



# Getting Started Kit: Prevent Ventilator- Associated Pneumonia

## How-to Guide

### **100,000 Lives Campaign**

We invite you to join a Campaign to make health care safer and more effective — to ensure that hospitals achieve the best possible outcomes for all patients. The Institute for Healthcare Improvement (IHI) and other organizations that share our mission are convinced that a remarkably few proven interventions, implemented on a wide enough scale, can avoid 100,000 deaths between January 2005 and July 2006, and every year thereafter. Complete details, including materials, contact information for experts, and web discussions, are available on the web at <http://www.ihl.org/IHI/Programs/Campaign/>.

This document is in the public domain and may be used and reprinted without permission provided appropriate reference is made to the Institute for Healthcare Improvement.

**Goal:**

Prevent ventilator-associated pneumonia by implementing the four components of care called “the ventilator bundle.”

**The Case for Preventing Ventilator-Associated Pneumonia**

By definition, ventilator-associated pneumonia (VAP) is an airway infection that developed more than 48 hours after the patient was intubated. Preventing pneumonia of any variety seems at first blush to be a laudable goal. However, there are some reasons to be particularly concerned about the impact of pneumonia associated with ventilator use.

- VAP is the leading cause of death among hospital-acquired infections, exceeding the rate of death due to central line infections, severe sepsis, and respiratory tract infections in the non-intubated patient. Perhaps the most concerning aspect of VAP is the high rate of associated mortality. Hospital mortality of ventilated patients who develop VAP is 46%, compared to 32% for ventilated patients who do not develop VAP.

Ibrahim EH, Tracy L, Hill C, et al. The occurrence of ventilator-associated pneumonia in a community hospital: risk factors and clinical outcomes. *Chest*. 2001;20(2):555-561.

- In addition, VAP prolongs time spent on the ventilator, length of ICU stay, and length of hospital stay after discharge from the ICU.

Rello J, Ollendorf DA, Oster G, et al. VAP Outcomes Scientific Advisory Group. Epidemiology and outcomes of ventilator-associated pneumonia in a large US database. *Chest*. 2002;22(6):2115-2121.

- Strikingly, VAP adds an estimated cost of \$40,000 to a typical hospital admission.

Tablan OC, Anderson LJ, Besser R, et al. CDC; Healthcare Infection Control Practices Advisory Committee. Guidelines for preventing health-care-associated pneumonia, 2003: recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee. *MMWR Recomm Rep*. 2004;53(RR-3):1-36.

## **The Ventilator Bundle**

Care bundles, in general, are groupings of best practices with respect to a disease process that individually improve care, but when applied together result in substantially greater improvement. The science supporting each bundle component is sufficiently established to be considered the standard of care.

The ventilator bundle is a group of evidence-based practices that, when implemented together for all patients on mechanical ventilation, result in dramatic reductions in the incidence of ventilator-associated pneumonia.

The ventilator bundle has four key components:

1. Elevation of the head of the bed to between 30 and 45 degrees
2. Daily “sedation vacation” and daily assessment of readiness to extubate
3. Peptic ulcer disease (PUD) prophylaxis
4. Deep venous thrombosis (DVT) prophylaxis (unless contraindicated)

Compliance with the ventilator 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.

### **Potential Impact of the Ventilator Bundle**

Applying IHI's ventilator bundle in the care of ventilated patients can markedly reduce the incidence of VAP. We have observed an average 45% reduction in the incidence of VAP in a recent ICU collaborative improvement project at IHI. Moreover, there is a trend toward greater success among teams that comply more fully with the terms of the bundle. That is, teams that unfailingly accomplish **every bundle element on every patient every time** have gone months without a single case of pneumonia associated with the ventilator.

The reasons for the success are most likely due to the effect of the underlying interventions either alone or as a group. In a randomized controlled trial of 86 intubated patients on mechanical ventilation assigned to semi-recumbent (45 degrees) or supine position, there were 18% fewer confirmed cases of VAP ( $p=0.018$ ).

Drakulovic MB, Torres A, Bauer TT, et al. Supine body position as a risk factor for nosocomial pneumonia in mechanically ventilated patients: a randomised trial. *Lancet*. 1999;354(9193):1851-1858.

In another study, Kress et al. were able to demonstrate that in 128 adults on mechanical ventilation randomized to daily interruption of sedation until the patient was awake or interruption at the clinician's discretion, the duration of ventilation was decreased from 7.3 days to 4.9 days ( $p=0.004$ ).

Kress JP, Pohlman AS, O'Connor MF, et al. Daily interruption of sedative infusions in critically ill patients undergoing mechanical ventilation. *N Engl J Med*. 2000;342(20):1471-1477.

These findings and others have contributed to the construction of the ventilator bundle and to its success in preventing VAP.

