Epidemiology of Community-Associated (CA) Methicillin-Resistant Staphylococcus aureus (MRSA) in the United States

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Division of Healthcare Quality Promotion
Acknowledgements

CDC
- Scott Fridkin
- Rachel Gorwitz
- Melissa Morrison
- Fred Tenover
- Jeff Hageman
- John Jernigan
- Roberta Carey

ABCs Collaborators
- CA
- CT
- CO
- GA
- MN
- NY
- OR
- TN

Cartoon from Harbarth, Pittet. The Lancet 2005;5:661
Number of References Listed in PubMed Including Community MRSA, 1999-2006

* Results through Oct 2006
Overview

- Describe:
  - measures of the burden of disease
  - changing epidemiology
  - prevention

- Mention microbiologic characteristics relevant to epidemiology
“Resistance”

Infected

Colonized
Proposed Approach to CA-MRSA in the United States
General Description National Health and Nutrition Examination Survey (NHANES)

- Collaboration with NCHS
- http://www.cdc.gov/nchs/nhanes.htm
  - Continuous representative sample of the noninstitutionalized US population since April 1999
  - 5000 persons per year
    - Interview
    - Physical examination
    - Medical tests and procedures
MRSA in NHANES

- Nasal swab
  - All participants >1 year of age
- CDC tests for *S. aureus* and determines resistance to oxacillin
- Interview added healthcare questions
- Data collection 2001-2002
**S. aureus Colonization**

NHANES Nasal Swab Survey 2001-2

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**Prevalence (%)**

- Male
- Female

**Age (years)**

1--5 6--11 12--19 20--29 30--39 40--49 50--59 60--69 70+

- **S. aureus** 32%
- MRSA 0.8%

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Kuehnert et al. *JID* 2006;193:172-179
Table 4. Risk Factors for Methicillin Resistance among Persons Colonized with *Staphylococcus aureus*: Logistic Regression

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Odds Ratio (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age &lt; 65 y</td>
<td>0.3 (0.1–0.9)</td>
<td>0.030</td>
</tr>
<tr>
<td>Men</td>
<td>0.4 (0.2–0.6)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td>0.010</td>
</tr>
<tr>
<td>Non-Hispanic white (reference)</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic black</td>
<td>1.5 (0.8–2.9)</td>
<td></td>
</tr>
<tr>
<td>Mexican American or Hispanic</td>
<td>0.3 (0.2–0.6)</td>
<td></td>
</tr>
<tr>
<td>Other race or multiracial group</td>
<td>1.4 (0.4–5.2)</td>
<td></td>
</tr>
<tr>
<td>Has diabetes</td>
<td>2.6 (1.1–6.1)</td>
<td>0.030</td>
</tr>
<tr>
<td>In long-term care facility in last 12 mo</td>
<td>7.4 (2.5–21.8)</td>
<td>0.001</td>
</tr>
</tbody>
</table>
S. aureus Colonization
NHANES Nasal Swab Survey 2001-2

Kuehnert et al. JID 2006;193:172-179
## Risk of Infection After Colonization or Infection

<table>
<thead>
<tr>
<th></th>
<th>Community ¹</th>
<th>Healthcare ²</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MRSA</strong></td>
<td>9/24 (38%)</td>
<td>24/63 (38%)</td>
</tr>
<tr>
<td><strong>MSSA</strong></td>
<td>8/229 (3%)</td>
<td>8/84 (10%)</td>
</tr>
</tbody>
</table>

1. Ellis MW et al. *CID* 2004;39:971-979
Voluntary reporting from Health Departments
Theoretical Spectrum of MRSA Surveillance

- Outbreak response
- Antibiogram surveillance
- Special populations
- All sites/invasive
- Active/passive
- Isolate testing
- Reportable
Current *Staphylococcus aureus* Surveillance by State 2004 & 2005

