MRSA Prevention: Are Hand Hygiene Products Effective at Reducing MRSA on the Hands?

Sarah Edmonds, MS¹
Christopher Beausoleil, BS²
David Macinga, PhD¹

¹GOJO Industries, Akron, OH, USA
²BioScience Laboratories, Bozeman, MT, USA

Contact information:
GOJO Industries, Inc.
One GOJO Plaza, Suite 500
Akron, OH 44311
Phone: 800-321-9647

Presented at:
Fifth Decennial International Conference on Healthcare - Associated Infections
March 18-22, 2010, Atlanta, GA
MRSA Prevention: Are Hand Hygiene Products Effective at Reducing MRSA on the Hands?

Abstract

Background: Methicillin-resistant Staphylococcus aureus (MRSA) is an increasingly problematic pathogen in hospitals. The CDC recommends proper hand hygiene for prevention of MRSA, including use of alcohol-based hand sanitizer and/or washing with soap and water. However, minimal data is available on the effectiveness of common hand hygiene products at reducing MRSA on the hands.

Objectives: The primary objective of this study was to evaluate, using in vitro handwash methodology, the effectiveness of three hand hygiene products containing different active ingredients versus MRSA. An additional objective of the study was to assess whether in vivo Time-Kill data are adequate predictors of in vivo product efficacy.

Methods: The test products were commercially available hand hygiene products: an alcohol-based hand sanitizer (ABHS) with 62% ethanol, an antibacterial handwash with 0.3% triclosan (TCS), and an antibacterial handwash with 4% chlorhexidine gluconate (CHG). MRSA ATCC#35591 was the test organism. In vitro Time-Kill experiments were carried out according to ASTM E 2153 guide using a 15-second contact time. A modification of ASTM E 1174-86 was used to evaluate test product efficacy on the hands of human volunteers. Twelve volunteers evaluated each test product (1.5 ml volume) in a cross-over design. Statistical comparison of log reductions (LR) was performed using the Fisher’s LSD Test (p<0.05).

Results: The ABHS achieved complete reduction (26.297 LR) of MRSA when tested with in vitro Time-Kill. The TCS and CHG handwashes produced a 3.11 LR and a 1.22 LR, respectively. By the in vitro method, the ABHS, the TCS handwash, and the CHG handwash produced LR standard deviations of 2.05 0.54, 1.93 ±0.35, and 1.53 ±0.27, respectively. The ABHS and TCS handwash were statistically equivalent, and both were significantly more effective than the CHG handwash.

Conclusions: In vitro test results were predictive of relative efficacies in vivo, but did not correlate with in vivo LRs; therefore, caution should be exercised when interpreting efficacy data for hand hygiene products. When testing using realistic product volumes, the ABHS and TCS handwash proved effective against MRSA, reducing levels on human hands by approximately 99%. The CHG handwash was less effective against MRSA, suggesting that CHG may not be an appropriate hand hygiene option for MRSA, particularly after a single use.

Introduction

MRSA has been a problematic pathogen in hospital environments for over 40 years. MRSA is a leading cause of skin and soft tissue infections and can result in severe infection and death8,9. Prevention of MRSA infections and transmission is an important part of controlling this pathogen in hospitals. Prevention is of increasing importance as new strains of MRSA emerge with various antimicrobial resistance patterns that make infections difficult to treat with antibiotics. Proper hand hygiene is recommended by the CDC for prevention of MRSA transmission10,11. Washing hands with soap and water or use of an alcohol-based hand sanitizer is one of the most important interventions to help prevent the spread of infections12. Multiple studies have shown the effectiveness of increased hand hygiene compliance including use of alcohol-based hand sanitizer for reduction of MRSA transmission13,14. Currently most hand hygiene products are evaluated in vitro, and in vivo are limited due to the difficult nature of conducting in vivo studies with this organism. Exist- ing in vitro MRSA data on the effectiveness of hand hygiene products indicates that the efficacy against MRSA is variable15. In addition, different strains of MRSA have variable susceptibility to biocides, and MRSA ATCC#35591 has intermediate susceptibility to common antimicrobials when compared to several clinical hospital-associated and community-associated MRSA strains16.

The aim of this study was to determine in vitro and in vivo effectiveness of common hand hygiene agents against a representative strain of MRSA. A secondary aim of this study is to determine whether in vivo data are a reasonable predictor of in vitro MRSA efficacy.

