

PREVENT VENTILATOR ASSOCIATED PNEUMONIA



Getting Started Kit

Effective March 14 2019, the Canadian Patient Safety Institute has archived the Ventilator-Associated Pneumonia (VAP) intervention. For additional inquiries, please contact info@cpsi-icsp.ca

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This Getting Started Kit has been written to help engage your interprofessional/interdisciplinary teams in a dynamic approach for improving quality and safety while providing a basis for getting started. The Getting Started Kit represents the most current evidence, knowledge and practice, as of the date of publication and includes what has been learned since the first kits were released in 2005. We remain open to working consultatively on updating the content, as more evidence emerges, as together we make healthcare safer in Canada.

Note:

The Getting Started Kits for all *Safer Healthcare Now!* interventions are the same and available in both French and English.

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Acknowledgements



The Canadian Patient Safety Institute (CPSI) is acknowledged for their financial and in-kind support of the Safer Healthcare Now! Getting Started Kits.



We wish to thank and acknowledge the Canadian ICU Collaborative and faculty members who have contributed significantly to the work of the Ventilator acquired pneumonia teams and the revisions to this kit.

In particular, we acknowledge the work of Ms. Paule Bernier, Dr. Paul Boiteau, Ms. Rosmin Esmail, Mr. Gordon Krahn, Dr. Denny Laporta, and Dr. John Muscedere.

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December 2011

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Summary of Revisions from Previous Versions of the Getting Started Kit

1. The case for preventing ventilator associated pneumonia
2. The definition of VAP was clarified
3. Adult VAP Bundle: has gone from 4 to 5 elements

Specific Revisions:

- a. The recommendation for HOB elevation has been reworded to “we recommend that the head of the bed be elevated to 45°. When this is not possible, attempts to raise the head of the bed at least > 30° should be considered,
- b. The recommendation for daily evaluation of readiness for extubation has been revised to reflect new evidence.
- c. The recommendation for endotracheal tubes with subglottic secretion drainage has been revised to reflect new evidence
- d. The recommendation for oral tubes has been removed from the bundle and replaced with “Initiate safe enteral nutrition within 24-48h of ICU admission”
- e. The recommendation for oral decontamination with Chlorhexidine has been upgraded as a VAP Bundle element and revised to include general recommendations for oral care.

4. Additional revisions to reflect new evidence were made for the following.

- a. Hand hygiene
- b. VTE prophylaxis
- c. The promotion of patient mobility and autonomy.

The Pediatric section was not revised in this version, as there was no notable evidence to modify current VAP prevention practices.

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Background

Goal

The goal is to prevent ventilator-associated pneumonia (VAP) by implementing the five components of care called the “**VAP Bundle.**” The current VAP Bundle was modified to reflect the elements of practice that have the greatest evidence for their ability to decrease VAP.

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

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

Nosocomially acquired infections in the intensive care unit (ICU) are common; higher rates are associated with increased severity of illness, utilization of invasive monitoring and treatment, morbidity, mortality and health care costs.^{1,2,3,4} Invasively mechanically ventilated patients are particularly susceptible to nosocomial infections and pneumonia. Pneumonia that occurs in this context (i.e. mechanical ventilation with an endotracheal tube) is termed *ventilator-associated pneumonia* (VAP).

The reason that VAP remains relevant is that the number of patients requiring mechanical ventilation increased in the past decade and is expected to increase further in the future.^{5,6} In spite of intensive efforts to prevent VAP, it remains relatively common. The most recent data from the United States where surveillance data are available, reported that the incidence ranged from 2 to 10 cases per 1000 ventilator days. VAP is a cause of morbidity in mechanically ventilated patients resulting in prolongation of mechanical ventilation, ICU, and hospital days by an average of 7.6, 8.7 and 11.5 days, respectively.^{7,8} Although the attributable mortality of VAP is controversial, it may be substantial if therapy is delayed or inappropriate.⁹ Further, wide scale use of antibiotics for nosocomial infections such as VAP also exposes patients to antibiotic-related diarrhoea and colitis which carry their own burden and impact on outcome.^{10,11}

Estimates of the costs to the healthcare system from VAP have ranged from \$10 000-16 000 US.^{8,12,13} In Canada it is estimated that the prevention of one case of VAP could result in a cost saving of approximately \$14,000 per patient.¹⁴ It is estimated that the number of adult cases of VAP in Canada are around 4 000 per year, resulting in approximately 230 deaths consuming 17 000 excess ICU days or 2% of all ICU days in Canada, at an estimated cost to the Canadian health care system of CAN \$46 million per year.

In the pediatric population, although VAP is an important clinical entity, there are fewer studies quantifying the problem.^{15,16,17} The latest rates for pediatric VAP from the National Nosocomial Infections Surveillance (NNIS) group are 0 to 4.6 per 1,000 ventilator days with an average of 1.8 per 1,000 ventilator days.³ The presence of VAP in children leads to a longer duration of ventilation and increased length of stay and associated costs.^{15,16,17} It is estimated that in the pediatric population, VAP prolongs hospital length of stay by 8.7 days. VAP is also associated with increased mortality. In one study the difference in mortality rate was VAP 19.1% vs. non-VAP 7.2%.¹⁶

Two points are worthy of mention when discussing VAP rates. Because multiple alternative diagnoses can mimic the clinical signs of VAP, the apparent rate of VAP in ICUs may vary significantly, depending on the prevalence of other ICU-acquired conditions; this has raised the concern that VAP rate may be an unreliable measure of quality of care.¹⁸ Secondly, it is suspected that surveillance underestimates VAP occurrence and that true rates are likely much higher.^{19,20} Despite these concerns regarding reported VAP rates, there appears to be no controversy that all efforts should be made to reduce VAP.²¹ The Canadian ICU Collaborative Faculty and Canadian Patient Safety Institute's *Safer Healthcare Now!* supports the reporting of VAP rates in combination with measurements of adherence to VAP prevention practices.²² By reporting both, the incidence of VAP over time can be tracked and the adherence to best practices can similarly be followed. Thus the correlation between both measures can be observed for any particular institution allowing for insight into both practice and surveillance methods.

For more information, the reader is referred to the topic “VAP Diagnosis” in the FAQ Section.

In summary VAP is a common problem in Canadian ICUs, which is associated with poor outcomes, in vulnerable critically ill patient populations. There are evidence-based practices that can reduce the incidence of VAP; implementation of these practices have been effective in reducing VAP and its associated sequelae.^{23,24,25,26,27,28,29} Although it is often argued that in the Canadian Healthcare system money is not saved by improving efficiency (because each discharged patient is replaced by a new patient with comparable overall costs), our incentive to reduce VAP should be directed towards liberating wasted ICU and hospital days, thus improving ICU access for other patients in need.

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 two consecutive days.

Diagnostic criteria are as follows:

a) Radiographic abnormalities:

New or progressive, and persistent chest radiographic opacity(ies) compatible with Pneumonia, e.g. infiltrate, consolidation or cavitation

b) And at least 1 of the following:

- WBC \geq 12,000 or $<$ 4,000
- Temperature $>$ 38⁰ C with no other cause

c) And at least 2 of the following:

- tracheal secretions: new onset of purulence, or change in character, or increase in volume
- increase in suctioning requirements
- inspiratory crackles (rales) or bronchial breath sounds on auscultation
- Worsening gas exchange (e.g., O₂ desaturations; PaO₂/FiO₂ $<$ 240, an increase in oxygenation or ventilatory requirements.

If multiple episodes are suspected, one needs to look for resolution of the initial infection. The additional isolation of a new pathogen alone is *not* indicative of a new episode of pneumonia. The full spectrum of a combination of new signs, symptoms and radiographic evidence is required.

The Faculty acknowledges that different opinions on timelines 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. The CDC recommends³⁰ including patients supported by a breathing device within the 48h before the onset of the infection. Canadian guidelines for the prevention of VAP were developed using a variety of definitions as reported by the original authors of the evidentiary base.³¹ The primary purpose of our Collaborative and SHN 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.³²

For more information, the reader is referred to the topic “VAP Diagnosis” in the [FAQ Section](#)

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 may result in substantially greater improvement. The science supporting each bundle component is sufficiently established that the bundle is considered best practice. Bundles have been demonstrated to reduce VAP by the Canadian ICU Collaborative teams, examples of which are illustrated in this guide and by published data from pediatric and adult centres.^{33,34}

Safer Healthcare Now! (SHN) has defined a “VAP bundle” as a group of evidence-based practices that, when implemented together, should result in reductions in the incidence of VAP. 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.³¹

A recent ICU collaborative improvement project at IHI reported an average 45% reduction in the incidence of VAP using a “VAP bundle”.³⁵ Moreover, there is a trend toward greater success among teams that comply more fully with every element of the bundle.

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.

The components of SHNs VAP Bundle are (not listed in order of importance):

1. Elevation of the head of the bed to 45° when possible, otherwise attempt to maintain the head of the bed greater than 30° should be considered
2. Daily evaluation of readiness for extubation.
3. The utilization of endotracheal tubes with subglottic secretion drainage.
4. Oral care and decontamination with Chlorhexidine.
5. Initiation of safe enteral nutrition within 24-48h of ICU admission.

Adult VAP Bundle: Five Components of Care

1. Elevation of the Head of the Bed to 45° when possible, otherwise attempt to maintain the head of the bed greater than 30°

Elevation of the head of the bed (HOB) is correlated with reductions in VAP rates and is an integral part of the VAP bundle.³⁶

The rationale for this intervention is two-fold: 1) to decrease the risk of aspiration of aerodigestive (e.g. oropharyngeal and gastrointestinal) fluids.^{37,38,39} and 2) to improve patients’ lung volumes and 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.^{40,41}

In addition HOB elevation is congruent with other emerging concepts in the management of ventilated patients such as safe and timely enteral nutrition, patient interaction and orientation with environment, and liberation from immobility (eg. early ambulation) and from ventilatory support.⁴²

In a recently performed meta-analysis of the three available RCTs studying the semi-recumbent position³⁶, a total of 337 mechanically ventilated ICU patients were evaluated. The odds of developing clinically diagnosed VAP were significantly lower among patients randomized to the semi-recumbent 45° position compared to patients randomized to the supine position (OR = 0.47; 95% CI, 0.27-0.82). A sub-analysis regarding the incidence of microbiologically documented VAP, ICU length of stay, and the duration of mechanical ventilation showed that patients randomized to the semi-recumbent 45° position had a trend toward better clinical outcomes. The authors concluded that 1) the usual practice of back-rest elevation of 15° to 30° is not sufficient to prevent VAP in mechanically ventilated patients, and 2) patients positioned semi-recumbently 45° have significantly lower incidence of clinically diagnosed VAP compared to patients positioned supinely.

