Getting Started Kit:

Prevention of Ventilator-Associated Pneumonia in Adults and Children

How-to Guide

Safer Healthcare Now!

We invite you to join the *Safer Healthcare Now!* Campaign (SHN) to help improve the safety of the Canadian healthcare system. *Safer Healthcare Now!* is a National campaign supporting Canadian healthcare organizations to improve patient safety by using quality improvements methods to integrate evidence and best practices in patient care delivery. The campaign is supported by the Institute for Healthcare Improvement (IHI) and is patterned after IHI's *100,000 Lives Campaign* (now 5 Million Lives Campaign). To join the SHN! Campaign, obtain further information about resources, contacts, and tools, visit our website http://www.saferhealthcarenow.ca/EN/Pages/default.aspx

Patient safety interventions are organized as bundles and described in Getting Started Kits, based on those originally developed by IHI for its *100,000 Lives* Campaign (now 5 million lives campaign). These kits are designed to engage your teams and clinicians in a dynamic approach for quality improvement, and to provide a thorough basis for *getting started*. **Please note that although the SHN kits and the original kits developed by IHI are similar, there are also key differences in the content of the interventions and corresponding measures for some kits.** These differences are clearly noted in the body of the SHN kits themselves, and on the SHN website.

The "Getting Started" kits are based on the current state of knowledge. Consistent with the dynamic nature of this campaign, which continues to evolve, emerging evidence may influence adaptation of the kits in the future. This kit was

reviewed and updated in April 2009. We remain open to working consultatively on updating the content as together we make healthcare safer in Canada.

The Quebec Campaign: Together, let's improve healthcare safety! works collaboratively with the SHN Campaign. The GSKs for all targeted interventions used in both campaigns are the same and the leader for the Quebec Campaign is a member of the SHN National Steering Committee.

Acknowledgement

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In addition, we also wish to thank and acknowledge our Canadian ICU Collaborative faculty who has contributed significantly to the work of the VAP teams and the revisions to this kit. In particular, we acknowledge the work of Dr. Denny Laporta,Dr. Paul Boiteau, Ms. Paule Bernier, Mr. Gordon Krahn and Ms. Rosmin Esmail.

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Background

Goal:

Prevent ventilator-associated pneumonia (VAP) by implementing the four components of care called the "**VAP Bundle**."

Teams are also strongly encouraged to implement the *Additional evidence-based component of care described in this document.*

The Case for Preventing Ventilator-Associated Pneumonia (VAP)in Adults and Children

Preventing pneumonia of any variety seems at first blush to be a laudable goal and there are some reasons to be particularly concerned about the impact of pneumonia associated with ventilator use.

The incidence of pneumonia increases 6-fold to 20-fold by placement of an endotracheal tube with ventilator circuit "by providing bacteria colonizing the aerodigestive tract a convenient, one-way path around the ETT cuff into the lower respiratory tract " [1].

Perhaps the most concerning aspect of VAP is the high rate of associated mortality. VAP is the leading cause of death among hospital-acquired infections, exceeding the rate of death due to central line infections, severe sepsis, and respiratory tract infections in the non-intubated patient... Most authors believe that VAP contributes between 6-30% of additional mortality[2-6] to these critically ill patients. Moreover, many of these poor outcomes result from systems failures that are preventable.

For the individual patient, VAP prolongs time spent on the ventilator by 4-32 days[4, 7], as well as ICU and hospital length of stay by 4.3-7days and 10 days, respectively[8, 9] Recent estimates of costs for I episode of VAP are $10 000-16 000 US [4, 6, 8, 10].

In Canada it is estimated that the prevention of one VAP could result in a minimum cost saving of 14,000$ per patient [6]. With the number of adult cases of VAP estimated to be 4 000 per year, resulting in approximately 230 deaths, 17 000 ICU days or 2% of all ICU days in Canada, at a cost to the Canadian health care system estimated at CAN$46 million per year [6] .

In the pediatric population, although VAP is an important clinical entity, there are fewer studies quantifying the problem[11-13]. The latest rates for pediatric VAP from the National Nosocomial Infections Surveillance (NNIS) group are 1.4 to 3.5 per 1,000 ventilator days with an average of 2.9 per 1,000 ventilator days [14]. The presence of VAP in children leads to a longer duration of ventilation and increased length of stay and associated costs[11-13]. It is estimated that in the pediatric population, VAP prolongs hospital length of stay by 8.7days [15]. VAP is also associated with increased mortality. In one study the difference in mortality rate was VAP 19.1% vs. non-VAP 7.2% [12].

In the Canadian Healthcare system, it is often argued that money is not saved by improving efficiency because each patient discharged is replaced by a new patient with comparable overall costs. In this context, the incentive to reduce VAP is perhaps more

on its ability to help decrease ICU and hospital LOS, and therefore improve access to the system.

Preventing VAP in Adult Patients

Defining VAP in Adults:

Ventilator-associated pneumonia (VAP) is defined as a pneumonia occurring in patients requiring a device intermittently or continuously to assist respiration through a tracheostomy or endotracheal tube. Further, the device must have been in place within the 48-hour period before onset of infection and for at least 2 consecutive days. Diagnostic criteria are as follows[16]

a) **One** of the following:
   - New or progressive and persistent infiltrate,
   - consolidation
   - cavitation on CXR compatible with pneumonia

b) **AND** at least **1** of the following:
   - WBC ≥ 12,000 or < 4,000
   - Temperature greater than 38 degrees Celsius with no other cause
   - Altered mental status with no other cause, in patient > 70 years old.

c) **And** at least **2** of the following:
   - New onset of purulent sputum, or change in character of sputum, or increase respiratory secretions or increase in suctioning requirements
   - new onset or worsening cough, or dyspnea, or tachypnea
   - rales or bronchial breath sounds on auscultation
   - Worsening gas exchange (e.g., O2 desaturations, PaO2/FiO2 < 240, an increase in O2 requirements or an increase in ventilation demand)

If multiple episodes, one needs to look for resolution of the initial infection. The addition of or change in pathogen alone is ***not*** indicative of a new episode of pneumonia. The combination of new signs and symptoms and radiographic evidence or other diagnostic testing is required.

The Faculty acknowledges that different opinions on timeline for inclusion of patients may arise. Most of the critical care literature refers to VAP in patients who have been intubated for at least 48h. In fact, the IHI in its first campaign selected this definition but has decided to change the definition for their 5 Million Lives Campaign to adopt the CDC definition. The CDC recommendation is to include patients supported by a breathing device within the 48h before the onset of the infection. Some guidelines refer only to early and late onset pneumonia. Cook et al defined a VAP as a pneumonia occurring in patients who were receiving mechanical ventilation or who stopped receiving mechanical ventilation within the last 48 hours [17]. Moreover, Canadian guidelines for the prevention of VAP were developed with research results using a variety of definitions [18]. The primary purpose of our Collaborative and of the Campaign is not research but aims at improving performance within each institution. The Faculty believes that adopting a congruent definition will not only allow intra-unit comparison over time but inter-unit comparisons, however it must be remembered that benchmarking and comparison between centres, although interesting, are not the aims of this effort [19, 20].

The Adult VAP Bundle: Concept and Potential Impact

Care bundles, in general, are groupings of best practices with respect to a disease process that individually improve care, but when applied together result in substantially greater improvement. The science supporting each bundle component is sufficiently established that the bundle be considered itself a best practice. The bundles themselves have been demonstrated to reduce VAP by the Canadian ICU Collaborative teams, examples of which are illustrated in this guide and by recently published data from pediatric and adult centres [21, 22].

Safer Healthcare Now! (SHN) has defined a "**VAP bundle,"** a group of evidence-based practices that, when implemented together, should result in dramatic reductions in the incidence of ventilator-associated pneumonia. The Canadian Campaign has endorsed the inclusion of practices that are recommended by the published Clinical Practice Guideline Committee of the Canadian Critical Care Society and the Canadian Critical Care Trials Group.[18]

A recent ICU collaborative improvement project at IHI reported an average 45% reduction in the incidence of VAP using a "VAP bundle" [23]. The application of SHN's **VAP bundle** should at the very least result in similar reductions in the rate of VAP as IHI's ***ventilator bundle*** in the care of ventilated patients. Moreover, there is a trend toward greater success among teams that comply more fully with the terms of the bundle. That is, teams that unfailingly accomplish **every bundle element on every patient every time** have gone months without a single case of pneumonia associated with the ventilator.

Compliance with the VAP bundle can be measured by simple assessment of the completion of each item. The approach has been most successful when all elements are executed together, an "all or none" strategy.

Adult VAP Bundle: Four Components of Care

1. Elevation of the Head of the Bed

Elevation of the head of the bed (HOB) is an integral part of the **VAP bundle** and has been correlated with reduction in the rate of ventilator-associated pneumonia. The recommended elevation is 30-45 degrees. Drakulovic et al. [24] conducted a randomized controlled trial in 86 mechanically ventilated patients assigned to semi-recumbent or supine body position. The trial demonstrated that suspected cases of ventilator-associated pneumonia in the supine position had an incidence of 34%, while in the semi-recumbent position suspected cases had an incidence of 8% (p=0.003). Similarly, confirmed cases were 23% and 5% respectively (p=0.018)

While it is not immediately clear whether the intervention aids in the prevention of ventilator-associated pneumonia by decreasing the risk of aspiration of gastrointestinal

contents or oropharyngeal and nasopharyngeal secretions, this was the ostensible reason for the initial recommendation. Another reason that the intervention was suggested was to improve patients' ventilation. For example, patients in the supine position will have lower spontaneous tidal volumes on pressure support ventilation than those seated in an upright position. Although patients may be on mandatory modes of ventilation, the improvement in position may aid ventilatory efforts and minimize atelectasis.

A prospective multi-centered trial by van Nieuwenhoven et al [25], compared patients undergoing mechanical ventilation who were randomly assigned to the semi recumbent position, with a target backrest elevation of 45 degrees (n=112) or standard care (e.g., supine position) with patients with a backrest elevation of 10 degrees (n=109).The study found that targeted backrest elevation of 45 degrees for semi recumbent positioning was not reached Furthermore, when they compared the difference in treatment position of 28 degrees which was reached versus 10 degrees which is standard care, VAP was not prevented. Unfortunately, the authors were unclear on why the aimed position of 45 degrees was not achieved. Therefore, one cannot conclude that raising the HOB >30 degrees is not effective in preventing VAP from this study. One of the secondary measures of the study was the development of pressure sores. Pressure sores developed in 33 patients in the standard care group and 31 in the semi recumbent group. This difference was not found to be statistically significant. In both study groups, most patients had stage 1 or 2 pressure sores and in the majority of these cases, the pressure sores were present at the heel and/or sacral region.
Thus, this paper suggests that keeping the head of the bed at 45 degrees is a more challenging task than would be otherwise imagined and underscores the need for concerted and continuous efforts by all team members to maintain this standard under routine conditions.

What changes can we make that will result in improvement?

Hospital teams across Canada and the United States have developed and tested process and system changes that allowed them to improve performance on elevation of HOB. These measures, taken together, support the implementation of the **VAP bundle**. Some of these changes are:

• Implement a mechanism to ensure head-of-the-bed elevation, such as including documentation of this intervention on nursing flow sheets (electronic or paper) at regular intervals (e.g., every 4 hours) and on daily goals sheet and as a topic at daily multidisciplinary rounds.

•Bring a protractor into the ICU to show staff exactly what 45 degrees elevation looks like. Once you have measured 45 degrees for that bed, place a piece of coloured tape on the wall behind the bed and verify compliance during vent checks.

• When purchasing new beds include a specification about monitoring of HOB position (a QA project done at the JGH in Montreal identified that mechanical measuring devices are more accurate than electronic devices).

•Create an environment where all allied health care professionals, not only nurses and MDs, are encouraged to notify nursing if the head of the bed is not elevated; alternately, have these disciplines chart on the position of the HOB and empower them and others to carefully place the patient in this position with nursing assistance. Include other personnel such as orderlies and radiology technicians.

• Educate patients and families to the importance of elevation of HOB and create an environment where family is encouraged to notify nursing if the head of the bed is not elevated.

• Include this intervention on standard orders for the initiation and weaning of mechanical ventilation, delivery of tube feedings, and provision of oral care.

•Use reminders within the patient care areas including the use of communication boards at every bedside which actually empower families to ensure that the HOB of their loved one is indeed elevated to at least 30 degrees in the absence of contra-indications.

• Provide educational material & posters for display in family waiting rooms.

•Share and post compliance with the intervention in a prominent place in your ICU to encourage change and motivate staff.

2. Daily assessment of readiness to extubate by daily performance of temporary interruption of sedation ("sedation vacation"), and a spontaneous breathing trial (SBT)

The link between timely liberation of the patient from mechanical ventilation and VAP is the hypothesis that decreasing the duration of mechanical ventilation (MV) and thus exposure to the "ventilator-circuit-endotracheal tube device" should reduce the chance of acquiring a ventilator (i.e. the device)-associated pneumonia. This is suggested by the results of several case series where ventilator protocols which incorporate the use of non-invasive ventilation (NIV) to facilitate liberation from mechanical ventilation in selected patients with respiratory failure [26-28] .

Historically, Kress et al. [29] conducted a randomized controlled trial in 128 adult patients on mechanical ventilation, randomized to daily interruption of sedation irrespective of clinical state or interruption at the clinician's discretion(sedation was administered as continuous i.v. infusion) .Daily interruption was associated with a marked and highly significant reduction in time on mechanical ventilation. The duration of mechanical ventilation decreased from 7.3 days to 4.9 days (p=0.004).

Previously, two important trials on weaning from mechanical ventilatory assistance indicated that daily weaning assessments reduced the duration of mechanical ventilation[30, 31]. They also noted during the process that weaning patients from ventilatory support became easier as the patients were better able to cough and clear their secretions.

A spontaneous awakening trial (SAT) by temporary interruption of sedation is not without potential risks such as patient-ventilator asynchrony, accidental or self-extubation, and

oxygen desaturation. Schweickert et al [32] however, in a post-hoc analysis of the Kress trial [31,33], the critically ill ICU patients undergoing daily interruption of sedative infusions experienced significantly less complications associated with mechanical ventilation (VAP, upper gastrointestinal hemorrage, bacteremia, barotrauma, venous thromboembolic disease, cholestasis or sinusitis requiring surgical intervention) than those subjected to conventional sedation techniques (2.8% vs. 6.2%, p =.04). In addition, these patients had a reduced ICU length of stay. Further analysis of these patients revealed that these same patients did not appear to be at risk for worse psychological outcomes (anxiety, inability to cope with pain) after critical illness compared with conventional therapies [33].

