JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Ventilator Associated Pneumonia (VAP) (CPG ID:45)

To establish guidance for the prevention and mitigation of Ventilator Associated Pneumonia (VAP)

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TABLE OF CONTENTS

Goal....3
Background....3
Diagnosis....3
Prophylactic Measures....4
- General Measures:....4
- Staff Education priorities....4
- VAP Bundle Components....5
- Respiratory Equipment Management....5
  - Breathing Circuits with Humidifiers....5
  - Breathing Circuit/Tubing Condensation....5
  - Humidifiers....5
- Prevention of Person-to-Person Transmission of Bacteria....5
  - Cohorting....5
  - Standard Precautions....5
  - Gloves....6
  - Care of Patients with Tracheostomy....6
  - Suctioning of Respiratory Tract Secretions....6

Prevention of Mucus Plugging (Endotracheal Tube) 6
Prevention of Aspiration Related Infection (Gastrointestinal) 6
Prevention of Postoperative Pneumonia 7
Aeromedical Evacuation Considerations 7
Performance Improvement (PI) Monitoring 8
Population of Interest 8
Intent (Expected Outcomes) 8
Performance/Adherence Metrics 8
Data Sources 8
System Reporting & Frequency 8
Responsibilities 8
References 9
Appendix A: Ventilator-associated Events Surveillance Algorithm 10
Appendix B: Antimicrobials Agents Eligible for IVAC, PVAP 11
Appendix C: ABCDEF Bundle 12
Appendix D: Additional Information Regarding Off-label Uses in CPGs 13

GOAL

The goal of this Clinical Practice Guideline (CPG) is to provide guidance for the diagnosis, treatment, prevention, and mitigation of Ventilator Associated Pneumonia (VAP). These guidelines are not intended solely for clinical care, but also to help unit commanders and supporting medical components to consider the unique challenges of the management of a common healthcare associated infection in both traditional and expeditionary settings.

BACKGROUND

VAP is a common healthcare-associated infection (HAI), but what defines VAP and how it is diagnosed have remained moving targets. Due to wide variations in the surveillance and diagnosis of VAP, the true rate of VAP is unknown, but it is believed to occur in at least 5-15% of patients placed on a ventilator.[1-2]

While much of combat casualty care in the intensive care unit setting is largely similar to the care of trauma patients in civilian centers, there are several challenges unique to expeditionary care, chief among them being microbiological variabilities. Military operations in Iraq and Afghanistan are notable for a high number of multi-drug resistant (MDR) bacterial infections in combat casualties, particularly Acinetobacter calcoaceticus-baumannii complex (ABC).[3]

Several benchmark studies, along with other data, implicate nosocomial transmission as the major contributing source of these infections.[4-6] *An outbreak of multi-drug resistant Acinetobacter baumannii-calcoaceticus complex infections in the U.S. military health-care system associated with military operations in Iraq* described cluster outbreak strains of ABC within the military healthcare system suggesting that, at least in the case of ABC, the bacteria has spread from field hospitals in Iraq to those within the continental U.S.[7] Additionally, bacteria identical to those found in clinical isolates have been cultured from numerous environmental surfaces from U.S. medical treatment facilities within Iraq. These experiences have been replicated in more recent times with similar results, indicating that this issue is endemic and not related to individuals or groups of service members.

DIAGNOSIS

The diagnosis of VAP is difficult and varies across institutions. American Thoracic Society and Infectious Disease Society of America guidelines define VAP as a "new lung infiltrate plus clinical evidence that the infiltrate is of an infectious origin, which include the new onset of fever, purulent sputum, leukocytosis, and decline in oxygenation" which develops >48 hours after endotracheal intubation.[8]

Determination of whether a pulmonary abnormality is of infectious origin is particularly challenging, especially in trauma patients. Blast injury and penetrating chest injury patients are highly likely to have injury-related chest radiography findings that may obscure or mimic infections.