## Preventing Ventilator-Associated Pneumonia: Four Components of Care

### 1. Elevation of the Head of the Bed

Elevation of the head of the bed is an integral part of the ventilator bundle and has been correlated with reduction in the rate of ventilator-associated pneumonia. The recommended elevation is 30-45 degrees.

Drakulovic et al. conducted a randomized controlled trial in 86 mechanically ventilated patients assigned to semi-recumbent or supine body position. The trial demonstrated that suspected cases of ventilator-associated pneumonia had an incidence of 34 percent, while in the semi-recumbent position suspected cases had an incidence of 8 percent ( $p=0.003$ ). Similarly, confirmed cases were 23 percent and 5 percent respectively ( $p=0.018$ ).

Drakulovic MB, Torres A, Bauer TT, Nicolas JM, Nogue S, Ferrer M. Supine body position as a risk factor for nosocomial pneumonia in mechanically ventilated patients: a randomised trial. *Lancet*. Nov 27 1999;354(9193):1851-1858.

While it is not immediately clear whether the intervention aids in the prevention of ventilator-associated pneumonia by decreasing the risk of aspiration of gastrointestinal contents or oropharyngeal and nasopharyngeal secretions, this was the ostensible reason for the initial recommendation.

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

Some concerns with regard to this position have included patients sliding down in bed and, if skin integrity is compromised, shearing of skin. Others have commented on the possibility of patient discomfort. Although it is difficult to

**100,000 Lives Campaign**  
**How-to Guide: Prevent Ventilator-Associated Pneumonia**

assess for these concerns in a controlled manner, anecdotal experience is that neither has been a complaint of care providers or patients when able to speak off the ventilator.

» **What changes can we make that will result in improvement?**

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

- Implement a mechanism to ensure head-of-the-bed elevation, such as including this intervention on nursing flow sheets and as a topic at multidisciplinary rounds.
- Create an environment where respiratory therapy is encouraged to notify nursing if the head of the bed is not elevated; alternately, empower respiratory therapists to carefully place the patient in this position with nursing assistance.
- Include this intervention on order sets for initiation and weaning of mechanical ventilation, delivery of tube feedings, and provision of oral care.
- Post compliance with the intervention in a prominent place in your ICU to encourage change and motivate staff.

## Preventing Ventilator-Associated Pneumonia: Four Components of Care

### 2. Daily “Sedation Vacation” and Daily Assessment of Readiness to Extubate

Using daily "sedation vacations" and assessing the patient's readiness to extubate are an integral part of the ventilator bundle and have been correlated with reduction in the rate of ventilator-associated pneumonia.

Kress et al. conducted a randomized controlled trial in 128 adult patients on mechanical ventilation, randomized to daily interruption of sedation irrespective of clinical state or interruption at the clinician's discretion. Daily interruption resulted in a marked and highly significant reduction in time on mechanical ventilation. The duration of mechanical ventilation decreased from 7.3 days to 4.9 days (p=0.004).

Kress JP, Pohlman AS, O'Connor MF, Hall JB. Daily interruption of sedative infusions in critically ill patients undergoing mechanical ventilation. *N Engl J Med.* 2000;342(20):1471-1477.

It appears that lightening sedation decreases the amount of time spent on mechanical ventilation and therefore the risk of ventilator-associated pneumonia. In addition, weaning patients from ventilators becomes easier when patients are able to assist themselves at extubation with coughing and control of secretions.

Sedation vacations are not without risks, however. Patients who are not sedated as deeply will have an increased potential for self-extubation. Therefore, the maneuver must be conducted in a careful fashion. In addition, there may be an increased potential for pain and anxiety associated with lightening sedation. Lastly, increased tone and poor synchrony with the ventilator during the maneuver may risk episodes of desaturation.

» **What changes can we make that will result in improvement?**

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

- Implement a protocol to lighten sedation daily at an appropriate time to assess for neurological readiness to extubate. Include precautions to prevent self-extubation such as increased monitoring and vigilance during the trial.
- Include a sedation vacation strategy in your overall plan to wean the patient from the ventilator; if you have a weaning protocol, add sedation vacation to that strategy.
- Assess compliance each day on multidisciplinary rounds.
- Consider implementation of a sedation scale such as the Riker scale to avoid over-sedation.
- Post compliance with the intervention in a prominent place in your ICU to encourage change and motivate staff.

## Preventing Ventilator-Associated Pneumonia: Four Components of Care

### 3. Peptic Ulcer Disease (PUD) Prophylaxis

Applying peptic ulcer disease prophylaxis is an appropriate intervention in all patients who are sedentary; however, the higher incidence of stress ulceration in critical illness justifies greater vigilance. In addition, decreasing the pH of gastric contents may protect against a greater pulmonary inflammatory response to aspiration of gastrointestinal contents.