It should also be added that several institutions working on the prevention of VAP through the Canadian ICU Patient Safety Collaborative did not experience an increase in self extubations with this strategy. The manoeuvre must be conducted in a careful and well supervised fashion.

Interventional studies assessing the effect of implementing an ICU sedation protocol or of SBTs alone have provided inconsistent outcomes with respect to ventilator and ICU days, incidence of VAP and extubation failure [34-36]. Factors such as varying organizational models of medical and nursing care delivery and failure to link to other daily practices may have rendered redundant any added advantage of a stand alone sedation or SBT protocol.

A recent "wake up and breathe" protocol that pairs daily spontaneous awakening trials (SAT) (interruption of sedation – whether constant infusion or p.r.n) with daily spontaneous breathing trials (SBT) resulted in better outcomes for mechanically ventilated patients in intensive care than current standard approaches [37]. In this study, patients from four tertiary-care ICUs were randomized to management with a daily SAT followed by an SBT (intervention group) or with sedation per usual care plus a daily SBT (control group). Patients in the intervention group spent more days breathing without assistance during the 28-day study period than did those in the control group (14.7 *vs.* 11.6 days; p=0.02) and were discharged from ICU (median time 9.1 days *vs.* 12.9 days; p=0.01) and the hospital earlier (median time 14.9 days *vs.* 19.2 days; p=0.04). Although more patients in the intervention group self-extubated than in the control group (p=0.03), the number of patients who required reintubation after self-extubation was similar. Furthermore, during the year after enrolment, patients in the intervention group were less likely to die than were patients in the control group (Hazard Ratio 0.68; p=0.01) such that for every 7 patients treated with the intervention, one life was saved (number needed to treat was 7·4, 95% CI 4.2-35.5). The "wake up and breathe" flowsheet is available at www.icudelirium.org/delirium/WakeUPandBreathe.html

What changes can we make that will result in improvement?

Hospital teams across Canada and 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 **VAP Bundle**.

Some of these changes are:

- Implement a process to temporarily interrupt sedation (spontaneous awakening trial or SAT) daily at an appropriate time (e.g., before multidisciplinary rounds but after AM nursing change of shift) to reappraise the patients' neurocognitive ability to assume a viable breathing pattern and his/her needs for sedation/analgesia. All patients receiving sedation administered as continuous i.v. infusion or as p.rn. should be candidates for SAT. Include precautions to prevent self-extubation such as increased monitoring and vigilance during the trial. (see FAQ for further discussion)

- Consider implementing a sedation scale (e.g. Riker, RASS etc.) to avoid over or under-sedation.

- Standardize the performance of SBTs for all mechanically ventilated patients.

- Link these two strategies (SAT and SBT) into your overall weaning process (protocol etc.)

- Consider NIV as a strategy to liberate selected patients from MV.

- Empower the RT to share results of evaluation at daily medical rounds. A successful evaluation should lead to action toward extubation if not otherwise contraindicated.

- Assess compliance each day on multidisciplinary rounds.

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

3. Use of oral versus nasal tubes for access to the trachea or stomach

The use of the oral, rather than nasal, route for endotracheal and gastric tubes can reduce the frequency of nosocomial sinusitis and possibly VAP, although causality between sinusitis and VAP has not been firmly established. Patients randomized to orotracheal and orogastric intubation had decreased incidence of maxillary sinusitis compared to patients with nasotracheal and nasogastric tube placement (34% vs. 73%) [38].

In another study, 300 patients were randomized to receive both endotracheal and gastric intubation via either the nasal or oral route. Radiographic evidence of sinusitis was observed in 45 patients from the nasal group vs. 33 from the oral group ($p = .08$). Nosocomial pneumonia was observed in 17 patients in the nasal group vs. 9 in the oral group ($p = .11$). A multivariable analysis considering sinusitis as a time-dependent factor has suggested that sinusitis increased the risk of nosocomial pneumonia by a factor of 3.8 [39].

These same investigators later reported on another series of 400 nasotracheally intubated patients randomized to a systematic search of sinusitis by CT scan (study group) or not (control group). Nosocomial sinusitis was diagnosed in 80 study group

patients, but none in the control group. VAP was diagnosed in 37 patients in the study group versus 51 in the control group (p = 0.02; relative risk (RR) = 0.61, 95% CI = 0.40 to 0.93) [40].

The mechanisms leading to higher rates of VAP are not clear. They are potentially related to (a) increasing drainage of purulent material from incompletely obstructed meatus with subsequent aspiration around cuffed endotracheal tubes (ETTs); (b) neurally mediated decreases in either tracheobronchial ciliary beat frequency; and/or (c) amplitude in the presence of active inflammation within sinus cavities.

What changes can we make that will result in improvement?

Hospital teams across Canada and the United States have developed and tested process and system changes that allowed them to improve performance on the placement of oral versus nasal tubes in patients requiring mechanical ventilation. These measures, taken together, support the implementation of the **VAP bundle**. Some of these changes are:

- Make orotracheal intubation the standard of care for MV within the unit, reserving nasotracheal intubations for exceptional circumstances
- Implement a protocol that ensures that all mechanically ventilated patients with an expected duration of stay of greater than 24 hours and without contra-indications are to have their gastric tubes placed orally for purposes of decompression or feeding.
- Include ER and OR in protocol implementation to facilitate the placement of only oral gastric and tracheal tubes in patients destined for the ICU.
- Obtain radiological confirmation of the location of an enteric feeding tube and implement a documentation process
- Implement a nutrition feeding protocol that standardizes the approach to enteral feeding specifically to the approach to gastric intolerance and the timing of changing regular gastric tubes to small bore nasal feeding tubes or insertion of a percutaneous endoscopic gastrostomy (PEG) if appropriate.
- Recruit your nutrition support specialist as part of your VAP team.
- Use reminders within the patient care and staff areas.
- Assess compliance each day on multidisciplinary rounds when reviewing your daily goals.
- Share and post compliance with the intervention in a prominent place in your ICU to encourage change and motivate staff.

4. Use of endotracheal (ET) tubes with integrated port for continuous aspiration of subglottic secretions (CASS)

To state the obvious, it is best to avoid endotracheal intubation if the patient meets criteria for a trial of non-invasive mechanical ventilation. Data demonstrate the lower VAP rate in patients ventilated non-invasively compared to those ventilated with an ETT [41].

One purpose of an ETtube is to help prevent inoculation of tracheobronchial airways via recurrent micro aspiration of colonized/infected extra-pulmonary secretions arising from the aerodigestive tract.

As these secretions accumulate above the ETtube cuff, it may be conceivable that removal of these pooled secretions through suctioning of the subglottic region (referred to as the continuous aspiration of subglottic secretions, or CASS) could reduce the risk for aspiration and VAP. It became possible to test this hypothesis when an ETtube with a separate dorsal lumen which opens into the subglottic region became available. When 150 Spanish intubated patients with an expected duration of mechanical ventilation of > 3 days were randomized to receive CASS versus usual ET tube, a significant reduction in VAP was noted (19.9 vs. 39.6 episodes of pneumonia/1000 ventilator days; *RR* =1.98; *95% CI* = 1.03 to 3.82) [42]. A similar study from Amsterdam showed similar findings. Despite similar demographic characteristics and severity of illness, the CASS group had a lower VAP rate than the control group (4% vs. 16%; *RR* = 0.22; *95% CI* = 0.06-0.81; *p*=0.014) [43].

A meta-analysis of 5 studies including a total of 896 patients showed that CASS reduced the incidence of VAP by nearly half (*risk ratio* = 0.51; *95% CI* = 0.37 to 0.71), primarily by reducing early-onset pneumonia (pneumonia occurring within 5 to 7 days after intubation) [44]. Since the meta-analysis, two other reports confirmed the effect of CASS on decreasing VAP, one in a mixed medical-surgical ICU, the other in major heart surgery patients [45, 46].

Concerns have been voiced about the cost difference in using these special ETtubes (EVAC™) versus standard ETtubes. A decision-model analysis of the cost and efficacy of Ettubes with integrated port for CASS (CASS-ETTube) at preventing VAP resulted in US $1,924 saved per case of VAP prevented assuming a relative risk reduction at 50% of the base-case estimate.[47] Currently, such a tube is approximately 0.8 mm larger in outer diameter than conventional ETTubes; however the inner diameter is identical for the same size tube. The tubes currently come in 6.0, 6.5, 7.0, 7.5, 8.0 range of sizes. Thus, for patients with smaller airways (anatomic or disease related), one should consider ***inserting a CASS-ETtube that is at least a half size smaller than usual***. If a patient requires fiberoptic intubation for placement of the CASS-ETtube through a specific airway device, it is recommended that you verify the fit of the tube through the airway device prior to starting the procedure.

The use of CASS-ETtubes has been endorsed or recommended as a strategy to prevent aspiration and the subsequent development of VAP by 4 different healthcare organizations.[18, 19, 48, 49]

A recent randomized trial using a silver-coated ET tube in intubated mechanically ventilated patients demonstrated a relative reduction in VAP of 36%. The silver coating had been previously shown in animals to delay formation of biofilm, bacterial colonization on the inner tube surface, lung colonization, and VAP. Cost-benefit analyses are awaited before considering any recommendations for this novel ET tube design [50].

What changes can we make that will result in improvement?

Hospital teams across Canada are developing and testing process and system changes that allow them to improve performance on the placement of CASS-ETtubes in patients requiring mechanical ventilation. These measures, taken together, support the implementation of the **VAP bundle**. Some of these changes are:

- Develop alliances or cooperative relationships with key stakeholder groups who influence the choice of ETTs used for invasively ventilating patients in need of mechanical support: Emergency Departments, Anesthesia and Operating Theatre staff, In–Hospital Resuscitation / Medical Emergency Team staff and Regional / Community Emergency Medical Services.

- Establish the business case for your hospital administration and purchasing Department for CASS_ET tubes versus standard ETTs.

- Develop an educational program for staff within your organization explaining the rationale behind the wholesale change in types of ETTs to be used for patients destined for the ICU**.**

- Establish a Policy and Procedure document outlining the nuts and bolts of how to insert and maintain the proper functioning of such tubes.

- Doing the right thing. CASS-ETTube are required for all patients intubated in ICU, those intubated in the OR who are destined for ICU post operatively, and all crash carts, for routine intubations.

- Follow up on the reasons for non-compliance and assess opportunities for system improvement within your organization.

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

A VAP prevention program entails numerous other evidence-based practices which have been reviewed in the previously mentioned guidelines. It is assumed that health care institutions are adhering to these practices to provide the safest possible environment for the care of their mechanically ventilated patients.

Additional Evidence Based Components of Care

1. Hand Hygiene

The key role of healthcare workers washing their hands in the transmission of pathogens from patient to patient was demonstrated over 150 years ago by Ignaz Semmelweis. This Viennese obstetrician dramatically reduced the mortality related to puerperal fever by implementing systematic hand disinfection in chlorinated lime before examining patients. Since then, routine hand washing before and after patient contact has been espoused as the most important infection control measure in hospitals. The endemic transmission of exogenous staphylococci and other potential pathogens by the hands of healthcare workers has been well-documented [51].

This phenomenon is of particular concern in the ICU where patient care necessitates frequent contact. In fact, one study has shown that on average each ICU patient experiences on average 159 direct and 191 indirect contacts by healthcare workers in a 24 hour period. Much of the previous literature in this field has identified the very poor rates of hand washing by healthcare workers before and after patient contacts (21-66%) [52].

Hospital wide programs to improve compliance with hand hygiene have generally shown improvement in practices over the short term but more recently they have also shown reductions in nosocomial infections. Rosenthal and colleagues found a 42 % decrease in overall nosocomial infections (47.55 to 27.93 infections per 1000 patient-days) with implementation of an education, training and performance feedback program in 2 Argentinean ICUs. This was attributed to the observed progressive increase in hand hygiene practices over 20 months, climbing from a compliance rate of 23.1% at baseline to 64.5 % at the end of the study [53].
Similarly, Johnson et al implemented a multifaceted hand hygiene culture-change program in five clinical areas of a large Australian university teaching hospital that had high levels of MRSA. They found significant reductions in hospital-wide rates of total clinical MRSA isolates (40% decrease), patient episodes of MRSA bacteremia (57% reduction) and clinical isolates of ESBL-producing E. coli and Klebsiella spp (90% reduction) over 36 months in association with a doubling in hand hygiene compliance (21 to 42%) [54].

Thus, attention to hand hygiene plays an important role in the prevention of nosocomial infections in the ICU and is likely to be more rewarding since the advent of alcohol-based hand rub solutions [55].

There is an emerging consensus among experts that educational campaigns alone have not produced sustained improvement [56]. Rather, in order to succeed, strategies must be multimodal and include at least 5 components: staff education, monitoring of practices and performance feedback, reminders in the workplace, adoption of an institutional safety climate, and, last but not least, a system change—the preferential recourse to the use of alcohol-based hand rub as the new standard for patient care [57]. Moreover, in its testing of the WHO recommendations, Ontario points to the importance of engaging senior management so that hand hygiene becomes an organizational

priority and to the use of opinion leaders and champions in modeling behaviour [58]. A summary of recommendations from the WHO, pertaining to hand hygiene can be found at http://www.who.int/patientsafety/information_centre/ghhad_download_link/en/

The Canadian Patient Safety Institute sponsors the "Stop! Clean your hands" campaign . http://handhygiene.ca/. Additional helpful information will be found in the resources links provided.

2. Oral Decontamination

Oropharyngeal colonization as well as colonization of dental plaque have been identified as risk factors for VAP as there is high concordance between the bacteria isolated from the oropharyngeal cavity or the dental plaque and those recovered from tracheal aspirates.[59, 60]

Certain authors have reported benefits of doing oral decontamination with antibiotics-containing regimen on the rate of VAP. However, the benefits of these antibiotic-containing regimens (e.g., gentamicin/colistin/vancomycin), must be weighted against the risk of increased selection of antibiotic-resistant pathogens.[61]

Ideally, oropharyngeal decontamination should be achieved with either antiseptics or antibiotic classes that are not used for patient treatment. In addition, such agents should have a low potential for induction and selection of antibiotic resistance. Chlorhexidine (CHX) and povidone-iodine (PI) are reported to have excellent antibacterial effects, and resistance rates of nosocomial pathogens have remained exceptionally low, despite their long-term use.[64-68]

Three studies using CHX as a gel or as a rinse either before or after admission to ICU and one study comparing CHX to Listerine showed a decrease in VAP rates in the CHX groups as compared to the control groups [62, 63, 66, 67]. One study using CHX as a gel did not show a reduction in VAP rate [68]. Although the patient populations, the concentrations (0.12%, 0.2% and 2.0%) of CHX used, the combination of therapies (antiseptic alone or with Colistin), the timing of the intervention and the physical form of the CHX (oral rinse vs. gel applied to oral cavity and teeth) differed in all studies, the evidence suggests that CHX should be considered in the routine care of ventilated patients.

