

Multidrug-Resistant Hospital-Acquired Infections: Reducing Risk Through Quality Improvement

Hospital-Acquired Infections

- Associated with significant morbidity and mortality
- High economic cost
- Frequent sites of HAIs
 - Surgical wound
 - Urinary tract
 - Lower respiratory tract
 - Bloodstream
- Highest prevalence
 - ICUs
 - Acute surgical and orthopedic wards
- Pathogens can be transmitted to community by patients, staff, visitors

HAI=hospital-acquired infections; ICU=intensive care unit.

World Health Organization, 2002. Available at: <http://www.who.int/csr/resources/publications/whocdscsreph200212.pdf>.

Accessed February 24, 2009.

Impact of Multidrug Resistance on HAIs

- Many HAIs are caused by MDR organisms¹
 - For example, MRSA, VRE, ESBL producers
- ESKAPE pathogens cause majority of US hospital infections²
 - *Enterococcus faecium*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, *Enterobacter* spp
- Widespread use of antibiotics in hospitals suppresses normal flora; allows MDR bacteria to flourish¹
- Colonized or infected patients spread MDR pathogens to hospital environment, staff, and other patients¹
- Resistant pathogens can transfer resistance genes and virulence factors to other types of bacteria¹

ESBL=extended-spectrum β -lactamase; MDR=multidrug-resistant; MRSA=methicillin-resistant *Staphylococcus aureus*; VRE=vancomycin-resistant enterococci.

1. Gould IM. *J Antimicrob Chemother.* 2008;61:763-765. 2. Boucher HW et al. *Clin Infect Dis.* 2009;48:1-12.

Infection Control and Quality Assurance for HAIs

- Infection control was once surveillance oriented; now it is prevention oriented
- Financial pressures from CMS and others
- Promotion of prevention
 - From CMS; JC; IHI; VHA; Premier, Inc.; and others
- Public reporting
- Patient safety movement
- Antimicrobial stewardship
- Performance improvement movement
 - Focus on system-wide change

Forces Driving the Quality Movement



Antibiotic-Resistant Gram-Positive Bacteria

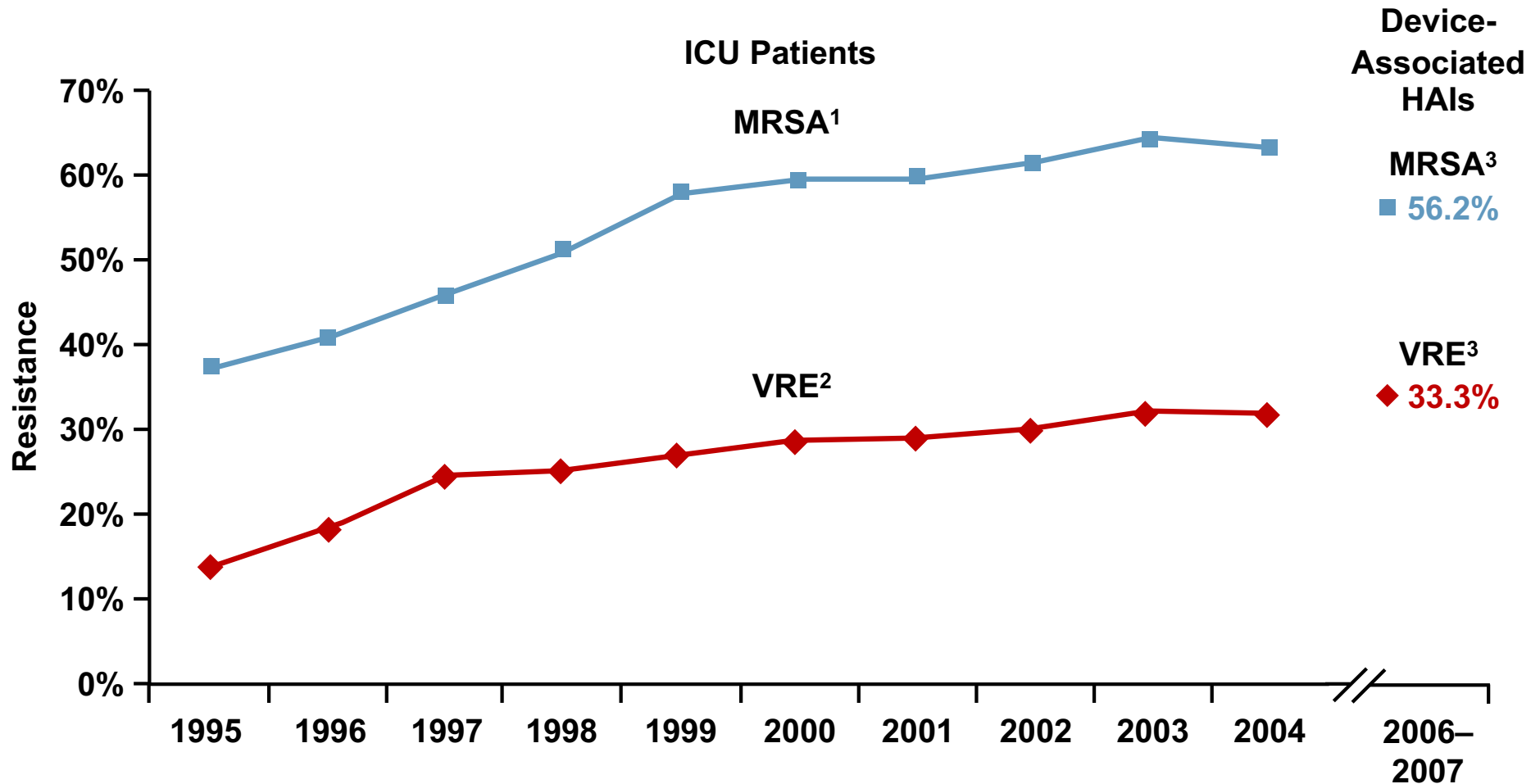
- Resistance among Gram-positives is increasing
- *Streptococcus pneumoniae*¹
- VRE¹
- MRSA
 - HA-MRSA
 - Agents that may be effective: vancomycin, quinupristin-dalfopristin, minocycline, linezolid, daptomycin, and tigecycline¹
 - Vancomycin-resistant *S aureus* has been reported²
 - CA-MRSA resistant to β -lactams³
 - Agents that may be effective: clindamycin, doxycycline, and TMP/SMX¹

CA-MRSA=community-associated MRSA; HA-MRSA=healthcare-associated MRSA;TMP/SMX=trimethoprim/sulfamethoxazole.

1. Cunha BA. *Med Clin N Am.* 2006;90:1165-1182. 2. Sievert DM et al. *MMWR.* 2002;51:565-567.

3. Gordon RJ, Lowy FD. *Clin Infect Dis* 2008;46(suppl 5):S350-S359.

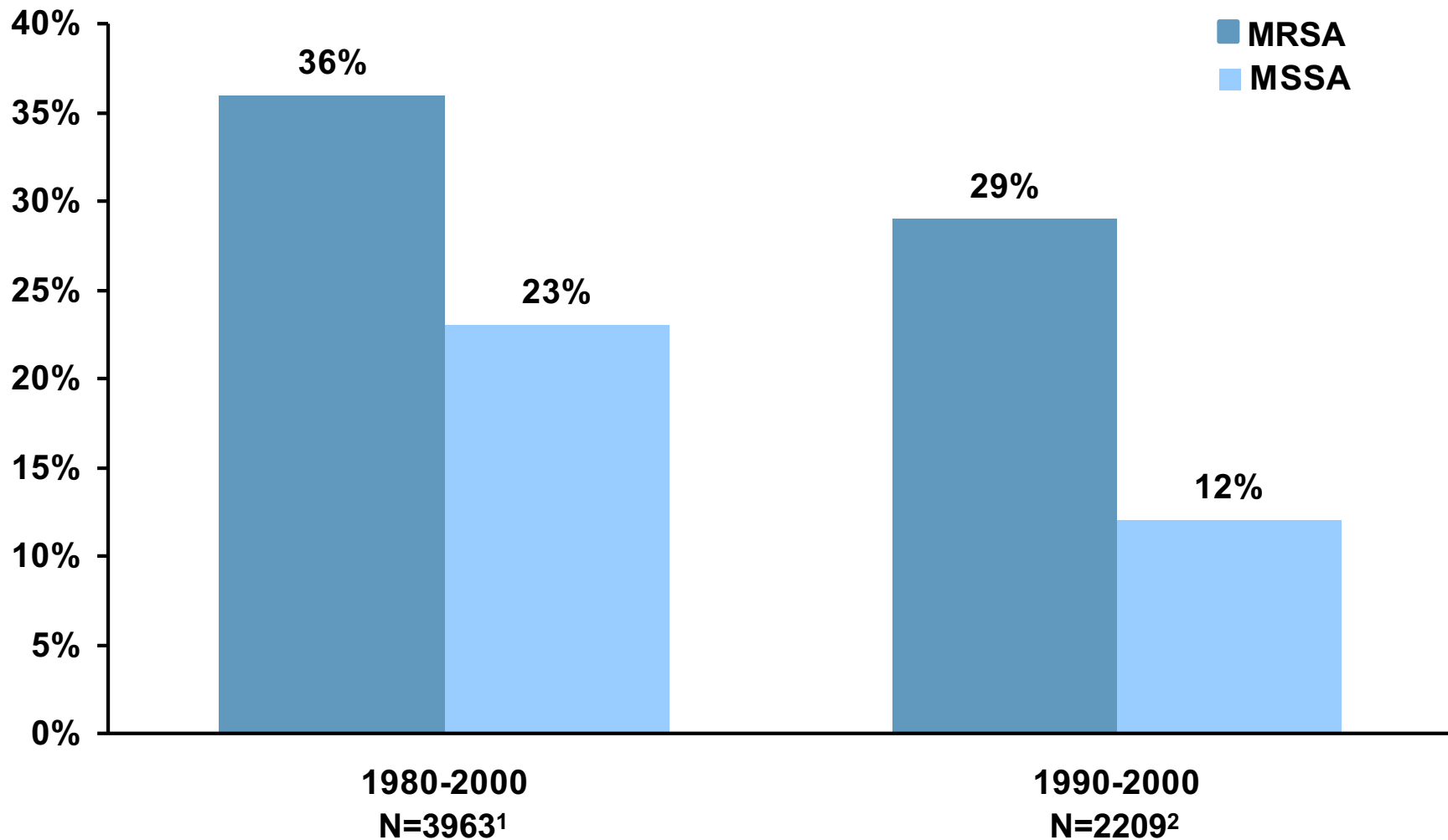
Proportion of MRSA and VRE in Hospitalized Patients, 1995-2007 (NNIS/NHSN)



NHSN=National Healthcare Safety Network; NNIS=National Nosocomial Infections Surveillance System.

1. Methicillin (oxacillin)-resistant *Staphylococcus aureus* (MRSA) among ICU patients, 1995-2004. Available at: http://www.cdc.gov/ncidod/dhqp/pdf/ar/ICU_RESTrend1995-2004.pdf. Accessed March 3, 2009. 2. Vancomycin-resistant *Enterococci* among ICU patients, 1995-2004. Available at: http://www.cdc.gov/ncidod/dhqp/pdf/ar/ICU_RESTrend1995-2004.pdf. Accessed March 3, 2009. 3. Hidron AI et al. *Infect Control Hosp Epidemiol.* 2008;29:996-1011.