Aspiration causes either pneumonitis or pneumonia and can be prevented. The effects of aspirating acidic contents may be worse than those with a higher pH. Although some studies have shown increased risks of VAP with certain agents, such as sucralfate, others have not shown this association. In addition, the extent to which reflux of gastric contents and secretions occurs even in healthy individuals suggests that these critically ill patients are susceptible to aspiration events. Critically ill intubated patients lack the ability to defend their airway.

The Surviving Sepsis Campaign Guidelines were produced after a thorough review of the literature, including peptic ulcer disease prophylaxis. They conclude, “H2 receptor inhibitors are more efficacious than sucralfate and are the preferred agents. Proton pump inhibitors have not been assessed in a direct comparison with H2 receptor antagonists and, therefore, their relative efficacy is unknown. They do demonstrate equivalency in ability to increase gastric pH.”

Dellinger RP, Carlet JM, Masur H, et al. Surviving Sepsis Campaign guidelines for management of severe sepsis and septic shock. *Crit Care Med.* Mar 2004;32(3):858-873.

While it is unclear if there is any association between PUD prophylaxis and decreasing rates of ventilator-associated pneumonia, our experience is that when PUD prophylaxis is applied as part of a package of interventions for ventilator care, the rate of pneumonia decreases precipitously. The intervention remains excellent practice in the general care of ventilated patients.

**100,000 Lives Campaign**  
**How-to Guide: Prevent Ventilator-Associated Pneumonia**

» **What changes can we make that will result in improvement?**

Hospital teams across the United States have developed and tested process and system changes that allowed them to improve performance on peptic ulcer disease prophylaxis. These measures, taken together, support the implementation of the ventilator bundle. Some of these changes are:

- Include peptic ulcer disease prophylaxis as part of your ICU order admission set and ventilator order set. Make application of prophylaxis the default value on the form.
- Include peptic ulcer disease prophylaxis as an item for discussion on daily multidisciplinary rounds.
- Empower pharmacy to review orders for patients in the ICU to ensure that some form of peptic ulcer disease prophylaxis is in place at all times on ICU patients.
- Post compliance with the intervention in a prominent place in your ICU to encourage change and motivate staff.

## **Preventing Ventilator-Associated Pneumonia: Four Components of Care**

### **4. Deep Venous Thrombosis (DVT) Prophylaxis**

Applying deep venous thrombosis prophylaxis is an appropriate intervention in all patients who are sedentary; however, the higher incidence of deep venous thrombosis in critical illness justifies greater vigilance.

The risk of venous thromboembolism is reduced if prophylaxis is consistently applied. A clinical practice guideline issued as part of the Seventh American College of Chest Physicians Conference on Antithrombotic and Thrombolytic Therapy recommends prophylaxis for patients undergoing surgery, trauma patients, acutely ill medical patients, and patients admitted to the intensive care unit. The level of cited evidence was that of several randomized control trials.

Geerts WH, Pineo GF, Heit JA, et al. Prevention of venous thromboembolism: the Seventh ACCP Conference on Antithrombotic and Thrombolytic Therapy. *Chest*. Sep 2004;126(3 Suppl):338S-400S.

While it is unclear if there is any association between DVT prophylaxis and decreasing rates of ventilator-associated pneumonia, our experience is that when DVT prophylaxis is applied as part of a package of interventions for ventilator care, the rate of pneumonia decreases precipitously. The intervention remains excellent practice in the general care of ventilated patients.

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

» **What changes can we make that will result in improvement?**

Hospital teams across the United States have developed and tested process and system changes that allowed them to improve performance on deep venous thrombosis prophylaxis. These measures, taken together, support the implementation of the ventilator bundle. Some of these changes are:

- Include deep venous thrombosis prophylaxis as part of your ICU order admission set and ventilator order set. Make application of prophylaxis the default value on the form.
- Include deep venous thrombosis prophylaxis as an item for discussion on daily multidisciplinary rounds.
- Empower pharmacy to review orders for patients in the ICU to ensure that some form of deep venous thrombosis prophylaxis is in place at all times on ICU patients.
- Post compliance with the intervention in a prominent place in your ICU to encourage change and motivate staff.

## **Forming the Team**

IHI 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 should include intensive care physicians, intensive care nurses, respiratory therapists, and 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 therapists 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 using data to define and solve the problem; finding champions within the hospital who are of sufficiently high profile to lend the effort immediate credibility; and working with those who want to work on the project, rather than trying to convince those who do not.

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 re-addresses 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.

## **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; so is allocating the people and resources necessary to accomplish the aim.

