# Effectiveness and Microbial Contamination of an In-house Alcohol-Based Hand Rub

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***Objectives :*** *To evaluate the effectiveness and contamination of an in-house alcohol-based hand rub in a real clinical setting and to compare its effectiveness in bacterial reduction with that of a commercial product.*
***Material andMethod :*** *Effectiveness of the hand rub in bacterial reduction was compared to a commercial product using the modified antiseptic/disinfectant testing method of European Standard (EN 1500) in 12 volunteers. In-house alcohol-based hand rub in 50 clinical wards were serially collected and cultured to determine contamination.*
***Results :*** *The bacterial reduction factor of the hand rub was comparable to that of the commercial product. There was no organisms grown from serial cultures of the in-house alcohol-based hand rub in use for 28 days.*
***Conclusion :*** *The in-house alcohol-based hand rub was effective and there was no contamination up to 28 days in use.*

***Keywords :*** *Effectiveness, Contamination, Alcohol-based hand rub*

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Nosocomial infection (NI) is one of the most important problems occurring in modern medicine. Rates of nosocomial infection vary from 5%-10% of total admission depending on the efficiency of nosocomial control system in each institute. However, the rate of antibiotic resistance is mounting among organisms causing NI due to constantly increasing antibiotic pressure. Common organisms causing NI are methicillin-resistant *Staphylococcus aureus* (MRSA), *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, members of Enterobacteriaceae and enterococci. There have been reports of clonal spread of multiply resistant organisms implying that cross infections commonly happen, and the most important route of transmission is by the hands of healthcare workers. About 20 to 50 % reduction rate of infection can be accomplished by proper hand hygiene which is the most effective, cheapest, and easiest method for prevention and control of NI[1]. Unfortunately, compliance with hand hygiene practice is very low[2]. Reasons for low compliance include high work load, no time, too few washing sinks, and improperly placed sinks[3-7]. To eliminate such problems, hand hygiene using waterless alcohol-based hand rub has been successfully introduced for clinical use[8]. The alcohol-based hand rub kills organisms effectively and rapidly, therefore its use is widely accepted[7]. However, the cost of imported alcohol-based hand rub is high. This led to the production of a cheaper in-house formula. It is essential to evaluate the effectiveness and safety of the in-house product before endorsing its use in a wide scale. The study was aimed to determine the bacterial reduction property of an in-house alcohol hand rub over time in clinical use and to compare its effectiveness with a commercial product. Bacterial contamination of the in-house alcohol hand rub was also serially studied.

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## Material and Method

Effectiveness of in-house alcohol-based hand rub in bacterial reduction was compared to a commer-

cial product by the test method developed by the European Committee for Standardization (EN 1500)[8]. Twelve volunteer nurses were included. The test bacteria were *Staphylococcus aureus* (4), *Escherichia coli* (4), *Pseudomonas aeruginosa* (2) and *Acinetobacter baumanii* (2). The volunteer's hands were soaked with 20 ml. of $10^7$ CFU/ml. of test organisms for 30 seconds and left to dry in room temperature for 5 minutes. The hands were rubbed with 5 ml. of the in-house alcohol-based hand rub according to normal practice for hand hygiene for 1 minute. The hands then were rinsed with 20 ml. of sterile broth. Bacterial reduction was the difference between the numbers of bacteria in the original test organism solution and those in the broth.

The experiment was repeated using a commercial chlordexidine and alcohol hand rub.

**Table 1.** Effectiveness of in-house alcohol-based hand rub as indicated by the reduction of clinically relevant bacteria on volunteer hands on day one

