Hygiene Strategies to Prevent Methicillin-Resistant Staphylococcus aureus Skin and Soft Tissue Infections: A Cluster-Randomized Controlled Trial Among High-Risk Military Trainees

Michael W. Ellis,1 Carey D. Schlett,2 Eugene V. Millar,3 Kenneth J. Wilkins,3 Katrina B. Crawford,2 Stephanie M. Morrison-Rodriguez,2 Laura A. Pacha,4 Rachel J. Gorwitz,5 Jeffrey B. Lanier,6 and David R. Tribble2

1Department of Medicine and 2Infectious Disease Clinical Research Program, Department of Preventive Medicine and Biometrics, Uniformed Services University of the Health Sciences, 3National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health, Bethesda, Maryland; 4US Army Public Health Command, Army Institute of Public Health, Aberdeen Proving Ground, Maryland; 5Centers for Disease Control and Prevention, Atlanta, and 6Martin Army Community Hospital, Fort Benning, Georgia

Background. Effective measures are needed to prevent methicillin-resistant Staphylococcus aureus (MRSA) skin and soft tissue infections (SSTIs) in high-risk community settings. The study objective was to evaluate the effect of personal hygiene-based strategies on rates of overall SSTI and MRSA SSTI.

Methods. We conducted a prospective, field-based, cluster-randomized trial in US Army Infantry trainees from May 2010 through January 2012. There were 3 study groups with incrementally increased education and hygiene-based interventions: standard (S), enhanced standard (ES), and chlorhexidine (CHG). The primary endpoints were incidence of overall SSTI and MRSA SSTI.

Results. The study included 30,209 trainees constituting 540 platoons (168 S, 192 ES, and 180 CHG). A total of 1,203 (4%) participants developed SSTI, 316 (26%) due to MRSA. The overall SSTI rate was 4.15 (95% confidence interval [CI], 3.77–4.58) per 100 person-cycles. SSTI rates by study group were 3.48 (95% CI, 2.87–4.22) for S, 4.18 (95% CI, 3.56–4.90) for ES, and 4.71 (95% CI, 4.03–5.50) for CHG. The MRSA SSTI rate per 100 person-cycles for all groups was 1.10 (95% CI, .91–1.32). MRSA SSTI rates by study group were 1.0 (95% CI, .70–1.42) for S, 1.29 (95% CI, .98–1.71) for ES, and 0.97 (95% CI, .70–1.36) for CHG.

Conclusions. Personal hygiene and education measures, including once-weekly use of chlorhexidine body wash, did not prevent overall SSTI or MRSA SSTI in a high-risk population of military trainees.

Clinical Trials Registration. NCT01105767.

Keywords. Staphylococcus aureus; methicillin-resistant Staphylococcus aureus (MRSA); skin and soft tissue infection; chlorhexidine; military.

Skin and soft tissue infections (SSTI), especially those caused by methicillin-resistant Staphylococcus aureus (MRSA), have become endemic in congregate populations such as athletic teams, inmates, and military trainees [1–3]. Among military personnel, SSTI rates are highest among recruits [4, 5]. During the first 2 years of military service, SSTI is the leading infectious cause of hospital admission, exceeding those for influenza and pneumonia [6]. At Fort Benning, Georgia, one of the US Army’s largest training bases, nearly 1 in 10 soldiers may develop an SSTI during basic training [4], and the majority of those cultured are MRSA [7, 8]. Indeed, at Fort Benning, annual rates of medically attended
MRSA SSTI as high as 42 per 1000 have been reported, with 4% requiring hospitalization [7, 8].

As an SSTI impairs a recruit’s participation and successful completion of a training program, prevention is essential. In other congregate settings, timely implementation of hygiene-based prevention programs (eg, hand washing, environmental disinfection, education) have stemmed MRSA SSTI outbreaks [1, 3, 9]. Such strategies have also been shown to prevent respiratory and gastrointestinal infections in community settings [10, 11].