Patients on mechanical ventilation are at risk for a variety of serious complications in addition to VAP, including acute respiratory distress syndrome, pneumothorax, pulmonary embolism, lobar atelectasis, and pulmonary edema. The Centers for Disease Control have large scale, ongoing quality projects designed to validate and streamline surveillance measures, though these have yet to be validated for a priori diagnosis of various ventilator associated conditions. Despite the changing language surrounding ventilator associated conditions, the strongest and most consistent evidence continues to support daily

sedation interruptions and spontaneous breathing trials for aggressive liberation from mechanical ventilation as the factors most likely to reduce all ventilator associated conditions.[9]

PROPHYLACTIC MEASURES

GENERAL MEASURES:

1. Conduct active surveillance for ventilator associated conditions,[10] including but not limited to:
   - Ventilator associated pneumonia
   - Pulmonary edema
   - Acute respiratory distress syndrome
   - Atelectasis
2. Perform daily assessments of readiness for extubation including:
   - Daily sedation interruptions for patients in whom it is not contra-indicated (e.g., severe cerebral edema).
   - Protocoled conduction of spontaneous breathing trials for all patients meeting the following criteria:

   Required criteria

   a. The cause of the respiratory failure has improved.

   b. PaO2/FiO2 ≥150 or SpO2 ≥90 percent on FiO2 ≤ 50 percent and positive end-expiratory pressure (PEEP) ≤ 8 cmH2O

   c. pH >7.25

   d. Hemodynamic stability (no or low dose vasopressor medications)

   e. Able to initiate a spontaneous inspiratory effort.

   Additional criteria (optional criteria)

   a. Hemoglobin ≥7 mg/dL

   b. Core temperature ≤38 to 38.5°Centigrade

   c. Mental status awake and alert or easily arousable with ability to protect airway.

STAFF EDUCATION PRIORITIES

1. Epidemiology of Ventilator Associated Events
2. Infection-control procedures for prevention of VAP

   a. Avoid intubation and utilize non-invasive ventilation when possible.

   b. ABCDEF bundle[11] (see Appendix C)

   c. VAP bundle components and use[12] (See below.)

3. Periodic audits of the use of guidelines with aggressive education and enforcement of procedures.

VAP BUNDLE COMPONENTS

RESPIRATORY EQUIPMENT MANAGEMENT

Breathing Circuits with Humidifiers

Change the circuit when it is visibly soiled or mechanically malfunctioning. Do not routinely change on the basis of duration of use of the breathing circuit (i.e. ventilator tubing and exhalation valve and the attached humidifier) that is in use on an individual patient.

Breathing Circuit/Tubing Condensation

Periodically drain and discard any condensation that collects in the tubing of mechanical ventilators, taking precautions not to allow condensation to drain toward the patient. Wear gloves to perform the procedure and/or when handling the fluid. Decontaminate hands with soap and water (if hands are visibly soiled) or with an alcohol-based hand solution before and after performing the procedure or handling the fluid.

Humidifiers

Use sterile (not distilled, nonsterile) water to fill bubbling humidifiers. Between the uses of reusable hand-powered resuscitation bags on different patients, sterilize or subject to high-level disinfection. Do not routinely sterilize or disinfect the internal machinery of anesthesia equipment. Between uses on different patients, clean reusable components of the breathing system or patient circuit (e.g., tracheal tube or face mask) inspiratory and expiratory breathing tubing, y-piece, reservoir bag, humidifier, and tubing, and then sterilize or subject them to high-level liquid chemical disinfection or pasteurization in accordance with the device manufacturers' instructions for their reprocessing.

Keep all ventilators covered when not in use to reduce dust accumulation on devices.

PREVENTION OF PERSON-TO-PERSON TRANSMISSION OF BACTERIA

Cohorting

Implement patient and staff cohorting whenever possible by using geographically distinct areas of care. In the deployed setting, this includes separating Host National from non-Host National patient due to differences in the microbiomes. Disinfect all patient care equipment after each patient transfer. Terminally clean rooms between patients and consider periodic (monthly) ICU/ICU subunit closure for thorough cleaning and disinfection. In deployed settings, this should be conducted as regularly as field conditions permit.

Standard Precautions

Decontaminate hands by washing either with antimicrobial soap and water (if hands are visibly dirty or contaminated with blood or body fluids), or by using an alcohol-based waterless antiseptic agent if hands are not visibly soiled. Use personal protective equipment based on clinical circumstance.