Higher Mortality Associated With MRSA Than MSSA Bacteremia

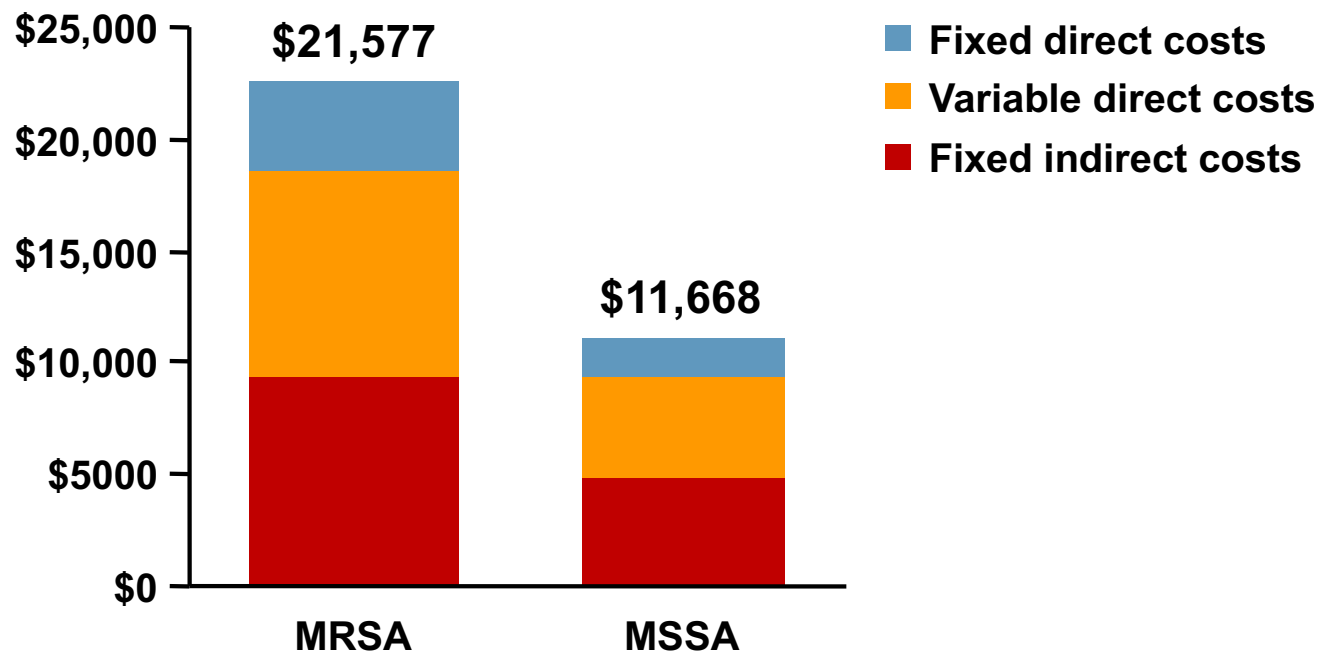


MSSA=methicillin-susceptible *S aureus*.

1. Cosgrove SE et al. *Clin Infect Dis*. 2003;36:53-59. 2. Whitby M et al. *Med J Aust*. 2001;175:264-267.

Economic Impact of MRSA Bacteremia

Adjusted Hospital Costs After *S aureus* Bacteremia Analysis of Covariance (n=353)

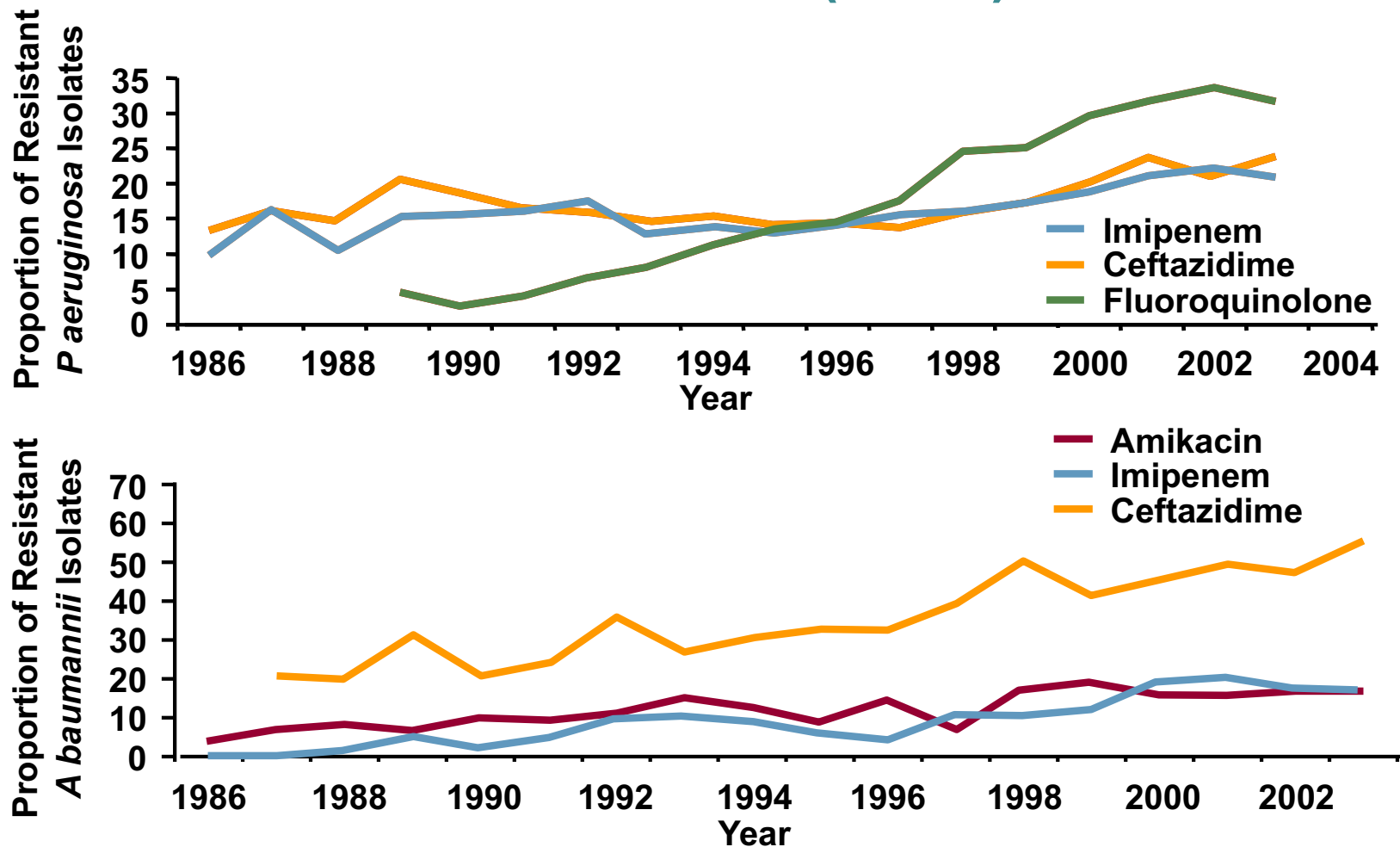


Fixed direct costs are costs such as administration, clerical support, and building overhead; fixed indirect costs are costs such as hotel costs, utilities, maintenance, and housekeeping; variable direct costs are costs such as nursing staff and medications.

MDR, Panresistant, and XDR Gram-Negative Bacteria

- MDR strains may be defined as those resistant to ≥ 2 classes of normally active antibiotics¹
 - Classes: antipseudomonal cephalosporins, antipseudomonal carbapenems, β -lactam/ β -lactamase inhibitor combinations, antipseudomonal fluoroquinolones, aminoglycosides
- Panresistant strains are not susceptible to all of the following²
 - Antipseudomonal cephalosporins, antipseudomonal carbapenems, piperacillin/tazobactam, ciprofloxacin, levofloxacin
- Extremely drug-resistant (XDR) strains are not susceptible to all of the following²
 - Antipseudomonal cephalosporins, antipseudomonal carbapenems, piperacillin/tazobactam, ticarcillin/clavulanate, ampicillin/sulbactam, ciprofloxacin, levofloxacin, aminoglycosides, tigecycline, polymyxins

MDR *P aeruginosa* and *A baumannii* Isolates in US ICUs, 1986-2003 (NNIS)¹⁻³



For imipenem, ceftazidime, and amikacin, results of Cochran-Armitage χ^2 tests for trend were significant ($P < 0.001$).

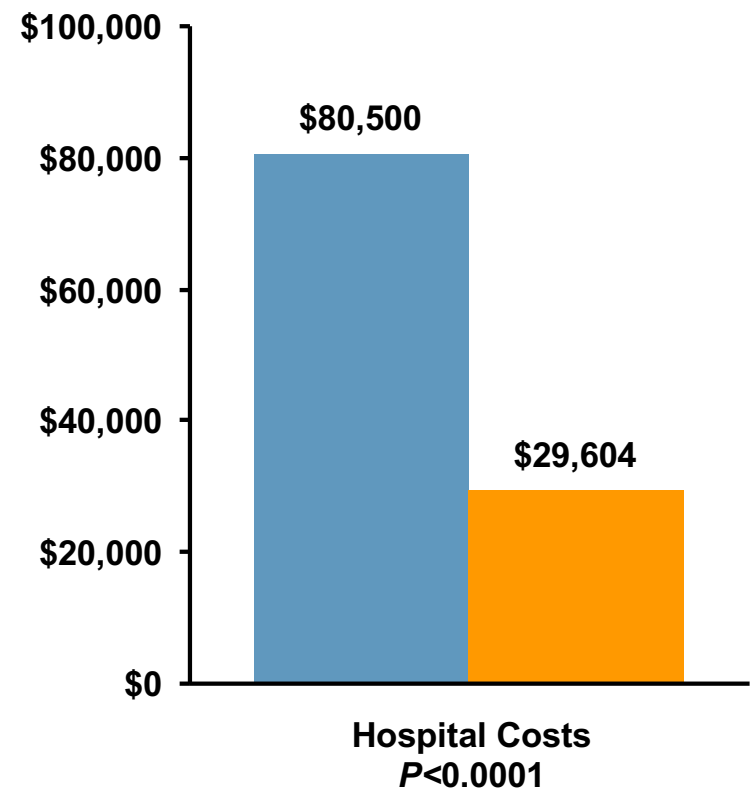
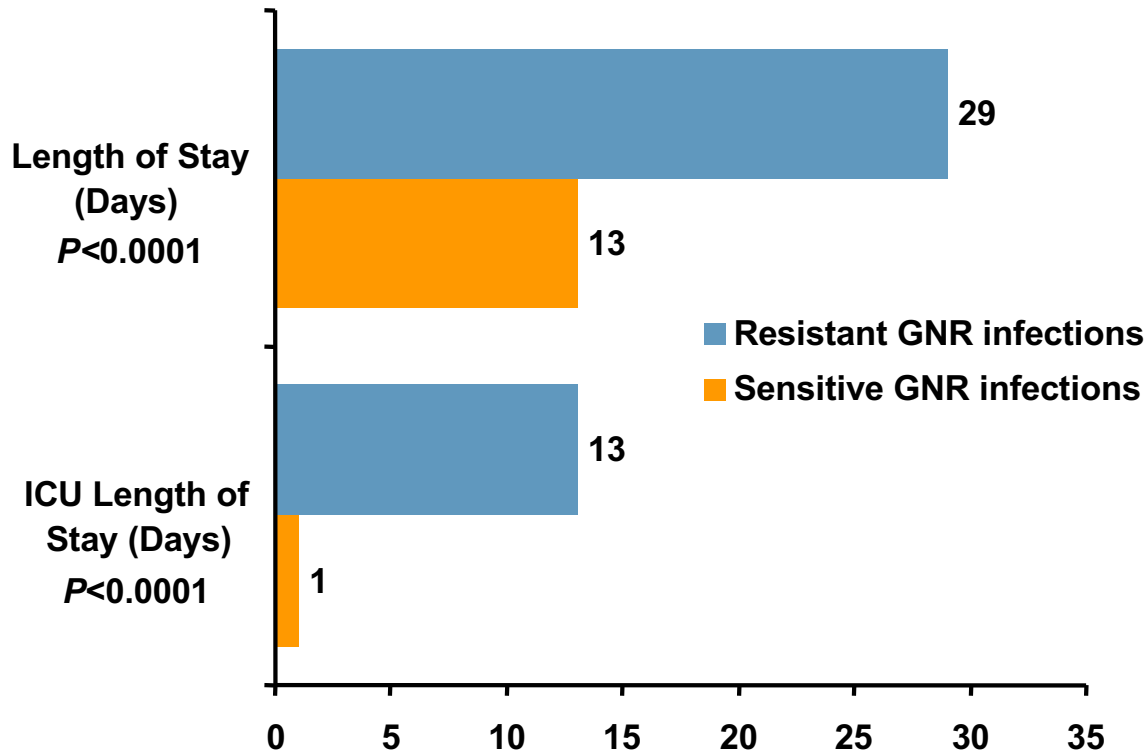
Upper graph adapted from Gaynes R et al. *Clin Infect Dis.* 2005;41:848-854.