The optimal SSTI prevention strategy remains unclear. In a household-based study of children with community-acquired SSTI, a 5-day regimen of hygiene education, intranasal mupirocin, and chlorhexidine body wash prevented recurrence [12]. Two prospective, controlled trials conducted in military settings, one of nasal mupirocin administered to MRSA-colonized trainees [13], and another of chlorhexidine-impregnated body cloths [14], showed no effect. In 2005, a US Marine Corps training center mandated a site-wide, hygiene-based intervention that included weekly use of chlorhexidine body wash by recruits. Retrospective analyses of surveillance data demonstrated significant rates reductions for overall SSTI and MRSA SSTI (30% and 64%, respectively) in the post- vs preintervention period [15].

The apparent success of the prevention strategy among Marine recruits necessitated a follow-up evaluation with a prospective study design. Herein we report the results of a large-scale, field-based, cluster-randomized trial to evaluate the effectiveness of hygiene-based interventions on SSTI in a high-risk military population.

**METHODS**

**Study Design**

We conducted a 3-group, prospective, cluster-randomized trial to evaluate the effectiveness of a hygiene-based strategy against overall SSTI and MRSA SSTI.

**Study Participants and Setting**

The study population was US Army soldiers undergoing 14-week Infantry One Station Unit Training (OSUT) at Fort Benning, Georgia. This population was all male, 17–42 years of age, ethnically diverse, and in good physical condition. OSUT is separated into different phases (weeks) according to training activities. Phase 1 (9 weeks) includes basic tasks such as marching, physical fitness, and marksmanship. Phase 2 (5 weeks) includes advanced infantry training culminating in a week-long field exercise. Trainees arrived individually throughout the study period; however, they were subsequently arranged into companies that comprised 4 platoons (approximately 200/company and 50/platoon). These companies were then assigned to one of the 6 battalions (approximately 6 companies/battalion). Individuals within platoons had minimal interactions with trainees belonging to different companies or battalions. Platoons were led and supervised by a cadre of drill sergeants.

**Interventions**

There were 3 study groups. Each was comprised of 2 battalions of trainees (approximately 10 000 soldiers per group). Study groups were assigned an increasing number of overlapping components, as follows.

**Standard**

Upon arrival, trainees received a preventive medicine briefing augmented with SSTI and MRSA SSTI prevention information and personal hygiene instructions [16]. Trainees seeking medical care for an SSTI received standardized SSTI care (eg, antimicrobial therapy, wound management, patient education) at the Troop Medical Clinic (TMC). High-touch common surfaces within the battalion areas were cleaned with standard Environmental Protection Agency (EPA)–registered disinfectants.

**Enhanced Standard**

For the enhanced standard (ES) group, trainees received the components of the standard group and were instructed to take an additional 10-minute shower with soap and a washcloth every week. They were also issued a first aid kit. Supplemental SSTI education for trainees and drill sergeants was also provided (eg, pocket cards, posters). Drill sergeants received briefings on SSTI and skin inspection/minor wound care.

**Chlorhexidine**

In the chlorhexidine (CHG) group, trainees received the components of the Standard and Enhanced Standard groups and were offered chlorhexidine body wash (4% chlorhexidine gluconate, Hibiclens, Mölnlycke Heath Care, Norcross, Georgia) to use with a washcloth after using their personal soap for the additional once-weekly shower. Trainees were provided with verbal and written/graphic instructions for use.

**Enrollment and Eligibility**

Enrollment began on 7 May 2010 and follow-up was completed on 20 January 2012. All trainees during this period comprised the eligible study population. Trainees underwent a group-based informed consent process. Trainees diagnosed with SSTI at either the TMC or the hospital were eligible. If a trainee agreed to participate, he provided consent and his pertinent SSTI data were abstracted.

**Randomization**

Training battalions were the unit of randomization and platoons were the unit of analysis. Two battalions each were
assigned by computer-generated random numbers to 1 of the 3 study groups. Each platoon received the intervention assigned to its respective battalion at study start.

