

# The Role of Active Surveillance in Controlling Healthcare Associated MRSA

Tobi Karchmer, MD, MS  
Assistant Professor of Infectious Diseases  
Wake Forest University School of Medicine  
Hospital Epidemiologist  
Wake Forest University Baptist Medical Center

May 4, 2007

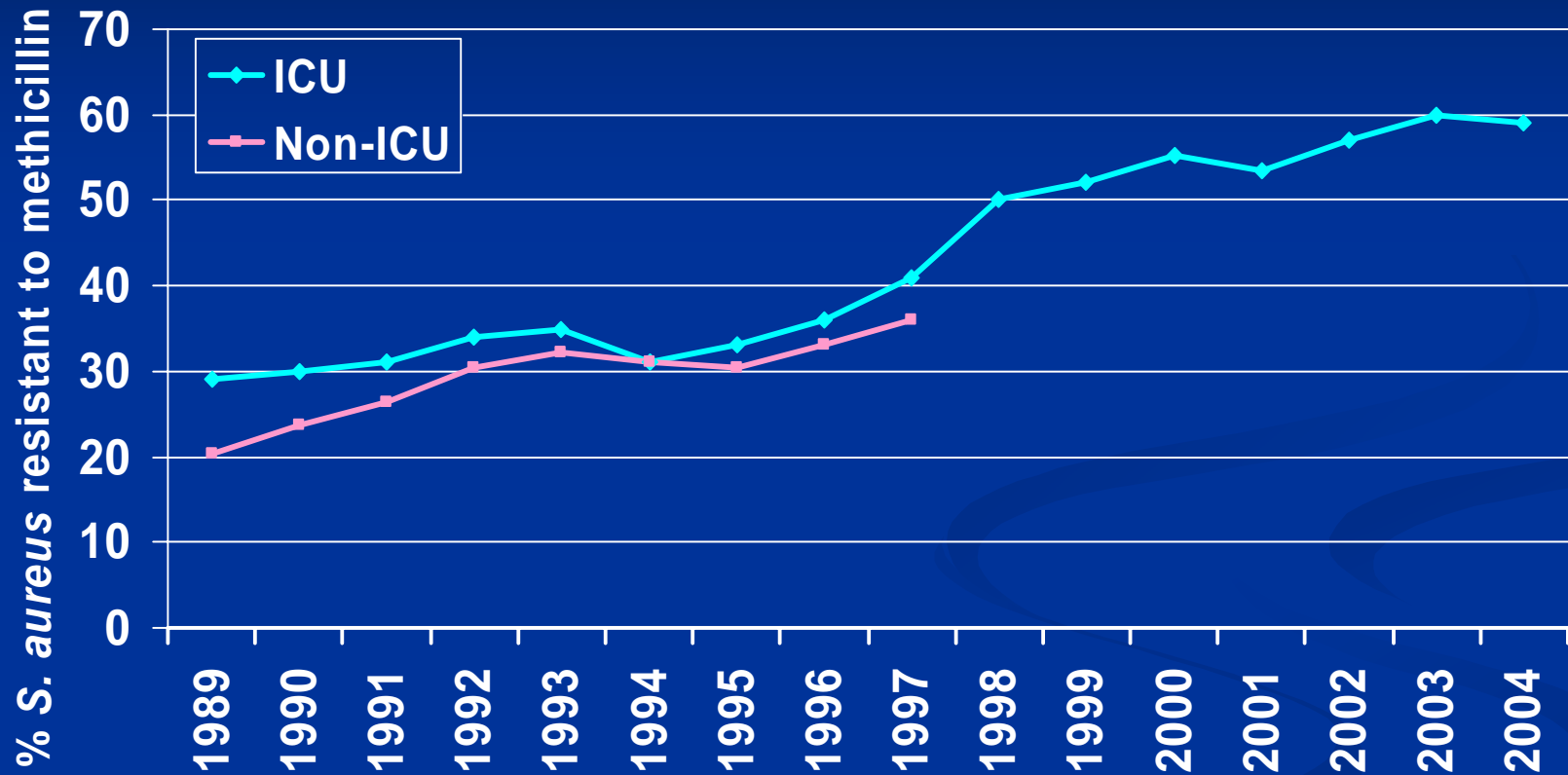
# Objectives

- Epidemiology and impact of MRSA healthcare associated infections (HAIs)
- Description of guidelines for control of MDRO
- Active Surveillance and Contact Precautions
- Additional measures that are important for control
  - Environmental cleaning
  - Dedicated equipment
  - Hand hygiene
- Other adjunctive measures