Lower graph reproduced with permission from Gaynes R, Edwards JR, and the NNIS System. *Clin Infect Dis.* 2005;41:848-854.

1. Gaynes R, Edwards JR, NNIS System. *Clin Infect Dis.* 2005;41:848-854. 2. Fridkin SK, Gaynes RP. *Clin Chest Med.* 1999;20:303-316. 3. NNIS System. Fluoroquinolone-resistant *P aeruginosa* among ICU patients, 1995-2004. Available at: http://www.cdc.gov/ncidod/dhqp/pdf/ar/ICU_RESTrend1995-2004.pdf. Accessed March 3, 2009.

Costs of Gram-Negative Resistance

- University hospital surgical ICU and ward
- 604 surgical patients with GNR infections
 - 467 sensitive and 137 resistant* GNR infections

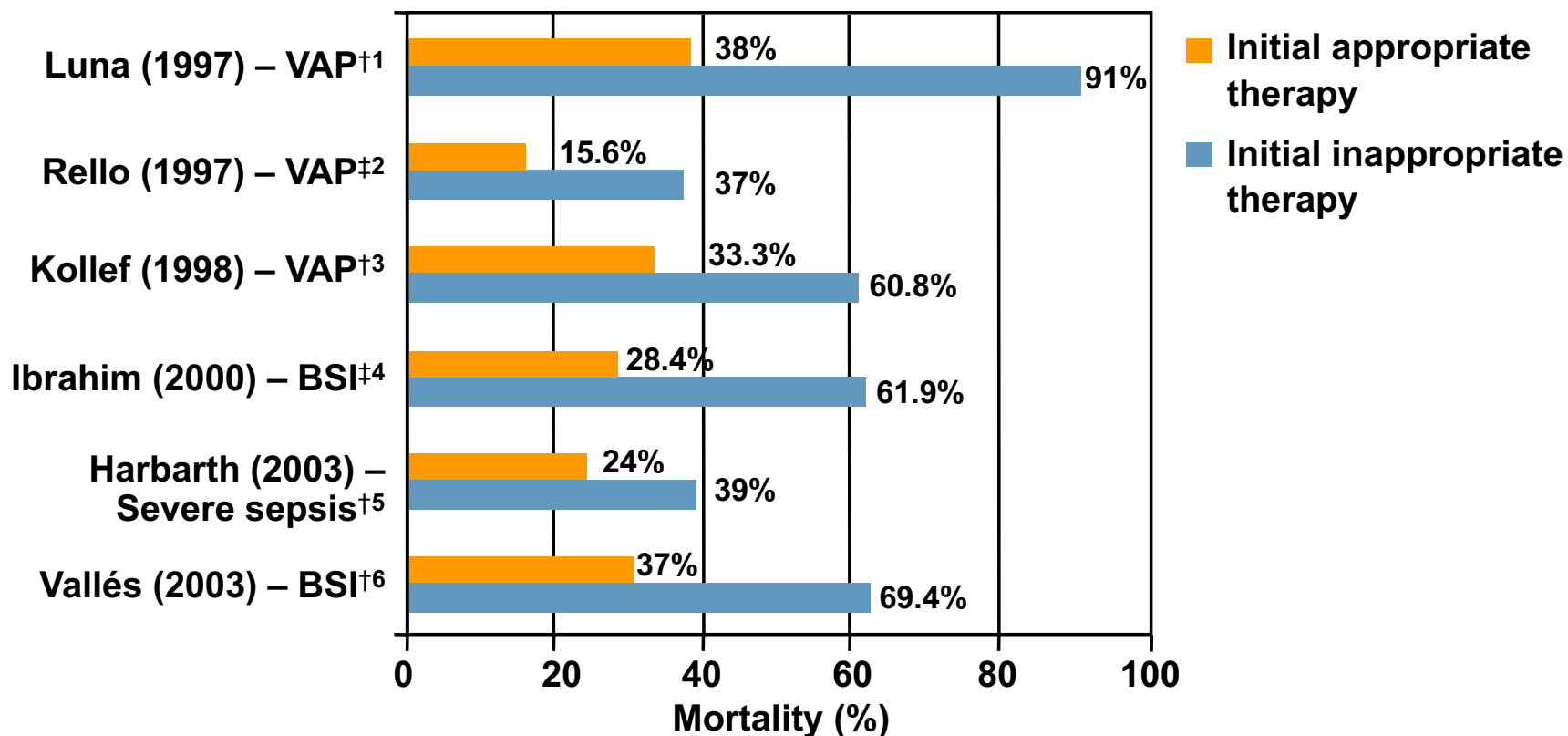


*Resistance was defined as resistance to all drugs in ≥ 1 of these antibiotic classes: aminoglycosides, cephalosporins, carbapenems, and fluoroquinolones.
GNR=Gram-negative rod.

Evans HL et al. *Crit Care Med.* 2007;35:89-95.

Mortality Associated With Initial Inappropriate* Antimicrobial Therapy

Critically Ill Patients With VAP or BSI

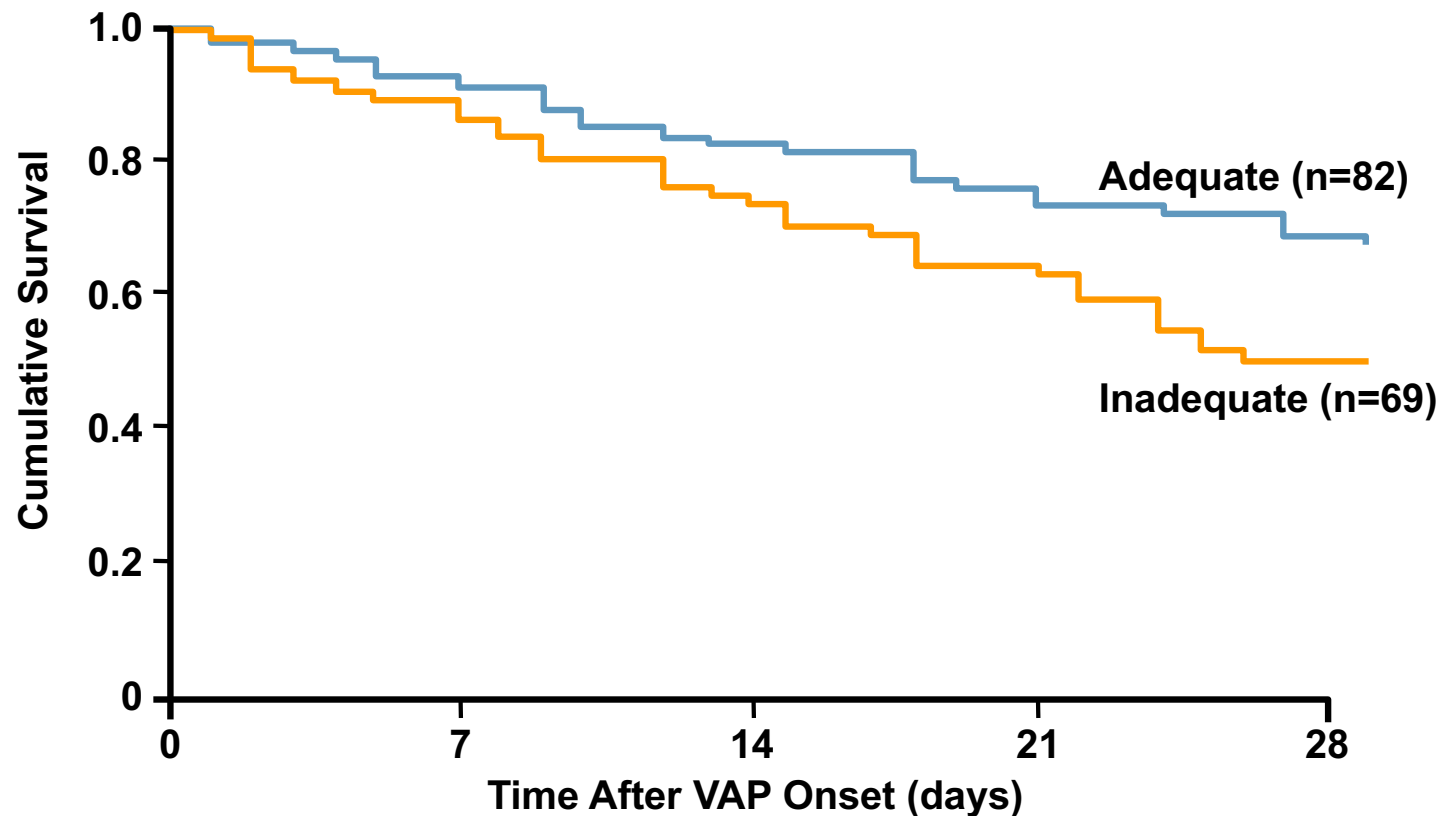


*Based on the 2005 American Thoracic Society (ATS)/Infectious Diseases Society of America (IDSA) guidelines for hospital-acquired pneumonia (HAP)/VAP/healthcare-associated pneumonia (HCAP) (*Am J Respir Crit Care Med.* 2005;171:388-416), “inappropriate” would be the term used to refer to the inadequate therapy noted on this slide. [†]Crude (overall) mortality; [‡]Infection-related mortality
BSI=bloodstream infection; VAP=ventilator-associated pneumonia.

1. Luna CM et al. *Chest.* 1997;111:676-685. 2. Rello J et al. *Am J Respir Crit Care Med.* 1997;156:196-200. 3. Kollef MH et al. *Chest.* 1998;113:412-420. 4. Ibrahim EH et al. *Chest.* 2000;118:146-155. 5. Harbarth S et al. *Am J Med.* 2003;115:529-535. 6. Vallés J et al. *Chest.* 2003;123:1615-1624.

Resistance as a Risk Factor for Inadequate Therapy and Mortality in VAP

- 151 patients with VAP: 82 received adequate therapy; 69, inadequate therapy
- Risk factors for inadequate treatment of VAP: MDR bacteria (OR=3.07), polymicrobial infection (OR=3.67), and late-onset VAP (OR=2.93)



Reproduced with permission from Teixeira PJZ et al. *J Hosp Infect.* 2007;65:361-367.

OR=odds ratio.

Pneumonia Definitions

- HAP: pneumonia occurring ≥ 48 hours after admission¹
 - Not incubating at time of admission
- VAP: pneumonia arising > 48 to 72 hours after endotracheal intubation¹
- HCAP: includes patients¹
 - Hospitalized in acute care hospital for ≥ 2 days within 90 days of infection
 - Residing in nursing home or long-term care facility
 - Receiving intravenous antibiotic therapy, chemotherapy, or wound care within 30 days of infection
 - Attending a hospital or hemodialysis clinic
- CAP: pneumonia occurring outside the hospital setting in patients not meeting HCAP criteria^{2,3}

CAP=community-acquired pneumonia.

1. ATS/IDSA. *Am J Respir Crit Care Med.* 2005;171:388-416. 2. Micek ST et al. *Antimicrob Agents Chemother.* 2007;51:3568-3573.