Outcomes
The primary outcomes were the first episode of SSTI and the first episode MRSA SSTI. Clinical cultures were obtained at the healthcare provider’s discretion. Clinical providers were not informed of randomization assignment.

Definitions
We defined an SSTI case as a trainee presenting to the TMC or admitted to the hospital with one of the following: cellulitis, abscess, folliculitis, impetigo, paronychia, infected blister, or pilonidal cyst. A MRSA SSTI case was defined as an SSTI with a MRSA-positive culture from the corresponding clinical site. We defined a purulent SSTI case as all abscesses, plus any SSTI for which a culture of the lesion was obtained.

Laboratory Methods
Clinical cultures were processed according to standard protocols. Staphylococcus aureus isolates underwent identification and susceptibility testing using Microscan Walk-Away-96 (Dade Behring Inc, Deerfield, Illinois), according to Clinical and Laboratory Standards Institute methods [17]. Additionally, all MRSA isolates underwent typing with pulsed-field gel electrophoresis (PFGE) [18], and polymerase chain reaction for resistance [19] and toxin genes [20]. PFGE findings were resolved and analyzed using BioNumerics (Applied Maths, Austin, Texas). Laboratory personnel were blinded to randomization assignment.

Data Collection
Company and platoon characteristics were obtained from the OSUT command. Research coordinators obtained study data from cases using the electronic health record. We administered questionnaires to determine adherence, SSTI risk factors, and hygiene practices. Anonymous questionnaires were also completed by drill sergeants. We assessed chlorhexidine-related adverse events by capturing data on dermatitis due to soap or detergent (International Classification of Diseases, Ninth Revision codes 692.0 and 693.0). Research coordinators were blinded to randomization assignment.

Sample Size
Based on previous studies in this population [8,13], we estimated an overall SSTI incidence of 2.4% and a MRSA SSTI incidence of 1.2% per training cycle. Assuming an α of .05, the study was designed to detect a 40% relative reduction in MRSA SSTI in the chlorhexidine group with 80% power, assuming each intervention component had an additive effect. The intraclass correlation coefficient was assumed to be 0.01 and we estimated a design effect of 1.49 based on 50 trainees per platoon. Using these assumptions, 9650 trainees (193 platoons) were required in each of the 3 groups.

After study initiation, the command reduced the number of trainees and increased average platoon size, which reduced the overall number of available platoons from 700 to 540. Accounting for the changes in number of platoons and platoon size, and incorporating the observed MRSA SSTI rate in the standard group, the study had a post hoc power of 80% to detect a 50% reduction in the incidence of MRSA SSTI.

Statistical Analysis
Rates were calculated as the number of trainees experiencing a first-episode SSTI or MRSA SSTI per platoon, and were expressed as the number of cases per 100 person-cycles. Person-time estimates were based on numbers of trainees at the start of each training cycle aggregated on a company level and did not account for attrition. Outcomes were analyzed on an intention-to-treat basis. We conducted exploratory analyses of rates stratified by season and training phase. The seasons were defined based on standard calendar year (ie, solstices and equinoxes). The training start date was used in seasonal stratification.

Differences in trainee-level characteristics were assessed using conventional test statistics. We summarized trainee- and unit-level characteristics using counts and proportions for categorical variables, and mean, standard deviations, and ranges for continuous variables. To assess the additive effect of the education- and hygiene-based components on disease rates, a Poisson regression model using a log link generated rate estimates from platoon-level counts. We accommodated for over-dispersion with a scale parameter estimated using Pearson residuals. Intervention components’ effects on rates were assessed using Wald-type tests, with adjusted analyses including additional regression terms, season of training start, and training phase. Analyses were conducted using SAS version 9.3 (SAS Institute, Cary, North Carolina), with model fitting replicated within either Stata version 10 (StataCorp, College Station, Texas) or StatXact v8 (Cytel Inc, Cambridge, Massachusetts).