Furthermore, a study comparing an oral rinse of 10% PI aqueous solution to normal saline and to standard care in patients with **severe head injury** showed a significant reduction in VAP rate in the PI Group (8%, 39% and 42% respectively). Use of this product in selected populations should be considered [69].

Meta analyses published since 2006 have shown that oral decontamination is associated with a reduction of VAP. Most studies used Chlorhexidine but in various form (gel, paste, liquid) and concentration (0,12% to 2.0%) and for a duration after intubation varying from 0-28 days or until pneumonia/extubation/discharge from ICU or death [70-72, 73{Siempos, 2007 #74] . Although definite recommendations with regards to product selection and concentration cannot be made, oral decontamination should be integrated into the care plan of intubated patients.

Selected products should be stored appropriately, dispensed in small formats and manipulated to avoid contamination of the solutions.

3. Nutrition

The impact of nutrition support in critically ill patients has been widely studied. Conclusions from various studies are difficult to draw as the populations are often heterogeneous and the treatments differ. Also good randomized controlled trials are not always possible due to ethical considerations. In September 2006, the American Dietetic Association (ADA), through their Evidence Analysis Team, using a rigorous process, reviewed the literature on specific topics and published their recommendations. The full work is available (registration free of charge) at http://www.adaevidencelibrary.com/topic.cfm?cat=1031. (Details of all the recommendations can be accessed at: *http://www.adaevidencelibrary.com/topic.cfm?cat=2809&library=EBG)*

Major recommendations that impact on VAP are presented below:

Click here to see the explanation of recommendation ratings (Strong, Fair, Weak, Consensus, Insufficient Evidence) and labels (Imperative or Conditional).

- If the critically ill ICU patient is hemodynamically stable with a functional GI tract, then **enteral nutrition (EN) is recommended over parenteral nutrition (PN**). Patients who receive EN experience less septic morbidity and fewer infectious complications than patients who received PN. In the critically ill patient, EN is associated with significant cost savings when compared to PN. There is insufficient evidence to draw conclusions about the impact of EN or PN on LOS and mortality.

    - Recommendation rating and label: *Strong, Conditional*

- If the critically ill patient is adequately fluid resuscitated, then **EN should be started within 24 to 48 hours following injury or admission to the ICU**. Early EN is associated with a reduction in infectious complications and may reduce LOS. The impact of timing of EN on mortality has not been adequately evaluated.

    - Recommendation rating and label: *Strong, Conditional*

- Monitoring plan of critically ill patients must include a **determination of daily actual EN intake**. Enteral nutrition should be initiated within 48 hours of injury or admission and average intake actually delivered within the first week should be **at least** 60-70% of total estimated energy requirements as determined in the assessment . Provision of EN within this time frame and at this level may be associated with a decreased LOS, days on the mechanical ventilation and infectious complications.

    - Recommendation rating and label: *Fair, Imperative*

- Enteral Nutrition (EN) administered into the stomach is acceptable for most critically ill patients. Consider placing feeding tube in the small bowel when patient is in supine position or under heavy sedation. If your institution's policy is to measure

gastric residual volumes (GRV), then consider small bowel tube feeding placement in patients who have more than 250ml GRV or formula reflux in two consecutive measures. Small bowel tube placement is associated with reduced GRV. Adequately-powered studies have not been conducted to evaluate the impact of GRV on aspiration pneumonia. There may be specific disease states or conditions that may warrant small bowel tube placement (e.g., fistulas, pancreatitis, and gastroparesis), however they were not evaluated at this phase of the analysis.

- Recommendation rating and label: *Fair, Conditional*

- Blue dye should not be added to EN for detection of aspiration. The risk of using blue dye outweighs any perceived benefit. The presence of blue dye in tracheal secretions is not a sensitive indicator for aspiration.

  - Recommendation rating and label: *Strong, Imperative*

- Evaluating GRV in critically ill patients is an optional part of a monitoring plan to assess tolerance of EN. Enteral nutrition should be held when a GRV greater than or equal to 250ml is documented on two or more consecutive occasions. Holding EN when GRV is less than 250ml is associated with delivery of less EN. Gastric residual volume may not be a useful tool to assess the risk of aspiration pneumonia. Adequately-powered studies have not been conducted to evaluate the impact of GRV on aspiration pneumonia.

  - Recommendation rating and label*: Consensus, Imperative*

- If the patient exhibits a history of gastroparesis or repeated high GRVs, then **consider the use of a promotility agent in critically ill ICU patients**, if there are no contraindications. The use of a promotility agent (e.g., Metoclopramide) has been associated with increased GI transit, improved feeding tolerance, improved EN delivery and possibly reduced risk of aspiration.

  - Recommendation rating and label*: Strong, Conditional*

It must be noted that the Canadian group led by Dr Heyland has published and updated guidelines on the nutritional care of critically ill patients [74]. The Canadian and the American recommendations are in accordance for all topics common to both.

4. Peptic Ulcer Disease (PUD) Prophylaxis

Applying peptic ulcer disease prophylaxis is an appropriate intervention for patients with critical illness given the incidence of stress ulceration. The Canadian Critical Care Trials Group found in a paper published in 1994 that out of 2252 ICU patients, 33 (1.5%; 95% CII = 1.0 to 2.1) had clinically important bleeding. Two strong independent risk factors for bleeding were identified: respiratory failure (odds ratio (*OR*) = 15.6) and coagulopathy (*OR* = 4.3). Of 847 patients who had one or both of these risk factors, 31 (3.7%; *95% CI* = 2.5 to 5.2%) had clinically important bleeding [75].

Increasing the pH of gastric contents may in addition protect against a greater pulmonary inflammatory response to aspiration of gastrointestinal contents. Aspiration causes either pneumonitis or pneumonia and can be prevented. A concern about prophylactic therapy for stress ulceration has been the potential for increased risk of nosocomial pneumonia. Agents that raise gastric pH may promote the growth of bacteria in the stomach, particularly gram-negative bacilli that originate in the duodenum. Although some studies have shown increased risks of VAP with certain agents, such as H2 receptor inhibitors, others have not shown this association [76, 77].

In addition, the extent to which reflux of gastric contents and secretions occurs even in healthy individuals suggests that these critically ill patients are susceptible to aspiration events. Critically ill intubated patients lack the ability to defend their airway. The Surviving Sepsis Campaign includes peptic ulcer disease prophylaxis in their recommendations [78]. Yet the evidence for these recommendations is tenuous.

Proton pump inhibitors may be considered as alternatives to sucralfate or H2 antagonist. They have become the standard of care in many ICUs now that the formulations are available in intravenous form (prior to the introduction of IV pantoprazole in 2001, they were only available orally). Proton pump inhibitors tend to provide more consistent pH control than histamine H2 receptor antagonists. There is a paucity of data comparing these regimens, but the evidence that does exist indicates it is as good as H2 blockers [79, 80].

Questions arise as to whether PUD prophylaxis is appropriate due to risk of C. difficile. Use of any gastric acid suppressive agent could be a risk factor for C.difficile, and ICU patients might be receiving several things that increase the risk of C. difficile. PPIs and H2 blockers have been associated with C. difficile in community and hospital acquired disease, and although there do not appear to be specific reports in the literature about ICU-acquired C.difficile associated with this, it stands to reason that there may well be an association in ICU-acquired C. difficile. For ventilated patients in the ICU setting, stress ulcer prophylaxis may be more beneficial than the potential for this risk. As with any clinical intervention, the risk/benefit analysis must occur to ensure that the patient receives care that has greater potential benefit than risk [81, 82].

5. Deep Venous Thrombosis (DVT) Prophylaxis

Applying deep venous thrombosis prophylaxis is an appropriate intervention in all patients who are sedentary; however, the higher incidence of deep venous thrombosis in critical illness justifies greater vigilance. The risk of venous thromboembolism is reduced if prophylaxis is consistently applied. A clinical practice guideline issued as part of the Seventh American College of Chest Physicians Conference on Antithrombotic and Thrombolytic Therapy recommends prophylaxis for patients undergoing surgery, trauma patients, acutely ill medical patients, and patients admitted to the intensive care unit. The level of cited evidence was that of several randomized control trials [83].

The intervention remains excellent practice in the general care of ventilated patients. Important considerations include that the risk of bleeding may increase if anticoagulants are used to accomplish prophylaxis. Often, sequential compression devices (a.k.a. “venodynes” or “pneumoboots”) are not applied to patients when they go to or return from procedures.

Preventing VAP in Children

The challenge faced when dealing with the pediatric population is the lack of evidence to support best practice. Most of the practices are extrapolated from the adult literature. This requires assessing each of the adult recommendations based on risk and potential benefit.

Diagnosis in Children

The diagnosis of VAP faces similar difficulties to that of the adult population with there being no gold standard [84]. To complicate matters further the Centre for Disease Control (CDC) definition is separated into categories by age range resulting in 3 definitions as opposed to the one definition for adults [16]. See APPENDIX D

Surveillance

Surveillance for VAP is the same in pediatric as in adults. The rate is calculated per 1000 ventilator days. It is recommended that all suspected incidences of VAP are reviewed and that the definition is applied in a consistent manner.

The Pediatric VAP Bundle

Care bundles are supposed to be based on clinical evidence such that the components of the bundle are considered standard of care. Because of the lack of evidence in children we need to assess what parts of the established adult bundle can be applied to the pediatric population. This is done by using the limited research available and using the concept of “low risk”. In other words applying the adult components where the risk of doing so does not out way the possible benefit. Based on this rational the pediatric bundle was developed. There are a few small studies showing a decrease in paediatric VAP when some form of bundle is applied.[12, 15]
The concept of preventing VAP in children is the same as in adults. The risk factors are similar, micro aspiration of gastric and oral secretions.[85] Prevention of micro aspiration is more challenging in children due the use of un-cuffed endotracheal tubes and the lack of CASS-ETtubes in appropriate sizes for the paediatric population. Other risk factors include reintubation, transport out of the ICU, genetic syndrome, and brochcoscopy.[11, 13]

1. Elevation of the Head of Bed (HOB) in infants and children

Elevation of the Head of Bed has been shown to be of benefit in the adult population and positioning has been shown to be of benefit in neonates in preventing VAP.[86] Although no evidence is available to support this in children the concept seems applicable. Contraindications exist if the patient is unstable from a cardio-vascular point of view or they have had orthopaedic spinal procedures which require them to lay flat.

What changes can we make that will result in improvement?

Using a measuring device to ensure the patient’s upper torso is at a 30 to 45 degree angle to demonstrate what 30 to 45 degrees is. (Many people underestimate the degree of elevation)
Document the measurement on a daily flow sheet every 4 hours

Include the discussion on morning rounds for the appropriateness of maintaining HOB elevation.

2. Proper positioning of oral or nasal gastric tube in infant and children.

Having a gastric tube that is in the stomach decreases the chances of gastric contents being aspirated.

What changes can we make that will result in improvement?

- Reviewing Chest X-rays and documenting the proper position of the gastric tube on a daily goals sheet.
- Inform radiology of the initiative and they can help monitor.

3. Oral Care in children

The research into the association of VAP and oral care has been done in the adult population. Recognizing there is no literature to support oral care in the prevention of VAP in children routine oral care is a low risk procedure and maintaining at least the recommendation of the American Association of Dentistry with regard to oral care in infants and children is prudent.[87] This includes:

- Wiping of the babies' gums with a clean gauze pad after each feeding to remove plaque and residual food
- For children with teeth, brush them gently with a child's size toothbrush and water (toothpaste is used for children two and older).

What changes can we make that will result in improvement?

- Institute an oral care guideline for all patients.
- Document oral care on a daily flow sheet.
- Provide the appropriate equipment for oral care, tooth brushes for patients with dentition and swabs for those without dentition.

4. Eliminate the routine use of instil for suctioning for pediatric patients.

The use of instil for suctioning is common practice in children based on the belief that it prevents the endotracheal tube from becoming blocked with secretions. There is no evidence to support this practice.[88, 89] There is evidence that instil flushes the biofilm coating the inside of the endotracheal tube into the lungs and might contribute to VAP.[50, 90]

What changes can we make that will result in improvement?

Educate the staff in regards to the risks vs. benefits of instil for suctioning.
Document any instances of blocked endotracheal tubes to evaluate the practice of not using instil.

5. Keep the ventilator tubing in a dependant position.

Condensate from the humidified ventilator circuit can build up in the ventilator tubing. If the ventilator tubing is not in a dependant position the condensate can drain down the endotracheal tube washing the biofilm into the patient's lungs. [86]

What changes can we make that will result in improvement?

Move the ventilators to allow the tubing to hang in a dependant position.
Take pictures of the tubing properly positioned and have them at the bedside for reference.

Additional Components for the Pediatric Population

- Hand Hygiene: As per the adult bundle
- Use of oral decontamination solutions in children: Although there is no evidence in the literature for children the theory and risk assessment support this practice.

Components of the Adult bundle which <u>Are Not</u> Included

- Sedation Vacation: Sedation Vacations are not recommended for young pediatric patients due to the inability of the patient to comprehend what is happening. This might put them at risk for an unplanned extubation and reintubation which is a contributing factor for VAP.[13] However, an appropriate assessment of the patients need for mechanical ventilation should be done on a daily basis as extubation is the most important factor in preventing VAP.

- Peptic Ulcer Disease (PUD) Prophylaxis: There are two studies in children where the use of PUD prophylaxis did not demonstrate a reduction in VAP.[91, 92]
- CASS-ETTUBE tubes: CASS-ETTUBE tubes are not currently available in common pediatric sizes.

- Oral vs. Nasal endotracheal tubes. The science behind using oral vs. nasal endotracheal tubes was conducted in adults. [38, 39] In Children the maxillofacial sinuses are not fully developed until 12 years of age, [93] which conceivably reduces the possibility of the sinus being a source of bacteria and subsequent cause of VAP. Given that there is no literature to support the use of oral vs. nasal tubes in children for the prevention of VAP and the risks of unplanned extubations associated with

fixing of the endotracheal tube no recommendations are made with regards to oral vs. nasal tubes.

Implementing the VAP Bundle in Adults and Children

1. Forming the Team

SHN recommends a multidisciplinary team approach to ventilator care. Improvement teams should be heterogeneous in make-up, but homogeneous in mindset. The value of bringing diverse personnel together is that all members of the care team are given a stake in the outcome and work to achieve the same goal. In ventilator care, the team must include a intensive care physician and should include:

- Intensive Care Nurses
- Respiratory Therapists
- Physiotherapists
- Nutritionists
- Infection Control Practitioners
- Pharmacists

All the stakeholders in the process must be included, in order to gain the buy-in and cooperation of all parties. For example, teams without nurses are bound to fail. Teams led by nurses and allied health professionals may be successful, but often lack leverage; physicians must also be part of the team.

