Update on MRSA Infections In Children: 2015

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• No conflicts of interest to declare

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Staphylococcus aureus – “The Persistent Pathogen”*

Coagulase-positive staphylococci that typically form “golden” colonies on blood agar

Remain major causes of human morbidity and mortality – leading bacterial cause of death in U.S. today

* Sheagren, NEJM 1984 - widely used in articles and commentaries since then
Methicillin-Resistant *Staphylococcus aureus* (MRSA)

- First reported by *Barrett and colleagues* as a cause of nosocomial infection in 1968
- Emerged as important causes of community-associated infection in the U.S. in the late 90s and 2000s (CA-MRSA)
- Mechanism of resistance meant that these “MRSA” were in fact resistant to all beta-lactam antibiotics at that time
Case Presentation

• 2 month old infant presents to the hospital with 3 day Hx of URI Sx and 12 hr Hx of fever and difficulty breathing
• Term infant, no problems during neonatal period

• Initial exam reveals T 39, RR 50, decreased breath sounds on left; not in distress
• CBC 28K with 80% P, 8% band forms
Empiric Therapy for Hospitalized Children with Pneumonia

- “One Size Fits All” strategy is inadequate
- Must know local epidemiology and antibiotic-resistance patterns
- In Memphis, TN, in December 2001, this infant was hospitalized and treated with oxygen, IV fluids and IV ceftriaxone (100 mg/kg/day)
- 24 hours later ….
Did The Empiric Antibiotic Fail?

- Potential failures of cephalosporin therapy?
- -- Penicillin and Cephalosporin-Resistant Pneumococcus
- -- MRSA
Management of parapneumonic empyema

“Empyema needs a surgeon and three inches of cold steel, instead of a fool of a physician.”

Sir William Osler
Community-Associated MRSA (CA-MRSA) Infections in Children I

- In 1998, Herold and colleagues at the University of Chicago reported an alarming increase (25-fold) in methicillin-resistance amongst CA S. aureus isolates in Chicago from 1990 - 1995 (JAMA 279: 593, 1998)

- MMWR Aug 20, 1999: Four Pediatric Deaths from CAMRSA infections in Minnesota and North Dakota
Community-Associated MRSA (CA-MRSA) Infections in Children II

• By 2000-2005, MRSA was more prevalent than MSSA in many U.S. communities

• Most CA-MRSA isolates differ from classical nosocomial MRSA in that they are susceptible to antimicrobial agents other than vancomycin—e.g. clindamycin, TMP-SMZ

• However, CA-MRSA were uniformly R to all available* beta-lactam antibiotics and will fail therapy with these agents (*ceftaroline licensed in adults, being studied in children)
Community-Associated MRSA (CA-MRSA) Infections in Children III

- NOT the spread of HA-MRSA into the community
- In fact the opposite has happened: “CA-MRSA” strains have now spread into the healthcare setting and are now the major causes of nosocomial MRSA infections
- Currently circulating MRSA and MSSA strains likely more virulent than previous strains – new virulence factors
Rising CA-MRSA: Houston, TX 2001-04

Rising rates of nasal MRSA carriage

- U.S. population (NHANES study)
  - MRSA carriage rose from 0.8% of healthy adults (2001-02) to 1.5% (2004)
  - Overall *S. aureus* carriage fell from 32% of healthy adults (2001-02) to 29% (2004)
- Healthy children in Nashville: MRSA carriage rose from 0.8% (2001) to 9.2% (2004)
- St. Louis, 2005-06:
  - 2.5% of children colonized with MRSA
  - 24.2% colonized with MSSA

Community-Onset Pneumonia Caused by CA-MRSA

• Emerged as significant problem in U.S. in children*, adolescents# and adults^

• May complicate influenza

• Frequently associated with empyema

• High rate of complications and sequelae, associated with sepsis, endocarditis, thrombophlebitis
Treatment of Pneumonia Caused by CA-MRSA

• Vancomycin is the historical standard for MRSA infections but is a mediocre drug for treatment of pneumonia

• If the isolate is susceptible to clindamycin, this agent appears to be effective in most cases (but would likely be inadequate therapy for endocarditis or meningitis)

• However, inducible resistance to clindamycin may develop in MRSA strains which test S to CL but R to Erythro (“D” test screen)
Empiric Therapy of Presumed Bacterial Pneumonia in Children

- Cefotaxime/Ceftriaxone reasonable empiric therapy for pneumococcus, *Haemophilus*, *Moraxella*, MSSA

- Add clindamycin or vancomycin in patients with severe or complicated pneumonia in communities with endemic CA-MRSA infections (clindamycin in most cases if low rates of R; vancomycin if life-threatening)
Optimal Therapy for Severe MRSA Pneumonia?

