
HEALTHCARE-ASSOCIATED PNEUMONIA: EPIDEMIOLOGY, MICROBIOLOGY & PATHOPHYSIOLOGY

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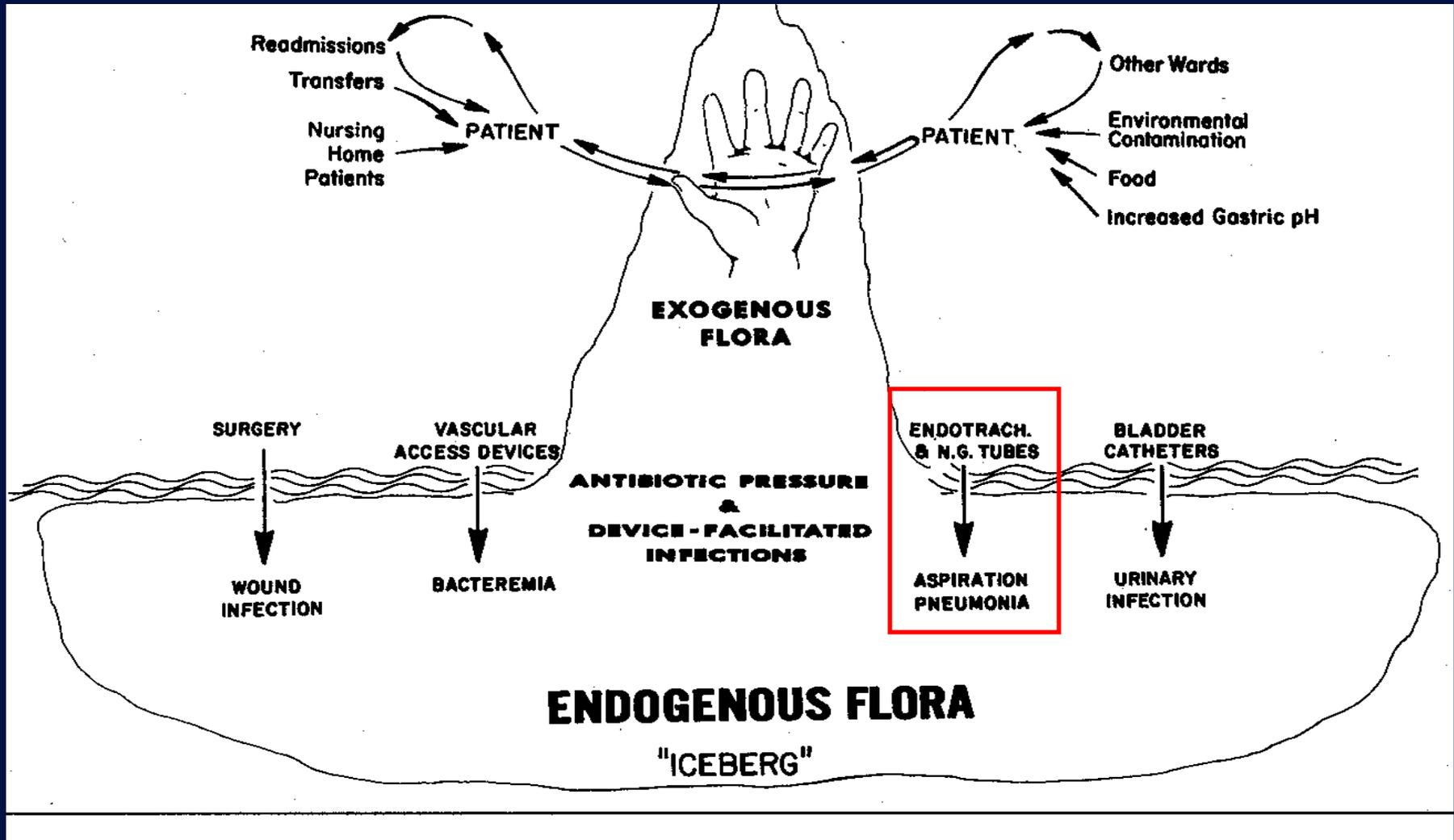
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HAZARDS IN THE ICU





GOALS OF LECTURE

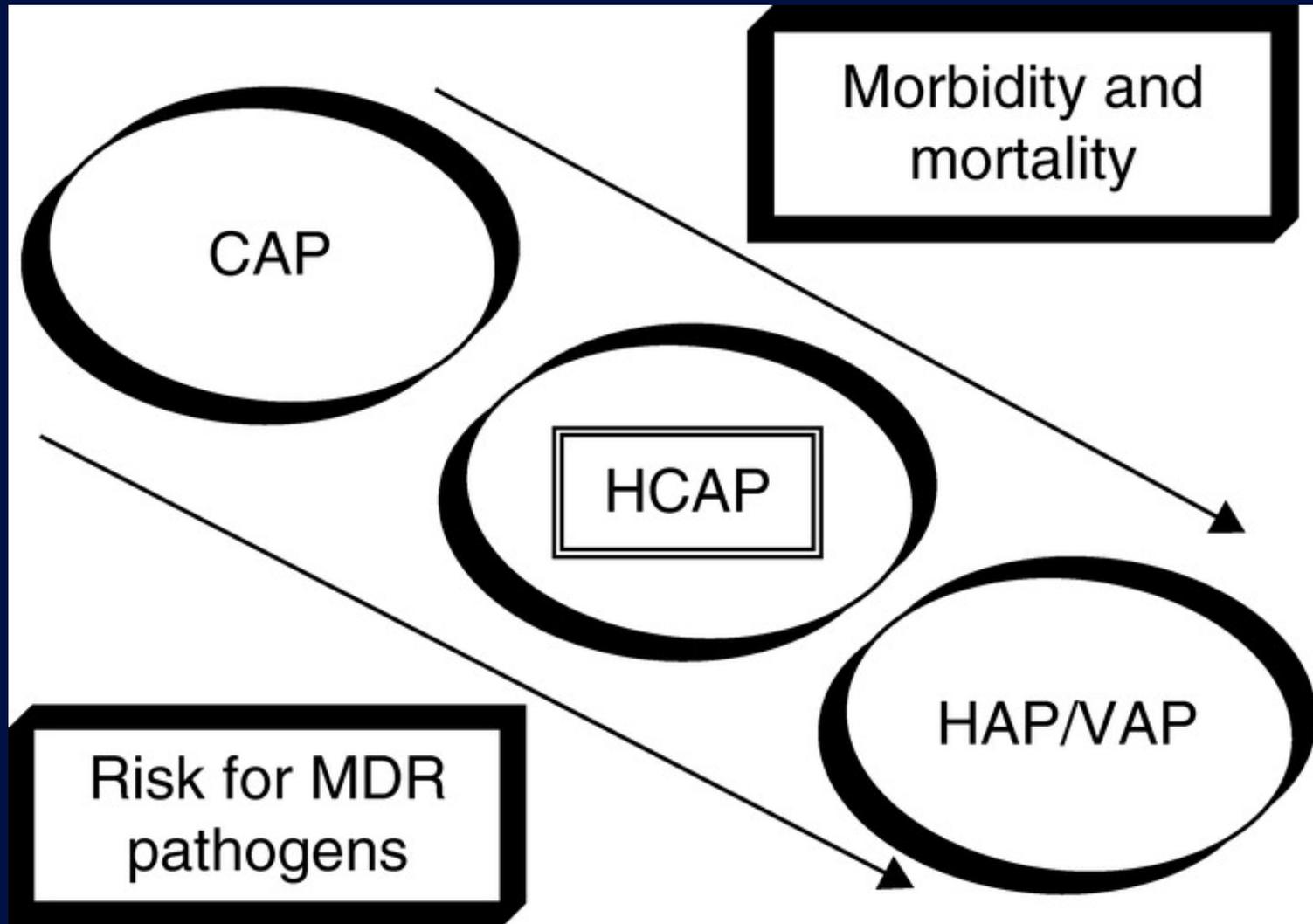
- Understand the epidemiology of nosocomial pneumonia
 - Impact
 - Incidence
 - Risk factors for acquisition and mortality
- Review the microbiology of HAP & VAP
- Understand the pathophysiology of HAP & VAP
 - Diagnosis
 - Treatment