3. Mandell LA et al. *Clin Infect Dis.* 2007;44(suppl 2):S27-S72.

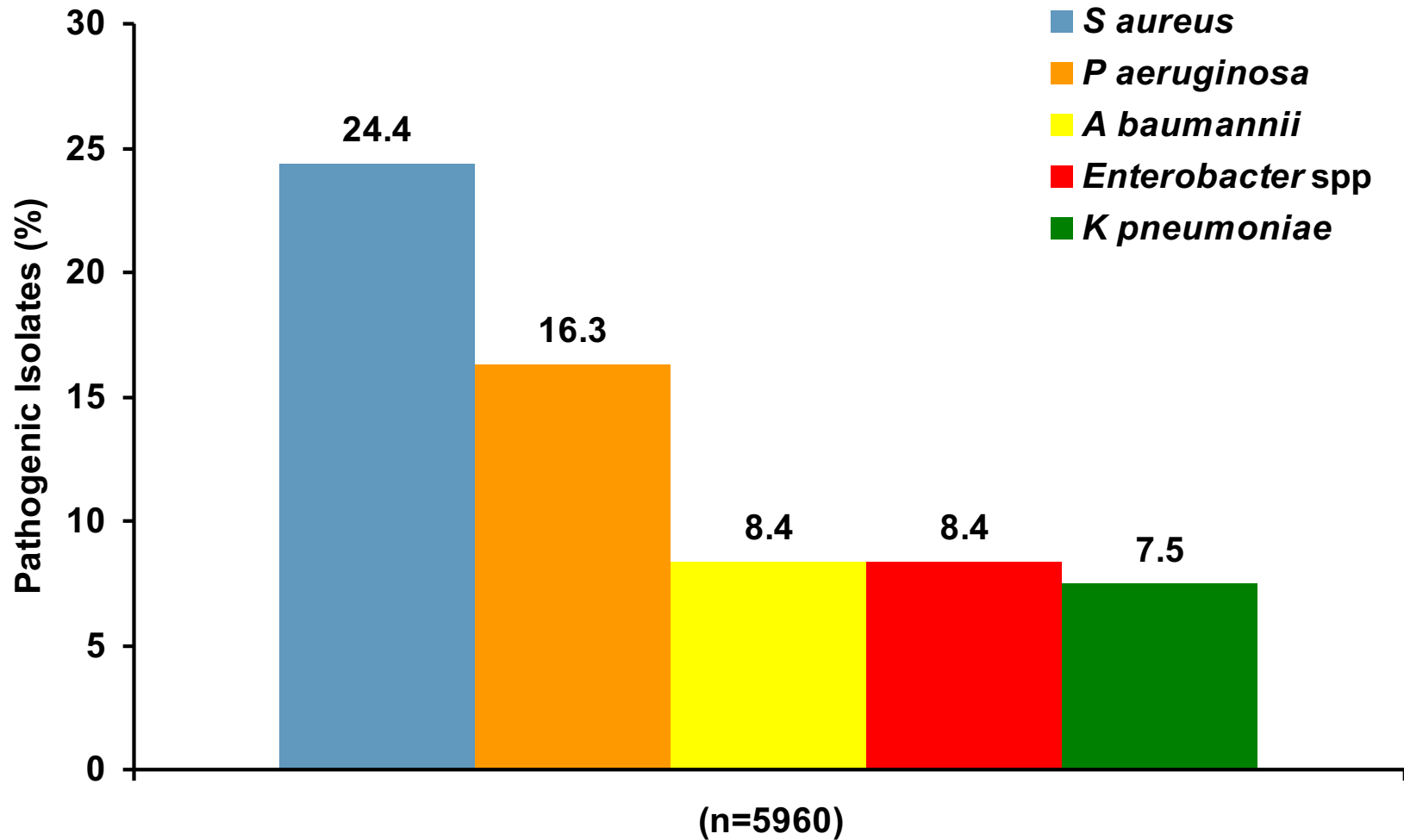
Recent Decline in VAP Rates per 1000 Ventilator Days in the US (NHSN)

Type of ICU	Pooled Means		
	2004 ¹	2006 ²	2007 ³
Burn	12.0	12.3	10.7
Cardiothoracic	7.2	5.7	4.7
Coronary	4.4	2.8	2.5
Medical	4.9	3.1	2.5
Medical-surgical			
Major teaching	5.4	3.6	3.3
All others	5.1	2.7	2.3
Neurosurgical	11.2	7.0	6.5
Pediatric	2.9	2.5	2.1
Surgical	9.3	5.2	5.3
Trauma	15.2	10.2	9.3

1. NNIS. *Am J Infect Control*. 2004;32:470-485. 2. Edwards JR et al. *Am J Infect Control*. 2007;35:290-301.

3. Edwards JR et al. *Am J Infect Control*. 2008;36:609-626.

Pathogens Associated With VAP in US Hospitals, 2006-2007 (NHSN)



- 54.4% of *S aureus* isolates were MRSA

Risk Factors for MDR Pathogens Causing HAP, HCAP, and VAP

- Antimicrobial therapy in preceding 90 days
- Current hospitalization of ≥ 5 days
- High frequency of antibiotic resistance in community or in specific hospital unit
- Immunosuppressive disease and/or therapy
- Presence of risk factors for HCAP
 - Including recent hospitalization or residence in a nursing home or extended-care facility

MRSA CAP Pneumonia, 2006-2007

- 51 *S aureus* CAP cases referred to the CDC in 2006-2007
 - From 19 states
 - Median age 16 years
 - 44% had no underlying comorbidities
 - 33% had positive influenza test; 91% of these died
 - Of 47 patients with reported outcome, 51% died
 - Median time from symptoms onset to death: 4 days
- 37 of the 51 cases were due to MRSA
 - 48% died
 - Only 43% received MRSA coverage (linezolid or vancomycin) empirically

Initial Empiric Therapy for HAP: Late-Onset Disease or Risk Factors for MDR Pathogens

Potential Pathogens

Potential pathogens for patients without risk factors and

MDR pathogens

P aeruginosa

K pneumoniae (ESBL+)*

Acinetobacter spp*

MRSA

*Legionella pneumophila**

Initial Broad-Spectrum Combination Antibiotic Therapy

Antipseudomonal cephalosporin

or

Antipseudomonal carbapenem

or

β -lactam/ β -lactamase inhibitor

plus

Antipseudomonal fluoroquinolone*

or

Aminoglycoside

plus

Linezolid or vancomycin†

*If an ESBL strain, such as *K pneumoniae* or an *Acinetobacter* spp is suspected, a carbapenem is a reliable choice. If *L pneumophila* is suspected, the combination antibiotic regimen should include a macrolide (eg, azithromycin), or a fluoroquinolone (eg, ciprofloxacin or levofloxacin) should be used rather than an aminoglycoside.

†If MRSA risk factors are present or there is a high incidence locally.

Adapted with permission from ATS/IDSA. *Am J Respir Crit Care Med.* 2005;171:388-416.

Deescalation of Antibiotic Therapy

- Approach to deescalation/streamlining
 - Initially treat with broad-spectrum antibiotics^{1,2}
 - Discontinue antibiotic therapy if no evidence of infection³
 - Narrow the spectrum of activity based on culture findings, when possible^{1,2}
 - Shorten course of therapy, based on culture findings and clinical course⁴
- Exceptions to general approach
 - Do not discontinue antibiotics in a patient who is decompensating
 - Patients may be ill and require therapy, notwithstanding negative culture results

Microbiology of Intraabdominal Infection

Primary¹

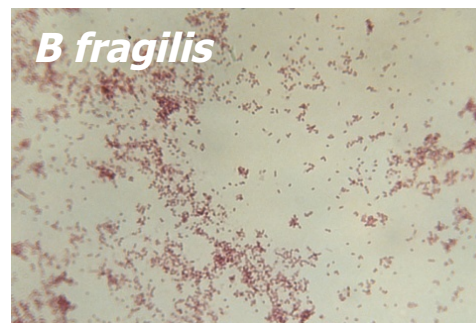
Enterobacteriaceae
(Gram-negative rods including
Escherichia coli, *Klebsiella* spp)
S pneumoniae
Enterococcus faecalis

Secondary (Bowel Perforation); Complicated Intraabdominal Infection¹

Enterobacteriaceae
(Gram-negative rods)
Anaerobic bacteria
(including *Bacteroides fragilis*,
Enterococcus spp)



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E coli (38% of intraabdominal infections) and *B fragilis* (24%) are the 2 most commonly isolated bacteria in intraabdominal infections²

Worldwide Antimicrobial Resistance in *E coli* Isolates Causing cIAI

- SMART study (17 countries)¹
 - 3134 Gram-negative bacilli from intraabdominal infections
 - *E coli* (45%) and *Klebsiella* spp (17%) most common
 - 56% of 1403 *E coli* isolates susceptible to ampicillin/sulbactam
- Germany²
 - 425 patients with community-acquired cIAI
 - Pathogens isolated within 2 days of surgery
 - 47% of isolates *E coli*
 - 32 of 147 *E coli* isolates resistant to antimicrobial agents (not further specified)

cIAI=complicated intraabdominal infection; SMART=Study for Monitoring Antimicrobial Resistance Trends.

1. Chow JW, et al. *Surg Infect.* 2005;6:439-448. 2. Krobot K et al. *Eur J Clin Microbiol Infect Dis.* 2004;23:682-687.

Recommended Regimens for cIAI in High-Risk Patients

IDSA Guidelines¹ High-Severity Infections

SIS Guidelines² High-Risk Patients

Single agents

1. Piperacillin/tazobactam
2. Imipenem/cilastatin
3. Meropenem

1. Piperacillin/tazobactam
2. Imipenem/cilastatin
3. Meropenem

Combinations

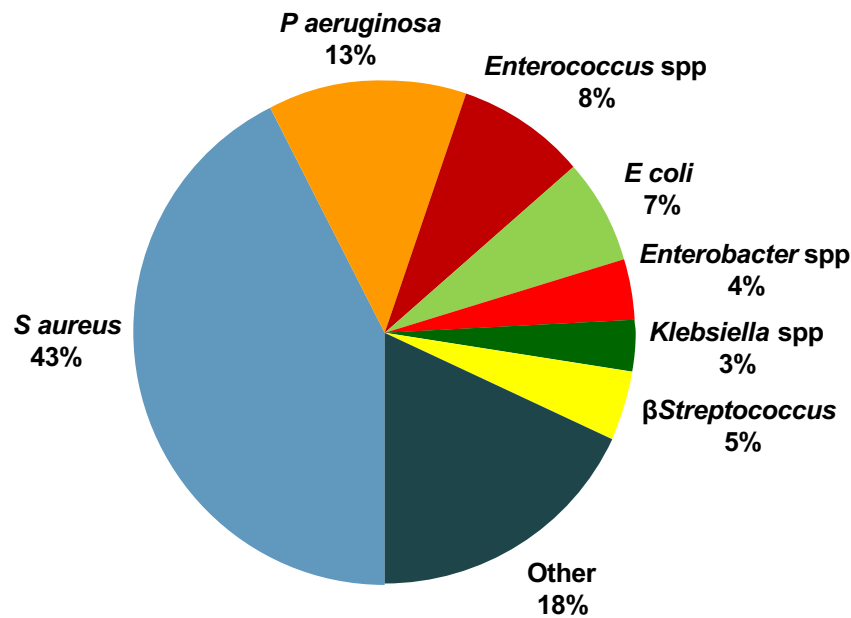
1. Third-/fourth-generation cephalosporin + metronidazole
2. Aztreonam + metronidazole
3. Ciprofloxacin + metronidazole

1. Ciprofloxacin + metronidazole
2. Aminoglycoside + antianaerobe
3. Aztreonam + clindamycin
4. Third-/fourth-generation cephalosporin + antianaerobe

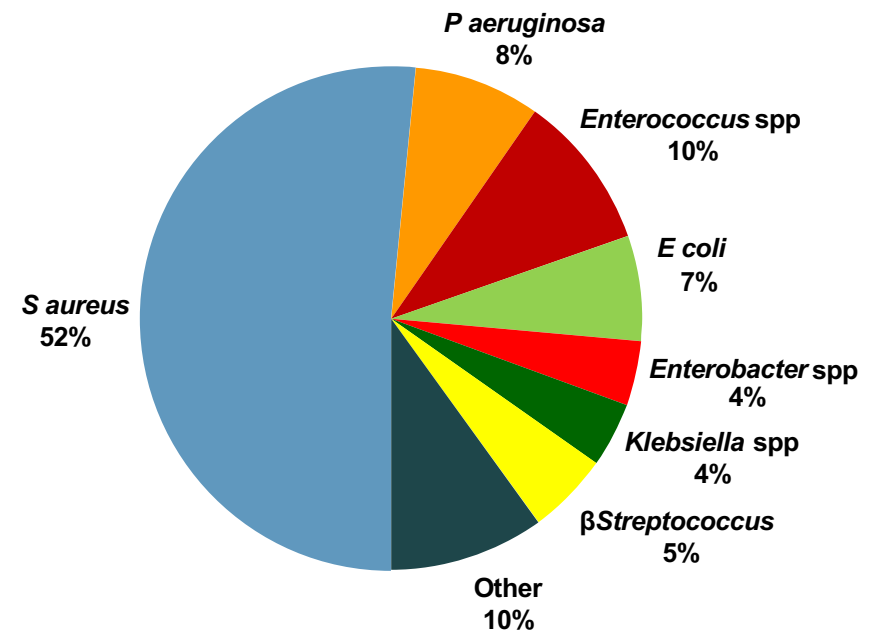
SIS=Surgical Infection Society.