- Multicenter study of ventilator-associated pneumonia in adult ICUs reported that linezolid was superior to vancomycin in adults with nosocomial MRSA pneumonia (but no survival advantage) (Wunderink et al, Clin Infect Dis 54: 621-9, 2012)

- Does this apply to CA-MRSA pneumonia? To children?
## MRSA-Related Diagnoses, Le Bonheur, 2000-2002

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Community-associated (N=151)</th>
<th>Healthcare-associated (N=138)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Skin/soft tissue infection (%)</strong></td>
<td>106 (70)</td>
<td>29 (21)</td>
</tr>
<tr>
<td>Noninvasive respiratory infection/colonization (%)</td>
<td>26 (17)</td>
<td>84 (61)</td>
</tr>
<tr>
<td><strong>Invasive infection (%)</strong></td>
<td>19 (13)</td>
<td>25 (18)</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Primary bacteremia</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Lymphadenitis</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Meningitis/ventriculitis</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Bone/joint infection</strong></td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Mastoiditis</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Urinary tract infection</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Osteomyelitis in Children

• *S. aureus* most common agent of culture-confirmed AHO (40 to 80% of all cases)
• *S. aureus* uniquely suited as bone pathogen
  – adheres to components of bone matrix (fibronectin, laminin, collagen)
  – Colonies of bacteria produce glycocalyx (antiphagocytic biofilm)
  – Once phagocytosed by osteoblasts may survive intracellularly
Which bones are affected most commonly?*

<table>
<thead>
<tr>
<th>Bone/region</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Femur</td>
<td>28%</td>
</tr>
<tr>
<td>Tibia</td>
<td>22%</td>
</tr>
<tr>
<td>Fibula</td>
<td>5%</td>
</tr>
<tr>
<td>Humerus</td>
<td>10%</td>
</tr>
<tr>
<td>Radius</td>
<td>4%</td>
</tr>
<tr>
<td>Ulna</td>
<td>2%</td>
</tr>
<tr>
<td>Calcaneus</td>
<td>5%</td>
</tr>
<tr>
<td>Pelvis</td>
<td>10%</td>
</tr>
<tr>
<td>Vertebra</td>
<td>2%</td>
</tr>
<tr>
<td>Hand</td>
<td>4%</td>
</tr>
<tr>
<td>Foot</td>
<td>6%</td>
</tr>
<tr>
<td>Clavicle</td>
<td>2%</td>
</tr>
</tbody>
</table>

*Excludes unusual miscellaneous bones (scapula, ribs) as only 1 or 2 cases across all series, intervertebral disc infections and infections of facial and skull bones (usually due to contiguous focus or trauma).
Septic Arthritis in Children

• Pathogenesis:
  • Most hematogenous or contiguous spread from osteomyelitis (proximal femur, humerus or any joint in children < 18 mos)
  • Knee > hip > ankle > upper extremity
  • May be initiated by trauma or joint puncture (iatrogenic)
  • Most common in children under 3 yo
Treatment of MSSA / MRSA
Bone & Joint Infections

Empiric therapy must cover MRSA in most parts of the world today – vancomycin or clindamycin, depending on severity of illness, age of patient, and rates of clindamycin resistance in your community.

