



Methicillin-Resistant *Staphylococcus aureus* (MRSA) Infections

Activity C: ELC Prevention Collaboratives

John Jernigan, MD, MS

Alex Kallen, MD, MPH

Division of Healthcare Quality Promotion

Centers for Disease Control and Prevention

Draft – 1/19/10 ---- Disclaimer: The findings and conclusions in this presentation are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.



Outline



- **Background**
 - Impact
 - HHS Prevention Targets
 - Pathogenesis
 - Epidemiology
- **Prevention Strategies**
 - Core
 - Supplemental
- **Measurement**
 - Process
 - Outcome
- **Tools for Implementation/Resources/References**



Background: Impact



Staphylococcus aureus is common cause of healthcare-associated infections

- Second most common overall cause of healthcare-associated infections reported to the National Healthcare Safety Network (NHSN)
 - Coagulase-negative staphylococci (15%), *S. aureus* (14%)
 - Most common cause of surgical site infections(30%) and ventilator associated pneumonia (24%)
- Methicillin-resistance in *S. aureus* was first identified in the 1970s primarily among hospitalized patients
- Since that time, methicillin-resistant *S. aureus* (MRSA) has become a predominant cause of *S. aureus* infections both healthcare and community settings
 - Primarily due to transmission of relatively few ancestral clones rather than the de novo development of methicillin-resistance among sensitive strains

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



Background: Impact



- Current estimates suggest that 49-65% of healthcare-associated *S. aureus* infections reported to NHSN are caused by MRSA
- National population-based estimates of invasive MRSA infections
 - 94,360 invasive MRSA infections annually in the US
 - Associated 18,650 deaths each year
 - 86% of all invasive MRSA infections are healthcare-associated

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

Klevens et al. JAMA 2007;298:1763-71



Background: Impact

Why the Emergence of MRSA is a Healthcare Pathogen is Important (1)



- MRSA has emerged as one of the predominant pathogens in healthcare-associated infections
- Treatment options for MRSA are limited and less effective than options available for susceptible *S. aureus* infections higher morbidity and mortality
- High prevalence influences unfavorable antibiotic prescribing, which contributes to further spread of resistance
 - prevalent MRSA → more vancomycin use → more vancomycin resistance (VRE and VRSA)
more linezolid/daptomycin use → more resistance



Background: Impact

Why the Emergence of MRSA is a Healthcare Pathogen is Important (2)



- MRSA adds to overall *S. aureus* infection burden
 - Preventing MRSA infections reduces overall burden of *S. aureus* infections
- MRSA is a marker for ability to contain transmission of important pathogens in the healthcare setting
 - Programs that successfully prevent MRSA transmission are likely to have benefit when applied to other epidemiologically important healthcare pathogens that spread by patient-to-patient transmission



Background: HHS Prevention Targets



- Population-based surveillance
 - 50% reduction in incidence rate of all healthcare-associated invasive MRSA infections
- National Healthcare Safety Network
 - 50% reduction in incidence rate of hospital-onset MRSA bacteremia (hospital wide)

HHS Action Plan to Prevent HAI

(<http://www.hhs.gov/ophs/initiatives/hai/infection.html>)



Background: Pathogenesis



- For MRSA, colonization generally precedes infection
- In addition, colonization can be long-lasting -- months or years in some subpopulations.
- In general, MRSA is transmitted person to person, the “*de novo*” generation of resistance in *S. aureus* is very rare
- Transmission of MRSA from the environment to people, although it can occur, is less common than transmission from person to person



Background: Epidemiology



- Once acquired, MRSA colonization can be long-lasting -- months or years in some subpopulations
 - A patient acquiring MRSA colonization during a hospital stay has increased risk for MRSA infections following discharge, or during subsequent acute and long-term care admissions
- MRSA carriers also serve as reservoirs for further transmission as they move through and across healthcare facilities
- Therefore healthcare facilities that share patients are interdependent upon one another with regard to their MRSA experience
 - The quality of MRSA control in one facility may influence the MRSA experience in others
 - Therefore, there may be advantages to coordinated multicenter control programs involving facilities that share patients with one another



Background: Epidemiology



- Successful MRSA prevention is possible
 - Single and multi-center studies have demonstrated that MRSA prevention programs can be effective
 - Reductions in incidence of MRSA disease by up to 70% have been documented in acute care facilities
 - Significant intervention-associated reductions in the proportion of *S. aureus* infections caused by MRSA has also been documented in these studies

Ellingson K et al. Presented at SHEA 2009, Abstract 512.