# Increasing Rates of HAI Bloodstream infections due to *Staphylococcus aureus*

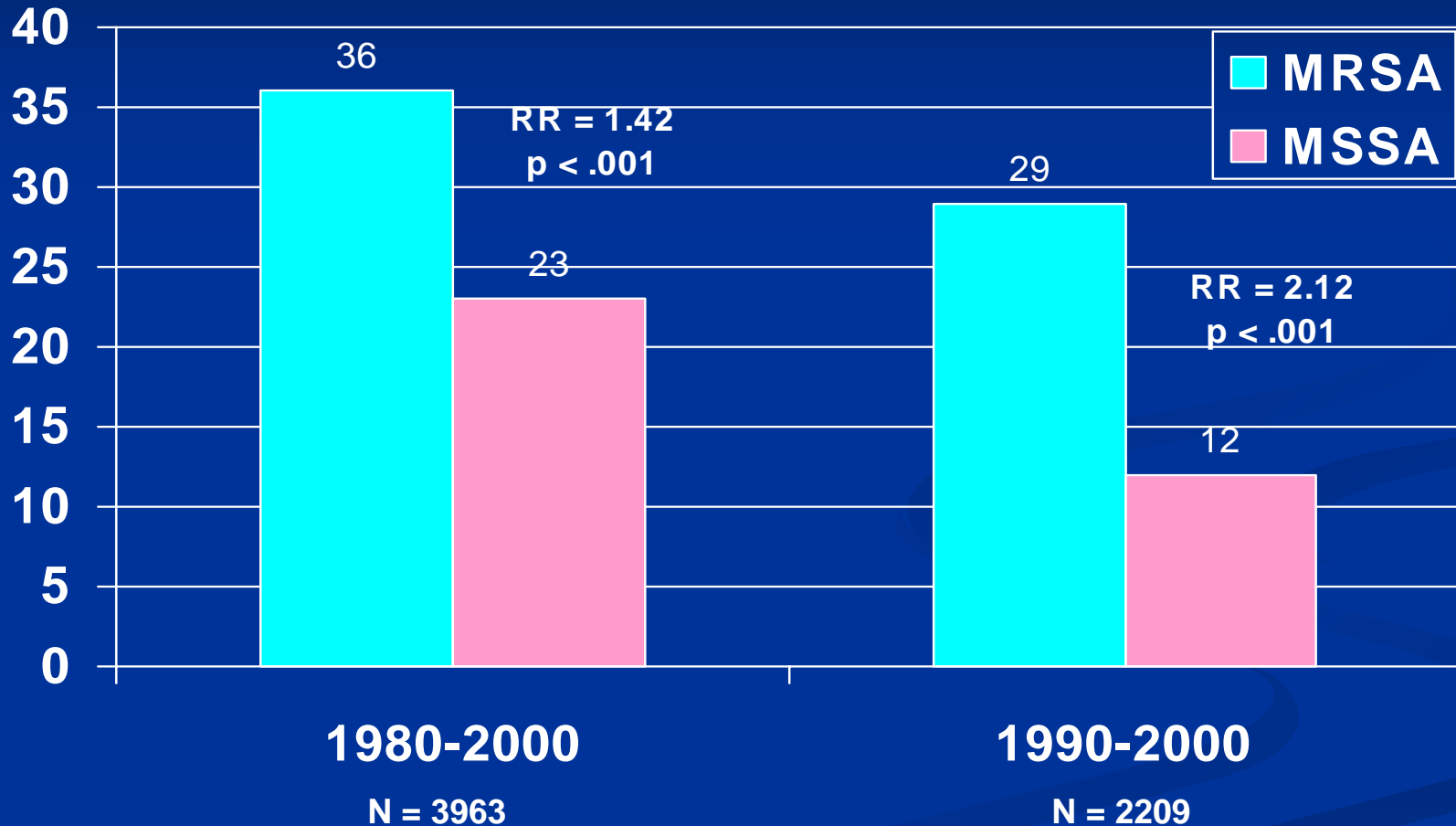
- 273% increase in *S. aureus* HAI BSI in a study that compared 1980-83 to 1990-93
- MRSA increased from 1.5% to 31.7%
  - Increase in absolute number of infections
  - 1 of 65 (1980-83) vs. 73 of 230 (1990-93)

# Is there a problem with MRSA HAIs?



Fridkin. *Clin Chest Med.* 1999;20:303.  
NNIS reports in AJIC (2000-2004)

# Outcome of MRSA / MSSA Bacteremia: Mortality



Cosgrove et al., CID 2003;36:53-9

Whitby et al., Med J Aust 2001;175:264-7

# Outcomes of HAIs: MRSA vs. MSSA

	Reference	Excess cost	Excess length of stay (days)
<b>BSI</b>	Abramson, ICHE 1999	<b>\$17,000</b>	<b>8</b>
	Lodise, Diag Micro Inf Dis, 2005	<b>2.0 fold higher</b> <b>\$9,099</b>	<b>1.5 fold longer</b> <b>4.9</b>
<b>SSI</b>	Engemann, CID, 2003	<b>1.2 fold higher</b> <b>\$13,901</b>	<b>5</b>
<b>VAP</b>	Shorr, Crit Care, 2006	<b>\$7,731</b>	<b>3.8 (overall)</b>
			<b>5.3 (ICU)</b> <b>4.4 (MV)</b>

MV = mechanical ventilation

# Guidelines for Control of Multidrug-Resistant Organisms

## 1996 – CDC guidelines

- recommend contact isolation for “patients known or suspected to be infected or colonized with epidemiologically important microorganisms.”
  - Garner, et al. ICHE 1996;17:53.

## 2003 – SHEA guidelines

- recommend that all healthcare facilities try to control MRSA & VRE by identifying colonized patients with active surveillance cultures so they can be cared for using contact precautions
  - Muto et al, ICHE 2003;24:362-386

# Guidelines for Control of Multidrug-Resistant Organisms

- October 2006
- CDC released updated guidelines
- <http://www.cdc.gov/ncidod/dhqp/pdf/ar/mdroGuideline2006.pdf>
- Address MRSA, VRE and multidrug-resistant Gram negative rods (MDR-GNR)
- Summary tables

