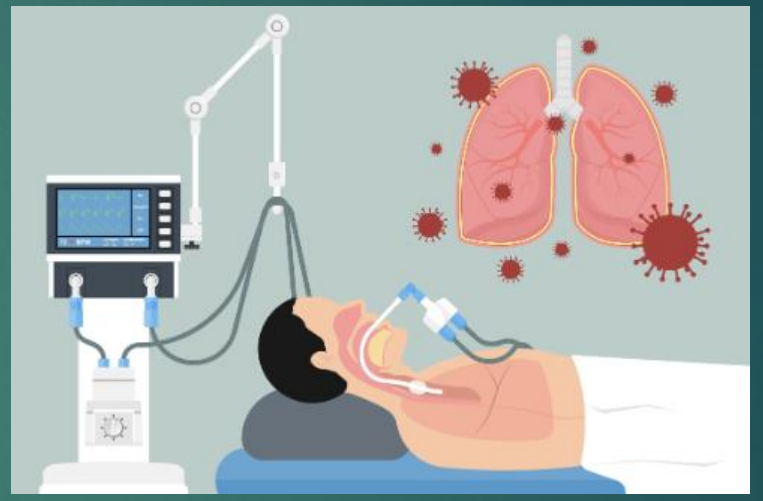
VAP in picu

DR MARYAM ALEMZADEH

(PEDIATRIC INTENSIVIST)



- (VAP) is the most common hospital-acquired infection in patients receiving mechanical ventilation, and it accounts for **about half of all antibiotics given in the** ICU.

- it prolongs the **duration of ventilation**, **intensive care**, and **hospital stay**, which in turn increased **morbidity and mortality.**

CDC definitions for ventilator associated events : (VAE-VAC-IVAC-VAP) January 2013

- This term was proposed to provide a more uniform and consistent manner of reporting cases of ventilator-associated complications.
- The definitions are not intended to be used clinically so their impact on VAP prevention management is uncertain.
- The effect of these criteria on clinical outcomes is unknown.

Ventilator-associated condition (VAC)

- patients with a period of sustained respiratory deterioration (changes in **[PEEP] ≥3 cm H2O** or **[FiO2] ≥0.2** [ie, 20 points] for **two days**) following a sustained period of stability or improvement on the ventilator (greater than or equal to two days).

- Qualitative studies suggest that most VAcs in adults and children are caused by pneumonia, fluid overload, atelectasis, and/or ARDS.
- Only **~25%–33%** of VAcs are due to pneumonia.

- many mild pneumonias do not meet the VAc thresholds for increased ventilator settings.

Infection-related ventilator-associated complication (IVAC)

patients with VAC also have

- an abnormal temperature (below 36°C or above 38°C)

  or

- white blood cell count (≤4000 or ≥12,000 cells/mm3)

  and

- be started on one or more new antibiotics that continue for ≥4 days all beginning within 2 days before or 2 days after VAC onset.

Possible and probable VAP

- **Possible VAP** is defined as Gram stain evidence of purulent pulmonary secretions **or** a pathogenic pulmonary culture in a patient with IVAC .

- **Probable VAP** is defined as Gram stain evidence of purulence **plus** quantitative or semiquantitative growth of a pathogenic organism beyond specified thresholds .
- Probable VAP can also be triggered by positive tests for respiratory viruses, Legionella species, pleural fluid cultures, and suggestive histopathology with or without an abnormal Gram stain result.

Review Article

Ventilator-associated pneumonia

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Abstract

Ventilator-associated pneumonia (VAP) has traditionally been defined as pneumonia in patients with mechanical ventilation for at least 48 h. Despite advancements in critical care, VAP remains to be a complication resulting in huge financial burden to patients. The limitations to the criteria have resulted in an urge to redefine VAP by the Centers for Disease Control and Prevention. Ventilator-associated event (VAE) has been well categorized in adult population; however, in pediatric cohort, while surveillance enhances the detection of infectious and noninfectious complications which can influence patient outcomes, there are many gaps in its classification and management. Establishing a diagnosis of VAP/VAE is crucial in management of a critically ill patient. The role of clinical criteria in concordance with laboratory evidence of inflammatory markers along with chest X-ray helps in supplementing the diagnosis. The presence of culture positivity aids in diagnosis with minimally invasive bronchoalveolar lavage providing a reasonable and safe method. Early empiric antibiotic treatment in suspected patients is beneficial. The role of antibiotic stewardship will help in prevention of antimicrobial resistance in treatment of VAP. More emphasis on VAP prevention measures with multidisciplinary approach is the way forward in overcoming this morbid condition in the intensive care units.

