Challenges in Diagnosis, Surveillance and Prevention of Ventilator-associated pneumonia

Massachusetts Coalition for the Prevention of Errors
November 6, 2008

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Outline

1. Why is there a movement to report VAP?
2. How accurate is clinical diagnosis of VAP?
3. What are the implications for VAP surveillance and reporting?
4. BWH approach to surveillance
5. What can we do to prevent VAP?

Why is there a push to report VAP?

Ventilator-associated pneumonia

- Most common nosocomial infection in ICU's
- Affects ~10% of ventilated patients
- Increases ICU length of stay by ~5 days
- Crude mortality rate of 30-50%
- VAP patients about 2x as likely to die as matched patients without VAP
- Adds ~$10-15,000 to cost of hospital stay

Safdar et al, *Crit Care Med* 2005; 33:2184
Tejerina et al, *J Crit Care* 2006; 21:56

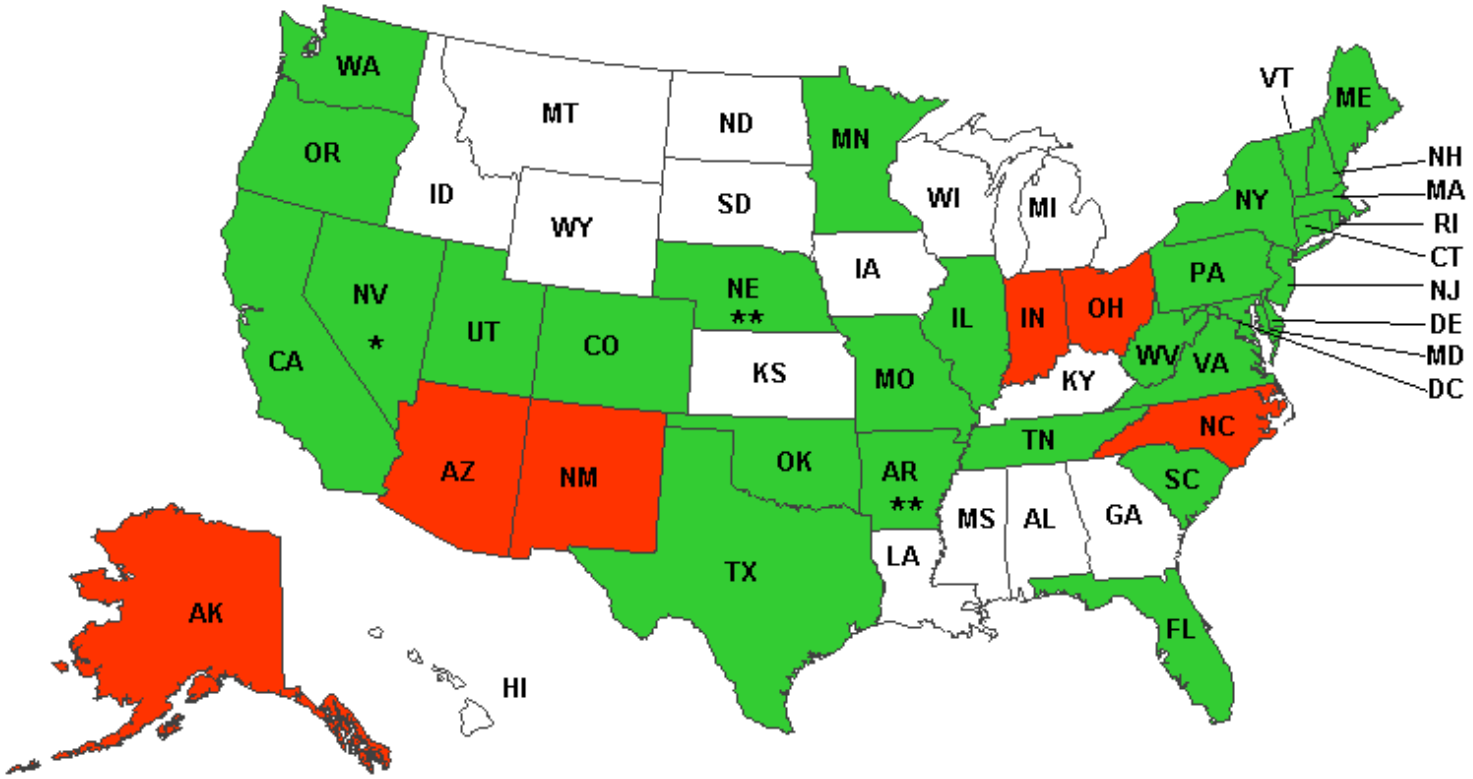
Institute for Healthcare Improvement

- Rapid Response Teams
- Evidence-based care for MI
- Prevent adverse drug events
- Prevent central line infections
- Prevent ventilator-associated pneumonia

Mandatory Reporting Legislation

Mandatory reporting enacted

Study bill



Association for Professionals in Infection Control and Epidemiology 2008

The NEW ENGLAND JOURNAL of MEDICINE

Perspective

OCTOBER 18, 2007

Nonpayment for Performance? Medicare's New Reimbursement Rule

Meredith B. Rosenthal, Ph.D.

"Recently, the Centers for Medicare and Medicaid Services (CMS) announced its decision to cease paying hospitals for some of the care made necessary by 'preventable complications'"

The Facts
• Hospital-wide Measures
▸Infections
Preventing Ventilator Associated Pneumonia
Central Line Associated Blood Stream Infections
Hand Hygiene
Nursing Care
Why is this Information Important to You?
2007 Joint Commission Accreditation Survey Findings
Specific Service Measures
Our Priorities for Improvement
Our Awards & Recognitions
What Our Patients Say About Us
Tell Us What You Think
HOME > For Patients > The Facts > Hospital-wide Measures > Infections

THE FACTS AT BIDMC
we're putting ourselves under a microscope

Infections

Infections are a serious concern in hospitals. Nationwide, 2.5 million patients develop healthcare-associated infections annually. Not only do infections cause additional medical problems for patients, but they can increase the time a patient spends in the hospital, and sometime, can result in serious illness. The risk of healthcare-associated infections can be reduced by following best practices for infection control. Learn more about what BIDMC is doing to address this problem in several important areas.

Infections		
Infections	**BIDMC Performance**	**Comparison***
Preventing Ventilator Associated Pneumonia A **higher** score is better.	99%	90%
Central Line Associated Blood Stream Infections A **lower** score is better.	0.99	1.55
Hand Hygiene: Intensive Care Unit A **higher** score is better.	73%	N/A
Hand Hygiene: Medical-Surgical A **higher** score is better.	59%	N/A

**Source of comparison for each measure may vary. It may be drawn from national, regional, or local databases and can include internal goals and/or benchmarks that BIDMC has established.*

For more information about each measure and its benchmark, click on the name of the measure.

Back to Main Menu

Other useful hospital-wide measures:

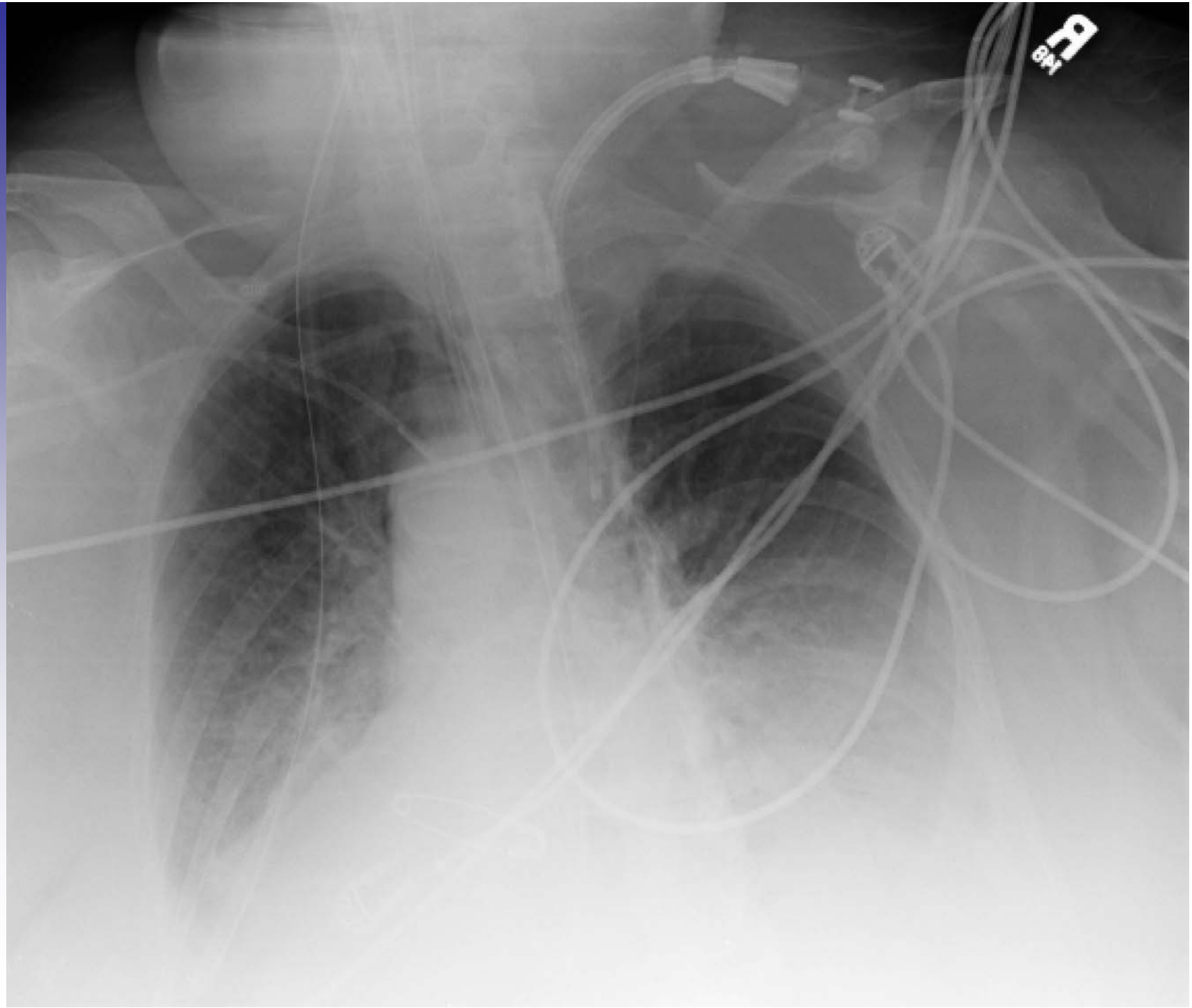
- Nursing Care

These initiatives all presume we can accurately identify and track healthcare-associated infections ….

…but ventilator-associated pneumonia (VAP) is a difficult diagnosis

The Challenge of VAP Diagnosis

- Many complications of critical care present with clinical signs that can mimic VAP
  - ✓ Radiographic opacities
  - ✓ Fever
  - ✓ Abnormal white blood cell count
  - ✓ Impaired oxygenation
  - ✓ Increased pulmonary secretions


R
BWH

"Diffuse patchy airspace disease left greater than right with obliteration of both hemi-diaphragms. Opacities possibly slightly increased since yesterday accounting for changes in patient position and inspiration. This could represent atelectasis, pneumonia, or effusion."

Fever and pulmonary densities

- Prospective study of 50 patients clinically suspected of having VAP on the basis of fever and pulmonary densities. On intensive investigation:
  - ✓ Only 42% confirmed to have VAP
  - ✓ Most patients had 2 or more diagnoses

Meduri et al, *Chest* 1994; 106:221-235

Pulmonary Densities

- Pneumonia
- ARDS
- Congestive heart failure
- Atelectais
- Pulmonary infarction

Fever

- Pneumonia
- Sinusitis
- Bloodstream infection
- Urinary tract infection
- Gall bladder disease
- Empyema
- Peritonitis
- ARDS (lung inflammation)
- Chemical aspiration
- Pancreatitis
- Drug fever

Meduri et al, *Chest* 1994; 106:221-235

Physician diagnosis poor

- Series of 84 ICU patients with abnormal chest xrays and purulent sputum
  - ✓ Evaluated by 7 physicians for VAP
  - ✓ "True diagnosis" established by histology or quantitative bronchoscopy cultures
  - ✓ 32% found to have VAP

Fagon et al, *Chest* 1993; 103:547-53

Physician agreement and accuracy poor

- Physicians disagreed on presence or absence of VAP in 35/84 (42%) of patients
  - ✓ The "best" doc missed 28% of true VAP's
  - ✓ The "worst" doc missed 50% of true VAP's
  - ✓ Both labeled ~20% of patients without VAP as having VAP

Fagon et al, *Chest* 1993; 103:547-53

Infection control practitioner agreement poor

- 90 sick patients from Brigham ICU's evaluated for VAP by two infection control practitioners

		Practioner 2	
		VAP present	**VAP absent**
Practioner 1	**VAP present**	**15**	**4**
	VAP absent	**17**	**54**

disagreement on 21/90 (23%) of patients!

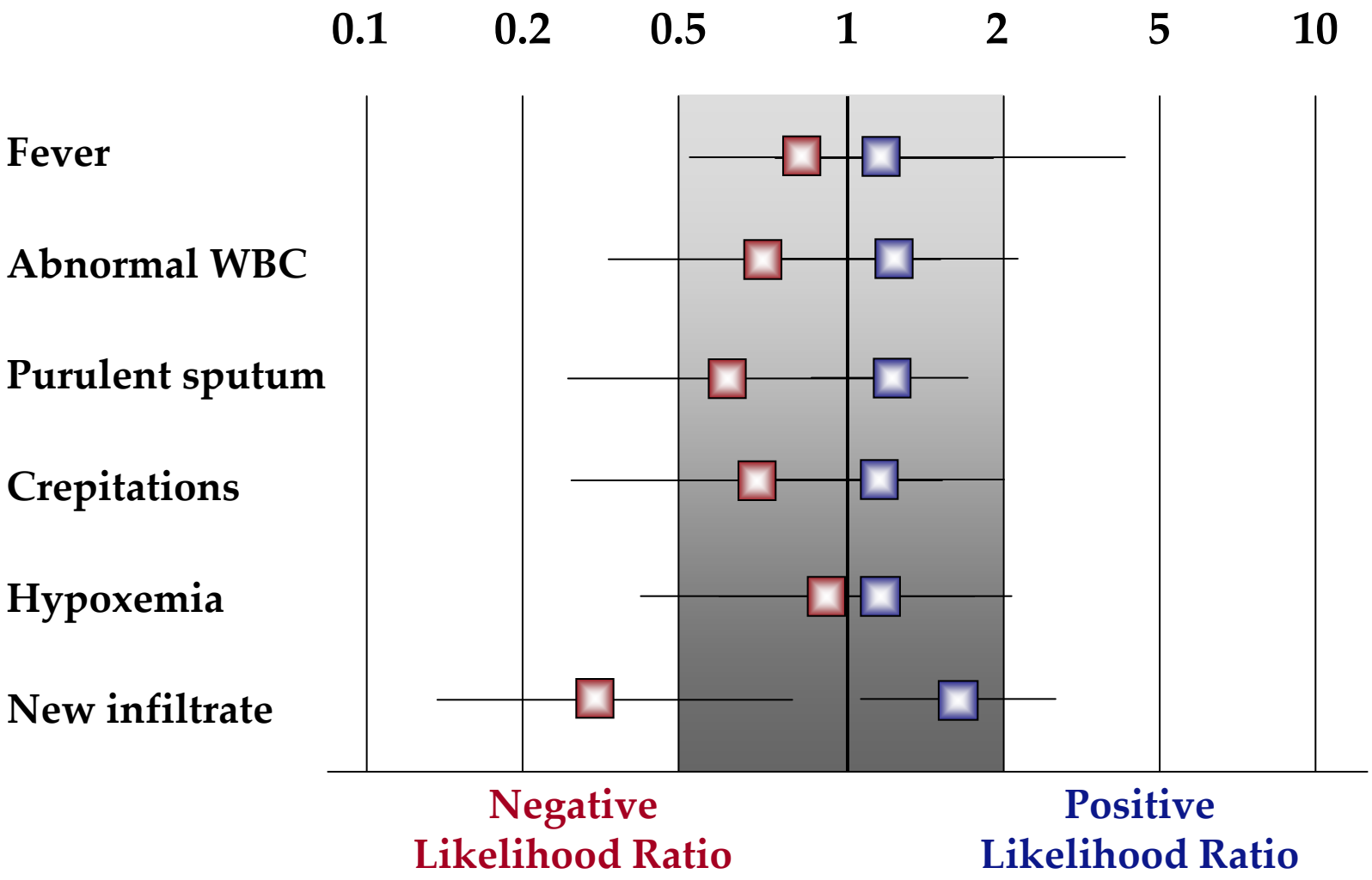
Are there any clinical signs that reliably indicate VAP?