Information collected from:
Three-Community All-Site Surveillance for MRSA

- 2001-2 project in Atlanta, Baltimore, MN*:  
  - Record reviews  
    - Known risk factors for healthcare-associated (HA)  
  - Follow up interview of probable community-associated (CA) confirmed  
  - Described geographic variability  
    - Incidence invasive MRSA 19-40/100,000  
    - Of MRSA, 8-20% CA-MRSA  
    - Incidence CA-MRSA 18-26/100,000

* Emerging Infections Program – Active Bacterial Core Surveillance

† Fridkin SK et al. *NEJM* 2005;352:1436-44.
CA-MRSA Predominantly Causes Skin Disease

<table>
<thead>
<tr>
<th>Disease Syndrome</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin/soft tissue</td>
<td>1,266 (77%)</td>
</tr>
<tr>
<td>Wound (Traumatic)</td>
<td>157 (10%)</td>
</tr>
<tr>
<td>Urinary Tract Infection</td>
<td>64 (4%)</td>
</tr>
<tr>
<td>Sinusitis</td>
<td>61 (4%)</td>
</tr>
<tr>
<td>Bacteremia</td>
<td>43 (3%)</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>31 (2%)</td>
</tr>
</tbody>
</table>
CA-MRSA Incidence Varies by Age and Race

Atlanta, 2001-2002
26 per 100,000

Baltimore, 2002
18 per 100,000

Incidence, Cases per 100,000

Age Group (yr)
<2 2-18 19-64 >64

Black
White

Black
White

Fridkin SK et al. NEJM 2005;352:1436-44.
Three-Community All-Site Surveillance for MRSA

- 31% of CA-MRSA hospitalized
- 45% of CA-MRSA hx of some contact healthcare system
- Percentage resistant varied

<table>
<thead>
<tr>
<th></th>
<th>Atl</th>
<th>Balt</th>
<th>MN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cipro</td>
<td>37</td>
<td>79</td>
<td>20</td>
</tr>
<tr>
<td>Eythро</td>
<td>89</td>
<td>88</td>
<td>53</td>
</tr>
</tbody>
</table>
★ Hospital and community outbreaks
Hospital Transmission of CA-MRSA

- Hospital transmission of CA-MRSA among postpartum women, NY (Saiman L, CID, 2003;37:1313-9)

- CA-MRSA in a NICU, TX (Healy CM, CID, 2004;39:1460-6)

- CA-MRSA in hospital nursery and maternity units, NY (Bratu S, EID, 2005;11:808-13)
  - Nasal carriage in HCW 3/189, HA-MRSA

- CA-MRSA associated with 20% of nosocomial BSI (Seybold U, CID, 2006;42)
## Percentage of Isolates of Invasive MRSA Cases, Comparing Healthcare Risk Factors and Pulsed-Field Type

<table>
<thead>
<tr>
<th>Pulsed-Field Type</th>
<th>No HCRFs (n=27)</th>
<th>Healthcare Risk Factors</th>
<th>&gt;48 hours (n=29)</th>
<th>≤48 hours (n=44)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA300,400,1000</td>
<td>70%(19)</td>
<td>28%(8)</td>
<td>18%(8)</td>
<td></td>
</tr>
<tr>
<td>USA100,200,500</td>
<td>26%(7)</td>
<td>72%(21)</td>
<td>80%(35)</td>
<td></td>
</tr>
<tr>
<td>Not typeable</td>
<td>4%(1)</td>
<td>0</td>
<td>2%(1)</td>
<td></td>
</tr>
</tbody>
</table>

Klevens RM et al. *EID* in press
Community MRSA Outbreaks

- Various settings
  - Sports participants
  - Inmates in correctional facilities
  - Military recruits
  - Daycare attendees
  - Native Americans / Alaskan Natives
  - Healthy full-term newborns
  - Men who have sex with men
  - Tattoo recipients
  - Hurricane evacuees in shelters