Huang et al. Clin Infect Dis 2006; 43:971-88.

Robicsek et al. Ann Intern Med 2008; 148:409-18.



Epidemiology

- Successful MRSA prevention is possible
 - According to NSHN data, rates of central line-associated BSI (CLABSI) caused by MRSA have declined by nearly 50% in the past decade.
 - This observation may be primarily attributable to successful CLABSI prevention efforts
 - The proportion of all *S. aureus* CLABSI caused by MRSA has continued to increase during the same time period
- Population-based estimates suggest the incidence of invasive healthcare-associated MRSA disease decreased by 11-17% in the US between 2005-2007

Burton et al. JAMA 2009; 301:727-36

Kallen AJ, et al. Presented at SHEA 2009 Abstract 49



Prevention Strategies

- **Core Strategies**

- High levels of scientific evidence
- Demonstrated feasibility

- **Supplemental Strategies**

- Some scientific evidence
- Variable levels of feasibility

*The Collaborative should at a minimum include core prevention strategies. Supplemental prevention strategies also may be utilized. Hospitals should not be excluded from participation if they already have ongoing interventions using supplemental prevention strategies. Project coordinators should carefully track which prevention strategies are being utilized by participating facilities.



Background: Prevention Strategies

Basic Rationale



- Because MRSA colonization generally precedes infection with this organism, MRSA interventions primarily have targeted two broad areas:
 - Preventing transmission from colonized to uncolonized – most of the interventions in this toolkit target preventing transmission
 - Preventing infection in colonized individuals, which include
 - Strategies aimed at preventing device and procedure-associated infections (e.g., ventilator associated pneumonias, central line associated bloodstream infections, etc), not necessarily MRSA-specific
 - MRSA decolonization strategies



Prevention Strategies: Core



- Assessing hand hygiene practices
- Implementing Contact Precautions
- Recognizing previously colonized
- Reporting lab results
- Providing education for healthcare providers



Prevention Strategies: Core Hand Hygiene



- Hand Hygiene should be a cornerstone of prevention efforts
 - Prevents transmission via hands of healthcare personnel
- As part of a hand hygiene intervention, consider:
 - Ensuring easy access to soap and water/alcohol-based hand gels
 - Education for healthcare personnel and patients
 - Observation of practices - particularly around high-risk procedures (before and after contact with colonized or infected patients)
 - Feedback – “Just in time” feedback if failure to perform hand hygiene observed



Prevention Strategies: Core Contact Precautions



- Involves use of gown and gloves for patient care
 - Don equipment prior to room entry
 - Remove prior to room exit
- Single room or cohorting for MRSA colonized/infected patients
- Use of dedicated non-essential items may help decrease transmission due to contact with these fomites
 - Blood pressure cuffs
 - Stethoscopes
 - IV poles and pumps



Prevention Strategies: Core Recognizing Previously Colonized

- Patients can be colonized with MRSA for months
- There is no single 'best' strategy for discontinuation of isolation precautions for MRSA patients
- Being able to recognize previously colonized or infected patients who have not met criteria for discontinuing isolation allows them to be subject to interventions in a timely fashion



Prevention Strategies: Core Laboratory Reporting



- Facilities should have a mechanism for rapidly communicating positive MRSA results from laboratory to clinical area
- Allows for rapid institution of interventions on newly identified MRSA patients