Is 45° the correct evidence-based angle of head of bed elevation? A more careful analysis of the three trials is informative in this regard. The first trial was a single-center study of 86 mechanically ventilated patients assigned to semi-recumbent or supine body position.⁴³ The investigators 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 ($p=0.018$). Unfortunately there was no mention of how the head of bed angle was measured, nor of how and to what extent this was achieved and adhered to. Excluded from the study were patients who have undergone recent abdominal surgery, neurosurgical intervention, previous endotracheal intubation, or in refractory shock. The second trial was multi-centered and compared the semi-recumbent position targeted to 45° backrest elevation compared to a control position (10° backrest elevation).⁴⁴ The investigators observed that the targeted 45° backrest elevation was not reached, and the difference in the attained treatment position of 28° did not prevent the onset of VAP compared to the 10° control position. The authors did not clearly describe why the aimed position of 45° was not achieved. This study showed that 1) raising the HOB between 10° and 30° is not effective in preventing VAP, and 2) maintaining the HOB at 45° is a challenging task and underscores the need for concerted and continuous efforts by all team members to maintain this standard under routine conditions. Interestingly, the authors also found no difference in the development of pressure sores in both groups, suggesting that at least the intervention was not harmful. 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. The third study is a prospective randomized trial comparing semi-recumbency with head of the bed elevation at 45°(intervention) to 25°(control).⁴⁵ The rate of VAP was 5/17 (29.4%) in the patients whose HOB was elevated to 45° vs. 7/13 (53.8%) in the control group. The degree of compliance with 45° was not measured and co-interventions were not reported. Unfortunately the small sample size and methodological analysis limit any conclusions from this pilot study where 46% of randomized patients were withdrawn because of intubation/ventilation <24hrs or patient discomfort.

The potential for harm associated with HOB elevation has been addressed in the published literature. Pressure ulcers are more likely to occur at higher HOB elevation in critically ill patients⁴⁶ as well as in normal subjects.⁴⁷ Of note is that the Wound, Ostomy and Continence Nurses Society recommends maintaining the HOB at 30° elevation for supine positions.⁴⁸ Other factors similarly impede bedside practitioners' adherence to higher degrees of HOB elevation⁴⁹ decreased systolic blood pressure, SOFA score⁵⁰, sliding down the bed, skin shearing, insomnia, inability to accurately estimate back rest elevation.⁵¹ In order to address these issues, the American Association of Critical Care Nurses issued a Practice Alert for VAP prevention in 2004 which was revised in 2007 to include evidence-based Practice Alert Statements and tools.⁵²

A systematic review on the benefits and disadvantages of semi-upright position in ventilated patients was done by a European expert panel.⁵³ Based on their results, they recommended that ICU caregivers “elevate the head of the bed of mechanically ventilated patients to a 20 to 45° position and preferably in a ≥30° position as long as it does not pose risks and conflicts with other nursing tasks, medical interventions or with patients' wishes”.

It thus appears that:

- the optimal semi-recumbent HOB elevation position that reduces the development of aspiration and VAP, while deriving the least risk to patients is not known.
- the level of evidence for the use of lower HOB elevation to prevent the most controversial complication - sacral pressure ulcers- is not as strong as that for HOB elevation to prevent aspiration and VAP.⁵⁴

We conclude that until further evidence becomes available, patients without contraindications to HOB elevation should be kept at 45°, and when this is not possible, keeping the head of the bed above 30° should be considered. In all cases, the exact angle strategy is determined on a patient-to-patient basis according to individual patient needs.

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 support the implementation of the VAP bundle. Some of these changes are:

- Identify local implementation challenges (e.g. insufficient awareness of the benefit of the 45° backrest elevation, disagreement about who is responsible for patients' bed positioning, difficulties in enabling and reinforcing such strategies) to tailor improvement strategies to the environment in your ICU.⁵⁵
- Be aware of other practical challenges in maintaining head of bed elevation throughout the day and night such as: 1) patients sliding down the bed if overly elevated, 2) bed often needs to be lowered for procedures such as line placement, bathing, wound care, patient turns, etc., 3) caregivers forget to re-elevate the head of the bed following these procedures.
- Determine what constitute valid contraindications for semi-recumbency in your ICU population (e.g. recent spine surgery or spinal cord trauma, abdominal wound, unstable pelvic fracture, mod-high-grade sacral ulcer, hemodynamic instability, increased

intracranial pressure (HOB >45° contraindicated), undergoing procedure, post-removal femoral arterial sheath, ECMO/VAD, etc.).

- Implement mechanisms 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), including HOB elevation on daily goal sheets or discussing it as a topic at daily multidisciplinary rounds.
- Bring a protractor into the ICU to demonstrate exactly what 45° elevation looks like. Once you have measured 45° for that bed, place a piece of coloured tape on the wall behind the bed and verify compliance during ventilator 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).
- Educate all personnel and 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 45° 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 Evaluation of Readiness for Extubation

The timely liberation from mechanical ventilation is thought to help prevent VAP by minimizing “device exposure”, whereby the “device” is the ventilator-circuit-endotracheal tube (ETT) complex and “exposure” is the duration of mechanical ventilation (i.e. “device-days”). It should be noted that with current practice standards of ventilator management, the ETT component appears to carry the greatest burden of risk for pneumonia.⁵⁶ This is also supported by a recent review several small studies of non-invasive ventilation showing a marked reduction in pneumonia compared to invasive (e.g. with ETT) mechanical ventilation.⁵⁷

In this context it thus appears sound for ICU teams to regularly re-evaluate the need for an endotracheal tube in their mechanically ventilated patients. This concept has been examined in

detail, and supporting evidence is presented in this section. The daily evaluation of readiness for extubation involves two central issues: minimization of unnecessary sedation, and testing the patient's ability to assume unassisted breathing while still intubated.

Minimization of unnecessary sedation

Sedation has traditionally been prescribed in mechanically ventilated patients in order to maintain comfort, decrease pain and anxiety, improve patient-ventilator interaction, help maintain major organ homeostasis, facilitate nursing care by avoiding self-injury and to allow safe completion of daily activities and procedures. Unfortunately, over sedation may lead to unintended consequences, such as longer duration of mechanical ventilation and ICU stay, decreased communication with patient with consequent decreased ability to evaluate the patient for - among other items - delirium, weaning and readiness for extubation, as well as ventilator-related complications) such as neuromuscular weakness and pneumonia.⁵⁸

In 2000, Kress reported the results of a randomized controlled trial in which 128 adult mechanically ventilated patients sedated by continuous IV infusion received either daily interruption of sedation (irrespective of clinical state) or sedation interruption at the clinician's discretion.⁵⁹ Interruption was considered complete if the patient could perform 3 of 4 items on command: open eyes, squeeze hands, lift head and protrude tongue. Daily sedation interruption was associated with a marked and highly significant reduction in time on mechanical ventilation from 7.3 days to 4.9 days ($p=0.004$). Schweickert et al performed a post-hoc analysis of the Kress trial and found that patients undergoing spontaneous awakening trials via daily interruption of sedative infusions experienced significantly less complications associated with mechanical ventilation (VAP, upper gastrointestinal haemorrhage, bacteremia, barotrauma, venous thromboembolic disease, cholestasis or sinusitis requiring surgical intervention) than in those subjected to conventional sedation techniques (2.8% vs. 6.2%, $p=.04$).⁶⁰ In addition, these patients had a reduced ICU length of stay and were not at risk for worse psychological outcomes (anxiety, inability to cope with pain) after critical illness compared with conventional therapies.⁶¹

In an important proof-of-concept study by Strom et al showed that a no-sedation approach in mechanically ventilated ICU patients is associated with an increase in days without ventilation.⁶² In reality, as the intervention (no sedation) group was administered morphine as required, the true concept demonstrated was rather that a conservative approach of less sedation does not appear to cause harm in critically ill mechanically ventilated patients. Three caveats for this study are 1) the intervention group ("no" sedation) had a greater incidence of delirium, 2) the trial utilized more than usual resources, i.e. 1:1 patient: nurse ratios for all patients, 3) the trial was a single center study. A multicentre study is required to ascertain the reproducibility of these findings. In an observational study of 335 patients admitted to a mixed medical-surgical ICU, Salgado observed that minimal use of continuous sedation (42% of patients received some sedation, and only 10% of patients received sedation for >24 hours; 20% of ventilator hours were accompanied by a continuous sedative infusion) was feasible without apparent adverse effects (e.g. self-extubation requiring re-intubation).⁶³

Interventional studies assessing the effect of implementing an ICU sedation protocol alone have provided inconsistent outcomes with respect to ventilator and ICU days, incidence of VAP and

extubation failure.^{64,65} The benefits and risks of daily sedation interruption were also studied in a meta-analysis of five randomized controlled trials, comparing daily sedation interruption with no interruption in 699 critically ill patients.⁶⁶ Although daily sedation interruption was not associated with a significant reduction in duration of mechanical ventilation, length of intensive care unit or hospital stay, mortality, or self-extubation by the patients, it was however associated with a reduced risk of requiring tracheostomy (odds ratio 0.57, 95% confidence interval 0.35 to 0.92, $P=0.02$; $I^2=3\%$). The authors concluded that current evidence suggests that daily sedation interruption appears to be safe, but the significant heterogeneity and small sample sizes of the existing studies suggest that large randomised controlled studies with long-term survival follow-up are needed before daily sedation interruption can be recommended as a standard sedation practice for critically ill adult patients.

However, the implementation and titration of ICU sedation is more than simply interrupting sedative infusions. It is rather a balancing act to minimize sedation-associated complications and improve patient comfort. Factors such as varying organizational models of medical and nursing care delivery and failure to link to other daily practices may render redundant any added advantage of a stand-alone sedation or weaning protocol.

Testing the patient's ability to assume unassisted breathing

Two historic trials demonstrated the important value of daily spontaneous breathing trials in reducing the duration of mechanical ventilation.^{67,68} The authors also noted during the process that weaning patients from ventilatory support was easier if patients were better able to cough and clear their secretions.

We wish to acknowledge that specific weaning protocols are not proposed in this document. To this issue, a recent systematic review investigated the effect of weaning protocols on the duration of mechanical ventilation and other clinical outcomes. Despite a reduction in the duration of mechanical ventilation, weaning, and ICU stay when standardised weaning protocols are used, there was also significant heterogeneity among studies.⁶⁹ In another study reviewing international data, it was hypothesized that the observed large variability in organizational contexts and processes for weaning (e.g. regarding ICU structure, staffing, skill mix, education, roles, responsibilities, interdisciplinary organization, participation and collaboration) could account for some of the variability in weaning outcomes and perhaps in the added value of weaning protocols in ICUs.⁷⁰ ICU teams are urged to review the organizational context in which they wean their patients as well as the weaning process itself in order to optimize weaning outcomes. In passing, the contribution of non-invasive ventilation (NIV) to ventilator protocols may be one evidence-based method to facilitate liberation from mechanical ventilation in selected patients with respiratory failure.^{71, 72,73}

Linking the two

The recent “Awakening and Breathing” trial linked the concepts of sedation interruption and regular reassessment of weaning and readiness for extubation. A “wake up and breathe” protocol that sequentially applies a daily spontaneous awakening trial (SAT) (interruption of sedation - whether constant infusion or p.r.n) and a daily spontaneous breathing trial (SBT) resulted in better outcomes for mechanically ventilated ICU patients than current standard approaches.⁷⁴ 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 re-intubation 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” flow sheets are readily available online.^{75,76} Furthermore, in an a priori planned substudy conducted in one participating ICU during this trial, the authors found that the *wake up and breathe protocol* resulted in similar cognitive, psychological, and functional outcomes among patients tested 3 and 12 months post-ICU, ie the protocol benefits were not offset by adverse long-term outcomes.⁷⁷ It should be noted that the protocol was devised so that an SAT required holding even narcotics unless they were specifically prescribed for analgesia, underlining the importance of documenting the goals for medication use in these patients.

