VAP/VAE Prevention and Innovation

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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
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
- Associated with poor outcomes
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

Nasogastric tube
Endotracheal tube
Larynx
Endotracheal tube cuff
Lungs
Nasopharynx and oropharynx
Esophagus
Lower esophageal sphincter
Stomach
Duodenum
Jejunum

Seminars in Respiratory Infections 3:157, 1990
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

Delirium

- Transient reversible brain dysfunction of rapid onset
- Marked by rapid fluctuations in mental status, disorientation, agitation or lethargy and reduced cognition
- Etiology multifactorial (closely linked with benzodiazepines)
Incidence, Risk Factors and Consequences of ICU Delirium

- Prospective observational study of 820 patients assessing risk factors for delirium
- Delirium occurred in 32% of patients
- Delirium associated with HTN, alcoholism, severity of illness and with sedatives and analgesics used to induce coma
- Delirium linked with longer length of ICU stay (11 vs 5 days) and mortality (26% vs 21%)
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
To determine the efficacy and safety of a protocol linking:

spontaneous awakening trials (SATs) and spontaneous breathing trials (SBTs)

- Ventilator-free days
- Duration of mechanical ventilation
- ICU and hospital length of stay
- Duration of coma and delirium
- Long-term neuropsychological outcomes
### ABC trial

<table>
<thead>
<tr>
<th></th>
<th>Intervention group (n=167)</th>
<th>Control group (n=168)</th>
<th>p value</th>
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<tr>
<td><strong>Ventilator-free days</strong></td>
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<tr>
<td>Mean</td>
<td>14.7 (0.9)</td>
<td>11.6 (0.9)</td>
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<td>Median</td>
<td>20.0 (0 to 26.0)</td>
<td>8.1 (0 to 24.3)</td>
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<td><strong>Time to discharge (days)</strong></td>
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<tr>
<td>From intensive care</td>
<td>9.1 (5.1 to 17.8)</td>
<td>12.9 (6.0 to 24.2)</td>
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<tr>
<td>From hospital</td>
<td>14.9 (8.9 to 26.8)</td>
<td>19.2 (10.3 to NA)†</td>
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<td><strong>28-day mortality</strong></td>
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<tr>
<td>47 (28%)</td>
<td></td>
<td>58 (35%)</td>
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<tr>
<td><strong>1-year mortality</strong></td>
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<td>74 (44%)</td>
<td></td>
<td>97 (58%)</td>
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<tr>
<td><strong>Duration of brain dysfunction (days)</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Coma</td>
<td>2 (0 to 4)</td>
<td>3 (1 to 7)</td>
<td>0.002</td>
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<tr>
<td>Delirium</td>
<td>2 (0 to 5)</td>
<td>2 (0 to 6)</td>
<td>0.50</td>
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<tr>
<td><strong>RASS at first successful SBT</strong></td>
<td>-1 (-3 to 0)</td>
<td>-2.5 (-4 to 0)</td>
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<tr>
<td><strong>Complications</strong></td>
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<td></td>
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<tr>
<td>Any self-extubation</td>
<td>16 (10%)</td>
<td>6 (4%)</td>
<td>0.03</td>
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<tr>
<td>Self-extubation requiring reintubation‡</td>
<td>5 (3%)</td>
<td>3 (2%)</td>
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<tr>
<td>Reintubation‡</td>
<td>23 (14%)</td>
<td>21 (13%)</td>
<td>0.73</td>
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<tr>
<td>Tracheostomy</td>
<td>21 (13%)</td>
<td>34 (20%)</td>
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Effectiveness and Safety of the Awakening and Breathing Coordination, Delirium Monitoring/Management, and Early Exercise/Mobility Bundle (ABCDE Bundle)

- Before and after study in 5 ICUs and 2 special care units
- 146 patients prebundle, 150 postbundle
- Coordinated SAT with SBT, delirium monitoring/management and early mobility bundle
- Bundled care spent 3 more days off ventilator, experienced less delirium and were more likely to be mobilized

- Balas et al, CCM 42:1024-1036, 2014
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
Reappraisal of Routine Oral Care With Chlorhexidine Gluconate for Patients Receiving Mechanical Ventilation: Systematic Review and Meta-Analysis

Klompas et al., JAMA, 2014
Reappraisal of Routine Oral Care With Chlorhexidine Gluconate for Patients Receiving Mechanical Ventilation
Systematic Review and Meta-Analysis  Klompas et al, JAMA, 2014