Keywords: Pneumonia, ventilator-associated pneumonia, ventilator

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pediatric VAc (PedVAc):

- an increase in the daily minimum MAP of **≥4 cm H2O** sustained **for ≥2 calendar days** after **≥2 days** of stable or decreasing daily minimum MAP.

or

- an increase in FiO2 of **≥25** points sustained for **≥2 days** after **≥2 days** of stable or decreasing daily minimum FiO2.

#(1) Increase in daily minimum FiO_2 of >0.25 (25 points) over the daily minimum FiO_2 of the 1st day in the baseline period, sustained for >2 calendar days, (2) increase in daily minimum MAP values of >4 cmH_2O over the daily minimum MAP of the 1st day in the baseline period, sustained for > 2 calendar days.

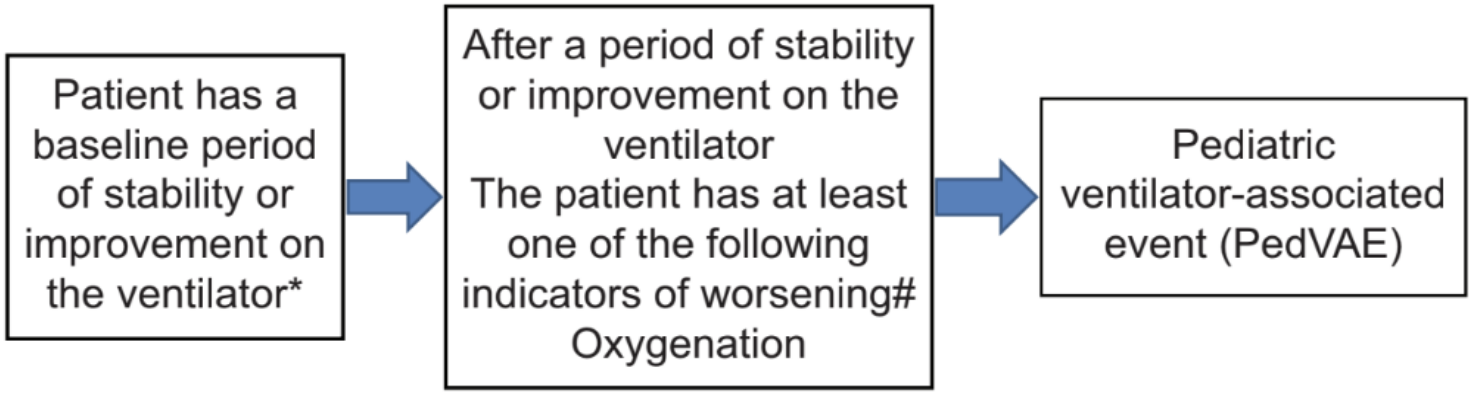

Image 1: Pediatric ventilator-associated event surveillance algorithm


Review Article

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Standard diagnostic criteria

- **Clinical suspicion of VAP**
- Fever >38°C or hypothermia lower than 36°C
- Change in volume of character of the secretions/increased need of suctioning
- Worsening of gaseous exchange after a period of either improvement on ventilator (e.g. oxygen desaturations and increased oxygen requirements)
- Presence of at least one of the following on two or more serial chest radiographs:(new or progressive infiltrates, consolidation, and cavitation).
- Positive serum biomarkers (C-reactive protein [CRP]/procalcitonin [PCT])
- Positive microbiological findings (still debatable).

Endotracheal tube cultures

- The role of quantitative cultures and the use of bronchoscopic versus nonbronchoscopic methods such as blind bronchial sampling or protected specimen brush remains controversial.
- Bronchoscopic methods, compared to nonbronchoscopic techniques, have technical difficulties and complications causing hypoxemia during the procedure.
- Nonbronchoscopic techniques are less invasive and less expensive.