## Tier 1. General Recommendations for Routine Prevention and Control of MDROs in Healthcare Settings

Administrative Measures/Adherence Monitoring	MDRO Education	Judicious Antimicrobial Use	Surveillance	Infection Control Precautions to Prevent Transmission	Environmental Measures	Decolonization
<p>Make MDRO prevention/control an organizational priority. Provide administrative support and both fiscal and human resources to prevent and control MDRO transmission. <i>(IB)</i> Identify experts who can provide consultation and expertise for analyzing epidemiologic data, recognizing MDRO problems, or devising effective control strategies, as needed. <i>(II)</i></p> <p><b>Implement systems to communicate information about reportable MDROs to administrative personnel and state/local health departments. <i>(II)</i></b></p> <p>Implement a multi-disciplinary process to monitor and improve HCP adherence to recommended practices for Standard and Contact Precautions. <i>(IB)</i></p> <p>Implement systems to designate patients known to be colonized or infected with a targeted MDRO and to notify receiving healthcare facilities or personnel prior to transfer of such patients within or between facilities. <i>(IB)</i></p> <p>Support participation in local, regional and/or national coalitions to combat emerging or growing MDRO problems. <i>(IB)</i></p> <p>Provide updated feedback at least annually to healthcare providers and administrators on facility and patient-care unit MDRO infections. Include information on changes in prevalence and incidence, problem assessment and performance improvement plans. <i>(IB)</i></p>	<p>Provide education and training on risks and prevention of MDRO transmission during orientation and periodic educational updates for HCP; include information on organizational experience with MDROs and prevention strategies. <i>(IB)</i></p>	<p>In hospitals and LTCFs, ensure that a multi-disciplinary process is in place to review local susceptibility patterns (antibiograms), and antimicrobial agents included in the formulary, to foster appropriate antimicrobial use. <i>(IB)</i></p> <p>Implement systems (e.g., CPOE, susceptibility report comment, pharmacy or unit director notification) to prompt clinicians to use the appropriate agent and regimen for the given clinical situation. <i>(IB)</i></p> <p>Provide clinicians with antimicrobial susceptibility reports and analysis of current trends, updated at least annually, to guide antimicrobial prescribing practices. <i>(IB)</i></p> <p>In settings with limited electronic communication system infrastructures to implement physician prompts, etc., at a minimum implement a process to review antibiotic use. Prepare and distribute reports to providers. <i>(II)</i></p>	<p>Use standardized laboratory methods and follow published guidelines for determining antimicrobial susceptibilities of targeted and emerging MDROs.</p> <p>Establish systems to ensure that clinical micro labs (in-house and outsourced) promptly notify infection control or a medical director/designee when a novel resistance pattern for that facility is detected. <i>(IB)</i></p> <p>In hospitals and LTCFs:          ...develop and implement laboratory protocols for storing isolates of selected MDROs for molecular typing when needed to confirm transmission or delineate epidemiology of MDRO in facility. <i>(IB)</i>          ...establish laboratory-based systems to detect and communicate evidence of MDROs in clinical isolates <i>(IB)</i>          ...prepare facility-specific antimicrobial susceptibility reports as recommended by CLSI; monitor reports for evidence of changing resistance that may indicate emergence or transmission of MDROs <i>(IA/IC)</i>          ...develop and monitor special-care unit-specific antimicrobial susceptibility reports (e.g., ventilator-dependent units, ICUs, oncology units). <i>(IB)</i>          ...monitor trends in incidence of target MDROs in the facility over time to determine if MDRO rates are decreasing or if additional interventions are needed. <i>(IA)</i></p>	<p>Follow Standard Precautions in all healthcare settings. <i>(IB)</i></p> <p>Use of Contact Precautions (CP):          --- In <i>acute care settings</i>: Implement CP for all patients known to be colonized/infected with target MDROs. <i>(IB)</i>          --- In <i>LTCFs</i>: Consider the individual patient's clinical situation and facility resources in deciding whether to implement CP <i>(II)</i>          --- In <i>ambulatory and home care settings</i>, follow <i>Standard Precautions</i> <i>(I)</i>          --- In <i>hemodialysis units</i>: Follow dialysis specific guidelines <i>(IC)</i></p> <p>No recommendation can be made regarding when to discontinue CP. <i>(Unresolved issue)</i></p> <p>Masks are not recommended for routine use to prevent transmission of MDROs from patients to HCWs. Use masks according to Standard Precautions when performing splash-generating procedures, caring for patients with open tracheostomies with potential for projectile secretions, and when there is evidence for transmission from heavily colonized sources (e.g., burn wounds).</p> <p>Patient placement in hospitals and LTCFs:          When single-patient rooms are available, assign priority for these rooms to patients with known or suspected MDRO colonization or infection. Give highest priority to those patients who have conditions that may facilitate transmission, e.g., uncontained secretions or excretions. When single-patient rooms are not available, cohort patients with the same MDRO in the same room or patient-care area. <i>(IB)</i></p> <p>When cohorting patients with the same MDRO is not possible, place MDRO patients in rooms with patients who are at low risk for acquisition of MDROs and associated adverse outcomes from infection and are likely to have short lengths of stay. <i>(II)</i></p>	<p>Follow recommended cleaning, disinfection and sterilization guidelines for maintaining patient care areas and equipment.          Dedicate non-critical medical items to use on individual patients known to be infected or colonized with an MDRO. Prioritize room cleaning of patients on Contact Precautions. Focus on cleaning and disinfecting frequently touched surfaces (e.g., bed rails, bedside commodes, bathroom fixtures in patient room, doorknobs) and equipment in immediate vicinity of patient.</p>	<p>Not recommended routinely</p>

## Tier 2. Recommendations for Intensified MDRO control efforts

Institute one or more of the interventions described below when 1) incidence or prevalence of MDROs are not decreasing despite the use of routine control measures; or 2) the *first* case or outbreak of an epidemiologically important MDRO (e.g., VRE, MRSA, VISA, VRSA, MDR-GNB) is identified within a healthcare facility or unit *(IB)* Continue to monitor the incidence of target MDRO infection and colonization; if rates do not decrease, implement additional interventions as needed to reduce MDRO transmission.

Administrative Measures/Adherence Monitoring	MDRO Education	Judicious Antimicrobial Use	Surveillance	Infection Control Precautions to Prevent Transmission	Environmental Measures	Decolonization
<p>Obtain expert consultation from persons with experience in infection control and the epidemiology of MDROs, either in-house or through outside consultation, for assessment of the local MDRO problem and guidance in the design, implementation and evaluation of appropriate control measures. <i>(IB)</i></p> <p>Provide necessary leadership, funding and day-to-day oversight to implement interventions selected. <i>(IB)</i></p> <p>Evaluate healthcare system factors for role in creating or perpetuating MDRO transmission, including staffing levels, education and training, availability of consumable and durable resources; communication processes, and adherence to infection control measures. <i>(IB)</i></p> <p>Update healthcare providers and administrators on the progress and effectiveness of the intensified interventions. <i>(IB)</i></p>	<p>Intensify the frequency of educational programs for healthcare personnel, especially for those who work in areas where MDRO rates are not decreasing. Provide individual or unit-specific feedback when available. <i>(IB)</i></p>	<p>Review antimicrobial use, especially for target MDROs, and in antimicrobial stewardship programs. Indicate target agents, such as vancomycin, cephalosporins, anaerobics, VRE, cephalosporins, ESBLs, and carbapenems.</p>	<p>Calculate and analyze incidence and prevalence of the target MDRO to determine if transmission has decreased or ceased. <i>(IB)</i></p> <p>Repeat point-prevalence culture-surveys at routine intervals and at time of patient discharge or transfer until transmission has ceased. <i>(IB)</i></p> <p>If indicated by assessment of the MDRO problem, collect cultures to assess the colonization status of roommates and other patients with substantial exposure to patients with known MDRO infection or colonization. <i>(IB)</i></p> <p>Obtain cultures from HCP for target MDROs when there is epidemiologic evidence implicating the staff member as a source of ongoing transmission. <i>(IB)</i></p>	<p>Use of Contact Precautions:</p> <p>Give highest priority to those patients who have conditions that may facilitate transmission, e.g., uncontained secretions or excretions. When single-patient rooms are not available, cohort patients with the same MDRO in the same room or patient-care area. <i>(IB)</i></p> <p>When cohorting patients with the same MDRO is not possible, place MDRO patients in rooms with patients who are at low risk for acquisition of MDROs and associated adverse outcomes from infection and are likely to have short lengths of stay. <i>(II)</i></p> <p><b>Stop new admissions to the unit or facility if transmission continues despite the implementation of the intensified control measures. <i>(IB)</i></b></p>	<p>Dedicated equipment</p> <p>Staff who are trained for control.</p> <p>Choose to staff to the areas to be cleaned and disinfected. <i>(IB)</i></p> <p>Ensure that surfaces in the unit are cleaned and disinfected. <i>(II)</i></p> <p>Obtain environmental cultures (e.g., surfaces, shared equipment) only when epidemiologically implicated in transmission <i>(IB)</i></p> <p><b>Vacate units for environmental assessment and intensive cleaning when previous efforts to control environmental transmission have failed <i>(II)</i></b></p>	<p>Consult with experts on a case-by-case basis regarding the appropriate use of decolonization therapy for patients or staff during limited period of time as a component of an intensified MRSA control program <i>(II)</i></p> <p>When decolonization for MRSA is used, perform susceptibility testing for the decolonizing agent against the target organism or the MDRO strain epidemiologically implicated in transmission. Monitor susceptibility to detect emergence of resistance to the decolonizing agent. Consult with microbiologists for appropriate testing for mupirocin resistance, since standards have not been established.</p> <p>Do not use topical mupirocin routinely for MRSA decolonization of patients as a component of MRSA control programs in any healthcare setting. <i>(IB)</i></p> <p>Limit decolonization to HCP found to be colonized with MRSA who have been epidemiologically implicated in ongoing transmission of MRSA to patients. <i>(IB)</i></p> <p>No recommendation can be made for decolonization of patients who carry VRE or MDR-GNB.</p>