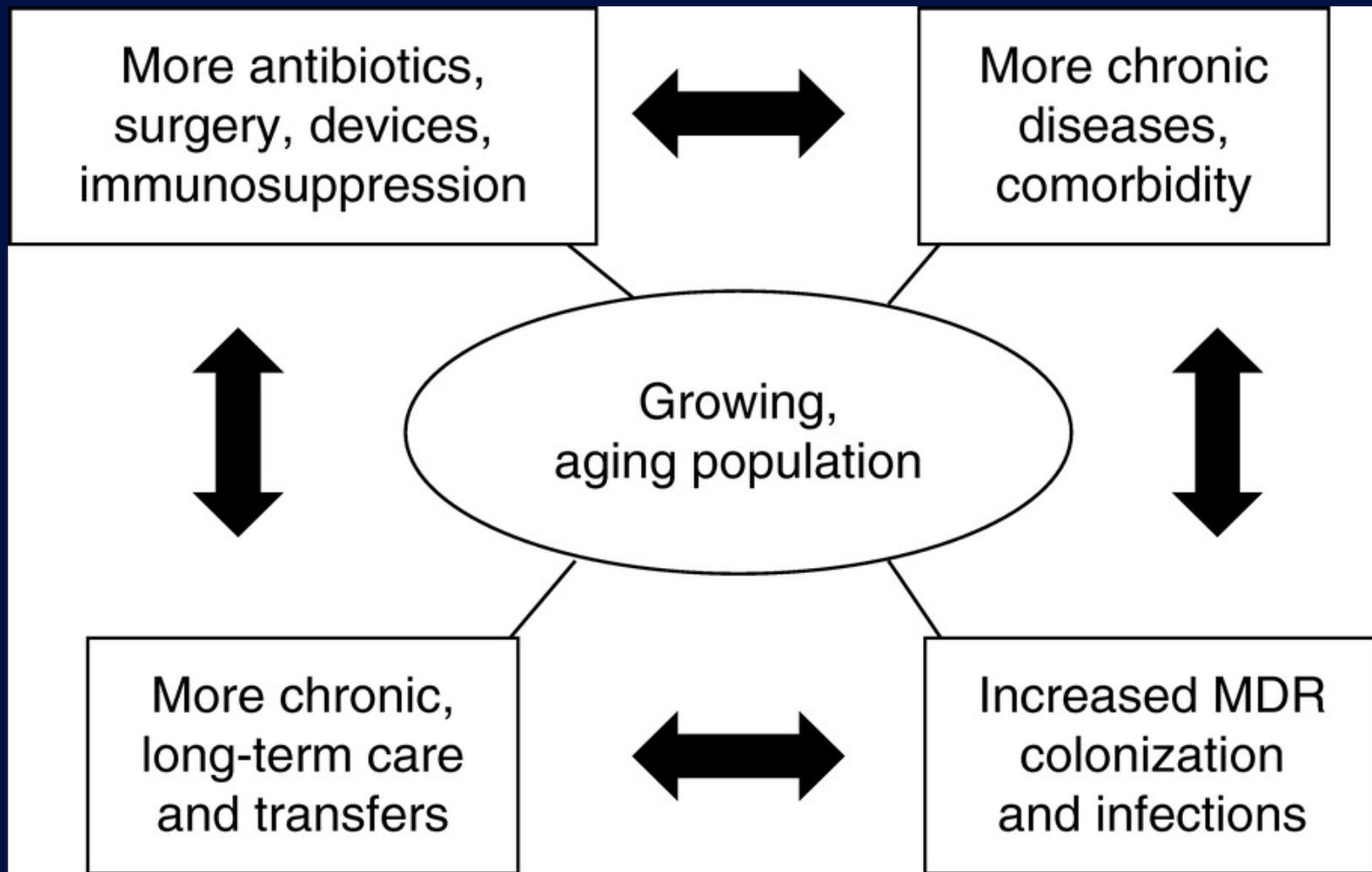
DEFINITIONS

Table 1. Pneumonia classification for patients in the intensive care setting

CAP	<ul style="list-style-type: none">● Infection present at hospital admission in patients who do not meet the criteria for HCAP
HCAP	<ul style="list-style-type: none">● Pneumonia present at hospital or ICU admission in patients with at least one of the following risk factors:<ul style="list-style-type: none">● Hospitalization for ≥ 2 days in an acute care facility within 180 days of infection● Residence in a nursing home or long-term care facility● Antibiotic therapy, chemotherapy, or wound care within 30 days of current infection● Hemodialysis treatment at a hospital or clinic● Home infusion therapy or home wound care● Family member with infection due to MDR bacteria● Significant immune suppression (corticosteroids, HIV, organ transplant)
NHAP	<ul style="list-style-type: none">● Pneumonia occurring during residence in a nursing home or rehabilitation facility
HAP	<ul style="list-style-type: none">● Pneumonia occurring typically ≥ 48 hrs after hospital admission in a nonintubated patient
VAP	<ul style="list-style-type: none">● Pneumonia occurring typically > 48 hrs after hospital admission and endotracheal intubation

CAP, community-acquired pneumonia; HCAP, healthcare-associated pneumonia; ICU, intensive care unit; HIV, human immunodeficiency virus; MDR, multidrug resistant; NHAP, nursing home-associated pneumonia; HAP, hospital-acquired pneumonia; VAP, ventilator-associated pneumonia.





HEALTHCARE-ASSOCIATED PNEUMONIA

- HAI

- An infection is considered an HAI if ALL elements of a CDC/NHSN site-specific criterion were first present together on or after the 3rd hospital day (day of admission is Day 1). For an HAI, an element of the infection criterion must be present during the first 2 hospital days as long as it is also present on or after Day 3. All elements used to meet the infection criterion must occur within a timeframe that does not exceed a gap of 1 calendar day between elements

- Pneumonia (PNEU)

- Pneumonia is identified using a combination of radiologic, clinical and laboratory criteria. For VAP the date of the event is the date when the last element used to meet the pneumonia criteria are occurred.

<http://www.cdc.gov/nhsn/acute-care-hospital/vae/index.html>

VENTILATOR-ASSOCIATED EVENT (adult patients ≥ 18 years of age)