The Uniformed Services University Infectious Diseases Institutional Review Board approved the investigation.

RESULTS

Participant Characteristics
A total of 30 209 trainees from 135 companies (540 platoons) contributed to the analysis. Study groups were similar (Table 1). Participant attrition was lowest in the chlorhexidine group (11.8%; P = .05). A total of 1203 trainees developed SSTI and consented to participate; of these, 316 (26%) had MRSA SSTI (Figure 1). The proportion who declined participation did not differ between groups (P = .19). Among cases, there were no
differences with regard to age and race/ethnicity between groups (Table 2).

**Outcomes**

**Overall SSTI and MRSA SSTI**

The overall SSTI and MRSA SSTI rate was 4.15 (95% confidence interval [CI], 3.77–4.58) and 1.10 (95% CI, .91–1.32) cases per 100 person-cycles, respectively (Table 3). The overall SSTI rates by study group were 3.48 (95% CI, 2.87–4.22) for S, 4.18 (95% CI, 3.56–4.90) for ES, and 4.71 (95% CI, 4.03–5.50) for CHG. When overall SSTI rates were compared among groups, the CHG:S rate ratio (RR) was significantly increased (RR, 1.35 [1.06–1.73]). MRSA SSTI rates did not differ between groups: 1.0 (95% CI, .70–1.42) for S, 1.29 (95% CI, .98–1.71) for ES, and 0.97 (95% CI, .70–1.36) for CHG.

Overall SSTI rates were highest in summer: 6.69 (95% CI, 5.28–8.47) for S, 9.2 (95% CI, 7.84–10.8) for ES, and 8.78 (95% CI, 7.28–10.58) for CHG (Supplementary Table 1A). When adjusting for season, rates of overall SSTI in spring were significantly lower in the ES group than in the S group (RR, 0.55 [0.33–0.92]). By contrast, overall SSTI rates in the spring were significantly higher in the CHG group (RR, 2.11

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**Figure 1.** Progression of trainees through skin and soft tissue infection prevention trial. Abbreviations: MRSA, methicillin-resistant *Staphylococcus aureus*; SSTI: skin and soft tissue infection.
than in the ES group. MRSA SSTI rates were highest in spring and summer (Supplementary Table 1B). During summer, rates of MRSA SSTI were significantly higher in the ES than in the S group (RR, 2.02 [1.18–3.45]), whereas MRSA SSTI rates were significantly lower in the CHG than in the ES group (RR, 0.54 [0.33–0.87]). To avoid the arbitrary nature of seasonal division, we combined spring and summer as the peak period and fall and winter as the nonpeak period (Supplementary Table 2A and 2B). With this analysis, rates in the CHG and ES groups did not differ significantly (RR, 0.67 [0.43–1.03]).

Overall SSTI and MRSA SSTI rates were highest during phase 1, particularly during summer. Overall SSTI rates during phase 1/summer were 11.19 (95% CI, 8.87–14.12) for S, 13.23 (95% CI, 11.16–15.68) for ES, and 13.87 (95% CI, 11.48–16.76) for CHG (Supplementary Table 3). MRSA SSTI rates during phase 1/summer were 2.4 (95% CI, 1.46–3.93) for S, 4.21 (95% CI, 3.12–5.67) for ES, and 2.81 (95% CI, 1.86–4.26) for CHG (Table 4). When adjusting for phase of training and season, there were no significant differences in rates of MRSA SSTI between study groups by season during phase 1; however, during phase 2/summer, MRSA SSTI rates were lower in the CHG than in the ES group (RR, 0.24 [0.08–0.74]).

Clinical Manifestations

Table 5 displays the clinical diagnoses of cases. Rates of culture-confirmed S. aureus SSTI did not differ between groups. Overall, 85% (550/650) of all cultured SSTI were due to S. aureus (57% MRSA, 43% MSSA). Cellulitis was the most common clinical diagnosis. There were significantly fewer purulent SSTI in the CHG group (P < .01). Additionally, proportions of cellulitis, abscesses, and folliculitis differed significantly among the groups (P < .05). There were no differences among study groups with regard to SSTI body location, with lower extremities being the most common site (62%).

