Epidemiology and Control of Methicillin-Resistant Staphylococcus aureus (MRSA) in the Community

Rachel J. Gorwitz, MD MPH
John A. Jernigan, MD, MS
Division of Healthcare Quality Promotion
Centers for Disease Control and Prevention, Atlanta, GA

Disclaimer: The findings and conclusions in this presentation are those of the author and do not necessarily represent the views of CDC
Background

• Strains of MRSA distinct from those that have caused infections in healthcare settings since the 1960s have emerged worldwide as a cause of infection among otherwise healthy adults and children in the community.

• Genetic characteristics of these new epidemic strains suggest they arose de novo in the community, and did not “escape” from hospitals.
MRSA is an emerging community pathogen among patients without established risk factors for MRSA infection (e.g., recent hospitalization, recent surgery, residence in a long-term-care facility, or injecting-drug use).

MMWR 48:707; 1999
Definition: Community-Associated MRSA

• MRSA infection in which:
  – MRSA culture was obtained in the community (or within 1st 48 hours of hospitalization)
  – Patient lacks established MRSA risk factors (recent hospitalization or surgery, long-term care, dialysis, indwelling catheters, history of MRSA)
Isolates from patients with community- and healthcare-associated MRSA infections were *initially* distinct

<table>
<thead>
<tr>
<th></th>
<th>HA-MRSA</th>
<th>CA-MRSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antimicrobial resistance</td>
<td>Multiple agents</td>
<td>Few agents</td>
</tr>
<tr>
<td>SCC<em>mec</em> (genetic element carrying <em>meca</em> resistance gene)</td>
<td>Type II</td>
<td>Type IV</td>
</tr>
<tr>
<td>Prevalent genotypes</td>
<td>Varies by country</td>
<td>Different than healthcare strains</td>
</tr>
<tr>
<td>PVL toxin gene</td>
<td>Rare</td>
<td>Common</td>
</tr>
</tbody>
</table>
Panton-Valentine Leukocidin (PVL)

- Leukocidins: bacterial toxins that create pores in leukocyte cell membranes and cause tissue necrosis
- PVL first identified in methicillin-susceptible S. aureus*
- Strongly associated with abscesses and severe pneumonia**

**Lina et al. CID 1999; 29:1128-32,
A Few MRSA Strains Cause Most Community Outbreaks in U.S.

- Pneumonia (AL, AR, IL, MD, TX, WA)
  - Missouri
  - California
  - Pennsylvania
  - Colorado
  - Mississippi
  - Texas
  - Georgia
  - Tennessee
  - Texas
- Community
  - Hospital Strain
  - Hospital Strain

- Athletes
- Prisoners
- Children

- USA300-114
- USA100
- USA200

CDC
Methicillin-Susceptible S. aureus Related to Epidemic MRSA Strains and Carrying PVL Genes Contributes to S. aureus Disease Burden in Community
Changing Antimicrobial Susceptibilities of New MRSA Strains in U.S.

- Increasing prevalence of resistance to clindamycin and tetracycline among USA300 isolates reported in some areas.
- Clusters of USA300 isolates with multiple resistance to erythromycin, clindamycin, tetracycline, and ciprofloxacin, and elevated mupirocin MICs have been identified.

CDC, Unpublished.
Definitions / Microbiology

Epidemiology

Management

Prevention
S. aureus Clinical Spectrum

- Colonization
- Skin Infections
- Severe / Invasive Infections
- Fatal Infections
S. aureus Colonization
NHANES Nasal Swab Survey 2001-2, N=9,622

S. aureus Colonization
NHANES Nasal Swab Survey 2001-2

S. aureus: 32% = 89.4 M people

S. aureus Colonization
NHANES Nasal Swab Survey 2001-2

S. aureus: 32.4% = 89.4 M people

MRSA: 0.8% = 2.3 M people

MRSA colonization associated with age >= 60 years & being female
S. aureus Clinical Spectrum

- Colonization
- Skin Infections
- Severe / Invasive Infections
- Fatal Infections
CA-MRSA Infections are Mainly Skin Infections

<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>

Fridkin SK, NEJM, 2005;352(14):1436-44
FIGURE. Methicillin-resistant *Staphylococcus aureus* in the leg of an evacuee from Hurricane Katrina — Dallas, Texas, September 2005

Photo/P Hicks, Children's Medical Center of Dallas
EMERGEncy ID Net — Coordinating Site: Olive View-UCLA, PI: DA Talan

MSSA 17%
42% PVL+
31% USA300

59%
98% PVL+
97% USA300
72% 300-0114

46/69 (67%)
25/42 (60%)
43/58 (74%)
18/30 (60%)
11/28 (39%)
3/20 (15%)
24/47 (51%)
32/58 (55%)
17/25 (68%)

