been shown to successfully reduce and control DAIs in different studies conducted in INICC member hospitals. [73-77,80,81,84,85]

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1. General Strategies to prevent VAP

i. Conduct active surveillance for VAP. [88]

Perform ongoing surveillance of the incidence density of VAP on units that care for patients undergoing mechanical ventilation who are known or suspected to be at high risk for VAP, to permit longitudinal assessment of process of care.

Incidence density of VAP, reported as the number of episodes of VAP per 1,000 ventilator-days.

Preferred measure of VAP incidence density: 1- Numerator: number of patients undergoing mechanical ventilation who have VAP, defined using National Healthcare Safety Network definitions; 2- Denominator: number of ventilator-days; 3- Multiply by 1,000 so that the measure is expressed as cases per 1,000 ventilator-days.

ii. Educate healthcare personnel who care for patients undergoing ventilation about VAP. [1-4]

1. Educate healthcare personnel who care for patients undergoing ventilation about VAP, including information about the following: a. Local epidemiology; b. Risk factors; c. Patient outcomes.

2. Educate clinicians who care for patients undergoing ventilation about noninvasive ventilatory strategies.

iii. Adhere to Hand-Hygiene Guidelines Published by the Centers for Disease Control and Prevention or the World Health Organization.[88,89]

Collect data on a sample of healthcare personnel from all disciplines who provide hands-on care to patients undergoing ventilation, including physicians, nurses, respiratory therapists, and radiology technicians. Perform observations at regular intervals (e.g., 1 set of measurements per week). The frequency of observations can be adjusted on the basis of compliance rates (e.g., as compliance improves, less frequent observations may be needed).

iv. Limit the use of mechanical ventilation: Use noninvasive ventilation whenever possible.[90-97]

Noninvasive ventilation (NIV) refers to the administration of ventilatory support without using an invasive artificial airway (endotracheal tube or tracheostomy tube). NIV has been used primarily for patients with acute hypercapnic ventilatory failure, and especially for acute exacerbation of chronic obstructive pulmonary disease. In this population, the use of NIV is associated with a marked reduction in the need for endotracheal intubation, a decrease in complication rate, a reduced duration of hospital stay and a substantial reduction in hospital mortality. Similar benefits have also been demonstrated in patients with asphyxic forms of acute cardiogenic pulmonary edema. Major benefits have also been demonstrated in selected populations with no contraindications such as multiple organ failure, loss of consciousness or haemodynamic instability. One important factor in success seems to be the early delivery of noninvasive ventilation during the course of respiratory failure. Noninvasive ventilation allows many of the complications associated with

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mechanical ventilation to be avoided, especially the occurrence of nosocomial infections.

iv. Limit the use of mechanical ventilation: Minimize the duration of ventilation.[93,98-104]

Daily interruption of sedation followed by a readiness to wean assessment and readiness for a spontaneous breathing trial. Around the clock sedation assessment using a reliable and valid tool.

iv. Limit the use of mechanical ventilation: Perform daily assessments of readiness to wean.[88,100] **Use weaning protocols.**[105,106]

Hospital teams across the United States have developed and tested process and system changes that allowed them to improve performance on daily sedation vacations and daily assessment of readiness to extubate. These measures, taken together, support the implementation of the ventilator bundle. Some of these changes are:

1- Implement a protocol to lighten sedation daily at an appropriate time to assess for neurological readiness to extubate. Include precautions to prevent self-extubation such as increased monitoring and vigilance during the trial.

2- Include a sedation vacation strategy in your overall plan to wean the patient from the ventilator; if you have a weaning protocol, add sedation vacation to that strategy.

3- Assess compliance each day on multidisciplinary rounds.

4- Consider implementation of a sedation scale such as the Riker scale to avoid over-sedation.

5- Post compliance with the intervention in a prominent place in your ICU to encourage change and motivate staff.

v. Implement a multidimensional approach. [73-76]

Apply a multidimensional approach for VAP prevention including the following measures:

1- Bundle of infection control interventions,
2- Education,
3- Outcome surveillance,
4- Process surveillance,
5- Feedback of VAP rates, and
6- Performance feedback of infection control practices.

2. Core Strategies to Prevent VAP

i. Prevent Aspiration of Secretions

Maintain patients in a semi-recumbent position (30-45 elevation of the head of the bed) unless there are contraindications. [104]

Head of the bed elevated for the majority of the day (unless medically contraindicated). It is understood that patients might be cared for at different bed angles during different times of the day, and that continuous monitoring of bed angles is impossible. Therefore, to implement this measure, the ventilator patient in the intensive care unit must be monitored at least two times in a 24-hour period to see if the head of the bed is elevated to 30 degrees or greater. The observations should coincide with the structure of the ICU shifts and one observation should be made on at least two different shifts within the 24 hour period. It is recommended that there be a minimum of 8 hours between observations. In order to achieve the most valid results, it is suggested that a pre-determined schedule be devised. The schedule may or may not be random, but should ensure that equal numbers of observations are made during each day of the week.

Consider progressive mobility: continuous lateral rotation therapy or at least early mobility.