Prevention Strategies: Core Education



- To improve adherence to hand hygiene
- To improve adherence to interventions (e.g., Contact Precautions)
- Encourage behavioral change through a better understanding of the problem



Prevention Strategies: Core Device and Procedure-Associated Prevention Measures

- In addition to measures designed to prevent MRSA transmission, healthcare facilities should routinely implement strategies for preventing device- and procedure-associated infections
 - Central line-associated bloodstream infections
 - Surgical site infections
 - Catheter-associated urinary tract infections
 - Ventilator-associated pneumonia



Prevention Strategies: Supplemental

- Active surveillance testing
 - Widely used and even recommended as a core prevention strategy by some, but precise role remains controversial
- Other novel strategies
 - Decolonization
 - Chlorhexidine bathing



Prevention Strategies: Supplemental Active Surveillance Testing (AST)



- When clinical culture results alone are used to identify MRSA carriers, more than half of all MRSA-colonized patients remain unrecognized
 - The rationale for active surveillance testing is to identify all colonized patients in order that additional precautions can be applied (e.g. Contact Precautions)
- To date, results of studies evaluating AST have had mixed results
 - Huang et al. Clin Infect Dis 2006; 43:971-978
 - Observational study
 - Found biggest decrease in MRSA bacteremia associated with institution of active surveillance
 - Robicsek et al. Ann Intern Med 2008; 148:409-418
 - Observational study
 - Found significant decrease in MRSA disease with universal institution of AST combined with decolonization regimens
 - Harbarth et al. JAMA 2008; 299:1149-1157
 - Observational study
 - No significant decrease in MRSA disease with institution of rapid AST
- **Several successful MRSA prevention collaboratives have used AST as one of their interventions**



Prevention Strategies: Supplemental Active Surveillance Testing (2)



Testing methods:

- Culture
 - Pros
 - Generally less costly
 - A common practice most labs are used to
 - Cons
 - May take 72 hours to identify MRSA colonized patients. If pre-emptive isolation not employed, may allow for transmission prior to recognizing patient as positive
- Polymerase chain reaction
 - Pros
 - Rapid results
 - Cons
 - Expensive
 - Technically more challenging



Prevention Strategies: Supplemental Active Surveillance Testing (3)



Unknowns:

- **Which body sites should be tested?**
 - Nares most common
 - Other potential sites include wounds, axillae, groin
 - Adding more sites increases yield of testing but unclear if adds significantly to goal of decreasing transmission
- **Frequency of testing?**
 - Generally done at time of admission, some also test weekly
 - Including discharge AST allows for identification of transmission events that occurred during hospitalization
- **Who should be tested?**
 - One commonly employed strategy is testing high risk areas (e.g. ICUs)
 - Some employ facility-wide AST
 - Relative benefits of these strategies is unknown



Prevention Strategies: Supplemental Decolonization Therapy for MRSA Carriers

- May reduce risk of subsequent infections in MRSA carriers
- May help decrease MRSA spread by reducing reservoir of transmission
- No data yet to definitively support its routine use in general patient care settings
 - Robicsek and Harbarth studies used decolonization in addition to AST with mixed results
 - Growing evidence that pre-operative *S. aureus* decolonization regimens decrease risk of subsequent *S. aureus* infection in surgical populations



Prevention Strategies: Supplemental Decolonization Therapy for MRSA Carriers (2)

Unknowns:

- Which body sites should be decolonized?
 - just nares or whole body
- Which decolonization regimen?
 - Intranasal mupirocin, chlorhexidine baths
 - May be advantageous to use combination of mupirocin and chlorhexidine
- Will emergence of mupirocin resistance be a limiting factor?