An example of an aim that would be appropriate for reducing ventilator-associated pneumonia can be as simple as, “Decrease the rate of VAP by 50 percent 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.

## **Using the Model for Improvement**

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

The model has two parts:

- Three fundamental questions that guide improvement teams to 1) set clear aims, 2) establish measures that will tell if changes are leading to improvement, and 3) identify changes that are likely to lead to improvement.
  
- The Plan-Do-Study-Act (PDSA) cycle to conduct small-scale tests of change in real work settings — by planning a test, trying it, observing the results, and acting on what is learned. This is the scientific method, used for action-oriented learning.

Implementation: After testing a change on a small scale, learning from each test, and refining the change through several PDSA cycles, the team can implement the change on a broader scale — for example, test medication reconciliation on admissions first.

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](http://www.IHI.org)

## **Getting Started**

Hospitals will not successfully implement the ventilator 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 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 ventilator bundle to the key stakeholders in the process.

### **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.
- Work with each nurse and respiratory therapist who cares for the patient to be sure they are able to follow the demands of the bundle.
- Make sure that the approach is carried over from shift to shift, to eliminate gaps in teaching and utilization.
- Process feedback and incorporate suggestions for improvement.
- Once the bundle has been applied to one patient, increase utilization to the remainder of the ICU.
- Engage in subsequent PDSA cycles to refine the process and make it more reliable.

## **Measurement**

There is only one way to know if a change represents an improvement: measurement.

See measurement information forms for specific information regarding the recommended process and outcomes measures for preventing ventilator-associated pneumonia. (Appendix B).

### **1. VAP Rate**

The total number of cases of ventilator-associated pneumonia for a particular time period.

For example, if in February there were 12 cases of VAP, the number of cases would be 12 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. Thus, if 25 patients were ventilated during the month and each, for purposes of example, was on mechanical ventilation for 3 days, the number of ventilator days would be  $25 \times 3 = 75$ . The Ventilator-Associated Pneumonia Rate per 1000 ventilator days then would be  $12/75 \times 1000 = 160$ .

$(\text{Total no. of VAP Cases} / \text{Ventilator Days}) \times 1000 = \text{VAP Rate}$

### **2. Ventilator Bundle Compliance**

In our experience, teams begin to demonstrate improvement in outcomes when they provide all four components of the ventilator bundle. Therefore, we choose to measure compliance with the entire ventilator bundle, not just parts of the bundle.

**100,000 Lives Campaign**  
**How-to Guide: Prevent Ventilator-Associated Pneumonia**

On a given day, select all the ventilated patients and assess them for compliance with the ventilator bundle. If even one bundle component is missing, the case is not in compliance with the bundle. For example, if there are 7 ventilated patients, and 6 have all 4 bundle elements completed, then 6/7 (86%) is the compliance with the ventilator bundle. If all 7 had all 4 elements completed, compliance would be 100%. If all seven were missing even a single item, compliance would be 0%.

$$\frac{\text{No. receiving ALL 4 components of vent bundle}}{\text{No. on ventilators for the day of the sample}} = \text{reliability of bundle compliance}$$

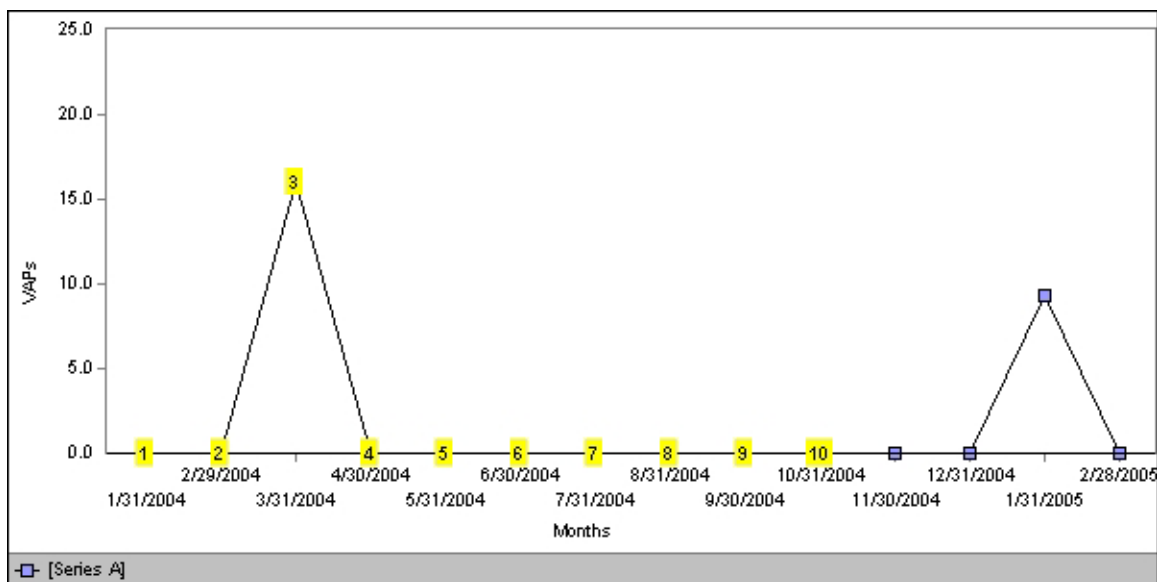
### Track Measures over Time

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: Our Lady of Lourdes Hospital, Binghamton, NY