**August 22, 2003 / 52(33);793-795**

- Fencers
- Football
- Wrestlers

**BOX. Measures for preventing staphylococcal skin infections among sports participants**

- Cover all wounds. If a wound cannot be covered adequately, consider excluding players with potentially infectious skin lesions from practice or competitions until the lesions are healed or can be covered adequately.
- Encourage good hygiene, including showering and washing with soap after all practices and competitions.
- Ensure availability of adequate soap and hot water.
- Discourage sharing of towels and personal items (e.g., clothing or equipment).
- Establish routine cleaning schedules for shared equipment.
- Train athletes and coaches in first aid for wounds and recognition of wounds that are potentially infected.
- Encourage athletes to report skin lesions to coaches and encourage coaches to assess athletes regularly for skin lesions.
CA-MRSA Abscesses among Professional Football Players

- MRSA abscesses in 5/58 players at sites of turf burns
- Association with:
  - BMI > 30 (RR 7.9, p=0.048)
  - Lineman/Linebacker (RR 10.6, p=0.02)
  - Antibiotics past year (RR 7.8, p=0.06)
- Antibiotic use (p<0.001)
  - 2.6 scripts/yr for team members
  - 0.2 scripts/yr for gen pop’n
- Nasal colonization survey, Environmental sampling: No MRSA

Kazakova et al. *NEJM* 2005;352:468-75
CA-MRSA Abscesses among Professional Football Players

- Observational:
  - Trainers providing wound care had no access to hand hygiene
  - Towels frequently shared
  - Players often did not shower before using whirlpool
  - Weight-training equipment not regularly cleaned

- Transmission controlled with improved wound care, targeted therapy, enhanced hygiene

Kazakova et al. *NEJM* 2005;352:468-75
CA-MRSA Outbreaks College Football Players

- **Nguyen DM. EID 2005;11(4):526-532**
  - Attack rate 10%; nasal carriage 8%
  - Risk factors for infection: sharing bar soap, pre-existing cuts or abrasions

- **Begier EM. CID 2004;39:1446-53**
  - Attack rate 10/100, No nasal carriers identified
    - 6 isolates USA 300 mecA SCCmec IVa
  - Risk factors for infection: cornerback and wide receiver position, turf burns, body shaving, frequent shared whirlpool use
Correctional Facilities
Methicillin-Resistant *Staphylococcus aureus* Skin or Soft Tissue Infections in a State Prison – Mississippi, 2000

- 45 inmates infected 1999-2000 in a 3000 inmate prison
  - Nasal carriage 86/1,757 (4.9%)
- Case-patients frequently reported:
  - Helping or being helped by other inmates with wound care
  - Lancing own or other inmates’ boils with fingernails or tweezers
  - Sharing potentially contaminated personal items (linen, pillows, clothing, tweezers)

MMWR 2001 50:919-22
Intervention to Reduce the Incidence of MRSA Skin Infections in a Correctional Facility in Georgia

- Cluster 16 cases in 200-bed detention center
- Barriers to hygiene:
  - Co-pay required for clinic visit
  - Lesions treated with warm compresses and topical antibiotics (no capacity for I&D)
  - Soap kept in locked drawers under bed
- Rates declined 11.6 to 8.8 to 0/10,000 d-days
  - improved skin disease screening
  - targeted antimicrobial therapy
  - wound care
  - personal hygiene

Wootton et al. *ICHE* 2004;25:402-7
Factors Contributing to MRSA Spread in Correctional Facilities

- Barriers to routine hygiene
- Barriers to inmates accessing the medical system
- Barriers within the medical system
- Unrecognized cause of skin infections
- Crowding
Prevention and Control

- Collaborated with Bureau of Prisons*
  - Implement skin infection screening and monitoring
  - Culture suspect lesions and provide targeted therapy
  - Improve inmate hygiene (education, availability of soap, etc)
  - Improve access to wound care and trained healthcare staff
  - Additional Interventions (antiseptic washes, nasal decolonization) to be considered in consultation with public health

*http://www.bop.gov/news/PDFs/mRSA.pdf
Military Training Facility, 2001-2003
Cases of CA-MRSA Soft Tissue Infections