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 interruption 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 either as continuous IV infusion or as PRN should be candidates for SAT.
- Consider a SAT Safety Screen, with specific allowable contraindications (e.g. Patient receiving sedative infusion for active seizures or alcohol withdrawal, or escalating doses due to ongoing agitation, or the presence of neuromuscular blocking agents, has experienced myocardial ischemia within 24 hours or currently has increased intracranial pressure).
- Spontaneous Awakening Trial (SAT). After having stopped all sedatives and analgesics used for sedation (continue analgesics for active pain), patient passes SAT if: opens eyes to verbal stimuli or tolerates sedation interruption for >4 hours. Patient fails if experiences: sustained anxiety, agitation, or pain, or has respiratory rate > 35 or SpO₂ < 88% for 5 or more minutes, or 2 or more signs of respiratory distress, or acute dysrhythmia. If SAT failed, medications are restarted at half dose and titrated.

- Include precautions to prevent self-extubation such as increased monitoring and vigilance during the trial. (see FAQ for further discussion)
- Implement a process to standardize the performance of Spontaneous Breathing Trials (SBT).
- If patient has passed a SAT screen, consider a SBT screen:
 - Comfort:** able to follow commands, adequate cough during suctioning
 - Gas exchange:** $P_{aO_2} \geq 60$ mmHg on $F_{iO_2} \leq 0.4$ and $PEEP \leq 10$ cmH₂O
 - Hemodynamics:** acceptable MAP with no/minimal vasopressor/ionotropic infusions and no active cardiac ischemia.
 - Breathing:** respiratory rate ≤ 35 and minute ventilation ≤ 15 LPM.
 - If passes SBT screen, perform SBT on minimal ventilator support (current F_{iO_2} , T-piece or tracheal collar, or CPAP 5cmH₂O + PS ≤ 7 cmH₂O for 1-2 hours.
 - SBT is failed if ≥ 1 of these signs occurs for ≥ 5 minutes: respiratory rate >35 /min or <8 /min, $SpO_2 < 90\%$, heart rate >140 /min or changed by $>20\%$ baseline, systolic BP >180 or <90 mmHg, ≥ 2 signs of respiratory distress (marked dyspnea or restlessness, increased use of accessory muscles, abdominal paradox, or diaphoresis), acute dysrhythmia.
 - If SBT is passed, assess before considering extubation: ability to protect the airway (good cough strength, minimal suctioning requirement), alertness and ability to follow commands), risk of post-extubation stridor (perform cuff leak test), history of difficult intubation.
- Link these two strategies (SAT and SBT) into your overall weaning process (protocol etc.). NB The thresholds cited for SAT and SBT, although based on the results of clinical trials, should be reviewed with the ICU physicians and respiratory therapy staff for consensus/modification according to patient case mix and other factors).
- 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. Subglottic Secretion Drainage

The main cause of VAP is the microscopic aspiration of pathogen laden secretions into the lower respiratory tract in endotracheally intubated patients. Intubated patients are at risk of microscopic aspiration because of impairment of laryngeal function by the endotracheal tube (ETT), sedation that blunts upper airway reflexes, regurgitation from gastro-esophageal sphincter dysfunction, associated enteral feeding, and as previously discussed nursing in the supine position.⁷⁸ Exacerbating the significance of micro-aspiration is that the gastro-intestinal

tract including the mouth and oropharynx become colonized with pathogenic organisms soon after ICU admission.⁷⁹ As previously discussed, measures to prevent VAP that aim to reduce the quantity of aspirated pathogenic bacteria, such as the reduction of bacterial loads in the oropharynx with antiseptic mouth care and elevation of the head of the bed, have also been shown to be effective in reducing VAP.^{36,80}

There has been increasing research on endotracheal tube (ETT) design as a means of reducing the risk of VAP; these include changes to materials composing the tube, changes to cuff design and subglottic secretion drainage (SSD). Kollef et al. studied the effects of silver coated ETTs versus conventional ETTs and found that there was a 35.9% decrease in VAP in patients intubated longer than 24 hours receiving silver coated ETTs with a number needed to treat of 37 to prevent 1 case of VAP.⁸¹ Several mechanisms were postulated; silver has broad-spectrum antimicrobial activity, prevents bacterial adhesion to the ETT and may prevent biofilm formation. However, there were no differences in duration of MV, length of ICU stay and overall mortality. This study has several limitations including a low incidence of VAP, increased presence of patients with chronic obstructive lung disease and a high rate of pneumonia within 24 hours in the control group. Even though they are costlier than conventional ETTs, in an economic analysis of silver coated ETTs they were found to be associated with cost savings.⁸² Nevertheless, silver coated ETTs have only been studied in a single RCT with significant limitations and further studies are required to determine the role of these novel ETTs, specifically in relation to other VAP preventive strategies.

The prevention of aspiration of pathogen laden secretions that accumulate above the inflated cuffs of ETTs has also been the research since there is increasing evidence that standard cuffs do not prevent micro-aspiration due to folds in the membrane when inflated and pressed against tracheal mucosa.¹ To reduce micro-aspiration around the cuff research has focused on cuff design improvements, the reduction of secretions accumulating above the cuff through sub-glottic secretion drainage (SSD) or both.

Cuff design changes have focused on the geometry of the cuff or the cuff material. Changing the cylindrical shape of the cuff to a tapered one such that there is a better zone of apposition to the tracheal mucosa has been found to reduce aspiration in lab models by 90%.^{83,84} However, clinical studies studying the significance of this have not been published and these are required. The replacement of standard polyvinyl chloride cuffs with an ultra thin polyurethane cuff (PUC) also decreases fluid leakage around the cuff. There are two clinical studies studying the effect of these type of cuffs. In one randomized clinical study of a PUC cuffed ETT combined with SSD, there was a significant reduction in the rate of VAP.⁸⁵ However, a standard ETT was utilized in the control group in this study and it is unclear if the reduction in VAP rate was the result of the PUC cuff or the SSD. The second study of a PUC cuffed ETT employed a time series analysis.⁸⁶ With the replacement of standard ETTs with a PUC cuffed tube the rate of VAP fell and then rose slightly when the tubes were withdrawn. Given the large amount of clinical evidence for SSD, the role of PUC cuffed tubes remains to be determined.

A measure that reduces the amount of aspirated secretions into the lower respiratory tract is the evacuation of secretions that pool above the cuff of the endotracheal tube or sub-glottic secretion drainage.⁸⁷ Sub-glottic secretion drainage (SSD) through a specialized ETT incorporating a suction port above the cuff as a method to prevent VAP was first reported in 1992.⁸⁸ This strategy has undergone a large amount of study to ascertain its effectiveness for the reduction of VAP. A meta-analysis of five randomized controlled studies published in 2005 by Dezfulian et al concluded that it was an effective intervention for the prevention of early onset VAP among patients expected to require >72 hours of MV.⁸⁹ Further in this meta-analysis, SSD was associated with reduced duration of MV and ICU length of stay although there was no effect on mortality.

A repeat meta-analysis of 13 randomized controlled studies studying ETTs with SSD including a total of 2442 patients was published in 2011.⁹⁰ In this meta-analysis, it was found that SSD was associated with a highly significant reduction of VAP of approximately 50% (risk ratio 0.55 (95% CI 0.46 - 0.66, $p < 0.00001$) with no heterogeneity ($I^2 = 0\%$). Further the time to first VAP was significantly increased in the SSD group. The use of SSD was associated with reduced ICU length of stay (- 1.68 days, 95% CI -3.20 to -0.17, $p = 0.03$) and decreased duration of MV (- 1.18 days, 95%CI - 2.19 to - 0.18, $p = 0.02$). There was no effect on mortality. It should be emphasized that the expected duration of mechanical ventilation for these ETTs to be placed was variable and in only 6 of the studies was the inclusion criteria greater than 72 hours. In 5 of the studies, it was greater than 24 hours and in 2 it was not specified. Adverse events such as re-intubation or post extubations stridor were not increased in the patients receiving SSD.

Airway difficulties have been reported in animal models instrumented with ETTs with SSD but the significance of this in humans is not known.⁹¹ Case reports in humans have reported stridor and stenosis of the airway. In spite of this, they have been adopted in wide scale clinical use without incident.

In an older cost effectiveness analysis, the utilization of ETT with SSD was shown to be cost effective.⁹² Given the morbidity and costs associated with VAP, the low numbers needed to treat with SSD to prevent 1 case of VAP (NNT of 11)⁹⁰ and the low acquisition cost of ETTs with SSD, they should be routinely used in all patients who are expected to be invasively mechanically ventilated long enough to put them at risk for VAP.

What changes can we make that will result in improvement?

All high risk for prolonged mechanical ventilation and VAP should receive ETTs with SSD. Identification of these patients at the time of intubation is difficult for clinicians and implementing population based methods may improve their utilization. Some of the processes that can be put in place to increase the utilization of ETTs with SSD are as follows:

- Respiratory therapy (RT) will need to be intimately involved in the implementation of these ETTs.
 - Having an RT champion is crucial for this implementation.
 - Procedures required for maintaining ETTs with SSD will need to be put in place; either continuous or intermittent suction on the suction ports of the ETT.
 - All RTs working in the institution will need to be inserviced on the importance of SSD.

- Utilizing ETTs with SSD in all patients intubated in the emergency department. These patients are likely to be intubated for longer periods of time. This can be facilitated as follows.
 - Discussion with emergency department physicians to emphasize the importance of these ETTs.
 - Stocking the emergency department with only ETTs with SSD.
 - Since ETTs with SSD are slightly larger than tubes without SSD, standard ETTs should be stocked in the difficult airway cart or tray.
- Utilizing ETTs with SSD in all patients intubated on the medical wards or the in the Intensive Care Unit. This can be facilitated as follows.
 - Discussion with all the ICU attendings, physicians who respond to cardiac arrests, physicians who are likely to intubate patients on general hospital wards and physicians who may be part of medical response teams.
 - Stocking airway trays, cardiac arrest carts or intubation kits with only ETTs with SSD
 - Stocking standard ETTs only in difficult airway carts.
- Utilizing ETTs with SSD in high risk patients coming from the operating room. This can be facilitated as follows.
 - Discussion with anaesthetists, anaesthesia housestaff (if any) and respiratory therapists working in the operating room.
 - Make it standard operating procedure that any patient who may require ICU post operatively will be intubated with an ETT with SSD in the operating room.
- All patients intubated in the ICU for more than 24 hours with standard ETTs should be reviewed. The review would examine the implementation process for SSD failed and feedback provided to the clinicians involved in the original intubation. It should be recognized that some patients may not be candidates for these tubes and the review should take this into consideration. Patients who may not be candidates for ETTs with SSD or who may not have received these tubes appropriately.
 - Patients who are nasally intubated.
 - Patients in whom there was difficulty with the intubation process.
 - Patients from OR who were not expected to require ICU care but due to difficulties intra-operatively come to require post-operative mechanical ventilation.
- Post the rates of utilization of ETTs with SSD in patients who are mechanically ventilated.