Using the ventilator bundle, this hospital went 290 days with a VAP rate of zero (from March 2004 to January 2005). They had one VAP case in January 2005 and have, as of February 28, 2005, gone an additional 48 days with a VAP rate of zero. The Y axis shows the VAP rate per 1,000 ventilator days.



## 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 and staff “partial buy-in”** (i.e., “Just another flavor of the week?”)

In order to enlist support and engage staff, it is important to share baseline data on VAP rates and to share the results of improvement efforts. If the run charts suggest a large decrease in VAP compared to baseline, issues surrounding “buy-in” tend to fade.

- **Unplanned extubations**

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

### **Work To Achieve a High Level of Compliance**

Our analysis of the hospitals that have used the ventilator bundle to date shows that the greater the level of compliance with *all* of the items in the bundle, the better the reduction in the VAP rate.

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

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

### **Tips for Gathering Data**

Use a data collection form that 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. One hospital, Dominican Hospital (Santa Cruz, CA), uses a Ventilator Bundle Checklist to help track the process. (See Appendix A.) 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. (See Appendix A.)

APPENDIX A

**VENTILATOR BUNDLE CHECKLIST**  
 (Individual Patient)

Patient: \_\_\_\_\_

Admit Date: \_\_\_\_\_

**ICU Day**

	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>
<b>1. Head of the Bed 30<sup>o</sup></b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>2. Daily Sedation Vacation and daily assessment of readiness to extubate</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>3. PUD Prophylaxis</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>4. DVT Prophylaxis</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

\*Adapted from a tool created by Dominical Hospital (Santa Cruz, CA)



**VENTILATOR BUNDLE CHECKLIST (SAMPLE)**

Date	Bed/Pt Initials	HOB 30°	Sedation Vacation and Assessment of Readiness to Extubate	PUD Prophylaxis	DVT Prophylaxis
9/25	1206 D. O.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	1208 M. H.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	1214 M. K.	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
9/26	1206 D. O.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	1208 M. H.	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

\*Adapted from a tool created by Dominical Hospital (Santa Cruz, CA)

**100,000 Lives Campaign  
How-to Guide: Prevent Ventilator-Associated Pneumonia**

**Daily Goals**

Patient Name \_\_\_\_\_  
Room Number \_\_\_\_\_

Date \_\_\_\_/\_\_\_\_/\_\_\_\_

---Initial as goals are reviewed ---

<b>GOAL</b>	<b>NOTES</b>	<b>0700-1500</b>	<b>1500-2300</b>	<b>2300-0700</b>
What needs to be done for the patient to be discharged from the ICU?				
What is this patient's greatest safety risk?				
Pulmonary/Ventilator: HOB 30 degrees or greater				
Sedation Vacation and Assessment of Readiness to Extubate				
PUD Prophylaxis				
DVT Prophylaxis				
Cardiac Rhythm, Hemodynamics				
Volume Status, net goal for 12 MN				
Neuro/Pain Mgt/Sedation				
GI/ Nutrition/Bowel Regimen				
Mobilization/OOB				
ID, Cultures, Drug levels				
Medication changes (Can any be discontinued?)				
Tests/Procedures Today				
Review scheduled labs. Can any be discontinued?				
Morning labs and PCXR				
Consultations				
Can any catheters/tubes be DC'd?				
Attending up to date?				
Family Updated?				
Any social issues to address?				
Emotional/spiritual issues addressed?				
Skin Care Addressed?				
Code Status Addressed?				
Advanced Directive in place?				
Parameters for calling MD				

\*Adapted from the Johns Hopkins University Quality & Safety Research Group Tool Kit

APPENDIX B

**Measure Information Form:**  
**Ventilator-Associated Pneumonia (VAP) Rate in ICU**  
**per 1000 Ventilator Days**

**Intervention(s):** Prevention of Ventilator-Associated Pneumonia

**Definition:** The number of ventilator-associated pneumonias per 1000 ventilator days is the standard measure for surveillance by the CDC. The specific surveillance criteria are outlined in the CDC Guidelines: *MMWR* Mar 26, 2004; 53(RR-3):1-179 and in Gaynes RP, Horan TC. Surveillance of nosocomial infections. In: Mayhall CG, editor. *Hospital epidemiology and infection control*. 2<sup>nd</sup> ed. Philadelphia; Lippincott Williams and Wilkins; 1999, pp. 1285-331.