1. Adapted with permission from Solomkin JS et al. *Clin Infect Dis*. 2003;37:997-1005. 2. Adapted with permission from Mazuski JE et al. *Surg Infect (Larchmt)*. 2002;3:161-173.

Pathogens Producing Hospitalized SSTIs (SENTRY, North America)



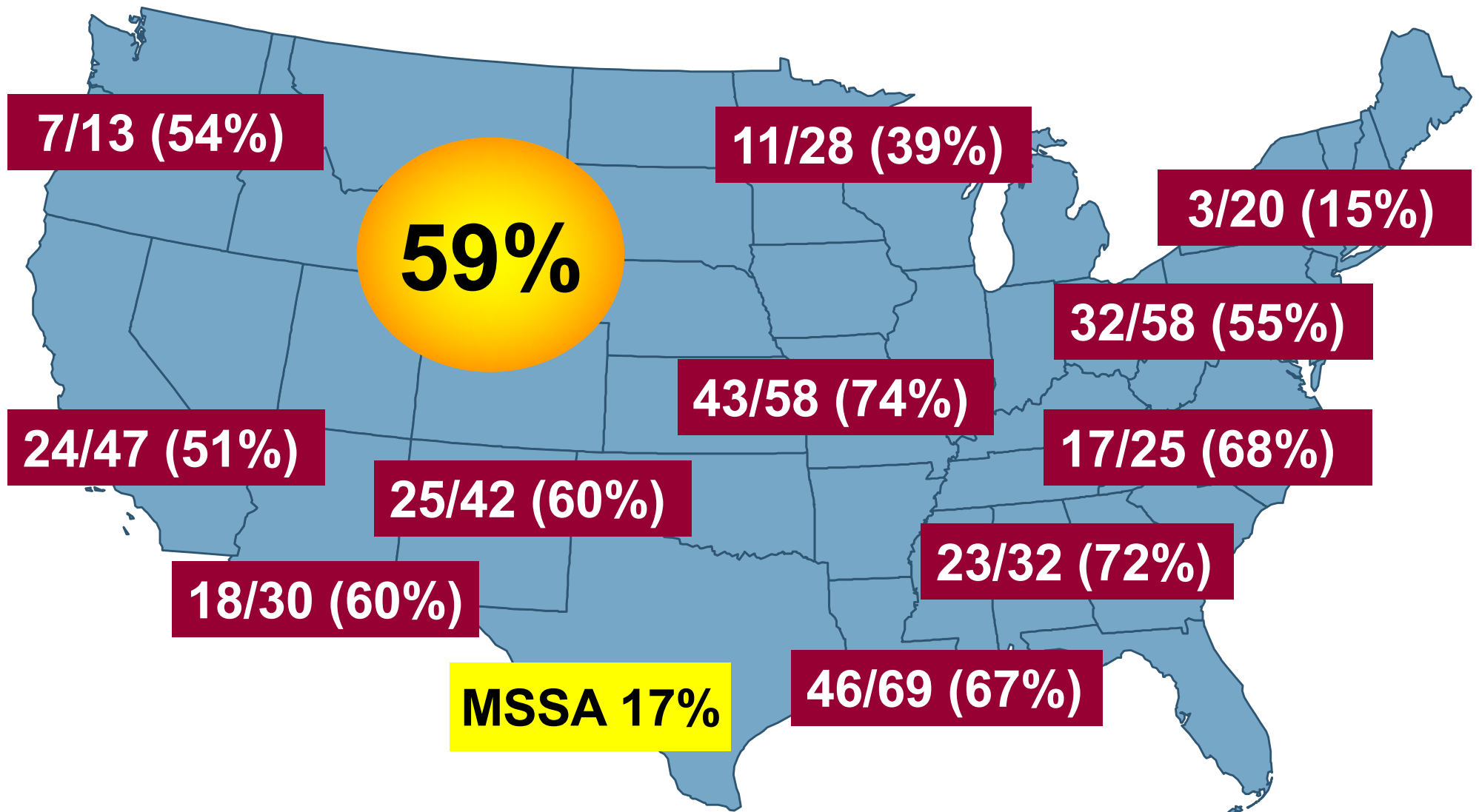
1998



2004

- In 1998, 26.2% of *S aureus* isolates were MRSA
- In 2004, 47.4% of *S aureus* isolates were MRSA

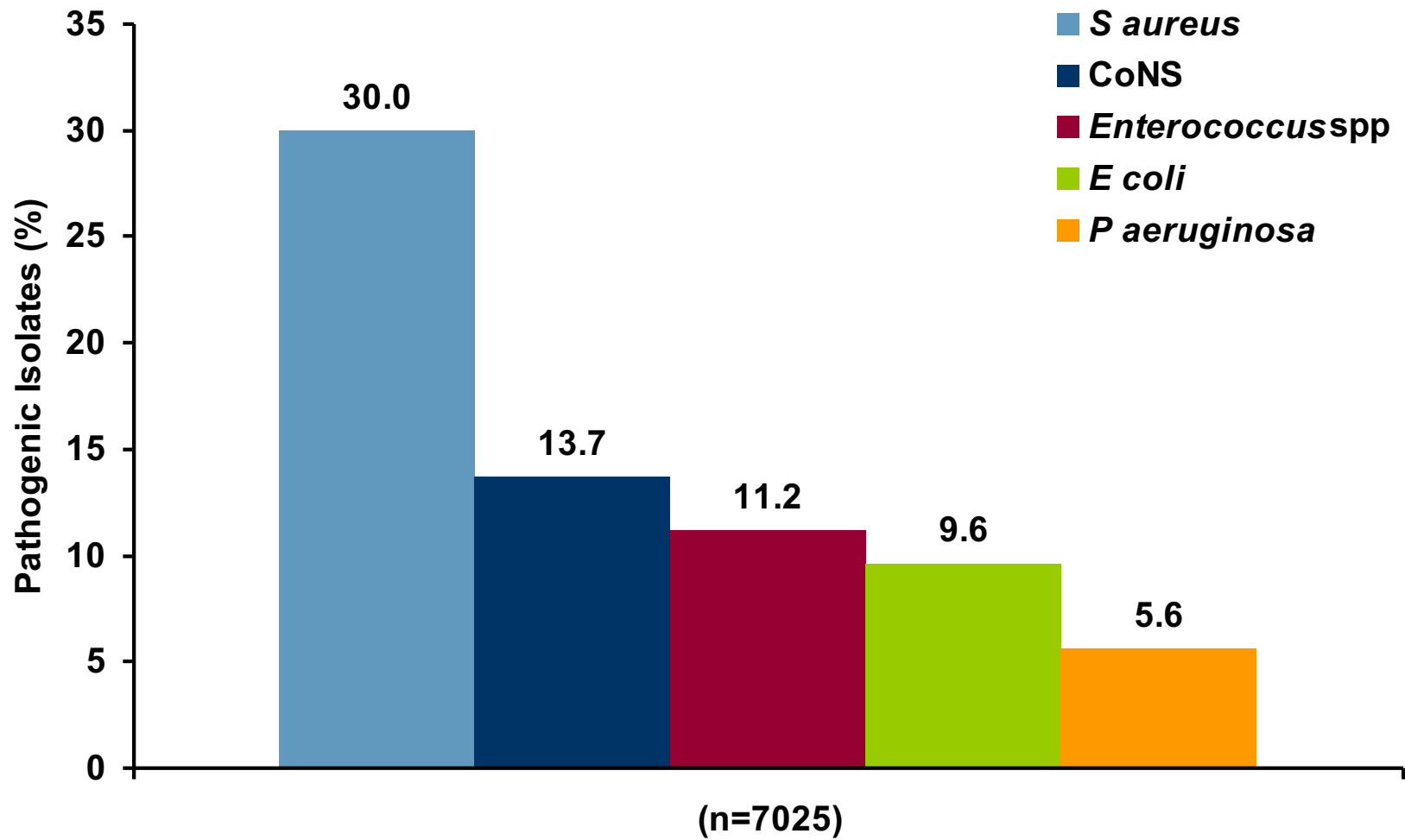
Prevalence of MRSA Among 422 ED Patients With SSTI, 2004



ED=emergency department.

Moran GJ et al. *New Engl J Med.* 2006;355:666-674.

Pathogens Associated With Surgical Site Infection in US Hospitals, 2006-2007 (NHSN)



CoNS= coagulase-negative staphylococci.

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

Catheter-Related BSIs

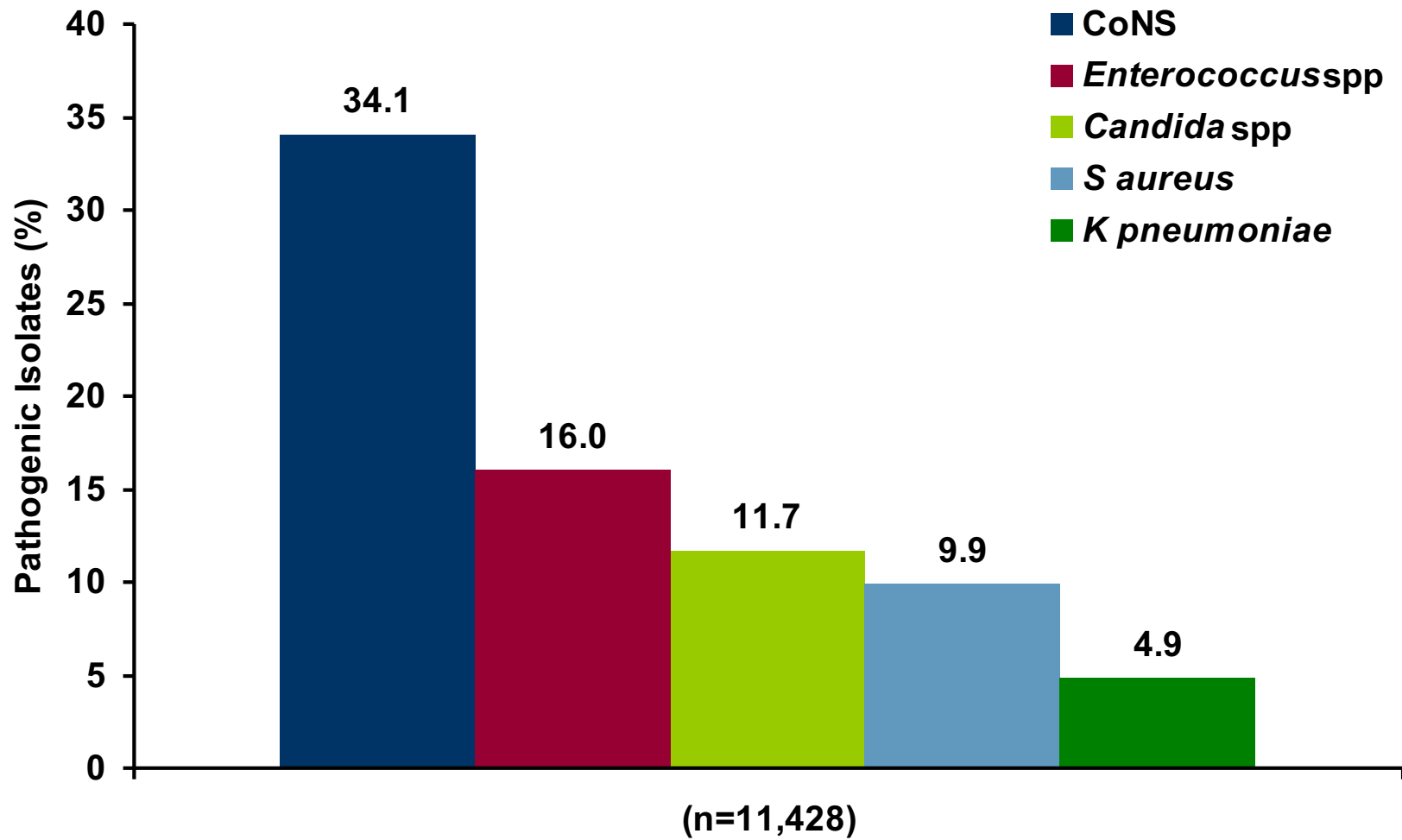
- ICU patients are at increased risk for CR-BSIs
 - 48% of ICU patients have indwelling CVCs
 - This accounts for 15 million CVC days per year in US ICUs
- As many as 28,000 ICU patients die of CR-BSIs annually in the United States
 - Assuming average CR-BSI rate of 5.3 per 1000 catheter days and attributable mortality of 18% (0% to 35%)
- Most CR-BSIs are preventable
- Therefore, efforts to decrease CR-BSIs are paramount

