Ventilator-Associated Event Prevention: (Ventilator-Associated Pneumonia Prevention)

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VAP: Why is it Important?

VAP occurs in 10-25% of patients undergoing mechanical ventilation (4-16 cases/1000 ventilator days)

Patients stay in ICU on average 4-9 more days

Attributable mortality 20-50%

High morbidity and mortality

IT IS PREVENTABLE
VAP Definition

Clinically defined pneumonia

Is associated with a ventilator
  • Pneumonia occurs after being placed on ventilator
  • Pneumonia occurs within 48 hours after extubation

Number of VAP/number of ventilator days x 1000
Hospital Acquired Pneumonia: Routes of Entry

- Microaspiration
- Gross aspiration
- Inhalation of infected aerosol
- Hematogenous spread
- Exogenous spread (i.e. pleural space)
- Direct inoculation (health care providers)
Therapeutic Interventions Which May Predispose to Pneumonia

- Antacids
- H$_2$-blocking drugs
- High oxygen concentrations
- Sedating drugs
- Corticosteroids
- Nasogastric tube use
- Broad spectrum antibiotics
- Endotracheal intubation
Medical Interventions that Bypass Host Defenses

Seminars in Respiratory Infections 3:157, 1990
Ventilator-Associated Pneumonia: Risk Factors

277 patients requiring mechanical ventilation for more than 24 hours

4 factors associated with VAP

- Multiple organ system failure
- Age 60 years or older
- Prior administration of antibiotics
- Supine head positioning (less than 30 degrees)

Diagnostic Strategies: Clinical vs. Bacteriologic

Clinical
- Dx as subsequent slide
- Sensitivity vs specificity altered based on number of criteria used
- Etiology defined by semi-quantitative cultures
- Emphasizes prompt abx
- Abx choice based on risk factors
- Therapy modified by response and cultures
- Over sensitive, less specific

Bacteriologic
- Uses quantitative cultures of lower resp secretions (BAL or PSB) to define pna and org
- Decision on initial abx still clinically based
- Consistently finds less org than qualitative cultures
- Less abx used
- Findings not always consistent or reproducible
- False neg may lead to under treatment
Clinically Defined Pneumonia: Diagnosis

Two or more serial CXRs with at least one of the following:
- New or progressive and persistent infiltrate
- Consolidation
- Cavitation

At least one of the following:
- Fever (>38 C with no other recognized cause)
- Leukopenia (<4,000 WBC/mm3) or leukocytosis (>12,000 WBC/mm3)
- For adults ≥ 70 years old, altered mental status with no other recognized cause

And at least two of the following:
- New onset of purulent sputum, or change in character of sputum, or increased respiratory secretions, or increased suctioning requirements
- New onset or worsening cough, or dyspnea, or tachypnea
- Rales or bronchial breath sounds
- Worsening gas exchange, increased oxygen requirements, or increased ventilator demand
  - The National Healthcare Safety Network (NHSN))
Clinical Diagnosis of Ventilator Associated Pneumonia Revisited: Comparative Validation Using Immediate Post-mortem Lung Biopsies

Presence of infiltrate and two of three clinical criteria (leukocytosis, purulent secretions, fever) had a sensitivity of 69% and specificity of 75%

Non-invasive and invasive sampling techniques had comparable results

- Fabregas et al, Thorax 54:867-873, 1999
NHSN New Surveillance Definition for Ventilator-Associated Events

Old VAP Definition:
- Good for internal QI
- Poor objectivity for public reporting

New VAE Definition
- Surveillance not clinical
- Less subjectivity
Supine Body Position as a Risk Factor for Nosocomial Pneumonia in Mechanically Ventilated Patients: A Randomized Trial

86 mechanically ventilated patients randomized to either supine (flat) vs semi-recumbent (45 degrees) to assess relationship to nosocomial pneumonia

Trial stopped early

Clinically suspected pneumonia decreased from 34% to 8% (p=0.003) in semi-recumbent group

Microbiologically confirmed pneumonia was reduced from 23% to 5% in the semi-recumbent group (p=0.018)

The semi-recumbent body position reduces frequency and risk of pneumonia. The risk of pneumonia increased with longer duration of mechanical ventilation and with decreased consciousness

• Drakulovic et al, Lancet 1999;354:1851-58
Daily Interruption of Sedative infusions in Critically Ill Patients Undergoing Mechanical Ventilation

Randomized, controlled trial of 128 adults on mechanical ventilation and continuous sedation.