Prevention Strategies: Supplemental Universal use of Chlorhexidine Bathing in High- Risk Patient Populations

- Use of daily chlorhexidine baths in ICU populations may decrease overall rates of bloodstream infections and MRSA acquisition, but effect on MRSA infections less clear
- Does not require AST since applied to all patients in the target population

Climo MW, et al. Crit Care Med 2009; 37:1858-65



Summary of Prevention Strategies

Core Measures

- Assessing hand hygiene practices
- Implementing Contact Precautions
- Recognizing previously colonized
- Reporting lab results
- Providing education for healthcare providers

Supplemental Measures

- Active surveillance testing
- Decolonization
- Chlorhexidine bathing



Measurement: Outcome Using NHSN to support MRSA Prevention Collaboratives

- NHSN provides a module designed to facilitate prevention of healthcare-associated MRSA and other multidrug-resistant organisms
 - Provides methods and reporting mechanisms for both outcome and process measures

<http://www.cdc.gov/nhsn>



Measurement: Outcome MRSA Outcome Measures



- MRSA Infection Incidence Rate
 - Numerator = Number of MRSA infections*
 - Denominator = Number of patient-days (stratified by time and location)

**per current NHSN definitions for healthcare associated infection*

<http://www.cdc.gov/nhsn>



Measurement: Outcome NHSN



- **Laboratory Identified MRSA Events**
 - Proxy Measure for MDRO Healthcare Acquisition
 - Numerator = Number of 1st MRSA isolates per patient (infection or colonization) identified from a clinical culture (i.e. not from AST) among those with no documented prior evidence of previous infection or colonization
 - Denominator = number of patient days for the location or facility
 - Proxy Measure for MDRO Bloodstream Infection
 - Numerator = Total number of patients with MRSA blood isolate and no prior positive blood culture in ≤ 2 weeks
 - Denominator = Number of patient-days for same period

Note : isolates of MRSA are generally attributed to the location or facility under surveillance if they come from cultures collected more than 3 calendar days after admission (if day of admission is day 1)

<http://www.cdc.gov/nhsn>



Measurement: Outcome Other Potential Measures Available in NHSN



- **Measures Based on Active Surveillance Testing**
 - Admission prevalence rate
 - Incidence of MRSA colonization
- **Other Laboratory Identified MRSA Events**
 - Admission prevalence rate (community-onset MRSA)
 - Overall prevalence rate (community-onset plus healthcare facility-onset)
 - MRSA bloodstream infection admission prevalence rate
 - Proportion of *S. aureus* resistant to methicillin

<http://www.cdc.gov/nhsn>



Measurement: Process **MRSA Process Measures**



- As part of the MDRO module, NHSN allows facilities to follow adherence to:
 - Active surveillance testing
 - Contact Precautions
 - Hand hygiene

<http://www.cdc.gov/nhsn>



Evaluation Considerations

- **Assess baseline policies and procedures**
- **Areas to consider**
 - Surveillance
 - Prevention strategies
 - Measurement
- **Coordinator should track new policies/practices implemented during collaboration**

Standardized questions forthcoming



References

- Burton DC, Edwards JR, Horan TC, et al. Methicillin-resistant *Staphylococcus aureus* central line-associated bloodstream infections in US intensive care units. JAMA 2009;301:727-36.
- Calfee D, Salgado CD, Classen D, et al. SHEA Compendium: Strategies to Prevent MRSA Transmission in Acute Care Hospitals Infect Control Hosp Epidemiol 2008; 29:S62-S80.



References

- Climo MW, Sepkowitz KA, Zuccotti G, et al. The effectiveness of daily bathing with chlorhexidine on the acquisition of methicillin-resistant *Staphylococcus aureus*, vancomycin-resistant *Enterococcus*, and healthcare-associated bloodstream infections: results of a quasi-experimental multicenter trial. *Crit Care Med* 2009;37:1858-65.
- Cohen AI, Calfee D, Fridkin SK, et al. Recommendations for metrics for multidrug-resistant organisms in healthcare settings: SHEA/HICPAC Position Paper. *Infect Control Hosp Epidemiol* 2008; 29:901-13.