Some suggestions to attract and retain excellent team members include:

- use data to define and solve the problem;
- work with those who want to work on the project, rather than trying to convince those who do not;
- schedule meetings in advance with dates/times that are MD friendly;
- ensure that meetings are structured (agenda and minutes);
- ensure meetings are managed effectively (attention to time allocation);
- ensure that there is clarity about task delegation and time lines;
- engage them in the overall goal of the Campaign;
- find champions within the hospital that are of sufficiently high profile to lend the effort immediate credibility.

The team needs encouragement and commitment from an authority in the intensive care unit. Identifying a champion increases a team's motivation to succeed. When measures are not improving fast enough, the champion readdresses the problems with staff and helps to keep everybody on track toward the aims and goals.

Eventually, the changes that are introduced become established. At some point, however, changes in the field or other changes in the ICU will require revisiting the processes that have been developed. Identifying a "process owner," a figure who is responsible for the functioning of the process now and in the future, helps to maintain the long-term integrity of the effort.

2. Setting Aims

Improvement requires setting aims. An organization will not improve without a clear and firm intention to do so. The aim should be time-specific and measurable; it should also define the specific population of patients that will be affected. Agreeing on the aim is crucial, as is allocating the people and resources necessary to accomplish the aim.

An example of an aim that would be appropriate for reducing VAP can be as simple as, "Decrease the rate of VAP by 50% within one year." Teams are more successful when they have unambiguous, focused aims. Setting numerical goals clarifies the aim, helps to create tension for change, directs measurement, and focuses initial changes. Once the aim has been set, the team needs to be careful not to back away from it deliberately or "drift" away from it unconsciously.

3. Using the Model for Improvement

In order to move this work forward, SHN and IHI recommend using the Model for Improvement. Developed by Associates in Process Improvement, the Model for Improvement is a simple yet powerful tool for accelerating improvement that has been used successfully by hundreds of health care organizations to improve many different health care processes and outcomes.

The model has two parts:

- Three fundamental questions that guide improvement teams to 1) set clear aims, 2) establish measures that will tell if changes are leading to improvement, and 3) identify changes that are likely to lead to improvement.

- The Plan-Do-Study-Act (PDSA) cycle to conduct small-scale tests of change in real work settings — by planning a test, trying it, observing the results, and acting on what is learned. This is the scientific method, used for action-oriented learning.

Implementation: After testing a change on a small scale, learning from each test, and refining the change through several PDSA cycles, the team can implement the change on a broader scale — for example, for an entire pilot population or on an entire unit.

Spread: After successful implementation of a change or package of changes for a pilot population or an entire unit, the team can spread the changes to other parts of the organization or to other organizations.

You can learn more about the Model for Improvement on www.IHI.org . The Canadian Collaborative to Improve Patient Care and Safety in the ICU provides Teams with the knowledge and support to successfully implement the model.
http://www.improvementassociates.com/dnn/CanadianICUCollaborative/tabid/190/Default.aspx

4. Getting Started

Hospitals will not successfully implement the **VAP bundle** overnight. If they do, chances are that they are doing something sub-optimally. A successful program involves careful planning, testing to determine if the process is successful, making modifications as needed, re-testing, and careful implementation.

- Select the team and the venue. Many hospitals will have only one ICU, making the choice easier.
- Assess where you stand presently. Does the respiratory therapy department have a process in place now for ventilator care to prevent pneumonia? If so, work with the department to begin preparing for changes.
- Contact the infectious diseases or infection control department. Learn about your ventilator associated pneumonia rate and how frequently the hospital reports it to regulatory agencies.
- Organize an educational program. Teaching the core principles to the respiratory therapy department as well as to the ICU staff (doctors, nurses, therapists, and others) will open many people's minds to the process of change.
- Introduce the **VAP bundle** to the key stakeholders in the process.

5. First Test of Change

Once a team has prepared the way for change by studying the current process and educating the key stakeholders, the next step is to begin testing the bundle at your institution.

Begin using the bundle with one patient from the time of initiation of mechanical ventilation.

Teams that are just starting can begin by testing and implementing one component of the bundle element at a time working towards consistently implementing all components of the VAP bundle.

- Measurement can be reported as compliance with the individual bundle element and should be noted on the worksheet accordingly.
- It is recommended that VAP bundle compliance be measured as compliance with all 4 elements of the bundle rather than a 'part' of the bundle.
- Work with each nurse and respiratory therapist who cares for the patient to be sure they are able to follow the demands of the bundle.
- Make sure that the approach is carried over from shift to shift, to eliminate gaps in teaching and utilization.
- Process feedback and incorporate suggestions for improvement.
- Once the bundle has been applied to one patient, increase utilization to the remainder of the ICU.
- Engage in subsequent PDSA cycles to refine the process and make it more reliable.

6. Measurement

There is only one way to know if a change represents an improvement: measurement. SHN recommends that teams implementing the **VAP bundle** collect data on two measures.

1. VAP Rate
The total number of cases of VAP for a particular time period.

For example, if in February there were 6 cases of VAP, the number of cases would be 6 for that month. We want to be able to understand that number as a proportion of the total number of days that patients were on ventilators.

The process of attributing a day of mechanical ventilation (MV) to a patient should be kept simple and the same from day to day. One such process is to count the number of MV patients in the ICU at approximately the same time every day and assign one day of MV to each of these patients. Some institutions have elected to perform such a count at midnight when planned extubations are unlikely to occur. For example, on Monday there are 7 mechanically ventilated patients at the time of the count which equates to 7 days of mechanical ventilation. Add the total number of mechanical ventilation days for the month based on your daily log. Thus, if there are 168 total days of MV during the month (sum of the daily mechanical ventilation days during all of February), then the VAP rate per 1000 ventilator days would be 6/168 x 1000 = 35.7.

Total no. VAP cases	X 1000	= *VAP Rate*
---------- _		
No. ventilator days _		

2. VAP Bundle Compliance
In our experience, teams begin to demonstrate improvement in outcomes when they provide all four components of the **VAP bundle**. Therefore, we encourage Teams to measure compliance with the entire **VAP bundle.** We recognize however that for new Teams there is a learning curve and that not all aspects of the bundle can be implemented on day 1 of their improvement journey. Therefore, Teams can report compliance with individual bundle components (see Measurement Worksheet 2.0).

On a given day, select all the ventilated patients and assess them for compliance with the **VAP bundle** or selected components of the bundle. For Teams that have implemented all 4 components of the bundle, even if one bundle component is missing, the case is not in compliance with the bundle.

For example, if there are 7 ventilated patients, and 6 have all 4 bundle elements present, then 6/7 (86%) is the compliance with the **VAP bundle**. If all 7 had all 4 elements completed, compliance would be 100%. If all seven were missing even a single item, compliance would be 0%.

No. receiving ALL 4 components of VAP bundle	= *Bundle compliance*

No. on ventilators for the day of the sample	

Appendix A contains further details on the technical descriptions of these measures, including definitions of terms, numerators, denominators, exclusions, and collection strategies.

Appendix A also contains a worksheet for each measure. The worksheets provide step-by-step tables for calculating the numerator, denominator, and final calculation for each measure. The worksheets can be used at the baseline stage (before you have started to implement the bundle) or implementation stage. You may be able to collect some or all measures retrospectively, through chart review, but ideally your data will be collected concurrently.

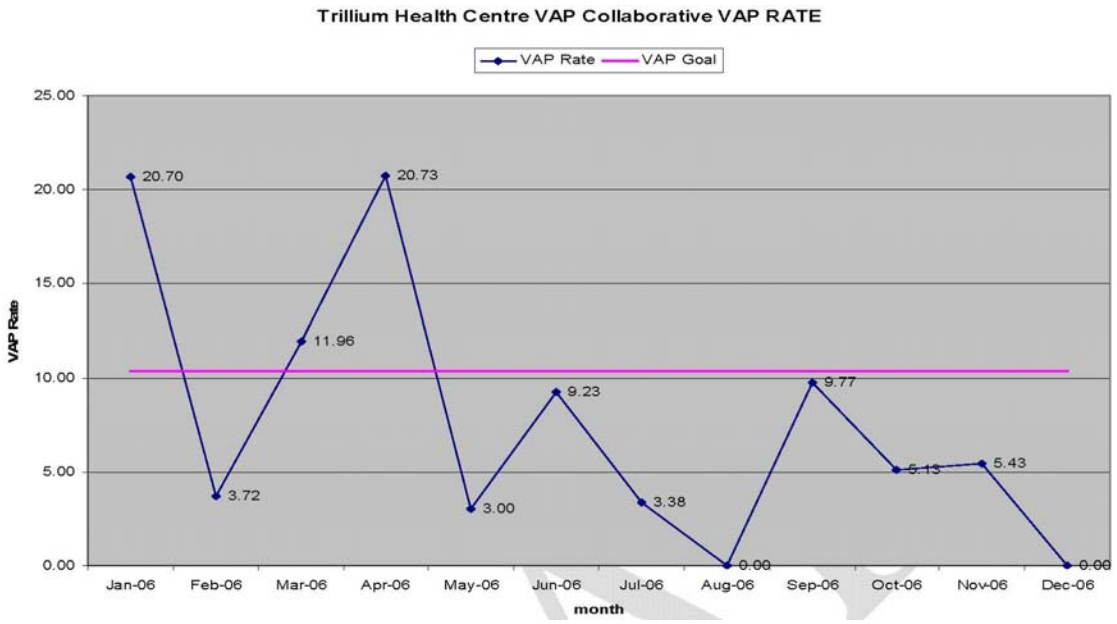
SHN recommends that before your facility, team or unit begins implementing the intervention, you obtain **baseline data**, using the worksheets provided. Baseline data will give you a sense of where you are starting from, and what some of the potential areas of focus are for your facility or unit. We suggest that you take a "snapshot" of three months or more, or whatever is feasible for your organization.

7. Track Measures over Time

Improvement takes place over time. Determining if improvement has really occurred and if it is a lasting effect requires observing patterns over time. Run charts are graphs of data over time and are one of the single most important tools in performance improvement. Using run charts has a variety of benefits:

- They help improvement teams formulate aims by depicting how well (or poorly) a process is performing.
- They help in determining when changes are truly improvements by displaying a pattern of data that you can observe as you make changes.
- They give direction as you work on improvement and information about the value of particular changes.

Example:
Y axis indicates VAP rate per 1000 days of MV



8. Barriers That May be Encountered

- **Fear of change**
  All change is difficult. The antidote to fear is knowledge about the deficiencies of the present process and optimism about the potential benefits of a new process.

- **Communication breakdown**
  Organizations have not been successful when they failed to communicate with staff about the importance of ventilator care, as well as when they failed to provide ongoing teaching as new staff become involved in the process.

- **Physician & staff "partial buy-in"** (e.g., "Just another flavour of the week")
  In order to enlist support and engage staff, it is important to share baseline data on VAP rates and to share the results of improvement efforts. If the run charts suggest a large decrease in VAP compared to baseline, issues surrounding "buy-in" tend to fade.

- **Unplanned extubations**
  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.

9. Work to Achieve a High Level of Compliance

Evidence shows that the greater the level of compliance with *all* of the components in a bundle, the better the outcomes.

Several hospitals in the USA have achieved greater than 95% compliance with the **ventilator bundle**. Those hospitals tend to have the fewest cases of VAP. For example, some unpublished data from the IHI initiatives shows the following:

Level of Reliability (compliance with all elements):	**Reduction in VAP Rate:**
Unchanged	22%
<95% compliance	40%
>95% compliance	61%

10. Tips for Gathering Data

Use a data collection form, such as the worksheets in Appendix A, which allows you to track compliance with the bundle elements over time. Using a data collection form makes it easier to create run charts each month as well. A hospital may also wish to use a **VAP bundle checklist** to help track the process (**Appendix B**).

Note that the checklist is particularly effective if used in conjunction with a Daily Goals assessment form that can be completed during daily rounds on the patient (**Appendix B**).

Frequently Asked Questions: VAP

Can I implement most of the VAP bundle, but exclude some items?
While this is possible, it is not recommended. In fact, the goal of bundling therapies together aims to create a linkage between practices that makes the overall process more effective. Certainly, in terms of monitoring compliance with the VAP bundle, "picking and choosing" items would be unwise however we recognize that Teams starting their journey may implement components of the bundle in a staged process. Compliance with specific components of the bundle can in the early stages assist teams in targeting areas for improvement. Hence reporting compliance with components of the bundle for Teams beginning their process improvement is acceptable remembering that the ultimate goal however is to implement all elements as early as possible.

How can you compare VAP rates between institutions?
The practice of comparing rates of disease entities or patterns of therapy across institutions is commonly known as "benchmarking." Benchmarking may not be a valid method to compare performance between facilities because of differences in patient population, resource availability, or severity of illness. Fortunately, none of the work

required to improve the care of ventilated patients requires a comparison of rates between institutions. As long as you establish methods in your institution to determine the patterns and methods of your regular data collection, your results will be consistent over time with respect to your own performance and your own improvement, which is our primary interest. Presumably, any improvements you make would be reflected in any benchmarking work that you do for other organizations.

What are the inclusion and exclusion criteria for the VAP bundle? For the individual bundle elements?

No specific exclusion criteria exist, but good clinical judgment should be exercised in conjunction with a close reading of the evidence cited in the How-to Guide. Likewise, no specific inclusion criteria are available. Instead, teams interested in improving their performance should develop these standards in conjunction with their clinical staff and apply them uniformly over time. In so doing, teams will have an accurate standard whereby they can measure their own progress in comparison to the only standard that is truly meaningful: their own data. As an example, some institutions have proposed criteria for excluding patients from various parts of the bundle.

One institution excludes patients from interruption of sedation if any of the following criteria apply:

- Open abdominal wound in which fascia is not closed, unless ordered by a physician
- Documentation of intra-cranial hypertension (ICP > 20) in previous 24 hours, unless ordered by a physician
- Severe gas exchange abnormalities (e.g., P/F <150), unless ordered by a physician
- Hemodynamic instability usually defined by the infusion of vasopressors and/or inotropes, unless ordered by a physician.

Workable inclusion criteria, exclusion criteria, measurement systems, and protocols all require customization at the local level to be effective. The only key factor in all of these decisions is that the standards, once decided, are adhered to over time. Hence, if a patient is appropriately excluded from a component of the bundle, Teams should consider them in compliance with the specific component for purposes of measurement.

I am looking for policy/procedures on how to conduct a sedative interruption? Can anyone help me with this?