Compared daily interruptions until the patient was awake with interruptions only at the discretion of the clinicians in the ICU

Median time of mechanical ventilation was 4.9 days in the intervention group and 7.3 days in the control group (p=0.004)

Median LOS in the ICU was 6.4 days in the intervention group and 9.9 days in the control group (p=0.02)

In-hospital mortality was 36% in intervention group and 47% in control group (p=0.25)

Effect of a Nursing-Implemented Sedation Protocol on Duration of Mechanical Ventilation

Randomized control trial comparing protocol-directed sedation during mechanical ventilation implemented by nurses with a traditional non-protocol-directed sedation administration

The median duration of mechanical ventilation was 55.9 hours for patients treated with protocol-directed sedation and 117.0 hours for traditionally sedated patients (p=0.04)

LOS in hosp was reduced from 7.5 to 5.7 days (p=0.013) in the protocol-directed group

Hospital LOS was reduced from 19.9 days to 14.0 days (p<0.001) in the protocol directed group

Protocol directed group had significantly lower tracheostomy rate (13.2% vs 6.2%)

- Brook et al, CCM, 1999:27:2609-2615
A Protocol of No Sedation for Critically Ill Patients Receiving Mechanical Ventilation: A Randomized Trial

Single center non-blinded trial comparing no sedation with daily interruption of sedation (140 patients with 1:1 nursing)

No sedation had significantly more days without ventilation (13.8 vs. 9.6), shorter length of ICU stay (13.1 vs. 22.8), and hospital LOS (34 vs 58). Mortality in ICU 22% vs 38% P=0.06.

No difference in complications but higher incidence of delirium

Need multicenter trial to confirm

Decrease in Ventilation Time With a Standardized Weaning Process

Compared 515 mechanically ventilated patients who underwent protocol-guided weaning from mechanical ventilation by respiratory therapists with 578 historical control patients who underwent physician-directed weaning.

Mean hours of mechanical ventilation decreased by 58 hours, a 46% decrease ($p<0.001$). The length of hospital stay decreased by 1.77 days, a 29% decrease.

Numbers of reintubations did not change.

Marginal cost savings was $603,580.

- Mathida et al, Arch Surg, 1998;133:483-489
Randomized Controlled Trial and Meta-analysis of Oral Decontamination with 2% Chlorhexidine Solution for the Prevention of Ventilator-Associated Pneumonia

207 patients randomized to receive oral care with 2% chlorhexidine solution vs normal saline

VAP rate 4.9% (7/1000 ventilator days) in chlorhexidine group vs 11.4% (21/1000 ventilator days) in normal saline group

Conclusion: Oral decontamination with 2% chlorhexidine solution is an effective and safe method for preventing VAP in patients who receive mechanical ventilation.

Oral Care

Meta-analysis of 7 randomized controlled trials (1650 patients; 812 chlorhexidine, 838 control)

Topical chlorhexidine resulted in reduced incidence of VAP (RR 0.74; 95% CI 0.56-0.96; p=0.02)

Subgroup analysis showed greatest benefit in cardiac surgery patients (RR 0.41)

No mortality benefit

Chlebicki, CCM, 2007, 35:595-602
Early Activity in Respiratory Failure Patients

Prospective study of early activity in respiratory failure patients requiring mechanical ventilation more than 4 days

Sit on bed, sit in chair, ambulate

1449 activity events in 103 patients

In patients with endotracheal tube, 593 activity events; 249 (42%) ambulation

No extubations during activity

Bailey et al, CCM, 2007, 35:139-145
Early ICU Mobility Therapy in the Treatment of Acute Respiratory Failure

Prospective cohort MICU study comparing mobility protocol with usual care for respiratory failure patients

Nurse, assistant and PT initiated protocol within 48 hours of MV

More patients in protocol group received PT (80% vs. 47%), OOB earlier (5 vs 11 days), had PT in ICU more frequently (91% vs. 13%)

Protocol patients had lower ICU LOS (5.5 vs. 6.9), and hospital LOS (11.2 vs. 14.5)

- Crit Care Med 2008;306:2238-2243
Peptic Ulcer Disease Prophylaxis

Stress ulcerations are the most common cause of gastrointestinal bleeding in intensive care unit patients.