Definitive IV therapy for MSSA infections – nafcillin or cefazolin

Definitive IV therapy for MRSA infections – vancomycin or clindamycin, depending on susceptibility results, presence of endocarditis or other intravascular focus, etc.
Parenteral versus oral therapy

- Oral therapy in sufficient doses should give same serum and bone/pus drug levels as IV (e.g., clindamycin given orally should be as effective as clindamycin IV)
- Concerns about oral therapy include compliance, absorption
- Exact timing of switch – depends on study, usually when patient afebrile and improving (5-7 days)
<table>
<thead>
<tr>
<th>Outcome</th>
<th>Intravenous Therapy (N = 1021), n (%)</th>
<th>Oral Therapy (N = 948), n (%)</th>
<th>Propensity Score-Adjusted OR (95% CI) for Those Children Treated With Early Transition to Oral Therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary outcome</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment failure within 6 mo of diagnosis</td>
<td>54 (5)</td>
<td>38 (4)</td>
<td>0.77 (0.49–1.22)</td>
</tr>
<tr>
<td>Chronic osteomyelitis</td>
<td>13 (1.3)</td>
<td>8 (0.8)</td>
<td>0.84 (0.33–2.13)</td>
</tr>
<tr>
<td>Musculoskeletal surgery</td>
<td>18 (1.8)</td>
<td>15 (1.6)</td>
<td>0.80 (0.38–1.70)</td>
</tr>
<tr>
<td>Complication of osteomyelitis&lt;sup&gt;a&lt;/sup&gt;</td>
<td>11 (1.1)</td>
<td>6 (0.6)</td>
<td>0.75 (0.27–2.07)</td>
</tr>
<tr>
<td>Acute osteomyelitis as sole readmission diagnosis</td>
<td>12 (1.2)</td>
<td>9 (0.9)</td>
<td>0.72 (0.25–2.08)</td>
</tr>
<tr>
<td>Secondary outcomes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any rehospitalization within 6 mo of diagnosis</td>
<td>102 (10)</td>
<td>56 (5.9)</td>
<td>0.6 (0.38–0.96)</td>
</tr>
<tr>
<td>Catheter-associated complication</td>
<td>35 (3)</td>
<td>0 (0)</td>
<td>—</td>
</tr>
<tr>
<td>Adverse effect of antimicrobial agents&lt;sup&gt;b&lt;/sup&gt;</td>
<td>15 (1.5)</td>
<td>4 (0.4)</td>
<td>0.39 (0.14–1.1)</td>
</tr>
</tbody>
</table>
Oral stepdown therapy for osteomyelitis

1. MRSA – clindamycin, linezolid, ? TMP-SMZ -- ? role for adjunctive rifampin

2. MSSA – cephalexin, cefadroxil, cefuroxime axetil

3. Total duration at least 3-4 weeks for SA; at least 4-6 weeks for osteomyelitis
Skin and Soft Tissue Infections (SSTI) in the Era of CA-MRSA
Furunculosis

• Furuncle: a deep staphylococcal folliculitis (carbuncle—group of furuncles)
  – Etymology: Latin *furunculus*, petty thief, boil
  – Sites of predilection: hair-bearing areas of the face, neck, axillae, buttocks, and groin
  – Constitutional symptoms are rare
  – But bacteremia and even sepsis can occur

Image: [www.merck.com/.../mmanual/plates/112pla2_1.jsp](http://www.merck.com/.../mmanual/plates/112pla2_1.jsp)
Mainstay of Treatment for SSTIs: Drainage

• Most important: **drain purulent collections**
• Antimicrobial therapy is an adjunct (at best) to drainage
• Lee et al (2004):
  – 69 children with MRSA skin infections; 92% drained
  – 93% received “inappropriate” therapy; of these, 94% were improved 1-6 days later
  – No differences in clinical resolution between those that had antibiotics changed and those that did not
• Duong et al (2010):
  – RCT of 161 children with skin abscess, all drained in ED
  – Failure rates: 5.3% (placebo) vs. 4.1% (TMP/SMX)
  – No difference in recurrence rates at 3 mo. follow-up

So when should antibiotics be administered after the I &D?