4. Oral care and Decontamination with Chlorhexidine

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.^{93,94}

Oral care

Garcia et al showed that implementing a comprehensive oral and dental care system and protocol (without Chlorhexidine) for critically ill medical patients compared to “standard oral care” was associated with a decrease in VAP rate (12 vs. 8 / 1000 ventilation-days, $P = .06$).⁹⁵ Duration of mechanical ventilation and length of stay in the intensive care unit differed significantly between groups, as did mortality. Compliance with protocol components exceeded 80%.

The oral care policies and practices in intubated critically ill patients are varied and no gold standard exists. There are very few well designed studies exploring the different protocols thus the strength of the evidence supporting the practice is not strong.⁹⁶

The American Association of Critical Care Nurses (AACN) and Association for Professionals in Infection Control and Epidemiology (APIC) recommend a comprehensive oral hygiene program for patients in critical care and acute care settings.^{97,98,99} AACN has published practice guidelines addressing tooth brushing, use of toothpaste or cleansing solution, use of peroxide, and suctioning of the oropharynx after brushing or cleaning. However, these guidelines are not widely known.¹⁰⁰

No standard tools for the assessment of the oral cavity of intubated critically ill patients are accepted. The *AACN Procedure Manual for Critical Care* recommends assessment of the oral cavity every 8 hours. In a study of nurses practice, Feider et al observed that the most common frequency for oral assessment was every 4 hours however, 93% of participants reported not using a standardized oral assessment tool. Therefore it is unclear what was actually assessed.¹⁰⁰ APIC has produced a scoring system for evaluating the oral cavity to help decide on the frequency of oral hygiene to be performed but it is unclear if this tool has been validated.⁹⁹

The recommendation for a given oral care protocol is currently not possible due to an insufficient number of well-designed studies, the heterogeneity of practices pre-intervention and the lack of information regarding compliance with other components of care to reduce VAP. Questions also arise as to the safety of oral care procedure in labile patients. Little information is available but the study by Prendergast suggests that execution of oral care does not seem to affect intracranial pressure adversely.¹⁰¹ Further studies are necessary although it is clear that a comprehensive oral care protocol is required in daily practice.

Oral decontamination

The benefits of oral decontamination with antibiotic-containing regimens on the rate of VAP have been reported. 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.¹⁰² 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 (CHG) 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.^{103,104,105,106,107}

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.¹⁰⁸

Chlorhexidine is a broad spectrum antibacterial agent that has been used extensively in healthy populations as an oral rinse to control dental plaque and to prevent and treat gingivitis. It is the most extensively studied antiseptic for oral decontamination in intubated critically ill patients. Its use has been evaluated in both medical and surgical ICU populations, and in varying concentrations including 0.12%, 0.2%, and 2%.

Originally, three studies using CHG as a gel or as a rinse either before or after admission to ICU and one study comparing CHG to Listerine showed a decrease in VAP rates in the CHG groups as compared to the control groups.^{106,107,109,110,111} One study using CHG as a gel did not show a reduction in VAP rate. Although the patient populations, the concentrations (0.12%, 0.2% and 2.0%) of CHG used, the combination of therapies (antiseptic alone or with Colistin), the timing of the intervention and the physical form of the CHG (oral rinse vs. gel applied to oral cavity and teeth) differed in all studies, the evidence indicates that CHG should be considered in the routine care of ventilated patients

Meta analyses published since 2006 have shown that oral decontamination is associated with a reduction of VAP. Studies included medical, cardiac surgery and other surgical patients. Most studies used Chlorhexidine but in various form and concentration and for a duration after intubation varying from 0-28 days or until pneumonia/extubation/discharge from ICU or death.^{112,113,114,115,116,117,118}

Sona et al conducted a pre-intervention and post-intervention observational study in a twenty four bed surgical/trauma/burn intensive care units in an urban university hospital.¹¹⁹ The new oral care protocol included tooth brushing with toothpaste, rinsing, suctioning and application of CHG 0.12% solution. The pre-intervention hospital policy offered no specific guidelines on what products to use or how to perform oral care and it was inconsistently done. This oral care protocol was added to the other elements of VAP prevention implemented and sustained for several years. The new protocol showed a 46% reduction in VAP rate ($P < .04$). This reduction in VAP occurred without a change to the gram-negative or gram-positive microorganism profile. Staff compliance with the oral care protocol during the 12-month period, monitored biweekly, averaged 81%. The implementation of this oral care protocol proved to be cost-effective. Moreover the use of the existing available products was estimated to be 16-19 times less expensive compared to a commercial oral care kit.

There is no conclusion as to the effect of toothpaste prior to, in conjunction with, and after CHG solution on the reduction in oral plaque and antimicrobial benefits.^{120,121,122,123,124} However, Munro et al in randomized controlled clinical trial with a 2 x 2 factorial design conclude that Chlorhexidine, but not tooth brushing, reduced early ventilator-associated pneumonia in patients without pneumonia at baseline.¹²⁵

The most common cited side effect of CHG in healthy individuals using it after dental procedure or for the treatment of gingivitis is teeth staining. This side effect was not reported in any of the studies.

Currently in Canada, the only concentration available for chlorhexidine is 0.12%.¹²⁶

Initial doses of CHG given the night before and on call for cardiac surgery have been shown to be beneficial. Future research would be helpful to determine the validity of giving a first dose of CHG the night before and on call for other surgeries and to determine the optimal duration of use of CHG including assessing continuation of use after extubation until discharge from ICU to prevent colonization in the event of re-intubation.

Oral decontamination should be integrated into the care plan of all intubated patients. Of note, the ACCN guidelines does not recommend generalized use of oral decontamination but their guidelines are prior to the more recently published meta-analysis.¹²⁷ Although definite recommendations with regards to product selection and concentration cannot be made, a frequent approach has been to use 15mL CHG solution every 12 hours after performing oral care. Use of pre-printed orders for all patients admitted to ICU helps in optimizing compliance. Selected products should be stored appropriately, dispensed in small formats and infrequently manipulated to avoid contamination of the solutions.

5. Initiation of safe enteral nutrition within 24-48h of ICU admission

The impact of nutrition support in critically ill patients has been widely studied. The extensive literature base has been reviewed by multiple groups and professional societies and multiple guidelines exist.^{128,129,130,131,132}

In summary some of the consensus recommendations are as follows. Please refer to the original publications for in depth discussions.

- In patients who are critically ill, enteral nutrition (EN) is the preferred route of nutritional support. Enteral nutrition should be utilized in patients with a functional gastro-intestinal tract and who are hemodynamically stable and/or who are adequately fluid resuscitated^{128,129,131}
- Enteral nutrition should be started within 24 to 48 hours^{117,118} the feeding should be advanced to goal within the next 48 to 72 hours¹¹⁸. The specific reasons for providing early EN are to maintain gut integrity, modulate stress and the systemic immune response, and to attenuate disease severity. Feedings started within this time frame (compared to feedings started after 72 hours) are associated with less gut permeability, diminished activation, and release of inflammatory cytokines (i.e. tumour necrosis factor [TNF and reduced systemic endotoxemia]).¹³¹ Early EN is associated with a reduction in infectious complications, reduced LOS and reduced mortality when compared to delayed initiation.^{128,130,131} Supplemental parenteral nutrition (PN) or routine initiation of PN within the first week of ICU admission is not recommended.^{128,131,133}
- The type and the quantity of nutrients can influence outcome. However this topic is beyond the scope of this document and is best discussed in the various guidelines.^{128,130,131}

What improvements can we do to minimize the risk of aspiration or pneumonia when administering enteral nutrition?

- **Oral vs. nasal?** When possible large bore feeding tubes should be placed orally while it is acceptable to place small bore feeding tubes nasally.
- **Obtain confirmation of correct placement** of a newly blindly-inserted tube before initiating feeding or administering medication. Place a mark on the exit site of the feeding tube and monitor patient for tube dislodgement and reconfirm placement if in doubt.¹³² We strongly recommend that medical order authorizing initiation of enteral nutrition include a statement about the anatomical location of the tip of the tube. This is best achieved by the use of pre-printed orders (see ex JGH). Readers are invited to read the Enteral Nutrition Practice Guidelines for further discussion on techniques for insertion and monitoring of feeding tubes.
- **Position patients correctly all the time.** Elevation of the head of the bed (HOB) to 45° (and if not possible, attempts to keep > 30°) should be considered as an integral part of the VAP bundle. Moreover, there is a consensus that critically ill patients receiving enteral nutrition have the head of the bed elevated to 45°. When this is not possible, attempts to raise the head of the bed at least > 30° should be considered. Where this is not possible, attempts to raise the head of the bed as much as possible should be considered.^{128,130,131,132} Among the recognized contraindications to a semi-recumbent position are an unstable spine, hemodynamic instability, prone positioning, and certain medical procedures (such as a central venous catheter insertion). The reverse Trendelenberg position to elevate the HOB, unless contraindicated, when the patient cannot tolerate a backrest elevated position should be used. The position should be returned to 45° as soon as possible after a procedure. When this is not possible, attempts to raise the head of the bed at least > 30° should be considered. To increase compliance use written (pre-printed orders).
- **Understand the limitations of Gastric residuals.** Measurement of gastric residual volumes (GRV) to monitor tolerance to enteral nutrition is controversial and there is confusion as to its impact on clinical outcome as it does not reflect the pathophysiology of critical illness and is influenced by numerous factors including the type of tube, the syringe, the position of the patient etc“ the elevated residual volumes by themselves have little clinical meaning and that only when combined with vomiting, sepsis, sedation, or the need for pressor agents does the correlation with worsening patient outcome emerge.”¹³⁴ Nevertheless it is recommended to measure gastric residuals every 4 hours in critically ill patients.¹³² Gastric residual volumes in the range of 200-500 mL should raise concern and lead to the implementation of measures to reduce risk of aspiration, but automatic cessation of feeding should not occur for gastric residual volumes <500 mL in the absence of other signs of intolerance.¹³¹ A GRV >500 mL should result in holding EN and reassessing patient tolerance by use of an established algorithm including physical assessment, GI assessment, evaluation of glycemic control, minimization of sedation, and consideration of promotility agent use, if not already prescribed.¹³²

