Which of the following VAP prevention measures is NOT part of the widely adopted “ventilator bundle”?

A. Elevation of the HOB at least 30-45°
B. “Sedation vacation” each day on vent
C. Continuous subglottic suctioning (CSS)
D. Hand hygiene
E. Daily assessment of readiness to wean

Ventilator Associated Pneumonia: Prevention and Treatment

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Ventilator Associated Pneumonia (VAP)

- Causes excess morbidity/mortality in ICUs
- Accurate diagnosis is a major challenge
  - Affects treatment, prevention, study
- Prevention focuses primarily on limiting risk of aspiration of pathogens into LRT
- Empiric therapy increasingly broad as antimicrobial resistance advances
  - Obtain micro sample, reassess response at 48-72 hours, reduce duration of therapy

Ventilator Associated Pneumonia

- Most common nosocomial infection in the ICU
  - 25% of all NI reported from Med-Surg ICUs
  - Affects between 9-27% of intubated patients
- Increased morbidity, mortality and LOS
  - Increases LOS by 7-9 days
  - Increases hospital costs by $11- 40K
  - Attributable mortality from 0-50%!

Hidron AI, et al. Infect Cont Hosp Epidemiol 2008;29:996.
Safdar N, et al. Crit Care Med 2005;33:2184-93.
Rello J, et al. Chest 2002;122:2115-2121.
Rello J, et al. Chest 1991;100:439-444.

ORIGINAL INVESTIGATION

Clinical and Economic Outcomes Attributable to Health Care–Associated Sepsis and Pneumonia

Michael R. Eber, BSE; Ramanan Laxminarayan, PhD, MPH; Eli N. Perencevich, MD, MS; Anup Malani, PhD, JD

- Used discharge records from National Inpatient Sample database
- Healthcare associated pneumonia/VAP
  - Excess LOS = up to 14 days
  - Excess costs = $22-46K
  - Attributable mortality = 10-12%

Eber et al. Arch Intern Med 2010;170:347-53.

Limitations of VAP Definitions

"The wards and the post-mortem room show a very striking contrast in their pneumonia statistics…"
Sir William Osler, 1907

- One third with VAP have no autopsy evidence
- One fourth without VAP have autopsy evidence
- Aspects of definition are subjective
- Conditions with similar clinical findings:
  - atelectasis, pulmonary edema, thromboembolic dz, ARDS, alveolar hemorrhage, hypersensitivity pneumonitis, pulmonary contusion, combinations of disorders (e.g. BSI + pulmonary edema)

Klompas M. JAMA 2007;297:1583.

Clinical Diagnosis

Findings	SENS	SPEC	Likelihood ratio (+/-)
Infiltrate, + sputum cx, fever or leukocytosis	54	62	1.4/0.7
Purulent secretions and leukocytosis or infiltrate	72	42	1.2/0.7
Infiltrate plus at least 2 of: fever, leukocytosis, or purulent sputum	69	75	2.8/0.4
Clinical Pulmonary Infection Score > 6	72-77	42-85	2.1/0.4

Adapted from Klompas M. JAMA 2007;297:1583-93.
Wunderink et al. Chest 1992;101:458-463.
Torres et al. Am J Respir Crit Care Med 1994;149:324-331.
Fabregas et al. Thorax 1999;54:867-873.
Papazian et al. Am J Resp Crit Care Med 1995;152:1982.

Clinical definitions vs. autopsy

Definition	Sensitivity	Specificity	+ LR
Infiltrate + 2/3 clinical criteria	65 (57-72)	36 (28-45)	1.01
Infiltrate + all 3 clinical criteria	16 (11-22)	91 (84-95)	1.72
CPIS > 6 pts	46 (38-54)	60 (51-69)	1.15

"Accuracy of three commonly used clinical definitions was poor"

Tejerina E, et al. J Crit Care 2009;Epub (in press)

Ventilator-Associated Pneumonia—The Wrong Quality Measure for Benchmarking

Michael Klompas, MD, MPH, and Richard Platt, MD, MSc

- Lower VAP rates could mean:
  - Excellent care, fewer actual infections
  - Change in application of definition or diagnostic practices

"*Subjectivity and inaccuracy in the VAP definition allow hospitals to undertake practices that will markedly decrease their VAP rates and yet do little or nothing to improve patient outcomes.*"

Klompas M, Platt R. Ann Intern Med 2007;147:803-805.
Klompas M. Thorax 2009;64:463-65

Ventilator Associated Pneumonia
Organism Distribution: NHSN data

Organism	% of all
Staphylococcus aureus	24.4
Pseudomonas aeruginosa	16.3
Acinetobacter baumannii	8.4
Enterobacter spp.	8.4
Klebsiella pneumoniae	7.5

Hidron AI, et al. Infect Control Hosp Epidemiol 2008;29:996-1011.