The presence of gastrointestinal bleeding due to ulcerations is associated with increased mortality compared to ICU patients without bleeding.

Applying peptic ulcer disease prophylaxis is a necessary intervention in critically ill patients.
DVT Prophylaxis

The risk of venous thromboembolism is reduced if prophylaxis is consistently applied.

A clinical practice guideline from the ACCP recommends prophylaxis for patients undergoing surgery, trauma patients, acutely ill medical patients, and patients admitted to the intensive care unit.

Several randomized controlled trials support this recommendation.

• Geerts *Chest*. 2004
Bundle Methodology

Bundles are groups of interventions that when instituted together give better outcomes than when they are done individually.

Based on solid evidence or tradition that it is the right thing to do.

Brings together team effort around solid principles that eventually consider care far beyond what the bundle itself recommends.

Encourages the care team to look at the process involved in a particular aspect of the patients care.

The guidelines become a roadmap for the team to enhance care and measure outcomes.
First pants, 
THEN 
your shoes
Implementation of Clinical Practice Guidelines for Ventilator-Associated Pneumonia: A Multicenter Prospective Study

- Two year, 11 center multicenter trial
- Enrolled 30 patients at each center and evaluated at 4 data collection periods (baseline, 6, 15 and 24 months)
- Guideline implementation with multifaceted intervention (education, reminders, local opinion leaders and implementation teams)
- Aggregate concordance with all 14 recommendations increased from 50.7% to 58.7% (p=0.007)
- Ventilator associated pneumonia decreased from 47/330 (14.2%) to 29/330 (8.8%) (p=0.03)
University of Rochester Medical Center Strong Memorial Hospital

739 bed tertiary care medical center. Strong Health is a Trauma Center, Transplant Center (bone marrow, kidney, liver & heart). 5 adult ICU’s: MICU (16 beds), SICU (18 beds), Burn/Trauma (17 beds), NeuroMedicine (8 beds) and Cardiovascular ICU (14 beds)
VENTILATOR BUNDLE

Elevate HOB 30 degrees unless contraindicated

Sedation Vacation
• Turn off sedation until patient is able to follow commands or is fully awake.

DVT Prophylaxis

PUD Prophylaxis

Daily assessment for readiness to wean

Structured Oral Care and Mobility were added as adjunct therapies to enhance effectiveness of bundle
Implementation Process

Daily Goal Sheet
- Vital to implementation of the ventilator bundle
- Checklist with prompts for patient care priorities that were addressed each day during daily morning rounds by physicians, residents, nurses and the care coordinator
- Form kept in the patient bedside binder
- Initially tested on 4 patients
- Extensive modifications were required before final approval from the healthcare team
- Unit wide implementation of daily goal sheet and ventilator bundle
Our Ventilator Bundle Challenges

Resistance to practice change

- Physicians
  - Lack of buy-in
  - Daily Goal Sheets time consuming
  - Individual practice preferences
  - Skepticism about results of research and evidence provided to support the initiative

- Staff
  - Need to learn new protocols
  - Concern about compromised patient safety with sedation vacation
  - Practice boundary issues between Respiratory Therapy and Nursing when RT- Driven Weaning Protocol was implemented
Our Ventilator Bundle Challenges

HOB Noncompliance
- Inaccurate perception of 30 degrees
- Posted bedside signs and measurement cues
- HOB position documentation required on Flow Sheet

Sedation Vacation
- Nursing Resistance (perceived risk to patient safety)
  - Medical Director appealed to staff to develop a nurse-driven sedation

Daily Assessment for Ability to Wean
- Mechanical Ventilator Liberation Protocol presented issues of practice boundaries between Nursing and Respiratory Therapy
- Extensive in-services, 1:1 education and reinforcement required before successful implementation achieved
Ventilator Bundle: Cycles of Improvement

Numerous, rapid PDSA cycles of vent bundle as part of goal sheet on a few patients led to refinement of goal sheet.