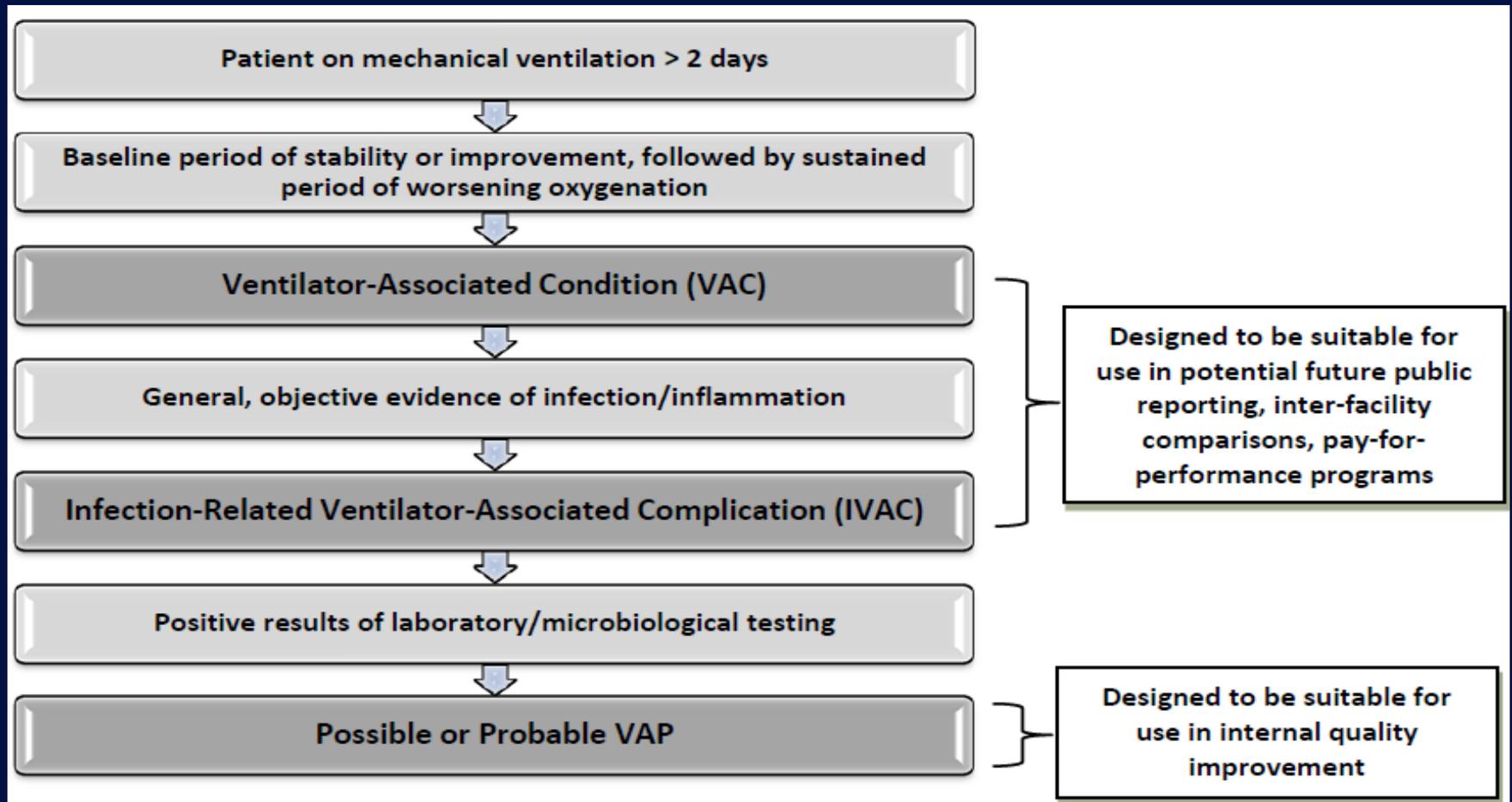
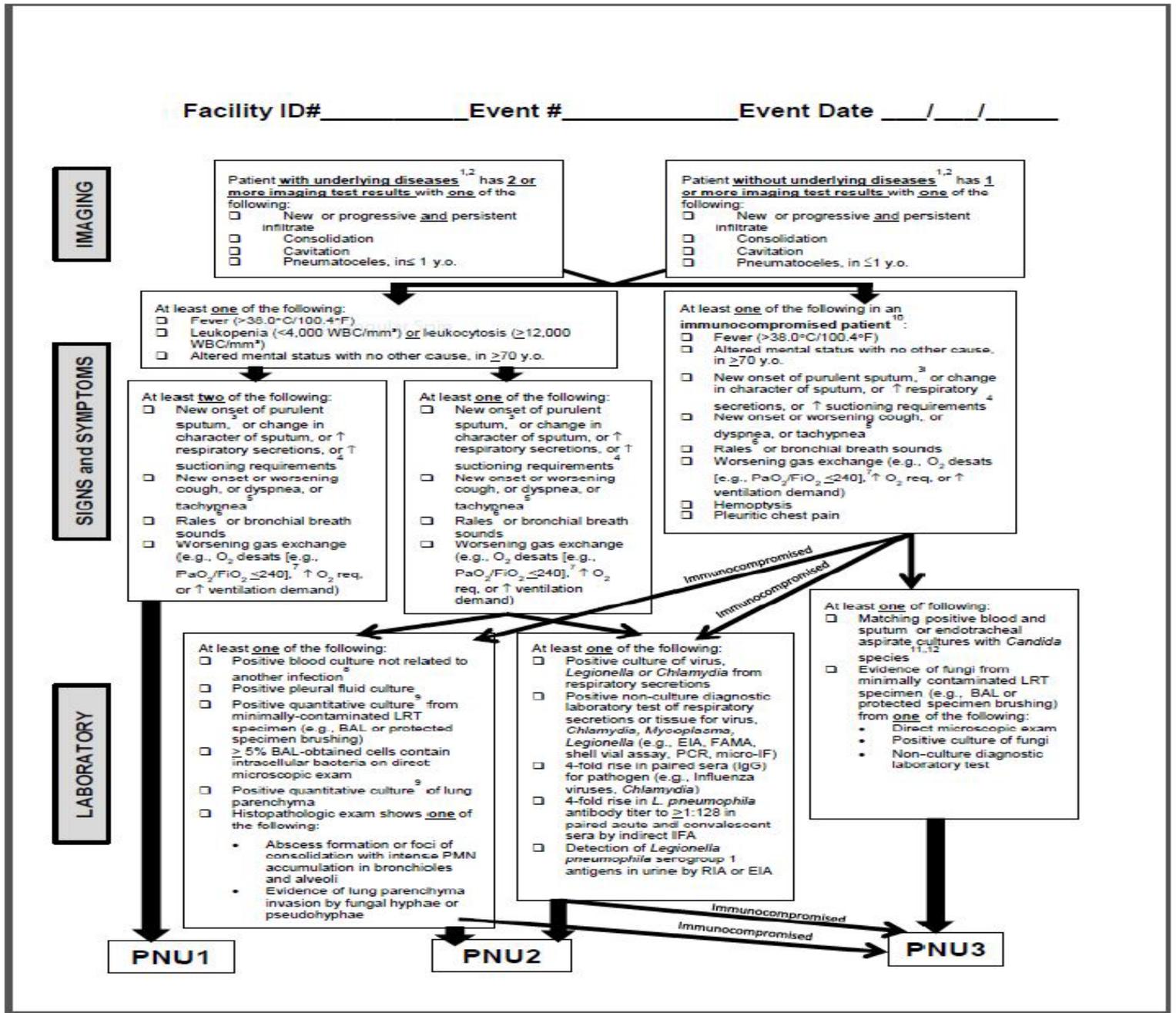


Figure 1: Pneumonia Flow Diagram for Patients of Any Age

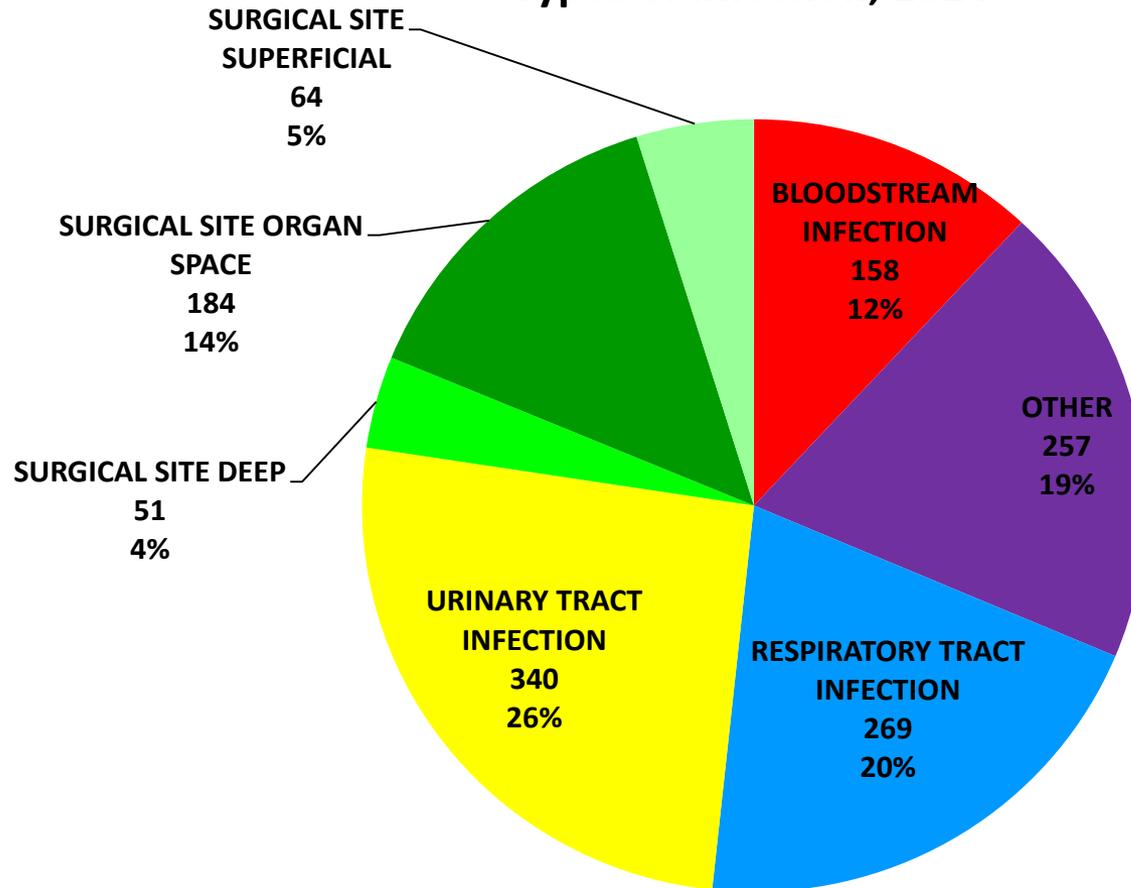


EPIDEMIOLOGY

HAP & VAP: IMPACT

- Potential complications of mechanical ventilation
 - Pneumonia, acute respiratory distress syndrome (ARDS), pulmonary embolism, barotrauma, pulmonary edema, and death
- Incidence
 - >300,000 patients receive mechanical ventilation each year in the US
 - ◆ 10% TO 20% develop VAP
 - 2011, an estimated 157,000 healthcare-associated pneumonias in US
- Mortality (VAP)
 - Patients 15-19 years, 24%; patients >80 years of age, 60%
 - Attributable mortality ~10%

Types of Infection, 2014



Proportion of infection types were similar to 2013.