| Volunteer | Organism | Date of test (Day 0) | | | | |
|---|---|---|---|---|---|---|
| | | Number of organism | | | | Reduction Factor |
| | | Before | | After | | |
| | | CFU/ml | $Log_{10}$ | CFU/ml | $Log_{10}$ | |
| 1 | *S.aureus* ATCC 25923 | $8.0x10^6$ | 6.9 | $7.6x10^2$ | 2.88 | 4.02 |
| 2 | *S.aureus* ATCC 25923 | $5.2x10^6$ | 6.72 | $3.5x10^2$ | 2.54 | 4.18 |
| 3 | *S.aureus* (blood isolate) | $8.7x10^6$ | 6.94 | $2.8x10^2$ | 2.45 | 4.49 |
| 4 | *S.aureus* (blood isolate) | $6.0x10^6$ | 6.78 | $3.2x10^2$ | 2.51 | 4.27 |
| 5 | *E.coli* ATCC 25922 | $8.5x10^6$ | 6.93 | $2.0x10^2$ | 2.3 | 4.63 |
| 6 | *E.coli* ATCC 25922 | $6.8x10^6$ | 6.83 | $2.0x10^1$ | 1.3 | 5.53 |
| 7 | *E.coli* (urine isolate) | $8.6x10^6$ | 6.93 | $5.4x10^2$ | 2.73 | 4.20 |
| 8 | *E.coli* (urine isolate) | $8.3x10^6$ | 6.92 | $1.2x10^2$ | 2.08 | 4.84 |
| 9 | *P.aeruginosa* (1) | $7.9x10^6$ | 6.9 | $1.6x10^2$ | 2.2 | 4.70 |
| 10 | *P.aeruginosa* (2) | $5.6x10^6$ | 6.75 | $2.5x10^2$ | 2.4 | 4.35 |
| 11 | *A.baumannii* (1) | $9.2x10^6$ | 6.96 | $5.6x10^2$ | 2.75 | 4.21 |
| 12 | *A.baumannii* (2) | $7.2x10^6$ | 6.86 | $1.5x10^2$ | 2.18 | 4.68 |
| | | | | Mean±SD | | 4.50±0.41 |
| | | | | Range | | 4.02-5.53 |

**Table 2.** Effectiveness of in-house alcohol-based hand rub as indicated by the reduction of clinically relevant bacteria on volunteer hands on day twenty-eight

| Volunteer | Organism | Date of test (Day 30) | | | | |
|---|---|---|---|---|---|---|
| | | Number of organism | | | | Reduction Factor |
| | | Before | | After | | |
| | | CFU/ml | $Log_{10}$ | CFU/ml | $Log_{10}$ | |
| 1 | *S.aureus* ATCC 25923 | $2.2x10^6$ | 6.34 | $1.2x10^2$ | 2.08 | 4.26 |
| 2 | *S.aureus* ATCC 25923 | $6.5x10^6$ | 6.81 | $6.0x10^2$ | 2.78 | 4.03 |
| 3 | *S.aureus* (blood isolate) | $6.0x10^6$ | 6 | $2.0x10^2$ | 1.3 | 4.7 |
| 4 | *S.aureus* (blood isolate) | $7.6x10^6$ | 6.88 | $2.3x10^2$ | 2.36 | 4.52 |
| 5 | *E.coli* ATCC 25922 | $1.6x10^6$ | 6.2 | $8.0x10^2$ | 1.9 | 4.3 |
| 6 | *E.coli* ATCC 25922 | $2.0x10^6$ | 6.3 | $2.6x10^1$ | 2.41 | 3.89 |
| 7 | *E.coli* (urine isolate) | $1.4x10^6$ | 6.15 | $2.0x10^2$ | 2.3 | 3.85 |
| 8 | *E.coli* (urine isolate) | $1.15x10^6$ | 6.06 | $1.2x10^2$ | 2.48 | 3.58 |
| 9 | *P.aeruginosa* (1) | $6.4x10^6$ | 6.8 | $4.0x10^2$ | 1.6 | 5.2 |
| 10 | *P.aeruginosa* (2) | $5.2x10^6$ | 6.72 | $2.0x10^2$ | 2.3 | 4.42 |
| 11 | *A.baumannii* (1) | $3.6x10^6$ | 6.7 | $6.0x10^2$ | 2.78 | 3.92 |
| 12 | *A.baumannii* (2) | $4.2x10^6$ | 6.62 | $2.2x10^2$ | 2.34 | 4.28 |
| | | | | Mean±SD | | 4.24±0.44 |
| | | | | Range | | 3.58-5.20 |

To determine contamination, 45 patient wards and 5 out-patient clinics were randomly enrolled. Two ml. of alcohol gel in use was collected from 1 container in each ward/clinic on days 1, 3, 5, 7, 14, 21 and 28. The outside surface of the container was swabbed with saline on days 0, 7 and 28. The solutions and swabs were sent for culture.

