Optimizing Contact Precautions to Curb the Spread of Antibiotic-resistant Bacteria in Hospitals: A Multicenter Cohort Study to Identify Patient Characteristics and Healthcare Personnel Interactions Associated With Transmission of Methicillin-resistant *Staphylococcus aureus*

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Background

- 100’000 hospitalizations due to MRSA-infections
- Antibiotic-resistant bacteria on gloves and gowns of healthcare personnel (HCP) (acquisition rates of MRSA 17-20%)
- Risk factors for transmissions were investigated
- No data on relationship between nasal MRSA burden and MRSA transmission
- Are some patients more likely to transmit antibiotic-resistant bacteria?
- Private rooms and contact precautions for MRSA colonized patients
- Struggle with the decision of if and how to use contact precautions
Aim of the study

• To understand which factors lead to MRSA transmission from patient to HCP
  • Patient characteristics
  • Patient care
  • Environmental interactions
  • HCP characteristics

• Association between the type of HCP, contact with patient or environment and specific activities performed and the contamination of gloves or gown

• Association between bacterial burden and contamination rates
Study Design and Participants

• Prospective multicenter cohort study in 4 hospitals (2 Baltimore, 1 Torrance, 1 New York)
• January 2016 - August 2018 MRSA-colonized patients on ICU
• May 2017 - August 2018 collection of patient samples to assess bacterial burden
• Eligible patients had a surveillance or clinical culture positive for MRSA within 7 days of enrollment.
Data Collection

• 10 HCP per patient were observed and cultures from gloves/gown taken
• Interactions were categorized into 2 domains:
  • Interactions with patient domain
  • Interactions with environmental domain
• Clinical patient characteristics were reported by nursing stuff at time of observation
• Following patent care, but prior to doffing gloves and gown of each HCP observed were sampled
Sampling technique

https://www.medicalcorner24.ch/hygiene/einmalhandschuhe-einweghandschuhe.html

https://www.weita.ch/de/Hygienebekleidung/Einwegmaentel-und-Einwegschuerzen.html
Statistical Analyses

• Patient bacterial burden: $\log_{10} \text{CFU/ml oder CFU/cm}^2$

• Associations with HCP glove or gown contamination:
  • HCP type
  • Patient or environmental domain
  • Specific patient care interactions
  • Patient bacterial burden

• Potential confounders: HCP type and time spent in a room
Patient and HCP Risk Factors

- 402 patients with MRSA
- 3982 healthcare worker-patient interactions observed
- 89% had at least 1 clinical characteristic
- Glove contamination: 14.3% (570/3982)
- Gown contamination: 5.9% (233/3982)
- Overall contamination rate 16.2%
- Median 8 min in patient’s room

| Table 1. Description of Enrolled Patients With Methicillin-resistant Staphylococcus aureus (N = 402) |
| Study Site                          | n  (%) |
| Maryland, hospital A                | 263 (65.4) |
| Maryland, hospital B                | 42 (10.4) |
| California                          | 53 (13.2) |
| New York                            | 44 (10.9) |

| Clinical characteristic     | n  (%) |
| Diarrhea                    | 95 (23.6) |
| Surgical drain              | 76 (18.9) |
| Rectal tube                 | 65 (16.2) |
| Chest tube                  | 31 (7.7)  |
Contamination according to Healthcare Personnel Type

Table 2. Adjusted Association Between Healthcare Personnel Type and Contamination of Gloves or Gowns With Methicillin-resistant *Staphylococcus aureus*

<table>
<thead>
<tr>
<th>Type of Healthcare Personnel (N = 3982)</th>
<th>Number of Gloves or Gowns With MRSA/Number of Observations (% Gloves or Gowns With MRSA)</th>
<th>Odds Ratio (95% Confidence Interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental services</td>
<td>13/204 (6.4)</td>
<td>0.98 (0.46, 2.09)</td>
</tr>
<tr>
<td>Other&lt;sup&gt;a&lt;/sup&gt;</td>
<td>16/247 (6.5)</td>
<td>Ref</td>
</tr>
</tbody>
</table>

Adjusted for time spent in the patient’s room.

<sup>a</sup>Includes social workers, nutritionists, researchers, and similar personnel.