Urinary tract infections increased by 13%; surgical site infections decreased by 12%. Bloodstream, respiratory tract and other infections were within 5% of previous year's numbers.

Table 4. Estimated Numbers of Major Types of Health Care–Associated Infection in the United States in 2011.

Type of Infection	Infections Identified in Survey	Surveyed Patients with Type of Infection	Estimated Infections in the United States*
	no.	% (95% CI)	no. (95% CI)
All health care–associated infections			
Pneumonia	110	24.3 (20.6–28.5)	157,500 (50,800–281,400)
Surgical-site infection	110†	24.3 (20.6–28.5)	157,500 (50,800–281,400)
Gastrointestinal infection	86	19.0 (15.6–22.8)	123,100 (38,400–225,100)
Urinary tract infection	65	14.4 (11.4–17.9)	93,300 (28,100–176,700)
Primary bloodstream infection	50	11.1 (8.4–14.2)	71,900 (20,700–140,200)
Eye, ear, nose, throat, or mouth infection	28‡	6.2 (4.2–8.7)	40,200 (10,400–85,900)
Lower respiratory tract infection	20	4.4 (2.8–6.6)	28,500 (6900–65,200)
Skin and soft-tissue infection	16	3.5 (2.1–5.6)	22,700 (5200–55,300)
Cardiovascular system infection	6	1.3 (0.5–2.7)	8,400 (1200–26,700)
Bone and joint infection	5	1.1 (0.4–2.4)	7,100 (1000–23,700)
Central nervous system infection	4	0.9 (0.3–2.1)	5,800 (700–20,700)
Reproductive tract infection	3	0.7 (0.2–1.8)	4,500 (500–17,800)
Systemic infection	1	0.2 (0.01–1.1)	1,300 (0–10,900)
Total			721,800 (214,700–1,411,000)
Infections in non-neonatal intensive care units			
Catheter-associated urinary tract infection	25	5.5 (3.7–7.9)	35,600 (9100–78,000)
Central-catheter–associated primary bloodstream infection	11	2.4 (1.3–4.2)	15,600 (3200–41,500)
Ventilator-associated pneumonia	35	7.7 (5.5–10.5)	49,900 (13,600–103,700)
Surgical-site infections attributed to Surgical Care Improvement Project procedures§	46	10.2 (7.6–13.2)	66,100 (18,700–130,300)
Hospital-onset infections caused by specific pathogens			
<i>Clostridium difficile</i> infection¶	56	12.4 (9.6–15.7)	80,400 (23,700–155,000)
MRSA bacteremia	7	1.5 (0.7–3.0)	9,700 (1700–29,600)

PREVALENCE: ICU (EUROPE)

- Study design: Point prevalence rate
 - 17 countries, 1447 ICUs, 10,038 patients
- Frequency of infections: 4,501 (44.8%)
 - Community-acquired: 1,876 (13.7%)
 - Hospital-acquired: 975 (9.7%)
 - ICU-acquired: 2,064 (20.6%)
 - ◆ Pneumonia: 967 (46.9%)
 - ◆ Other lower respiratory tract: 368 (17.8%)
 - ◆ Urinary tract: 363 (17.6%)
 - ◆ Bloodstream: 247 (12.0%)

PREVALENCE: ICU (WORLDWIDE)

- Study design: Point prevalence, 8 May 2007
 - 75 countries, 1265 ICUs, 13,796 adult patients
- Frequency of infections: 7,087 (51%)
 - Sites of infection
 - ◆ Respiratory tract: 4,503 (63.5%)
 - ◆ Abdominal: 1,392 (19.6%)
 - ◆ Bloodstream: 1,071 (15.1%)
 - ◆ Renal/urinary tract: 1,011 (14.3%)
- Antibiotic therapy: 71%
- Pathogens of infected patients: 47% GPC, 62% GNR, 19% fungi
- Infected patients had higher ICU (25.3% vs 10.7%) and hospital mortality (33.1% vs 14.8%)

VENTILATOR-ASSOCIATED PNEU RATES, NHSN, 2012

Table 6
Pooled means and key percentiles of the distribution of ventilator-associated PNEU rates and ventilator utilization ratios, by type of location, DA module, 2012

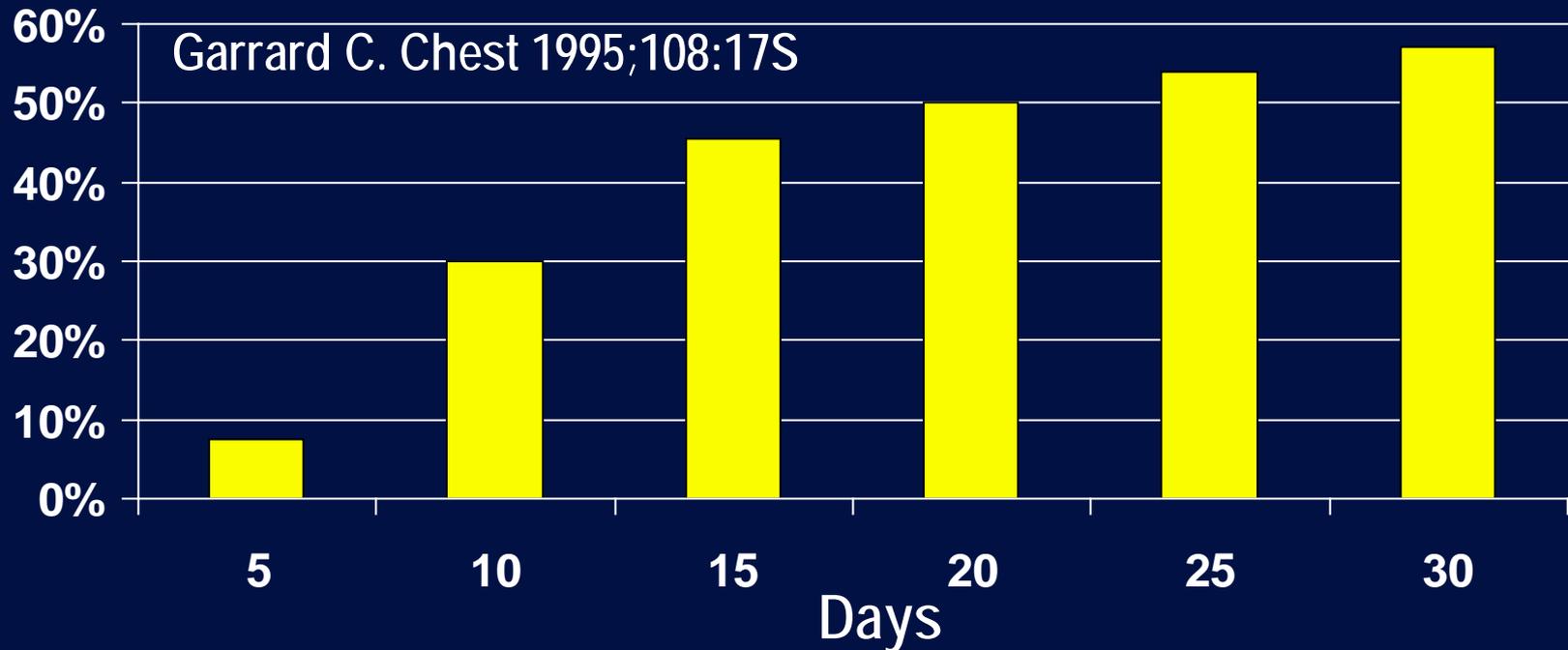
Ventilator-associated PNEU rate*					Percentile					
	Type of location	No. of locations [†]	No. of VAP	Ventilator–days	Pooled mean	10%	25%	50% (median)	75%	90%
Acute Care Hospitals										
Critical Care Units										
Burn	36 (34)	86	19,503	4.4	0.0	0.0	1.1	6.7	10.9	
Medical										
Major teaching	112 (111)	205	212,392	1.0	0.0	0.0	0.5	1.6	2.9	
Medical										
All other	223 (197)	191	206,731	0.9	0.0	0.0	0.0	1.3	3.4	
Medical cardiac	178 (170)	135	139,864	1.0	0.0	0.0	0.0	1.5	3.6	
Medical/surgical										
Major teaching	152 (145)	372	234,972	1.6	0.0	0.0	0.9	2.2	3.9	
Medical/surgical										
All other <15 beds	841 (660)	419	383,926	1.1	0.0	0.0	0.0	1.2	3.6	
Medical/surgical										
All other >15 beds	405 (400)	666	711,280	0.9	0.0	0.0	0.4	1.3	2.8	
Neurologic	23	62	20,859	3.0	0.0	0.0	0.2	2.5	7.0	
Neurosurgical	76 (74)	210	98,026	2.1	0.0	0.0	1.5	2.9	3.8	
Pediatric cardiothoracic	20	9	36,187	0.2	0.0	0.0	0.0	0.2	0.6	
Pediatric medical	16 (9)	2	6,634	0.3						
Pediatric medical/surgical	142 (132)	113	147,441	0.8	0.0	0.0	0.0	0.9	2.4	
Pediatric surgical	5 (4)	1	2,328	0.4						
Respiratory	7	4	6,037	0.7						
Surgical										
Major teaching	81 (80)	280	127,251	2.2	0.0	0.6	1.5	3.1	5.6	