- Larger abscesses (> 5 cm for older children)
- Children with signs and symptoms of systemic illness (fever, etc), rapid progression, poor response to I&D alone
- Abscesses in areas difficult to drain completely
- Children with immunocompromising conditions (note that the differential diagnosis here may be much broader than *S. aureus*)
- Younger infants
Clindamycin or TMP-SMZ? SSTI in TennCare Study

- Retrospective cohort study of children (0-17 years) from 2004-2007
- 41,094 subjects were diagnosed with a SSTI and received antibiotics
- 6,407 children were identified who underwent drainage and received systemic antimicrobial therapy
  - 568 treatment failures (9%)
  - 994 recurrences (23%)

Williams et al. Pediatrics 2011
## Odds Ratio for Treatment Failure

### Table 2: ORs for Treatment Failure, Stratified According to Drainage Status

<table>
<thead>
<tr>
<th>Drainage</th>
<th>Clindamycin</th>
<th>Trimethoprim-Sulfamethoxazole</th>
<th>β-Lactam</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Incident SSTIs, n</td>
<td>2270</td>
<td>2206</td>
</tr>
<tr>
<td></td>
<td>Treatment failures, n (%)</td>
<td>107 (4.7)</td>
<td>246 (11.2)</td>
</tr>
<tr>
<td></td>
<td>Unadjusted OR (95% CI)</td>
<td>1.00 (reference)</td>
<td>2.54 (2.01–3.21)</td>
</tr>
<tr>
<td></td>
<td>Adjusted OR (95% CI)</td>
<td>1.00 (reference)</td>
<td>1.92 (1.49–2.47)</td>
</tr>
<tr>
<td>No drainage</td>
<td>Incident SSTIs, n</td>
<td>5189</td>
<td>8417</td>
</tr>
<tr>
<td></td>
<td>Treatment failures, n (%)</td>
<td>253 (4.9)</td>
<td>739 (8.8)</td>
</tr>
<tr>
<td></td>
<td>Unadjusted OR (95% CI)</td>
<td>1.00 (reference)</td>
<td>1.88 (1.62–2.18)</td>
</tr>
<tr>
<td></td>
<td>Adjusted OR (95% CI)</td>
<td>1.00 (reference)</td>
<td>1.67 (1.44–1.95)</td>
</tr>
</tbody>
</table>
# Hazard Ratios for Recurrence

<table>
<thead>
<tr>
<th></th>
<th>Clindamycin</th>
<th>Trimethoprim-Sulfamethoxazole</th>
<th>β-Lactam</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Drainage</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First recurrences, n (%)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>280 (12.3)</td>
<td>359 (16.3)</td>
<td>355 (18.4)</td>
</tr>
<tr>
<td>Follow-up period, person-years</td>
<td>1619</td>
<td>1329</td>
<td>1415</td>
</tr>
<tr>
<td>Events, No. per 1000 person-years</td>
<td>173.0</td>
<td>270.1</td>
<td>250.9</td>
</tr>
<tr>
<td>Unadjusted HR (95% CI)</td>
<td>1.00 (reference)</td>
<td>1.51 (1.29–1.77)</td>
<td>1.47 (1.26–1.72)</td>
</tr>
<tr>
<td>Adjusted HR (95% CI)</td>
<td>1.00 (reference)</td>
<td>1.26 (1.06–1.49)</td>
<td>1.42 (1.19–1.69)</td>
</tr>
<tr>
<td><strong>No drainage</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First recurrences, n (%)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>610 (11.8)</td>
<td>1272 (15.1)</td>
<td>3554 (12.9)</td>
</tr>
<tr>
<td>Follow-up period, person-years</td>
<td>3736</td>
<td>5136</td>
<td>21 015</td>
</tr>
<tr>
<td>Events, No. per 1000 person-years</td>
<td>163.3</td>
<td>247.7</td>
<td>169.1</td>
</tr>
<tr>
<td>Unadjusted HR (95% CI)</td>
<td>1.00 (reference)</td>
<td>1.46 (1.32–1.60)</td>
<td>1.06 (0.97–1.15)</td>
</tr>
<tr>
<td>Adjusted HR (95% CI)</td>
<td>1.00 (reference)</td>
<td>1.30 (1.18–1.44)</td>
<td>1.08 (0.99–1.18)</td>
</tr>
</tbody>
</table>
NIH-DMID 07-0051