Evaluation of clinical signs to diagnose VAP

- Systematic search of Medline and Google Scholar to find every English-language study ever published evaluating the accuracy of clinical, radiographic, and laboratory data to diagnose VAP **relative to lung biopsy as gold standard**
  - ✓ 14 studies describing 655 patients

Klompas, *JAMA* 2007; 297:1583

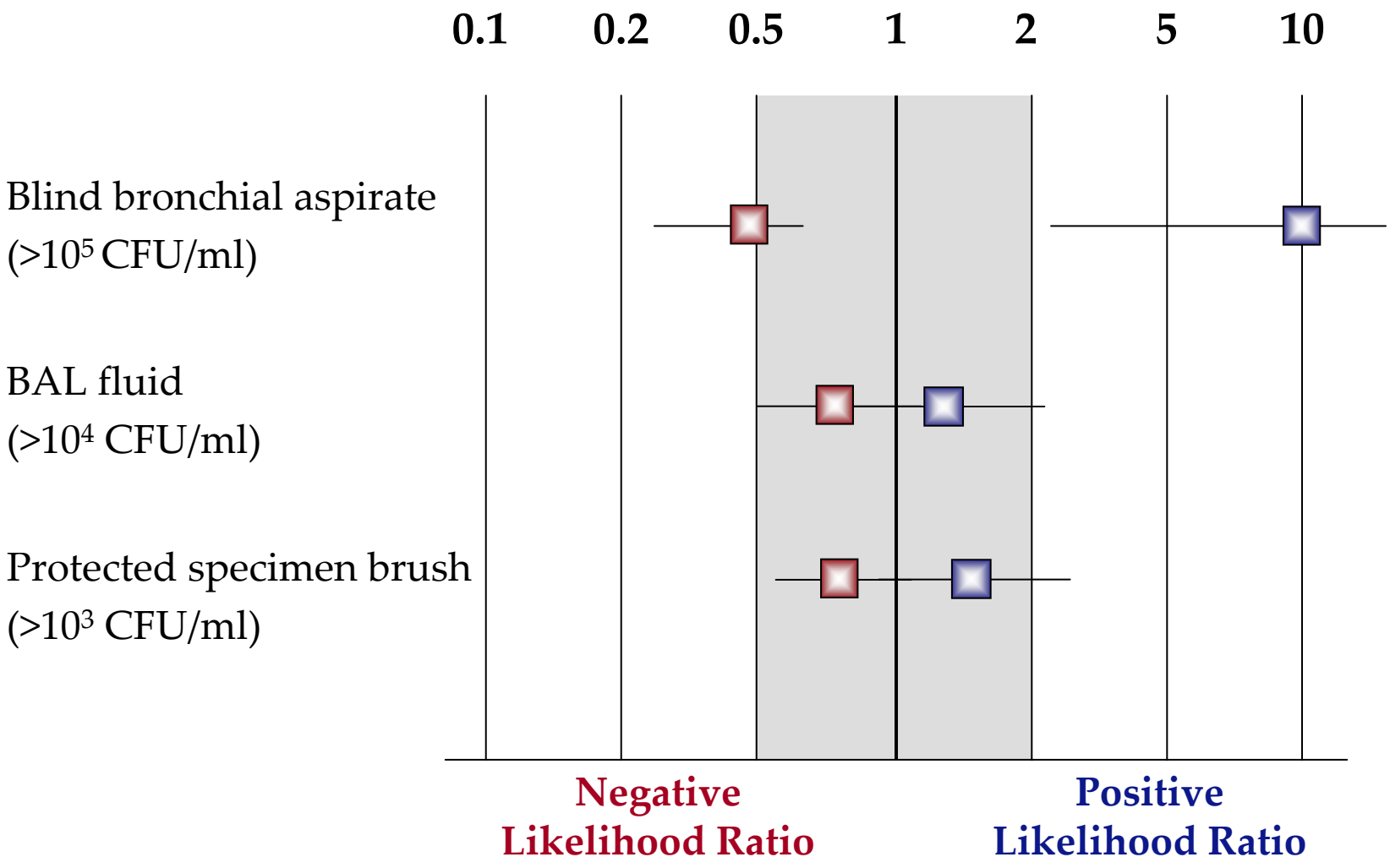
Accuracy of Clinical Signs for VAP



——— 95% confidence interval

Klompas, *JAMA* 2007; 297:1583

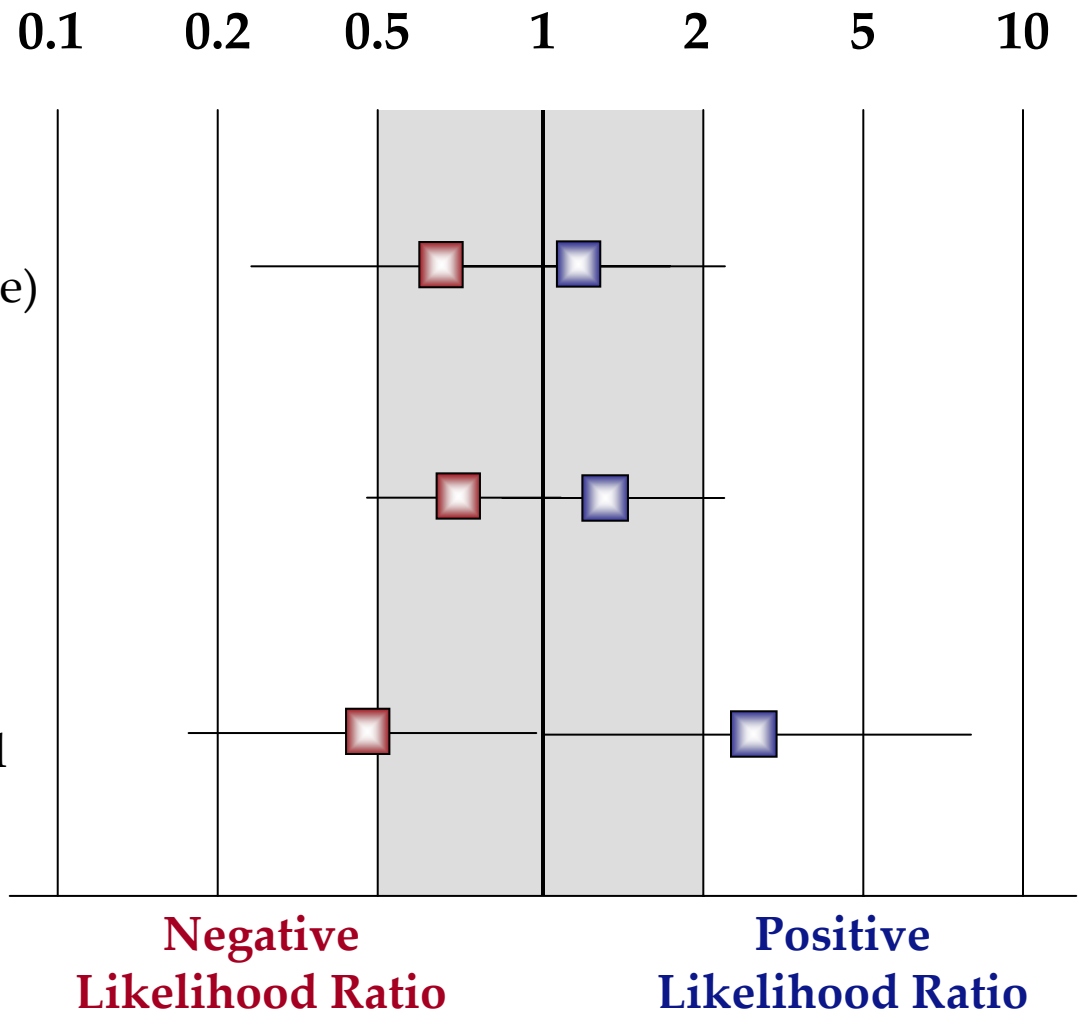
Accuracy of Bacterial Cultures for VAP



——— 95% confidence interval

Klompas, *JAMA* 2007; 297:1583

Accuracy of Findings in Combination for VAP



——— 95% confidence interval

Klompas, *JAMA* 2007; 297:1583

What are the implications of diagnostic uncertainty for VAP surveillance?

CDC Surveillance Definition of VAP

Patient must fulfill each of the three categories below:

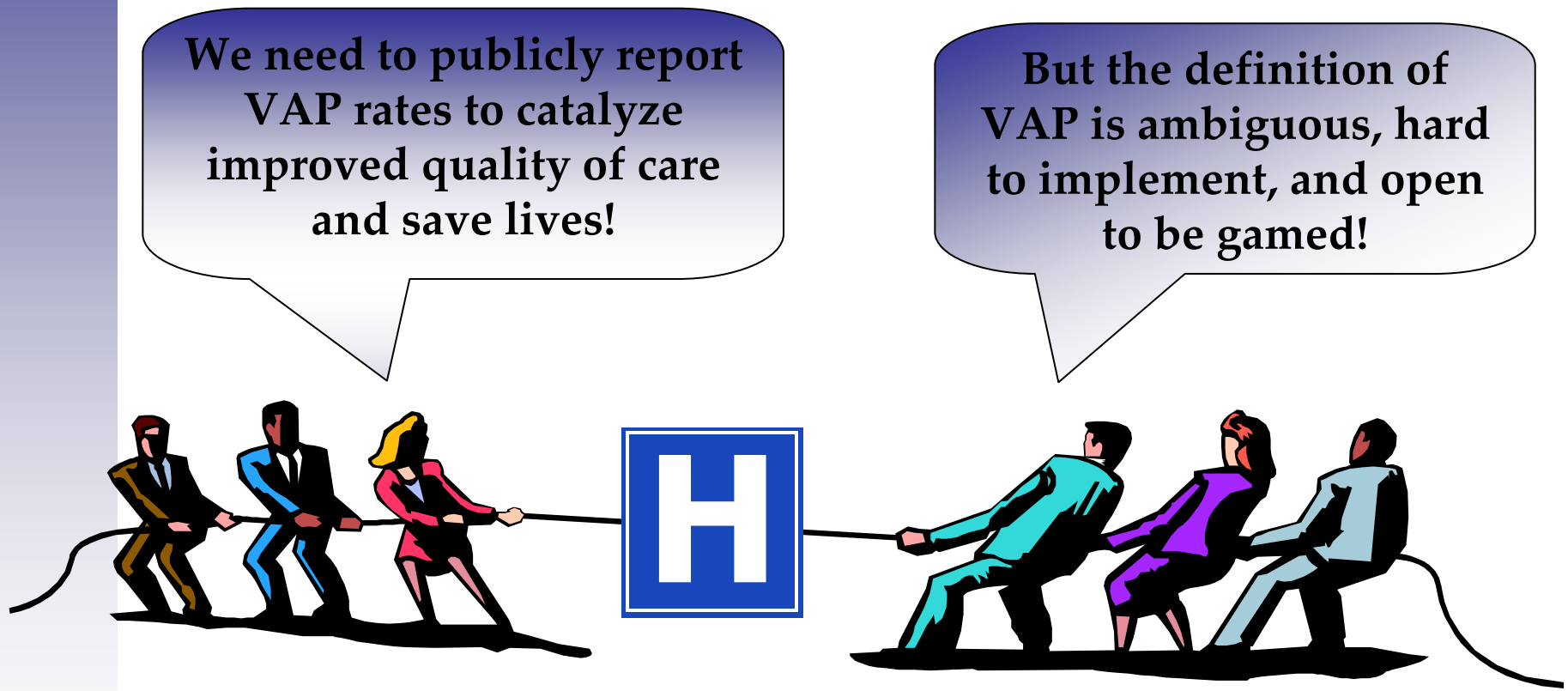
Chest Radiograph	*Any one of the following:* 1. New, progressive, or persistent infiltrate 2. Consolidation 3. Cavitation
Systemic Signs	*Any one of the following:* 1. Temperature >38°C 2. WBC <4,000 or >12,000 WBC/mm^3 3. For adults 70 years old, altered mental status with no other recognized cause
Pulmonary Signs	*Any two of the following:* 1. New onset of purulent sputum, or change in character of sputum, or increased respiratory secretions, or increased suctioning requirements 2. New onset or worsening cough, or dyspnea, or tachypnea 3. Rales or bronchial breath sounds 4. Worsening gas exchange, increased oxygen requirements, or increased ventilation demand

Problems with CDC VAP Criteria

- Subjective
  - "change in character of sputum"
  - "worsening gas exchange"
- Non-specific
  - "rales"
  - "delirium"
  - "new or progressive infiltrate"
- Labour intensive to gather
  - "increased suctioning requirements"
  - "new onset tachypnea"
- Liable to be gamed if hospitals' reputations and compensation become linked to VAP rates

Klompas and Platt, *Ann Intern Med* 2007; 147:803-5

Where does this leave hospitals?