**Goal:** Decrease the VAP rate by 50% in one year.

**Matches Existing Measures:**

- CDC

**CALCULATION DETAILS:**

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

**Numerator Exclusions:**

- Same as the denominator

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

**Denominator Exclusions:**

- Patients less than 18 years of age at the date of ICU admission
- Patients with documentation of contraindication for any of the components of the Prevention of Ventilator-Associated Pneumonia bundle, as defined by JCAHO.

**Measurement Period Length:** Measure monthly.

**Definition of Terms:**

- **Ventilator-Associated Pneumonia:** Nosocomial pneumonia in a patient on mechanical ventilatory support (by endotracheal tube or tracheostomy) for greater than or equal to 48 hours
- **Ventilator Day:** Total number of days of exposure to ventilators by all patients in the selected population during the selected time period

**100,000 Lives Campaign**  
**How-to Guide: Prevent Ventilator-Associated Pneumonia**

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

**Comments:** Please see CDC guidelines for more specific information.

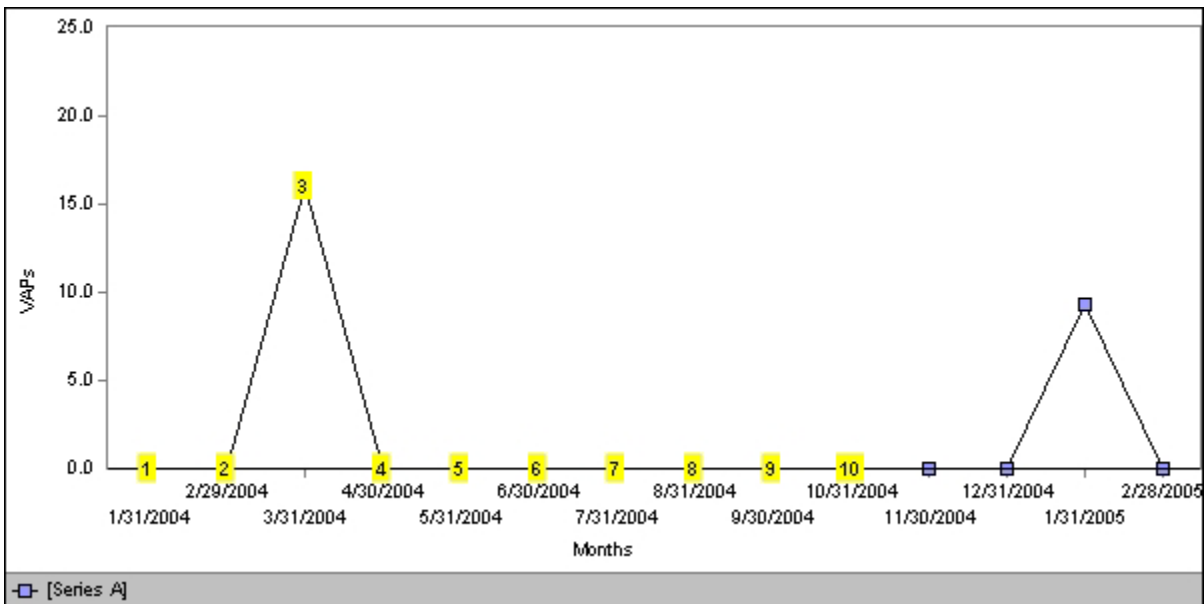
**COLLECTION STRATEGY:**

**Sampling Plan:** Report the monthly VAP rate for the last several months (preferably all of 2004). This will serve as your baseline. Continue to track the measure monthly. If possible, track the rate in an annotated run chart, with notes reflecting any interventions you made to improve.

If your organization’s infection control practitioner reports data quarterly, we strongly encourage you to disaggregate this data and report monthly.

**SAMPLE GRAPH:**

**Y axis = VAP rate per 1000 ventilator days**



**DATA COLLECTION AND ANALYSIS TOOLS:**

**Measure Rate Worksheet**  
**Ventilator-Associated Pneumonia (VAP) Rate in ICU**  
**per 1000 Ventilator Days**

1. What is the total number of patients in the previous month who received care in Intensive Care Units? \_\_\_\_\_
2. What is the total number of patients in #1 above who did not receive mechanical ventilation? \_\_\_\_
3. Subtract the answer to #2 from the answer to #1 and enter here. \_\_\_\_
4. What is the total number of patients in #3 above whose age was < 18 years on admission to the ICU? \_\_\_\_\_
5. Subtract the answer to #4 from the answer to #3 and enter here. \_\_\_\_
6. What is the total number of days of exposure to ventilators by all patients in #5 above? \_\_\_\_

