

# Actionable Patient Safety Solutions (APSS) #2D: **Ventilator-associated pneumonia (pedVAP/PVAP)**

## How to use this guide

This guide gives actions and resources for creating and sustaining safe practices for pedVAP/PVAP. In it, you'll find:

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## Ventilator-associated pneumonia (pedVAP/PVAP)

# Executive summary checklist

Ventilator-associated pneumonia (VAP) –pedVAP in children and Possible VAP (pVAP) when suspected in adults—is a lung infection that develops in a patient who is on a ventilator. An infection may occur if germs enter through the tube and get into the patient’s lungs (CDC, 2014). VAP is a serious problem in critically-ill patients, resulting in many patient deaths each year.

Use this checklist to help you prioritize your actions and measure your organization’s progress in each area. Prevention of VAP requires the following actions:

### Create an action plan

- Show leadership’s commitment to support a program to eliminate VAP
- Implement evidence-based guidelines to prevent the occurrence of VAP

### Ensure best patient care

- Prevent aspiration of body secretions, following these protocols:
  - Maintain elevation of head of bed (HOB) between 30-45 degrees
  - Avoid gastric overdistention
  - Prevent unplanned, uncontrolled extubation
    - Patient self extubation
    - Accidental extubation
  - Minimize pooling of secretions above the cuff of endotracheal tube
  - Maintain the endotracheal tube cuff pressure at greater than 20 cmH<sub>2</sub>O
  - Encourage physical or occupational therapy to help patients get moving
  - Before patients are extubated, ensure they
    - Are conscious and responsive
    - Have undergone readiness testing and weaning
- Decrease duration of ventilation:
  - Conduct “sedation vacations”
  - Assess readiness to wean from ventilator daily
  - Conduct spontaneous breathing trials
- Reduce colonization of aero-digestive tract:
  - Use non-invasive ventilation methods when possible (i.e., CPAP, BiPap)
  - Use oro-tracheal over naso-tracheal intubation
  - Perform regular oral care with an antiseptic agent (see Appendix A for antiseptic ingredients to consider)
  - Reduce opportunities to introduce pathogens into the airway
- 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

- Measure adherence to VAP prevention practices and consider monitoring compliance:
  - Hand Hygiene
  - Daily sedation vacation/interruption and assessment of readiness to wean
  - Regular antiseptic oral care
  - Semi-recumbent position of all eligible patients—head up to 30 degrees
- Monitor ventilated patients for:
  - Positive cultures
  - Temperature chart/log
  - Pharmacy reports of antimicrobial use
  - Change in respiratory secretions
  - If complications arise, list these at the top of the patient's Electronic Health Record (EHR) problem list

### **Engage staff and use data to find areas for improvement**

- Create an education plan for physicians and nurses to cover key curriculum about the prevention of VAP
- Encourage continuous process improvement through the implementation of:
  - Quality process measures and metrics
  - A monthly display of data results through a dashboard
- Encourage each unit to monitor and perform an event analysis on each VAP infection using a multidisciplinary approach to engage all unit staff
- Complete a full root cause analysis (RCA) for any VAP that is identified—through event analysis—to be associated with patient death
- Implement—and share—all learnings from the RCA
- Utilize patient stories - written and in video - to help teach and inspire change in your staff

# What we know about VAP

## Ventilator-associated pneumonia

Ventilator-associated pneumonia is a lung infection that develops in a patient who is on a ventilator. Mechanically ventilated hospital patients are usually critically ill and need to be treated in an intensive care unit (ICU).

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).

## Ventilator associated events (VAE)

In 2011 the Centers for Disease Control's (CDC) National Healthcare Safety Network (NHSN) expanded the definition of VAP to address limitations in the previous standing surveillance definition. The surveillance definition was expanded to include additional pulmonary conditions indicative of processes that could be identified as or lead to a VAP.

The updated tiered definition—Ventilator Associated Events, or VAE, for short—includes the updated criteria of Possible Ventilator Associated Pneumonia, or PVAP, in adults. The purpose of this definition is for surveillance only and is not meant to be used for clinical identification of pneumonia in a ventilated patient.

## The risks with the standard treatment

VAP is the leading cause of death associated with healthcare-associated infections (HAIs) (IHI, 2012). In the US, a multi-state prevalence survey estimated the occurrence of VAP in the US at 49,900 cases annually (Magill, 2014).

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.

- Unplanned, uncontrolled extubation increases the occurrence of pneumonia from 14% to 30% (DeLassence et al., 2002)
- There are more than 120,000 incidents of unplanned extubation in adult U.S. ICUs yearly—causing more than 36,000 VAPs every year (DeLassence et al., 2002)
- The crude mortality rate for VAP is between 20% and 60%—incidence ranges from 4% to 48% (Cook, 1998; Heyland et al., 1999)

Depending on the type of pneumonia, the mortality rate may vary. Pseudomonas and Acinetobacter are associated with higher mortality rates than other strains of bacteria (Fagon, 1996). It is believed that when antibiotic therapy is delayed or improperly dosed, mortality also increases. These factors are largely preventable.