The best resource to understand the procedure used is the original article [29]. In the study, an investigator interrupted the sedation each day until the patients were awake and could follow instructions or until they became uncomfortable or agitated and were deemed to require the resumption of sedation. A nurse evaluated the patients each day throughout the period when infusions were stopped until the patients were either awake or uncomfortable and in need of resumed sedation. This nurse immediately contacted a study physician when a patient awakened, at which time the study physician examined the patient and decided whether to resume the infusions. The sedative regimen was restarted after the patient was awake or, if agitation prevented successful waking, at half the previous dosage and was readjusted according to the need for sedation. For patients receiving paralytic agents, a slightly modified procedure was used. The follow-up study of Girard et al used the same approach.

Some people use sedation scales to manage over sedation. Is this a reasonable substitute for the interruption of sedation in the bundle?
The use of subjective and objective criteria may be helpful in maintaining the desired level of sedation, despite changes in medical personnel and sedation goals. Although no true reference measure or criterion exists for sedation assessment, several subjective patient assessment scoring systems have been developed, including the following:

- Motor Activity Assessment Scale (MAAS)[94]
- The Sedation-Agitation Scale (SAS)[95]

The Richmond Agitation-Sedation Scale (RASS) [96]

However, these scales are not substitutes for the standard of interruption of sedation. In the Kress trial, patients were in fact subjected to both a sedation scale and interruption of sedation.

Should I include patients with tracheotomies in the ventilator bundle?
The ventilator bundle has primarily been tested on intubated patients, rather than those with tracheotomies, so we do not have specific evidence to adequately tell you the effect of the current VAP bundle on this population. Some bundle components are not applicable such as the presence of a CASS-ETtube. These patients may still however benefit from the other VAP bundle components.

If a patient is admitted to the ICU without a CASS-ETTube, what do we do?
The decision to change a regular ETT to a CASS-ETTube must take into consideration the patient specific risks associated with the change of such a tube (loss of airway, regurgitation and aspiration, cardiopulmonary arrest etc…). Specifically, one must balance the fact that we know that re-intubated patients have a higher risk of VAP [5] against the protective effects of an initial CASS-ETTUBE intubation. We do not have specific evidence about the risk-benefit ratio of electively re-intubating an ICU patient with a CASS-ETTube.

I would like to implement the use of CASS-ETTubes, but I am concerned about reports of tracheal injury.
It is the Faculty's opinion that the weight of current evidence favours the use of the CASS-ETTube. In 2004, an in vivo study on sheep documented tracheal mucosal injury at the level of the subglottic suction orifice, along with heavy tracheal bacterial colonization when in the sheep that were maintained "head-up" [97] . During that study, the sheep were in the prone position with the head remaining midline and posterior neck flexed. This position alters the normal curvature of the ET tube and places the subglottic suction orifice in the upper subglottic region. Extrapolation of these findings to humans may be limited, in as much as only one small case series reported such injury in 2 of 5 patients with the Hi-Lo Evac™, developing laryngeal edema immediately after extubation and requiring reintubation [98]. Whether the CASS-ETtube contributed to laryngeal edema alone is not known. Standard ETtubes are known to be associated with tracheal trauma because they do not conform to the patient's anatomy resulting in pressure on

soft tissue. ET tube suctioning and suction catheters have been known to cause mucosal injury by denuding the tracheal mucosa at the site where the suction catheter lumen contacts the tracheal tissue during suction application. The potential for a CASS-ETTube to cause similar mucosal injury is not known. However, Valles reported no increase in post-extubation edema or reintubations in more than 3,000 patients over 10 years using CASS-ETtube, and reported no more tracheal mucosal injury than that accounted by prolonged intubation . [99] In addition, Dragoumanis et al. [100] identified an impaired ability of CASS-ETTubes to reliably drain supraglotic secretions because of intermittent occlusion of the suction channel.
In response to this communication the manufacturer redesigned the tube by increasing the diameter of the subglottic aspiration channel and lowering its dorsal orifice to immediately above the superior (proximal) junction of the inflation cuff and ETTube *[101]*

APPENDIX A: Technical Descriptions and Worksheets

1. VAP Rate per 1000 Ventilator Days – Technical Description

Intervention(s): Prevention of Ventilator-Associated Pneumonia
Definition VAP rate: The number of ventilator-associated pneumonias per 1000 ventilator days is the standard measure for surveillance by the CDC. The specific surveillance criteria are outlined in the CDC's National Healthcare Safety Network (NHSN), Patient Safety Component Protocol, Division of Healthcare Quality Promotion National Center for Infectious Diseases, Atlanta, Georgia.[16]
Goal: Decrease the VAP rate by ___% in one year.
Matches Existing Measures: CDC

CALCULATION DETAILS:

Numerator Definition: Total number of VAP cases in all ICUs in the organization during the set time interval

Numerator Exclusions:
- Exclude non invasive ventilation days
- For adult population: Exclude patients less than 18 years of age at the date of ICU admission
- For pediatric population: Exclude patients 18 years old and more

Denominator Definition: Number of ventilator days in all ICUs in same time interval used in numerator (see definition below)

Denominator Exclusions:
- Same as the nominator

Calculate as: Number of Ventilator-Associated Pneumonias / Number of ventilator days [x 1,000] = VAP rate per 1000 ventilator days

Measurement Period Length: Measure monthly.

Definition of Terms:

- **Ventilator-Associated Pneumonia:** Pneumonia occurring in patients requiring a device intermittently or continuously to assist respiration through a tracheostomy or endotracheal tube. Further, the device must have been in place within the 48-hour period before onset of infection and for at least 2 consecutive days

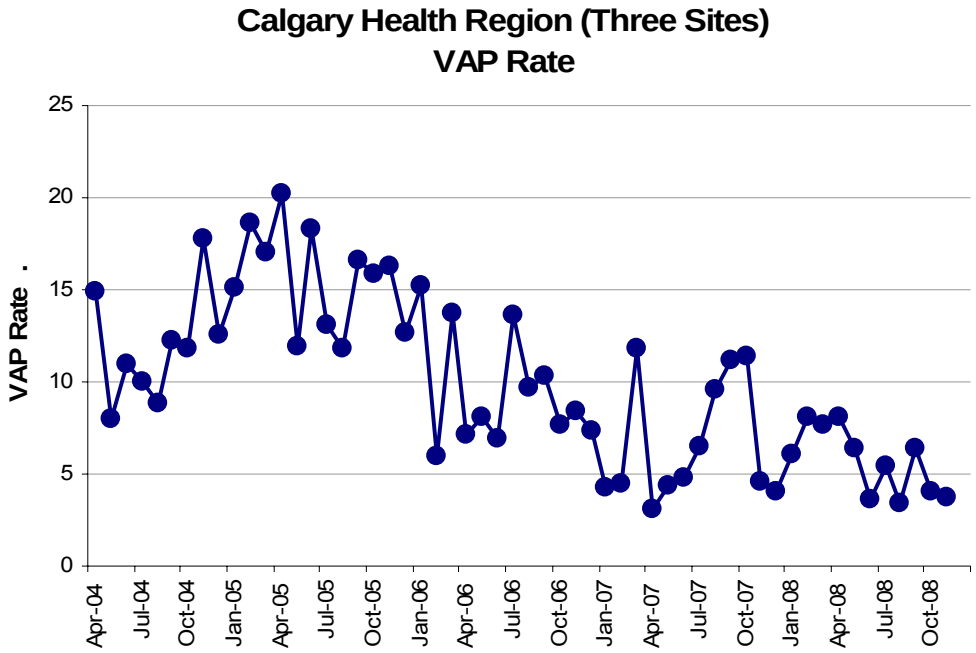
- **Ventilator Day:** Total number of days of exposure to ventilators by all patients in the selected population during the selected time period

COLLECTION STRATEGY:

Sampling Plan: Report the monthly VAP rate for the last several months (minimum 3 months). This will serve as your baseline. Continue to track the measure monthly. If possible, track the rate in an annotated run chart, with notes reflecting any interventions you made to improve. If your organization's infection control practitioner reports data quarterly, we strongly encourage you to disaggregate this data and report monthly.

SAMPLE GRAPHS:

Y axis = VAP rate per 1000 ventilator days



Applying the VAP bundle, over time this health region has been able to substantially reduce its VAP rate. VAP is reported per 1000 ventilator day for each month. Therefore, for the given period, VAP cases per 1000 ventilator days is calculated by counting the number of patients with VAP (according to definition above) divided by the number of mechanical ventilator days multiplied by 1000.

1.0 VAP Rate in ICU per 1000 Ventilator Days: Measurement Worksheet

Prevention of Ventilator-Associated Pneumonia					
Intervention:				Prevention of Ventilator-Associated Pneumonia	
Definition:				The number of ventilator-associated pneumonias per 1000 ventilator days in selected ICUs is the standard measure for surveillance by the CDC. Ventilator-associated pneumonia (VAP) is defined as a pneumonia occurring in patients requiring a device intermittently or continuously to assist respiration through a tracheostomy or endotracheal tube within the 48-hour period before onset of infection. Furthermore, patients must have received such mechanical ventilatory assistance for at least 2 consecutive days.	
Goal:				Decrease the VAP rate by ___ % in one year	
Data Collection Details					
Hospital Name:			**Health Region:** NA or ***Specify Region:***		
Completed by:	**Name:**	**E-mail Address:**	**Phone Number:** ( ) -	**Date of Submission:**	
Year:	*Indicate the year for which the data was collected:* 2005 2006 2007 2008 Other (specify):	**Collection Method:**	Concurrent Retrospective		
Month:			*Indicate the month for which the data was collected:* Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.		
Implementation Stage:	Baseline Stage *(Pre-intervention)*	Early implementation stage *(Team members are applying some components of the bundle)*	Full implementation stage *(All team members in selected unit(s) are consistently implementing VAP bundle)*		
Patient Sample:			*Describe the source of the patient population: e.g., Intensive Care Unit, Neuro ICU, Surgical ICU etc.* Pediatric, neonatal		
Additional Information:			*Describe any other pertinent information here, including Team # if there is more than one VAP team in your hospital* **Team #: N/A**		
Calculation of Denominator				***Formula***	***Answer***
1.1	What is the total number of patients this month who received care in selected Intensive Care Units?			**1.1=**	

1.2	What is the total number of patients in # **1.1** who did not receive mechanical ventilation? *Exclude from patient list for calculating VAP Rate*		**1.2=**	
1.3	Subtract the answer to # **1.2** from the answer to # **1.1** and enter here.	(**1.1** - **1.2**=)	**1.3=**	
1.4	**Adult**: What is the total number of patients in # 1.3 whose age was less than 18 yrs on admission to ICU? Exclude for adult population. **Pediatric**: What is total number of patients in #1.3 whose age was 18 years or more on admission to ICU? Exclude for pediatric population. Pediatric only patient samples should indicate "pediatric only" in Patient Sample Box above and leave 1.4 blank.		**1.4=**	
1.5	Subtract the total of # **1.4** from the total of # **1.3** and enter here. *(This represents the finals list of patients eligible for inclusion in the denominator)*	(**1.3** - **1.4**=)	**1.5=**	
1.6	~~Count and record the total number of days of exposure to ventilators for **each** patient accounted for in # **1.5**.~~		**1.6=**	
1.7	Count, record and add the total number of days (any portion of a day = one day of Mechanical Ventilation) of exposure to ventilators for each patient accounted for in # 1.5. Enter sum in # **1.7.**		**1.7=**	
Calculation of Numerator		***Formula***		***Answer***
1.8	What is the total number of patients in # **1.5** who developed Ventilator-Associated Pneumonia (e.g., pneumonia occurring in patients requiring a device intermittently or continuously to assist respiration through a tracheostomy or endotracheal tube. Further, the device must have been in place within the 48-hour period before onset of infection and for at least 2 consecutive days.		**1.8=**	
Final Calculation		***Formula***		***Answer***
1.9	Divide # **1.8** by # **1.7**. Multiply by 1000.	(**1.8** / **1.7**) x 1000	**1.9=**	

2. VAP Bundle Compliance – Technical Description

Intervention(s): Prevention of Ventilator-Associated Pneumonia
Definition: The percentage of intensive care patients on mechanical ventilation for whom all elements of the **VAP bundle** are implemented unless contra-indicated and documented on the daily goals sheet and/or elsewhere in the medical record through regular audit processes.
Goal: 95% of all patients on mechanical ventilation in the intensive care unit(s) receive all four elements of the **VAP bundle**. Historically, this level of reliability has been achieved by building an infrastructure using multidisciplinary rounds and daily goals.

CALCULATION DETAILS:

Numerator Definition: Number of intensive care unit patients on mechanical ventilation at time of audit for which all elements of the **VAP bundle** are documented and in place.

The 4 **ADULT VAP bundle** elements, unless contra-indicated, are:

1. Head of bed elevation to between 30 and 45 degrees
2. Daily "sedation vacation" and assessment of readiness to extubate via SBT
3. Use of oral versus nasal tubes for access to the trachea or stomach
4. Use of CASS-ETTUBE tubes for the drainage of subglottic secretions

The 5 **Pediatric VAP bundle** elements, unless contra-indicated, are:

1. Elevation of the Head of Bed (HOB) in infants and children
2. Proper positioning of oral or nasal gastric tube in infant and children
3. Oral Care in pediatric patients
4. Eliminate the routine use of instil for suctioning for paediatric patients
5. Keep the ventilator tubing in a dependant position

NOTE: This is an "all or nothing" indicator. If any of the elements are not documented or visualized at the time of audit, do not count the patient in the numerator. If a bundle element is contraindicated for a particular patient and this is documented appropriately in the medical record, then the bundle can still be considered compliant with regard to that element. Patients receiving enteral feeding via **specially designed small bore nutrition tubes** placed nasally are deemed in compliance with the third Adult -VAP prevention strategy.

Numerator Exclusions:

- Exclude patients receiving non invasive ventilation
- For adult population: Exclude patients less than 18 years of age at the date of ICU admission
- For pediatric population: Exclude patients 18 years old and more

Denominator Definition: Total number of ICU mechanically ventilated patients
Denominator Exclusions:

- Same as numerator

Measurement Period Length: Report compliance on a monthly basis. However you will need to conduct weekly sample of mechanically ventilated patients. The aim is to sample approximately 10% of the total ventilator days in a given month. For example, if

a 12 bed unit has 300 ventilator days per month, this means sampling 7-8 patients per week.

Definition of Terms:

- **VAP Bundle** - A group of interventions for all patients on mechanical ventilation (unless medically contraindicated) that, when implemented together, result in better outcomes than when implemented individually. When implemented with a higher level of reliability, basic structural changes are required on unit to maintain compliance.