**This is the denominator for this measure.**

---

7. What is the total number of patients in #6 who developed **Ventilator-Associated Pneumonia** (i.e., nosocomial pneumonia in a patient on mechanical ventilatory support (by endotracheal tube or tracheostomy) for greater than or equal to 48 hours)? \_\_\_\_\_

**This is the numerator for this measure.**

## **Measure Information Form: Ventilator Bundle Compliance**

**Intervention(s):** Prevention of Ventilator-Associated Pneumonia

**Definition:** The percentage of intensive care patients on mechanical ventilation for whom all four elements of the ventilator “bundle” are implemented and documented on the daily goals sheet and/or elsewhere in medical record

**Goal:** 95% of all patients on mechanical ventilation in the intensive care unit(s) receive all four elements of the ventilator bundle. Historically, this level of reliability has been achieved by building an infrastructure using multidisciplinary rounds and daily goals.

**Matches Existing Measures:** JCAHO ICU-1, ICU-2, ICU-3 recommendations. In addition, a fourth component that the JCAHO measures do not include, “Daily sedation vacation and daily assessment of readiness to extubate,” has been included. This bundle measure uses an “all or nothing” approach, which differs from JCAHO data collection.

### **CALCULATION DETAILS:**

**Numerator Definition:** Number of intensive care unit patients on mechanical ventilation at time of survey for whom all four elements of the ventilator bundle are documented and in place. The ventilator bundle elements are:

- Head of bed elevation 30 degrees or greater (JCAHO, ICU-1)
- Daily “sedation vacation” and daily assessment of readiness to extubate
- PUD (peptic ulcer disease) prophylaxis (JCAHO, ICU-2: stress ulcer disease)
- DVT (deep venous thrombosis) prophylaxis (JCAHO, ICU-3)

JCAHO definitions and guidelines should be followed for measures corresponding to JCAHO ICU-1-3.

NOTE: This is an “all or nothing” indicator. If any of the elements are not documented, do not count the patient in the numerator. If a bundle element is contraindicated for a particular patient (as defined by JCAHO ICU-1-3) and this is documented appropriately in the medical record, then the bundle can still be considered compliant with regard to that element.

**Numerator Exclusions:**

- Same as the denominator

**Denominator Definition:** Total number of intensive care unit patients on mechanical ventilation

**100,000 Lives Campaign**  
**How-to Guide: Prevent Ventilator-Associated Pneumonia**

**Denominator Exclusions:**

- Patients less than 18 years of age at the date of ICU admission

**Measurement Period Length:** Weekly sample of mechanically ventilated patients. Rotate the day and time of weekly survey. This is an on-going weekly measure.

**Definition of Terms:**

- **Ventilator 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.
- **Head-of-the-Bed Elevation 30 Degrees or Greater** – Head of the bed elevated for the majority of the day (unless medically contraindicated). It is understood that patients might be cared for at different bed angles during different times of the day, and that continuous monitoring of bed angles is impossible. Therefore, to implement this measure, the ventilator patient in the intensive care unit must be monitored at least two times in a 24-hour period to see if the head of the bed is elevated to 30 degrees or greater. The observations should coincide with the structure of the ICU shifts and one observation should be made on at least two different shifts within the 24 hour period. It is recommended that there be a minimum of 8 hours between observations. In order to achieve the most valid results, it is suggested that a pre-determined schedule be devised. The schedule may or may not be random, but should ensure that equal numbers of observations are made during each day of the week.
- **Daily “Sedation Vacation” and Daily Assessment of Readiness to Extubate** – Process in which patient sedation is interrupted until the patient follows commands and patient is assessed for discontinuation of mechanical ventilation
  - Parameters around the assessment of readiness to extubate include:
    - Resolution of reason for intubation
    - Inspired oxygen content roughly 40%
    - Assessment of patients ability to defend airway after extubation due to heavy sedation during intubation
    - Minute ventilation less than or equal to 15 liters/minute
    - Respiratory rate / tidal volume less than or equal to 105/min/L (RR/TV  $\leq$  105)
- **DVT Prophylaxis** – Either with drugs or appropriately used mechanical devices
- **PUD Prophylaxis** – Drugs with a preference for sucralfate

