How to use this guide
This guide gives actions and resources for creating and sustaining safe practices for VAP.
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Executive Summary

The Problem
Ventilator-Associated Pneumonia (VAP) is the leading cause of death associated with healthcare-associated infections (HAIs) (IHI, 2012). With 300,000 cases of VAP annually in the U.S., this preventable illness is estimated to cost $50,000 per patient (Fraser et al., 2008). In addition to being the second most common nosocomial infection worldwide, VAP is the most life threatening (Timsit et al., 2017). Prevention of VAP is inexpensive and could save up to $1.5 billion per year (Scott, 2009).

The Cost
VAP mortality ranges between 20% and 60%, with an annual incidence of 4% to 48% (Cook, 1998; Heyland et al., 1999). Patients who acquire VAP have significantly longer durations of mechanical ventilation and a longer stay in the ICU (Rello et al., 2002). VAP cases account for 250,000 annual infections in U.S. hospitals, costing $9,966 per infection in the hospital, and resulting in an annual mean of 35,967 deaths per year (NCBI). In the US, the incidence of VAP ranges from 2 to 16 episodes per 1,000 ventilator-days (Timsit et al., 2017). In the UK, the cost of treating VAP patients was significantly higher than for patients without VAP. This resulted in an additional cost of £8829 per patient when VAP occurred. The average ICU stay was significantly different between patients with VAP and patients without VAP, at 7.8 and 2.9 days respectively (Luckraz et al., 2018).

The Solution
Many healthcare organizations have successfully implemented and sustained improvements and reduced death from VAP. These organizations have focused on projects that included implementing a ventilator “bundle”, with the additional effects of increasing patient satisfaction, improving clinician engagement, and growing the financial bottom line.

This document provides a blueprint that outlines the actionable steps organizations should take to successfully reduce VAP and summarizes the available evidence-based practice protocols. This document is revised annually and is always available free of charge on our website. Hospitals who make a formal commitment to improve VAP and share their successes on the PSMF website have access to an additional level of consulting services.
Leadership Checklist

On a monthly basis, or more frequently if a problem exists, the executive team should review the outcomes of patients who are placed on a ventilator for any duration of time (outside anesthesia). Use this checklist as a guide to determine whether current evidence-based guidelines are being followed in your organization:

- Measure and report VAP incidence monthly (Ventilator-associated pneumonia infections/Ventilator-days). Note trends in areas with low compliance and high VAP incidence. Routinely reassess outcomes.
- If VAP rates indicate room for improvement, initiate a PI (performance improvement) project. If a problem is not indicated, routinely reassess to identify gaps, and ensure integrity of the data collected.
- Ensure frontline involvement in VAP improvement activities. Maintain their engagement and remove barriers to progress.
- If a PI plan is put in place, measure the associated process outcomes.
- Ensure that VAP protocols are embedded into clinical workflows, whether electronic or paper.
- Ensure there are enough staff to effectively manage necessary preventive care.
- Ensure adequate training and documentation of VAP prevention competencies and skills.
- Eliminate barriers to making rapid changes to documentation templates and order sets.
- Debrief on a regular basis to solicit team feedback about barriers to sustained compliance. Adjust the plan quickly and nimbly as needed.
- Hold staff accountable for providing the standard of care and reward success.
- Ensure that leaders have a simple process to oversee VAP improvement work while also considering how it aligns with other initiatives across the organization.
Assess the risk for VAP. Consider recent surgery, thoracic surgery, recent surgery status, immunosuppression, trauma, age, nutrition status, length of stay (LOS), post-operative care, VAP risk (Dr. D.C. and Dr. M.C.).

Perform routine oral care to reduce the colonization of microbes. Swab mouth every 2 hours with an antimicrobial solution (best evidence: chlorhexidine). Keep mouth and lips moist. Brush teeth every 4 hours.

Maintain a stable, effective airway. Coordinate subglottic suctioning. Maintain ETT cuff pressure at >20cm. Rotate ETT and re-tape every 72 hours. Use a continuous aspiration of subglottic secretion (CASS) device. C-reactive protein (CRP), daily. Implement Unplanned Extubation standards (APSS 8B). Provide nebulizer therapy as indicated.