Recent Decline in Central Line–Associated BSI Rates per 1000 Central Line Days (NHSN)

Type of ICU	Pooled Means		
	2004 ¹	2006 ²	2007 ³
Burn	7.0	6.8	5.6
Cardiothoracic	2.7	1.6	1.4
Coronary	3.5	2.8	2.1
Medical	5.0	2.9	2.4
Medical-Surgical			
Major Teaching	4.0	2.4	2.0
All Others	3.2	2.2	1.5
Neurosurgical	4.6	3.5	2.5
Pediatric	6.6	5.3	2.9
Surgical	4.6	2.7	2.3
Trauma	7.4	4.6	4.0

1. NNIS. *Am J Infect Control*. 2004;32:470-485. 2. Edwards JR et al. *Am J Infect Control*. 2007;35:290-301. 3. Edwards JR et al. *Am J Infect Control*. 2008;36:609-626.

Pathogens Associated With Central Line-Associated BSI in US Hospitals, 2006-2007 (NHSN)

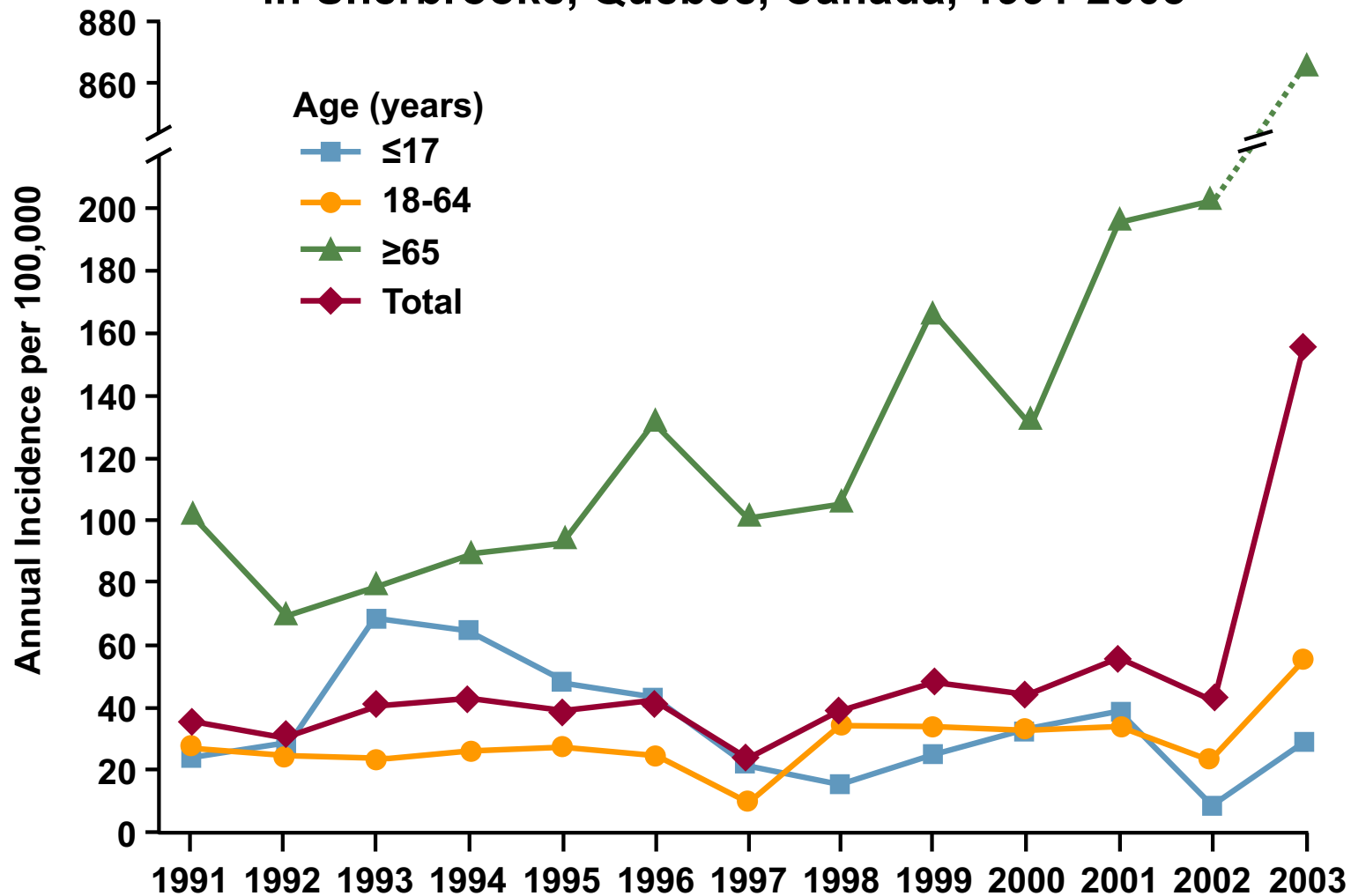


Collateral Damage: Selection of Drug-Resistant Organisms

- Cephalosporin use has been linked to subsequent infection with
 - VRE
 - ESBL-producing *K pneumoniae*
 - β -Lactam-resistant *Acinetobacter* spp
 - *Clostridium difficile*
- Quinolone use has been linked to
 - Infection with MRSA
 - Infection with ESBL-producing *Klebsiella* spp and *E coli*
 - Quinolone resistance in Gram-negative bacilli, such as *P aeruginosa*

C difficile–Associated Disease: a Reemerging Problem

Annual Incidence of *C difficile* Infection per 100,000 Population in Sherbrooke, Quebec, Canada, 1991-2003



New Treatment Options for MDR Pathogens

- Gram-negative activity
 - Tigecycline
 - Doripenem
 - Others ≥ 5 years to patients
 - Reintroduction of old therapy (eg, colistin)
- Gram-positive activity
 - Linezolid
 - Daptomycin
 - Tigecycline
 - Telavancin
 - Dalbavancin
 - Oritavancin
 - Iclaprim
 - Ceftobiprole
 - Ceftaroline

Agents in orange are FDA approved.

Antibacterial Agents in Clinical Development

Agent	Manufacturer	Class	Development Status
Ceftobiprole	Basilea/J&J	Cephalosporin	Phase 3
Ceftaroline	Cerexa/Forest	Cephalosporin	Phase 3
Telavancin	Theravance	Lipoglycopeptide	Phase 3
Dalbavancin	Pfizer	Lipoglycopeptide	Approvable letter/ Phase 3
Oritavancin	The Medicines Company	Glycopeptide	Phase 3
Iclaprim	Arpida	Diaminopyrimidine	Phase 2/3

J&J=Johnson & Johnson.

Talbot GH et al. *Clin Infect Dis.* 2006;42:657-668; Boucher HW et al. *Clin Infect Dis.* 2009;48:1-12.

CMS Preventable Hospital-Acquired Conditions

- These conditions, if not present at the time of admission, are not taken into account in calculating payments to hospitals
- HAIs no longer reimbursed as of October 1, 2008
 - Catheter-associated urinary tract infections
 - Vascular catheter-associated BSIs
 - SSIs following elective surgery (certain orthopedic procedures or bariatric surgeries)
 - Mediastinitis after coronary bypass surgery
- HAIs being considered for nonreimbursement
 - VAP
 - *S aureus* septicemia
 - MRSA
 - *C difficile*–associated disease
 - Legionnaires' disease

Role of Hospital Administration: CMS Regulations

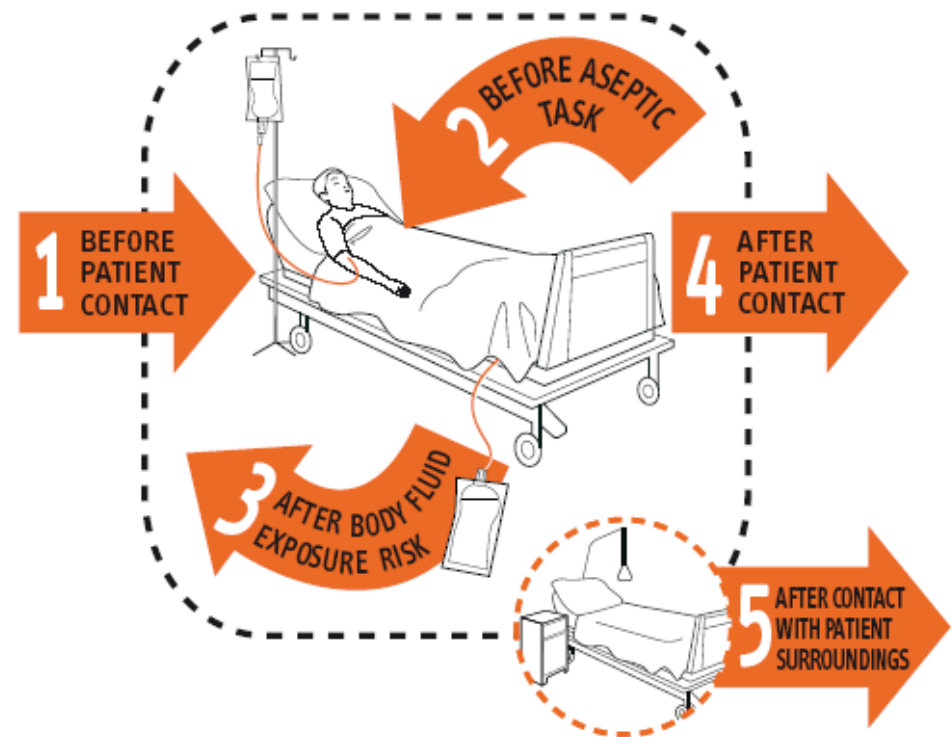
- CMS conditions of participation: quality assessment and performance improvement program
- Executive responsibilities
 - Maintain ongoing quality improvement program
 - Maintain ongoing patient safety program, including reduction of medical errors
 - Ensure hospital-wide quality assessment and performance improvements address priorities for improved quality of care and patient safety
 - Establish clear expectations for safety
 - Must provide adequate resources for measuring, assessing, improving, and sustaining performance and reducing risk for patients

World Health Organization: Hand Hygiene in Healthcare

“Hand hygiene, a very simple action, remains the primary measure to reduce health care–associated infection and the spread of antimicrobial resistance, enhancing patient safety across all settings.