**100,000 Lives Campaign**  
**How-to Guide: Prevent Ventilator-Associated Pneumonia**

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

**Comments:** Incorporating the four elements of the ventilator 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:**

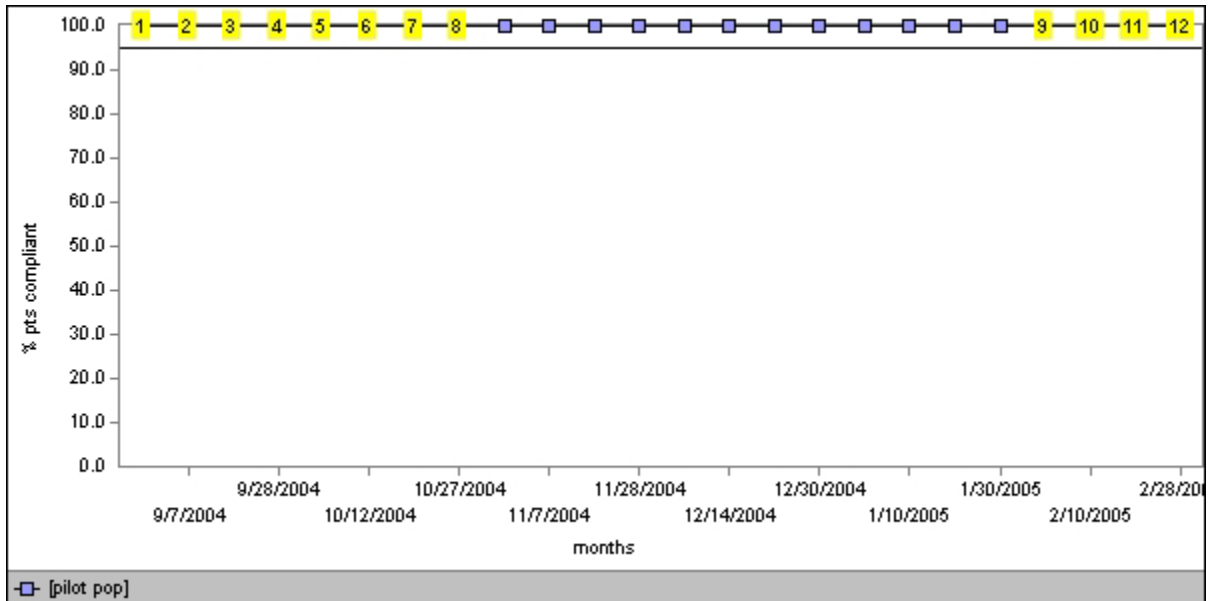
Use a daily goal sheet and/or medical record as data source. Review for implementation of the ventilator bundle. Compliance with head-of-the-bed elevation can also be checked visually.

The sample should include all patients on mechanical ventilation in the intensive care unit(s). Only patients with all four aspects of ventilator bundle in place are recorded as being in compliance with the ventilator bundle.

**Sampling Plan:** Conduct the sample one day per week. This is a weekly compliance measure. 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. Team may more easily sample 100% of patients if they have a rounding system in place and can collect information as part of rounds.

**100,000 Lives Campaign  
How-to Guide: Prevent Ventilator-Associated Pneumonia**

**SAMPLE GRAPH:**



**DATA COLLECTION AND ANALYSIS TOOLS:**

**100,000 Lives Campaign**  
**How-to Guide: Prevent Ventilator-Associated Pneumonia**

**Measure Rate Worksheet**  
**Ventilator Bundle Compliance**  
**(Incorporates JCAHO ICU-1 – ICU-3)**

1. What is the total number of patients in the previous month who received care in Intensive Care Units? \_\_\_\_\_
2. What is the total number of patients in #1 above who did not receive mechanical ventilation? \_\_\_\_
3. Subtract the answer to #2 from the answer to #1 and enter here. \_\_\_\_
4. What is the total number of patients in #3 above whose age was < 18 years on admission to the ICU? \_\_\_\_\_
5. Subtract the answer to #4 from the answer to #3 and enter here. \_\_\_\_  
**This is the denominator for this measure.**

- 
6. What is the total number of patients in #5 for whom **all** of the following elements were in place at the time of survey? (JCAHO definitions and guidelines should be followed for measures corresponding to JCAHO ICU-1 - ICU-3. Guidelines can be accessed online at <http://www.jcaho.org/pms/core+measures/icu+manual.htm>) \_\_\_\_\_  
**This is the numerator for this measure.**

Head of bed elevation over 30 degrees (JCAHO, ICU-1)

**-AND-**

Daily “sedation vacation” and daily assessment of readiness to extubate.  
Guidelines can be accessed online at  
<http://www.ihl.org/NR/rdonlyres/A448DDB1-E2A4-4D13-8F02-16417EC52990/0/VAPGettingHowtoGuideFINAL.pdf>

**-AND-**

PUD (peptic ulcer disease) prophylaxis (JCAHO, ICU-2: stress ulcer disease)

**-AND-**

DVT (deep venous thrombosis) prophylaxis (JCAHO, ICU-3)