Each sample of 0.5 ml. of hand rub solution was added to 4.5 ml. of brain heart infusion broth and incubated at $37^0$C and observed for sign of growth of organisms everyday. If there was any sign, and at day 7 in samples without the signs, the broth was sub-cultured on blood agar, incubated at $37^0$C for 48 hours and followed by species identification. The swabs taken from the outer surface of in-house alcohol-based hand rub were cultured on blood and Mc Conkey agar, incubated and the organisms grown were subsequently identified by conventional method.

Descriptive statistics and transformation to log10 were used for data analysis

## Results

Effectiveness in bacterial reduction of the test solutions in 12 volunteers is shown in Tables 1-3. On the first day of use of the in-house alcohol-based hand rub, the reduction factors for each bacteria were all above 4 with a mean$\pm$SD of 4.5$\pm$0.4 (Table 1). The bacterial reduction was slightly decreased to 4.2$\pm$0.4 on day 28 (Table 2). Bacterial reduction was higher by the commercial hand rub which was the mixture of alcohol

**Table 3.** Efficacy of a commercial chlorhexidine plus alcohol hand rub as indicated by the reduction of bacteria on volunteer hands

| Volunteer | Organism | Date of test (Day 0) | | | | Reduction Factor |
|---|---|---|---|---|---|---|
| | | Number of organism | | | | |
| | | Before | | After | | |
| | | CFU/ml | $Log_{10}$ | CFU/ml | $Log_{10}$ | |
| 1 | *S.aureus* ATCC 25923 | $5.5x10^6$ | 6.74 | 0 | 0 | $\geq$6.74 |
| 2 | *S.aureus* ATCC 25923 | $8.2x10^6$ | 6.91 | $1.2x10^2$ | 2.07 | 4.84 |
| 3 | *S.aureus* (blood isolate) | $3.9x10^6$ | 6.59 | 0 | 0 | $\geq$6.59 |
| 4 | *S.aureus* (blood isolate) | $4.3x10^6$ | 6.63 | 0 | 0 | $\geq$6.63 |
| 5 | *E.coli* ATCC 25922 | $2.5x10^6$ | 6.4 | 0 | 0 | $\geq$6.4 |
| 6 | *E.coli* ATCC 25922 | $5.8x10^6$ | 6.76 | 2x10 | 1.3 | 5.46 |
| 7 | *E.coli* (urine isolate) | $1.56x10^6$ | 6.19 | 0 | 0 | $\geq$6.19 |
| 8 | *E.coli* (urine isolate) | $1.14x10^6$ | 6.06 | 0 | 0 | $\geq$6.09 |
| 9 | *P.aeruginosa* (1) | $6.08x10^6$ | 6.78 | 3x10 | 1.48 | 5.3 |
| 10 | *P.aeruginosa* (2) | $8.0x10^6$ | 6.99 | 2x10 | 1.3 | 5.6 |
| 11 | *A.baumannii* (1) | $8.0x10^6$ | 6.9 | 2x10 | 1.3 | 5.6 |
| 12 | *A.baumannii* (2) | $6.3x10^6$ | 6.8 | 0 | 0 | $\geq$6.8 |
| | | | | Mean$\pm$SD | | 6.02$\pm$0.65 |
| | | | | Range | | 4.84-6.8 |

**Table 4.** Frequency of organisms isolated from the surface of the in-house alcohol based hand rub containers

| Organisms | Number of specimens positive for organisms on the bottle's surface | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Day 0 | | Day 7 | | Day 14 | | Day 21 | | Day 28 | | Total | |
| | n=50 | % | n=50 | % | n=50 | % | n=48 | % | n=46 | % | n=244 | % |
| CNS | 16 | 32 | 29 | 58 | 22 | 44 | 23 | 48 | 18 | 39 | 108 | 44 |
| *Bacillus spp.* | 1 | 2 | 3 | 6 | 5 | 10 | 2 | 4 | 3 | 7 | 14 | 6 |
| NF | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 4 | 0 | 0 | 2 | 1 |
| MSSA | 0 | 0 | 0 | 0 | 2 | 4 | 0 | 0 | 0 | 0 | 2 | 1 |
| Fungi | 1 | 2 | 13 | 26 | 6 | 12 | 4 | 8 | 2 | 4 | 26 | 11 |

CNS = coagulase-negative staphylococci
NF = lactose non-fermenter

and chlorhexidine (Table 3).