Maintain effective hydration. Wean from the ventilator as soon as possible. Provide nebulizer therapy as indicated.

Prevent peptic ulcers. Avoid high dose proton pump inhibitors if possible. Keep head of bed (HOB) up at 30-45 degrees. Ensure effective nutrition. Wean from the ventilator as soon as possible.

Prevent delirium. Allow for effective rest. Minimally disturb patients between 22:00 and 5:00. Encourage, if possible. Conduct a “sedation vacation” daily.

Ensure effective breathing exercises. Minimally disturb patients between 22:00 and 5:00. Encourage, if possible. Conduct a “sedation vacation” daily.

Implement consistent weaning trials. Support effective rest. Minimally disturb patients between 22:00 and 5:00. Encourage, if possible. Conduct a “sedation vacation” daily.

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Performance Improvement Plan

Follow this checklist if the leadership team has determined that a performance improvement project is necessary:

- **Gather the right project team.** Be sure to involve the right people on the team. You’ll want two teams: an oversight team that is broad in scope, has 10-15 members, and includes the executive sponsor to validate outcomes, remove barriers, and facilitate spread. The actual project team consists of 5-7 representatives who are most impacted by the process. Whether a discipline should be on the advisory team or the project team depends upon the needs of the organization. Patients and family members should be involved in all improvement projects, as there are many ways they can contribute to safer care.

<table>
<thead>
<tr>
<th>RECOMMENDED VAP IMPROVEMENT TEAM</th>
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<tbody>
<tr>
<td>Nurses</td>
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<tr>
<td>Respiratory therapists</td>
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<td>Physicians</td>
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<td>Physical and occupational therapists</td>
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<td>Environmental service staff</td>
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<td>Engineering staff</td>
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<td>Dietary staff</td>
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<td>Infection control specialists</td>
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<td>Clinical educators</td>
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<td>Information technology</td>
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<td>Patient/family members</td>
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<td>Admitting and registration staff</td>
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<td>Quality and safety specialists</td>
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Table 1: Understanding the necessary disciplines for a ventilator-associated pneumonia project improvement team

- **Understand what is currently happening and why.** Reviewing objective data and trends is a good place to start to understand the current state, and teams should spend a good amount of time analyzing data (and validating the sources), but the most important action here is to go to the point of care and observe. Even if team members work in the area daily, examining existing processes from every angle is generally an eye-opening experience. The team should ask questions of the frontline during the observations that allow them to understand each step in the process and identify the people, supplies, or other resources needed to improve patient outcomes.

<table>
<thead>
<tr>
<th>VAP PROCESSES TO CONSIDER ASSESSING</th>
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<tbody>
<tr>
<td>Hand hygiene</td>
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<td>Intubation protocols</td>
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<td>Environmental cleaning</td>
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<td>Equipment disinfection</td>
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<td>Frequent and routine oral care</td>
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<td>Suctioning protocols</td>
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<td>Patient positioning</td>
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<td>Peptic ulcer (PU) prevention protocol</td>
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<td>Sedation vacations</td>
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<tr>
<td>Deep vein thrombosis (DVT) prophylaxis</td>
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<td>Endotracheal cuff and tube maintenance</td>
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<td>Weaning protocols</td>
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<td>Patient and family education</td>
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Table 2: Consider assessing these processes to understand where the barriers contributing to ventilator-associated pneumonia may be in your organization
Prioritize the gaps to be addressed and develop an action plan. Consider the cost effectiveness, time, potential outcomes, and realistic possibilities of each gap identified. Determine which are a priority for the organization to focus on. Be sure that the advisory team supports moving forward with the project plan so they can continue to remove barriers. Design an experiment to be trialed in one small area for a short period of time and create an action plan for implementation.

