Bacterial reduction of alcohol-based liquid and gel products on hands soiled with blood

Julia Y. Kawagoe, RN, PhD,[a] Kazuko Uchikawa Graziano, RN, PhD,[b] Marines Dalla Valle Martino, MD, PhD,[c] Itacy Siqueira, MT,[c] and Luci Correa, MD, PhD[a]
São Paulo, Brazil

The antibacterial efficacy of three alcohol-based products (liquid and gel) were tested on the hands with blood and contaminated with *Serratia marcescens* (ATCC 14756), using EN 1500 procedures in 14 healthy volunteers. The alcohol-based products tested, either gel or liquid-based, reached bacterial reduction levels higher than 99.9% in the presence of blood and did not differ significantly (ANOVA test; $P = 0.614$).

Key Words: Analysis of variance; anti-infective agents; local agents/administration and dosage; alcohols; Brazil; colony count; microbial; cross-over studies; ethanol; gels; handwashing; hygiene/standards; *Serratia marcescens*.

Alcohol is the preferred agent for hand hygiene because of antimicrobial activity, requiring less time, resulting in less skin irritation, and improving hand hygiene adherence. Health care workers (HCW) should wash hands with soap and water when hands are visibly dirty with blood or other organic material (OM).[1-3] Studies have shown HCW low adherence to the standard precautions, and their hands may have contact with blood/OM.[4-8]

It has been described that liquid-based alcohol products have antibacterial activity in the hands with blood.[9,10] We evaluated the antibacterial activity of 3 alcohol-based products (2 gel based and 1 liquid) on the hands pre-exposed to blood, and we hypothesized that gel-based alcohol also has antibacterial activity in the hands with blood.

From the Infection Control Service of Hospital Israelita Albert Einstein, São Paulo, Brazil[a]; Department of Medical Surgical Nursing, School of Nursing, University of São Paulo, São Paulo, Brazil[b]; and Microbiology Laboratory of Hospital Israelita Albert Einstein, São Paulo, Brazil.[c]

Address correspondence to Julia Y. Kawagoe, RN, PhD, Infection Control Service of Hospital Israelita Albert Einstein, 627 Avenida Albert Einstein, São Paulo 05652-000, Brazil. E-mail: julia@einstein.br.

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METHODS

This was a controlled, experimental, laboratory-based study with a cross-over design, conducted on the same day, and blinded for the volunteers as well as for the microbiology personnel. The alcohol-based products tested (A, B, and C) in the dirty hands with sterile sheep blood and contaminated with *Serratia marcescens* ATCC 14756 were all ethanol based: product A, 62% gel-based (Purell, GOJO, Akron, OH); product B, 70% gel based (Álcool Gel Dr Clean, Dr Clean, São Paulo, Brazil); product C, 70% liquid based with 2% glycerol (Álcool glicerinado; Rio Química, São Paulo, Brazil) (all products provide free of charge by manufacturers).

To assess the effect of blood on the antimicrobial activity of the alcoholic products, either gel and liquid based, we applied the procedure of the European Standard EN1500 to determine the initial count (IC), the final count (FC), and the reduction factor (RF). EN 1500 requires 12 to 15 volunteers and is described elsewhere.[11-13]

The analysis of variance (ANOVA) was used to assess differences in mean $\log_{10}$ RF among the test products, considering $P < .05$ as statistically significant. The volunteers enrolled were 14 healthy adults with no skin problems, age ranging between 18 and 55 years (mean, 31; median, 25); 1 participant was male; 6 nursing students, 3 administrative personnel, and 5 HCW (physician/administrative nurses). They participated in training sessions and signed the consent form.