VENTILATOR-ASSOCIATED PNEU RATES, NHSN, 2012

Ventilator-associated PNEU rate*	Type of location	No. of locations [†]	No. of VAP	Ventilator–days	Pooled mean	Percentile				
						10%	25%	50% (median)	75%	90%
	Surgical									
	All other	93 (88)	192	96,388	2.0	0.0	0.0	0.9	2.8	5.9
	Surgical cardiothoracic	207 (203)	319	190,785	1.7	0.0	0.0	0.6	2.5	5.1
	Trauma	75 (74)	508	141,314	3.6	0.0	0.8	2.6	6.0	9.4
	Specialty Care Areas/Oncology									
	Hematopoietic stem cell transplant	5	0	1,951	0.0					
	Step-Down Units									
	Adult step-down (post-critical care)	102 (82)	31	42,462	0.7	0.0	0.0	0.0	0.0	1.8
	Pediatric step-down (post-critical care)	5 (4)	1	5,813	0.2					
	Step-down NICU (level II)	7 (1)	0	119	0.0					
	Inpatient Wards									
	Medical	39 (22)	3	6,472	0.5	0.0	0.0	0.0	0.0	1.4
	Medical/surgical	64 (35)	22	25,731	0.9	0.0	0.0	0.0	0.0	1.3
	Pediatric medical	6 (5)	0	2,026	0.0					
	Pediatric medical/surgical	11 (8)	0	3,146	0.0					
	Pulmonary	9 (8)	7	7,241	1.0					
	Surgical	8 (1)	0	107	0.0					
	Telemetry	10 (5)	1	1,770	0.6					
	Critical Access Hospitals									
	Critical care units [‡]	67 (14)	3	2,964	1.0					
	Non-critical care units [§]	9 (1)	4	2,660	1.5					
	Long-Term Acute Care Hospitals									
	Adult critical care	18 (17)	8	12,544	0.6					
	Adult ward	195 (190)	103	316,632	0.3	0.0	0.0	0.0	0.3	1.4

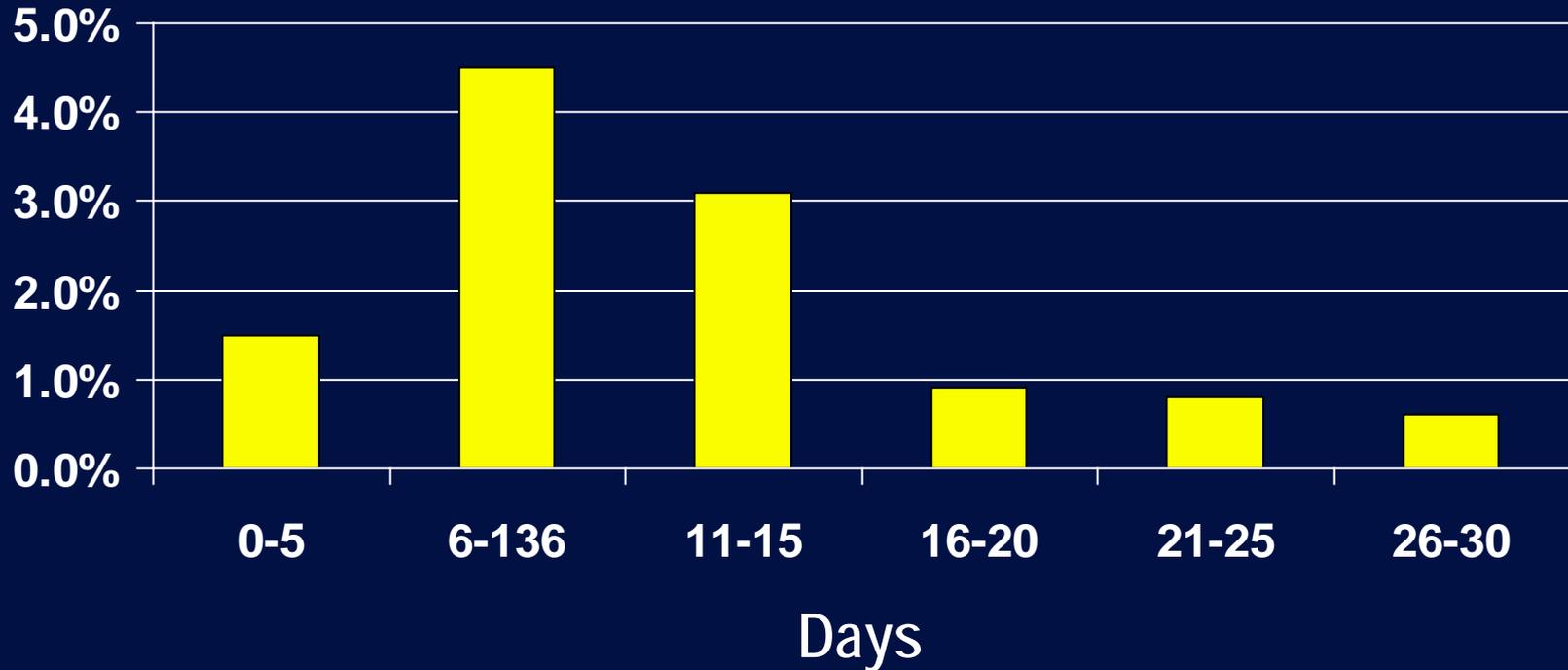
VAP: TIME COURSE

Cumulative Incidence ICU VAP



VAP: TIME COURSE

Mean Daily Risk Of VAP



MICROBIOLOGY

CAUSES OF LOWER RESPIRATORY TRACT INFECTIONS IN ADULTS

Organisms	Inhalation	Aspiration		Hemato- genous
		Community- acquired	Hostital- acquired	
<i>Haemophilus influenzae</i>				
<i>Streptococcus pneumoniae</i>				
Oropharyngeal streptococci and anaerobes				
<i>Staphylococcus aureus</i>				
Enterobacteriaceae				
<i>Pseudomonas aeruginosa</i>				
Legionellaceae				
<i>Mycoplasma pneumoniae</i>				
<i>Chlamydia pneumoniae</i>				
Viruses				
<i>Histoplasma capsulatum</i>				
<i>Blastomyces dermatitidis</i>				
<i>Coccidioides immitis</i>				
Mycobacteria				