**Develop and implement protocols to obtain active surveillance cultures from patients in populations at risk. *(IB)* (See recommendations for appropriate body sites and culturing methods.)**

# Theory of Active Surveillance

- What is active surveillance?
  - Detection of asymptomatic or subclinical state in a group of persons who are at risk but would not otherwise be identified
- For patients identified by the active surveillance an intervention can be done
  - Early treatment
  - Isolation
  - Cohorting
- Goal to prevent development of disease

# Colonization vs. Infection

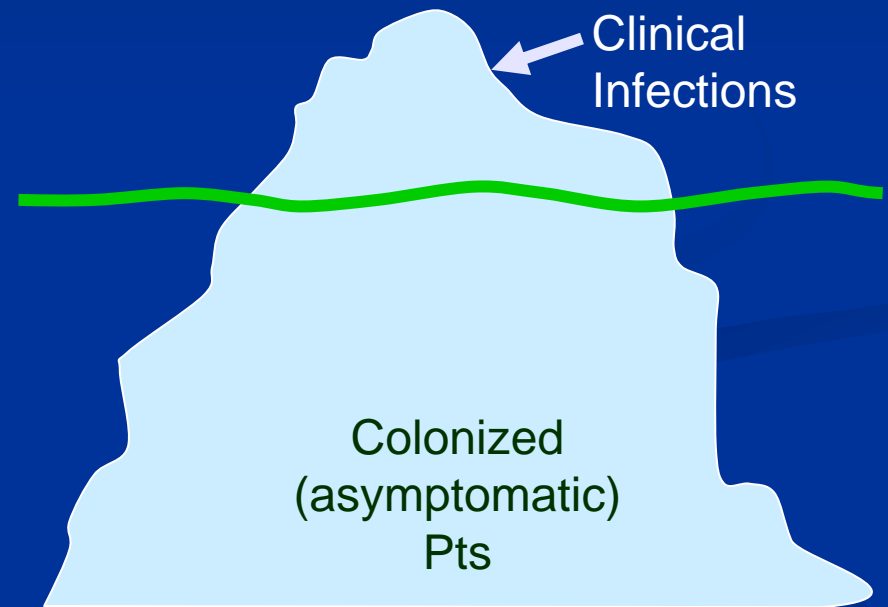
- Colonization: presence of microorganisms in or on a host with growth and multiplication, but without tissue invasion or damage
- Infection: the entry and multiplication of microorganisms in the tissues of the host leading to signs and local or systemic symptoms

# How does Active Surveillance apply to MRSA?

- Asymptomatic, carrier state occurs
- Intervention
  - contact precautions (isolation)
    - gown, gloves and appropriate hand hygiene
- Intended outcome
  - Prevention of transmission
  - Prevention of infection

# MRSA: Asymptomatic Patients Exist

- Clinical cxs
  - 15% of pts with (+) surveillance cultures (95% CI 11.9-18.8%)
- 30% - no clinical cx
- Days un-isolated = 3247 day or 7.4 d/pt
- 84% of patients would have escaped detection if only clinical cxs used
- Duration of un-isolation
  - 11 days/pt
  - 81% of all isolation days in the study group



Salgado et al., *ICHE* 2006;27:116-21  
Lucet et al., *ICHE* 2005;26:121-6

# Colonized Patients are Reservoir for Transmission



Both infected and colonized pts contaminate their environment with the same relative frequency

# CA-MRSA: Impact on Active Surveillance

- Spreading in the community
  - USA-300, USA-400
  - *mecA* type IV
  - PVL and other toxins
- Causes skin and soft tissue infections
- Can cause severe invasive disease
  - high morbidity and high mortality
- Can spread in the healthcare setting
- What does it mean for hospital infection control?\*
- Want to avoid nosocomial transmission of CA-MRSA
- Probably changes high risk groups that need screening

# Need to screen for MRSA colonization, but who?

- High risk patients
  - Exposure to health care
    - Previous hospitalization
    - Length of stay in the hospital
    - Transfer from other health care facilities
    - Exposure to particular high risk units
      - Maybe facility specific
      - ICUs, dialysis units, other specialized units
  - Exposure to antimicrobials
  - Other MDROs
  - For CA-MRSA – Skin/soft tissue infections, congregate settings, MSM, sports teams –
  - ? All admissions?