Clinical Outcomes

All SSTI participants were managed in a similar fashion with similar outcomes (Supplementary Table 4). The mean number of days until first SSTI episode was 46.2 (range, 1–101) days. Thirty-five (3%) required hospitalization. Of these, 17 were cultured during admission, 13 (76%) of which yielded MRSA.

Table 2. Characteristics of Skin and Soft Tissue Infection Cases

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Standard</th>
<th>Enhanced Standard</th>
<th>Chlorhexidine</th>
<th>Total</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of SSTI cases</td>
<td>303</td>
<td>439</td>
<td>461</td>
<td>1203</td>
<td></td>
</tr>
<tr>
<td>Age, y, mean (SD)</td>
<td>20.4 (3.1)</td>
<td>20.3 (3.2)</td>
<td>20.3 (2.9)</td>
<td>20.3 (3.0)</td>
<td>.81</td>
</tr>
<tr>
<td>Age range, y</td>
<td>17–37</td>
<td>17–35</td>
<td>17–41</td>
<td>17–41</td>
<td></td>
</tr>
<tr>
<td>Race/ethnicitya</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.47</td>
</tr>
<tr>
<td>White, non-Hispanic</td>
<td>92 (79.6)</td>
<td>167 (81.1)</td>
<td>172 (86.4)</td>
<td>431 (82.6)</td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>13 (11.1)</td>
<td>24 (11.7)</td>
<td>18 (9.0)</td>
<td>55 (10.5)</td>
<td></td>
</tr>
<tr>
<td>Black, non-Hispanic</td>
<td>7 (6.0)</td>
<td>7 (3.4)</td>
<td>4 (2.0)</td>
<td>18 (3.4)</td>
<td></td>
</tr>
<tr>
<td>Other, non-Hispanic</td>
<td>5 (4.3)</td>
<td>8 (3.9)</td>
<td>5 (2.5)</td>
<td>18 (3.4)</td>
<td></td>
</tr>
</tbody>
</table>

Data are presented as No. (%). Abbreviations: SD, standard deviation; SSTI, skin and soft tissue infection.

a Collected on participants (n = 522) who developed an SSTI from 20 April 2011 through 20 January 2012.

Table 3. Number of Cases and Rate of Overall and Methicillin-Resistant Staphylococcus aureus Skin and Soft Tissue Infection by Study Group

<table>
<thead>
<tr>
<th>Study Group</th>
<th>No. of Cases</th>
<th>Rate (95% CI)</th>
<th>Rate Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overall SSTI</td>
<td>MRSA SSTI</td>
<td>Overall SSTI</td>
</tr>
<tr>
<td>Standard</td>
<td>303</td>
<td>86</td>
<td>3.48 (2.87–4.22)</td>
</tr>
<tr>
<td>Enhanced standard</td>
<td>439</td>
<td>135</td>
<td>4.18 (3.56–4.90)</td>
</tr>
<tr>
<td>Chlorhexidine</td>
<td>461</td>
<td>95</td>
<td>4.71 (4.03–5.50)</td>
</tr>
<tr>
<td>Total</td>
<td>1203</td>
<td>316</td>
<td>4.15 (3.77–4.58)</td>
</tr>
</tbody>
</table>

Rates are defined as ≥1 episodes of an SSTI per 100 person-cycles. Abbreviations: CHG, chlorhexidine; CI, confidence interval; ES, enhanced standard; MRSA, methicillin-resistant Staphylococcus aureus; S, standard; SSTI, skin and soft tissue infection.
Almost all (99%) participants received antimicrobial therapy and 67% received work/duty limitations.

**MRSA Isolates**

Of the 382 clinical MRSA isolates collected, 342 (90%) were available for molecular analysis. All but 1 (blood) were from abscesses. USA300 MRSA comprised 99% (337/342) of isolates, and 98% (336/342) were positive for Panton-Valentine leukocidin. MRSA molecular characteristics or antibiotic susceptibility did not differ between groups.