Ventilator Associated Pneumonia: Risk Factors (partial list)

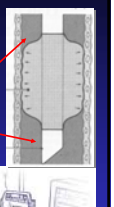
- *Mechanical ventilation*
- Recumbent position
- Increased gastric pH
- Enteral feeding
- ↓ level of consciousness
- Advanced age
- Male sex
- Pre-existing pulmonary disease

aspiration

http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5303a1.htm
Niederman et al. Am J Resp Crit Care Med 2005;171:388-416.

Pathogenesis of VAP

- Entry of pathogens into lower respiratory tract → colonization → infection
  - Leakage/aspiration around ET tube
  - Biofilm adherent to ET tube
  - Inhalation of contaminated aerosols
  - Direct inoculation
  - Hematogenous spread
- Infection often multifocal
  - Sampling issues?



Niederman, Craven, et al. Am J Resp Crit Care Med 2005;171:388-416.

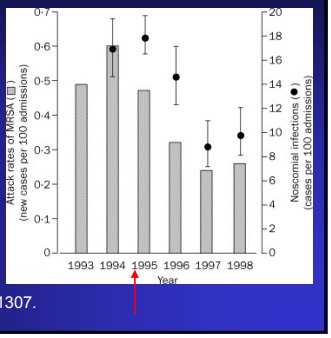
Preventing VAP: ↓ use of mechanical ventilation

- Facilitate/accelerate weaning
  - Protocols require adequate staffing
  - Reintubation also increases VAP risk
- Use non-invasive ventilation when possible
  - Positive pressure ventilation/facemask
  - COPD exacerbations, acute hypoxemic respiratory failure, immunocompromise with inflitrates and respiratory failure

Niederman, Craven, et al. Am J Resp Crit Care Med 2005;171:388-416.

Preventing VAP: Reducing pathogen transmission

- Hand hygiene
  - Hospital-wide hand hygiene campaign with alcohol product led to ↓ in overall nosocomial infection rate



Pittet D, et al. Lancet 2000;356:1307.

Preventing VAP: Reducing aspiration risk

- Head of bed elevation (30-45 degrees):
  - Torres et al, *Annals of Int Med* 1992;116:540-543
  - Ibanez et al. *JPEN* 1992;16:419-422
  - Orozco-Levi et al. *Am J Respir Crit Care Med* 1995;152:1387.
  - Drakulovic et al. *Lancet* 1999;354:1851-1858
  - Davis et al. *Crit Care* 2001;5:81-87
  - Grap et al. *Am J of Crit Care* 2005 14:325-332
- Subglottic suctioning:
  - Mahul et al. *Int Care Med* 1992;18:20-25
  - Valles et al. *Ann Int Med* 1995;122:179-186
  - Kollef et al. *Chest* 1999;116:1339-1346
  - Smulders et al. *Chest* 2002;121:858-862
  - Dezfulian et al. Am J Med 2005;118:11-18

Feasibility and effects of the semirecumbent position to prevent ventilator-associated pneumonia: A randomized study*

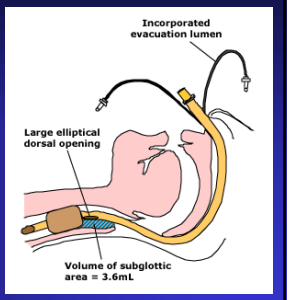
Christianne A. van Nieuwenhoven, MD; Christine Vandenbroucke-Grauls, PhD; Frank H. van Tiel, PhD; Hans C. A. Joore, MD; Rob J. M. Strack van Schijndel, MD; Ingeborg van der Tweel, PhD; Graham Ramsay, PhD; Marc J. M. Bonten, PhD

Crit Care Med 2006;34:396

- Pts randomized to target HOB of 45° (n=112) vs standard care (10°) (n=109)
- Achieved difference was 28% vs. 10%, with no significant difference in VAP rate
- Generalizability (can HOB elevation be maintained? Are any patients tx at 0°?)