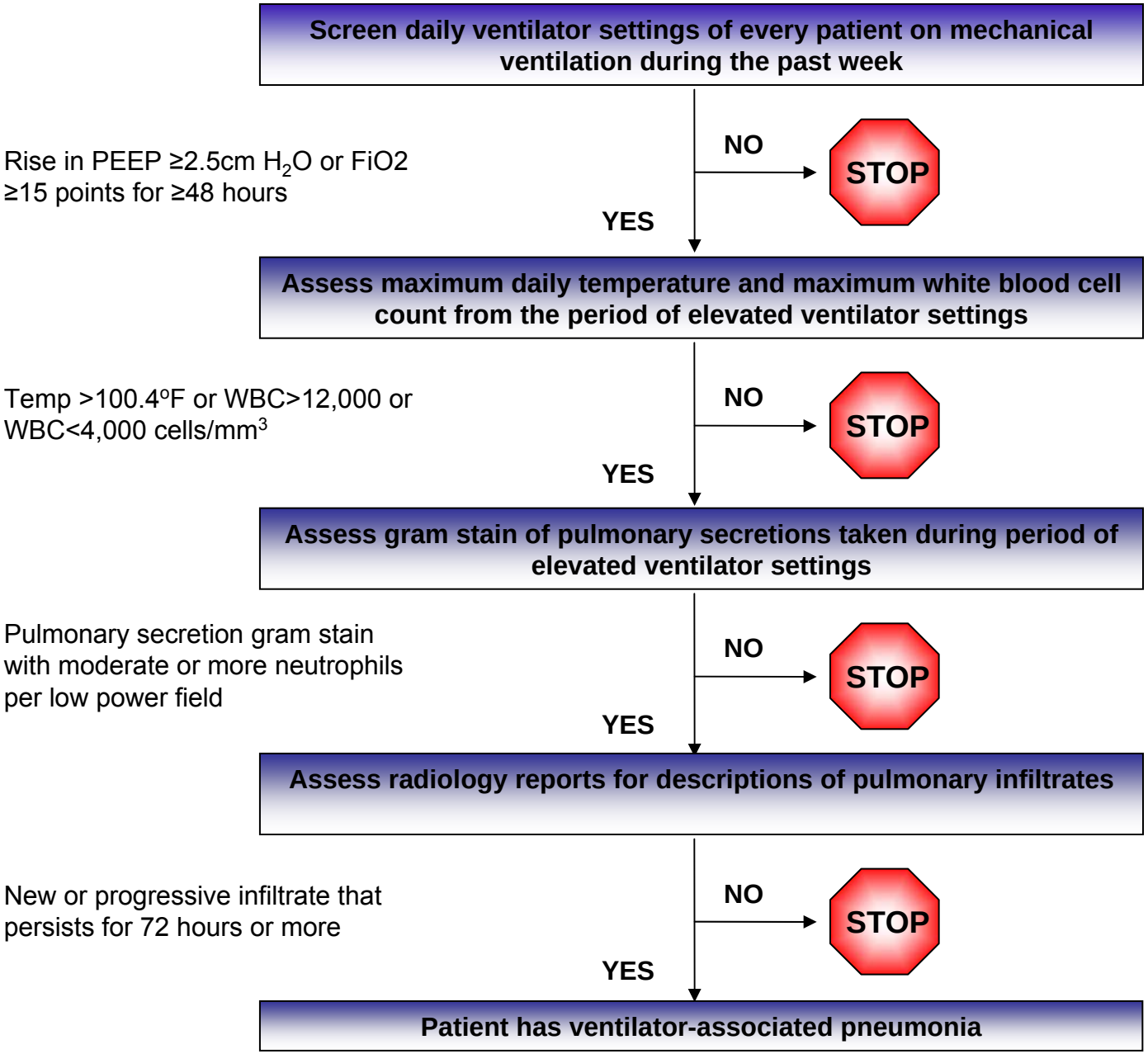
BWH Approach to VAP Surveillance

- Refine the CDC surveillance definition
  - ✓ Reduce ambiguity
  - ✓ Improve reproducibility
  - ✓ Enable electronic collection of all variables
  - ✓ Retain validity by remaining faithful to the structure and content of the CDC definition

Infect Control Hosp Epidemiol 2008;29:31

BWH Modified CDC Criteria

Chest Radiograph	*Any one of the following:* 1. Opacity, infiltrate, or consolidation that appears, evolves, or persists over ≥72 hours 2. Cavitation
Systemic Signs	*Any one of the following:* 1. Temperature >100.4°F within past 24 hours 2. WBC <4,000 or >12,000 WBC/mm^3 within past 24 hours
Pulmonary Signs	*Both of the following* 1. Sustained rise in ventilator FiO2 ≥ 15mm Hg OR rise in PEEP by ≥2.5cm H_2O sustained for ≥ 48 hours 2. Gram stain of respiratory secretions with moderate (2+) or more neutrophils per high power field within past 72 hours


Screen daily ventilator settings of every patient on mechanical ventilation during the past week
Rise in PEEP ≥2.5cm H_2O or FiO2 ≥15 points for ≥48 hours
NO
STOP
YES
Assess maximum daily temperature and maximum white blood cell count from the period of elevated ventilator settings
Temp >100.4°F or WBC>12,000 or WBC<4,000 cells/mm^3
NO
STOP
YES
Assess gram stain of pulmonary secretions taken during period of elevated ventilator settings
Pulmonary secretion gram stain with moderate or more neutrophils per low power field
NO
STOP
YES
Assess radiology reports for descriptions of pulmonary infiltrates
New or progressive infiltrate that persists for 72 hours or more
NO
STOP
YES
Patient has ventilator-associated pneumonia

VAP Screening – An Approach

- Use the "change in oxygenation" criteria as a screen – if a patient's ventilator settings are stable then they do not have VAP
- Only review temperature, white blood cell count, sputum gram stain, and xray if ventilator-change criteria are met

Ventilator Management Tracking - [RptActive]

VPM Report Menu

Ventilator Management - VAP Surveillance

MRN	Patient Name	Unit	Room	Intubation Date	Ventilator Day: Current Intub. Day	Ventilator Day: Total Days Since 1st Intubated	Date	PEEP	FIO2	Daily Max Temp
		7C	52	10/25/2006						
					1	1	10/25/2006	5	60	
					2	2	10/26/2006	5	40	95.2
					3	3	10/27/2006	5	40	98.7
					4	4	10/28/2006	5	40	101.2
					5	5	10/29/2006	5	40	101.3
					6	6	10/30/2006	5	40	101.8
				Total Patient-Ventilator Days	6					