Yet compliance with hand hygiene is very low throughout the world...”¹

Your 5 moments for HAND HYGIENE²



WHO=World Health Organization.

1. WHO. Available at: http://www.who.int/patientsafety/events/05/HH_en.pdf. Accessed April 15, 2009.

2. WHO. Available at: http://www.who.int/gpsc/tools/5momentsHandHygiene_A3.pdf. Accessed April 15, 2009.

Surgical Care Improvement Project

- Sponsored by CMS
 - Partners include [AHA](#), CDC, IHI, and JC
- Goal: reduce postoperative complications by 25% by the year 2010
- Initiatives in 4 categories
 - Infection
 - Venous thromboembolism
 - Cardiac events surrounding surgery
 - Respiratory events

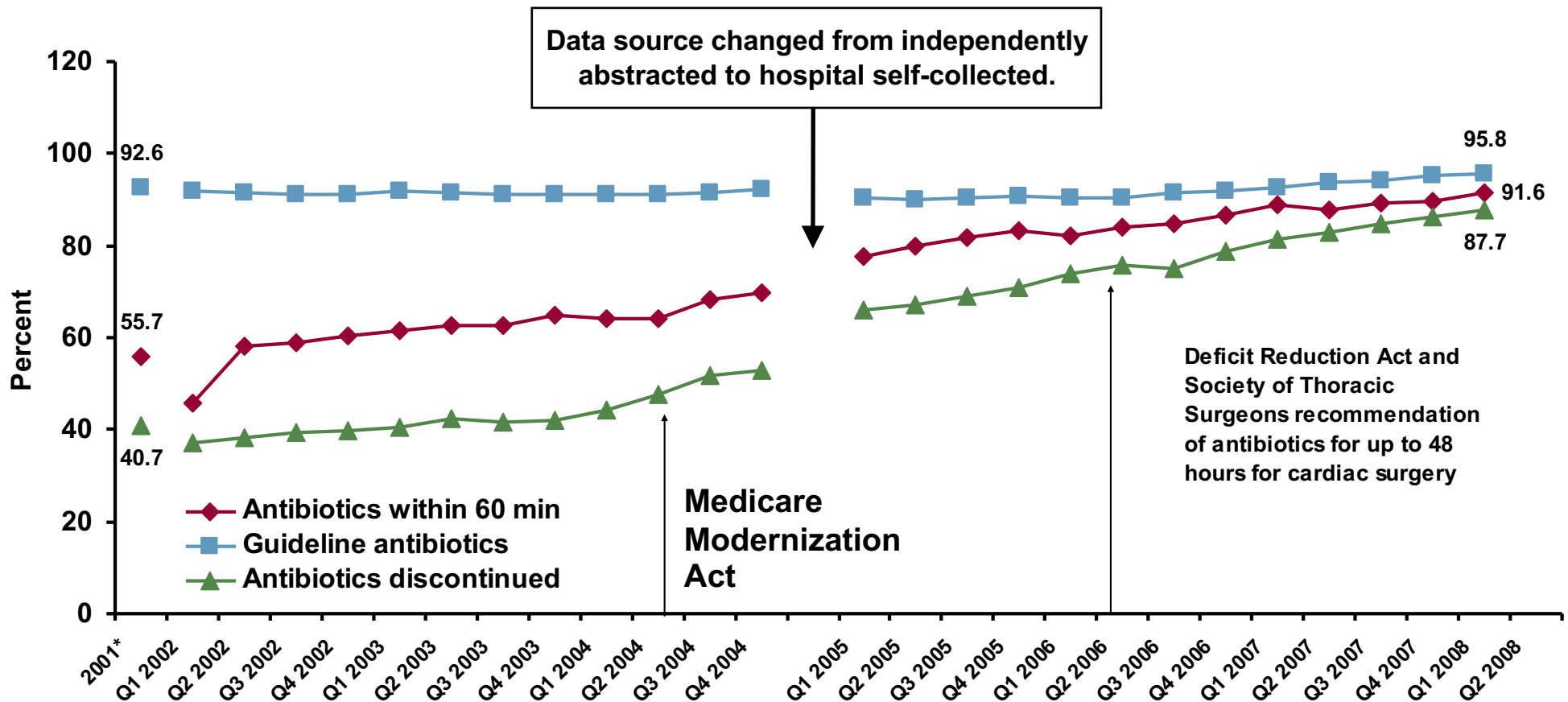


AHA=American Hospital Association.

Premier. Available at: <http://www.premierinc.com/safety/topics/scip/index.jsp>. Accessed March 13, 2009. American Hospital Association.

Introduction to SCIP and SCIP Measures. Available at: <http://www.aha.org/aha/issues/Quality-and-Patient-Safety/scip.html>. Accessed February 27, 2009.

Changes in National Performance on Antibiotics Administration



*National sample of 39,000 Medicare patients undergoing surgery in US hospitals during 2001.

Bratzler DW et al. *Arch Surg.* 2005;140:174-182. Additional data provided by D Bratzler, MD (2009).

Compendium of Strategies to Prevent HAIs in Acute Care Hospitals

- Implementation focused; not intended to replace detailed guidelines in each area
- Collaboration of several organizations
 - SHEA*
 - IDSA*
 - Association for Professionals in Infection Control and Epidemiology
 - AHA
 - JC

*Appointed task force.

SHEA=Society of Healthcare Epidemiology in America.

Yokoe DS et al. *Infect Control Hosp Epidemiol.* 2008;29(suppl 1):S12-S21.

Care Bundles (JC)

- Bundle: collection of interventions that improve patient care outcomes when combined
- Included practices must be backed by excellent research
- Excellent starting point for improving patient care
 - Can easily score whether all elements of bundle were performed
- All components must be performed to maximize success
- Several types of bundles, including ventilator care, central line care, and sepsis management
 - Example: central line bundle stipulates hand hygiene, chlorhexidine, maximal barrier precautions, subclavian insertion, daily evaluation of insertion site, and need for central line

IHI 5 Million Lives Campaign

- Continuation of 100K Lives campaign
- SSIs¹
 - Appropriate use of antibiotics, appropriate hair removal, perioperative glucose control, and perioperative normothermia
- VAP²
 - Elevation of head of bed (30°-45°), daily “sedation vacation,” and daily assessment of readiness to extubate, peptic ulcer disease prophylaxis, and deep vein thrombosis prophylaxis
- Central line infections³
 - Hand hygiene, maximum barrier precautions, chlorhexidine, optimal catheter site selection (ideally subclavian vein), daily review of line necessity, and prompt removal of unnecessary lines

1. IHI. Available at: <http://www.ihl.org/NR/rdonlyres/17764BD1-B191-40D2-A91D-C8E421C47491/0/ssi.pdf>. Accessed March 4, 2009.

2. IHI. Available at: <http://www.ihl.org/NR/rdonlyres/35B687FE-D4D0-44E5-A671-E76D74BB8D9F/0/vap.pdf>. Accessed March 4, 2009.

3. IHI. Available at: <http://www.ihl.org/NR/rdonlyres/01E7F0ED-EEDE-41BA-ABB0-982405602158/0/cli.pdf> Accessed March 4, 2009.

CDC/HICPAC Interventions for Control of MDROs

- Administrative (eg, dedicated staff for infection control)
- MDRO education (eg, hand hygiene, antimicrobial prescribing patterns)
- Antimicrobial stewardship (eg, limited third-generation cephalosporins)
- MDRO surveillance (antibiogram)
- Contact precautions (eg, gown and gloves)
- Environmental measures (eg, decontamination and adherence to recommended cleaning practices)
- Decolonization (not routinely recommended)

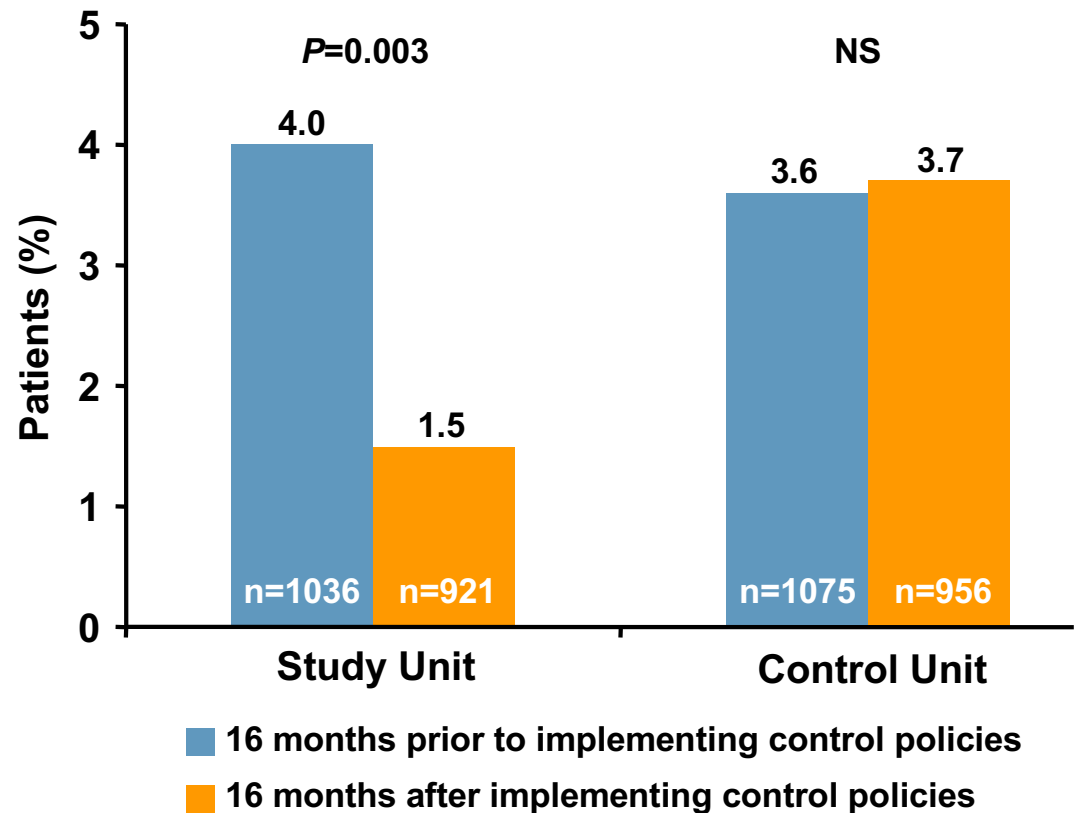
SHEA/APIC Position Statement on Active Surveillance for MRSA

- SHEA/APIC *do not* support legislation to mandate use of active surveillance cultures
 - Considerable evidence supports active surveillance cultures during outbreaks or in high-risk patients
 - Not enough evidence to support mandatory surveillance of all hospitalized patients
- SHEA/APIC support development of validated, efficacious, and cost-effective strategies to prevent infections
 - Support ongoing research on effectiveness of active surveillance culturing
 - Support stronger collaboration between local health authorities and institutional infection control experts