**Risk Factors, Hygiene Practices, and Adherence**

SSTI risk factors, which were assessed in 1030 (86%) of 1203 participants, and hygiene practices and adherence, which were assessed in 3395 participants (11% of total study population), did not significantly differ between groups (data not shown).

Participants reported similar opportunities for the extra weekly shower (78% in ES, and 83% in CHG). In the CHG group, 86% acknowledged having been issued chlorhexidine, 82% reported using it, and 71% used it at least weekly. Of the 268 drill sergeants surveyed, adherence was similar between groups. Approximately 96% of drill sergeants reported that they gave trainees the opportunity for an additional weekly shower and that they inspected trainees’ skin at least once per week (77% reported >1 time/week).

**Adverse Events**

Among participants surveyed, 96% reported no skin irritation with chlorhexidine. There were only 18 documented minor cases of dermatitis due to soap or detergent, only 4 (2%) of which occurred in the chlorhexidine group.

**DISCUSSION**

In a prospective, cluster-randomized trial involving >30,000 high-risk military trainees, hygiene-based strategies did not reduce rates of SSTI or MRSA SSTI. Specifically, we observed no benefit of enhanced education or surveillance beyond basic preventive medicine hygiene measures and education, nor did there appear to be a beneficial effect of weekly chlorhexidine body wash.

These findings are in contrast to a hygiene-based intervention in another military trainee population that also employed weekly use of a chlorhexidine-based body wash [15]. One important difference may be that we did not implement chlorhexidine use on the trainees’ day of arrival. Due to the way trainees were assigned to battalions, and thus study groups, some trainees may not have begun chlorhexidine use until 7 days after arrival. Nevertheless, attributing the observed ineffectiveness to 1 week without chlorhexidine is challenging. The reasons for these differences are likely multifactorial, including inherent

**Table 4. Rate of Methicillin-Resistant Staphylococcus aureus Skin and Soft Tissue Infection Cases by Study Group, Phases of Training, and Season**

<table>
<thead>
<tr>
<th>Training phase 1</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Training phase 2</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Summer</td>
<td>Fall</td>
<td>Winter</td>
<td>Spring</td>
<td>Summer</td>
<td>Fall</td>
<td>Winter</td>
<td>Spring</td>
<td>Rate (95% CI)</td>
</tr>
<tr>
<td></td>
<td>2.4 (1.46–3.93)</td>
<td>0.17 (0.1–2.16)</td>
<td>1.9 (1.66–4.21)</td>
<td>1.98 (1.06–3.68)</td>
<td>2.4 (1.17–5.67)</td>
<td>0.10 (0.05–2.02)</td>
<td>0.5 (0.25–1.32)</td>
<td>0.99 (0.38–2.62)</td>
<td>4.21 (3.12–5.67)</td>
</tr>
<tr>
<td>Training phase 2</td>
<td>ES:S 1.76 (0.99–3.13)</td>
<td>ES:S 6.31 (4.2–9.52)</td>
<td>ES:S 0.27 (0.05–1.41)</td>
<td>ES:S 0.50 (1.16–1.59)</td>
<td>CHG:S 1.17 (0.62–2.24)</td>
<td>CHG:S 7.84 (4.5–13.71)</td>
<td>CHG:S 0.24 (0.05–1.31)</td>
<td>CHG:S 0.84 (0.36–1.94)</td>
<td>CHG:S 0.67 (0.40–1.11)</td>
</tr>
<tr>
<td></td>
<td>CHG:ES 0.67 (0.40–1.11)</td>
<td>CHG:ES 1.24 (0.26–5.97)</td>
<td>CHG:ES 0.92 (0.11–7.46)</td>
<td>CHG:ES 1.66 (0.54–5.12)</td>
<td>CHG:ES 0.24 (0.08–0.74)</td>
<td>CHG:ES 0.83 (0.04–15.9)</td>
<td>CHG:ES 11.9 (0.47–301)</td>
<td>CHG:ES 1.66 (0.54–5.12)</td>
<td></td>
</tr>
</tbody>
</table>

Rates are defined as ≥1 episodes of an skin and soft tissue infection per 100 person-cycles.