# Interventions for Colonized Patients

- Contact Precautions
- Cohorting
- Decolonization

# Contact Precautions

- Gloves to enter patient room
- Gowns to enter the room
- Hand hygiene
- Dedicated equipment – stethoscopes
- Private room or cohorted
  
- Isolate on readmission

# Other Affiliated Control Measures

- Hand Hygiene (of course)
- Environmental cleaning and disinfection

# Survival of MRSA/VRE in the environment

- Duration of survival of MRSA in dry conditions<sup>1</sup>
  - Plastic charts = 11 days
  - Laminated tabletop = 12 days
  - Cloth curtains = 9 days
- Environmental survival of VRE<sup>2</sup>
  - 50% survival at 7 days on upholstery, furniture and wall coverings
  - VRE could be transferred easily by touching contaminated surfaces

1. Huang et al., Infect Control Hosp Epidemiol 2006;27:1267-69

2. Lankford et al., Am J Infect Control 2006;34:258-63

# Impact of environmental contamination

- Increased risk of VRE/MRSA for patients in presence of environmental contamination
  - Placement in room with VRE contamination increased risk in multivariate analysis<sup>1</sup>
  - Excess risk of acquisition<sup>2</sup>
    - 5.1% for MRSA
    - 6.8% for VRE

1. Martinez et al., Arch Intern Med 2003;163:1905-12

2. Huang et al., Arch Intern Med 2006;166:1945-51

# Cleaning of the environment

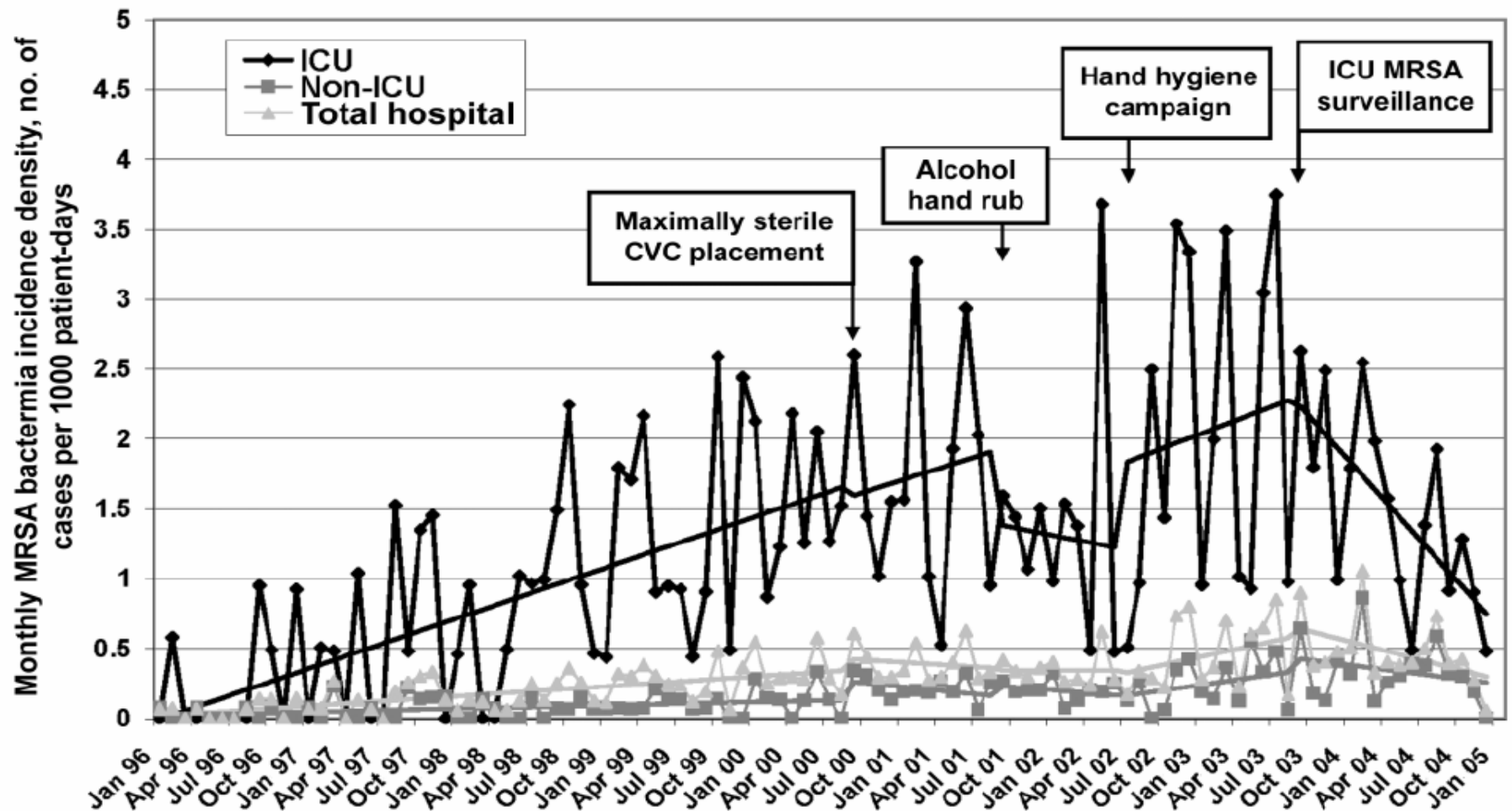
- “Bucket” cleaning using wet (not damp) cloth is more effective in removing VRE from the hospital environment.

Byers et al., Infect Control Hosp Epidemiol 1998;19:261-4.

- Use of fluorescent markers demonstrated inadequate cleaning in approximately 50% of rooms

Carling et al., Am J Infect Control 2006;54:531-9

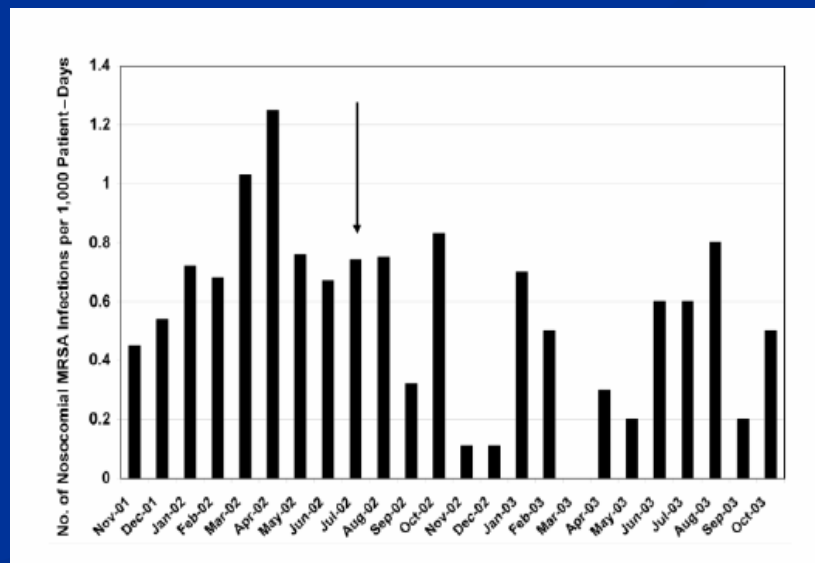
# Outcomes: Active Surveillance Controls MRSA BSIs