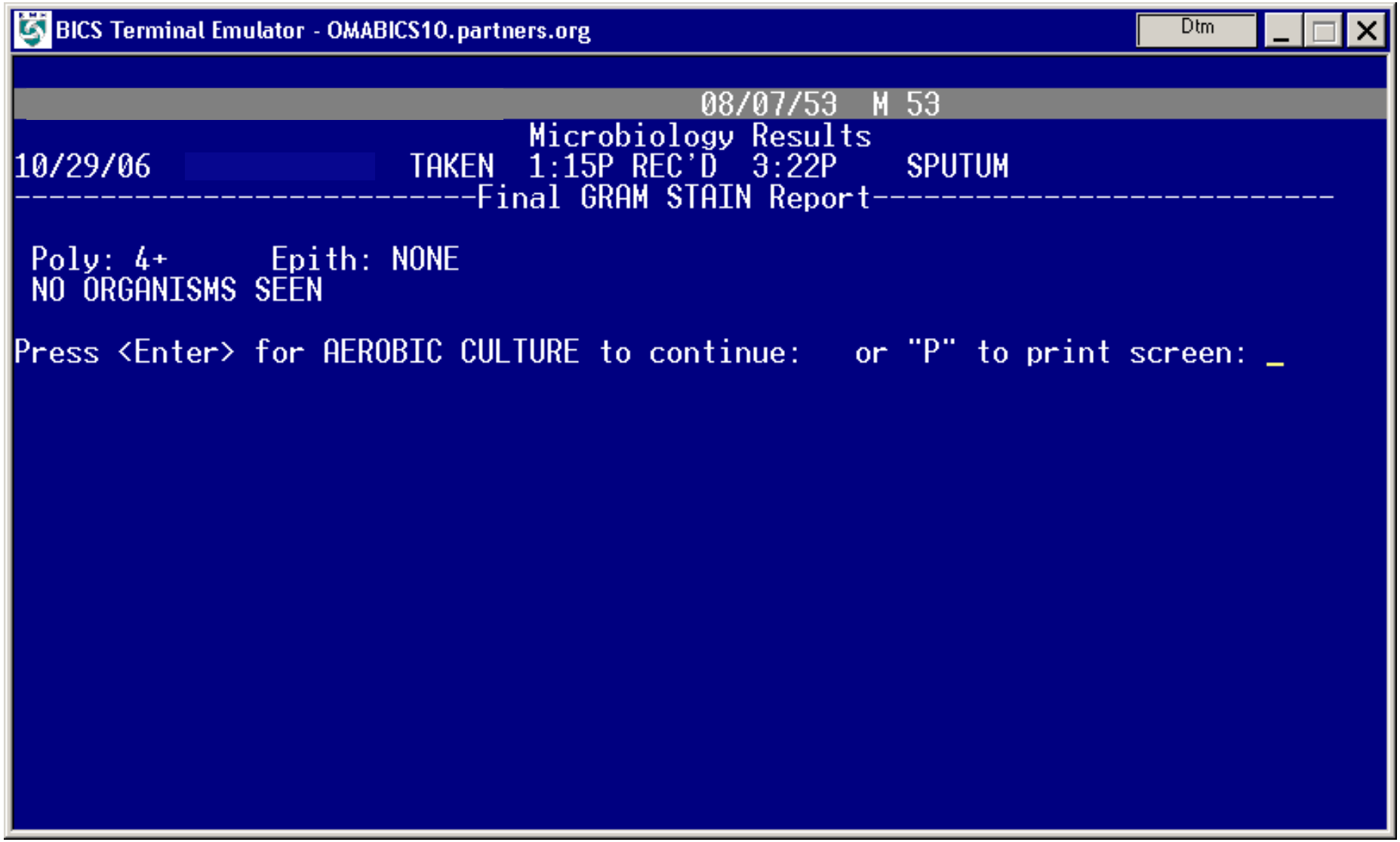
Page: 1

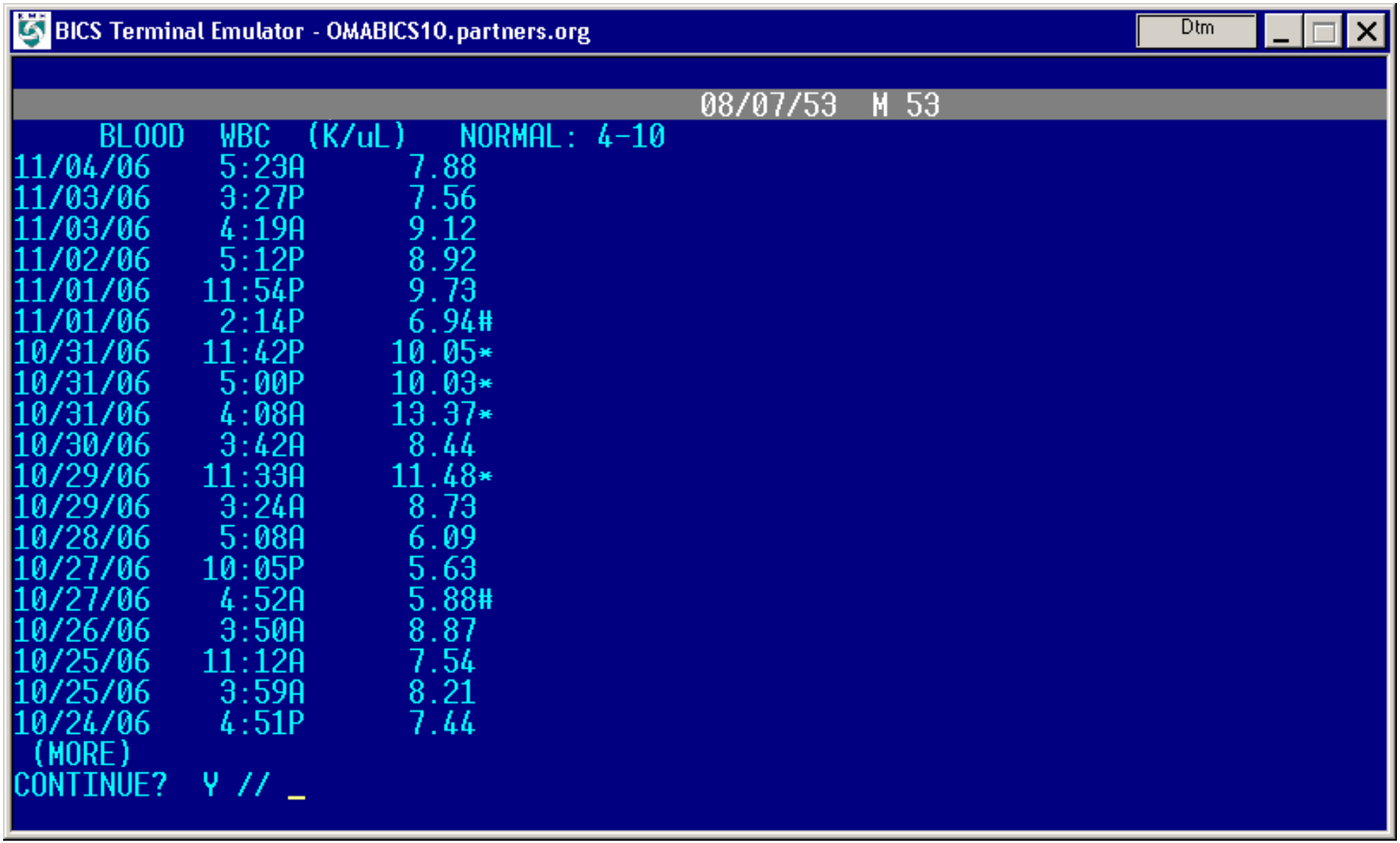
Ventilator Management Tracking - [RptActive]