Common causes of infection



Less common cause of infection

Table 3. Reported Causative Pathogens, According to Type of Infection.*

Pathogen	All Health Care–Associated Infections (N= 504)†		Pneumonia (N= 110)	Surgical-Site Infections (N= 110)	GI Infections (N= 86)	UTIs (N= 65)	Bloodstream Infections (N= 50)
	no. (%)	rank					
<i>Clostridium difficile</i>	61 (12.1)	1	0	0	61 (70.9)	0	0
<i>Staphylococcus aureus</i>	54 (10.7)	2	18 (16.4)	17 (15.5)	1 (1.2)	2 (3.1)	7 (14.0)
<i>Klebsiella pneumoniae</i> or <i>K. oxytoca</i>	50 (9.9)	3	13 (11.8)	15 (13.6)	1 (1.2)	15 (23.1)	4 (8.0)
<i>Escherichia coli</i>	47 (9.3)	4	3 (2.7)	14 (12.7)	1 (1.2)	18 (27.7)	5 (10.0)
Enterococcus species‡	44 (8.7)	5	2 (1.8)	16 (14.5)	5 (5.8)	11 (16.9)	6 (12.0)
<i>Pseudomonas aeruginosa</i>	36 (7.1)	6	14 (12.7)	7 (6.4)	1 (1.2)	7 (10.8)	2 (4.0)
Candida species§	32 (6.3)	7	4 (3.6)	3 (2.7)	3 (3.5)	3 (4.6)	11 (22.0)
Streptococcus species¶	25 (5.0)	8	7 (6.4)	8 (7.3)	2 (2.3)	2 (3.1)	2 (4.0)
Coagulase-negative staphylococcus species	24 (4.8)	9	0	7 (6.4)	0	1 (1.5)	9 (18.0)
Enterobacter species	16 (3.2)	10	3 (2.7)	5 (4.5)	0	2 (3.1)	2 (4.0)
<i>Acinetobacter baumannii</i>	8 (1.6)	11, tie	4 (3.6)	2 (1.8)	0	0	0
<i>Proteus mirabilis</i>	8 (1.6)	11, tie	1 (0.9)	5 (4.5)	0	1 (1.5)	0
Yeast, unspecified	8 (1.6)	11, tie	3 (2.7)	0	1 (1.2)	4 (6.2)	0
<i>Stenotrophomonas maltophilia</i>	8 (1.6)	11, tie	6 (5.5)	0	0	2 (3.1)	0
Citrobacter species	6 (1.2)	15, tie	2 (1.8)	1 (0.9)	0	1 (1.5)	0
Serratia species	6 (1.2)	15, tie	2 (1.8)	0	0	2 (3.1)	0
Bacteroides species	6 (1.2)	15, tie	0	5 (4.5)	1 (1.2)	0	0
Haemophilus species	6 (1.2)	15, tie	2 (1.8)	2 (1.8)	0	0	0
Viruses	3 (0.6)	19, tie	1 (0.9)	0	0	0	0
Peptostreptococcus species	3 (0.6)	19, tie	0	2 (1.8)	0	0	1 (2.0)
<i>Klebsiella</i> species other than <i>K. pneumoniae</i> and <i>K. oxytoca</i>	2 (0.4)	21, tie	1 (0.9)	0	0	0	1 (2.0)
<i>Clostridium</i> species other than <i>C. difficile</i>	2 (0.4)	21, tie	0	2 (1.8)	0	0	0
Prevotella species	2 (0.4)	21, tie	0	1 (0.9)	0	0	0
<i>Morganella morganii</i>	2 (0.4)	21, tie	0	1 (0.9)	0	1 (1.5)	0
Lactobacillus species	2 (0.4)	21, tie	0	0	1 (1.2)	0	1 (2.0)
Other organisms**	13 (2.6)	—	1 (0.9)	6 (5.5)	0	1 (1.5)	3 (6.0)

McGill S
NEJM
2014;
370:
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ETIOLOGIC AGENTS ASSOCIATED WITH HAP: NNIS vs INVASIVE DX

Pathogen	NNIS	INVASIVE DX
<i>S. aureus</i> (ORSA 55.7%)	19%	20.4%
<i>S. Pneumoniae</i>	NA	4.1%
<i>Streptococcus</i> spp.	3%	8.0%
Coagulase-negative staphylococcus	2%	1.4%
Enterobacteriaceae	26%	14.15
<i>Pseudomonas aeruginosa</i>	17%	24.4%
<i>Acinetobacter</i> spp.	4%	7.9%
<i>Stenotrophomonas maltophilia</i>	<1%	1.7%
<i>Hemophilus</i> spp.	7.1%	9.8%
<i>Neisseria</i> spp.	<1%	2.6%
Anaerobes	2%	0.9%
Fungi	7%	0.9%
Other (<1% each)		3.8%

Chastre J, Fagon J-Y. Am J Respir Crit Care Med 2002;165:867-903

MICROBIOLOGY

- Determinants of pathogens
 - Setting
 - Prior antibiotic use
 - Duration of hospitalization
 - ◆ Early (<5 days): *S. pneumoniae*, *H. influenzae*, MSSA
 - ◆ Late (\geq 5 days): *P. aeruginosa*, MRSA, Gram (-) bacilli
 - ICU stay
 - Colonization

COMMON PATHOGENS BY PRESENCE OR ABSENCE OF RISK FACTORS FOR MDROs

Table 1. Common pathogenic organisms in ventilator-associated pneumonia according to presence or absence of risk factors for multidrug-resistant organisms^[10]

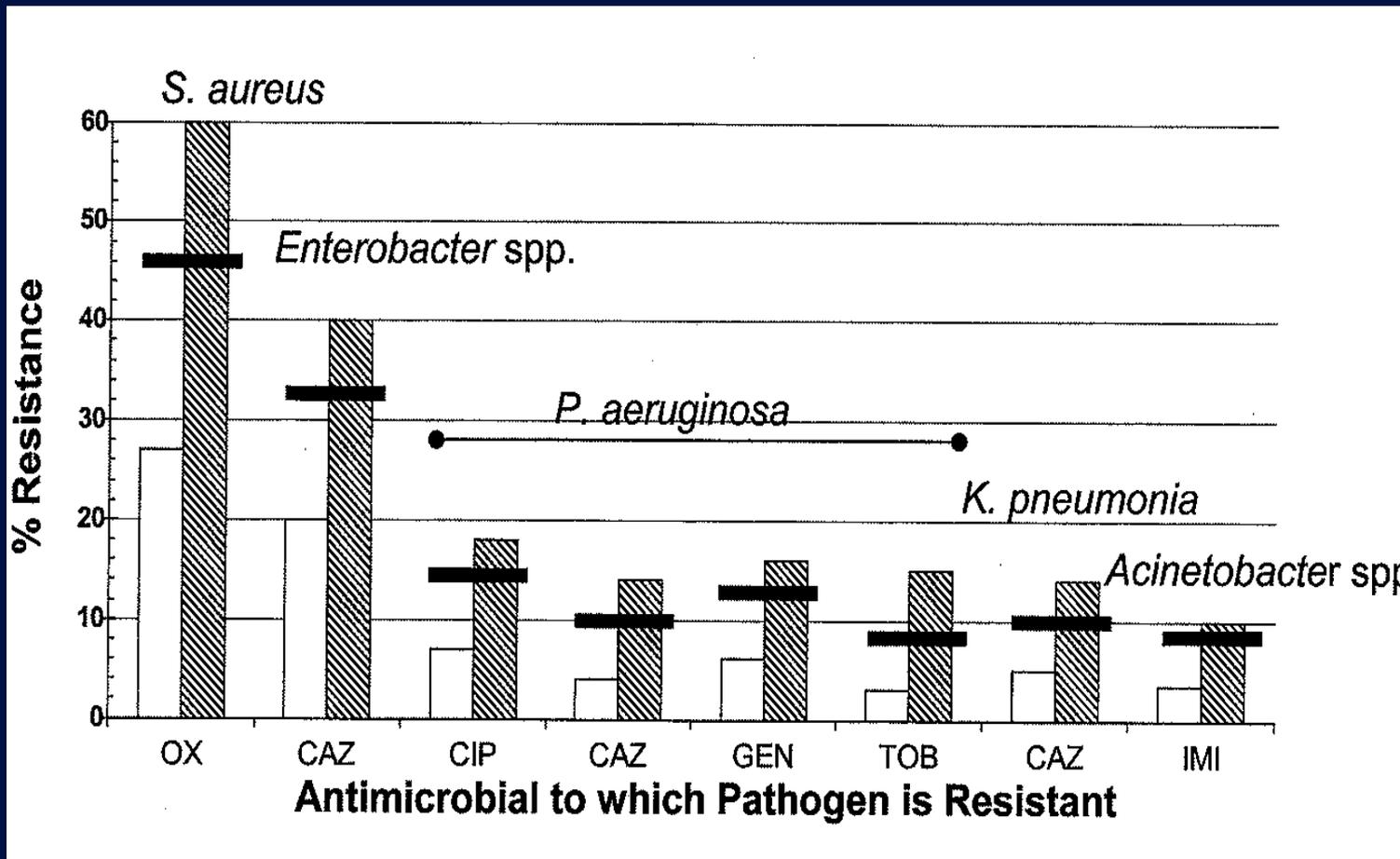
Risk factors	Commonly isolated organisms
No risk factors	<p><i>Streptococcus pneumoniae</i> <i>Haemophilus influenzae</i> Antibacterial-sensitive enteric Gram-negative bacilli <i>Escherichia coli</i> <i>Klebsiella pneumoniae</i> <i>Enterobacter</i> spp. <i>Proteus</i> spp. <i>Serratia marcescens</i></p>
Late onset (>5 days) or one of the following risk factors: antimicrobial therapy in preceding 90 days, current hospitalization of ≥5 days, high frequency of antibacterial resistance in the community or in the specific hospital unit, presence of risk factors for HCAP (hospitalization for ≥2 days in the preceding 90 days, residence in a nursing home or extended care facility, home infusion therapy [including antibacterials], chronic dialysis within 30 days, home wound care, family member with multidrug-resistant pathogen), immunosuppressive disease and/or therapy	<p>As above plus: <i>Pseudomonas aeruginosa</i> <i>K. pneumoniae</i> (ESBL) <i>Acinetobacter</i> spp. Methicillin-resistant <i>Staphylococcus aureus</i></p>

ESBL = extended-spectrum β-lactamase; **HCAP** = healthcare-associated pneumonia.