Contact precautions with gloves and gown for all patient contact for patients infected or suspected with epidemiologically significant pathogens, specifically MDR Acinetobacter spp., ESBL-producing Klebsiella spp. and Escherichia coli, carbapenem-resistant Enterobacteriaceae, vancomycin-resistant Enterococcus spp., and methicillin-resistant Staphylococcus aureus. Decontaminate hands before and after patient contact and use gloves as below.

Gloves

Wear gloves for handling secretions or objects contaminated with secretions of any patient. Change gloves and decontaminate hands as described previously between contacts with different patients. When anticipating becoming soiled from secretions, wear a gown and change it after soiling occurs and before providing care to another patient.

Care of patients with Tracheostomy

Perform tracheostomy care under aseptic conditions. When changing a tracheostomy tube, wear a gown and mask, use aseptic technique. Providers should familiarize themselves with manufacturers recommendations regarding the quality and frequency recommended for tracheostomy care. Additionally, the life expectancy of inner cannula is variable depending on the product used (e.g., 24h to 29 days). Tracheostomy care orders should be written specific to the product used.

Suctioning of respiratory tract secretions

Appropriate to use either the multiuse closed system suction (Ballard) catheter or the single-use open system suction catheter. Patients persistently on the ventilator should have a Ballard system in line, while those intermittently on or off the ventilator with a tracheostomy in place can have the open suction employed as appropriate. If the open-system suction is employed, use a sterile, single-use catheter and sterile technique when suctioning. Use only sterile fluid to remove secretions from the suction catheter if the catheter is to be used for re-entry into the patient's lower respiratory tract.

PREVENTION OF MUCUS PLUGGING (ENDOTRACHEAL TUBE)

- If feasible, use an endotracheal tube (Hi Lo Tube) with a dorsal lumen above the endotracheal cuff to allow drainage of tracheal secretions that accumulate in the patient's subglottic area.
- Before deflating the cuff of an endotracheal tube in preparation for extubation, ensure that secretions are cleared from above the tube cuff.

PREVENTION OF ASPIRATION RELATED INFECTION (GASTROINTESTINAL)

- Head of bed elevation: In the absence of contraindication(s), elevate the head of bed at an angle of 30° to 45° of a patient at high risk for aspiration (e.g., traumatic brain injury, mechanically assisted ventilation).
- As soon as the clinical indications for their use are resolved, remove devices such as endotracheal, tracheostomy, and/or enteral tubes from patients.
- Feeding tube verification: Verify appropriate placement of the feeding tube prior to use.
- Due to recent studies questioning the value and safety[12] of chlorhexidine-based oral care, this guideline does not advocate for the routine use of chlorhexidine-based oral decontamination.

Routine oral hygiene with a tooth brush or oral sponge should continue to be provided with the goals of removal of dental plaque and other debris from teeth, tongue and oral mucosa.

PREVENTION OF POSTOPERATIVE PNEUMONIA

- Encourage all postoperative patients to take deep breaths, move about the bed, and ambulate unless medically contraindicated.
- Use incentive spirometry on postoperative patients.
- Incorporate rehabilitation therapy as early as possible in the post-operative period.
- Antibiotic therapy:
  - Surgical prophylaxis: Minimize the duration and spectrum of surgical antibiotic prophylaxis in accordance with the JTS Infection Prevention Clinical Practice Guideline, 08 Aug 2016.13
  - Suspected infection: Initial therapy should be broad spectrum and informed by each facility's antibiotic susceptibility patterns, if available. When possible, cultures should be obtained prior to initiation of antibiotic therapy. Infectious Disease Society of America guidelines state that non-invasive sampling with semi-quantitative cultures is the preferred methodology. Therapy should be tailored based on culture results and should be given for a 7 day course.14