Additional Information

For additional information contact: Sarah Edmonds, GOJO Industries, Inc., T 330.255.6743, email: rlm@gojo.com

References:

10. In Vitro MRSA Time-Kill Assay: A challenge suspension of MRSA ATCC#35591 was prepared to achieve a concentration of 10^8 CFU/mL. The initial population was determined by ten-fold dilutions in Butner’s Phosphate Buffer with product neutralized (BBP+). A 1.0 mL aliquot of a challenge suspension containing 10^8 CFU/mL was transferred to a sterile test tube containing 9.9 mL of test article, vortexed thoroughly and exposed for 15 seconds. 1.0 mL was removed and neutralized in 50mL of BBP+ , sterilized diluted at 1:10, and post-plated in duplicate using TSA++. Plates were incubated at 35°C for 48-72 hours, or until sufficient growth was observed. A neutralization study according to ASTM E 1054-02 was conducted to ensure that the neutralizing solution BBP++ was effective. Following incubation, colonies on plates were counted manually. Counts in the range of 30-300 CFU (or those closest to that range) were used in data calculations. To calculate the log reduction, the following equation was used:

\[ \log_{10} \text{Reduction} = \log_{10} \text{Initial Population} - \log_{10} \text{Final Population} \]

Results:

- In vitro Time-Kill Assay (15 Exposure Cycle)

<table>
<thead>
<tr>
<th>Test Product</th>
<th>Log Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>62% Ethanol Gel Hand Sanitizer</td>
<td>&gt;3.00</td>
</tr>
<tr>
<td>0.3% Triclosan Foam Handwash</td>
<td>3.11</td>
</tr>
<tr>
<td>4% CHG Liquid Handwash</td>
<td>1.22</td>
</tr>
</tbody>
</table>

**Log Reduction = Log Initial Population - Log Final Population**

> sign indicates complete kill at the limit of detection

**Materials and Methods: Test Products**

Three commercially available hand hygiene products were assessed in this study. A 62% ethanol gel hand sanitizer (PURELL® Instant Hand Sanitizer, GOJO Industries, Inc., Akron, OH, 44314) and a 4% CHG liquid handwash (Hibiclens Antiseptic / Antimicrobial Skin Cleanser, Medlycke Health Care, Norcross, GA). In Vitro MRSA Time-Kill Assay: A challenge suspension of MRSA ATCC#35591 was prepared to achieve a concentration of 10^8 CFU/mL. The initial population was determined by ten-fold dilutions in Butner’s Phosphate Buffer with product neutralized (BBP+). A 1.0 mL aliquot of a challenge suspension containing 10^8 CFU/mL was transferred to a sterile test tube containing 9.9 mL of test article, vortexed thoroughly and exposed for 15 seconds. 1.0 mL was removed and neutralized in 50mL of BBP+ , sterilized diluted at 1:10, and post-plated in duplicate using TSA++. Plates were incubated at 35°C for 48-72 hours, or until sufficient growth was observed. A neutralization study according to ASTM E 1054-02 was conducted to ensure that the neutralizing solution BBP++ was effective. Following incubation, colonies on plates were counted manually. Counts in the range of 30-300 CFU (or those closest to that range) were used in data calculations. To calculate the log reduction, the following equation was used:

\[ \log_{10} \text{Reduction} = \log_{10} \text{Initial Population} - \log_{10} \text{Final Population} \]

**Conclusions:**

- Using “in vivo” Time-Kill product volumes, the 62% ethanol gel hand sanitizer achieved complete reduction of MRSA by in vivo Time-Kill and a 22 log10 reduction from baseline in the in vivo hand wash study. Therefore, use of alcohol-based hand sanitizers for prevention of MRSA transmission is supported.
- A well-formulated triclosan handwash was equivalent to the 62% ethanol hand sanitizer in the in vivo hand wash study and is therefore an effective option for reduction of MRSA on the hands.
- The 4% CHG liquid handwash was the least effective product tested, with the lowest log reduction in vitro and significantly less efficacy in vivo. Therefore, CHG products may not be appropriate for reducing MRSA on the hands.
- In vivo Time-Kill data was not predictive of in vitro log reductions, and should be interpreted cautiously. However, Time-Kill was useful for predicting the relative product efficacy of hand hygiene products.