The action plan should include the following:
- Assess the ability of the culture to change and adopt appropriate strategies
- Revise policies and procedures
- Redesign forms and electronic record pages
- Clarify patient and family education sources and content
- Create a plan for changing documentation forms and systems
- Develop the communication plan
- Design the education plan
- Clarify how and when people will be held accountable

<table>
<thead>
<tr>
<th>TYPICAL GAPS IDENTIFIED IN VAP</th>
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<tbody>
<tr>
<td>Lack of accountability</td>
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<tr>
<td>Little organizational focus on VAP prevention</td>
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<td>Lack of leadership oversight</td>
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<tr>
<td>Inconsistent communication of VAP prevention updates</td>
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<tr>
<td>Inconsistent education of new protocols</td>
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<tr>
<td>Complex work environment with many distractions</td>
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<tr>
<th>TYPICAL GAPS IDENTIFIED IN VAP</th>
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<tr>
<td>New or visiting staff members</td>
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<tr>
<td>Staffing needs</td>
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<tr>
<td>Emergent patient needs</td>
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<tr>
<td>Difficulty in performing oral care effectively</td>
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<tr>
<td>Lack of adequate supplies</td>
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<tr>
<td>Environmental cleaning</td>
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Table 3: By identifying the gaps in ventilator-associated pneumonia prevention compliance, organizations can tailor their project improvement efforts more effectively

Evaluate outcomes, celebrate wins, and adjust the plan when necessary. Measure both process and outcome metrics. Outcome metrics include the rates outlined in the leadership checklist. Process metrics will depend upon the workflow you are trying to improve and are generally expressed in terms of compliance with workflow changes. Compare your outcomes against other related metrics your organization is tracking. Routinely review all metrics and trends with both the advisory and project teams and discuss what is going well and what is not. Identify barriers to completion of action plans, and adjust the plan if necessary. Once you have the desired outcomes in the trial area, consider spreading to other areas (IHI, 2006).

It is important to be nimble and move quickly to keep team momentum going, and so that people can see the results of their labor. At the same time, don’t move so quickly that you don’t consider the larger, organizational ramifications of a change in your plan. Be sure to have a good understanding of the other, similar improvement projects that are taking place so that your efforts are not duplicated or inefficient.

<table>
<thead>
<tr>
<th>VAP COMPARATIVE OUTCOMES</th>
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<tbody>
<tr>
<td>Hand hygiene compliance</td>
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<tr>
<td>Ventilator LOS</td>
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<td>ICU LOS</td>
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Table 4: Consider evaluating related metrics to better understand ventilator-associated pneumonia presence and contributing factors
What We Know About VAP

Hospital-acquired (Nosocomial) Ventilator-Associated Pneumonia (VAP)

Pneumonia is defined as an infection that occurs inside one or both of the lungs that is initiated when the infection causes the air sacs of the lungs (alveoli) to fill with fluid pus, resulting in subsequent difficulty breathing. Difficulty breathing can deprive the body of the essential oxygen that it needs to function and survive (“Learn About Pneumonia”, 2020). One of the most common diseases associated with being on a ventilator is pneumonia. The breathing tube that is put in the airway can introduce bacteria from the environment into the trachea and lungs (US Department of Health and Human Services, 2012). Subsequently, as bacteria enters the sensitive inside environment of the lungs, one may develop VAP (US Department of Health and Human Services, 2012).

Mechanically-ventilated hospital patients are usually critically ill and need to be treated in an intensive care unit (ICU). The infection can develop after two days or more of mechanical ventilation and is caused when bacteria reaches the lower respiratory tract via the endotracheal tube or tracheostomy. When a patient’s airways are not properly maintained, intubation may allow for oral and gastric secretions to enter their lower airways (Amanullah, 2015). VAP and pediatric ventilator associated pneumonia (VAP in individuals aged 18 and younger) are among the most commonly occurring healthcare setting acquired infections in the ICU (“Daily Care Processes”, 2017).

Although patients receiving mechanically-assisted ventilation do not represent a major proportion of patients who have nosocomial pneumonia, they are at highest risk for acquiring the infection (CDC, 1997). Risk factors for VAP are greatly increased when intubated because mechanical ventilation alters the first line of defense for patients (CDC, 1997). Unplanned, uncontrolled, self and accidental extubation contribute significantly to higher risk for developing VAP (CDC, 1997). Unplanned, uncontrolled extubation increases the occurrence of pneumonia from 14% to 30% (DeLassence et al., 2002). Annually, there are more than 120,000 incidents of unplanned extubation in adult US ICUs, causing more than 36,000 VAP cases (DeLassence et al., 2002).