- **Elements of the bundle:** see previous descriptions of each element

Calculate as: Number of intensive care unit patients on mechanical ventilation for whom all elements of the ventilator bundle are documented and in place / Total number of intensive care unit patients on mechanical ventilation on day of week of sample [x 100 to express as a percentage]

Comments: Incorporating all elements of the **VAP bundle** into your daily goals form and reviewing them daily during multidisciplinary rounds allows for easy review of bundle compliance during weekly survey. This also serves as a reminder during rounds to increase compliance with the bundle elements.

COLLECTION STRATEGY:

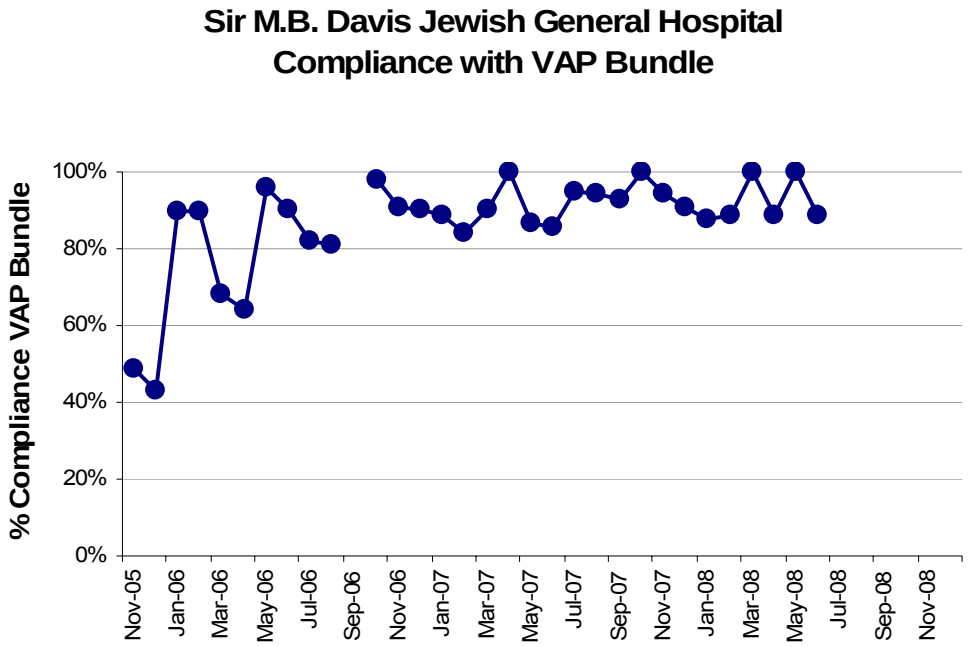
Use a daily goal sheet and/or medical record as data source. Review for implementation of the **VAP bundle**. Visually confirm compliance with head-of-the-bed elevation, placement of oral tubes ,use of CASS-ETTUBE tubes (adults) and position of the ventilator tubing in a dependant position (in pediatric)

Sampling Plan: The sample should include all patients on mechanical ventilation in the intensive care unit(s). Only patients with all aspects of **VAP bundle** in place are recorded as being in compliance with the **VAP bundle.** The recommended sample size should equal 10% of an ICU's total ventilator days in a month

Conduct the sample one day per week.. Rotate the days of the week and the shifts. On the day of the sample, examine the medical records of all patients on mechanical ventilation for evidence of bundle compliance that day and visually confirm compliance with elements of the bundle. Team may more easily sample 100% of patients if they have a rounding system in place and can collect information as part of rounds.

SAMPLE GRAPHS:

Y axis = VAP rate per 1000 ventilator days



2.0 VAP Bundle Compliance (Adult) – Measurement Worksheet

Prevention of Ventilator-Associated Pneumonia ADULTS					
Intervention:				Prevention of Ventilator-Associated Pneumonia	
Definition:				The percentage of intensive care patients on mechanical ventilation for whom all four elements of the VAP Bundle are implemented and documented on the daily goals sheet and/or elsewhere in the medical record through regular audit processes.	
Goal:				95% of all patients on mechanical ventilation in the intensive care unit(s) receive all four elements of the VAP Bundle.	
Data Collection Details					
Hospital Name:		**Health Region:** NA or ***Specify Region:***			
Completed by:	**Name:**	**E-mail Address:**	**Phone Number:** ( ) -	**Date of Submission:**	
Year:	*Indicate the year for which the data was collected:* 2005 2006 2007 2008 Other (specify):	**Collection Method:**		Concurrent Retrospective	
Month:				*Indicate the month for which the data was collected:* Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.	
Implementation Stage:	Baseline Stage *(Pre-intervention)*	Early implementation stage *(Team members are applying some components of the bundle)*		Full implementation stage *(All team members in selected unit(s) are consistently implementing VAP bundle)*	
Patient Sample:				*Describe the source of the patients population: e.g., Intensive Care Unit, Neuro ICU, Surgical ICU etc.*	
Additional Information:				*Describe any other pertinent information here, including Team # if there is more than one VAP team in your hospital*	
				Team #: N/A	
Initial Calculation of Weekly Sample Size			***Formula***	***Answer***	
2.1	What is the total number of patients in this month who received care in selected Intensive Care Units?		**2.1 =**		

2.2	What is the total number of patients in # **2.1** whose age was less than 18 yrs (*use Paediatirc VAP Bundle worksheet for Paediatric patients/teams)* on admission to ICU? Exclude from patient list for calculating weekly sample size.		**2.2 =**	
2.3	Subtract the total of # **2.2** from the total of # **2.1** and enter here. *(This represents the finals list of patients eligible for inclusion in the Weekly Sample Size)*	(**2.1** - **2.2** =)	**2.3 =**	
2.4	Count and record the total number of days of exposure to ventilators for each patient accounted for in # **2.3.**		**2.4 =**	
2.5	Add the total number of days of exposure to ventilators by all patients in # **2.3.** *e.g.: 300*		**2.5 =**	
2.6	Multiply #**2.5** by 0.10 **(10% of total ventilator days in month).** *e.g.: 300 x 0.10 = 30*	(**2.5** x 0.10 =)	**2.6 =**	
2.7	Divide # **2.6** by 4 weeks (**Number of patients on ventilators to sample per week).** *e.g. 30/4 = 7 or 8 patients per week*	(**2.6** / 4 =)	**2.7 =**	
Calculation of Denominator			***Formula***	***Answer***
2.8	What is the total number of patients who received mechanical ventilation in the selected Intensive Care Unit who are <u>actually</u> included in <u>this</u> monthly sample? *e.g.: recommended equivalent of 10% of ventilator days sampled - #**2.6***		**2.8 =**	

Implementation of Bundle Components *(Indicate "Yes" or "No" for questions in this section)*				***Answer***
2.9	Did you implement VAP Bundle Element #1 (***<u>Head of bed elevation over 30 degrees)</u>*** for this month's sample?		Yes	No
2.10	Did you implement VAP Bundle Element #2 (Daily assessment of readiness to extubate) for this month's sample?		Yes	No
2.11	Did you implement VAP Bundle Element #3 (***<u>Use of oral versus nasal tubes)</u>*** for this month's sample?		Yes	No
2.12	Did you implement VAP Bundle Element #4 (***<u>Use of CASS tubes)</u>*** for this month's sample?		Yes	No
Calculation of Numerator		***Formula***		***Answer***

2.13	What is the total number of patients in # **2.8** for whom ALL of the following four elements which have been implemented in your healthcare facility were in place at the time of the survey? (*Use attached VAP Bundle Checklist)* **Ventilator-Associated Pneumonia (VAP) Bundle Elements:** 1) Head of bed elevation over 30 degrees; 2) Daily assessment of readiness to extubate *3)* Use of oral versus nasal tubes; 4) Use of CASS tubes		**2.13 =**	
Final Calculation				
2.14	Divide # **2.13** by # **2.8.** Multiply by 100.	**(2.13 / 2.8)** x 100	**2.14=**	**%**
Numerator for Compliance Calculation				
2.15	What is the total number of patients in # **2.8** that were in compliance with Bundle Element #1 (Head of bed elevation over 30 degrees)?			
2.16	What is the total number of patients in # **2.8** that were in compliance with Bundle Element #2 (Daily "sedation vacation" and daily assessment of readiness to extubate)?			
2.17	What is the total number of patients in # **2.8** that were in compliance with Bundle Element #3 (Use of oral versus nasal tubes)?			
2.18	What is the total number of patients in # 2.8 that were in compliance with Bundle Element #4 (Use of CASS tubes)?			
Compliance Calculation				
2.19	Compliance Calculation for Bundle Element #1 (Head of bed elevation over 30 degrees) Divide # **2.15** by # **2.8.** Multiply by 100.	**(2.15 / 2.8)** x 100	**2.19=**	**%**
2.20	Compliance Calculation for Bundle Element #2 (Daily assessment of readiness to extubate) Divide # **2.16** by # **2.8.** Multiply by 100.	**(2.16 / 2.8)** x 100	**2.20=**	**%**
2.21	Compliance Calculation for Bundle Element #3 (Use of oral versus nasal tubes) **Divide # 2.17 by # 2.8. Multiply by 100.**	**(2.17 / 2.8) x 100**	**2.21=**	%
2.22	Compliance Calculation for Bundle Element #4 (Use of CASS tubes) **Divide # 2.18 by # 2.8. Multiply by 100.**	**(2.18 / 2.8) x 100**	**2.22=**	%

3.0 VAP Bundle Compliance (Paediatrics) – Measurement Worksheet

Prevention of Ventilator-Associated Pneumonia Paediatrics					
Intervention:	Prevention of Ventilator-Associated Pneumonia				
Definition:	The percentage of Paediatric intensive care patients on mechanical ventilation for whom all five elements of the VAP Bundle are implemented and documented on the daily goals sheet and/or elsewhere in the medical record through regular audit processes.				
Goal:	95% of all patients on mechanical ventilation in the intensive care unit(s) receive all five elements of the VAP Bundle.				
Data Collection Details					
Hospital Name:		**Health Region:** NA or ***Specify Region:***			
Completed by:	**Name:**	**E-mail Address:**	**Phone Number:** ( ) -		**Date of Submission:**
Year:	*Indicate the year for which the data was collected:* 2005 2006 2007 2008 Other (specify):	**Collection Method:**			Concurrent Retrospective
Month:	*Indicate the month for which the data was collected:* Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.				
Implementation Stage:	Baseline Stage *(Pre-intervention)*	Early implementation stage *(Team members are applying some components of the bundle)*		Full implementation stage *(All team members in selected unit(s) are consistently implementing VAP bundle)*	
Patient Sample:	*Describe the source of the Paediatric population: e.g., Intensive Care Unit, Neonatal ICU, Neuro ICU, Surgical ICU etc.*				
Additional Information:	*Describe any other pertinent information here, including Team # if there is more than one VAP team in your hospital*				
	Team #: **N/A**				

Initial Calculation of Weekly Sample Size			***Formula***	***Answer***
3.01	What is the total number of patients this month who received care in selected Intensive Care Units?		**3.01 =**	
3.02	What is the total number of patients in # **3.1** whose age was greater than 18 yrs on admission to the ICU? *Exclude from patient list for calculating Weekly Sample Size*		**3.02 =**	
3.03	Subtract the total of # **3.2** from the total of # **3.1** and enter here. *(This represents the finals list of patients eligible for inclusion in the Weekly Sample Size)*	(**3.01** - 3.**02** =)	**3.03 =**	

3.04	Count and record the total number of days of exposure to ventilators for each patient accounted for in # **3.3.**		**3.04 =**	
3.05	Add the total number of days of exposure to ventilators by all patients in # **3.3.** *e.g.: 300*		**3.05 =**	
3.06	Multiply #**3.5** by 0.10 **(10% of total ventilator days in month).** *e.g.: 300 x 0.10 = 30*	(**3.05** x 0.10 =)	**3.06 =**	
3.07	Divide # **3.6** by 4 weeks (**Number of patients on ventilators to sample per week).** *e.g. 30/4 = 7 or 8 patients per week*	(**3.06** / 4 =)	**3.07 =**	
Calculation of Denominator			***Formula***	***Answer***
3.08	What is the total number of Paediatric patients who received mechanical ventilation in the selected Intensive Care Unit who are actually included in this monthly sample? *e.g.: recommended equivalent of 10% of ventilator days sampled - #**3.6***		**3.08 =**	
Implementation of Bundle Components *(Indicate "Yes" or "No" for questions in this section)*				***Answer***
3.09	Did you implement VAP Bundle Element #1 (Head of bed elevation in infants and children) for this month's sample?			Yes No
3.10	Did you implement VAP Bundle Element #2 (Proper positioning of oral or nasal gastric tube in infant and children) for this month's sample?			Yes No
3.11	Did you implement VAP Bundle Element #3 (Use of oral care in children) for this month's sample?			Yes No
3.12	Did you implement VAP Bundle Element #4 (Elimination of the routine use of instil for suctioning for pediatric patients) for this month's sample?			Yes No
3.13	Did you implement VAP Bundle Element #5 (Ventilator tubing kept in a dependant position) for this month's sample?			Yes No
Calculation of Numerator			***Formula***	***Answer***
3.14	What is the total number of patients in # 3.08 for whom ALL of the following five Paediatric VAP bundle elements which have been implemented in your healthcare facility were in place at the time of the survey? (Use attached VAP Bundle Checklist) Paediatric Ventilator-Associated Pneumonia (VAP) Bundle Elements: 1. Elevation of the Head of Bed (HOB) in infants and children 2. Proper positioning of oral or nasal gastric tube in infants and children. 3. Oral Care in children 4. Elimination of the routine use of instil for suctioning for pediatric patients 5. Ventilator tubing kept in a dependant position.		**3.14 =**	
Final Calculation				