TABLE 3. Relative Frequency of Isolation of Selected Pathogens From Patients With Ventilator-Associated Pneumonia (VAP) and Nonventilated Patients With Hospital-Acquired Pneumonia (HAP), as a Function of Hospital Location of Care

Pathogen, by class	No. (%) of isolates			
	Patients with VAP ^a		Patients with HAP ^b	
	ICU	Non-ICU	ICU	Non-ICU
Gram-positive cocci				
<i>Staphylococcus aureus</i>				
Oxacillin-susceptible	35 (9.59)	2 (5.71)	13 (12.87)	23 (13.61)
Oxacillin-resistant	69 (18.90)	2 (5.71)	13 (12.87)	42 (24.85) ^c
<i>Streptococcus pneumoniae</i>	7 (1.92)	1 (2.86)	7 (6.93)	8 (4.73)
Gram-negative bacilli				
<i>Enterobacter</i> species	9 (2.47)	0 (0.00)	2 (1.98)	6 (3.55)
<i>Escherichia coli</i>	10 (2.74)	5 (14.29) ^c	3 (2.97)	5 (2.96)
<i>Klebsiella pneumoniae</i>	6 (1.64)	2 (5.71)	5 (4.95)	8 (4.73)
<i>Serratia marcescens</i>	8 (2.19)	2 (5.71)	3 (2.97)	2 (1.18)
<i>Acinetobacter</i> species	29 (7.95)	2 (5.71)	4 (3.96)	5 (2.96)
<i>Stenotrophomonas maltophilia</i>	25 (6.85)	2 (5.71)	2 (1.98)	1 (0.59)
<i>Pseudomonas aeruginosa</i>	60 (16.44)	10 (28.57)	11 (10.89)	14 (8.28)
<i>Moraxella catarrhalis</i>	6 (1.64)	0 (0.00)	2 (1.98)	5 (2.96)
<i>Hemophilus</i> species	18 (4.93)	0 (0.00)	4 (3.96)	2 (1.18)
Total, all pathogens	365	35	101	169

ICU (NNIS, 1989-99): Ventilator-Associated Pneumonia



Open bars ≤ 7 days hospitalization
 Closed bars > 7 days hospitalization

PATHOGENS AS A FUNCTION OF DURATION OF HOSPITALIZATION

TABLE 4. Frequency of Isolation of Selected Pathogens from Patients With Ventilator-Associated Pneumonia (VAP), as a Function of Duration of Hospitalization

Pathogen, by class	No. (%) of isolates		P
	Patients with early-onset VAP	Patients with late-onset VAP	
Gram-positive cocci			
<i>Staphylococcus aureus</i>			
Oxacillin-susceptible	12 (18.75)	24 (7.19)	.006
Oxacillin-resistant	8 (12.50)	63 (18.86)	.149
<i>Streptococcus pneumoniae</i>	4 (6.25)	4 (1.20)	.026
Gram-negative bacilli			
<i>Enterobacter</i> species	1 (1.56)	8 (2.40)	.561
<i>Escherichia coli</i>	2 (3.13)	13 (3.89)	.556
<i>Klebsiella pneumoniae</i>	1 (1.56)	7 (2.10)	.623
<i>Serratia marcescens</i>	2 (3.13)	8 (2.40)	.497
<i>Acinetobacter</i> species	0 (0.00)	31 (9.28)	.003
<i>Stenotrophomonas maltophilia</i>	1 (1.56)	26 (7.78)	.049
<i>Pseudomonas aeruginosa</i>	8 (12.50)	61 (18.26)	.176
<i>Moraxella catarrhalis</i>	2 (3.13)	4 (1.20)	.176
<i>Hemophilus</i> species	12 (18.75)	10 (2.99)	<.001
Total, all pathogens	64	334	

TABLE 5. Frequency of Isolation of Selected Pathogens From Non-ventilated Patients With Hospital-Acquired Pneumonia (HAP), as a Function of Duration of Hospitalization

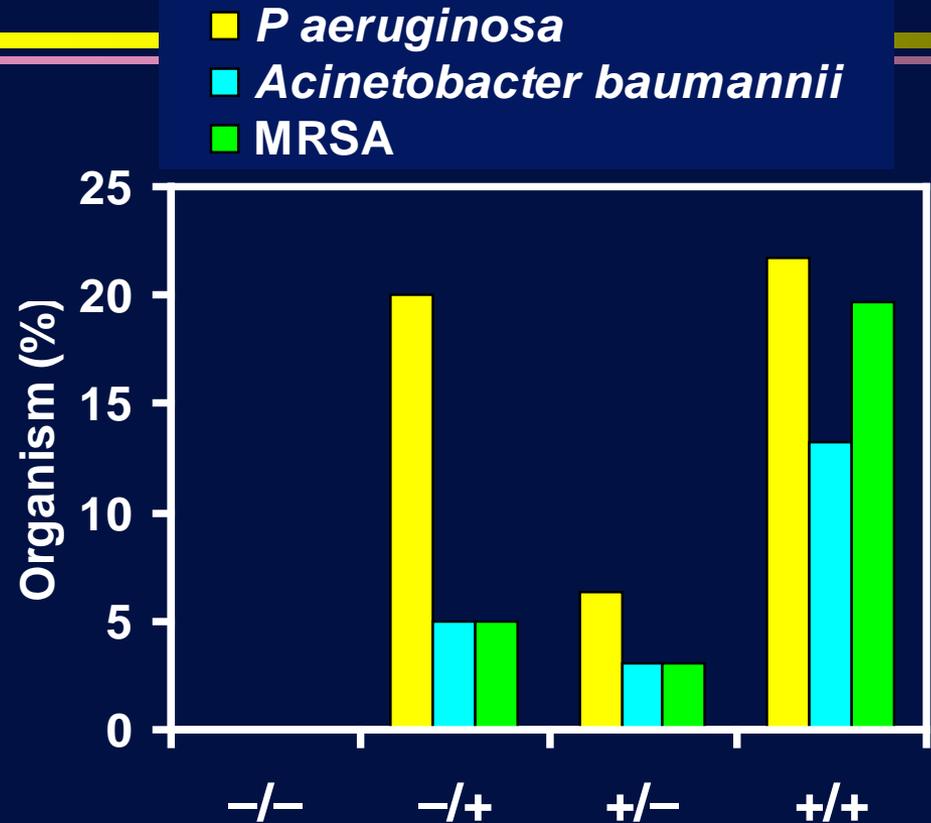
Pathogen	No. (%) of isolates		P
	Patients with early-onset HAP	Patients with late-onset HAP	
Gram-positive cocci			
<i>Staphylococcus aureus</i>			
Oxacillin-susceptible	13 (19.40)	22 (11.00)	.063
Oxacillin-resistant	8 (11.94)	47 (23.50)	.028
<i>Streptococcus pneumoniae</i>	8 (11.94)	7 (3.50)	.015
Gram-negative bacilli			
<i>Enterobacter</i> species	2 (2.99)	6 (3.00)	.639
<i>Escherichia coli</i>	1 (1.49)	7 (3.50)	.361
<i>Klebsiella</i> species	3 (4.48)	12 (6.00)	.454
<i>Serratia marcescens</i>	2 (2.99)	3 (1.50)	.369
<i>Acinetobacter</i> species	2 (2.99)	7 (3.50)	.598
<i>Stenotrophomonas maltophilia</i>	1 (1.49)	2 (1.00)	.581
<i>Pseudomonas aeruginosa</i>	2 (2.99)	23 (11.50)	.026
<i>Moraxella catarrhalis</i>	3 (4.48)	4 (2.00)	.244
<i>Hemophilus</i> species	4 (5.97)	4 (2.00)	.122
Total, all pathogens	67	200	

Antibiotic-Resistant VAP

Variable	Odds Ratio	P Value
Prior MV >7 days	6	0.009
Prior ABs	13	<0.001
Broad ABs	4	0.025

MV = Mechanical ventilation.

MRSA = Methicillin-resistant *S aureus*.