Reasons for Mechanical Ventilation

A ventilator is a machine utilized to support breathing in patients who cannot breathe efficiently on their own (US Department of Health and Human Services, 2012). Primarily found in hospitals, the main goals of these machines are to get oxygen into the lungs and deposit carbon dioxide from the body (US Department of Health and Human Services, 2012). Ventilators can be used in multiple instances ranging from short term to long term care. Ventilators are used for short periods of time during minor surgeries to administer anesthesia. On the other end of the spectrum, some patients may be on ventilators for days to weeks from diseases that damage or impair the function of the lungs (US Department of Health and Human Services, 2012).

Incidence and Epidemiology

The infection can develop after 2 days or more of mechanical ventilation and is caused when bacteria reaches the lower respiratory tract via the endotracheal tube or tracheostomy (when doctors put a plastic tube through a patient’s mouth or nose and down their windpipe to help them breathe). When a patient’s airways are not properly maintained, intubation may allow for oral and gastric secretions to enter their lower airways (Amanullah, 2015).

The likelihood of infection and subsequent VAP is seen to increase substantially in comatose patients, in patients being treated with antimicrobial agents, in patients who have hypotension, acidosis, pulmonary disease, and patients who have nasogastric or endotracheal tubes in place (CDC, 1997).

Entry of bacteria into the lower respiratory tract of patients can also occur through inhalation of aerosols from contaminated respiratory therapy or anesthesia breathing equipment. Examples of equipment that have been commonly identified as contaminated are nebulizers and even humidification devices which create an excessive amount of aerosol droplets in the air that can be inhaled by patients (CDC, 1997).

Furthermore, the stomach may also be a factor contributing to bacteria that can lead to subsequent infection. In healthy persons, a majority of
bacteria that reaches the stomach will not survive; however, in patients whose stomach pH increases from the normal levels to pH of greater than or equal to 4, microorganisms can survive, grow, and multiply inside of the stomach (CDC, 1997).

Nosocomial bacterial pneumonias are frequently polymicrobial and gram-negative bacilli are usually the predominant organisms; however, Staphylococcus aureus (especially methicillin-resistant S. aureus) and other gram-positive cocci, including Streptococcus pneumoniae, have emerged recently as important isolates which may contribute to VAP (CDC, 1997).

Clinical Implications
In the US, a multi-state prevalence survey estimated the occurrence of VAP at 49,900 cases annually (Magill et al., 2014). Patients who acquire VAP have significantly longer durations of mechanical ventilation and longer stays in the ICU (Rello et al., 2002). In addition, the development of VAP is associated with a significant rise in healthcare costs and poor economic outcomes. According to the Agency for Healthcare Research and Quality, approximately 10 to 20 percent of patients suffering from VAP are twice as likely to die from being hospitalized (“Daily care Processes”, 2017).

Among all variations of medical intensive care units (ICU), the median VAP rate is about 7.4 per every 1000 ventilator days (CDC, 1997). The crude mortality rate for VAP is between 20% and 60%—incidence ranges from 4% to 48% (Cook, 1998; Heyland et al., 1999). Despite the fact that patients receiving mechanically-assisted ventilation do not represent a major proportion of patients who have nosocomial pneumonia, they are at highest risk for acquiring the infection because of their weakened immune system and reliance on a hospital ventilator to breathe (CDC, 1997).

Critically-ill elderly adults and children are specifically at risk. Additionally, patients undergoing surgeries are also at an elevated risk of contracting VAP. Research shows that as many as 28% of patients who receive mechanical ventilation in the hospital will develop VAP—the frequency increases with the duration of mechanical ventilation (Hunter, 2006). Additionally, unplanned, uncontrolled extubation increases the occurrence of pneumonia from 14% to 30% (de Lassence et al., 2002).