Table 2: Threshhold values for cultured specimen used in possible ventilator-associated pneumonia definition

Bronchoscopically obtained specimen	NB obtained specimen	Values
B-BAL	NB-BAL	$>10^4$ CFU/mL
P-BAL		
B-PSB	NB-PSB	$>10^3$ CFU/mL
ETA		$>10^5$ CFU/mL
Lung tissue		$>10^4$ CFU/g

CFU: Colony-forming unit, B-BAL: Bronchoscopically bronchoalveolar lavage, P-BAL: Protected-bronchoalveolar lavage, B-PSB: Bronchoscopically protected specimen brushing, ETA: Endotracheal aspirate, NB-BAL: Nonbronchoscopically bronchoalveolar lavage, NB-PSB: Nonbronchoscopically protected specimen brushing, VAP: Ventilator-associated pneumonia

Risk Factors for the Development of Ventilator-associated Pneumonia:

- Enteral feeding
- Medication (e.g., proton pump inhibitors, histamine 2-receptor blockers)
- Re-intubation
- Aspiration of secretions
- Use of contaminated equipment
- Presence of genetic syndrome or neurological/cardiovascular disease
- Duration of mechanical ventilation

prevention

Infection Control & Hospital Epidemiology (2022), **43**, 687–713
doi:10.1017/ice.2022.88

SHEA

SHEA/IDSA/APIC Practice Recommendation

Strategies to prevent ventilator-associated pneumonia, ventilator-associated events, and nonventilator hospital-acquired pneumonia in acute-care hospitals: 2022 Update

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Abstract

The purpose of this document is to highlight practical recommendations to assist acute care hospitals to prioritize and implement strategies to prevent ventilator-associated pneumonia (VAP), ventilator-associated events (VAE), and non-ventilator hospital-acquired pneumonia (NV-HAP) in adults, children, and neonates. This document updates the Strategies to Prevent Ventilator-Associated Pneumonia in Acute Care Hospitals published in 2014. This expert guidance document is sponsored by the Society for Healthcare Epidemiology (SHEA), and is the product of a collaborative effort led by SHEA, the Infectious Diseases Society of America, the American Hospital Association, the Association for Professionals in Infection Control and Epidemiology, and The Joint Commission, with major contributions from representatives of a number of organizations and societies with content expertise.

(Received 21 March 2022; accepted 21 March 2022; electronically published 20 May 2022)

Table 4. Summary of Recommendations to Prevent VAP and/or PedVAE in Pediatric Patients

Category	Rationale	Intervention	Quality of Evidence
Essential practices	Interventions with minimal risk of harm and some data that they may lower VAP rates, PedVAE rates, and/or duration of mechanical ventilation.	Avoid intubation if possible. Use non-invasive positive pressure ventilation for selected populations[240–242]	MODERATE
		Assess readiness to extubate daily in patients without contraindications[244–248]	MODERATE
		Take steps to minimize unplanned extubations and reintubations[249]	LOW
		Avoid fluid overload[251,253,254]	MODERATE
		Provide regular oral care (i.e., toothbrushing or gauze if no teeth)[234,256,257]	LOW
		Elevate the head of the bed unless medically contraindicated[234]	LOW
		Change ventilator circuits only if visibly soiled or malfunctioning[259] (or per manufacturer's instructions)	MODERATE
		Prevent condensate from reaching the patient[234,266]	LOW
		Use cuffed endotracheal tubes[262–264]	LOW
		Maintain cuff pressure and volume at the minimal occlusive settings	LOW
		Suction oral secretions before each position change	LOW
Additional approaches	Risk of harm likely minimal with some evidence of benefit in adult patients, but data in pediatric populations are limited. Reasonable to consider implementing if rates remain elevated despite essential practices.	Interrupt sedation daily[267]	MODERATE
		Utilize endotracheal tubes with subglottic secretion drainage ports for older pediatric patients expected to require >48 or 72 hours of mechanical ventilation[395]	LOW
		Consider early tracheostomy[268–270]	LOW
Generally not recommended	Unknown impact on VAP rates and inadequate data on risks.	Prolonged systemic antimicrobial therapy for ventilator-associated tracheitis[272]	LOW
		Selective oropharyngeal or digestive decontamination[274]	LOW
		Prophylactic probiotics[163]	LOW
	No impact on VAP rates.[a]	Oral care with antiseptics such as chlorhexidine[280,284,285]	MODERATE
		Stress-ulcer prophylaxis[286–288]	LOW
	Lowers VAP rates in adults but no impact on duration of mechanical ventilation, length of stay, or mortality.	Silver-coated endotracheal tubes	LOW
No recommendation	Limited data on pediatric patients, no impact on VAP rates or outcomes in adults, unclear impact on costs	Closed or in-line suctioning[293]	LOW

Note.VAP, ventilator-associated pneumonia

[a]May be indicated for reasons other than VAP prevention.