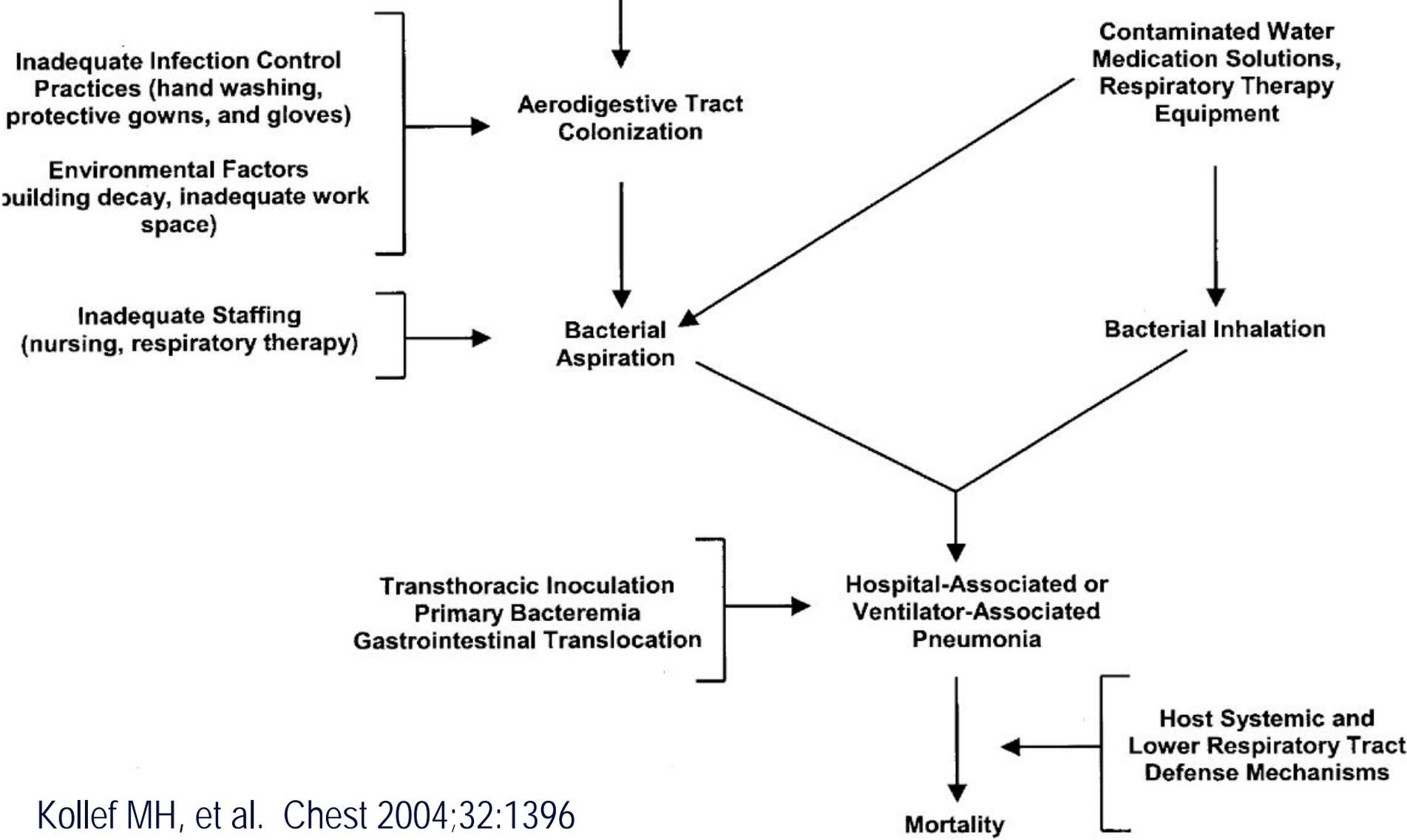
MV >7 Days / Prior Antibiotics

PATHOPHYSIOLOGY

PATHOGENESIS

- Colonization, aspiration, pneumonia in the setting of impaired host defenses
- Inhalation
- Instillation
- Bacteremic spread
- Contiguous spread

Medications Altering Gas Emptying and pH
 Invasive Devices with Biofilm (endotracheal tube, nasogastric tube)
 Prior Antibiotics
 Host Factors (immunosuppression, burns)



VAP: RISK FACTORS

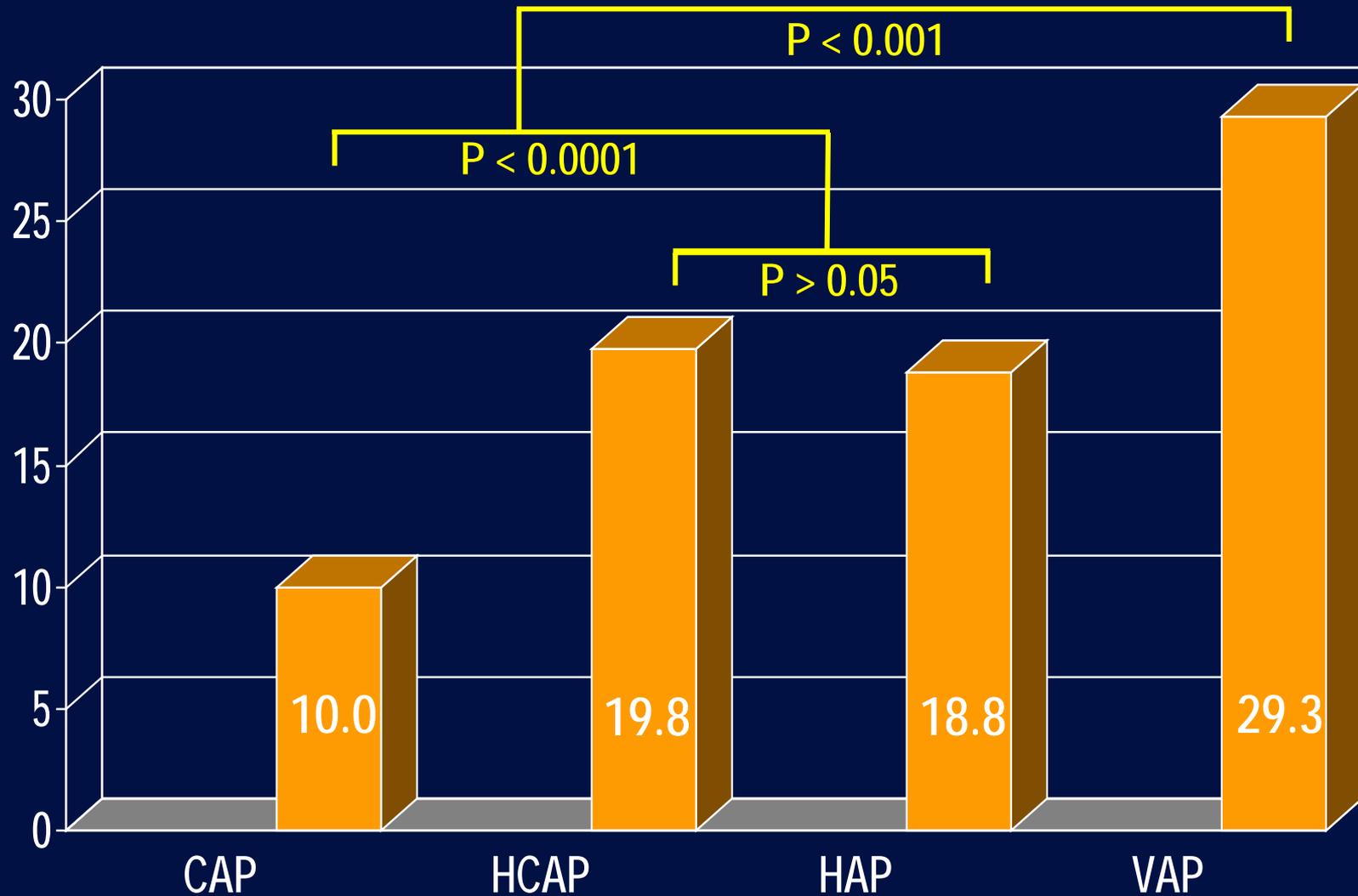
Intrinsic Risk Factors

- Chronic lung disease/COPD
- Severity of illness
- ARDS
- Witnessed aspiration
- Age >60 years
- Coma
- Head trauma/ICP monitoring
- Upper abdominal surgery
- Thoracic surgery
- Fall-winter season

Extrinsic Risk Factors

- Duration of intubation
- Emergent intubation
- Reintubation
- Elevated gastric pH
- Prior antibiotic therapy
- Nasogastric tube
- Enteral nutrition
- Supine head position
- Patient transport out of ICU

%Hospital Mortality by Classification



RISK FACTORS FOR MORTALITY (VAP)

- High risk pathogens: *P.aeruginosa*, *Acinetobacter*, *S. maltophilia* - 65% (Kollef, Chest 1995;108:165)
- Severity of underlying illness; shock
- Age
- Inappropriate antibiotic therapy
- Bilateral infiltrates
- Duration of prior hospitalization
- Prior antibiotic therapy
- Supine head position in ventilated patients

CONCLUSIONS

- Nosocomial pneumonia remains an important cause of patient morbidity and mortality in the US
- Nosocomial pneumonia results in a more prolonged hospital stay and increased cost

THANK YOU