- **Use continuous administration**, especially in patients at risk of aspiration or intolerant to intragastric feeding.¹³¹
- **Use motility agents:** The Canadian Guidelines recommend use of a promotility agent in critically ill patients who experience feed intolerance (high gastric residuals, emesis). Given the safety concerns associated with erythromycin, their recommendation is made for metoclopramide. And they note that there are insufficient data to make a recommendation about the combined use of metoclopramide and erythromycin.¹³⁰ Again because of the controversy surrounding measurement of GRV, it is difficult to recommend a cut-off point but a GRV >250 mL appears acceptable.^{128,130,132} The American guidelines recommend to use a prokinetic agent after a second GRV of 250mL or more.^{128,132}
- **Consider feeding in the small bowel vs. in the stomach.** According to ASPEN, either gastric or small bowel feeding is acceptable in the ICU setting.¹³¹ However, small bowel feeding compared to gastric feeding may be associated with a reduction in pneumonia in critically ill patients. Clinical trials with the largest number of subjects having pneumonia as a primary outcome suggest that post-pyloric enteral nutrition reduces aspiration pneumonia in critically ill adult patients.^{128,130} The Canadian guidelines recommends the routine use of small bowel feeding where logistically feasible. At the minimum, small bowel feeding should be considered for patients at high risk for intolerance to EN (on inotropes, continuous infusion of sedatives, or paralytic agents, or patients with high nasogastric drainage) or at high risk for regurgitation and aspiration (nursed in supine position), specifically if patients repeatedly demonstrate high gastric residuals and are not tolerating adequate amounts of EN intragastrically^{130,131}. High gastric residual volumes are defined as 250ml or 500ml.^{130,132} Of note, the recommendation for placement of long term enteral device is for patients who will need enteral nutrition for four weeks or more.¹³²
- **Use of protocol that incorporate key safety strategies** (see [Appendix D](#)), including positioning, confirmation of tube placement, measurement of GRV accepting a higher threshold (250mL), use of pro-kinetics, use of small post-pyloric tubes¹³⁰
- **Include a clinical dietitian as part of the interdisciplinary team**
- **Consider reorganisation of workload or work organisation so to allow the presence of a dietitian at least every day of the year, including week-ends and statutory holiday**

Additional Evidence Based Components of Care

1. Hand Hygiene

The required practice is to perform hand hygiene according to the four moments of hand hygiene which include before and after approaching a mechanically ventilated patient (as described in the four moments of hand at www.handhygiene.ca)

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.¹³⁵

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%).¹³⁶

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.¹³⁷ 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* sp. (90% reduction) over 36 months in association with a doubling in hand hygiene compliance (21 to 42%).¹³⁸

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.¹³⁹

There is an emerging consensus among experts that educational campaigns alone have not produced sustained improvement.¹⁴⁰ 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.¹⁴¹ 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.¹⁴² A summary of recommendations from the WHO, pertaining to hand hygiene can be found at: www.who.int/patientsafety/information_centre/ghhad_download_link/en/

The Canadian Patient Safety Institute sponsors “Stop! Clean your hands” www.handhygiene.ca. Additional helpful information will be found in the resources links provided.

2. Practices That Promote Patient Mobility and Autonomy

The deleterious effects of ICU-acquired delirium and neuromuscular weakness on patient outcomes are well-known. These two complications of critical illness are highly prevalent in a mixed ICU population, but go more often unrecognized than other ICU-acquired organ system failures despite being associated with increased ventilator-, ICU- and hospital days and mortality.^{143,144,145}

Recent data support practices that help mitigate the effects of these complications on ICU outcomes, and have been incorporated in a proposed “ABCDE” bundle as “an integrated and interdisciplinary approach to the management of mechanically ventilated patients”.^{146,147} The first two letters “A” and “B” of this proposed bundle (Awakening and Breathing coordination) constitute one of our VAP Bundle elements (see DAILY EVALUATION OF READINESS FOR EXTUBATION on page 15).

This section will outline practices represented by the letters “C” (choice of sedatives/analgesics), “D” (delirium screening and management) and “E” (early exercise) intended to better “*liberate* (from mechanical ventilation and sedation) *and animate*” (through early mobilization) our ventilated ICU patients.¹⁴⁸ A free interactive webcast on this topic is available online at www.aacn.org/CE-ABCDE-bundle (last accessed July 20 2011), and is accredited by the National Councils on continuing education for nurses (AACN), pharmacists (ACPE) and physicians (ACCME)).

Choice of Sedatives, Analgesics and Antipsychotics

For a variety of reasons, the critically ill ventilated ICU patient is at increased risk of adverse events related to sedative, analgesic, and antipsychotic therapy. These events are myriad, and require knowledge, vigilance and strategies to prevent or minimize them.¹⁴⁹ Conversely, improved outcomes are noted when ICU teams utilize a structured approach to sedation and analgesia administration and titration.¹⁵⁰ Despite the limited literature on the use of antipsychotics for ICU delirium, there is evidence that an approach that incorporates delirium to these modalities can positively affect clinical outcomes.^{151,152}

Delirium screening and management

Delirium is a syndrome characterized by a disturbance of consciousness and a change in cognition that develop over a short period of time.¹⁵³ When due to a general medical condition (DSM code 293.0), the disturbance tends to fluctuate during the course of the day, and there is clinical evidence that the disturbance is caused by the direct physiological consequences of a general medical condition. Delirium affecting ICU patients is complex and still poorly understood.¹⁵⁴ A large proportion of ICU patients develop delirium, and this is associated with longer stays,

increased costs, mortality and morbidity in ICU survivors.^{155,156}

The most important step in delirium management is early recognition. This can support ICU teams by alerting them to changes in physiological status. The converse is particularly relevant, e.g. delays in identifying delirium may delay identification of important changes in critical illness, with its known consequences on patient outcome. In addition, the decision to initiate or titrate medications (for example, analgesia, sedation) depends on accurate assessment of delirium. Without appropriate cognitive status information, treatment will not match the needs of the patient. Three major delirium screening tools have been utilized - the Nursing Delirium Screening Scale, Confusion Assessment Method for the Intensive Care Unit (CAM-ICU) and Intensive Care Delirium Screening Checklist (ICDSC). Although the CAM-ICU and ICDSC vary in their approach - the CAM-ICU provides a yes-no syndrome recognition, whereas the ICDSC grades the syndrome to include a range of “subsyndromal delirium”, they have been validated in ICU patients and been successfully used in delirium screening and management.^{157,158,159}

If delirium is detected, efforts should focus on identifying the cause, risk factors, and comorbidities which should then be minimized/or eliminated.^{160,161,162} This is aided by the combined application of the other interventions (“ABC” and “E”) described in this Section of the VAP Get Started Kit. When these efforts are unsuccessful patients are treated with psychoactive medications. Unfortunately the pharmacologic management of delirium is far from straightforward, and in need of much work to improve our understanding of this syndrome and its response to various medications.

Early Exercise

The first trial reporting the results of a progressive mobilization protocol in ventilated ICU patients proved the principle that it could be performed safely with successful outcomes.¹⁶³ After major organ (neurological and cardio-respiratory) stability was established, the investigators assessed protocol readiness. With increasing level of consciousness and strength, the level of mobility is progressed thus: physiotherapy is introduced, the first target being the sitting position in bed. Sitting on the edge of the bed is then attempted once the patient can move his arm against gravity; active transfer to the chair (out of bed) is then attempted once the patient can move his leg against gravity. Ambulation is the last target.^{164,165}

Two other studies followed which strengthened this notion and recognized the negative role of sedation on neuromuscular performance and mobility. Schweickert paired SATs and SBTs (see page 15 - VAP Bundle Section “DAILY EVALUATION OF READINESS FOR EXTUBATION”) with early exercise and mobilization(physical and occupational therapy) in mechanically ventilated patients.⁶⁰ Patients randomized to the early mobility group were three times more likely to return to independent functional status at hospital discharge (primary endpoint, 59% vs.35%, $p=0.02$), had a shorter duration of delirium (median 2 vs. 4 days $p=0.02$) and more days breathing without assistance (24 vs.21 ventilator-free days, $p=0.05$). Furthermore, intervention patients had higher functional scores ($p=0.05$) at hospital discharge and ambulated greater distances without assistance (33 vs.0 m, $p=0.004$) than did those in the control group. These observations indicate that early mobility is well tolerated and feasible, decreases both ICU and hospital length of stay and improves functional outcomes at hospital discharge.

The link between sedation, delirium, mobilization and ICU was further established by the study led by Needham.¹⁶⁶ This quality improvement project utilized a similar protocol, sought to improve sedation practices and increase mobilization in a medical ICU. At the completion of the study, there was a marked decrease in prescription for benzodiazepines as well as lower doses of narcotics were given. Accordingly patients were awake and alert on twice as many ICU days and the number of delirium-free days doubled. During the same time there was a 286% increase ($P < 0.001$) in the number of physical and occupational therapy treatments. This study showed that a progressive mobility program using a dedicated multidisciplinary team can effectively improve patient mobility while decreasing sedative requirements, delirium and ICU length of stay. The latter was associated with improved ICU access for more ICU admissions when compared to an equivalent time period. The study also identified an objective consultation trigger and consultation guideline for initiating and implementing a *progressive mobility* program for these patients, which has helped to better define the increasing importance and role physiotherapy in the ICU.¹⁶⁷

What changes can we make that will result in improvement?

Develop a structured and interdisciplinary approach to sedation and analgesia in the ICU. This would involve (non-inclusive list) MDs, RNs, pharmacists, and patient representatives. It would include:

- Values (e.g. maximizing patient well-being while avoiding harm, favour analgesia over sedation and intermittent over continuous infusion delivery), targets and goals.
- Regular and frequent measurement of pain and sedation using validated scales Use validated scales for these modalities : sedation scale (e.g. Riker, RASS etc.) to avoid over or under-sedation.
- Choice of medications based on clinical evidence for patient-focused outcomes that would be accepted and incorporated into daily care via improvement techniques of implementation and re-evaluation.

Consider implementing a similar approach to delirium and incorporating to that for sedation and analgesia. Assessment of delirium in patients is more reliable at times when the patient is not over sedated.

Consider starting a multidisciplinary “progressive mobility” group. Its focus is on identifying barriers and opportunities towards early mobilization for all eligible ICU patients.

Concerns: ICU staffing to include full-time physical and occupational therapists with new consultation guidelines.

For intubated/ventilated patients, structure their presentations at rounds such as to broaden the scope to clearly and succinctly include:

- a. Target and actual measurements of sedation, analgesia and cognition (delirium)
- b. Level of mobility.
- c. Current physical, environmental and pharmacologic interventions
- d. Interpretation of current status (assessment of dysfunction, its causes and drivers)
- e. Targeted improvements in current strategies of *liberation and animation*.

3. Venous Thromboembolism (VTE) 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 admitted to the intensive care unit. The level of cited evidence was that of several randomized control trials.¹⁶⁸

In a recent multicenter randomized trial across ICUs, dalteparin was not superior to unfractionated heparin in decreasing the incidence of proximal deep-vein thrombosis.¹⁶⁹ However there were reduced pulmonary emboli and a trend towards reduced incidence of heparin induced thrombocytopenia. Formal economic analyses are pending. The usage of pharmacologic prophylaxis remains excellent practice in the general care of ventilated patients. An important consideration is in patients where pharmacologic prophylaxis is contra-indicated and these patients sequential compression devices (a.k.a. “venodynes” or “pneumoboots”) may be useful although the evidence for their utilization is not as good as that for pharmacologic prophylaxis.