Support of Medical Director and nurse leaders key to implementation

Training of attendings, residents and bedside nurses vitally important (education)

Posting results, positive reinforcement leads to more excitement

Focusing all initiatives on patient centered care and not in isolation

Importance of initiatives echoed by senior leadership during walk rounds

PDSA cycles continue as utilization continues to vary (ie percentage utilization decreases under certain attendings)

Constant feedback from nurses

Forms remain as permanent record
Practice Changes During Ventilator Bundle Implementation

- Protocols/Guidelines
  - Revision of Mechanical Ventilator Orders/Guidelines
  - Nurse-driven Sedation/Delirium/Sleep Wake Protocol
  - Respiratory Therapist-driven Weaning Protocol
  - Structured Oral Care Protocol for ventilator patients
  - Mobility Guidelines (Carried out a pilot study and implemented a Lift Team)
  - Glucose Management Protocol
  - Daily Goal Sheet incorporated into daily resident note
  - Adult Critical Care Goal Sheet/Nursing Care Plan
Average Ventilator Days

Burn Trauma

Cardiovascular

Medical

Surgical
Sedation Utilization Medical ICU
Progressive Mobility Surgical ICU

Level I
- Level I Modified Mobility
  - Reposition and Turn Q 2 Hrs
  - Splints and / or boots (alternate) for contracture prevention
  - AROM/PROM
  - HOB @ 30 degrees
- Maintain Level I for Pt.’s with:
  - Arterial Groin Catheter/Line
- Withdrawal of Care within 12-24hrs

Level II
- Level II (Include Level I Interventions)
  - HOB @ 45° to 65° if hemodynamically stable
  - Place legs in dependent position
  - Advance to Cardiac Chair/Bed in chair position
  - OOB to Chair with assistive device

Level III
- Level III (Include Level I & II Interventions)
  - Sit on Side of Bed
  - Advance to Standing Position
  - Initiate Pivot / Stand to bedside chair @ least 2 X Daily

Level IV
- Level IV (Include Level I, II & III Interventions)
  - Independent: OOB, Sit in Chair, Stand, Ambulate

Document all Mobility on Flow Sheet

Monitor for Physical Therapy / Occupational Therapy Consult:
- OT consult on admission, then weekly follow-up evaluation
- PT consult when patient is able to cooperate with activity or begins SBT (Spontaneous Breathing Trials)

Progressive Mobility Compliance

Medicine of the Highest Order

University of Rochester Medical Center
Keys to Success, Barriers and Lessons Learned

- Involve key front line staff
- Ongoing education....why are we doing this?
- Participation by senior leaders
- Medical Director and Nurse Manager must be fully supportive
- Administrative assistance
- Resistance to change
- Perceived increased workload
- Another QI project which will go away
Benefits of our Initiative: Reduction in LOS $$$$ and Lives Saved

~3,000 ventilated patients/year at SMH

At 10 VAP/1000 days, 180 VAP/yr “expected”

90% reduction in VAP, 160 VAP avoided/yr

At 50% mortality rate, 80 lives saved/yr

10 ICU days saved/VAP avoided = 1,600 ICU days saved

Average cost of ICU day ~ $2,000/day

$3.2 million saved

(Plus beds available for elective/transfer cases)
Figure 1. Potential ways by which the endotracheal tube may disrupt lung host defense mechanisms and lead to enhanced risk of lower respiratory tract infection.
VAP: Prevention

Handwashing

Reduce or alter abx prescribing practices

Limit ventilator tube changes

Subglottic suctioning

Silver impregnated ET-tubes
Finally

“If at first you don’t succeed, keep on sucking until you do suck seed”

- Curley (of the Three Stooges)