42% PVL+
31% USA300
S. aureus Clinical Spectrum

- Colonization
- Skin Infections
- Severe / Invasive Infections
- Fatal Infections
Severe and Invasive Manifestations

- **Necrotizing pneumonia and empyema** – Francis JS, CID, 2005;40(1):100-7
- **Sepsis syndrome** – Gonzalez BE, Pediatrics, 2005;115(3):642-8
- **Disseminated infections with septic emboli** – Gonzalez BE, CID, 2005;41(5):583-90
- **Musculoskeletal infections (pyomyositis, osteomyelitis)** – Martinez-Aguilar G, PIDJ, 2004;23(8):701-6
- **Necrotizing fasciitis** – Miller LG, NEJM, 2005;352(14):1445-53
- **Purpura fulminans** – Adem PV, NEJM;2005;353(12):1245-51
- **Toxic shock-like syndrome**
S. aureus Community-Acquired Pneumonia Following Influenza-Like Illness, 2003-04

• 17 cases (15 MRSA)
  – Median age: 21 yrs.
  – 29% with underlying illness
  – Clinical evidence of influenza
    • 71% laboratory confirmed influenza
  – 94% were hospitalized
    • 81% admitted to ICU (8 intubated)
  – 29% died (median age = 28 yrs.)

Invasive MRSA Infections Increasing
Atlanta & Baltimore, 2001-02 and 2004

Atlanta

2001-2002: 19/100,000
2004: 33/100,000

Baltimore

2002: 40/100,000
2004: 115/100,000

Active Bacterial Core Surveillance, EIP
Slide courtesy of Monina Klevens and Melissa Morrison
MRSA is an emerging community pathogen among patients without established risk factors for MRSA infection (e.g., recent hospitalization, recent surgery, residence in a long-term-care facility, or injecting-drug use).

*MMWR 48:707; 1999*
Fatal Infections

- 2% of cases died in laboratory-based population surveillance in 3 states
  - Chart review revealed MRSA was causal or contributory to death in only a few cases
Active Bacterial Core Surveillance (ABCs)
MRSA Surveillance

Total Population: ~ 16.2 million

2001-02: All infections
2004-05: Invasive
CA-MRSA Outbreaks

• Often first detected as clusters of abscesses or “spider bites”

• Various settings
  – Sports participants
  – Inmates in correctional facilities
  – Military recruits
  – Daycare attendees
  – Native Americans / Alaskan Natives
  – Men who have sex with men
  – Tattoo recipients
  – Hurricane evacuees in shelters
Factors that Facilitate Transmission

Crowding
Factors that Facilitate Transmission

Crowding

Frequent Contact
Factors that Facilitate Transmission

Crowding

Frequent Contact

Compromised Skin
Factors that Facilitate Transmission

- Frequent Contact
- Contaminated Surfaces and Shared Items
- Crowding
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Factors that Facilitate Transmission

- Contaminated Surfaces and Shared Items
- Frequent Contact
- Crowding
- Compromised Skin
- Antimicrobial Use
- Cleanliness
Transmission Dynamics

Infected → Susceptible → Hands/Environment → Colonized

CDC

Centers for Disease Control and Prevention
New Epidemic Strains Enter Healthcare Settings
Hospital Transmission of New Epidemic MRSA Strains (USA300, USA400)

- Hospital transmission of USA400 among post-partum women, NY (Saiman L, CID, 2003;37:1313-9)

- Emergence of new strains of MRSA in a NICU, TX (Healy CM, CID, 2004;39:1460-6)

- USA300 in patients with prosthetic joint infections, GA (Kourbatova EV, AJIC, 2005;33:385-91)

- USA400 in hospital nursery and maternity units, NY (Bratu S, EID, 2005;11:808-13)

- USA300 in healthcare-associated bloodstream infections (Seybold U, CID, 2006;42:647-56)
MRSA Among Healthy Full-Term Newborns

- Outbreaks of MRSA skin infections among newborns delivered at a common facility*
  - Onset at 1-2 weeks of life
  - No likely source of acquisition following discharge
  - Resolved after reinforcement of nursery infection control practices (hand hygiene) +/- decolonization of colonized health care workers

*MMWR; March 31, 2006;55(12):329-332

National Nosocomial Infections Surveillance System

Klevens RM, CID, 2006;42:389-91
Definitions / Microbiology

Epidemiology

Management

Prevention
CA-MRSA Working Group Meeting Participants, July 2004

Gordon L. Archer
Carol L. Baker
Elizabeth Bancroft
Henry F. Chambers
Robert S. Daum
Jeffrey S. Duchin
Monica Farley
James Hadler
Jim Jorgensen
Sheldon K. Kaplan
Newton E. Kendig
Kathleen Harriman
Franklin D. Lowy
Ruth Lynfield
J. Kathryn MacDonald
Loren Miller