Financial Implications
VAP is associated with greater than $40,000 in mean hospital charges per patient (Rello et al., 2002). Annually, it was recorded that the mean deaths per year relating to VAP was 35,967 deaths (Stone, 2010). For patients in the hospital that acquire VAP, the average extended stay for them in the hospital is 4 to 9 days (“Daily care Processes”, 2017) which not only places more stress on patients, but it also places stress on medical professionals and is costly for the hospital.

Additionally, researchers predict that implementing system-wide change and the use of technology to reduce VAP can save up to $1.5 billion per year while significantly improving quality and safety (Scott, 2009).

National and International VAP Standards

National
- Use a semirecumbent position while patients are in their bed -- keep the bed angle between 30 degrees and 45 degrees (“Daily care Processes”, 2017).
- Routinely assess the patient’s cognitive function to help in determining the best sedation levels when sedating.
- Evaluate the potential for discontinuing ventilation on a daily basis -- ventilation should not be performed if it is on patients that do not need it to avoid VAP infection (“Daily care Processes”, 2017).
- Use the Ventilator Bundle Checklist from IHI (IHI, 2020):
  - Daily Sedation Interruption and Daily Assessment of Readiness to extubate
  - Peptic Ulcer Disease (PUD) prophylaxis
  - Deep Venous Thrombosis (DVT) prophylaxis
  - Follow hand hygiene procedures before and after touching a patient
  - Maintenance of the oral cavity with chlorhexidine

International
The European Respiratory Society compiled the evidence and recommendations of international guidelines on NV-HAP and VAP in their report titled “Summary of the international clinical guidelines for the management of hospital-acquired and ventilator-acquired pneumonia”. This summary was compiled with experts from the European Respiratory Society (ERS), the European Society of Intensive Care Medicine (ESICM), the European Society of Clinical Microbiology and Infectious Diseases (ESCMID) and the Latin American Society of Thoracic Diseases (ALAT).

Evidence-based guidelines produced by the British Society for Antimicrobial Chemotherapy synthesized the existing national
and international literature regarding prevention, diagnosis and treatment of hospital-acquired pneumonia. The following are among the most prominent guidelines mentioned in the article:

- Prevention of hospital-acquired pneumonia should be included in the education required for induction of new nursing staff
- The influenza vaccination should be encouraged in both healthcare workers and in patients. The pneumococcal vaccination should be encouraged in elderly and at-risk populations
- Hand hygiene practices should be actively incorporated into guidelines for hospital-acquired pneumonia prevention. Hand hygiene performance audits should be conducted to ensure adherence.
- Equipment, such as nebulizers and bag-valve mask ventilation bags, should be single patient use and should be disinfected thoroughly between every use. Spirometry mouthpieces should be single use only.

### Ensure Best Patient Care

Decreasing the aspiration by the patient, preventing cross-contamination or colonization via hands of health care workers, appropriate disinfection or sterilization of respiratory-therapy devices, use of available vaccines to protect against particular infections, minimal exposure to ventilation, and education of hospital staff and patients are all effective strategies to prevent VAP (CDC, 1997; IHI, 2020).

- **Minimizing ventilator exposure** is the most evidence-based practice to prevent VAP from occurring in the first place. Use non-invasive ventilation methods when possible (i.e., CPAP, BiPap). If noninvasive techniques are viable to treat the patient, then use of a ventilator can be bypassed (Boltey et al., 2017). If the situation requires use of a ventilator, it is best to keep the duration of use on the patient as short as possible to decrease the chances of any bacteria forming and entering the lungs. To decrease duration of ventilation:
  - Conduct "sedation vacations"
  - Assess readiness to wean from ventilator daily
  - Conduct spontaneous breathing trials

- **Oral care:** With mechanically ventilated patients, oral hygiene quickly deteriorates, resulting in the subsequent formation of bacteria in the oral cavity. Formation of such bacteria in the oral cavity in conjunction with compromised immunity and the endotracheal tube serving as a direct route to the lungs can quickly lead to VAP (Boltey et al., 2017).
  - New measures being investigated involve reducing oropharyngeal and gastric colonization by pathogenic microorganisms (Guidelines for Prevention, 2010).
  - Furthermore, patients may sustain injuries upon insertion of the ventilator and intubation tubes -- with poor oral hygiene, these injuries can serve as prime grounds for bacteria formation and spread (Boltey et al., 2017).
  - Guidelines regarding frequency, method, and tools for oral care provided here: Yurdanur and Yagmur, 2016.