• Randomized trial of clindamycin vs. TMP/SMX in children and adults (preliminary data here from abstract; part of these data published in March of this year by Miller et al, NEJM 372: 1093, 2015)

• Primary outcome
  – Clinical cure at end of therapy (EOT) and test of cure (TOC)
  – Rate of recurrence at one month follow-up
Demographics and Microbiology

- 524 subjects enrolled in large abscess arm
  - 264 received clindamycin
  - 260 received TMP/SMX

- Mean age 27.1 years
  - 369 adults and 155 children

- 53% of subjects were African-American, 40% Caucasian

- MRSA found in 34%, MSSA in 8%, CoNS in 7%, and 44% had no cultures (cellulitis)
## Efficacy at Test of Cure (TOC) (Evaluable Population)

<table>
<thead>
<tr>
<th></th>
<th>Clindamycin</th>
<th>TMP/SMX</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Efficacy at Test of Cure (Evaluable Population)</strong></td>
<td>N=238</td>
<td>N=229</td>
</tr>
<tr>
<td>Clinical Cure (n, %)</td>
<td>212 (89.1%)</td>
<td>202 (88.2%)</td>
</tr>
<tr>
<td>95% CI</td>
<td>84.8 – 93.4%</td>
<td>83.7 – 92.7%</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th></th>
<th>Clindamycin</th>
<th>TMP/SMX</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Efficacy at Test of Cure (Intent-to-Treat)</strong></td>
<td>N=264</td>
<td>N=260</td>
</tr>
<tr>
<td>Clinical Cure (n, %)</td>
<td>212 (80.3%)</td>
<td>202 (77.7%)</td>
</tr>
<tr>
<td>95% CI</td>
<td>75.2 – 85.4%</td>
<td>72.3 – 83.1%</td>
</tr>
</tbody>
</table>

Miller et al.
# Effect of Compliance on Efficacy

<table>
<thead>
<tr>
<th>Compliance</th>
<th>Clindamycin</th>
<th>TMP/SMX</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% compliant</td>
<td>94.2%</td>
<td>95.4%</td>
</tr>
<tr>
<td>75-100% compliant</td>
<td>92.3%</td>
<td>88.7%</td>
</tr>
<tr>
<td>&lt;75% compliant*</td>
<td>56.3%</td>
<td>41.7%</td>
</tr>
</tbody>
</table>

*p<0.001

Miller et al.
Recurrent Infections (1 mo)

<table>
<thead>
<tr>
<th></th>
<th>Clindamycin</th>
<th>TMP/SMX</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>212</td>
<td>202</td>
</tr>
<tr>
<td>Infection free at OMFU (n,%)</td>
<td>193 (91%)</td>
<td>171 (84.7%)</td>
</tr>
<tr>
<td>95% CI</td>
<td>87.0 – 95.1%</td>
<td>79.4% - 89.9%</td>
</tr>
</tbody>
</table>

\[ p=0.0507 \, (Fisher) \]
\[ p=0.0322 \, (Pearson \, chi-square) \]

*Data are limited to those who were deemed clinical cures at TOC visit*

Miller et al.
Clinical Results

• No differences in cure rates between clindamycin and TMP/SMX
  – Can cellulitis (usually caused by *S. pyogenes*) be adequately treated with TMP/SMX ?

• Compliance rates <75% were associated with higher failure rates
  – Implication is that drugs with difficult tolerability may affect cure rates
  – Also implies that antibiotics may be appropriate for large abscesses and cellulitis

• Recurrence rates* were higher in children (at one month) with TMP/SMX than with clindamycin
  
  *these data not in the NEJM paper
Recurrent MRSA SSTIs

- Furunculosis ("boils"):  
  - Most-reported manifestation of CA-MRSA infection  
  - Furuncle = deep staphylococcal folliculitis  
- Other manifestations: impetigo, pustulosis, cellulitis, locally invasive abscesses  
- Bacteremia can occur; septic shock and toxic shock-like syndrome have been reported  
- Tendency to recur is well recognized  
  - Kaplan: “Recurrent SSTIs occur . . . in up to 50% of patients”  
  - 20-30% recurrence within 3 months in one study