AEROMEDICAL EVACUATION CONSIDERATIONS

1. Aeromedical Evacuation from any AOR to CONUS can require multiple flights over the course of days before the patient arrives at his or her final destination.
2. All patients, including those on mechanical ventilation, will experience a decrease in PaO2 as ambient pressure decreases.
   - Patients with marginal gas exchange will require additional support during flight.
   - Cabin altitude restriction will lessen the impact on gas exchange.
3. All ventilated patients should have the head of bed elevated at least 30° unless there is a contraindication.
4. All ventilated patients require gastric decompression prior to flight. Barring specific surgical indications for nasal placement, orogastric tube is preferred to nasogastric tube to prevent sinusitis.
5. If NPO or not tolerating fluids, consider adding IV fluids to help prevent dehydration during flight. Consider increasing maintenance IV rate due to dry air at altitude and increased rate of insensible loss.
6. Consider repeat CXR prior to flight if > 12 hours has elapsed since most recent one or clinical condition has changed significantly.
7. Do not extubate patient less than 4 hours prior to take off.
8. Consider enteral nutrition according to JTS Nutritional Support Using Enteral and Parenteral Methods CPG.[15] Tube feeds not administered through a small bowel feeding tube should be discontinued prior to flight.

9. Patients with decreased mobility require routine Deep Venous Thrombosis prophylaxis. See the JTS CPG The Prevention of Deep Venous Thrombosis – Inferior Vena Cava Filter, 02 Aug 2016.[16]
    - If anatomically feasible, sequential compression devices should be used.
    - Enoxaparin 30mg sq BID or heparin 5000 IU sq q8h may be used as chemoprophylaxis providing patient does not have potential hemorrhagic issues.
10. Gastric ulcer prevention should be provided if indicated

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All patients receiving mechanical ventilation.

INTENT (EXPECTED OUTCOMES)

- Incidence of VAP is tracked in each ICU and for the system as a whole.
- Mechanically ventilated patients receive VAP bundle.

PERFORMANCE/ADHERENCE METRICS

- Number and percentage of mechanically ventilated patients who develop VAP, tracked for each role 3 and 4 separately and overall for the system as a whole.
- Number and percentage of patients who have daily sedation interruption and spontaneous breathing trial or contraindication documented.

DATA SOURCES

- Patient Record
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the Joint Trauma System (JTS) Director, JTS Program Manager, and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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APPENDIX A: VENTILATOR-ASSOCIATED EVENTS SURVEILLANCE ALGORITHM

Patient has a baseline period of stability or improvement on the ventilator, defined by ≥ 2 calendar days of stable or decreasing daily minimum* FiO_2 or PEEP values. The baseline period is defined as the 2 calendar days immediately preceding the first day of increased daily minimum PEEP or FiO_2. *Daily minimum defined by lowest value of FiO_2 or PEEP during a calendar day that is maintained for > 1 hour.

After a period of stability or improvement on the ventilator, the patient has at least one of the following indicators of worsening oxygenation:
1) Increase in daily minimum* FiO_2 of ≥ 0.20 (20 points) over the daily minimum FiO_2 of the first day in the baseline period, sustained for ≥ 2 calendar days.
2) Increase in daily minimum* PEEP values of ≥ 3 cmH_2O over the daily minimum PEEP of the first day in the baseline period† , sustained for ≥ 2 calendar days.
*Daily minimum defined by lowest value of FiO_2 or PEEP during a calendar day that is maintained for > 1 hour. †Daily minimum PEEP values of 0-5 cmH_2O are considered equivalent for the purposes of VAE surveillance

Ventilator-Associated Complication (VAC)

On or after calendar day 3 of mechanical ventilation and within 2 calendar days before or after the onset of worsening oxygenation, the patient meets both of the following criteria:
1) Temperature > 38 °C or < 36°C, OR white blood cell count ≥ 12,000 cells/mm^3 or ≤ 4,000 cells/mm^3
2) A new antimicrobial agent(s) (see Appendix B for eligible antimicrobial agents) is started, and is continued for ≥ 4 qualifying antimicrobial days.