Avoid intubation if possible

- Use noninvasive positive pressure ventilation (NIPPV) or high flow oxygen by nasal cannula whenever safe and feasible

Minimize duration of mechanical ventilation

- **1:Take steps to minimize unplanned extubations and reintubations.**

- **2:Assess readiness to extubate daily in patients without contraindications**

In adults, it is proven to have decreased incidence of VAP with assessing readiness to extubate; however, pediatric studies do not recommend daily interruption of sedation as the risk of accidental extubation is high result in adverse events.

Avoid fluid overload

- fluid overload is associated with increased risk for prolonged mechanical ventilation.

The Pediatric Surviving Sepsis Campaign and the Pediatric Acute Lung Injury Consensus Conference recommend limiting fluid intake, starting diuretics, and/or early renal therapy for children with ARDS and for children in the postresuscitation phase of sepsis.

Consider early tracheostomy

- A small, single-center, retrospective cohort study reported that early tracheostomy **(<10 days)** was associated with lower VAP rates and shorter ICU length of stay compared with late tracheostomy.

- Tracheostomy complications are more frequent in children
- versus adults.

Hand hygiene

- Hand hygiene before handling by the medical staff is the most effective method of reducing hospital-acquired infection.

Oral hygiene

- Poor oral hygiene has a strong association with VAP as it leads to formation of oral biofilm on teeth leading to colonization of oral cavity, tracheal/tracheostomy tube which eventually migrates to lower respiratory tract and lungs, thus increasing the risk of VAP.
- Oral hygiene can be maintained by decontamination of mouth with chlorhexidine solution which reduces the bacterial and yeast growth, debris, and dental plaques.
- The use of foam swabs or oral toothbrushes used to remove dental plaques is not recommended in critically ill patients due to the risk of contamination while dipping these in tap water.

Semi-recumbent positioning

- Positioning is considered a significant element in VAP bundle. There is a higher risk of aspiration of gastric content in supine position despite proper inflation of endotracheal cuff.
- de Neef et al. showed that head end elevation with **15°–30° for neonates and 30°–45° for infants or older children** decreases the risk of aspiration.
- Studies comparing lateral position with semi-recumbent showed that the incidence of aspiration of gastric contents was similar in both groups.

Ulcer prophylaxis

- Ulcer prophylaxis using H2 blockers and PPIs increases the gastric pH which results in increased gastric colonization of bacteria.
- Albert et al. revealed an increased incidence of VAP with the use of acid-suppression medication.

Cuffed endotracheal tubes and cuff pressure checks

- Studies have shown that compared to uncuffed tube, there is a **decreased risk of micro-aspiration** and need for **tube exchange** (30.8% vs. 2.1%) was less in cuffed tube.
- Kneyber et al. showed that high-volume low-pressure cuffed tubes with cuff pressure monitoring can be used safely in children.
- There is no risk of postextubation stridor when cuff pressure is maintained **<20 cmH2O** and regularly monitored.

Endotracheal Tube with a subglottic suction:

- In spite of proper cuff management, the retention of secretion in the subglottic area (over the cuff) could still be a problem and lead to pericuff leak.
- This may be solved with specialized cuffed tubes with the possibility of secretion clearance (by direct suctioning) from the subglottic area.
- This is only available from size **6.0** and hence only can be used in adolescents and adults.
- Based on a recent meta-analysis, there is moderate evidence that subglottic secretion drainage may be used as one of the several modalities in preventing VAP.

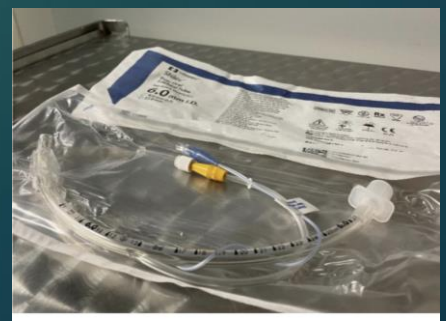

Figure 1. Endotracheal tube with a subglottic suction.