Preventing VAP: Continuous subglottic suctioning

- Meta-analysis, 5 studies, 896 pts
  - VAP RR = 0.51; 95% CI 0.37-0.71
  - Greatest effect in those intubated >72 hrs



Dezfulian et al. Am J Med 2005;118:11-18

Preventing VAP: The "sedation vacation"

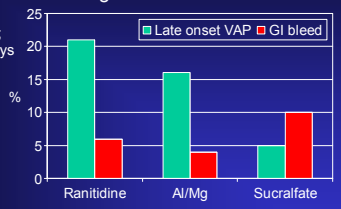
- Daily interruption of sedation:
  - 128 patients on mechanical ventilation randomized to daily interruption of sedation until awake
  - Duration of ventilation 4.9 vs. 7.3 days (p=0.004)

Kress JP et al. N Engl J Med 2000;342:1471-77.

Preventing VAP: Choice of ulcer prophylaxis?

- Ranitidine vs. Al/MgOH vs. sucralfate

N = 244 randomized;
213 observed > 4 days

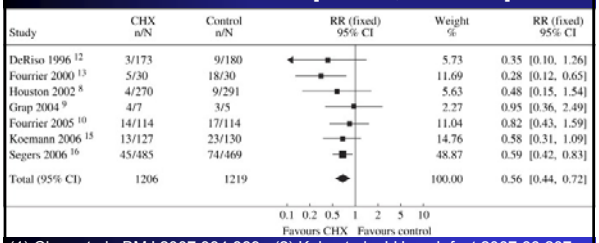


Larger, more recent studies demonstrate that H2 blockers or PPIs can more effectively prevent GI bleeding without increasing the VAP rate…

Prodhom et al. Ann Intern Med 1994;120:653.
Cook et al. N Engl J Med 1998;338:791-97.

Preventing VAP: Chlorhexidine oral care

- 2 meta-analyses published in 2007:
  - 11 RCTs → RR 0.56 [95% CI, 0.39-0.81][1]
  - 7 RCTs → RR 0.58 [95% CI, 0.44-0.72][2]



(1) Chan et al. BMJ 2007;334:889. (2) Kola et al. J Hosp Infect 2007;66:207.

Preventing VAP: Antibiotic Use: Selective DD +/- systemic

- Complex literature, variety of regimens used, definitions for outcome measure, etc.
  - 16 RCTs, 3361 patients[1]
    - OR 0.35 [95% CI, 0.29-0.41] for VAP
    - OR 0.8 [95% CI, 0.69-0.93] for mortality
  - 54 RCTs, 9473 patients[2]
    - OR 0.11 [95% CI, 0.06-0.2] for Gram negative LRTI
    - OR 0.52 [95% CI, 0.34-0.78] for Gram positive LRTI

(1) D'Amico et al. BMJ 1998;316:1275.
(2) Silvestri et al. Anaesth Intensive Care 2008;36:324.

Digestive or Oropharyngeal Decontamination?

- Cluster randomized, crossover trial in 13 Dutch ICUs, S-DD v. S-OD v. standard care
- All regimens used over 6 months in each ICU
- S-DD: IV cefotaxime + tobra-colistin-ampho B
- S-OD: oropharyngeal application only (T-C-A)
- Only those with expected ICU stay > 72 hrs
- 5939 enrolled, 28 day mortality = 27.5%
- MLR model compared to standard care:
  - S-OD: OR 0.86 [0.74-0.99] for 28 d mortality
  - S-DD: OR 0.83 [0.72-0.97] for 28 d mortality

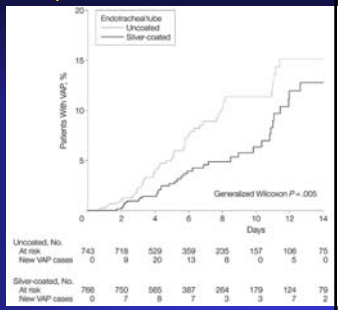
De Smet et al. N Engl J Med 2009;360:20.

S-DD for VAP Prevention

- Pro:
  - Accumulated trials data support efficacy in reducing VAP and mortality
- Cons:
  - Impact of systemic + oral antimicrobials on resistance emergence
  - Can oral decontamination with chlorhexidine provide similar benefit?