Infection Control and Education to Lower Rates of Unit-Acquired MRSA

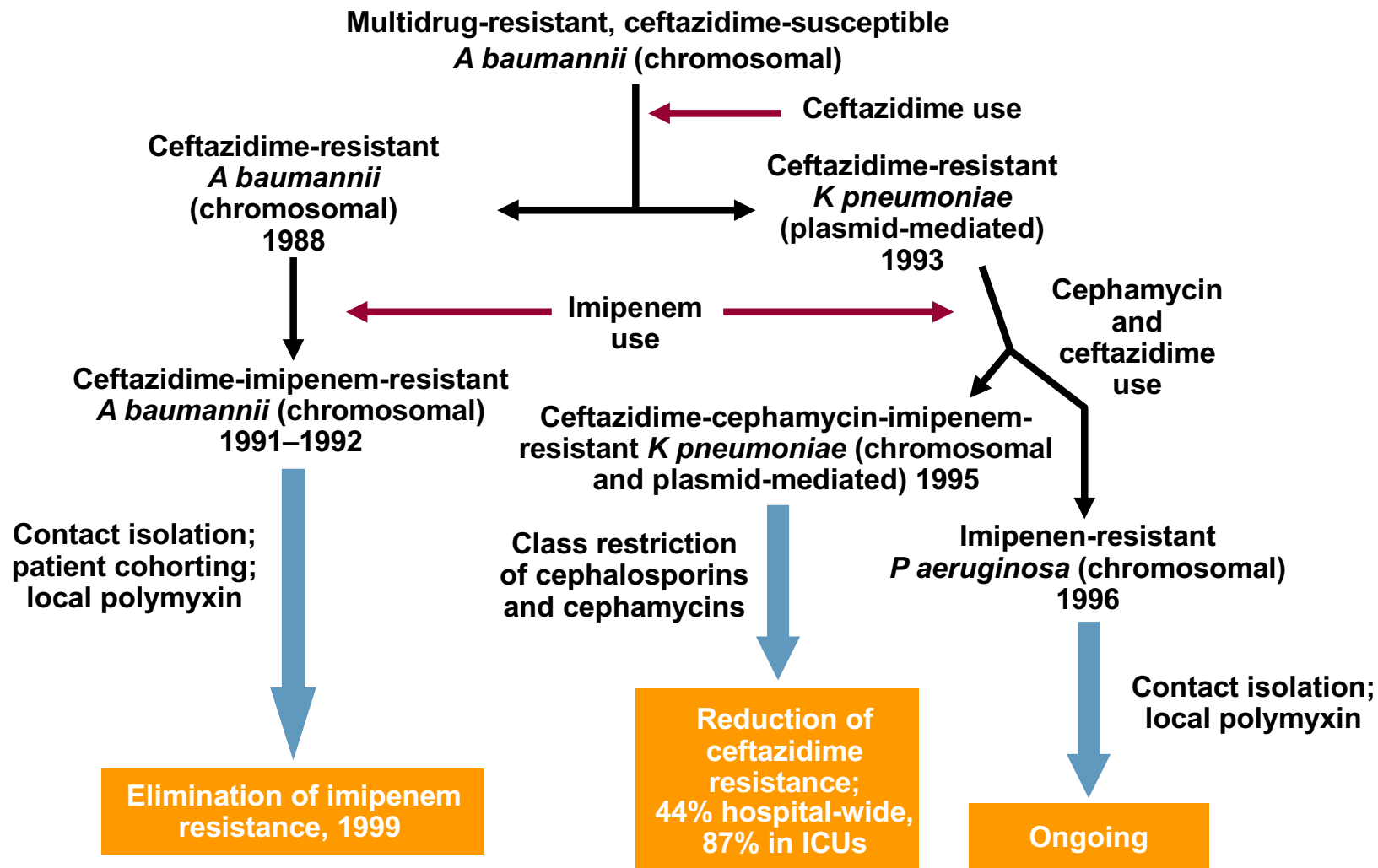
- Education for MRSA, contact precautions, isolation, antibiotic use
- For the on-unit group, lower MRSA infection rates for blood (1.1%–0.2%, $P=0.014$), sternal wound (2.6%–1.4%, $P=0.057$), and leg wound (1.5%–0.7%, $P=0.141$) sites were noted

Prevalence of MRSA Colonization



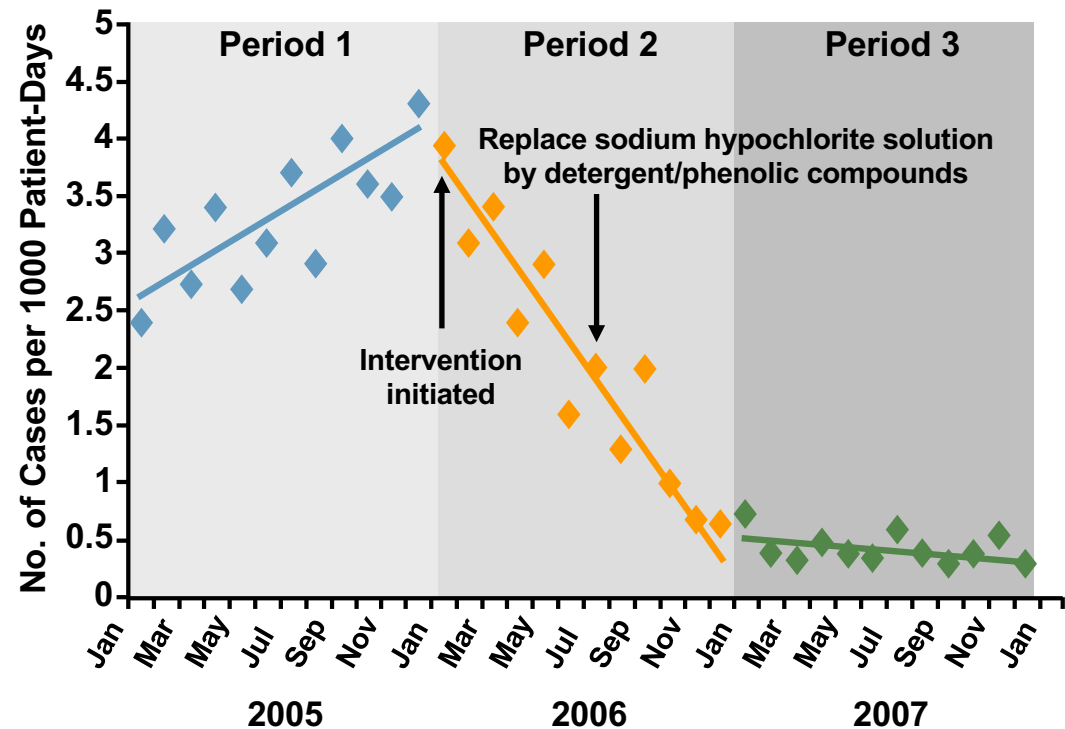
Ward acquisition of MRSA was defined as the isolation of MRSA from any site more than 72 hours after admission by patients who had no history of MRSA infection or colonization.

Antibiotic Control for MDR Gram-Negative Agents



Multifaceted Interventions to Reduce *A baumannii* Infections in the ICU

- 3 ICUs in tertiary center
- Period 1: preintervention
- Period 2: intervention
- Period 3: follow-up
- Interventions
 - Hand hygiene
 - Contact precautions
 - Surveillance cohorting of colonized and infected patients
 - Environmental cleaning with sodium hypochlorite (1:100)
- Rates: 66% reduction in period 2 and 76% in period 3



Control of CRE (CDC and HICPAC)

- CRKP is the most commonly encountered CRE
 - In 2007, 8% of *Klebsiella* isolates were CRKP (<1% in 2000)
 - Resistant to almost all available antimicrobials
 - Some CRE strains are within the susceptible range for carbapenems, making identification difficult
- Infection control
 - Implement CLSI guidelines for susceptibility testing and detection of carbapenemase production
 - Manage CRE patients with contact precautions
 - If CRE or carbapenemase-producing strains are identified, investigate facility for possible transmission

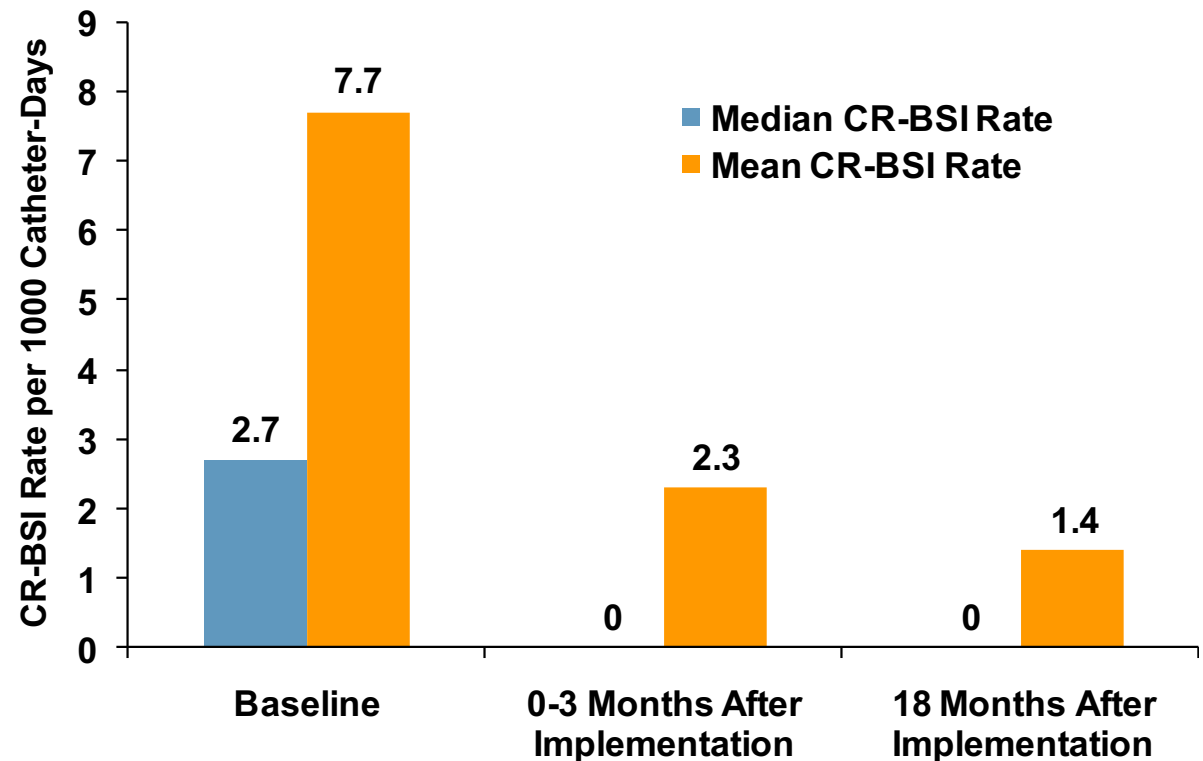
VAP Prevention

- Oral decontamination
 - Chlorhexidine 2%¹
 - Chlorhexidine 0.12%^{2,3}
- Bed position⁴⁻⁶
- Suctioning^{6,7}
- Humidification⁸
- Tracheotomy⁹
- Education and surveillance¹⁰
- Bundle¹¹

1. Koemann M et al. *Am J Respir Crit Care Med.* 2006;173:1348-1355. 2. Segers P et al. *JAMA.* 2006;296:2460-2466.
 3. Chlebicki MP et al. *Crit Care Med.* 2007;35:595-602. 4. Van Nieuwehoven CA, et al. *Crit Care Med.* 2006;34:396-402. 5. Delaney A. *Crit Care.* 2006;10:R70. 6. Muscedere J et al. *J Crit Care.* 2008;23:126-137. 7. Vonberg RP, et al. *Intensive Care Med.* 2006;32:1329-1335. 8. Lorente L et al. *Crit Care.* 2006;10:R116. 9. Barquist ES, et al. *J Trauma.* 2006;60:91-97. 10. Rosenthal VD et al. *Am J Infect Control.* 2006;34:58-63.
 11. Cocanour CS et al. *J Trauma.* 2006;61:122-130.

Intervention to Decrease CR-BSIs in the ICU

- 108 ICUs in Michigan
 - 1981 ICU months
 - 375,757 catheter-days
- 5 evidence-based procedures
 - Hand washing
 - Full barrier precautions during CVC insertion
 - Chlorhexidine prep
 - Avoidance of femoral site
 - Removal of unnecessary CVCs



Conclusions

- MDROs are increasing in prevalence
 - Both Gram-negative and Gram-positive
 - In HAP/VAP, cIAI, BSI, and SSI/cSSTI
- Limited availability of antimicrobials for treatment of MDR Gram-negative pathogens necessitates better use of current agents
- New Gram-positive agents are in development
- All efforts for prevention of hospital-acquired MDRO infections are necessary