For more information, refer to the Getting Started Kit on Venous Thromboembolism (VTE) Prophylaxis from *Safer Healthcare Now!*

www.saferhealthcarenow.ca/en/interventions/vte/pages/default.aspx

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. To complicate matters further the Centre for Disease Control (CDC) definition is separated into categories by age range resulting in three definitions as opposed to the one definition for adults. 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 rationale 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 to the use of un-cuffed endotracheal tubes and the lack of CASS-ET tubes in appropriate sizes for the paediatric population. Other risk factors include reintubation, transport out of the ICU, genetic syndrome, and bronchoscopy.^{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 AP.^{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 Are Not 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.
- CASS-ETT: CASS-ETT 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 axillofacial sinuses are not fully developed until 12 years of age,⁹³ which conceivable 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 an 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.¹⁷⁰ 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 healthcare 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.

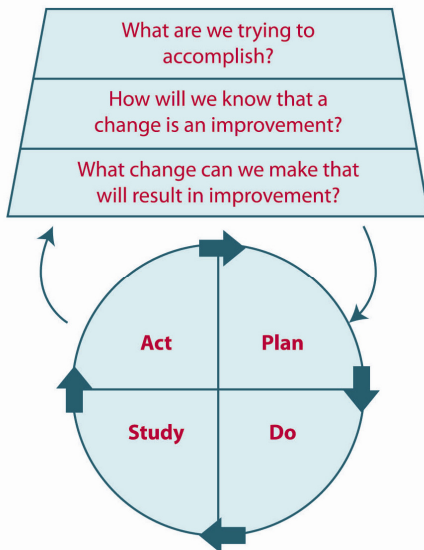
Implementation: After testing a change on a small scale, learning from each test, and refining the change through several PDSA cycles, the team can implement the change on a broader scale – for example, for an entire pilot population or on an entire unit.

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>

The Model for Improvement



Langley, G., Moen, R., Nolan, K., Nolan, T., Norman, C. & Provost, L. (2009). *The Improvement Guide. A Practical Approach to Enhancing Organizational Performance*. 2nd Edition. San Francisco: John Wiley & Sons, Inc. This material is reproduced with permission of John Wiley & Sons, Inc.

Setting Aims

Improvement requires setting aims. The aim should be time-specific and measurable; it should also define the specific population of patients or other system that will be affected.

Establishing Measures

Teams use quantitative measures to determine if a specific change actually leads to an improvement.

Selecting Changes

Ideas for change may come from the insights of those who work in the system, from change concepts or other creative thinking techniques, or by borrowing from the experience of others who have successfully improved.

Testing Changes

The Plan-Do-Study-Act (PDSA) cycle is shorthand for testing a change in the real work setting – by planning it, trying it, observing the results, and acting on what is learned. This is the scientific method adapted for action-oriented learning.

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 four 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.
- Use PDSA cycles to introduce elements of the bundle. 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 six 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 seven mechanically ventilated patients at the time of the count which equates to seven 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 $(6/168) \times 1000 = 35.7$.

$$\frac{\text{Total no. VAP cases}}{\text{No. ventilator days}} \times 1000 = \text{VAP Rate}$$

2. VAP Bundle Compliance

In our experience, teams begin to demonstrate improvement in outcomes when they provide all five 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 one of their improvement journey.

Therefore, Teams can report compliance with individual bundle components.

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

$$\frac{\text{No. receiving ALL five components of VAP bundle}}{\text{No. on ventilators for the day of the sample}} \times 100 = \text{Bundle compliance}$$

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

Appendix A also contains pictures of input screens from the SHN Patient Safety Metrics System. These 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.

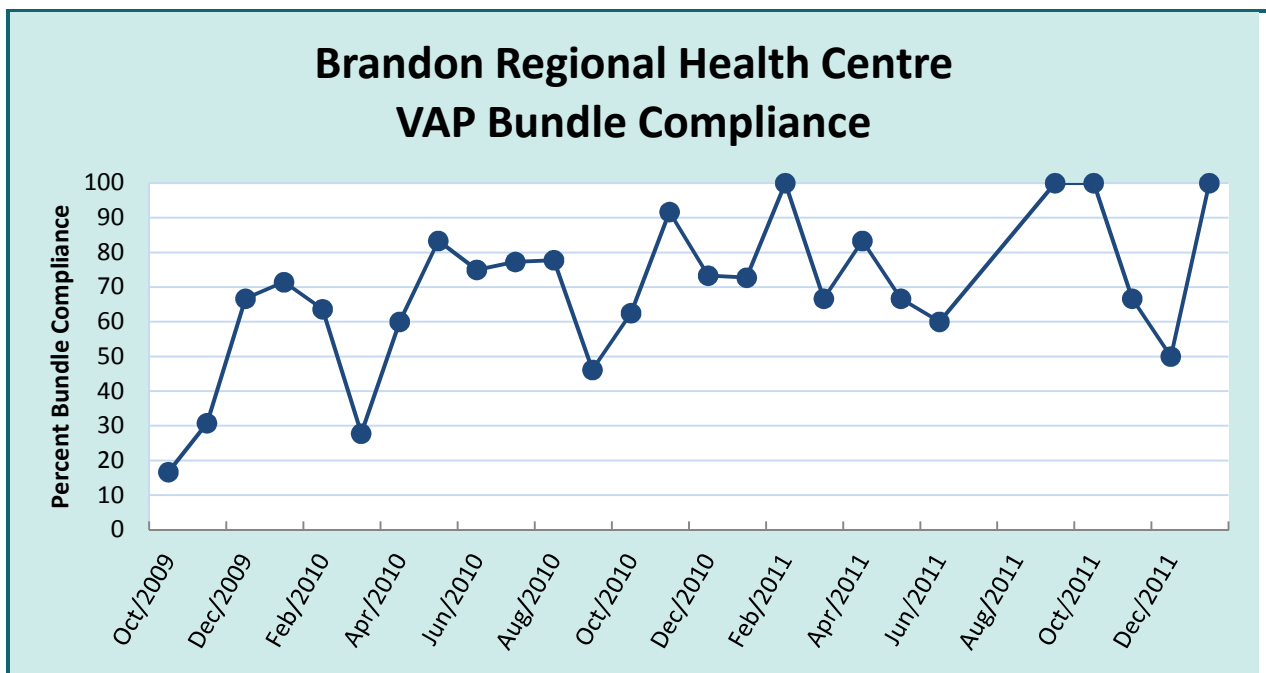
SHN recommends that before your facility, team or unit begins implementing the intervention, you obtain baseline data, using the worksheets provided. Baseline data will give you a sense of where you are starting from, and what some of the potential areas of focus are for your facility or unit. We suggest 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:



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 “buyin” 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

How do I Diagnose VAP?

There is currently much controversy on the accuracy and relevance of current criteria for diagnosing VAP. The major difficulty in establishing universally accepted diagnostic criteria for VAP is that there is no reference standard for VAP. In addition, as none of the available diagnostic tests when performed alone provide an accurate diagnosis of VAP, a diagnostic strategy incorporating a combination of several clinical criteria is required, which then describes a clinical syndrome called “VAP”. Unfortunately, this strategy is burdensome and may lead to variability in ascertaining VAP.¹⁷¹ The considerable inter-observer subjectivity, inter-institutional heterogeneity in surveillance/assessment and patient case mix may lead to gaming of the surveillance process if benchmarking and public reporting add undue pressures to hospital reputation and compensation instead of being used for internal quality improvement.

In order to address these issues the Center for Disease Control and Prevention Division of Healthcare Quality Promotion is currently piloting various diagnostic strategies in order to achieve a *revised definition for VAP* that will be objective, streamlined, reliable and potentially automatable. This will not be a clinical definition but one that will be *clinically credible* and will hopefully predict patient outcomes. The reader will be kept abreast of these events through available CPSI/SHN communication resources (e.g. VAP Community of Practice, Canadian ICU Collaborative Listserv discussion group).

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 this How-to Guide document. 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.⁵⁹ 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)¹⁷²
- The Sedation-Agitation Scale (SAS)¹⁷³
- The Richmond Agitation-Sedation Scale (RASS)¹⁷⁴

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-ETT. These patients may still however benefit from the other VAP bundle components.

If a patient is admitted to the ICU without a CASS-ETT, what do we do?

The decision to change a regular ETT to a CASS-ETT 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 VAP¹⁷⁵ against the protective effects of an initial CASS-ETT intubation. We do not have specific evidence about the risk-benefit ratio of electively re-intubating an ICU patient with a CASS-ETT.

I would like to implement the use of CASS-ETT, 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-ETT. 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".⁹¹ 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 two of five patients with the Hi-Lo Evac™, developing laryngeal edema immediately after extubation and requiring reintubation.¹⁷⁶ Whether the CASS-ETT contributed to laryngeal edema alone is not known. Standard ET tubes 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 CASSETT 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-ETT, and reported no more tracheal mucosal injury than that accounted by prolonged intubation.¹⁷⁷ In addition, Dragoumanis et al. identified an impaired ability of CASS-ET Tubes to reliably drain subglottic secretions because of intermittent occlusion of the suction channel.¹⁷⁸

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 ET Tube.

APPENDIX A: Technical Descriptions

The measurement methodology and recommendations regarding sampling size referenced in this GSK, is based on The Model for Improvement and is designed to accelerate the pace of improvement using the PDSA cycle; a "trial and learn" approach to improvement based on the scientific method.¹

It is not intended to provide the same rigor that might be applied in a research study, but rather offers an efficient way to help a team understand how a system is performing. When choosing a sample size for your intervention, it is important to consider the purposes and uses of the data and to acknowledge when reporting that the findings are based on an "x" sample as determined by the team.

The scope or scale² (amount of sampling, testing, or time required) of a test should be decided according to:

1. The team's degree of belief that the change will result in improvement
2. The risks from a failed test
3. Readiness of those who will have to make the change

Please refer to the [Improvement Frameworks GSK \(2015\)](#) for additional information.

1.0 VAP Rate per 1000 Ventilator Days - Worksheet

VAP 1 - VAP Rate in ICU per 1000 Ventilator Days	
Year	Month
<p>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.</p>	
1	Identify the total number of patients this month who received care in selected Intensive Care Units?
2	Subtract the total number of patients in # 1 who did not receive mechanical ventilation while in the ICU and exclude them from patient list for calculating Ventilator-Associated Pneumonia Rate.
3	<p>ADULT population: Subtract the total number of patients in # 2 whose age was less than 18 yrs on admission to the ICU.</p> <p>PAEDIATRIC population: Subtract the total number of patients in # 2 whose age was 18 years or more on admission to the ICU. The result is your patient sample for this month.</p>
4	Calculate the total number of ventilator days (any portion of a day = one day of mechanical ventilation) for all patients remaining in the sample by adding the number of days each patient was mechanically ventilated for the time-period being reported. Enter the total number of days for all patients in the denominator.
Denominator	
5	<p>Detail worksheet (optional)</p> <p>Enter the total number of ventilator days (any portion of a day = one day of mechanical ventilation) for all patients remaining in the sample by adding the number of days each patient was mechanically ventilated.</p>
Numerator	
6	Enter the total number of patients who developed Ventilator-Associated Pneumonia as defined above.
Your Result	
7	<p>Numerator/Denominator x 1000</p> <p>Your Result</p> <p>Goal: Decrease the VAP rate by 50% in one year.</p>

¹ Langley, G., Nolan, K., Nolan, T., Norman, C., Provost, L. The Improvement Guide: A Practical Approach to Enhancing Organizational Performance. San Francisco, Second Edition, CA. Jossey-Bass Publishers. 2009

² Provost, Lloyd P; Murray, Sandra (2011-08-26). The Health Care Data Guide: Learning from Data for Improvement (Kindle Locations 1906-1909). Wiley. Kindle Edition

1.0 VAP Rate per 1000 Ventilator Days - Technical Description

Intervention(s): Prevention of Ventilator-Associated Pneumonia

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 two consecutive days.