3% of staff colonized

- Improved diagnosis/TX*
- Concordant therapy
- Hand sanitizers for recruits
- Antibacterial soap
- Daily showers enforced
- Prohibited of sharing towels

Zinderman CE, EID 2004;10:941-944
* Miocycline or TMP/Sulfa with rifampin and mupirocin (10 days)
CA-MRSA: Factors for Transmission

- Crowding
- Frequent Contact
- Compromised Skin
- Contaminated Surfaces and Shared Items
- Cleanliness
« Sentinel hospital surveys »
Prevalence of MRSA as cause of SSTI in Adult ED Patients –

Moran GJ et al. NEJM 2006;355:666-674
Majority of *S. aureus* SSTI in Adult ED Patients Caused by a Single Pulsed-Field Type

27% HA-MRSA by Epi Definition

- 98% PVL+
- 72% MRSA (n=218)
- 42% PVL+
- 31% MSSA (n=55)

Moran GJ et al. *NEJM* 2006;355:666-674
National Nosocomial Infections Surveillance (NNIS) system

- Hospitals reporting since 1970’s
- Standardized reporting of:
  - Nosocomial infections
  - Associated pathogens
  - Antimicrobial susceptibilities
- From 1992 to 2003
  - 1248 ICUs in 337 hospitals
Proportion of *S. aureus* Isolates from Nosocomial Infections Resistant to Oxacillin (MRSA/ORSA) Among Intensive Care Unit Patients, 1992-2003

χ²=45.1, p<.0001

Klevens et al. *CID*, 2006;42:389-91
Resistance to non-beta lactam Antimicrobials Among Oxacillin Resistant S. aureus (ORSA) from Nosocomial Infections Among Intensive Care Unit Patients, 1992-2003

Klevens et al. CID, 2006;42:389-91
Resistance of Oxacillin Resistant *S. aureus* (ORSA) to Erythromycin Only Among Nosocomial Infections Among Intensive Care Unit Patients, 1992-2003

Klevens et al. *CID*, 2006;42:389-91
MRSA Hospitalizations in the United States, 2000

- National Hospital Discharge Data
  - ICD-9-CM for *S. aureus*
- The Surveillance Network
  - >200 laboratories in U.S.
- Results:
  - 43.2% of *S. aureus* were MRSA
  - 126,000 hospitalizations
  - 4 per 1000 discharges
  - Rate 2.8 (West) – 4.5 (South)

ABCs population-based (invasive)
# Participants

<table>
<thead>
<tr>
<th>State</th>
<th>Counties/Region</th>
<th>Population</th>
<th>Reportability</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA</td>
<td>3 counties</td>
<td>3.2 M</td>
<td></td>
</tr>
<tr>
<td>CO</td>
<td>5 counties (metro Denver)</td>
<td>2.1 M</td>
<td>Reportable</td>
</tr>
<tr>
<td>CT</td>
<td>Statewide</td>
<td>3.5 M</td>
<td>Reportable</td>
</tr>
<tr>
<td>GA</td>
<td>8 counties (Fulton, Dekalb, Clayton, Gwinnett, Cobb, Douglas, Rockdale, Newton)</td>
<td>3.3 M</td>
<td>Reportable if severe*</td>
</tr>
<tr>
<td>MD</td>
<td>Baltimore</td>
<td>651 K</td>
<td></td>
</tr>
<tr>
<td>MN</td>
<td>1 county (Ramsey)</td>
<td>506 K</td>
<td>Reportable</td>
</tr>
<tr>
<td>NY</td>
<td>1 county (Monroe )</td>
<td>2.1 M</td>
<td></td>
</tr>
<tr>
<td>OR</td>
<td>3 counties (metro Portland)</td>
<td>1.5 M</td>
<td></td>
</tr>
<tr>
<td>TN</td>
<td>1 county (Davidson)</td>
<td>570 K</td>
<td>Reportable ST</td>
</tr>
</tbody>
</table>