References

- Ellingson K, Iversen N, Zuckerman JM, et al. A successful multi-center intervention to prevent transmission of methicillin-resistant *Staphylococcus aureus*. Presented at SHEA 2009, Abstract 512.
- HICPAC – Management of Multidrug Resistant Organisms in Healthcare Settings, 2006
<http://www.cdc.gov/ncidod/dhqp/pdf/ar/MDROGuideline2006.pdf>
- Hidron AL, Edwards JR, Patel J, et al. NHSN annual update: antimicrobial-resistant pathogens associated with healthcare-associated infections: annual summary of data reported to the National Healthcare Safety Network at the Centers for Disease Control and Prevention, 2006-2007. *Infect Control Hosp Epidemiol*; 2008;29:966-1011.



References

- Huang SS, Yokoe, DS, Hinrichsen VL, et al. Impact of routine intensive care unit surveillance cultures and resultant barrier precautions on hospital-wide methicillin-resistant *Staphylococcus aureus* bacteremia. *CLin Infect Dis* 2006;43:971-8.
- Kallen AJ, Yi Mu, Bulens SN, et al. Changes in the incidence of healthcare-associated invasive MRSA infections and concurrent MRSA control practices in the US, 2005 to 2007 Presented at SHEA 2009. Abstract 49.
- Klevens, RM, Morrison MA, Nadle J, et al. Invasive methicillin-resistant *Staphylococcus aureus* infections in the United States. *JAMA*;2007:298:1763-71.



References

- Robicsek A, Beaumont JL, Paule SM, et al. Universal surveillance for methicillin-resistant *Staphylococcus aureus* in 3 affiliated hospitals. *Ann Intern Med* 2008;148:409-18.
- Harbarth S, Fankhauser C, Srenzel J, et al. Universal screening for methicillin-resistant *Staphylococcus aureus* at hospital admission and nosocomial infection in surgical patients. *JAMA* 2008;229:1149-57.



Additional Resources



- HHS Action Plan to Prevent Healthcare Associated Infections. June 2009
<http://www.hhs.gov/ophs/initiatives/hai/infection.html>
- Overview of Methicillin-Resistant *Staphylococcus aureus* Surveillance through the National Healthcare Safety Network
http://www.cdc.gov/nhsn/PDFs/Overview_MRSA_Surveillance_Final12_08.pdf
- Multidrug-Resistant Organism & *Clostridium difficile*-Associated Disease (MDRO/CDAD) Module
http://www.cdc.gov/nhsn/PDFs/pscManual/12pscMDRO_CDADcurrent.pdf
- NHSN Web site – www.cdc.gov/nhsn



Additional Reference Slides



- The following slides may be used for presentations regarding MRSA
- Explanations are available in the notes sections of the slides



Distribution and Rank Order of 9 Most Common Pathogens Reported for 28,502 HAIs, NHSN 2006-2007