Diagnostic criteria are as follows:

a) **Radiographic abnormalities:**

New or progressive, and persistent chest radiographic opacity(ies) compatible with
Pneumonia, e.g. infiltrate, consolidation or cavitation

b) **And at least 1 of the following:**

- WBC \geq 12,000 or $<$ 4,000
- Temperature $>$ 38⁰ C with no other cause

c) **And at least 2 of the following:**

- tracheal secretions: new onset of purulence, or change in character, or increase in volume
- increase in suctioning requirements
- inspiratory crackles (rales) or bronchial breath sounds on auscultation
- Worsening gas exchange (e.g., O₂ desaturations; PaO₂/FiO₂ $<$ 240, an increase in oxygenation or ventilatory requirements

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:

$$\frac{[\text{Number of Ventilator-Associated Pneumonias} / \text{Number of ventilator days}]}{\times 1,000} = \text{VAP rate per 1000 ventilator days}$$

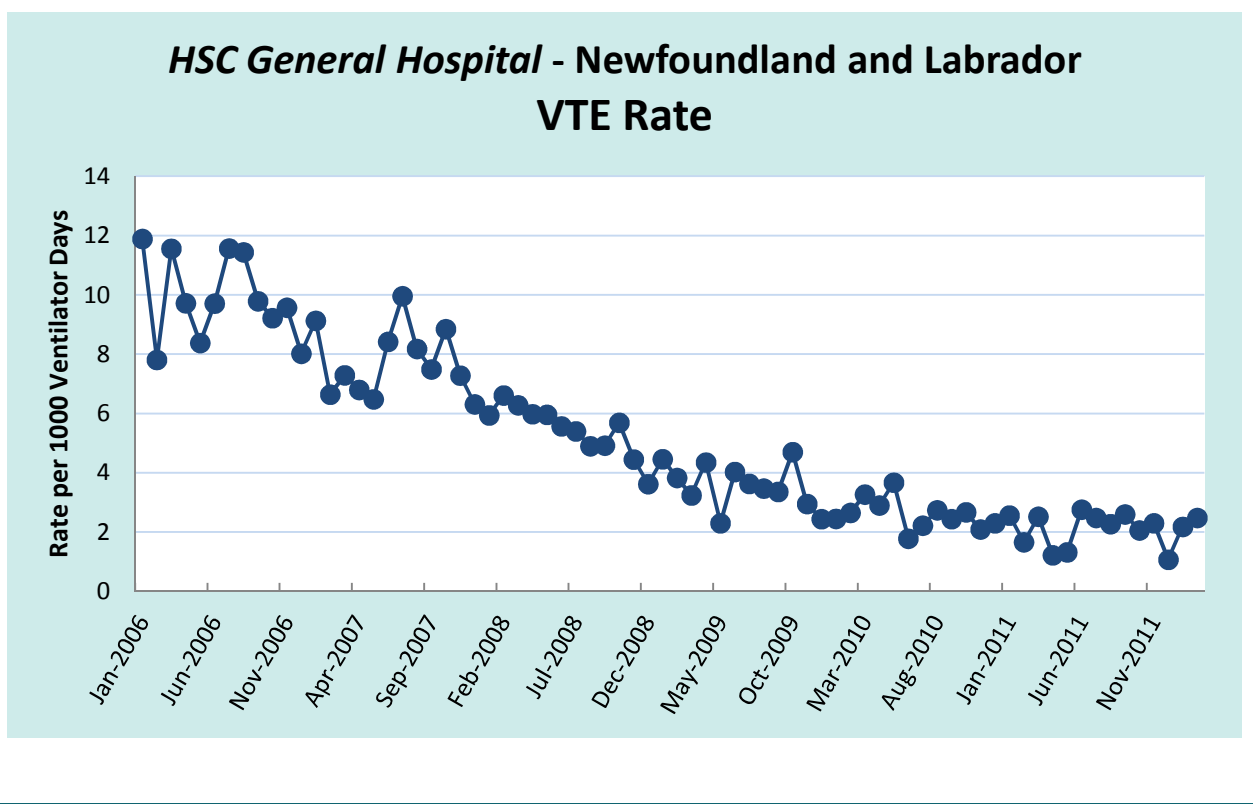
Measurement Period Length: Measure monthly.

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 three 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.



2.0 Adult VAP Bundle Compliance - Worksheet

VAP 2 - Adult VAP Bundle Compliance

Year Month

Effective April 2012 this measure has been revised. See GSK for updated definitions. The percentage of adult 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.

Denominator

1 Enter the total number of patients who received mechanical ventilation in the selected Intensive Care Units included in this sample population.

Numerator

2 Record which of the four VAP bundle elements listed below have been fully implemented in your healthcare facility and would apply to this month's sample:

- 1) Head of bed elevation to 45 degrees when possible, otherwise maintain between 30 and 45 degrees
- 2) Daily evaluation of readiness for extubation
- 3) Initiation of safe enteral nutrition within 24-48h of ICU admission
- 4) The utilization of endotracheal tubes with subglottic secretion drainage (CASS)
- 5) Oral care and decontamination with Chlorhexidine

3 Enter the total number of patients in #1 for whom ALL of the VAP Bundle Checklist Elements listed below which have been implemented in your healthcare facility as recorded in #2, were completed at the time of the survey:

Numerator for Compliance with individual VAP Bundle Elements and automatic calculation

- 4 Enter the total number of patients in #1 that were in compliance with the **Head of bed elevation to 45 degrees when possible, otherwise maintain between 30 and 45 degrees** bundle element.
- 5 Enter the total number of patients in #1 that were in compliance with the **Daily evaluation of readiness for extubation** bundle element.
- 6 Enter the total number of patients in #1 that were in compliance with the **Initiation of safe enteral nutrition within 24-48h of ICU admission** bundle element.
- 7 Enter the total number of patients in #1 that were in compliance with the **Utilization of endotracheal tubes with subglottic secretion drainage (CASS)** bundle element
- 8 Enter the total number of patients in #1 that were in compliance with the **Oral care and decontamination with Chlorhexidine** bundle element

Your Result

9 Numerator/Denominator x 100 = % Your Result

Goal 95% of all patients on mechanical ventilation in the intensive care unit(s) receive all four elements of the VAP Bundle.

3.0 Paediatric VAP Bundle Compliance - Worksheet

– VAP 3 - Paediatric VAP Bundle Compliance

Year Month

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.

Denominator

1 Enter the total number of **Paediatric** patients who received mechanical ventilation in the selected Intensive Care Units included in this sample population.

Numerator

2 Record which of the five Paediatric VAP bundle elements listed below have been fully implemented in your healthcare facility and would apply to this month's sample:

- 1) Head of bed elevation in infants and children
- 2) Proper positioning of oral or nasal gastric tube in infant and children
- 3) Use of oral care in children
- 4) Elimination of the routine use of instil for suctioning for paediatric patients
- 5) Ventilator tubing kept in a dependant position

3 Enter the total number of patients in #1 for whom **ALL** of the Paediatric VAP Bundle Checklist Elements listed below which have been implemented in your healthcare facility as recorded in #2, were completed at the time of the survey:

Numerator for Compliance with individual Paediatric VAP Bundle Elements and automatic calculation

4 Enter the total number of patients in #1 that were in compliance with the **Head of bed elevation in infants and children** bundle element.

5 Enter the total number of patients in #1 that were in compliance with the **Proper positioning of oral or nasal gastric tube in infant and children** bundle element.

6 Enter the total number of patients in #1 that were in compliance with the **Use of oral care in children** bundle element.

7 Enter the total number of patients in #1 that were in compliance with the **Elimination of the routine use of instil for suctioning for paediatric patients** bundle element.

8 Enter the total number of patients in #1 that were in compliance with the **Ventilator tubing kept in a dependant position** bundle element.

Your Result

9 Numerator/Denominator x 100 = % Your Result

Goal 95% of all patients on mechanical ventilation in the intensive care unit(s) receive all four elements of the VAP Bundle.

2.0 ADULT VAP Bundle Compliance

3.0 PAEDIATRIC 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 contraindicated 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**. 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 five **ADULT VAP bundle** elements, unless contra-indicated, are:

1. Elevation of the head of the bed to 45° when possible, otherwise attempt to maintain the head of the bed greater than 30° should be considered
2. Daily evaluation of readiness for extubation.
3. The utilization of endotracheal tubes with subglottic secretion drainage.
4. Oral care and decontamination with Chlorhexidine.
5. Initiation of safe enteral nutrition within 24-48h of ICU admission.

The five **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.

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 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

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.

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: **Time:** **Auditor:**

<input type="text"/> <input type="text"/> - <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> - <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> : <input type="text"/> <input type="text"/>	<input style="width: 100%;" type="text"/>	<input type="checkbox"/> FMC <input type="checkbox"/> PLC <input type="checkbox"/> RGH
DD	MMM	YYYY	24 HH:MM

Patient Information

Hospital ID #: <input style="width: 100%;" type="text"/>	Bed #: <input style="width: 100%;" type="text"/>
--	--

Head of the Bed Elevation

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

<input type="checkbox"/> YES	<input type="checkbox"/> No, but appropriate for the following reason: <input type="checkbox"/> CVS unstable <input type="checkbox"/> Femoral dialysis catheter / CRRT <input type="checkbox"/> Full Spinal precautions <input type="checkbox"/> Undergoing Procedure <input type="checkbox"/> Patient agitated <input type="checkbox"/> Other (specify) _____	<input type="checkbox"/> No, <u>not</u> appropriate
-------------------------------------	--	--

Ventilator Weaning Assessment

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

<input type="checkbox"/> YES	<input type="checkbox"/> No, but appropriate for the following reason: <input type="checkbox"/> ICU extubation pathway exclusion criteria exist <input type="checkbox"/> SBT criteria not met <input type="checkbox"/> Specific weaning plan (trached) <input type="checkbox"/> Other (specify) _____	<input type="checkbox"/> No, <u>not</u> appropriate
-------------------------------------	---	--

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?