Patients who acquire VAP have significantly longer durations of mechanical ventilation and a longer stay in the ICU (Rello, 2002). In addition, the development of VAP is associated with a significant rise in healthcare costs and poor economic outcomes.

- VAP is associated with greater than \$40,000 in mean hospital charges per patient

## Reducing and preventing VAP

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).

## Leadership plan

Addressing this safety issue will require hospitals and healthcare systems to commit to action in the form of specific leadership, action, and technology plans. Hospital governance, senior administrative leadership, clinical leadership, and safety/risk management leadership need to work collaboratively to reduce VAP infections.

To achieve a goal of zero preventable deaths, leaders need to commit to taking these key actions.

### Show leadership's commitment to reducing VAP

- Commitment and action are required at all levels for successful process improvement
- Hospital governance and senior administrative leadership must champion efforts in raising awareness to prevent and manage VAP infections safely

### Create the infrastructure needed to make changes

- Support the design and implementation of an antimicrobial stewardship program
- Integrate surveillance and metrics to ensure prevention measures are being followed by all staff
- Utilize patient stories - written & in video - to identify gaps and inspire change in your staff

## Action plan

Establish and consistently implement VAP prevention guidelines (Coffin, 2008) that focus on:

- Surveillance
- Decreasing the number of days patients spend on a ventilator
- Prevention of aspiration and gastric distention
- Equipment cleansing
- Oral hygiene
- Avoidance of unintended extubation and reintubation

An example of an evidence-based bundle is the Institute for Healthcare Improvement's How-to Guide: Prevent Ventilator Associated Pneumonia. You can access this guide by visiting the Institute for Healthcare Improvement's (IHI) website.

Johns Hopkins University's Armstrong Institute for Patient Safety and Quality has published a Toolkit to Improve Safety of Mechanically Ventilated Patients that includes recommendations on preventing, measuring and tracking outcomes related to VAP. This Toolkit can be accessed online through the John Hopkins Medicine website.

### Encourage action with the following practices

- If tolerated by your patient, elevate the head of the bed to between 30 and 45 degrees

- Use Daily Sedation Interruption and Daily Assessment of Readiness to extubate
- Use Deep Venous Thrombosis (DVT) prophylaxis
- Recommend daily oral care
- Follow hand hygiene procedures before and after touching a patient
- Although Peptic Ulcer Disease (PUD) prophylaxis was previously a component of the VAP bundle, recent studies have shown that the increase in gastric pH that results from these medications promotes the growth of bacteria in the upper GI tract, which actually increases the risk for VAP. For this reason, the use of PUD prophylaxis should be based upon each patient’s risk for GI bleed and has been excluded from current recommendations (Hellyer, Ewan, Wilson & Simpson, 2016).

**\*Unplanned, uncontrolled, self or accidental extubation contributes significantly to the overall occurrence of VAP. Therefore, prevention of unplanned extubation should be a top priority. If you would like to learn more about this topic, please go to The Patient Safety Movement Foundation’s Actionable Patient Safety Solutions (APSS) #8B - Unplanned Extubation.**

## Technology plan

These suggested practices and technologies have shown proven benefit or, in some cases, are the only known technologies for certain tasks. If you know of other options not listed here, please complete the form for the PSMF Technology Vetting Workgroup to consider: [patientsafetymovement.org/actionable-solutions/apss-workgroups/technology-vetting/](https://patientsafetymovement.org/actionable-solutions/apss-workgroups/technology-vetting/)

Consider implementing the following technologies to address VAP in your organization:

System or Practice	Available Technology
ONC Meaningful Use Certified EHR system Electronic Health Record (EHR) System with the following capabilities: <ul style="list-style-type: none"> <li>• Computerized Provider Order Entry (CPOE)</li> <li>• Drug-drug interaction check</li> <li>• Drug-allergy interaction check</li> <li>• Clinical Decision Support tools (CDS)</li> </ul>	
Implement endotracheal tubes designed to drain subglottic secretions	
If endotracheal tubes designed to drain subglottic secretions are not available	
Implement oral hygiene products	
Implement electronic surveillance technologies that support antimicrobial stewardship	<ul style="list-style-type: none"> <li>• In late onset cases of VAP, bacteria is often multidrug resistant, and can have great clinical and economic challenges</li> </ul>

Implement Electronic Measurement of hand hygiene compliance

- See APSS #2A to learn more

## Measuring outcomes

### Topic:

### 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:

$Lives = (VAP\ Rate_{baseline} - VAP\ Rate_{measurement}) \times Ventilator\ days_{baseline}$

#### 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 PFP 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 PfP. In conjunction with CMS’s overall leadership of the Pfp, 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).*

## 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. Some of the APSSs recommend technologies that are offered by companies involved in the Patient Safety Movement Foundation. The workgroups have concluded, based on available evidence, that these technologies work to address APSS patient safety issues. Workgroup members are required to disclose any potential conflicts of interest.