- **Subglotic secretion suctioning** can serve as an intervention to clean secretions that accumulate around the area of the endotracheal tube of mechanically-ventilated patients. It was found that subglottic suctioning reduced the risk of VAP by 45% compared to individuals who did not receive any subglottic suctioning (Boltey et al., 2017).

- **Proper bed positioning** with the patient sitting at a 30 to 45 degree angle and encouragement of patient mobility have been found to prevent VAP. Keeping patients elevated (30 to 45 degrees) can reduce the chances of acid reflux, thereby, reducing the chances of developing VAP (Boltey et al., 2017).

- **Staffing:** One intervention to prevent VAP from occurring is simply having the right staff and the right amount of medical aid available. Without the proper staffing, ventilators can be left unchecked, improperly handled or cleaned (Boltey et al., 2017).

- **Extubations:** Before patients are extubated, ensure they:
  - Are conscious and responsive
  - Have undergone readiness testing and weaning

- **Endotracheal tube cuff:** A cuffed endotracheal tube with in-line or subglottic suctioning should be used. Maintain the endotracheal tube cuff pressure at greater than 20 cmH2O

- **Monitoring:** Monitor ventilated patients for:
  - Positive cultures
  - Temperature chart/log
  - Pharmacy reports of antimicrobial use
  - Change in respiratory secretions

The NCBI reveals five evidence-based nursing practices for reducing VAP infection (Boltey et al., 2017). The five nursing practices include:

- Minimizing ventilator exposure at all
- Providing patients with oral hygiene care
- Coordinating care for subglottic suctioning
- Maintaining proper positioning
- Mobility
- Ensuring the adequate staffing to attend to each patient

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If complications arise, list these at the top of the patient’s Electronic Health Record (EHR) problem list.

**Equipment:** Prevent exposure to contaminated equipment:
- Use sterile water to rinse reusable respiratory equipment
- Remove condensation from ventilator circuits
- Change ventilator circuit only when malfunctioning or visibly soiled
- Store and disinfect respiratory equipment effectively

**Previous Successful Project Plans**

*Below are examples of case studies:*

- Development and implementation of a performance improvement project in adult intensive care units: overview of the Improving Medicine Through Pathway Assessment of Critical Therapy in Hospital-Acquired Pneumonia (IMPACT-HAP) study: [https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3222076/](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3222076/)


**Resources**

- IHI: Ventilator Bundle Checklist
- Daily Care Processes Guide for Reducing Ventilator-Associated Events in Mechanically Ventilated Patients
- CDC: Guidelines for Prevention of Nosocomial Pneumonia
- CMS: Ventilator-associated Pneumonia (VAP)
- SIPOC Example and Template
- CDC: Disinfection of healthcare equipment
- HQI: ICU Sedation Guidelines of Care toolkit
- AARC: Best practices for ventilator weaning protocols
Weaning is usually commenced with a short trial in which one stays connected to the ventilator, but they are also given a short period of time/chance to breathe on their own. Short term weaning trials may be performed multiple times until the patient can breathe well on their own; however, if the patient shows no improvement or ability to breathe on their own, long term ventilator care might be necessary (US Department of Health and Human Services, 2012).