# Outcome of Active Surveillance: MRSA HAIs

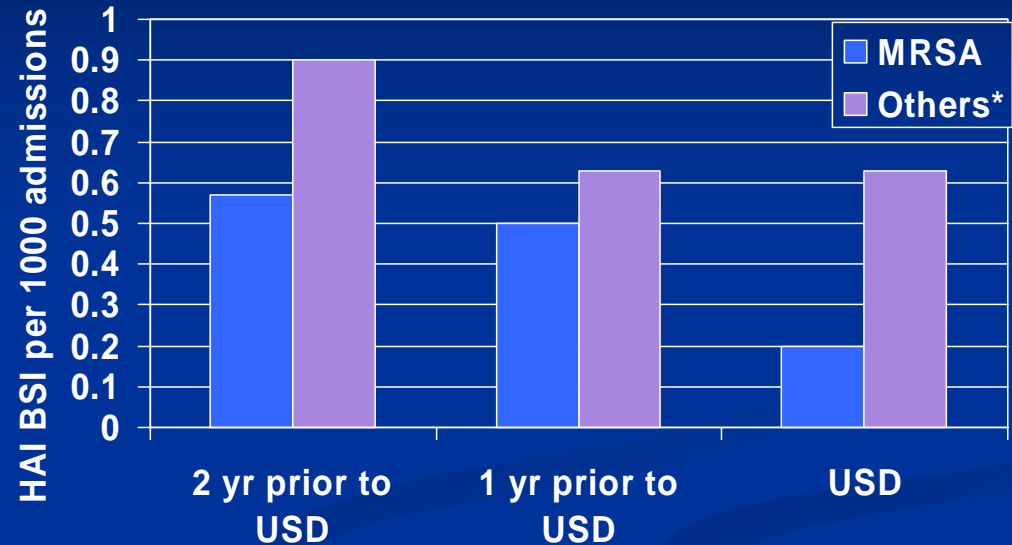
- 400 bed tertiary care facility
- High risk screening for MRSA
  - All ICU admissions
  - Transfer from another hospital or LTCF
  - Readmit within 30 days
  - Nephrology service

- Results: MRSA HAI
  - 0.76 to 0.46/1000 pt-days
  - 39% reduction
  - $p = .05$



# Outcome: Universal Surveillance and Decolonization (USD) on MRSA HAI BSI

- Evanston Northwestern Hospital
- Screened all admissions with PCR
- Pts with MRSA
  - Chlorhexidine bath QOD X 3 baths
  - Mupirocin bid X 5 days



1.6 fold decrease in MRSA BSI,  $p = 0.02$

No change in other HAI BSIs

\* other organisms that commonly cause HAI BSIs

# Screening Methods for Detection of MRSA Colonization

	Traditional culture	Combined culture plus rapid testing	Rapid testing
Turn around time (hours)	48 – 72	24	2
Isolate available	Yes	Yes	No
Details		Chromogenic agars, PCR from oxacillin- enhanced broth, PCR from culture	Real time PCR

# Chromagenic Agars

- Selective media with antimicrobial to inhibit grow of sensitive *S. aureus*
- Color change
- Colonies with color change at 24 hours = MRSA
- Negative required 48 hours to confirm