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Chlorhexidine</th>
<th>Control</th>
<th>Mean Difference (95% CI)</th>
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<tr>
<td>Cardiac Surgery Studies</td>
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<td>Open-label Studies</td>
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<td>Not estimable</td>
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<tr>
<td>Double-blind Studies</td>
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<td>Segers et al, 2006</td>
<td>0.51 (0.55)</td>
<td>0.56 (0.78)</td>
<td>-0.05 (-0.14 to 0.04)</td>
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<td>Subtotal</td>
<td>485</td>
<td>469</td>
<td>-0.05 (-0.14 to 0.04)</td>
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<tr>
<td>Total</td>
<td>485</td>
<td>469</td>
<td>-0.05 (-0.14 to 0.04)</td>
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<tr>
<td>Non-Cardiac Surgery Studies</td>
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<tr>
<td>Open-label Studies</td>
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<td></td>
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<tr>
<td>Fournier et al, 2000</td>
<td>13 (12)</td>
<td>18 (20)</td>
<td>-5.00 (-13.35 to 3.35)</td>
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<tr>
<td>Subtotal</td>
<td>30</td>
<td>30</td>
<td>-5.00 (-13.35 to 3.35)</td>
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<tr>
<td>Total</td>
<td>353</td>
<td>357</td>
<td>-0.15 (-2.18 to 1.89)</td>
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<tr>
<td>All Studies</td>
<td>838</td>
<td>826</td>
<td>0.01 (-1.12 to 1.14)</td>
</tr>
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</table>

Figure 4. Impact of Chlorhexidine Gluconate Use vs Comparators on Mean Duration of Mechanical Ventilation

Klompas et al, JAMA, 2014
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
Mobility/Sedation in the ICU

Old teaching:
- Keep sedated, comfortable and safe in bed
- Plenty of time to rehab once cured of their “critical illness”
- Early mobility is unsafe

New teaching:
- Sedation/delirium/lack of mobility contributes to long term poor outcome
- Sedation leads to delirium, prolonged mechanical ventilation, increased tracheostomies and death
- Early mobility is associated with improved patient outcomes
New Idea to Cut I.C.U. Trauma: Get Patients Up, Tubes and All

By GINA KOLATA

For years, doctors thought they had done their jobs if patients came out of an intensive care unit alive.

Now, though, researchers say they are alarmed by what they are finding as they track patients for months or years after an I.C.U. stay. Patients, even young ones, can be weak for years. Some have difficulty thinking and concentrating or have post-traumatic stress disorder and terrible memories of nightmares they had while heavily sedated.

While patients may be suffering lingering effects from illnesses that brought them to the I.C.U., researchers are increasingly convinced that spending days, weeks or months on life support in the units can elicit unexpected, long-lasting effects.

So now some I.C.U.’s are trying what seems like a radical solution: reducing sedation levels and getting patients up and walking even though they are gravely ill, complete with feeding tubes, intravenous lines and tethers to ventilators.

Even a few days in an I.C.U. can be physically devastating immediately afterward, said Dr. Naeem Ali of Ohio State University.

Continued on Page A11
Early physical and occupational therapy in mechanically ventilated, critically ill patients: a randomised controlled trial

- 104 patients on mech vent less than 72 hours but predicted to be on at least another 24 hours
- PT/OT during sedation interruption vs. sedation interruption
- Return to independent function in 59% (rx) vs 35% controls
- 2 days less delirium and 2.5 more vent free days.

Barriers to Mobilization

Over sedation

- Sedation/Analgesia Protocol
- Delirium Identification/Treatment

Unnecessary Lines/Catheters

- Early Removal of
  - Central Lines
  - Urinary Catheters
**SMH Critical Care Mobility Algorithm**

**Exclusion criteria:**
Order for strict bed rest (evaluate daily on rounds) – turn Q2, PROM
For patients with femoral catheter – discuss with provider

**Goal of Early Mobilization:**
- Promote mechanical ventilator weaning process
- Reduce ICU and Hospital LOS
- Prevent physical deconditioning
- Prevent Ventilator-Associated Pneumonia (VAP)
- Prevent Pressure Ulcers
- Maintain/achieve preadmission activity level
- Enhance Patient physical and psychological well being

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**General Safety & Precautions**

**Prevent Excessive WOB & Desaturation**
- Increase FiO₂ to maintain SaO₂ >90%
- Preoxygenate prior to mobilization

**Hemodynamic Stability**
- Allow 5-10 minutes after position change for equilibration

**Support Neuromuscular Weakness**
- Make sure sufficient personnel are available to keep patient safe
- Provide frequent rest periods during activity
- Follow patient with chair when ambulating or use ambulation device with seat
- Have a plan to transfer patient back to bed in event patient unable to stand pivot (Hover Matt, sling under patient, etc...)