- **Prevention:** Patients and family members should understand how to prevent pneumonia in the hospital:
  - **Hand hygiene:** “Hand hygiene is an effective measure to prevent many types of healthcare-associated infections, including pneumonia”
  - **Oral care:** “Proper oral care, such as toothbrushing, removes bacteria from the mouth that could be inhaled into the lungs”
  - **Prevention of aspiration:** “Aspiration is when a person accidentally inhales fluid or food into their lungs, which can cause pneumonia. An upright bed position during and after meals can decrease the likelihood of aspiration”
  - **Encourage cessation of smoking:** “Patients who smoke are more likely to get infections. Family members should encourage their loved ones to quit smoking.”
  - **Independent Breathing:** “We are always trying to get he/she off of the ventilator. Continue asking if they are okay to breath on their own yet”

- **Treatment:** Healthcare workers should ensure that patients and family members are aware if the patient acquired pneumonia in the hospital. Information to be communicated includes basic information about the condition, treatment options, and monitoring of their loved one for worsening symptoms
  - Maintain the inclusive discussion with the patient and family member. When assisting with oral care, explain that this will remove bacteria in the mouth that can cause pneumonia. When administering medications, explain what the medication is, why they are taking it, and how it will help. Active discussion with the patient will cultivate trust and a better patient experience (Lippincott Nursing Center).

- **Discharge:** Clinicians should communicate to patients what to expect upon discharge, including:
  - Common post-pneumonia symptoms
  - Instructions on breathing exercises
  - Methods to mitigate disrupted sleeping and eating patterns
  - When to seek help if symptoms worsen (Icahn School of Medicine)
  - If oxygen therapy is needed and if so, how to complete
  - If monitoring at home is needed and if so, how to complete
  - If nebulizer therapy is needed at home and if so, how to complete
Measuring Outcomes

Ventilator-associated Pneumonia Rate (VAP)
Rate of patients on a ventilator for more than 2 calendar days who develop pneumonia while on the ventilator or within 1 day of ventilator removal per 1,000 ventilator-days

Outcome measure formula:

**Numerator:** Ventilator-associated pneumonia (VAP) for pediatrics or Possible Ventilator Associated pneumonia for adults (PVAP) infections based on CDC NHSN surveillance definitions for all inpatient units (CDC, 2018).

**Denominator:** Total number of ventilator-days for all patients on a ventilator in all tracked units

* Rate is typically displayed as VAP/1000 ventilator days

Metric recommendations

**Indirect Impact:**
All patients with conditions that lead to temporary or permanent ventilation

**Direct Impact:**
All patients that require invasive ventilation.

**Lives Spared Harm:**

\[ \text{Lives} = (VAP \text{ Rate }_{\text{baseline}} - VAP \text{ Rate }_{\text{measurement}}) \times \text{Ventilator days }_{\text{baseline}} \]

**Notes:**

To meet the NHSN definitions, infections must be validated using the hospital acquired infection (HAI) standards (CDC, 2018). Infection rates can be stratified by unit types further defined by CDC (CDC, 2016). Infections that were present on admission (POA) are not considered HAIs and not counted.

Data collection

VAP and ventilator-days can be collected through surveillance (collected at least once per month and reported monthly) or gathered through electronic documentation. Denominators documented electronically must match manual counts (+/- 5%) for a 3 month validation period.

**Mortality** (will be calculated by the Patient Safety Movement Foundation):

The PSMF, when available, will use the mortality rates associated with Hospital Acquired Conditions targeted in the Partnership for Patient’s grant funded Hospital Engagement Networks (HEN). The program targeted 10 hospital acquired conditions to reduce medical harm and costs of care. “At the outset of the PIP initiative, HHS agencies contributed their expertise to developing a measurement strategy by which to track national progress in patient safety—both in general and specifically related to the preventable HACs being addressed by the PIP. In conjunction with CMS’s overall leadership of the PIP, AHRQ has helped coordinate development and use of the national measurement strategy. The results using this national measurement strategy have been referred to as the “AHRQ National Scorecard,” which provides summary data on the national HAC rate (AHRQ, 2019). Based on these data the estimated additional inpatient mortality for Ventilator-associated Pneumonia (VAP) is 0.144 (144 per 1000 events) (AHRQ, 2013).
Endnotes

Conflicts of interest disclosure

The Patient Safety Movement Foundation partners with as many stakeholders as possible to focus on how to address patient safety challenges. The recommendations in the APSS are developed by workgroups that may include patient safety experts, healthcare technology professionals, hospital leaders, patient advocates, and medical technology industry volunteers. Workgroup members are required to disclose any potential conflicts of interest.

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