Abbreviations: CHG, chlorhexidine; CI, confidence interval; ES, enhanced standard; S, standard.
The etiology of SSTIs is not uniform—not all are caused by *S. aureus* [24–26]. There is biological plausibility that the effectiveness of an intervention is restricted to a particular season and a particular pathogen, as each season poses unique risks and etiologies for SSTI. MRSA SSTI rates are highest during warmer months [7, 8, 27]. Additionally, MRSA appears to have distinctive colonization patterns, with perhaps greater importance of nonnasal sites [28]. Furthermore, besides being the predominant community-associated MRSA strain [29], USA300 MRSA possesses purported virulence factors that may allow it to colonize or persist on fomites [30, 31]. Indeed, USA300 MRSA appears to be adept at spreading between close contacts [32]. Chlorhexidine may have a differential effect on various *S. aureus* strains. In a study by Whitman et al, topical chlorhexidine did not prevent SSTI, but did significantly reduce the acquisition of MRSA USA300 [33].

Our investigation possesses several strengths. First, the clinically determined and culture-confirmed endpoints were rigorous. We limited analysis to first-episode SSTI patients, as those with recurrent SSTI are likely at higher risk for subsequent infection. Second, we benefited from the military healthcare framework and the supervisory structure surrounding trainees. All study participants received care from a single outpatient and hospital system where 1 laboratory processed all clinical specimens, ensuring capture of all study-related data. Last, recognizing that MRSA may be spread via environmental means [34],

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Standard, No. and % (95% CI)</th>
<th>Enhanced Standard, No. and % (95% CI)</th>
<th>Chlorhexidine, No. and % (95% CI)</th>
<th>Total, No. and % (95% CI)</th>
<th>P Value</th>
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<tbody>
<tr>
<td>Overall SSTI</td>
<td>303</td>
<td>439</td>
<td>461</td>
<td>1203</td>
<td>N/A</td>
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<tr>
<td><em>S. aureus</em> SSTI</td>
<td>131/158</td>
<td>224/267</td>
<td>195/225</td>
<td>550/650</td>
<td>.64</td>
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<tr>
<td></td>
<td>82.9 (75.0–88.7)</td>
<td>83.9 (78.1–88.4)</td>
<td>86.7 (80.6–91.0)</td>
<td>84.7 (81.3–87.7)</td>
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<tr>
<td>Purulent SSTI</td>
<td>178</td>
<td>300</td>
<td>252</td>
<td>730</td>
<td>&lt;.01</td>
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<tr>
<td></td>
<td>58.7 (52.3–64.9)</td>
<td>68.3 (63.2–73.1)</td>
<td>54.7 (49.4–59.8)</td>
<td>60.7 (57.5–63.8)</td>
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<tr>
<td>Clinical manifestation&lt;sup&gt;b&lt;/sup&gt;</td>
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<td></td>
<td></td>
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<tr>
<td>Cellulitis</td>
<td>164</td>
<td>195</td>
<td>239</td>
<td>598</td>
<td>.03</td>
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<tr>
<td></td>
<td>54.1 (48.1–60.0)</td>
<td>44.4 (39.6–49.4)</td>
<td>51.8 (47.0–56.7)</td>
<td>49.7 (46.7–52.7)</td>
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<td>Abscesses</td>
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<td>192</td>
<td>167</td>
<td>463</td>
<td>.04</td>
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<td></td>
<td>34.3 (28.5–40.7)</td>
<td>43.7 (38.5–49.1)</td>
<td>36.2 (31.4–41.4)</td>
<td>38.5 (35.4–41.7)</td>
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<tr>
<td>Folliculitis</td>
<td>37</td>
<td>40</td>
<td>72</td>
<td>149</td>
<td>.02</td>
</tr>
<tr>
<td></td>
<td>12.2 (8.8–16.6)</td>
<td>9.1 (6.7–12.4)</td>
<td>15.6 (12.4–19.4)</td>
<td>12.4 (10.6–14.5)</td>
<td></td>
</tr>
<tr>
<td>Impetigo</td>
<td>39</td>
<td>45</td>
<td>37</td>
<td>121</td>
<td>.21</td>
</tr>
<tr>
<td></td>
<td>12.9 (8.9–18.2)</td>
<td>10.3 (7.3–14.3)</td>
<td>8.0 (5.5–11.6)</td>
<td>10.1 (8.1–12.4)</td>
<td></td>
</tr>
<tr>
<td>Infected blister</td>
<td>25</td>
<td>41</td>
<td>49</td>
<td>115</td>
<td>.59</td>
</tr>
<tr>
<td></td>
<td>8.3 (5.5–12.3)</td>
<td>9.3 (6.8–12.7)</td>
<td>10.6 (8.0–14.1)</td>
<td>9.6 (7.9–11.5)</td>
<td></td>
</tr>
<tr>
<td>Paronychia</td>
<td>6</td>
<td>19</td>
<td>13</td>
<td>38</td>
<td>.19</td>
</tr>
<tr>
<td></td>
<td>2.0 (9.4–4.4)</td>
<td>4.3 (2.8–6.7)</td>
<td>2.8 (1.6–4.8)</td>
<td>3.2 (2.3–4.3)</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; N/A, not applicable; SSTI, skin and soft tissue infection.