Column %

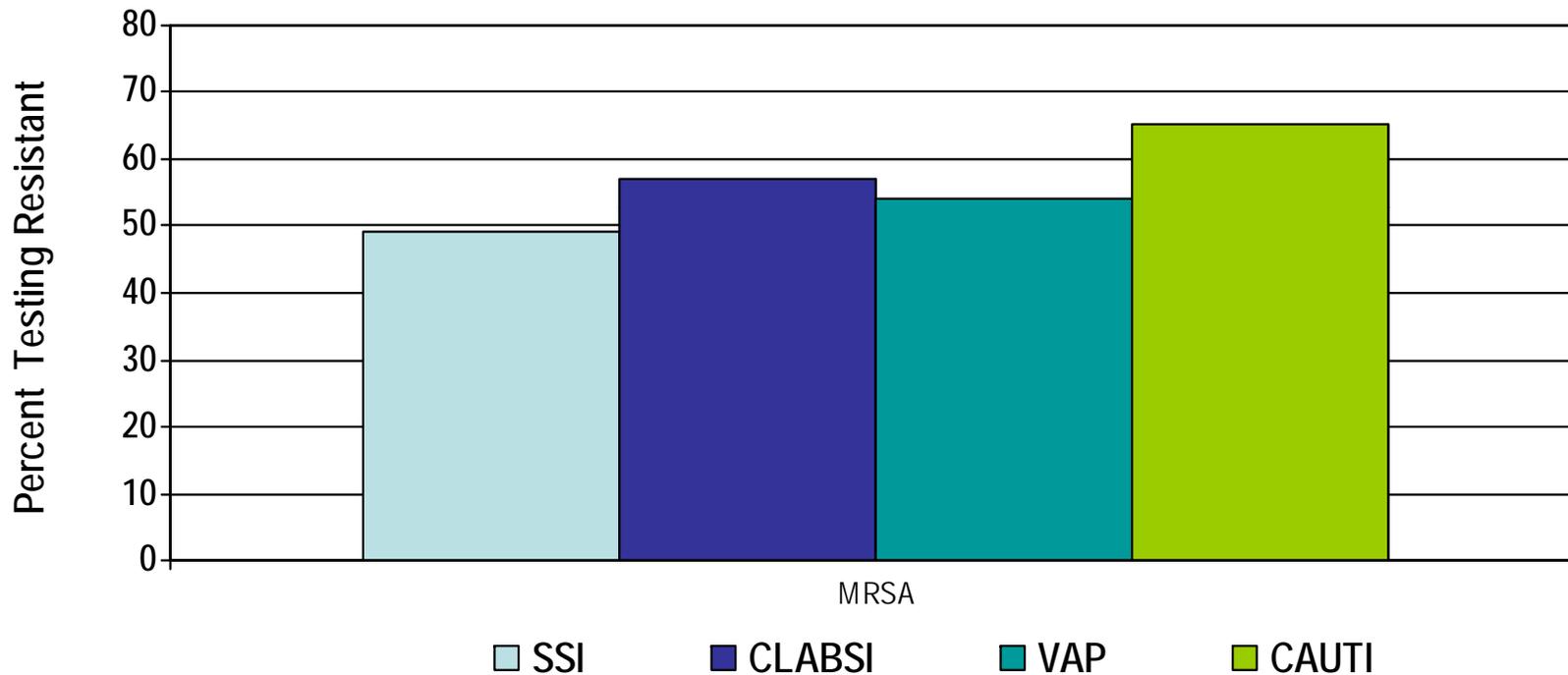
Pathogen	CLABSI 11,428	CAUTI 9,377	VAP 5,960	SSI 7,025	Total* 33,848
CoNS	34	3	1	14	15
<i>S. aureus</i>	10	2	24	30	14
<i>Enterococcus</i> spp.	15	15	1	11	12
<i>Candida</i> spp.	12	21	<1	2	11
<i>E. coli</i>	3	22	5	10	10
<i>P. aeruginosa</i>	3	10	16	5	8
<i>K. pneumoniae</i>	5	8	7	3	6
<i>Enterobacter</i> spp.	4	4	8	4	5
<i>A. baumannii</i>	2	1	8	1	3

15.6% of healthcare-associated infections had >1 pathogen (polymicrobial)