**Pressure Ulcer Prevention**
- Utilize pressure redistribution surface in chair
- Limit time OOB to Chair to no more than 2 hours 3 times per day
- Encourage patients who are able to slightly change position q 15-30 minutes while in chair
- Fully offload pressure for at least 1 minute hourly while in chair
- Evaluate for redness upon return to bed

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This algorithm is intended to serve as a guideline for patient mobility. Consideration must be given to patient baseline mobility, patient status and the recommendation of physical therapy.
Equipment for Mobility: Transfer and Lifting

Hover Mat

SARA Lift
Mobilizing!
SCCM Practice Guidelines

- Recommend pre-emptive pain management with opioids
- Use lightest levels of sedation possible
- Suggest non-benzodiazepine sedation strategies
- Recommend early mobilization to limit risk for delirium
- Routinely assess level of pain, depth of sedation, and monitoring for delirium
  - Barr et al, Crit Care Med 2013;41:263-306
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 \( (8.8\%) \) \( (p=0.03) \)
830 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 (12 beds) and Cardiovascular ICU (14 beds)
VENTILATOR BUNDLE

Elevate HOB 30 degrees unless contraindicated

Sedation Vacation/Intermittent sedation/(Pain/Agitation/Delirium protocols)

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
  - Not enough staff
  - Concern about compromised patient safety with sedation vacation/intermittent sedation
  - 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/Intermittent Sedation
• 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

Mobilization
• “Too busy to bag and drag”
• “This is PTs job”
2014 Vent Bundle Process Measure Summary

Mobility Summary

- # of patients with medical contraindication to mobility: 49
- # of patients who refused mobilization: 1
- # of patients eligible for mobilization but not mobilized: 0
- # of patients mobilized (see graph for details): 458
- Total: 508

Maximum Mobility Level

<table>
<thead>
<tr>
<th>Position</th>
<th>Series 1</th>
<th>Chair Position</th>
<th>Dangle</th>
<th>OOB with device</th>
<th>Stand Pivot</th>
<th>March in place</th>
<th>Ambulate</th>
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<tr>
<td></td>
<td></td>
<td>43.98%</td>
<td>1.97%</td>
<td>30.37%</td>
<td>14.40%</td>
<td>1.18%</td>
<td>8.05%</td>
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Overall Bundle Compliance

- Compliance: 79.50%
- Noncompliance: 20.50%

Sedation Summary

- # of vended patients: 317
- # on intermittent sedation: 142 (44.79%)
- # on continuous sedation: 170 (53.63%)
- # of patients with daily sedation interruption: 145 (85.29%)
- # of patients with sedation interruption held for medical contraindications: 25 (14.71%)
- # of patients eligible for daily sedation interruption who did not receive: 0 (0.00%)
- # of pts with evidence of intermittent bolus use prior to starting/continuing infusions: 211 (66.56%)

Compliance

- Mobility: 100.00% (Compliant: 458, Eligible: 458)
- Delirium Screen done Every Shift: 76.13% (Compliant: 386, Eligible: 507)
- HOB > 30: 100.00% (Compliant: 311, Eligible: 311)
- DVT Prophylaxis: 100.00% (Compliant: 311, Eligible: 311)
- PUD Prophylaxis: 100.00% (Compliant: 312, Eligible: 312)
- Oral Care Per Protocol: 100.00% (Compliant: 312, Eligible: 312)
- Daily Sedation Interruption: 100.00% (Compliant: 145, Eligible: 145)
- Daily Assessment of ability to wean from ventilator: 100.00% (Compliant: 275, Eligible: 275)
Quarterly VAE Rate – New Definition

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<th>Year/Qtr</th>
<th>Total VAE Rate</th>
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<th>PVAP</th>
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<td>2013Q1</td>
<td>2.90</td>
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<td>2013Q2</td>
<td>2.73</td>
<td>1.36</td>
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<td>2013Q3</td>
<td>9.38</td>
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<td>2013Q4</td>
<td>6.92</td>
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<td>2015Q1</td>
<td>4.75</td>
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MICU Central Line Utilization

LineDU

[Graph showing utilization rates over time]
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 variable cost of ICU day ~ $1,000/day

$1.6 million saved

(Plus beds available for elective/transfer cases)
when greek salad goes bad...
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/VAE: Prevention

Avoid intubation (NIPPV)

Avoid volume overload

Low tidal volume ventilation (6-8 mL/kg)

Handwashing

Reduce or alter abx prescribing practices

Limit ventilator tube changes

Subglottic suctioning
Finally

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

- Curley (of the Three Stooges)
UR Medicine | Strong Memorial Hospital

Medicine of the Highest Order