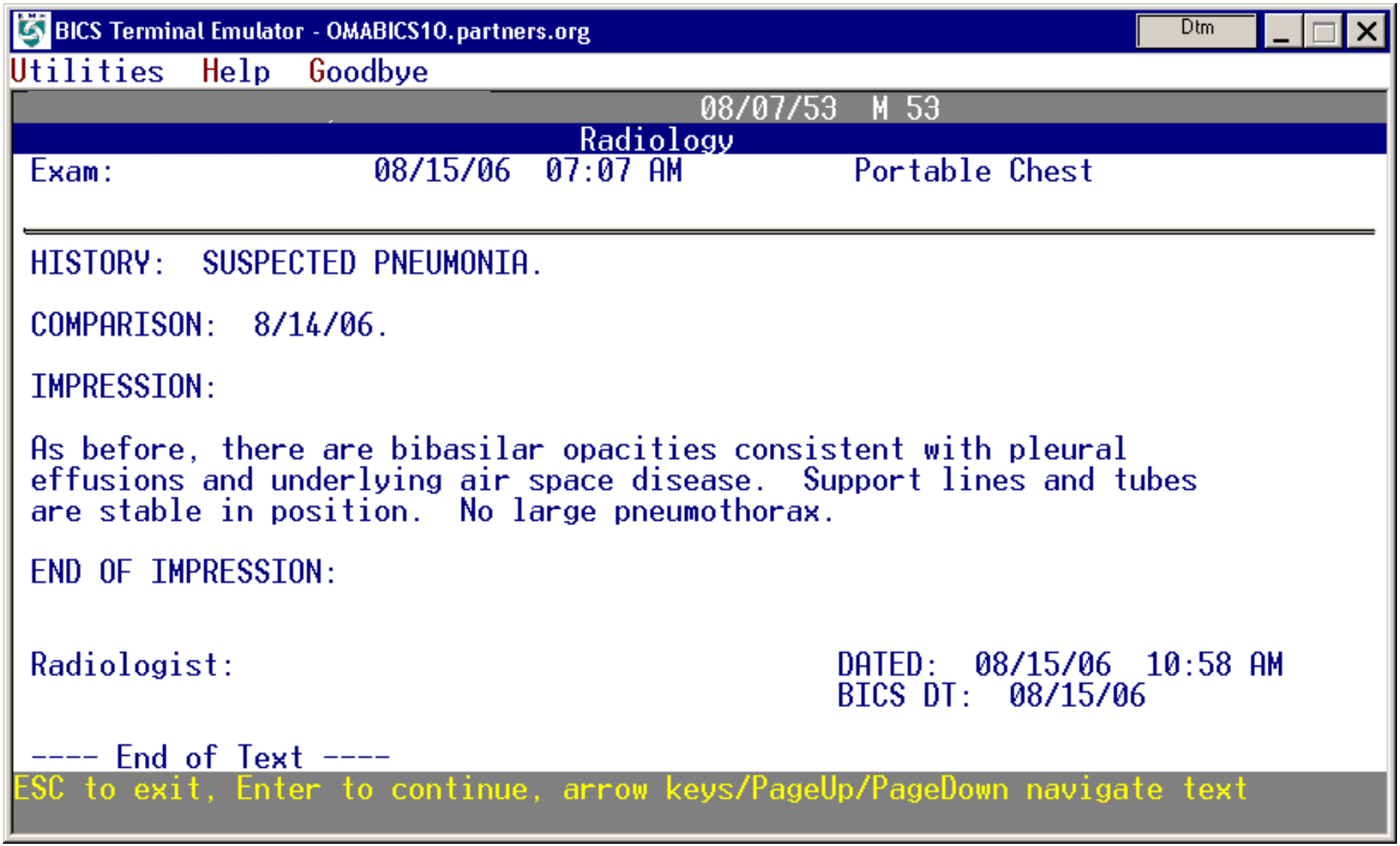
VPM Report Menu

Ventilator Management - VAP Surveillance

MRN	Patient Name	Unit	Room	Intubation Date	Ventilator Day: Current Intub. Day	Ventilator Day: Total Days Since 1st Intubated	Date	PEEP	FIO2	Daily Max Temp
		11C	58	5/27/2006						
					1	1	5/27/2006	5	40	
					2	2	5/28/2006	5	30	
					3	3	5/29/2006	5	40	102.2
					4	4	5/30/2006	5	40	100.0
					5	5	5/31/2006	7.5	40	102.7
					6	6	6/1/2006	5	40	103.0
					7	7	6/2/2006	5	40	102.8
					8	8	6/3/2006	5	40	103.8
					9	9	6/4/2006	5	40	104.0
					10	10	6/5/2006	5	40	103.7
					11	11	6/6/2006	5	40	102.2
					12	12	6/7/2006	5	100	99.0
					13	13	6/8/2006	5	40	102.4
					14	14	6/9/2006	15	80	96.9
					15	15	6/10/2006	15	70	99.1
					16	16	6/11/2006	15	70	98.0
					17	17	6/12/2006	10	50	98.4
					18	18	6/13/2006	10	50	98.6
					19	19	6/14/2006	10	40	98.1
					20	20	6/15/2006	5	40	99.1
					21	21	6/16/2006	5	40	101.1
					22	22	6/17/2006	5	40	100.1
					23	23	6/18/2006	5	40	101.4
					24	24	6/19/2006	5	40	101.3
					25	25	6/20/2006	5	40%	101.1
					26	26	6/21/2006	5	40	101.0
					27	27	6/22/2006	5	.40	97.9
					28	28	6/23/2006	5	40	100.2
					29	29	6/24/2006	5	40	97.2
					30	30	6/25/2006	5	40	98.6
					31	31	6/26/2006	5	40	97.9
					32	32	6/27/2006	5	40	97.9
					33	33	6/28/2006	5	40	97.3
					34	34	6/29/2006	5	40	96.0


BICS Terminal Emulator - OMABICS10.partners.org
Dtm
08/07/53 M 53
Microbiology Results
10/29/06 TAKEN 1:15P REC'D 3:22P SPUTUM
Final GRAM STAIN Report
Poly: 4+ Epith: NONE
NO ORGANISMS SEEN
Press <Enter> for AEROBIC CULTURE to continue: or "P" to print screen: _


BICS Terminal Emulator - OMABICS10.partners.org
Dtm
08/07/53 M 53
BLOOD WBC (K/uL) NORMAL: 4-10
11/04/06 5:23A 7.88
11/03/06 3:27P 7.56
11/03/06 4:19A 9.12
11/02/06 5:12P 8.92
11/01/06 11:54P 9.73
11/01/06 2:14P 6.94#
10/31/06 11:42P 10.05*
10/31/06 5:00P 10.03*
10/31/06 4:08A 13.37*
10/30/06 3:42A 8.44
10/29/06 11:33A 11.48*
10/29/06 3:24A 8.73
10/28/06 5:08A 6.09
10/27/06 10:05P 5.63
10/27/06 4:52A 5.88#
10/26/06 3:50A 8.87
10/25/06 11:12A 7.54
10/25/06 3:59A 8.21
10/24/06 4:51P 7.44
(MORE)
CONTINUE? Y // _


BICS Terminal Emulator - OMABICS10.partners.org
Dtm
Utilities Help Goodbye
08/07/53 M 53
Radiology
Exam: 08/15/06 07:07 AM Portable Chest
HISTORY: SUSPECTED PNEUMONIA.
COMPARISON: 8/14/06.
IMPRESSION:
As before, there are bibasilar opacities consistent with pleural effusions and underlying air space disease. Support lines and tubes are stable in position. No large pneumothorax.
END OF IMPRESSION:
Radiologist:
DATED: 08/15/06 10:58 AM
BICS DT: 08/15/06
---- End of Text ----
ESC to exit, Enter to continue, arrow keys/PageUp/PageDown navigate text

Validation

- Blinded retrospective comparison of electronic surveillance versus CDC criteria in 197 patients ventilated >48 hours in MICU or SICU
  - ✓ Sample enriched with patients ventilated ≥ 7 days
  - ✓ CDC criteria determined by consensus of independent reviews by 2 infection control practitioners

Time to Complete VAP Surveillance for 200 Patients Ventilated >48 Hours

	Total Time	Average Time per Chart
Nurse Reviewer	170 hours	~45 mins
Electronic Algorithm	7 hours	~2 mins

VAP Surveillance

Algorithm versus CDC ICP Consensus

	CDC Positive	CDC Negative
Algorithm Positive	10	19
Algorithm Negative	5	163

Sensitivity 67%
Specificity 90%

PPV 35%
NPV 97%

Interobserver Agreement
(preliminary results)

	Kappa
Agreement between ICP 1 and ICP 2	**0.44**
Agreement between ICP consensus and algorithm	**0.39**

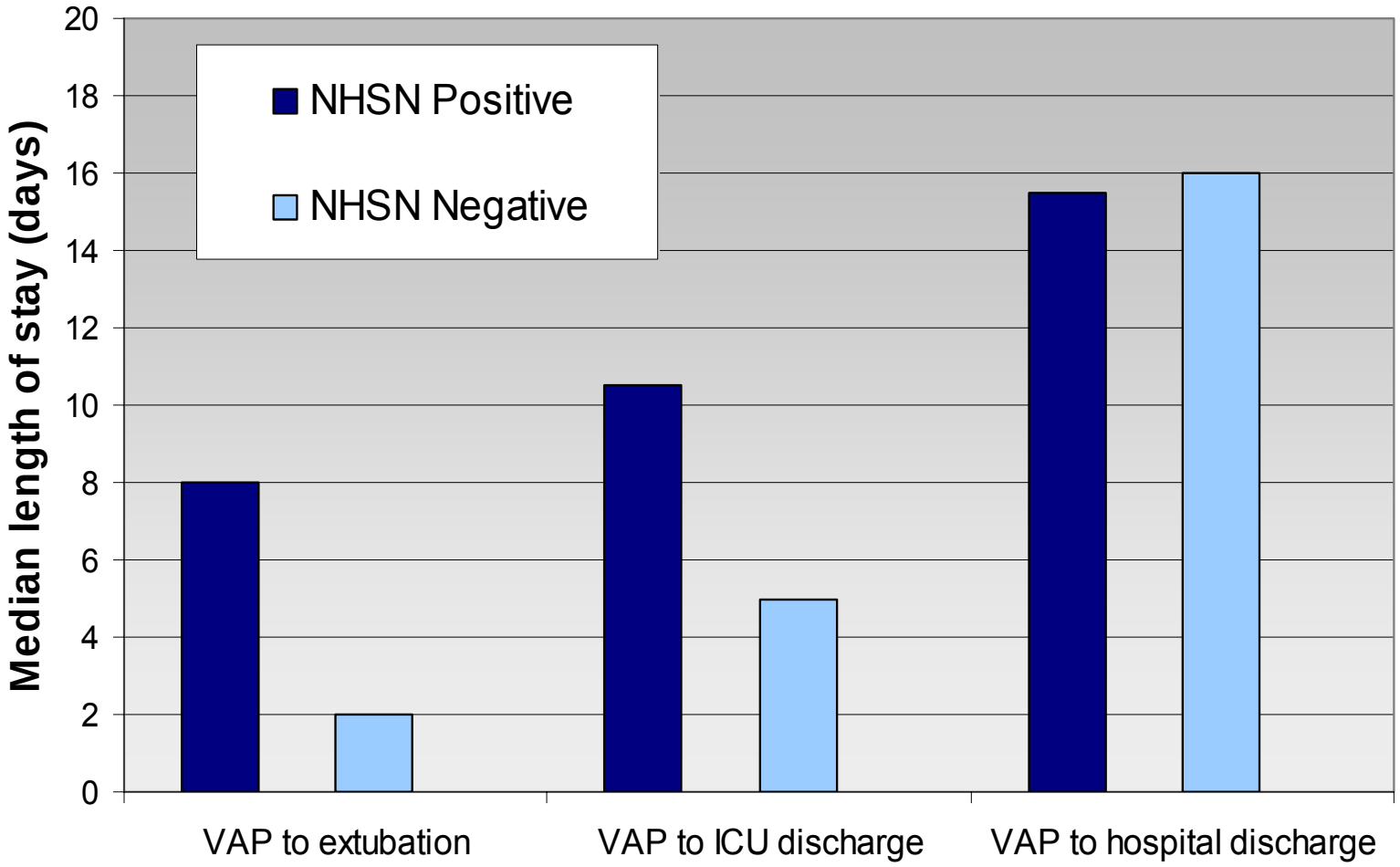
Who is right?