(a) Experimental trials have demonstrated that backrest elevation is associated with a reduced risk of pulmonary aspiration.[1071-2]

(b) Multivariable analysis of risk factors associated with VAP found up to a 67% reduction in VAP among patients maintained in semi-recumbency during the first 24 hours of mechanical ventilation.[108]

(c) The impact of semi-recumbency was confirmed in an observational study,[102] and a randomized trial.[109]

(d) However, recent studies indicate that semi-recumbent positioning is rarely maintained,[110] and may not be associated with a reduced rate of tracheal colonization[110] or VAP.[111]

Avoid gastric overdistention.[93,112-116]

According with Heyland study, patients fed into the stomach had more episodes of gastroesophageal regurgitation (39.8% vs. 24.9%, p =.04) and trended toward more microaspiration (7.5% vs. 3.9%, p =.22) compared with patients fed beyond the pylorus.

Avoid unplanned extubation and reintubation.[88,100,117,118]

Perhaps the most risky aspect of lightening the sedation that the patient is receiving daily is the chance that patients might self-extubate. This risk can be diminished by ensuring that the process is adequately supervised and that appropriate restraints are applied to the patient's arms in a comfortable fashion.

Use a cuffed endotracheal tube with in-line or subglottic suctioning.

Subglottic secretion drainage is associated with a decreased incidence of VAP. To increase their utility and cost-effectiveness, these tubes should only be placed in patients expected to require prolonged mechanical ventilation.

(a) Meta-analysis demonstrated that subglottic secretion drainage was effective in preventing early-on- set VAP.[119]

Maintain an endotracheal cuff pressure of at least 20 cm H2O. [1]

Cuff pressure must be monitored frequently.[120]

ii. Strategies to reduce colonization of the aerodigestive tract

Orotracheal intubation is preferable to nasotracheal intubation.

Oral endotracheal intubation is associated with a trend toward a reduction in VAP compared to

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nasotracheal intubation and with a decreased incidence of sinusitis (the incidence of VAP is lower in patients who do not develop sinusitis). Reintubation should be avoided if possible. (a) Nasotracheal intubation increases the risk of sinusitis,[121,122] which may increase the risk for VAP.[115,123]

Perform comprehensive oral care,[93,124-128] with an antiseptic solution.[129-132]

1- Perform tooth brushing, oral cleansing with antiseptic solution (e.g. Chlorhexidine 0.12%) and suctioning, twice daily.
2- Antiseptic oral rinse with Chlorhexidine after brushing.
3- In between tooth brushing, debride biofilm with swab impregnated with an oral solution (e.g. hydrogen peroxide) and suctioning simultaneously, every 4 hours.
4- Apply a mouth moisturizer to the oral mucosa and lips to keep tissue moist as needed.

Oral Care Rationale and Other Considerations:

(a) Oropharyngeal cleaning and decontamination with an antiseptic agent; develop and implement a comprehensive oral-hygiene program (that might include the use of an antiseptic agent) for patients in acute-care settings or residents in long-term care facilities who are at risk for healthcare associated pneumonia (II).[124,133]

(b) Use of Chlorhexidine Gluconate (0.12%) oral rinse during the perioperative period on adult patients who undergo cardiac surgery (II).[127]

(c) Antiseptic oral rinses (Chlorhexidine Gluconate, Cetylpyridinium Chloride [CPC]), added after brushing or done in conjunction with comprehensive oral care did achieve elimination of VAP.[4134]

iii. Strategies to minimize contamination of equipment used to care for patients receiving mechanical ventilation

Remove condensate from ventilatory circuits. Keep the ventilatory circuit closed during condensate removal.[88,93,100,135]

Periodically drain and discard any condensate that collects in the tubing of a mechanical ventilator, taking precautions not to allow condensate to drain toward the patient.

Change the ventilatory circuit only when visibly soiled or malfunctioning.[88,136-141]

Do not, on the basis of duration of use, routinely change the breathing circuit (ie, ventilator tubing and ex- halation valve and the attached humidifier) that is in use by an individual patient. Change the circuit when it is visibly soiled or mechanically malfunctioning.

Store and disinfect respiratory therapy equipment properly.[88]

Thoroughly clean all respiratory equipment to be sterilized or disinfected. Whenever possible, use steam sterilization or high- level disinfection by wet heat pasteurization at temperatures higher than 70C (158F) for 30 minutes for reprocessing semicritical equipment or devices (ie, items that come into direct or indirect contact with mucous membranes of the lower respiratory tract). Use low-temperature sterilization methods (as approved by the Office of Device Evaluation, Center for Devices and Radiologic Health, US Food and Drug Administration) for equipment or devices that are heat or moisture sensitive. After disinfection, proceed with appropriate rinsing, drying, and packaging, taking care not to contaminate the disinfected items.

Use sterile water to rinse reusable respirator equipment. [88]

Preferentially use sterile water to rinse reusable semicritical respiratory equipment and devices when rinsing is needed after chemical disinfection. If this is not feasible, rinse the device with filtered water (ie, water that has been through a 0.2-mm filter) or tap water, and then rinse with isopropyl alcohol and dry with forced air or in a drying cabinet.

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