Gregory Moran
Olga Nuno
John H. Powers
L. Barth Reller
Nalini Singh
Marcus Zervos
Craig Zinderman

CDC
Daniel B. Jernigan*
John Jernigan*
Jay C. Butler
Denise Cardo
Roberta Carey
Rachel Gorwitz
Jeffrey C. Hageman
Thomas Hennessy
James M. Hughes
Jean Patel
Fred Tenover
J. Todd Weber

*Meeting Co-Chair
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. Gorwitz¹, Daniel B. Jernigan¹, John H. Powers², John A. Jernigan¹, and Participants in the Centers for Disease Control and Prevention-Convened Experts’ Meeting on Management of MRSA in the Community³

¹Division of Healthcare Quality Promotion, Centers for Disease Control and Prevention*
²Center for Drug Evaluation and Research, U.S. Food and Drug Administration*
³Appendix A
Clinical Considerations - Evaluation

Increase Awareness

- MRSA belongs in the differential diagnosis of skin and soft tissue infections (SSTI’s) compatible with *S. aureus* infection:
  - Abscesses, pustular lesions, “boils”
  - “Spider bites”
  - Cellulitis?
Clinical Considerations - Evaluation

*Increase Awareness*

• MRSA should also be considered in differential diagnosis of severe disease compatible with *S. aureus* infection:
  
  – Sepsis syndrome
  – Osteomyelitis
  – Necrotizing pneumonia
  – Septic arthritis
  – Necrotizing fasciitis
Clinical Considerations

• Obtain material for culture
Clinical Considerations

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- Alternative agents have +’s and –’s: More data needed to identify optimal strategies
Clinical Considerations - Management
Antimicrobial Selection (SSTIs)

• Are beta-lactams still appropriate 1st-line therapy?
  – In patient with mild-moderate illness and no significant co-morbidities, if local prevalence of MRSA “low”.
Clinical Considerations - Management

Antimicrobial Selection (SSTIs)

- Alternative agents (More data needed to establish effectiveness!):
  - **Clindamycin** — Potential for inducible resistance, Relatively higher risk of *C. difficile* associated disease?
  - **TMP/SMX** — Group A strep isolates commonly resistant
  - **Tetracyclines** — Not recommended for <8yo
  - **Rifampin** — Not as a single agent
  - **Linezolid** — Expensive, Potential for resistance with inappropriate use
Clinical Considerations - Management

Antimicrobial Selection (SSTIs)

• Not optimal for MRSA (High prevalence of resistance or potential for rapid development of resistance):
  – Macrolides
  – Fluoroquinolones
D-zone test for Inducible Clindamycin Resistance

- Perform on erythromycin-resistant, clindamycin-susceptible S. aureus isolates if clindamycin therapy considered

- If empiric clindamycin therapy initiated and inducible resistance detected, assess response to therapy; Consider changing to another agent, particularly if response unsatisfactory
Clinical Considerations - Management

Antimicrobial Selection (Severe / Invasive)

• Vancomycin remains a 1st-line therapy for severe infections possibly caused by MRSA

• Other IV agents (clindamycin, daptomycin, linezolid, quinopristin-dalfopristin, tigecycline, TMP/SMX) may be appropriate to consider in some circumstances, as may addition of nafcillin or oxacillin for optimal MSSA coverage. Consult an infectious disease specialist.

• Final therapy decisions should be based on results of culture and susceptibility testing.
Clinical Considerations

• Obtain material for culture
• No data to suggest molecular typing or toxin-testing should guide management
• I&D should be routine for purulent skin lesions
• Empiric antimicrobial therapy may be needed
• Alternative agents have +’s and –’s: More data needed to identify optimal strategies
• Use local data for treatment
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- Alternative agents have +’s and –’s: More data needed to identify optimal strategies
- Use local data for treatment
- Patient education is critical!
- Maintain adequate follow-up
Decolonization?

• Nasal colonization with *S. aureus*, including MRSA, is associated with an increased risk of subsequent infection, and can result in spread to others.

• Regimens to eliminate colonization have been used in outbreak settings in healthcare institutions and in an attempt to minimize risk of infection in certain high-risk patients (surgical patients, dialysis).

• Regimens have included:
  – Topical nasal agents (mupirocin, others)
  – Antiseptic body washes (chlorhexidine, triclosan, others)
  – Systemic antimicrobials (rifampin, TMP/SMX, others)
Decolonization?

