Prevention of MRSA Infections

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Research support: Clorox, GOJO, Pfizer, Merck, PDI, Avery Dennison
Objectives

- Understand routes of MRSA transmission
- Review current approaches for prevention of MRSA infection
- Appreciate limitations of infection control strategies for MRSA
Pathogens often coexist

Week of hospitalization

Donskey CJ. Clin Infect Dis 2004;39:219
Transmission of healthcare-associated pathogens

Colonized or Infected Patient → Environment → Susceptible Patient
Contamination of hands with MRSA after contact with:

Patient

Environment

Basic infection control practices

- Chlorhexidine bathing
- Hand hygiene, gloves, gowns
- Colonized or Infected Patient
- Susceptible Patient
- Environmental Cleaning
- Decolonization

Environment
Transfer of MRSA to gloves and gowns, by type of care

1544 observations from 94 residents

Pineles L. AJIC 2017; Blanco N. Antimicrob Agents Chemother 2017
Transmission-based precautions based on risk factors or activities

- Focus control measures on nursing home residents with indwelling devices\(^1\)
  - 23% reduction in the prevalence density of MDROs

- Precautions based on risk for contamination of personnel with care activities\(^2-4\)
  - High-risk – wound care, hygiene assistance, changing linens
  - Low-risk - assistance with medications or feeding

Contamination of skin and clothing during PPE removal

Suboptimal gown design

Exposed glove-gown interface

One size does not fit all

Improved design

Standard Gown (blue)  Elastic band for snug fit at wrist
Small thumb hole for snug fit and reduced skin exposure
Increased coverage of palm

Alternative Design Gown (yellow)

Hajar Z. A Crossover Trial Comparing Contamination of Personnel During Removal of a Standard Gown versus a Modified Gown with Increased Skin Coverage at the Hands and Wrists. ICHE in press.
Current approaches may miss important sources of transmission

Stethoscope print after exam of MRSA patient

Vajrevelu R. Evaluation of stethoscopes as vectors of C. difficile and MRSA. ICHE 2012;33:96-8
Basic infection control practices:

Environmental cleaning

Colonized or Infected Patient → Environment → Susceptible Patient

Environmental Cleaning

X

X

Environment
## Cleaning interventions associated with reductions in MRSA

<table>
<thead>
<tr>
<th>Ref</th>
<th>Setting</th>
<th>Intervention</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10 ICUs</td>
<td>Feedback using fluorescent markers, bucket cleaning</td>
<td>↓ acquisition of MRSA and VRE</td>
</tr>
<tr>
<td>2</td>
<td>Surgical ward</td>
<td>Increased cleaning hours/wk including shared equipment and dust</td>
<td>↓ environmental contamination (11% to 0.7%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>↓ MRSA acquisition</td>
</tr>
<tr>
<td>3</td>
<td>2 surgical wards</td>
<td>1 additional cleaner; 6 month cross-over design</td>
<td>↓ microbial contamination 33%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No decrease environmental MRSA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>↓ MRSA infections 27%</td>
</tr>
<tr>
<td>4</td>
<td>2 ICUs at 2 hospitals</td>
<td>Randomized crossover trial Enhanced daily disinfection (microfiber cloths/copper biocide)</td>
<td>↓ MRSA contamination in environment (15% vs 9%) and physician hands (3% vs 0.7%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No decrease in MRSA acquisition</td>
</tr>
</tbody>
</table>

Contamination of equipment with MRSA during procedures in MRSA rooms

Alhmidi H. Shedding of MRSA by colonized patients during procedures and patient care activities. ICHE 2019;40:328-32
Spores on wheels: Movement of wheelchairs within a hospital and LTCF

From floor to socks and shoes

MRSA sock print

MRSA shoe print

High-touch surfaces are often in contact with the floor

Deshpande A, et al. Are hospital floors an underappreciated reservoir for transmission of health care-associated pathogens? Am J Infect Control 2017;45:336-8 (41% of rooms surveyed had 1 or more high-touch objects in contact with the floor; contact with objects on the floor resulted in hand contamination)
Cleaning and disinfection can reduce floor contamination

Floor cleaning: a cleaner/disinfectant was used with multiple disposable mop heads used per room

Basic infection control practices: chlorhexidine bathing (source control)

Chlorhexidine bathing

Colonized or Infected Patient

Susceptible Patient

Environment
Chlorhexidine

- Cationic biguanide - alters membrane integrity
- Broad-spectrum antimicrobial activity
- Persistent activity on skin
- Potential negatives
  - Emergence of resistance
  - Occasional contact dermatitis, rare anaphylaxis and hypersensitivity reactions
- Guidelines recommend daily ICU CHG bathing