Frequency of ventilator circuit changes

- Studies show that there is no difference in VAP rate between circuit change which are done once weekly or <1 week.
- cost–benefit with less frequent changes.
- It should be considered a part of VAP prevention bundle.
- Changing of the ventilator circuit only when visibly soiled

Suctioning techniques and equipment

- Maintenance of aseptic techniques when performing endotracheal suctioning is essential to prevent contamination of the airways.
- **Several studies showed that no difference in VAP incidence with open or closed suction system.**
- The use of (NSI) prior to endotracheal suctioning has been practiced widely in ICU to assist with eliciting cough, and the dilution and removal of thick secretions. There has been a debate that NSI **could increase** the incidence of VAP because it dislodges more viable bacterial colonies from the endotracheal tube to the lower respiratory tract than the insertion of suctioning catheter without saline instillation.

probiotics

- prophylactic use of probiotics reduced the incidence of VAP by 77% in PICUs .
- this effect was explained by the theoretical possibility of intestinal barrier function improvement caused by probiotics, together with the effect of regulating the composition of intestinal flora to minimize over-growth and colonization by pathogenic bacteria and increase host cell antimicrobial peptides

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Pediatric Infectious Diseases, a section of the journal Frontiers in Pediatrics

RECEIVED 21 September 2022
ACCEPTED 24 October 2022
PUBLISHED 15 November 2022

CITATION
Roshanzamiri S, Alemzadeh M, Ahmadizadeh SN, Behzad A, Hashemi SM, Salamzadeh J and Mirrahimi B (2022) Probiotic prophylaxis to prevent ventilator-associated pneumonia in children on mechanical ventilation: A randomized double-blind clinical trial.
Front. Pediatr. 10:1045941.
doi: 10.3389/fped.2022.1045941

Probiotic prophylaxis to prevent ventilator-associated pneumonia in children on mechanical ventilation: A randomized double-blind clinical trial

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Purpose: Ventilator-Associated Pneumonia (VAP) is one of the most common nosocomial infections in the Pediatric Intensive Care Unit (PICU). Using new strategies to prevent nosocomial infections is crucial to avoid antibiotic resistance. One of these strategies is the utilization of probiotics. This study aims to investigate the efficacy of probiotic prophylaxis in preventing VAP in mechanically ventilated children.

Method: This study was a randomized, double-blind clinical trial. The study included 72 children under 12 years of age under mechanical ventilation for more than 48 h in the Mofid Children's Hospital. Patients were randomly divided into Limosilactobacillus reuteri *DSM 17938* probiotic recipients ($n = 38$) and placebo groups ($n = 34$). In addition to the standard treatment, both groups received a sachet containing probiotics or a placebo twice a day. Children were screened for VAP based on clinical and laboratory evidence.

Results: The mean age of children in the intervention and placebo groups was 4.60 ± 4.84 and 3.38 ± 3.49 years, respectively. After adjusting the other variables, it was observed that chance of VAP among probiotics compared to the placebo group was significantly decreased (OR adjusted = 0.29; 95% CI: 0.09–0.95). Also, probiotic was associated with a significantly lower chance of diarrhea than the placebo group (OR adjusted = 0.09; 95% CI: 0.01–0.96).

Conclusion: Probiotic utilization is effective in preventing the incidence of VAP and diarrhea in children under mechanical ventilation in the PICU.

KEYWORDS

probiotics, ventilator-associated pneumonia (VAP), intensive care units, pediatric, mechanical ventilation

adequate rehabilitation.

- Although this study worked only with adult patients, it demonstrated that extensive rehabilitation intervention is advantageous to the ICU patients on mechanical ventilation.
- The incidence of VAP, time on mechanical ventilation and length of hospital stay were lower in patients that received comprehensive rehabilitation treatment (**passive exercise therapy**, **anti-respiratory exercise therapy**, **active exercise therapy**, etc.) compared to patients that were given only routine rehabilitation treatment.


children

MDPI

Review

Ventilator-Associated Pneumonia Prevention in Pediatric Patients: Narrative Review

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THANK
YOU !