* Hospitalization or death
Number and Percentage of Invasive MRSA Cases Without Healthcare-Related Risk Factors, by Site, July - December 2005

- MD: 98
- OR: 34
- CA: 62
- TN: 26
- GA: 81
- CO: 25
- CT: 43
- MN: 5
- NY: 12

Percent Without HRFs
Invasive MRSA Cases by Age Group

Significant difference in median age (44 vs. 63 years) by Wilcoxon Rank Sum
Location of Culture Collection for Invasive MRSA Cases

N=1446

Percent collected

ER 127
Outpt 357
ICU 1239
Non-ICU 124
Other 73

Community
Healthcare
Microbiologic Characteristics Most Relevant in Epidemiologic Studies

- Antibiotic Susceptibility
- Genomic Characteristics
  - Chromosome Cassettes
  - PFGE Patterns
- Toxin Profiles
## Percentage of Invasive MRSA Cases by Resistance† to Selected Antimicrobials, ABCs

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>CA</th>
<th>HA</th>
<th>Total N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erythromycin *</td>
<td>89.5</td>
<td>93.2</td>
<td>2433</td>
</tr>
<tr>
<td>Ciprofloxacin †</td>
<td>50.0</td>
<td>88.6</td>
<td>642</td>
</tr>
<tr>
<td>Clindamycin †</td>
<td>29.3</td>
<td>65.9</td>
<td>1516</td>
</tr>
<tr>
<td>Gentamicin †</td>
<td>2.9</td>
<td>8.1</td>
<td>131</td>
</tr>
<tr>
<td>Rifampin*</td>
<td>0.5</td>
<td>3.5</td>
<td>42</td>
</tr>
<tr>
<td>Tetracycline</td>
<td>8.6</td>
<td>9.7</td>
<td>189</td>
</tr>
<tr>
<td>Trimethoprim-sulfamethoxazole</td>
<td>4.8</td>
<td>7.5</td>
<td>181</td>
</tr>
</tbody>
</table>

† As reported in medical records
* Difference tested by Chi Square with p value <0.05; † p value <0.01
Methicillin resistance encoded in staphylococcal cassette chromosome (SCC) mec

- SCCmec I-V
  - Larger types II and III
  - Smaller I, IV, and V
- CA-MRSA strains type IV
USA 300: A Widely Disseminated Clone of Community-associated MRSA

60%  80%

Pneumonia (AL, AR, IL, MD, TX, WA)
Missouri
California
Pennsylvania
Colorado
Mississippi
Texas
Georgia
Tennessee
Texas
Missouri
California
USA300-114

Athletes
Prisoners
Children

Community
Hospital Strain
Hospital Strain

USA100
USA200
<table>
<thead>
<tr>
<th>Type</th>
<th>COL % POS</th>
<th>INFECT % POS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>II</td>
<td>IV</td>
</tr>
<tr>
<td>NO TOX</td>
<td>19</td>
<td>25</td>
</tr>
<tr>
<td>A</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>C</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>D</td>
<td>71</td>
<td>27</td>
</tr>
<tr>
<td>H</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>PVL</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>TSST</td>
<td>3</td>
<td>9</td>
</tr>
</tbody>
</table>

Courtesy George Kilgore
Comparison of Laboratory Characteristics of Healthcare- and Community- Associated MRSA, 2004

<table>
<thead>
<tr>
<th>HA-MRSA</th>
<th>CA-MRSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>More Resistant</td>
<td>Less Resistant</td>
</tr>
<tr>
<td>SCC\textit{mec} II</td>
<td>SCC\textit{mec} IV</td>
</tr>
<tr>
<td>Less Mobile</td>
<td>More Mobile</td>
</tr>
<tr>
<td>USA 100</td>
<td>USA 300</td>
</tr>
<tr>
<td>PVL Rare</td>
<td>PVL Common</td>
</tr>
</tbody>
</table>
Complete genome sequence of USA300, an epidemic clone of community-acquired meticillin-resistant Staphylococcus aureus