Effect of chlorhexidine bathing on VRE contamination and acquisition

- Decreased skin contamination:
  - 47% vs 94%
  - 2.5 log reduction on inguinal skin

- Decreased hand contamination:
  - 56% vs 37% in VRE rooms
  - 16% vs 8% in common areas

- Decreased environmental contamination:
  - 34% vs 11%

- Decreased VRE acquisition:
  - 20% vs 8%

Vernon MO. CHG to cleanse patients in a medical ICU: Effectiveness of source control to reduce the bioburden of VRE. Arch Int Med 2006;166:306-12
Routine chlorhexidine bathing

- 15 quasi-experimental, ward-level cross-over, or stepped wedge studies
  - 10 in ICUs and 5 outside the ICU
  - 13 of 15 (87%) - significant reduction in colonization or infection with 1 or more pathogens
- 5 randomized trials in ICUs
  - 3 of 5 (60%) - significant reductions in infections (bloodstream infections) or MDRO acquisition

Technical difficulty

Daily CHG bathing?
Colorimetric assay for chlorhexidine

Concentrations of chlorhexidine on skin of ICU patients prescribed daily bathing

Cleveland VA Medical Center chlorhexidine bathing

- CHG bathing
  - ICU patients
  - Patients with central lines outside the ICU
  - Surgical patients for 4 days postop while in the hospital
- Intermittent monitoring of compliance by assessing presence of CHG on skin
Another form of source control: Patient hand hygiene (and bathing)

- Hands of patients often contaminated with pathogens
- Patient hand hygiene occurs infrequently
- Interventions can increase patient hand hygiene
  - Education, personnel facilitate, access to hand hygiene products

Moist towelettes provided on meal trays

O’Donnell M, et al. Sustained increase in resident meal time hand hygiene through an interdisciplinary intervention engaging LTCF residents and staff. AJIC 2015;43:162-4
Could patient hand hygiene be helpful in preventing MRSA infections?

- 250-bed community hospital
- Intervention: patient and visitor hand hygiene facilitated by dedicated personnel
- 51% decrease in nosocomial MRSA infections
- Conclusion: systematic hand hygiene of patients and relatives inexpensive and effective for prevention of MRSA

Basic infection control practices: decolonization

Colonized or Infected Patient → Environment → Susceptible Patient

Decolonization
**S. aureus carriage is common**

1482 admissions to Cleveland VA screened for nasal *S. aureus*

- 1153 (78%) negative
- 92 (6%) MRSA positive*
- 237 (16%) MSSA positive

*Additional screening of other sites increases number detected by one-third over nares alone.

Kanwar A. Impact of Antibiotic Treatment on the Burden of Nasal *S. aureus* among Hospitalized Patients. Antimicrob Agents Chemother 2018;62(10); McKinnell JA. Quantifying the impact of extra-nasal testing body sites for MRSA colonization at the time of hospital or ICU admission. ICHE 2013;34:161-70.
Pre-op nasal MRSA screening misses some post-op *S. aureus* infections

**Clean Surgeries at Cleveland VA**

5528 Cases

**Post-Operative *S. aureus* Infections**

37 (0.7%)

**MRSA**

20*

**MSSA**

17

*Only 40% of patients with post-op MRSA infection had a positive pre-op nasal screen

Ibrahim A, et al. SHEA Meeting 2010
Patient Example: 62 year old man with Peripheral Vascular Disease

Nov 7th
Fem-Peroneal Bypass

Nov 20th, Incision & Drainage
MRSA (+) Wound Culture

Nov 6th, Admission:
Nasal MRSA (-)

Nov 8th Post-Op:
Nasal MRSA (-)

Nov 10th Discharge:
Nasal MRSA (-)

Nov 20th Readmission:
Nasal MRSA (-)

Nov 23rd Discharge:
Nasal MRSA (-)
Post-op *S. aureus* infections can be prevented by decolonization of carriers

- Randomized trial: screening and decolonization of *S. aureus* carriers (88% surgery patients)
- *S. aureus* infections: 3.4% in mupirocin/CHG group versus 7.7% in controls
- Deep SSIs reduced 79%

Decolonization to prevent *S. aureus* SSIs

Mupirocin ± CHG to reduce *S. aureus* SSIs after cardiac or orthopedic surgery

- **17 studies**
- **Overall – 59% reduction in infections**
- **Effective when only *S. aureus* carriers or all patients decolonized**