Abbreviation: MRSA, methicillin-resistant *Staphylococcus aureus.*
Contamination according to Domain

Table 3. Adjusted Association Between Patient and Environmental Domains and Contamination of Gloves or Gowns With Methicillin-resistant *Staphylococcus aureus*

<table>
<thead>
<tr>
<th>Domain Touched (N = 3982)</th>
<th>Number of Gloves or Gowns With MRSA/Number of Observations (% Gloves or Gowns With MRSA)</th>
<th>Odds Ratio (95% Confidence Interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contamination of gloves or gowns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environment only</td>
<td>45/620 (7.3)</td>
<td>1.13 (0.43, 3.00)</td>
</tr>
<tr>
<td>Nothing</td>
<td>5/88 (5.7)</td>
<td>Ref</td>
</tr>
<tr>
<td>Contamination of gowns only</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environment only</td>
<td>9/619 (1.5)</td>
<td>0.66 (0.13, 3.19)</td>
</tr>
<tr>
<td>Nothing</td>
<td>2/88 (2.3)</td>
<td>Ref</td>
</tr>
</tbody>
</table>

Adjusted for healthcare personnel (HCP) type and time spent in the patient's room.

*Includes interactions where the HCP touched the patient only as well as interactions where the HCP touched both the patient and the environment in the same interaction.*

Abbreviation: MRSA, methicillin-resistant *Staphylococcus aureus*
Contamination according to patient care interaction

**Multivariate model:**
Touching endotracheal tube, touching the bedding and bathing the patients are independent predictors for glove or gown contamination.

- Endotracheal Tube: OR 1.97
- Bathing the patient: OR 1.69
- Bedding: OR 1.58
- Wound care: OR 1.57
- Touching bedrail: OR 1.44
- Touching catheter: OR 1.39
- Phisical exam: OR 1.27
- Intravenous tubing: OR 1.22
Contamination by touching the environment
MRSA Bacterial Burden

- Cultures from 101 patients obtained
- Median bacterial burden in the nares 445 CFU/ml
  - in the nares: 59 patients (58%) >0 CFU/ml
    - 10% increase for each log_{10} bacterial burden
  - Perianal: 23 patients (24%) >0 CFU/ml
    - 28% increase for each log_{10} bacterial burden
  - Chest: 25 patients (25%) >0 CFU/ml
    - 25% increase for each log_{10} bacterial burden

Table 4. Association Between Methicillin-resistant *Staphylococcus aureus* (MRSA) Bacterial Burden and Contamination of Gloves or Gowns With MRSA by Body Site

<table>
<thead>
<tr>
<th>Body Site Sampled</th>
<th>Odds Ratio (95% Confidence Interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior nares (log_{10} CFU/mL)</td>
<td>1.10 (1.04, 1.16)</td>
</tr>
<tr>
<td>Perianal (log_{10} CFU/mL)</td>
<td>1.28 (1.15, 1.43)</td>
</tr>
<tr>
<td>Arm skin (log_{10} CFU/cm²)</td>
<td>1.10 (0.95, 1.28)</td>
</tr>
<tr>
<td>Chest skin (log_{10} CFU/cm²)</td>
<td>1.25 (1.12, 1.40)</td>
</tr>
</tbody>
</table>

Abbreviation: CFU, colony-forming unit.
Discussion

• Contamination of HCP gloves and gowns with MRSA occurs frequently
• If contact precautions are missing, hand hygiene could prevent some transmission, but cannot eradicate MRSA on HCP clothing.
• MRSA acquisition depends on HCP type
• Contamination of gloves and gowns 2 times more likely if the patient is touched
• Data provides additional evidence to support interventions that aim to decrease bacterial burden
Limitations

• No cultures from patient’s environment
• No information regarding quality and timing of room cleaning.
• Culture was not taken from entire surface of gloves and gowns
• High rates of contamination do not necessarily lead to high rates of subsequent patient transmission
• 65% of the sample was enrolled in 1 hospital
• All patients were in the ICU at time of observation. Therefore, findings may not be generalizable to patients in non-ICU areas.
Conclusions

• As the risk of MRSA transmission differs by HCP type and type of patient care interaction, the authors suggest to consider selectively mandating precautions for high-risk activities and HCP.

• Implementation of a risk-stratified approach to contact precautions would need to be implemented carefully as it could be more complicated than current practice.