Infection-related Ventilator-Associated Complication (IVAC)

On or after calendar day 3 of mechanical ventilation and within 2 calendar days before or after the onset of worsening oxygenation, ONE of the following criteria is met (taking into account organism exclusions specified in the protocol):
1) Criterion 1: Positive culture of one of the following specimens, meeting quantitative or semi-quantitative thresholds† as outlined in protocol, without requirement for purulent respiratory secretions:
- Endotracheal aspirate, ≥ 10^5 CFU/ml or corresponding semi-quantitative result
- Bronchoalveolar lavage, ≥ 10^4 CFU/ml or corresponding semi-quantitative result
- Lung tissue, ≥ 10^4 CFU/g or corresponding semi-quantitative result
- Protected specimen brush, ≥ 10^3 CFU/ml or corresponding semi-quantitative result

2) Criterion 2: Purulent respiratory secretions (defined as secretions from the lungs, bronchi, or trachea that contain >25 neutrophils and <10 squamous epithelial cells per low power field [lpf, x100])† **PLUS** organism identified from one of the following specimens (to include qualitative culture, or quantitative/semi-quantitative culture without sufficient growth to meet criterion #1):
- Sputum
- Endotracheal aspirate
- Bronchoalveolar lavage
- Lung tissue
- Protected specimen brush

3) Criterion 3: One of the following positive tests:
- Organism identified from pleural fluid (where specimen was obtained during thoracentesis or initial placement of chest tube and NOT from an indwelling chest tube)
- Lung histopathology, defined as: 1) abscess formation or foci of consolidation with intense neutrophil accumulation in bronchioles and alveoli; 2) evidence of lung parenchyma invasion by fungi (hyphae, pseudohyphae or yeast forms); 3) evidence of infection with the viral pathogens listed below based on results of immunohistochemical assays, cytology, or microscopy performed on lung tissue
- Diagnostic test for Legionella species
- Diagnostic test on respiratory secretions for influenza virus, respiratory syncytial virus, adenovirus, parainfluenza virus, rhinovirus, human metapneumovirus, coronavirus

† If the laboratory reports semi-quantitative results, those results must correspond to the quantitative thresholds.

Possible Ventilator-Associated Pneumonia (PVAP)

APPENDIX B: ANTIMICROBIALS AGENTS ELIGIBLE FOR IVAC, PVAP

Antimicrobials Agents Eligible for IVAC, PVAP	
1. Amikacin	35. Gentamicin
2. Amphotericin B	36. Imipenem/Cilastatin Isavuconazonium
3. Amphotericin B Liposomal	37. Itraconazole
4. Ampicillin	38. Levofloxacin
5. Ampicillin/Sulbactam	39. Linezolid
6. Anidulafungin	40. Meropenem
7. Azithromycin	41. Meropenem/Vaborbactam
8. Aztreonam	42. Metronidazole
9. Baloxavir Marboxil	43. Micafungin
10. Caspofungin	44. Minocycline
11. Cefazolin	45. Moxifloxacin
12. Cefepime	46. Nafcillin
13. Cefotaxime	47. Omadacycline
14. Cefotetan	48. Oritavancin
15. Cefoxitin	49. Oseltamivir
16. Ceftaroline	50. Oxacillin
17. Ceftazidime	51. Penicillin G
18. Ceftazidime/Avibactam	52. Peramivir
19. Ceftolozane/Tazobactam	53. Piperacillin
20. Ceftriaxone	54. Piperacillin/Tazobactam
21. Cefuroxime	55. Plazomicin
22. Ciprofloxacin	56. Polymyxin B
23. Clarithromycin	57. Posaconazole
24. Clindamycin	58. Quinupristin/Dalfopristin
25. Colistimethate	59. Rifampin
26. Dalbavancin	60. Sulfamethoxazole/Trimethoprim
27. Delafloxacin	61. Tedizolid
28. Doripenem	62. Telavancin
29. Doxycycline	63. Tetracycline
30. Eravacycline	64. Tigecycline
31. Ertapenem	65. Tobramycin
32. Fluconazole	66. Vancomyin, Intravenous Only
33. Fosfomycin	67. Voriconazole
34. Gemifloxacin	68. Zanamivir

APPENDIX C: ABCDEF BUNDLE

A: Assess, prevent and manage pain

B: Both Spontaneous Awakening Trials (SAT) and Spontaneous Breathing Trials (SBT)

C: Choice of analgesia and sedation

D: Delirium: Assess, Prevent and Manage

E: Early mobility and exercise

F: Family engagement and empowerment (challenging in the deployed environment)

The ABCDEF Bundle: Science and Philosophy of How ICU Liberation Serves Patients and Families, Ely EW, Crit Care Med. 2017 February; 45(2): 321–330

APPENDIX D: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.