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



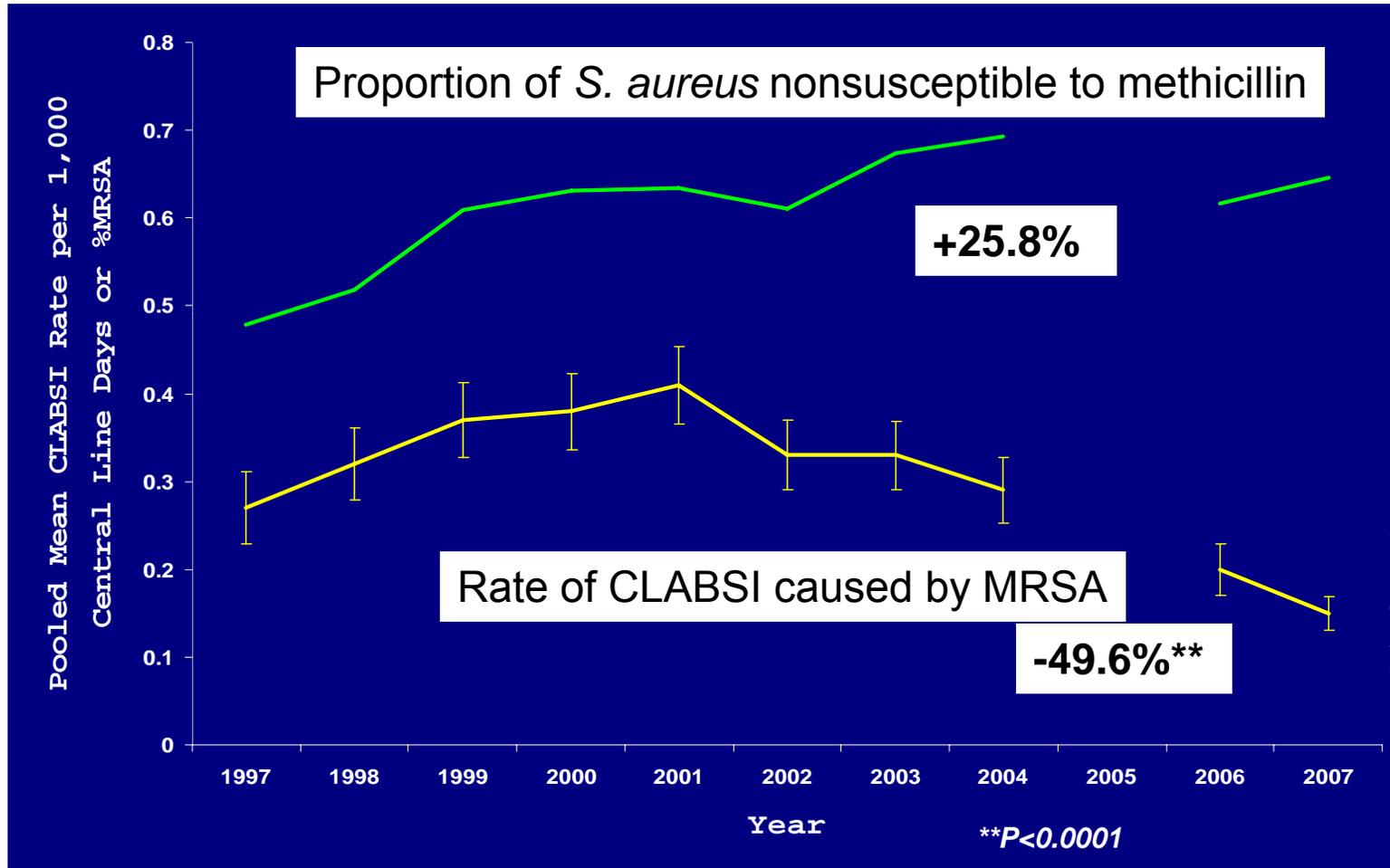
Pooled Mean Proportion of Methicillin Resistance among *Staphylococcus aureus* by HAI Type, NHSN 2006-2007



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



Trends in %MRSA and Rates of MRSA Central Line-Associated Bloodstream Infections (CLABSI) — United States, 1997-2007



Burton et al. JAMA 2009; 301:727-36



Modeled Incidence and Percent Change for All Invasive Hospital-Onset and Healthcare-Associated, Community-Onset MRSA infections, 2005-2007



<i>Year</i>	<i>Modeled incidence per 100,000 population</i>	<i>Modeled percent change from previous year</i>	<i>Total modeled percent change</i>	<i>P-value</i>
<i>Hospital-onset</i>				
2005	9.95			
2006	8.96	-9.97%		
2007	8.24	-8.08%	-17.2%	0.01
<i>Healthcare-associated, community-onset</i>				
2005	22.13			
2006	21.11	-4.59%		
2007	19.70	-6.71%	-11.0%	0.04

Kallen AJ, et al. SHEA 2009. Abstract 49