Household Versus Individual Approaches to Eradication of Community-Associated Staphylococcus aureus in Children: A Randomized Trial

Stephanie A. Fritz,1 Patrick G. Hogan,1 Genevieve Hayek,1 Kimberly A. Eisenstein,1 Marcela Rodriguez,1 Emma K. Epplin,1 Jane Garbutt,1,2 and Victoria J. Fraser1

Departments of 1Pediatrics and 2Medicine, Washington University School of Medicine, St Louis, Missouri

Randomized Trial of “Bleach Baths” Plus Routine Hygienic Measures vs Routine Hygienic Measures Alone for Prevention of Recurrent Infections

Sheldon L. Kaplan,1,3 Andrea Forbes,1,3 Wendy A. Hammerman,1,3 Linda Lamberth,3 Kristina G. Hulten,1,3 Charles G. Minard,2 and Edward O. Mason1,3

1Department of Pediatrics, and 2The Dan L. Duncan Institute for Clinical and Translational Research, Baylor College of Medicine; and 3Texas Children’s Hospital, Houston
“Bleach baths”

- Hypochlorite effectively kills MRSA isolates; maximal killing occurs after 5 minutes at concentration of 2.5 microliters/mL.
- Bleach (e.g., in Dakin’s solution [0.025% bleach]) is used in hospitals as a wound disinfectant; kills *S. aureus* at concentrations as low as 0.005%.
- In children with atopic dermatitis, bathing in dilute bleach baths (0.5 cup of 6% bleach in a 40-gallon bathtub) for 5-10 minutes twice weekly for 3 months:
  - was well tolerated by patients
  - decreased patients’ eczema severity scores, compared to placebo.
- **However**: no study has confirmed that bleach baths significantly reduce the frequency of *S. aureus* SSTIs.

Bleach baths alone not effective: RCT

• 987 children with suspected *S. aureus* SSTI or invasive infection, randomized to receive:
  – Bleach baths (5 mL/gallon bathwater) x 15 min twice weekly + hygienic measures, vs.
  – Hygienic measures alone
• Bleach baths were well tolerated; no serious adverse events reported
• Rates of recurrent infections: 17% for bleach bath group vs. 21% for control group (*P*=0.15)

Household Decolonization is More Effective than Index Case

• 183 pediatric cases
  – Randomized to either index-case decolonization or household group decolonization
  – Regimen was education, mupirocin BID x 5 days, and chlorhexidine body washes QD x 5 days
  – Follow-up ascertained at 1, 3, 6, and 12 months
Household decolonization: RCT

• 183 children with skin abscesses and *S. aureus* colonization, randomized to decolonization of the case alone (index group) or of all household members (household group)

• 5-day treatment regimen: hygiene education, twice-daily intranasal mupirocin, and daily chlorhexidine body washes.

• Eradication of colonization  
  1m  12m
  – Index group: 50% 54%
  – Household group: 51% 66%

• Recurrent SSTI rates  
  1m  6m*  12m*
  – Index group: 26% 61% 72%
  – Household group: 15% 38% 52%

• SSTIs in household contacts  
  1m*  6m*  12m
  – Index group: 7% 16% 22%
  – Household group: 2% 9% 16%

*P<0.05

Preventive educational messages

- Wash hands frequently, using soap and water
- Use waterless hand sanitizers
- Keep fingernails clean and cut short
- Keep cuts and abrasions clean and dry
- Wash towels, washcloths, underwear, sleepwear and bedsheets frequently
- Don’t share personal items such as razors, soap bars, washcloths, etc.
- Bathe or shower regularly
- Focus environmental cleaning efforts on high-touch surfaces that may contact bare skin or uncovered infections

*Consultant* 2008;48:1031; *Clin Infect Dis* 2011;52:1
Immunologic evaluation?

• Concern: phagocyte disorders (e.g., CGD)
• Workup NOT necessary in most children
• Consider evaluation if:
  – Recurrent invasive S. aureus infection
  – Deep organ (e.g., liver) abscess
  – Inadequate response to appropriate therapy
  – Other signs of immunodeficiency (e.g., growth failure, chronic diarrhea)
• High incidence in HIV+ adults