3.15	Divide # 3.**08 b**y # 3.14 Multiply by 100.	**(3.14** / **3.08)** x 100	**3.15=**	**%**
Numerator for Compliance Calculation				
3.16	What is the total number of patients in # 3.08 that were in compliance with Bundle Element #1 (Elevation of the Head of Bed (HOB) in infants and children)?			
3.17	What is the total number of patients in # 3.08 that were in compliance with Bundle Element #2 (Proper positioning of oral or nasal gastric tube in infant and children)?			
3.18	What is the total number of patients in # 3.08 that were in compliance with Bundle Element #3 (Oral care in children)?			
3.19	What is the total number of patients in # 3.08 that were in compliance with Bundle Element #4 (Elimination of the routine use of instil for suctioning for paediatric patients)?			
3.20	What is the total number of patients in # 3.08 that were in compliance with Bundle Element #4 (Ventilator tubing kept in a dependant position)?			
Compliance Calculation				
3.21	Compliance Calculation for Bundle Element #1 (Elevation of the Head of Bed (HOB) in infants and children) Divide # **3.16** by # 3.**08.** Multiply by 100.	**(3.16** / 3.08**)** x 100	**3.21=**	**%**
3.22	Compliance Calculation for Bundle Element #2 (Proper positioning of oral or nasal gastric tube in infant and children). Divide #**3.17** by # **3.08.** Multiply by 100.	**(3.17** / **3.08)** x 100	**3.22=**	**%**
3.23	Compliance Calculation for Bundle Element #3 (Oral care in children). **Divide # 3.18 by # 3.08. Multiply by 100.**	**(3.18 / 3.08) x 100**	**3.23=**	%
3.24	Compliance Calculation for Bundle Element #4 (Elimination of the routine use of instil for suctioning for paediatric patients). **Divide # 3.19 by # 3.08. Multiply by 100.**	**(3.19 / 3.08) x 100**	**3.24=**	%
3.25	Compliance Calculation for Bundle Element #4 (Ventilator tubing kept in a dependant position). **Divide # 3.20 by # 3.08. Multiply by 100.**	**(3.20 / 3.08) x 100**	**2.22=**	%

APPENDIX B: Sample Checklists and Daily Goals

SAMPLE VAP BUNDLE CHECKLIST
Calgary Health Region

6673239860

VAP Bundle Audit Tool
(For Ventilated Patients Only)

Date of Survey: ☐☐ - ☐☐☐ - ☐☐☐☐ (DD - MMM - YYYY) **Time:** ☐☐:☐☐ (24 HH:MM) **Auditor:** _____

☐ FMC
☐ PLC
☐ RGH

Patient Information

Hospital ID #: ☐☐☐☐☐☐☐☐☐☐ Bed #: ☐☐☐

Head of the Bed Elevation

1. On inspection was the HOB elevated to >30 degrees?

☐ YES	☐ No, but appropriate for the following reason:	☐ No, not appropriate
	☐ CVS unstable ☐ Femoral dialysis catheter / CRRT ☐ Full Spinal precautions ☐ Undergoing Procedure ☐ Patient agitated ☐ Other (specify) _____	

Ventilator Weaning Assessment

1. Was a Spontaneous Breathing Trial (SBT) performed today?

☐ YES	☐ No, but appropriate for the following reason:	☐ No, not appropriate
	☐ ICU extubation pathway exclusion criteria exist ☐ SBT criteria not met ☐ Specific weaning plan (trached) ☐ Other (specify) _____	

2. If the patient has successfully completed an SBT, has extubation been discussed with the Physician?
   ☐ YES
   ☐ NO, if no explain _____
   ☐ N/A

Use of an Evac Endotracheal Tube

1. Is an Evac ETT insitu?

☐ YES	☐ No, but appropriate for the following reason:	☐ No, not appropriate
	☐ Patient from another region ☐ < 6.0 ETT ☐ Patient Trached ☐ Other (specify) _____	☐ Post operative patient ☐ Intubated via EMS

Use of an Oral Gastric Tube

1. Is there an Oral Gastic Tube insitu?

☐ YES	☐ No, but appropriate for the following reason:	☐ No, not appropriate
	☐ < 24 hours from admission ☐ Silastic Feeding Tube ☐ Oral trauma preventing placement ☐ Post oral or esophageal surgery ☐ Planned extubation (within 24 hours) ☐ Sutured nasal tube ☐ Other (specify) _____	

Return form via interoffice mail to: Quality Improvement Consultant, ICU administration EG23, Foothills Medical Centre

Eastern Health, St. John's, N.L.
Cardiac/Critical Care Program
VAP bundle Audit Tool

Date of Audit: _____ Time: _____ # of Ventilated Patients in the Unit: _____

Person Performing the Audit: _____

Patient Information: Hospital (ID) Number: _____ Bed #: _____

Admitted From: _____

Number of Days on the Ventilator: _____

A.	Head of the Bed Elevation	
	1.	On inspection was the HOB elevated to > 30 degrees? YES NO, appropriate for the following reason: Hemodynamic Instability □ CRRT Unstable Spines, Thoracic/Lumbar □ Undergoing Procedure □ Other: _____ □ NO No reason documented
B.	Use of an Evac Endotracheal Tube	
	1.	Is an Evac ETT insitu? □ YES □ NO, appropriate for the following reason: □ Patient from another region □ < 6.0 ETT □ Post-op patient (ICU adm, not predicted) □ Other: _____ □ NO No reason documented
C.	Oral versus Nasal Gastric Tube	
	1.	Is there an Oral gastric tube in situ? □ YES □ NO, appropriate for the following reason: □ Oral trauma preventing placement □ Post oral, esophageal or upper GI surgery □ Tracheostomy in situ □ Sutured nasal tube □ Other: _____ □ NO No reason documented

D.	Ventilator Weaning Assessment	
	1.	Has the patient been assessed for weaning criteria? (Daily Screen) □ YES □ NO
	2.	Did the patient pass the daily weaning screen? □ YES □ NO
	3.	Has patient had SBT? □ YES □ NO
	4.	If receiving continuous sedation/analgesia infusions has the patient had a sedation vacation. □ YES □ NO □ Not Appropriate Due to Clinical Conditions □ N/A
E	Sedation/Analgesia Scale Usage	
	1.	Is the patient's sedation level being titrated and documented with the SAS? □ YES □ NO □ N/A
	2.	Is the patients' analgesia level being titrated and documented with the Pain Scale? □ YES □ NO □ N/A
F	DVT Prophylaxis	
	1.	Is the patient on DVT Prophylaxis? □ YES Indicate what DVT prophylaxis in place: □ Heparin/Lovenox □ SCD □ TEDS □ NO No reason documented
G	Stress Ulcer Prophylaxis	
	1.	Is the patient on Stress Ulcer Prophylaxis? □ YES □ NO, appropriate for the following reason: _____ □ NO No reason documented
H	1.	Is the patient on enteral feeds? □ YES, at target □ YES, not at target Indicate why? _____ □ NO, appropriate for the following reason: □ GI rest post surgery/trauma □ High residuals □ Other _____ □ NO, No reason documented
	2.	If unable to feed enterally with orogastric tube; is the patient being fed: □ With TPN □ Not fed, No Reason Given

I	1.	Is the patient on glucose monitoring? □ YES □ nomogram □ NO, Appropriate for the following reason: _____ □ NO, No Reason
J	Is the Evac Tube maintained as required?	
	1.	Is the Evac Tube suction line connected to 20 mmHg continuously? □ YES □ NO
	2.	Is the suction line irrigated with air Q3h? □ YES □ NO
	3.	Is the Evac suction line patent? □ YES □ NO
	4.	Is cuff pressure documented Q3h? □ YES □NO What is the cuff pressure? □ 22-24 cmH_2O □ < 22 cmH_2O If less than 22 cm H_2O, what is it on average? _____

(For information purposes only)

Palliser Health Region- Daily Goals Sheet

ICU Ventilator Checklist

(To be used as a guide to facilitate discussions at morning rounds)

	Goal	Notes
	ICU discharge planning: What needs to be done for the patient to prepare for transfer out of ICU	
	Is the reason for ICU admission resolved?	
	What is the patient's greatest safety risk?	
VAP Bundle	Is the HOB ≥ 30 degrees?	
	Was a SBT attempted?	
	Does the patient have an orogastric tube?	
	Can a sedation vacation be attempted?	
	Does the patient have an EVAC tube?	
CNS	Does patient have adequate pain control?	
	Is patient appropriately sedated?	
CVS	Is patient hemodynamically stable?	
	What is patient's volume status?	
	DVT prophylaxis	
	What are morning lab results? (cultures, drug levels, etc)	
Respiratory	What are x-ray results?	
	Frequency of suctioning?	
	Type of sputum - ? purulent	
	ABG's	
	Ventilator setting changes? (ventilation/oxygenation)	
GI/GU	PUD prophylaxis?	
	Nutritional support -Tube feed residuals	
	Bowel regimen	
	Can any catheters/tubes be D/C?	
Integ/MSK	Mobilization (?PT consult)	
	Skin care/integrity	
Psycho- social	Family updated?	
	Social issues to address?	
	Emotional/spiritual issues?	
	Code status addressed?	
	Personal directive in place?	

**Shaded areas not to be completed at this time.

DO NOT PLACE THIS FORM ON PATIENT CHART
(For information purposes only)

Sir M.B. Davis Jewish General Hospital, Montréal, Québec
Dept of Adult Critical Care
Daily Checklist-Daily Goals Sheet

JGH ICU DAILY CHECKLIST		
Check		
	1	**Feeding**: *have you: started feeding ? ensured adequate location of tip of feeding tube ? considered orogastric, nasoduodenal or PEG tube ?*
	2	**Analgesia**: *does your patient have adequate analgesia?*
	3	**Sedation:** is your patient: *comfortable ? getting his daily sedation holiday (if on continuous infusion) ?*
	4	**Thromboembolic prophylaxis** (TEP): *contraindication to TEP? if not, is he on TEP ?*
	5	**Head of the bed elevation**: *is HOB > 30^0 ?*
	6	**Ulcer prophylaxis:** *contraindication to Peptic Ulcer Prophylaxis (PUP) ? if not, is he on PUP ?*
	7	**Glucose control:** *are ≥ 2 consecutive CBGMs > 7 ? if so, adjust patient's CBGM sliding scale.*
	8	**Hygiene**: *have you… washed hands between patients ? …noted and respected PINK IPC cardboards ?*
	9	**Pneumonia:** …
	a)	**Prevention:** *have you verified performance to SBT (for readiness of extubation), compliance to Chlorhexidine (CHG) oral decontamination?*
	b)	**Diagnosis:** *does patient meet criteria for pneumonia (see reverse) ? if so: is antibiotic treatment appropriate for organism ? stop date ?*
	10	**ALI/ARDS:** *does your patient have ALI/ARDS ? if so, have you adapted the ventilator settings to the disease ?*
	11	**Catheters** (arterial & venous): *use CVAD insertion checklist ! are current catheters… necessary ? clean (no sepsis)? functional ?*
	12	**Diarrhea**: *implement CDAD protocol as required*
	13	**Severe Sepsis/shock:** *have you …implemented EGDT protocol, assessed need for drotrecogin (activated protein C) ?*
	14	**Anemia**: *can you justify the need for PRBC transfusion?*
	15	**Critical Intervention orders**: *Are they up to date ? Does the patient have… advance directives ? a Living Will ? other goals ?*

DATE : _____

Signature :_____

addressograph

GOALS FOR THE DAY
Tests, Procedures
Other

VAP RISK FACTORS

HOST	☐ Bed-bound/immobilization ☐ Aspiration/seizure ☐ Impaired airway reflexes (depressed GCS (non intubated) ☐ Shock/resuscitation ☐ MSOF ☐ Immunocompromised (systemic corticosteroids, immunosuppressive meds, cirrhosis, diabetes mellitus, chronic hemodialysis) ☐ Severe malnutrition/anasarca ☐ Significant cardiopulmonary/neurologic disease ☐ Hospitalization in last 3 months
POST-OPERATIVE	☐ Cardiothoracic surgery ☐ Upper abdominal surgery ☐ Neurosurgery
ETTube	☐ Non-oral route ☐ Not EVAC ☐ Intubation: traumatic, prolonged, reintubation
PERSONNEL	☐ Inadequate hand hygiene ☐ HOB ≤ 30 degrees ☐ NG tube (ie non-oral route) ☐ Hardware contamination : Ventilator circuit, oral suction catheter, Yankaur suction ☐ Non-compliance with CHG oral decontamination ☐ Transport out of ICU
INFECTION	☐ Recent Broad-spectrum antibiotics ☐ Other nosocomial infection ☐ Colonization with ARO (MRSA, VRE, MDR pseudomonas etc)

DOES MY PATIENT HAVE A VAP ?

Defining VAP : VAP is defined as a pneumonia occurring in patients requiring mechanical ventilation intermittently or continuously for 48 hours or at least 2 consecutive days before onset of pneumonia. Therefore pts who acquire pneumonia within 2 days post extubation may also be identified as having VAP.

Section "A"

#1	#2	#3	#4	#5
Ventilated (via ETT/ trach) ≥ 48hrs[1] ? [1] *Intermittently or continuously*	**CXR** compatible with pneumonia[2]? [2] *new, worsening or persistent infiltrate, consolidation or cavitation*	**WBC** ≥ 12,000 or <4,000	**Fever** >36°C with no other cause	**If >70 yrs:** Altered mental status with no other cause
☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes	☐ Yes	☐ Yes

- If **NO** to **#1** or **#2** do not continue – this is NOT VAP.
- If **YES** to **#1** and **#2 AND** #3, #4 , or #5, continue to section "B"

Section "B"

At least two (2) of the following must be present[3]

New onset of purulent sputum, or change in character of sputum, or increased respiratory secretions, or increased suctioning requirements	Inspiratory crackles, or bronchial breath sounds on auscultation	Worsening gas exchange (↓ Sao2, ↑ O2 requirement or ↑ minute ventilation)
☐ Yes	☐ Yes	☐ Yes

[3] If multiple episodes, look for resolution of the initial infection. The addition or change in pathogen alone is **not** indicative of a new episode of pneumonia

Patient meets VAP criteria ? ☐ **Yes**

APPENDIX C: Sample Enteral feeding pre-printed orders

Sir M.B. Davis Jewish General Hospital, Montréal, Québec
Dept of Adult Critical Care

HÔPITAL GÉNÉRAL JUIF SIR MORTIMER B. DAVIS
THE SIR MORTIMER B. DAVIS JEWISH GENERAL HOSPITAL
Montréal, Québec

FEUILLE D'ORDONNANCE DU MÉDECIN
DOCTOR'S ORDER SHEET

DATE	*HEURE* HOUR	*ORDONNANCES DU MÉDECIN / SIGNATURE* DOCTOR'S ORDERS / SIGNATURE	*Enregistrer heure, initiales* / Record, time, initials *Inscrit* / Transcribed	*Fait* / Done
		☐ **ICU & CCU - FEEDING TUBES**	**Ne pas utiliser l'espace ci-dessous si le cheminement critique abrégé est utilisé. If care map is in use do not use these columns**	
		NASO / ORO-GASTRIC AND NASODUODENAL		
		For Both Gastric and Duodenal Tubes:		
		• Head of bed > 30° at all times		
		• Tube feeding as per nutritionist's recommendations		
		• Flush tube with 30mL H_2O before and after medication administration		
		• Place a mark on the tube and verify position of tube every shift		
		as per Policy & Procedure II-ii-5.1		
		☐ For Naso-Gastric Tubes and /or Oro-Gastric Tubes		
		• May start feeding as tip of tube is confirmed to be in the stomach by		
		XRay as verified by physician signing below		
		• Do gastric residuals q2h; return gastric residuals to stomach		
	OR	• If gastric residuals > 250mL: return gastric residuals to stomach		
		and hold feeding X 2h then, verify gastric residuals. Return		
		gastric residuals to stomach. If gastric residuals remain >		
		250mL, notify Physician.		
		☐ For Naso-Duodenal Tubes		
		• May start feeding as the tip of tube is confirmed to be beyond		
		the pylorus by XRay as verified by physician signing below		
		Physician Signature: _____		
		Date: _____		