• Regimens can eliminate colonization temporarily; Effectiveness in preventing disease less clear
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- Little data from community settings
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- *May* be reasonable to administer (after optimizing basic strategies):
  - Patient with recurrent infections
  - Ongoing transmission in a closely-associated cohort (e.g., household)
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- Little data from community settings
- Resistance can emerge
- *May be reasonable to administer* (after optimizing basic strategies):
  - Patient with recurrent infections
  - Ongoing transmission in a closely-associated cohort (e.g., household)
- Appropriate regimens (agents and schedules) not established for community settings
Definitions / Microbiology

Epidemiology

Management

Prevention
New MRSA Educational Materials

http://www.cdc.gov/mrsa
Education Resources

CDC
- www.cdc.gov

Health Departments
- www.lapublichealth.org (Spanish)
- www.doh.wa.gov
- www.tdh.state.tx.us
- www.health.state.mn.us
Vaccines?

• *S. aureus* vaccines under development

• Nabi StaphVax failed in phase III clinical trials (hemodialysis patients)
  – External review panel identified potential explanations, development continues

• Being developed for individuals known to be at high risk of invasive infection
  – Uncertain if this would be a practical strategy for the general population
Public Health Management

*When to Investigate*

- Consider investigation when culture-proven MRSA cases have been detected in a cluster among epidemiologically-linked individuals in the community.
Public Health Management

**When to Investigate**

- Decision to investigate should take into account various factors
  - Number of cases and temporal proximity of the cluster
  - Setting in which transmission is occurring
  - Severity of illness among cases
  - Presence of ongoing transmission or recurrent illness among cohort members
  - Host factors of those likely to be infected
  - Likelihood that an intervention could be successfully implemented
Public Health Management

Risk Factor Study?

• Can be labor and resource intensive
• Not always necessary for outbreak management
• Consider when:
  – Cluster occurs in a new setting
  – Results are likely to:
    • Directly impact control efforts
    • Contribute to general understanding of the disease and future prevention efforts
Colonization Swab Surveys?

• Have been used in many published investigations
• Yield has often been low
• Not generally necessary to direct control and prevention efforts
• May be useful:
  – To determine extent of or identify risk factors for transmission ("carrier-control" study)
  – To contribute to the understanding of CA-MRSA epidemiology (non-nasal colonization sites)
Public Health Management

Environmental Culturing?

• MRSA can survive in environment for varying amounts of time, depending on temperature, humidity, surface type, etc
• Direct person-to-person contact has been most important in transmission
• Environmental / fomite transmission most likely with objects / surfaces that have come in close, sustained, and recent or repeated contact with a large number of organisms
• In outbreak investigation, consider culturing environmental surface or source with an apparent epidemiologic link to transmission (common exposure for multiple cases)
Public Health Management

Components of Interventions

- Enhance surveillance
Public Health Management

Components of Interventions

• Enhance surveillance
• Target empiric therapy to the pattern of the outbreak strain
Public Health Management

Components of Interventions

- Enhance surveillance
- Target empiric therapy to the pattern of the outbreak strain
- Educate on wound care and wound containment
Public Health Management

Components of Interventions

- Enhance surveillance
- Target empiric therapy to the pattern of the outbreak strain
- Educate on wound care and wound containment
- Promote enhanced personal hygiene and limit sharing of personal items
Public Health Management

Components of Interventions

• Enhance surveillance
• Target empiric therapy to the pattern of the outbreak strain
• Educate on wound care and wound containment
• Promote enhanced personal hygiene and limit sharing of personal items
• Consider excluding patients from certain activities
Public Health Management

Components of Interventions

• Enhance surveillance
• Target empiric therapy to the pattern of the outbreak strain
• Educate on wound care and wound containment
• Promote enhanced personal hygiene and limit sharing of personal items
• Consider excluding patients from certain activities
• Achieve and maintain a clean environment
Conclusions

- New strains of MRSA have emerged in the community, with implications for clinical and public health management of skin infections and other staphylococcal infections
- The new epidemic MRSA strains have entered healthcare settings
- Various studies are underway and more are needed to determine best methods for control and prevention of MRSA in the community
- Strategies focusing on increased awareness, early detection and appropriate management, enhanced hygiene, and maintenance of a clean environment appear to have been successful
Thanks to Rachel Gorwitz, MD MPH
Division of Healthcare Quality Promotion
National Center for Infectious Diseases
Post Teleconference Information

• Continuing Education Credit is available until November 2, 2006
• Complete evaluation URL: http://www.surveymonkey.com/s.asp?u=132962584782
• Evaluation must be completed by November 2, 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.