High interobserver variability

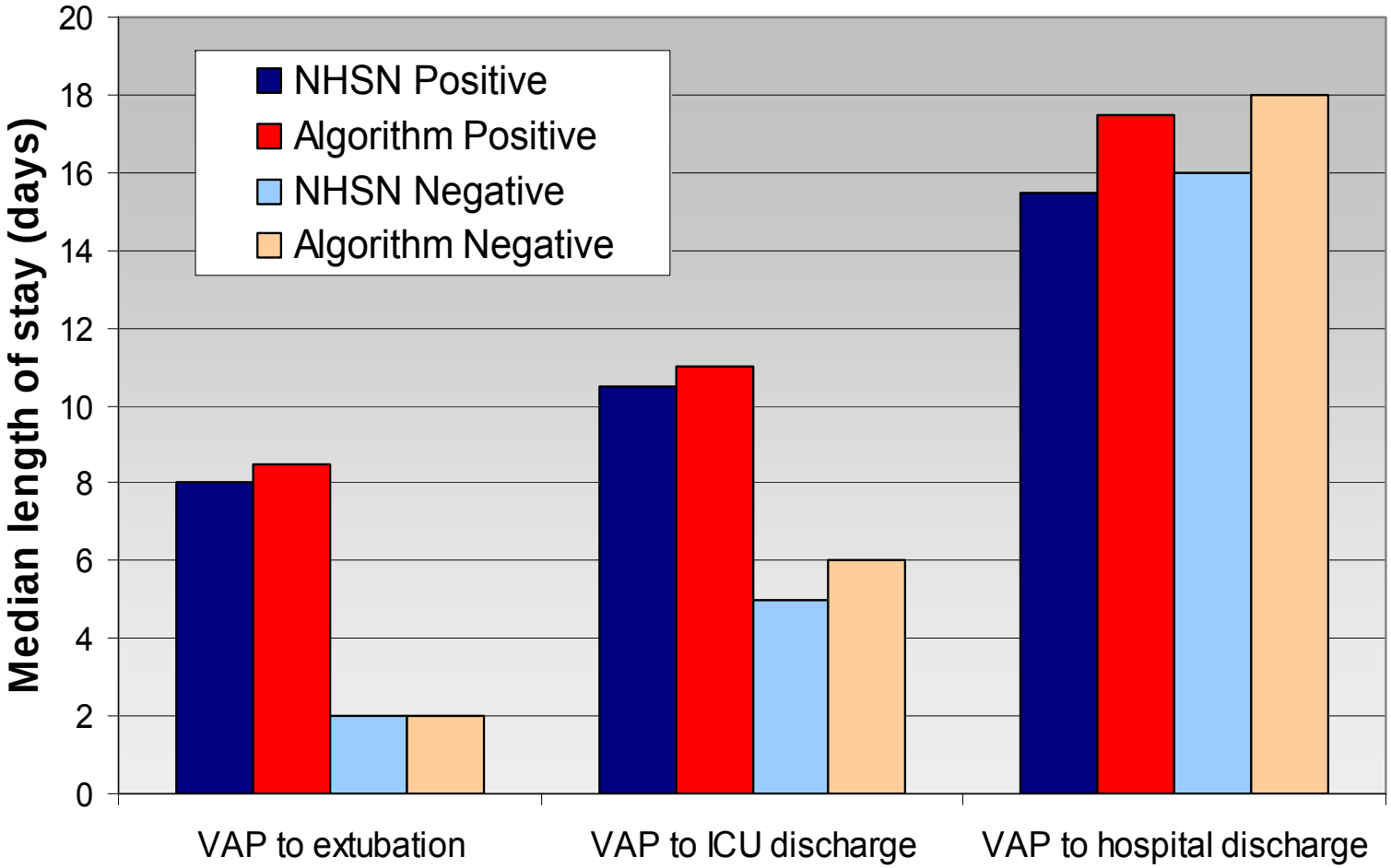
No clear way of knowing "truth"

We need to start looking at outcomes rather than events

Electronic versus NHSN Surveillance as predictors of patient outcomes



Electronic versus NHSN Surveillance as predictors of patient outcomes



How about the process measures?

VAP Prevention Measures

	Impact on VAP Rates
Daily interruption of sedation	↓ 64%
Daily assessment of readiness to extubate	↓ 10%
Head-of-bed elevation	↓ 78%
Regular oral care with chlorhexidine	↓ 40-60%

NEJM 2000;342:1471
Crit Care Med 2004;32:1272
Chest 2000;118:459
Am J Respir Crit Care Med 2006;174:894
Lancet 1999;354:1851
BMJ 2007;334:889

VAP Prevention Measures

	Vent LOS	ICU LOS	Hospital LOS	Mortality
Sedative interruption	✓	✓	✗	✗
Readiness to extubate	✓	✓	✗	✗
Head-of-bed elevation	✗	✗	✗	✗
Regular oral care	✗	✗	✗	✗

VAP Prevention Measures

	Vent LOS	ICU LOS	Hospital LOS	Mortality
Sedative interruption AND Readiness to extubate	✓	✓	✓	Maybe!

Is this a hint that bundles might improve outcomes beyond each measure alone?

Lancet 2008;371:126

No reliable studies yet but…

- Multiple reports of dramatic decreases in VAP rates following implementation of VAP bundle
- No control groups! INTERPRET WITH GREAT CAUTION

	Vent LOS	ICU LOS	Hospital LOS	Mortality
Mayo Clinic, Jacksonville, FL	?	✓	?	?
East Surrey Hospital, UK	✓	✓	?	✗
University of Kansas	✓	✓	✓	✗

Mayo Clin Proc 1996;81:849
Nursing Crit Care 2005;10:242
Surgical Infections 2007;8:505

VAP - The Bottom Line

- VAP is unreliable for measuring quality of care or for benchmarking hospitals
- A quantitative adaption of the CDC VAP definition is promising but needs further validation
- We need to develop new measures to assess quality of care for ventilated patients
  - ✓ Objective, easy to gather (electronic), predict outcomes
- Process measures are a reasonable interim step until better outcome measures can be developed
  - ✓ Daily sedation vacation
  - ✓ Daily assessment of readiness to wean
  - ✓ Bundles promising

Manual application of the BWH Surveillance Protocol

- Place a surveillance data sheet at the bedside of each patient
- RT, RN, MD, and/or ICP fills in small amount of data daily
- ICP collect sheets once a week or once a month to review

Date	PEEP	FiO2	Temp	WBC	Sputum or Bronch	Gram stain polys	CXR opacity
Nov 1	10	100	99.2	12.1	No	--	No
Nov 2	5	60	99.1	8.2	No	--	No
Nov 3	5	40	100.0	7.7	No	--	No
Nov 4	5	40	98.6	7.4	Yes	1+	No
Nov 5	5	40	97.7	5.6	No	--	No
Nov 6							

Thank you

- Richard Platt
- Deborah Yokoe
- Martin Kulldorff
- Ken Kleinman
- Susan Huang
- Susan Marino
- Elise Tamplin
- Maggie Bikowski
- Tricia Lemon
- Paul Nuccio
- Rose Villarreal
- Pam Fox

Enquiries Welcome!

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