Binh An Diep, Steven R Gill, Richard F Chang, Tiffany HaiVan Phan, Jason H Chen, Matthew G Davidson, Felice Lin, Jessica Lin, Heather A Carleton, Emmanuel F Mongodin, George F Sansabaugh, Françoise Perdreau-Remington

Lancet 2006; 367:731-39
Observations from Genome Sequence of USA300: ACME

- Genetic island of 6 genes
- New member of SCC mobile genetic elements
- Enhanced capacity to grow and survive in the host

Prevention
CA-MRSA Common Factors “The 5 Cs”

- **Contact** frequent from skin to skin
- **Contaminated** surfaces and shared items
- **Crowding**
- **Compromised** skin integrity
- **Cleanliness**
Education Resources

CDC
- www.cdc.gov

Health Departments
- www.lapublichealth.org
- www.doh.wa.gov
- www.tdh.state.tx.us
- www.health.state.mn.us

NCAA
- www2.ncaa.org
Strategies for Clinical Management of MRSA in the Community: Summary of an Experts’ Meeting Convened by the Centers for Disease Control and Prevention

March 2006

Rachel J. Gorwitz\textsuperscript{1}, Daniel B. Jernigan\textsuperscript{1}, John H. Powers\textsuperscript{2}, John A. Jernigan\textsuperscript{1}, and Participants in the Centers for Disease Control and Prevention-Convener's Experts’ Meeting on Management of MRSA in the Community\textsuperscript{3}

\textsuperscript{1}Division of Healthcare Quality Promotion, Centers for Disease Control and Prevention\textsuperscript{*}
\textsuperscript{2}Center for Drug Evaluation and Research, U.S. Food and Drug Administration\textsuperscript{*}
\textsuperscript{3}Appendix A
Key Prevention Messages for Patients with Skin and Soft Tissue Infections and their Close Contacts

1. Keep wounds that are draining covered with clean, dry, bandages.
2. Clean hands regularly with soap and water or alcohol-based hand gel (if hands are not visibly soiled). Always clean hands immediately after touching infected skin or any item that has come in direct contact with a draining wound.
3. Maintain good general hygiene with regular bathing.
4. Do not share items that may become contaminated with wound drainage, such as towels, clothing, bedding, bar soap, razors, and athletic equipment that touches the skin.
5. Launder clothing that has come in contact with wound drainage after each use and dry thoroughly.
6. If you are not able to keep your wound covered with a clean, dry bandage at all times, do not participate in activities where you have skin to skin contact with other persons (such as athletic activities) until your wound is healed.
7. Clean equipment and other environmental surfaces with which multiple individuals have bare skin contact with an over the counter detergent/disinfectant that specifies *Staphylococcus aureus* on the product label and is suitable for the type of surface being cleaned¹.

Gorwitz, CDC, 2006
Summary

Goals
- Measure burden of disease
- Describe changing epidemiology
- Prevention measures

ABCs population-based (invasive)
Sentinel hospital surveillance
Hospital and community outbreaks
Reporting from Health Departments
Population surveys
Summary - Epidemiology

• MRSA is an important cause of morbidity in the US
  • invasive 19-40/100,000
  • CA any site: 18-26/100,000
  • 126,000 hospitalizations
    • 43-64% of S. aureus

• Dynamic
  • Risk factors
  • Antimicrobial susceptibilities
Summary - Prevention

- Lack evidence-based community interventions
- Heavily relies on education to control transmission
  - Enhance surveillance
  - Wound and infection containment
  - Limit sharing fomites
  - Environmental cleaning
- Vaccine not available in the short term
http://www.cdc.gov/ncidod/hip/
Post Teleconference Information

- Continuing Education Credit is available until November 9, 2006
- Evaluation must be completed by November 9, 2006
- PACE CEU Certificates will be emailed within 4 weeks (PACE is a CA CEU provider). FL CEU information will be submitted to CE Broker.