Guidelines versus current practice at the Cleveland VAMC

- **Guidelines:** Screen for *S. aureus* (MSSA and MRSA) and decolonize carriers undergoing high-risk procedures
  - (moderate quality evidence)
- **Cleveland VAMC:** Mupirocin and CHG decolonization for all high-risk surgery patients (CT, Orthopedic, Vascular)

Impact of chlorhexidine bathing plus mupirocin for MRSA carriers in general medical and surgical units

- Cluster-randomized trial in 53 hospitals
- No difference overall
- Subset of patients with medical devices (central venous and midline catheters, lumbar drains)
  - Significant reduction in MRSA and VRE clinical cultures (37%) and all-cause bacteremia (32%)

MRSA decolonization to reduce postdischarge infection risk among MRSA carriers

- Randomized trial of hygiene education vs education plus CHG and mupirocin decolonization
- Decolonization group: 30% reduction in MRSA infections (6% vs 9%)
- 11% of participants had been discharged to nursing homes

Huang SS. Decolonization to reduce postdischarge infection risk among MRSA carriers. NEJM 2019:380:638-50
Chlorhexidine and mupirocin susceptibility of MRSA from nursing home residents

- 26 nursing homes in Orange County, CA
- All isolates had chlorhexidine MIC ≤4
- Mupirocin resistance
  - 12% overall with 9% high-level resistance
  - 0% to 31% resistance for individual facilities
- Alternatives to mupirocin are needed
  - Nursing home trial using povidone iodine

McDanel JS. Antimicrob Agents Chemother 2013;57:552-8
Are alternatives to mupirocin effective in reducing nasal *S. aureus*?

**Nozin nasal antiseptic**

- **Active ingredient:** ethanol
- **1** study showing reduction in MRSA in healthcare workers
- **1** before-after study showing a reduction in surgical site infections
- Aggressively advertised

Steed LL. Reduction of nasal *S. aureus* carriage in health care professionals by treatment with a nonantibiotic, alcohol-based nasal antiseptic. AJIC 2014;42:841-6; Mullen A. Perioperative participation of orthopedic patients and surgical staff in a nasal decolonization intervention to reduce *Staphylococcus* spp. surgical site infections. AJIC 2017;45:554-6.
Efficacy of one-time application of an alcohol sanitizer in reducing nasal MRSA

Efficacy of triple-dose application of an alcohol sanitizer in reducing nasal MRSA

Efficacy of one-time application of a povidone iodine nasal sanitizer in reducing nasal MRSA

Summary

- Colonized or Infected Patient
- Susceptible Patient
- Environment
- Hand hygiene, gloves, gowns
- Chlorhexidine bathing
- Decolonization
- Environmental Cleaning
Effect of a cleaning intervention on risk of acquiring MRSA and VRE

- Before and after study
- 10 ICUs
- Enhanced cleaning intervention = targeted feedback, education, bucket cleaning
- Reduced acquisition of:
  - MRSA: 3% vs 1.5% acquisition  \( P<0.001 \)
  - VRE: 3% vs 2.2% acquisition  \( P<0.001 \)

Impact of an environmental cleaning intervention in the ICU

<table>
<thead>
<tr>
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<th>Baseline Period</th>
<th>Intervention Period</th>
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<tbody>
<tr>
<td>Marker removal</td>
<td>44%</td>
<td>71%</td>
</tr>
<tr>
<td>% rooms with ≥1 positive culture for MRSA or VRE</td>
<td>45%</td>
<td>27%</td>
</tr>
<tr>
<td>Risk MRSA acquisition</td>
<td>--</td>
<td>Decrease 49%</td>
</tr>
<tr>
<td>Risk VRE acquisition</td>
<td>--</td>
<td>Decrease 29%</td>
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MRSA cleaning intervention

- MRSA outbreak on a surgical ward
- Intervention: ward closure and cleaning followed by enhanced cleaning (increased housekeeper time by 57 hours/week)
- Decrease in prevalence of MRSA environmental contamination (10.7% to 0.7%)
- Decrease in MRSA acquisition (30 versus 3 acquisitions in 6 months before vs after the intervention)

Impact of UV-C radiation devices on healthcare-associated infections

- Multiple quasi-experimental studies have reported reductions in CDI and other HAIs with UV-C 1-8
- Cluster randomized, multicenter, crossover study 9
  - No decrease in CDI for bleach versus bleach plus UV
  - Significant reduction in targeted MDROs (MRSA, VRE, Acinetobacter, C. difficile) when UV added to a quaternary ammonium disinfectant
- Systematic review: UV-C reduced CDI and VRE 8