## Workgroup

### Co-Chairs

**Ebony Talley** Kaiser Permanente Woodland Hills Medical Center  
**Carole Moss** Nile’s Project

### Members

This list represents all contributors to this document since inception of the Actionable Patient Safety Solutions

**Steven J. Barker** Patient Safety Movement Foundation; Masimo  
**Michel Bennett** Patient Safety Movement Foundation (formerly)  
**Naomi Bishop** Human-Centered Healthcare Design  
**Jonathan Coe** Prescient Surgical  
**Alicia Cole** Alliance for Safety Awareness for Patients (ASAP)  
**Peter Cox** SickKids  
**Maria Daniela DaCosta Pires** Geneva University Hospitals  
**Todd Fletcher** Resources Global Professionals  
**Kate Garrett** Ciel Medical  
**Helen Haskell** Mothers Against Medical Error  
**Brook Hossfeld** Sodexo  
**Lucas Huang** Global Network for Simulation In Healthcare  
**Mert Iseri** SwipeSense  
**Sarah Knowles** University Hospitals Geauga Medical Center  
**Terry Kuzma-Gottron** Avadim Technologies  
**Jerika Lam** Chapman University School of Pharmacy  
**Emily Leathers** Parrish Medical Center

<b>Gabriela Leongtez</b>	Gresmex
<b>Christian John Lillis</b>	Peggy Lillis Foundation
<b>Lori Lioce</b>	Global Network for Simulation In Healthcare
<b>Edwin Loftin</b>	Parrish Medical Center
<b>Ariana Longley</b>	Patient Safety Movement Foundation
<b>Jacob Lopez</b>	Patient Safety Movement Foundation (formerly)
<b>Olivia Lounsbury</b>	Patient Safety Movement Foundation
<b>Betsy McCaughey</b>	The Committee to Reduce Infection Deaths
<b>Derek Monk</b>	Poiesis Medical
<b>Armando Nahum</b>	Safe Care Campaign
<b>Neesha Nair</b>	Advocate
<b>Brent D. NiBarger</b>	BioVigil
<b>Anna Noonan</b>	University of Vermont Medical Center
<b>Kate O'Neill</b>	iCareQuality
<b>Donna Prosser</b>	Patient Safety Movement Foundation
<b>Kathy Puri</b>	Fitsi Health
<b>Caroline Puri Mitchell</b>	Fitsi Health
<b>Kellie Quinn</b>	Patient Advocate
<b>Julia Rasooly</b>	PuraCath Medical
<b>Judith Reiss</b>	Advocate
<b>Yisrael Safeek</b>	SafeCare Group
<b>Sundry Sankaran</b>	Kaiser Permanente
<b>Steve Spaanbroek</b>	MSL Healthcare Partners, Inc.
<b>Philip Stahel</b>	Patient Safety Movement Foundation
<b>Jeanine Thomas</b>	MRSA Survivors Network
<b>Greg Wiita</b>	Poiesis Medical

## **Metrics Integrity**

**Robin Betts** Kaiser Permanente, Northern California Region

\*This Workgroup member has reported a financial interest in an organization that provides a medical product or technology recommended in the Technology Plan for this APSS.

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# Appendix A: Active Ingredients in Antiseptic Skin Preparations

Table 3 lists the health care antiseptic active ingredients that have been considered under this rulemaking and shows whether each ingredient is eligible or ineligible for evaluation under the OTC Drug Review for use in health care antiseptics for each of the five specified uses:

Patient antiseptic skin preparation, health care personnel hand wash, health care personnel hand rub, surgical hand scrub, and surgical hand rub.

Table 3.--Eligibility of Antiseptic Active Ingredients for Health Care Antiseptic Uses<sup>1</sup>

Active Ingredient	Patient Antiseptic Skin Preparation	Health Care Personnel Hand Wash	Health Care Personnel Hand Rub	Surgical Hand Scrub	Surgical Hand Rub
Alcohol 60 to 95 percent	Y <sup>2</sup>	N <sup>3</sup>	Y	N	Y
Benzalkonium chloride	Y	Y	Y	Y	N
Benzethonium chloride	Y	Y	N	Y	N
Chlorhexidine gluconate	N	N	N	N	N
Chloroxylonol	Y	Y	N	Y	N
Cloflucarban	Y	Y	N	Y	N
Fluorosalan	Y	Y	N	Y	N
Hexylresorcinol	Y	Y	N	Y	N
Iodine complex (ammonium ether sulfate and polyoxyethylene sorbitan monolaurate)	N	Y	N	Y	N
Iodine complex (phosphate ester of alkylaryloxy polyethylene glycol)	Y	Y	N	Y	N
Iodine tincture United States Pharmacopeia (USP)	Y	N	N	N	N
Iodine topical solution USP	Y	N	N	N	N
Nonylphenoxypoly (ethyleneoxy) ethanoliiodine	Y	Y	N	Y	N
Poloxamer-iodine complex	Y	Y	N	Y	N
Povidone-iodine 5 to 10 percent	Y	Y	N	Y	N
Undecoylium chloride iodine complex	Y	Y	N	Y	N
Isopropyl alcohol 70-91.3 percent	Y	N	Y	N	Y
Mercufenol chloride	Y	N	N	N	N

*Courtesy of the Department of Health and Human Services, Food and Drug Administration*