All 350 samples of alcohol gel taken from 50 patient wards/clinics taken serially upto 28 days in-use were culture negative. The contamination of the surface of the containers is presented in Table 4. The commonest contaminant was coagulase-negative staphylococci (44%) followed by fungi (11%) and bacillus spp. (6%). They were environmental organisms. However, non-fermentative gram-negative bacilli and methicillin sensitive *Staphylococcus aureus* were found on 2 containers each.

## Discussion

Hand hygiene has been shown to be the most effective, cheapest and simplest method to reduce nosocomial infection[1]. Low compliance to hand hygiene guidelines prompted health care propessional to seek methods to increase handwashing practices in healthcare workers. Waterless handwash with alcohol-based preparation is convenient, effective and safe and has been proved to increase hand hygiene compliance[9-12]. Commercial alcohol-based hand rubs were considered expensive in developing countries. Attempts have been made to produce in-house alcohol-based solutions. The product of Siriraj Hospital was acceptable even though it did not contain a good smell as in the commercial ones. The present study proved that the in-house alcohol-based hand rub is effective and safe. In artificially contaminated hands with 4 different bacteria, the in-house product effectively reduced the bacterial loads on hands of volunteers (Tables 1-2). Even though the reduction factors by the in-house solution were less than those by a commercial alcohol plus chlorhexidine product, the effectiveness of the former was satisfactory[9]. The addition of chlorhexidine to alcohol enhances the antibacterial effect but it also increases cost. The presented in-house alcohol-based formula should be appropriate for hand hygiene in a clinical setting. After 1 month in use, the effects of the product on bacterial reduction remained satisfactory.

There was no microbial contamination of the in-house alcohol-based hand rub serially taken for culture upto 28 days in use. Contamination of the outer surface of its containers was found in high proportion. Unneccessary contact with the containers should be best avoided and the containers should be frequently cleaned.

## Conclusion

The in-house alcohol-based hand rub was effective in reducing micro-organisms on hands and was free from contamination up to 28 days in use.


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## ประสิทธิภาพและการปนเปื้อนเชื้อของแอลกอฮอล์เจลที่ผลิตใช้เอง

**สุวรรณา ตระกูลสมบูรณ์, กาญจนา คชินทร, รัชดา เจิดรังษี, กันทิมา แสงศิริวุฒิ, ชาญวิทย์ ตรีพุทธรัตน์, สมหวัง ด่านชัยวิจิตร**

***วัตถุประสงค์*** *: ศึกษาประสิทธิภาพของแอลกอฮอล์เจลที่ผลิตใช้เองเปรียบเทียบกับผลิตภัณฑ์ที่จำหน่ายและศึกษาการปนเปื้อนเชื้อของแอลกอฮอล์เจลที่ผลิตใช้เอง*

***วัสดุและวิธีการ :*** *ประสิทธิภาพของการลดจำนวนแบคทีเรียของแอลกอฮอล์เจลที่ผลิตใช้เองเปรียบเทียบกับผลิตภัณฑ์ที่จำหน่ายชนิดหนึ่งในอาสาสมัคร 12 คน โดยใช้วิธีมาตรฐานของยุโรป เก็บตัวอย่างแอลกอฮอล์เจลที่ใช้ในหอผู้ป่วย 50 แห่งเป็นระยะ ๆ ส่งตรวจเพาะเชื้อ*

***ผลการศึกษา :*** *ประสิทธิภาพการลดจำนวนแบคทีเรียของแอลกอฮอล์เจลที่ผลิตใช้เองใกล้เคียงกับผลิตภัณฑ์ที่จำหน่าย ไม่พบเชื้อจากแอลกอฮอล์เจลที่ผลิตใช้เอง จนถึงวันที่ 28 หลังเปิดใช้*

***สรุป*** *: แอลกอฮอล์เจลที่ผลิตใช้เองมีประสิทธิภาพดีและไม่มีเชื้อปนเปื้อน จนถึงวันที่ 28 หลังเปิดใช้*