Preventing VAP: Antmicrobial (silver) coated ET tubes

- 2003 pts randomized
- Among those intubated > 24 hrs:
  - 4.8 vs. 7.5% micro-confirmed VAP, p=0.03
  - No differences in intubation time, LOS, mortality



Kollef et al. N Engl J Med 2008;300:805.

Multifactorial Interventions: The "ventilator bundle"

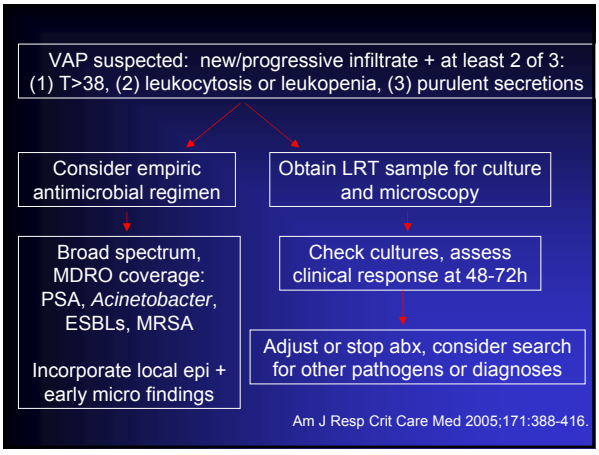
- Implementation of those interventions with the supporting evidence/feasibility
  - Hand Hygiene
  - Elevation of HOB
  - "Sedation vacation" each day
  - Assessment of readiness to wean
  - PUD and DVT prophylaxis

www.ihi.org

The IHI Ventilator Bundle: Meta-analysis

- Only four studies met inclusion criteria
  - All had methodologic problems
    - All were "before-after" study designs
    - Little information re diagnostic approach before and after
    - Selection/publication bias, confounding?
  - 38-60% reduction in VAP post-intervention
    - Resar et al. Jt Comm J Qual Pt Saf 2005;31:243.
    - Berriel-Cass et al. Jt Comm J Qual Pt Saf 2006;32:612.
    - Youngquist et al. Jt Comm J Qual Pt Saf 2007;33:219.
    - Unahalekhaka et al. Jt Comm J Qual Pt Saf 2007;33:387.
- Which aspects are most important? Should new elements be added? (CSS, silver coated ET tubes, etc.?)

Zilberberg et al. Crit Care Med 2009;37:305.



Am J Resp Crit Care Med 2005;171:388-416.

Important Treatment Considerations

- Tailor regimen to local epidemiology/AMR:
  - e.g. KPC-KPN, MDR-Acinetobacter
- Use appropriate dosing:
  - e.g. Adequate vanco dosing for MRSA
- 48-72 hour assessment:
  - Clinical response & culture data
- Duration of therapy:
  - Consider shorter course (e.g. 7-8 days) if pt improving, and bug not PSA or SA
    - Chastre et al. JAMA 2003;290:2588.

Re-assessment at 48-72 hours

- Responders
  - Pathogen isolated?
    - Directed therapy
    - Duration of therapy?
  - No pathogen, and no recent abx Δ?
    - Narrow regimen if no *Pseudomonas* or MRSA
    - Consider d/c abx?
    - Duration of therapy?
- Nonresponders
  - Wrong bug?
    - Resistant? Not bacterial?
    - Antibiotic dosing inadequate?
  - Wrong diagnosis?
    - PE, ARDS, bleed, neoplasm, etc.
  - Complication of infection?
    - Empyema, lung abscess, C. diff, drug fever, etc.

Am J Resp Crit Care Med 2005;171:388-416.

Ventilator Associated Pneumonia: Summary (1)

- VAP is common, and increases LOS, hospital costs, and (probably) mortality
- Better diagnostics for VAP are needed to reduce misclassification
- VAP prevention literature is murky, but:
  - IHI bundle + oral care with chlorhexidine
  - CSS if expect to be on vent >72 hrs
  - Other approaches (silver coated ET tubes, selective DD, etc.) if rate remains high

Ventilator Associated Pneumonia: Summary (2)

- Treatment should be based upon risk for MDR, microbiology, and clinical response
  - Broad (combination) therapy initially
  - Use appropriate dosing
  - Obtain LRT sample for Gram stain and culture
  - 48-72 hour re-assessment is critical
  - Narrow therapy and shorten course when able