# PCR based test for MRSA

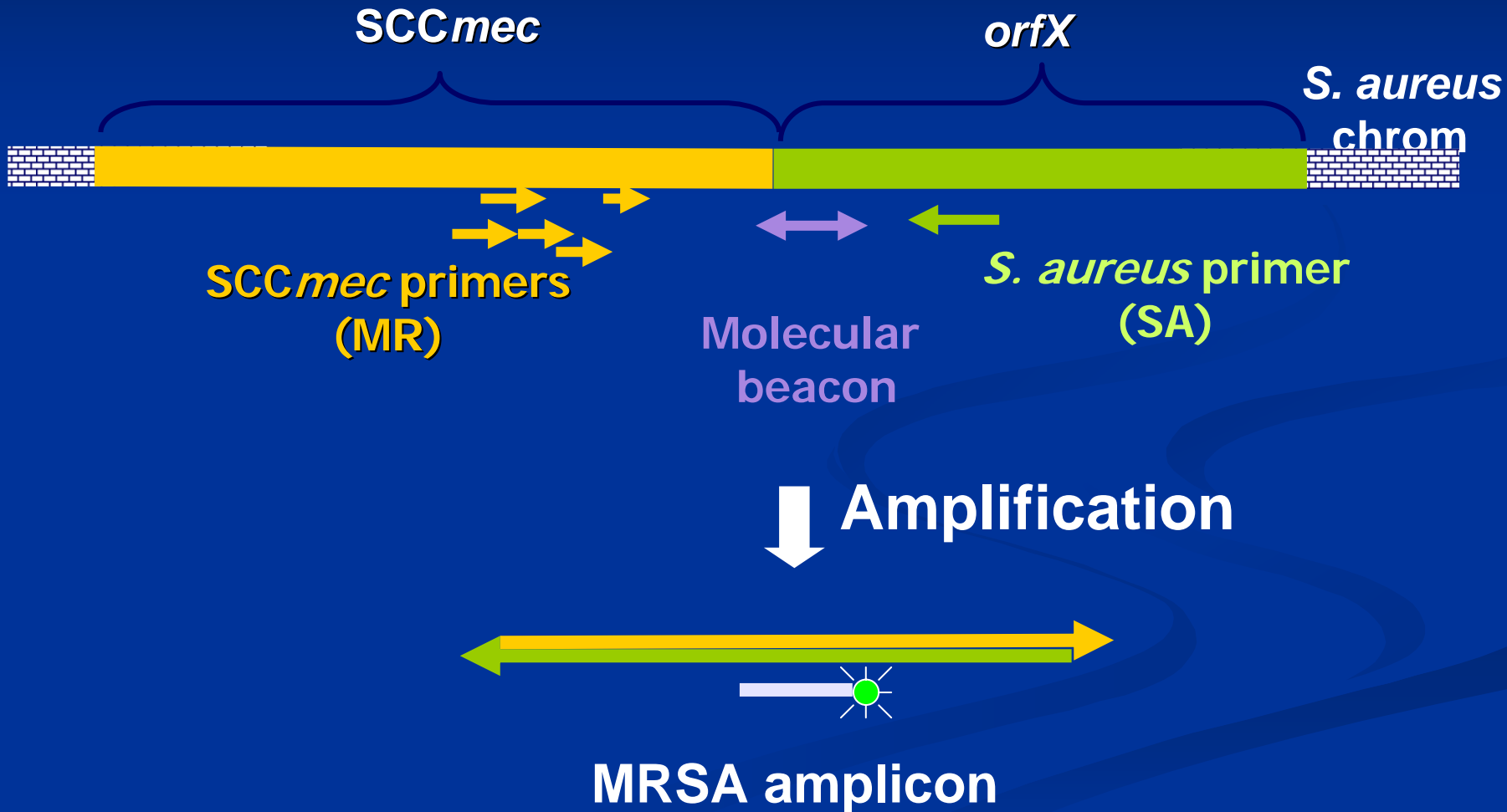
Nasal specimens

Collected by nursing as part of an active surveillance program

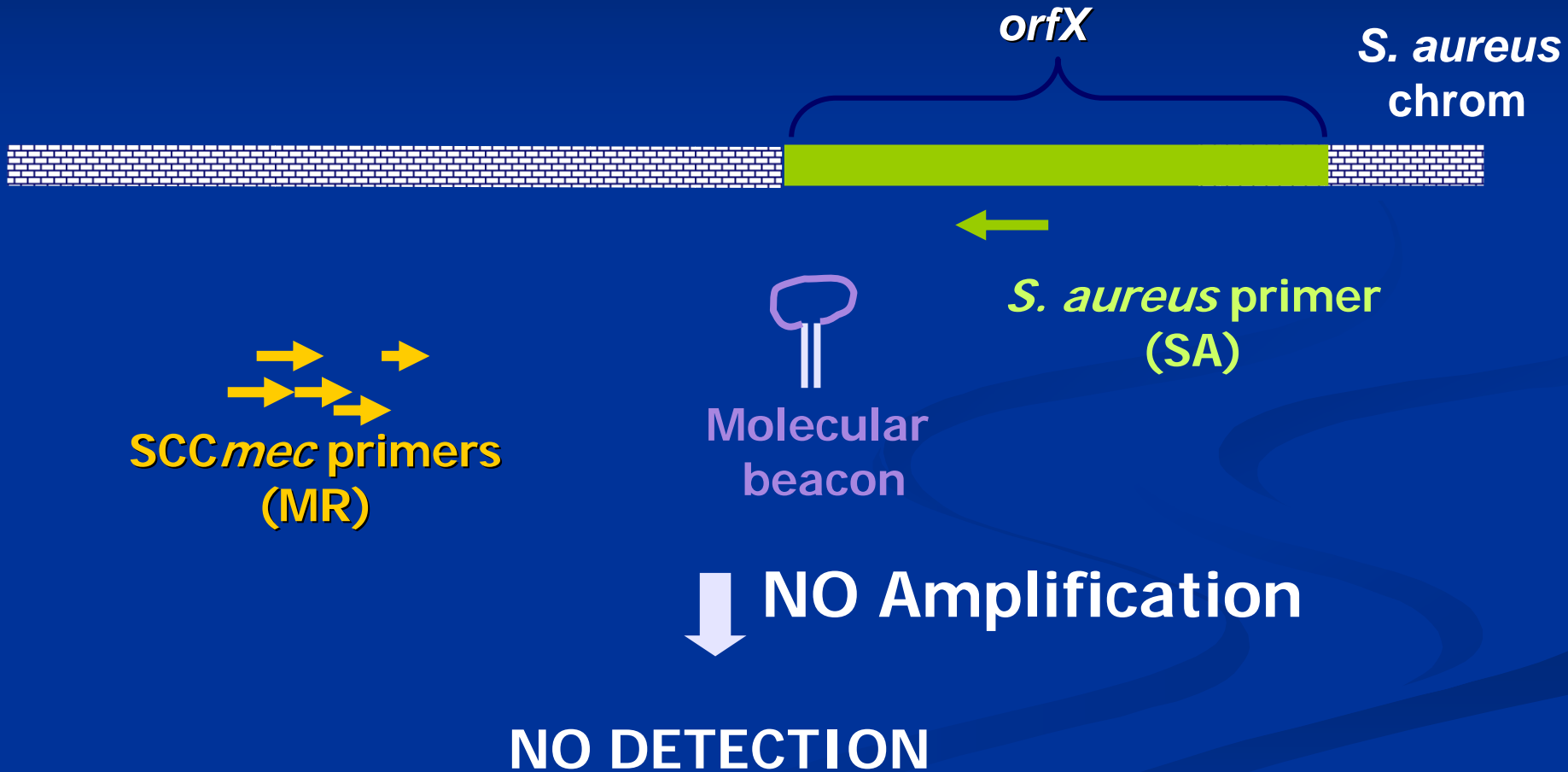
	Sensitivity (95% CI)	Specificity (95% CI)	Positive Predictive Value	Negative Predictive Value
Broth Enhancement	<b>93.8</b> (81.8, 98.4)	<b>97.0</b> (95.2, 98.2)	<b>71.4</b> (58.5, 81.8)	<b>99.5</b> (98.4, 99.9)

- Benefit of high negative predictive value in the setting of an active surveillance program
  - Very low number of false negatives