Initial(*e*)*s*	*Titre* / Title	Signature	Initial(*e*)*s*	*Titre* / Title	Signature

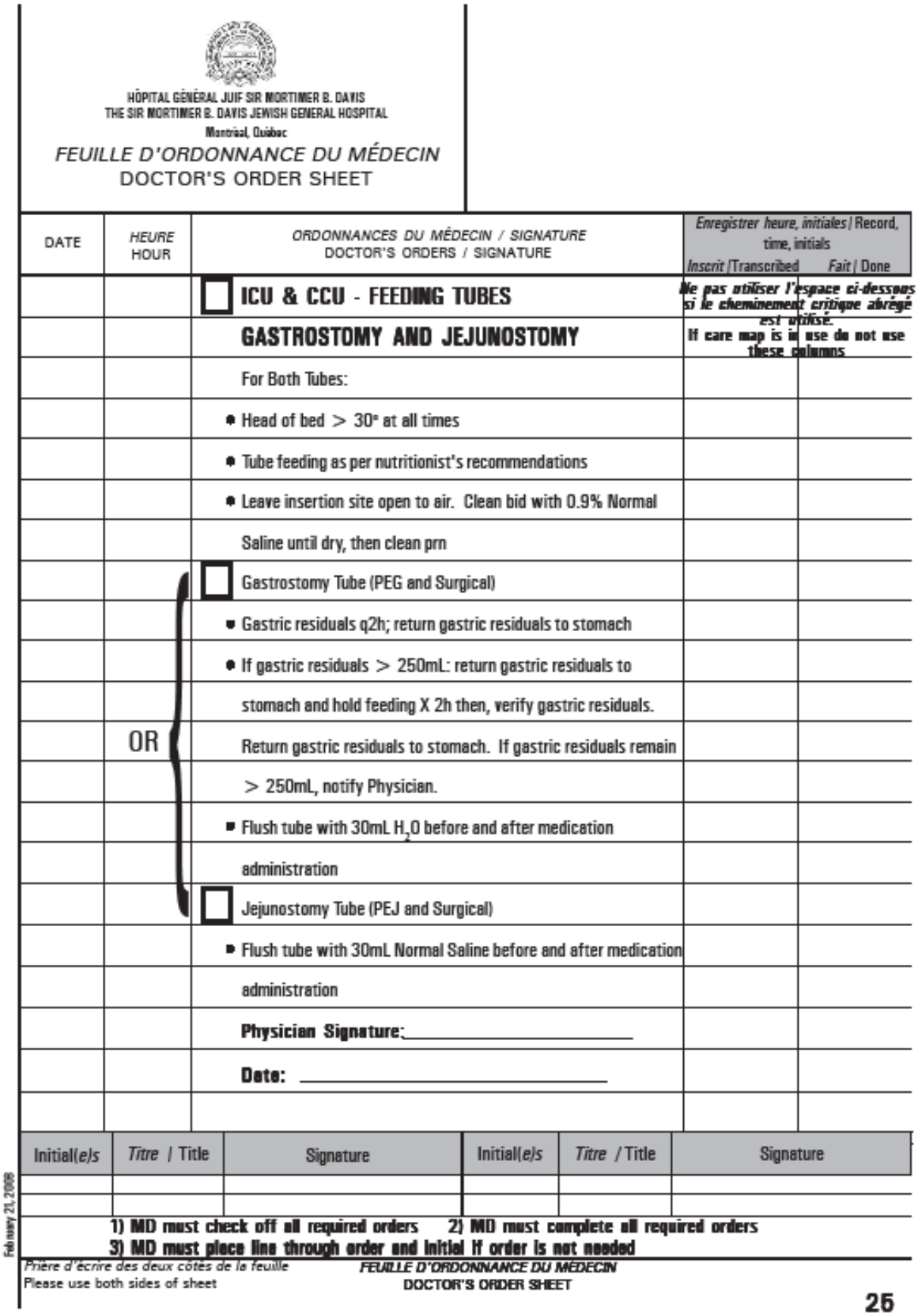
1) MD must check off all required orders 2) MD must complete all required orders
3) MD must place line through order and initial if order is not needed

Prière d'écrire des deux côtés de la feuille
Please use both sides of sheet

FEUILLE D'ORDONNANCE DU MÉDECIN
DOCTOR'S ORDER SHEET

D-1-60286 February 21, 2008

25



HÔPITAL GÉNÉRAL JUIF SIR MORTIMER B. DAVIS
THE SIR MORTIMER B. DAVIS JEWISH GENERAL HOSPITAL
Montréal, Québec

FEUILLE D'ORDONNANCE DU MÉDECIN
DOCTOR'S ORDER SHEET

DATE	*HEURE* HOUR	*ORDONNANCES DU MÉDECIN / SIGNATURE* DOCTOR'S ORDERS / SIGNATURE	*Enregistrer heure, initiales* / Record, time, initials *Inscrit* / Transcribed	*Fait* / Done
		☐ **ICU & CCU - FEEDING TUBES**	***Ne pas utiliser l'espace ci-dessous si le cheminement critique abrégé est utilisé.***	
		GASTROSTOMY AND JEJUNOSTOMY	**If care map is in use do not use these columns**	
		For Both Tubes:		
		• Head of bed > 30° at all times		
		• Tube feeding as per nutritionist's recommendations		
		• Leave insertion site open to air. Clean bid with 0.9% Normal		
		Saline until dry, then clean prn		
		☐ Gastrostomy Tube (PEG and Surgical)		
		• Gastric residuals q2h; return gastric residuals to stomach		
		• If gastric residuals > 250mL: return gastric residuals to		
		stomach and hold feeding X 2h then, verify gastric residuals.		
	OR	Return gastric residuals to stomach. If gastric residuals remain		
		> 250mL, notify Physician.		
		• Flush tube with 30mL H_2O before and after medication		
		administration		
		☐ Jejunostomy Tube (PEJ and Surgical)		
		• Flush tube with 30mL Normal Saline before and after medication		
		administration		
		Physician Signature:_____		
		Date: _____		

Initial(e)s	*Titre* / Title	Signature	Initial(e)s	*Titre* / Title	Signature

1) MD must check off all required orders 2) MD must complete all required orders
3) MD must place line through order and initial if order is not needed

February 21, 2008

Prière d'écrire des deux côtés de la feuille
Please use both sides of sheet

FEUILLE D'ORDONNANCE DU MÉDECIN
DOCTOR'S ORDER SHEET

25

APPENDIX D: Criteria for Ventilator Associated Pneumonia

Criteria for Ventilator Associated Pneumonia Infants < 1 year of age

Start tracking these criteria from the day the patient is intubated,

Date intubated: / /

Week of ventilation: ___ Day of ventilation:	1	2	3	4	5	6	7
Criteria checked today – nil radiology findings present.	❒	❒	❒	❒	❒	❒	❒
New or progressive and persistent infiltrate[2]	❒	❒	❒	❒	❒	❒	❒
Consolidation	❒	❒	❒	❒	❒	❒	❒
Cavitation	❒	❒	❒	❒	❒	❒	❒
Pneumatoceles	❒	❒	❒	❒	❒	❒	❒

If any of the above findings are present on 2 consecutive days[1] then consider the following criteria:

Worsening gas exchange (O_2 sat < 94%, ↑ FiO_2 requirement, ↑ mean airway pressure, or ↑ ventilation)	❒	❒	❒	❒	❒	❒	❒

If the above is present then consider the following:

Temperature instability with no other recognized cause	❒	❒	❒	❒	❒	❒	❒
Leukopenia (< 4 x10^6) or leukocytosis (> 15 x10^6 WBC/L) and left shift (> 10% band forms)	❒	❒	❒	❒	❒	❒	❒
New onset of purulent sputum,[3] or change in character of sputum,[4] or ↑ respiratory secretions, or ↑ suctioning requirements	❒	❒	❒	❒	❒	❒	❒
New apnea, tachypnea,[5] nasal flaring with retraction of chest wall or grunting	❒	❒	❒	❒	❒	❒	❒
New wheezing, rales,[6] or rhonchi	❒	❒	❒	❒	❒	❒	❒
New cough	❒	❒	❒	❒	❒	❒	❒
Bradycardia (<100) or tachycardia (> 170 beats/min)	❒	❒	❒	❒	❒	❒	❒

NB: Complete clinical criteria part only after x-ray criteria are met.

If radiological findings, worsening gas exchange and <u>3 other clinical findings</u> are present indicates a VAP

Addressograph:

Criteria for Ventilator Associated Pneumonia
Children 1 - 12 years of age

Start tracking these criteria from the day the patient is intubated,

Date intubated: / /

Week of ventilation: ___ Day of ventilation:	1	2	3	4	5	6	7
Criteria checked – nil criteria met.	❒	❒	❒	❒	❒	❒	❒
New or progressive and persistent infiltrate[2]	❒	❒	❒	❒	❒	❒	❒
Consolidation	❒	❒	❒	❒	❒	❒	❒
Cavitation	❒	❒	❒	❒	❒	❒	❒

If any of the above findings are present on 2 consecutive days[1] then consider the following criteria:

Fever (>38.4°C) or hypothermia (< 36.5°C) with no other recognized cause	❒	❒	❒	❒	❒	❒	❒
Leukopenia (< 4 x10^6) or leukocytosis (> 15 x10^6 WBC/L)	❒	❒	❒	❒	❒	❒	❒
New onset of purulent sputum,[3] change in character of sputum,[4] ↑ respiratory secretions, or ↑ suctioning requirements	❒	❒	❒	❒	❒	❒	❒
New onset or worsening cough, dyspnea, apnea, or tachypnea[5]	❒	❒	❒	❒	❒	❒	❒
New rales,[6] or bronchial breath sounds	❒	❒	❒	❒	❒	❒	❒
Worsening gas exchange (O_2 sat < 94%, ↑ FiO_2 requirement, ↑ mean airway pressure, or ↑ ventilation)	❒	❒	❒	❒	❒	❒	❒

NB: Complete clinical criteria part only after x-ray criteria are met.

If radiological findings and <u>3 clinical findings</u> are present indicates a VAP

Addressograph:

Criteria for Ventilator
Associated Pneumonia
Adolescents > 12 years of age.

Start tracking these criteria from the day the patient is intubated,

Date intubated: / /

Week of ventilation: ___ Day of ventilation:	1	2	3	4	5	6	7
Criteria checked – nil criteria met.	❒	❒	❒	❒	❒	❒	❒
New or progressive and persistent infiltrate[2]	❒	❒	❒	❒	❒	❒	❒
Consolidation	❒	❒	❒	❒	❒	❒	❒
Cavitation	❒	❒	❒	❒	❒	❒	❒

If any of the above findings are present on 2 consecutive days[1] then consider the following criteria:

Fever (>38.4°C) with no other recognized cause	❒	❒	❒	❒	❒	❒	❒
Leukopenia (< 4 x10^6) or leukocytosis (> 12 x10^6 WBC/L)	❒	❒	❒	❒	❒	❒	❒

If either of the above present then consider following:

New onset of purulent sputum,[3] change in character of sputum,[4] ↑ respiratory secretions, or ↑ suctioning requirements	❒	❒	❒	❒	❒	❒	❒
New onset or worsening cough, dyspnea, apnea, or tachypnea[5]	❒	❒	❒	❒	❒	❒	❒
New rales,[6] or bronchial breath sounds	❒	❒	❒	❒	❒	❒	❒
Worsening gas exchange (O_2 sat < 94%, ↑ FiO_2 requirement, ↑ mean airway pressure, or ↑ ventilation)	❒	❒	❒	❒	❒	❒	❒

NB: Complete clinical criteria part only after x-ray criteria are met.

If radiology findings plus <u>1 clinical criteria</u> from each of the other sections are present indicates a VAP

Footnotes to Ventilator Associated Pneumonia Criteria

1. Occasionally, in non ventilated patients, the diagnosis of nosocomial pneumonia may be quite clear on the basis of symptoms, signs, and a single definitive chest radiograph. However, in patients with other pulmonary or cardiac disease (for example, congestive heart failure, interstitial lung disease, respiratory distress syndrome, bronchopulmonary dysplasia, pulmonary edema, or chronic obstructive pulmonary disease) or smoke or inhalation pulmonary injury, the diagnosis of pneumonia may be particularly difficult. Other non-infectious conditions (for example, pulmonary edema from decompensated congestive heart failure) may simulate the presentation of pneumonia. In these more difficult cases, serial chest radiographs must be examined to help separate infectious from non-infectious pulmonary processes. To help confirm difficult cases, it may be useful to review radiographs on the day of diagnosis, 3 days prior to the diagnosis and on days 2 and 7 after the diagnosis. **Pneumonia may have rapid onset and progression, but it does not resolve quickly. Radiographic changes of pneumonia persist for several weeks.** As a result, rapid radiographic resolution suggests that the patient does not have pneumonia, but rather a non-infectious process such as atelectasis or congestive heart failure.
2. Note that there are many ways of describing the radiographic appearance of pneumonia. Examples include, but are not limited to, "air-space disease," "focal opacification," and "patchy areas of increased density." Although perhaps not specifically delineated as "pneumonia" by the radiologist, in the appropriate clinical setting these alternative descriptive wordings should be seriously considered as potentially positive findings.
3. Purulent sputum is defined as secretions from the lungs, bronchi, or trachea that contain >25 neutrophils and <10 squamous epithelial cells per low power field (x100). If your laboratory reports these data qualitatively (e.g., "many WBCs" or "few squames"), be sure their descriptors match this definition of purulent sputum. This laboratory confirmation is required since written clinical descriptions of purulence are highly variable.
4. A single notation of either purulent sputum or change in character of the sputum is not meaningful; repeated notations over a 24 hour period would be more indicative of the onset of an infectious process. Change in character of sputum refers to the color, consistency, odor and quantity.
5. Tachypnea is defined as:

newborns until the 40th week	>75 breaths per minute;
babies <2 months old	>60 breaths per minute;
infants 2-12 months old	>50 breaths per minute;
children >1 year old	>30 breaths per minute
children >12 years	>25 breaths per minute

6. Rales may be described as "crackles."

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