a Percentages reported are from the model fit to platoon-level data for group comparison.

b Counts are not mutually exclusive as individuals may have had >1 clinical manifestation.
uniform cleaning of surfaces with standard EPA-registered disinfectants was employed [16].

There are limitations to our study. First, due to the necessity to conform to a military training regimen, we were unable to assess individual adherence or adherence over time. Nevertheless, we sampled 10% of the study population and 82% reported using CHG and 71% at least weekly. Our adherence rates are similar to those of other community-based prevention studies [12, 14, 35]. Second, we instructed trainees to use chlorhexidine once weekly and did not employ intranasal mupirocin. More frequent chlorhexidine administration along with mupirocin has been used effectively in community-based strategies [12, 35, 36]. However, in a military training setting, this would have posed significant economic and logistical challenges. Instead, we mirrored the successful program conducted within the Marines and reasoned that chlorhexidine would prevent disease rather than decolonize [15].

The complex epidemiology of SSTI likely involves an interplay of host, pathogen, and environment [31]. Despite our multicomponent prevention strategy, environmental interventions and assessment of their effectiveness pose a separate set of challenges. Interrupting skin-to-fomite or even skin-to-skin transmission may be more important for disease prevention than education and personal hygiene practices [12, 31, 32, 37, 38].

In congregate settings, avoiding physical contact with a person with an SSTI may be difficult if not impossible. The role of environmental reservoirs for MRSA SSTI is unknown.

In summary, enhanced education and personal hygiene measures, including weekly chlorhexidine body wash, did not prevent overall SSTI. Our data suggest that there may be a differential benefit of chlorhexidine against MRSA SSTI during the summer months. Further studies are needed to determine the utility and optimal use of chlorhexidine in SSTI prevention strategies in congregate settings.

**Supplementary Data**

Supplementary materials are available at Clinical Infectious Diseases online (http://cid.oxfordjournals.org). Supplementary materials consist of data provided by the author that are published to benefit the reader. The posted materials are not copyrighted. The contents of all supplementary data are the sole responsibility of the authors. Questions or messages regarding errors should be addressed to the author.

**Notes**

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**Disclaimer.** The views expressed in this paper are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention (CDC).

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**Potential conflicts of interest.** All authors: No reported conflicts. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

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