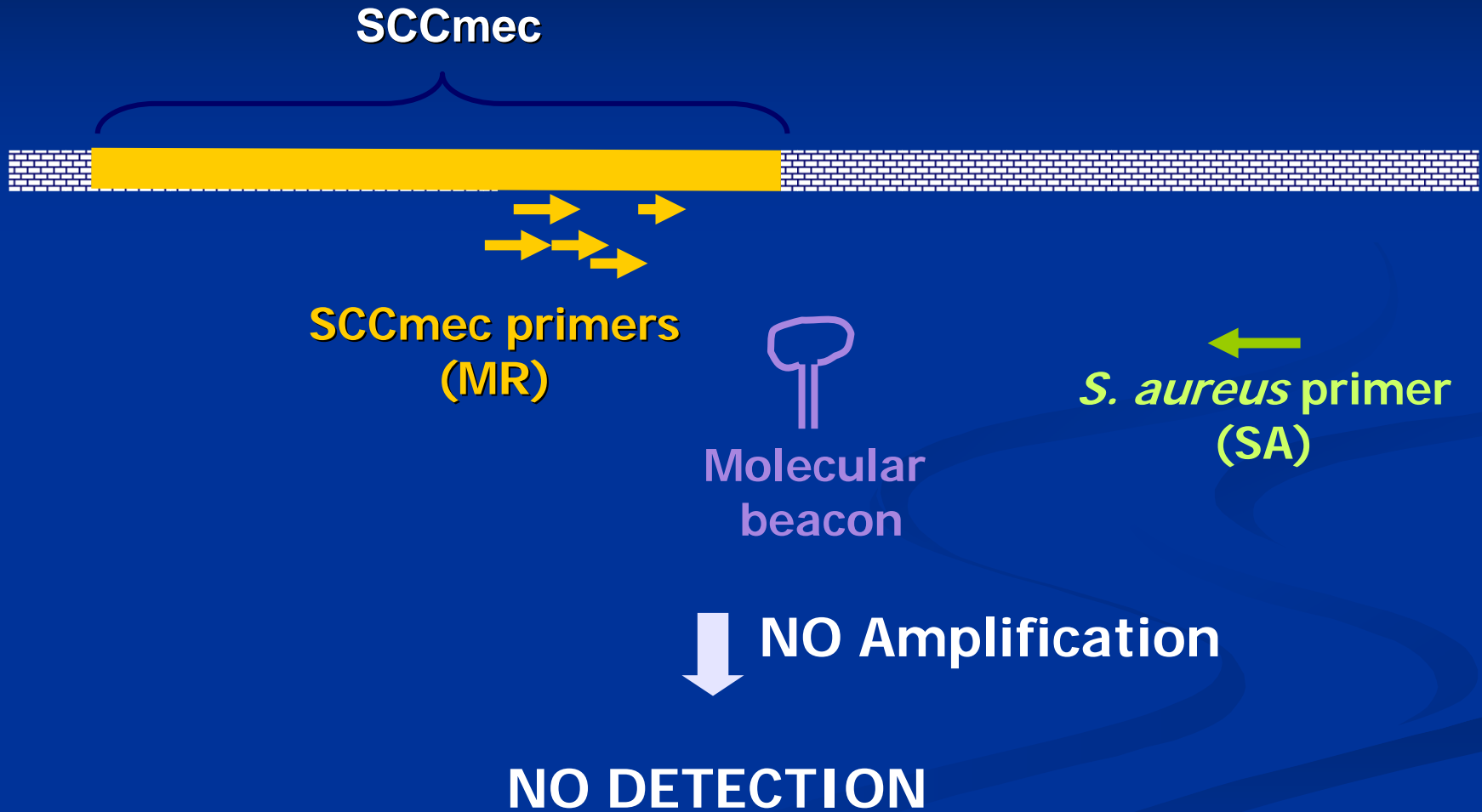
# Molecular Target: MRSA DNA



# Molecular Target: MSSA DNA



# Molecular Target: MR-CoNS DNA



# Benefits of Rapid Identification (PCR) Compared with Traditional Culture

- Rapid turn around time
  - Traditional culture: 48 - 72 hours
  - Real time PCR: 2 hours
- High negative predictive value
- Allows for rapid initiation of contact precautions
- Consideration of other interventions
  - Chlorhexidine/mupirocin

# Benefits of Rapid Identification (PCR) Compared with Traditional Culture

- Environmental Services
  - Rooms with patients with MRSA require enhanced terminal cleaning<sup>1</sup>
  - 60% to 80% of pts move between the time their surveillance specimen is collected and the results are available (at WFUBMC)
  - Acquisition of MRSA is increased for patients in a room that was previously occupied by a pt colonized with MRSA
    - OR = 1.4, p = 0.03

<sup>1</sup>Byers et al., ICHE 1998;19:261-4

<sup>2</sup>Huang et al., Arch Intern Med 2006;166:  
1945-51

# Benefits of Rapid Identification (PCR) Compared with Traditional Culture

- Soft benefits
  - Improved HCW satisfaction

# Adjunctive Therapy for MRSA

- Chlorhexidine plus intranasal mupirocin
- 10 month period in MICU compared with baseline from previous year
- Decreased MRSA transmission by 52% (2.5% to 1.2%,  $p = 0.04$ )

Ridenour et al., SHEA 2005: abstract #21

# Impact of presumptive isolation on spread of VRE

**Table 2. Estimated number of incident vancomycin-resistant enterococci (VRE) acquisitions and absolute number and proportion of cases prevented in 1 year with 3 competing infection-control strategies, after 1000 model simulations.**

Infection control strategy	Average no. of incident VRE acquisitions	Estimated no. of incident cases of VRE colonization/infection prevented, compared with no surveillance strategy	Reduction of cases of VRE colonization/infection, compared with no surveillance strategy, %
No surveillance	118	...	...
Passive surveillance only	113	5	4.2
Active surveillance			
Patients isolated after culture results are determined to be positive	72.2	45.8	39
Immediate isolation and removal of patient after culture results are determined to be negative	41.1	76.9	65

NOTE. Each strategy is compared with a setting where no surveillance is in place.

# Economic Analysis of Active Surveillance

- Compare:

Costs of testing and isolation

VS.

Potential savings from avoided infections

- New CPT codes for molecular diagnostics may also impact balance

# Cost-Analysis of Active Surveillance

- Assumptions:
  - 34-bed general medical unit for a year
  - Canadian \$\$
- Total cost of surveillance
  - culture-based = \$5,517
  - PCR based = \$38,325
- Attributable cost of infection = \$10,000 – \$16,000
- Cost of colonization = \$1,300
- Therefore, cost-effective
  - For culture based: if prevent 1 MRSA infection every 2 – 3 years (or 1 infection every 24,000 to 36,000 pt-days)
  - For PCR, if prevent 3 - 4 infections every year (1 infection every 3,000 – 4,000 pt-days)

# Summary

- MRSA HAIs
  - Increasing in frequency
  - Cause significant morbidity, mortality and economic burden
- Guidelines for control of MDRO suggest multiple interventions
  - New CDC guidelines (Oct 2006)
  - Active surveillance
    - Identification of reservoir
  - Contact Precautions
  - Hand hygiene
  - Environmental Cleaning

# Summary

- New Developments
  - Multiple methods exist for identification of MRSA
- Adjunctive activities
  - Prevention of infection in patients with colonization
- As with all Infection Prevention and Control activities - control of MRSA requires multidisciplinary, multifaceted interventions to achieve control