<input type="checkbox"/> YES	<input type="checkbox"/> No, but appropriate for the following reason: <input type="checkbox"/> Patient from another region <input type="checkbox"/> < 6.0 ETT <input type="checkbox"/> Patient Trached <input type="checkbox"/> Other (specify) _____	<input type="checkbox"/> No, <u>not</u> appropriate <input type="checkbox"/> Post operative patient <input type="checkbox"/> Intubated via EMS
-------------------------------------	---	---

Use of an Oral Gastric Tube

1. Is there an Oral Gastric Tube insitu?

<input type="checkbox"/> YES	<input type="checkbox"/> No, but appropriate for the following reason: <input type="checkbox"/> < 24 hours from admission <input type="checkbox"/> Silastic Feeding Tube <input type="checkbox"/> Oral trauma preventing placement <input type="checkbox"/> Post oral or esophageal surgery <input type="checkbox"/> Planned extubation (within 24 hours) <input type="checkbox"/> Sutured nasal tube <input type="checkbox"/> Other (specify) _____	<input type="checkbox"/> No, <u>not</u> appropriate
-------------------------------------	---	--

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

(For information purposes only)

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

(NOTE: this is an example based on the 2009 VAP Bundle)

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 <input type="checkbox"/> CRRT Unstable Spines, Thoracic/Lumbar <input type="checkbox"/> Undergoing Procedure <input type="checkbox"/> Other: _____ <input type="checkbox"/> NO No reason documented
----	--

B. Use of an Evac Endotracheal Tube

1.	Is an Evac ETT insitu? <input type="checkbox"/> YES <input type="checkbox"/> NO, appropriate for the following reason: <input type="checkbox"/> Patient from another region <input type="checkbox"/> < 6.0 ETT <input type="checkbox"/> Post-op patient (ICU adm, not predicted) <input type="checkbox"/> Other: _____ <input type="checkbox"/> 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	
	<p>1. Is the patient on DVT Prophylaxis?</p> <p><input type="checkbox"/> YES Indicate what DVT prophylaxis in place:</p> <p style="padding-left: 40px;"><input type="checkbox"/> Heparin/Lovenox <input type="checkbox"/> SCD <input type="checkbox"/> TEDS</p> <p><input type="checkbox"/> NO No reason documented</p>
G Stress Ulcer Prophylaxis	
	<p>1. Is the patient on Stress Ulcer Prophylaxis?</p> <p><input type="checkbox"/> YES <input type="checkbox"/> NO, appropriate for the following reason: _____</p> <p><input type="checkbox"/> NO No reason documented</p>
H 1. Is the patient on enteral feeds?	
	<p><input type="checkbox"/> YES, at target <input type="checkbox"/> YES, not at target</p> <p style="padding-left: 40px;">Indicate why? _____</p> <p><input type="checkbox"/> NO, appropriate for the following reason:</p> <p style="padding-left: 40px;"><input type="checkbox"/> GI rest post surgery/trauma</p> <p style="padding-left: 40px;"><input type="checkbox"/> High residuals</p> <p style="padding-left: 40px;"><input type="checkbox"/> Other _____</p> <p><input type="checkbox"/> NO, No reason documented</p> <p>2. If unable to feed enterally with orogastric tube; is the patient being fed:</p> <p style="padding-left: 40px;"><input type="checkbox"/> With TPN</p> <p style="padding-left: 40px;"><input type="checkbox"/> Not fed, No Reason Given</p>
I 1. Is the patient on glucose monitoring?	
	<p><input type="checkbox"/> YES nomogram</p> <p><input type="checkbox"/> NO, Appropriate for the following reason: _____</p> <p><input type="checkbox"/> NO, No Reason</p>

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 cmH₂O < 22 cmH₂O

If less than 22 cm H₂O, 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 \geq 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)

Daily Goals and VAP Prevention Checklist Jewish General Hospital

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° ?
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	<input type="checkbox"/> Bed-bound/immobilization <input type="checkbox"/> Aspiration/seizure <input type="checkbox"/> Impaired airway reflexes (depressed GCS (non intubated)) <input type="checkbox"/> Shock/resuscitation <input type="checkbox"/> MSOF <input type="checkbox"/> Immunocompromised (systemic corticosteroids, immunosuppressive meds, cirrhosis, diabetes mellitus, chronic hemodialysis) <input type="checkbox"/> Severe malnutrition/anasarca <input type="checkbox"/> Significant cardiopulmonary/neurologic disease <input type="checkbox"/> Hospitalization in last 3 months
POST-OPERATIVE	<input type="checkbox"/> Cardiothoracic surgery <input type="checkbox"/> Upper abdominal surgery <input type="checkbox"/> Neurosurgery
ETTtube	<input type="checkbox"/> Non-oral route <input type="checkbox"/> Not EVAC <input type="checkbox"/> Intubation: traumatic, prolonged, reintubation
PERSONNEL	<input type="checkbox"/> Inadequate hand hygiene <input type="checkbox"/> HOB \leq 30 degrees <input type="checkbox"/> NG tube (ie non-oral route) <input type="checkbox"/> Hardware contamination : Ventilator circuit, oral suction catheter, Yankaur suction <input type="checkbox"/> Non-compliance with CHG oral decontamination <input type="checkbox"/> Transport out of ICU
INFECTION	<input type="checkbox"/> Recent Broad-spectrum antibiotics <input type="checkbox"/> Other nosocomial infection <input type="checkbox"/> 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) \geq 48hrs ¹ ?	CXR compatible with pneumonia ^{2,3}	WBC \geq 12,000 or $<$ 4,000	Fever $>$ 38°C with no other cause	if $>$70 yrs: Altered mental status with no other cause
¹ Intermittently or continuously	² New, worsening or persistent infiltrate, consolidation or cavitation			
<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No

- ➔ 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 present³


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 (↓ Sao ₂ , ↑ O ₂ requirement or ↑ minute ventilation)
<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No

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

Jewish General Hospital, Montréal, Québec
Dept of Adult Critical Care

 HÔPITAL GÉNÉRAL JUJIF 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	
		<input type="checkbox"/>	ICU & CCU - FEEDING TUBES			Ne pas utiliser l'espace ci-dessous si le schéma ci-dessus 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 ₂ O 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			
			<input type="checkbox"/> 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.			
			<input type="checkbox"/> 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	
			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			

APPENDIX D: Criteria for Ventilator Associated Pneumonia (from 2009 PDF version)

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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
New or progressive and persistent infiltrate ²	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Consolidation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cavitation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Pneumatoceles	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

If any of the above findings are present on 2 consecutive days¹ then consider the following criteria:

Worsening gas exchange (O ₂ sat < 94%, ↑ FiO ₂ requirement, ↑ mean airway pressure, or ↑ ventilation)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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If the above is present then consider the following:

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

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

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

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.	10	10	10	10	10	10	10
New or progressive and persistent infiltrate ²	10	10	10	10	10	10	10
Consolidation	10	10	10	10	10	10	10
Cavitation	10	10	10	10	10	10	10
Pneumatoceles	10	10	10	10	10	10	10
If any of the above findings are present on 2 consecutive days¹ then consider the following criteria:							
Worsening gas exchange (O2 sat < 94%, ↑ FiO2 requirement, ↑ mean airway pressure, or ↑ ventilation)	10	10	10	10	10	10	10
If the above is present then consider the following:							
• Temperature instability with no other recognized cause	10	10	10	10	10	10	10
• Leukopenia (< 4 x10 ⁶) or leukocytosis (> 15 x10 ⁶ WBC/L) and left shift (> 10% band forms)	10	10	10	10	10	10	10
• New onset of purulent sputum, ³ or change in character of sputum, ⁴ or ↑ respiratory secretions, or ↑ suctioning requirements	10	10	10	10	10	10	10
• New apnea, tachypnea, ⁵ nasal flaring with retraction of chest wall or grunting	10	10	10	10	10	10	10
• New wheezing, rales, ⁶ or rhonchi	10	10	10	10	10	10	10
• New cough Bradycardia (<100) or tachycardia (> 170 beats/min)	10	10	10	10	10	10	10

NB: Complete clinical criteria part only after x-ray criteria are met. If radiological findings, worsening gas exchange and 3 other clinical findings are present indicates a VAP

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.	10	10	10	10	10	10	10
• New or progressive and persistent infiltrate ²	10	10	10	10	10	10	10
• Consolidation	10	10	10	10	10	10	10
• Cavitation	10	10	10	10	10	10	10
If any of the above findings are present on 2 consecutive days¹ then consider the following criteria:							
• Fever (>38.4°C) or hypothermia (< 36.5°C) with no other recognized cause	10	10	10	10	10	10	10
• Leukopenia (< 4 x10 ⁶) or leukocytosis (> 15 x10 ⁶ WBC/L)	10	10	10	10	10	10	10
• New onset of purulent sputum, ³ change in character of sputum, ⁴ ↑ respiratory secretions, or ↑ suctioning requirements	10	10	10	10	10	10	10
• New onset or worsening cough, dyspnea, apnea, or tachypnea ⁵	10	10	10	10	10	10	10
• New rales, ⁶ or bronchial breath sounds	10	10	10	10	10	10	10
• Worsening gas exchange (O ₂ sat < 94%, ↑ FiO ₂ requirement, ↑ mean airway pressure, or ↑ ventilation)	10	10	10	10	10	10	10

NB: Complete clinical criteria part only after x-ray criteria are met. If radiological findings and 3 clinical findings are present indicates a VAP

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.	10	10	10	10	10	10	10
• New or progressive and persistent infiltrate ²	10	10	10	10	10	10	10
• Consolidation	10	10	10	10	10	10	10
• Cavitation	10	10	10	10	10	10	10
If any of the above findings are present on 2 consecutive days then consider the following criteria:							
Fever (>38.4°C) with no other recognized cause	10	10	10	10	10	10	10
Leukopenia (< 4 x10 ⁶) or leukocytosis (> 12 x10 ⁶ WBC/L)	10	10	10	10	10	10	10
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	10	10	10	10	10	10	10
• New onset or worsening cough, dyspnea, apnea, or tachypnea ⁵	10	10	10	10	10	10	10
• New rales, ⁶ or bronchial breath sounds	10	10	10	10	10	10	10
• Worsening gas exchange (O ₂ sat < 94%, ↑ FiO ₂ requirement, ↑ mean airway pressure, or ↑ ventilation)	10	10	10	10	10	10	10
NB: Complete clinical criteria part only after x-ray criteria are met. If radiology findings plus 1 clinical criteria from each of the other sections are present indicates a VAP							

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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
New or progressive and persistent infiltrate ²	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Consolidation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cavitation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

If any of the above findings are present on 2 consecutive days¹ then consider the following criteria:

Fever (>38.4°C) with no other recognized cause	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Leukopenia (< 4 x10 ⁶) or leukocytosis (> 12 x10 ⁶ WBC/L)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

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	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
New onset or worsening cough, dyspnea, apnea, or tachypnea ⁵	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
New rales, ⁶ or bronchial breath sounds	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Worsening gas exchange (O ₂ sat < 94%, ↑ FiO ₂ requirement, ↑ mean airway pressure, or ↑ ventilation)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

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

If radiology findings plus 1 clinical criteria 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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