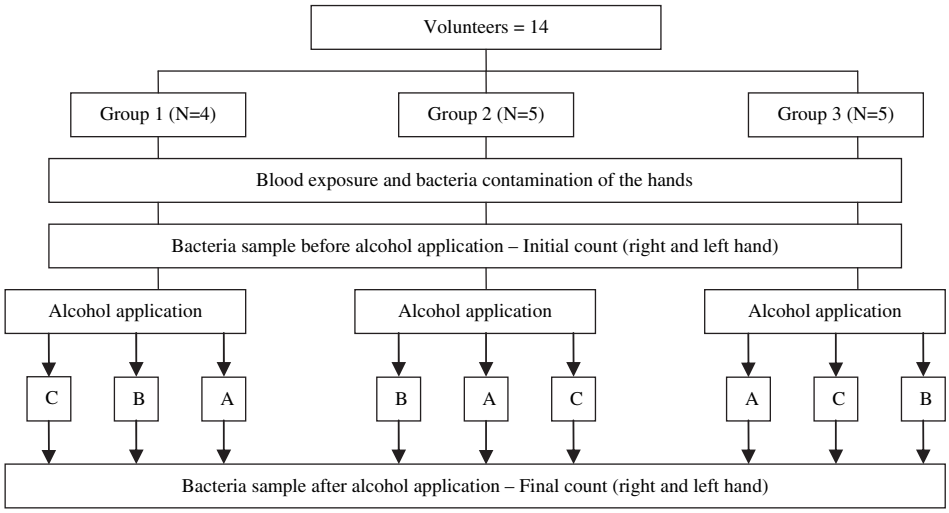

Fig 1. General study scheme to obtain the initial and final count of *S Marcescens* (224 samples). (A) 62% Ethanol gel based. (B) 70% Ethanol gel based. (C) 70% Ethanol liquid based with 2% glycerol.

Volunteers were randomized in 3 groups, and each one used the 3 products in different sequences (Fig 1).

The procedures described were followed by each volunteer[11]: Hands were washed with soft soap, rinsed, and dried. Sterile sheep blood (1.2 mL) was applied on the palm of the hands by a sterile syringe, rubbed over both hands, and air-dried for 2 minutes and immersed halfway to the metacarpals in the fluid containing 2.0×10^8 colony-forming units (CFU)/mL of *S marcescens* for 5 seconds and air-dried for 3 minutes. Next, the fingertips of each hand were rubbed for 1 minute in each Petri dish containing 10 mL of tryptone soya broth to obtain the IC.

Each one of the products was applied onto the hands, at a time described in Figure 1. Three milliliters of product A, B, or C was applied by sterile syringe and vigorously rubbed thoroughly over their entire surface (not exceeding 60 seconds). Next, the fingers were rinsed in running tap water for 5 seconds, and the excess water was shaken off.

FC was obtained as described to obtain IC. The CFU were counted after 24 and 48 hours of incubation at 36°C (±1°C) and transformed to the decimal logarithm. The $\log_{10}$ counts of the left and right hands of each participant were averaged separately for IC and FC. The $\log_{10}$ RF for each subject was established (individuals' log IC − log FC), and the arithmetic means of all subjects' log RF were calculated for each test product.

RESULTS

The IC of the hands revealed successful and equal contamination with *S marcescens* for the 3 products (6.30-7.65 $\log_{10}$) (Friedman test; $P = .1102$). The 3 alcohol-based products tested on the hands artificially dirty with blood showed a bacterial mean RF higher than 3 $\log_{10}$. The product C showed higher RF $\log_{10}$ than B, which in turn was higher than A, but there was no significant difference among them (ANOVA test; $P = .614$) (Table 1).

Table 1. Bacterial mean $\log_{10}$ reduction factor comparison of the test products used on the hands with blood

Product	Initial count, mean (SD)	Final count, mean (SD)	Reduction factor, mean (SD)
A	6.95 (0.36)	3.65 (0.61)	3.29 (0.77)
B	6.97 (0.29)	3.62 (0.69)	3.36 (0.75)
C	7.05 (0.37)	3.49 (0.60)	3.56 (0.72)

NOTE. $P = .614$ (A, B, and C; not significant). Product A, 62% ethanol gel based; product B, 70% ethanol gel based; product C, 70% ethanol-liquid-based with 2% glycerol. *SD*, standard deviation.

DISCUSSION

The 3 products tested produced bacterial reduction in presence of blood by more than 99.9%. Alcohol-based products may be affected by a number of factors including the presence of OM on the hands.[14] In our study, we used sterile sheep blood to simulate OM, as also done by 2 studies.[9,10] One evaluated 7 hand hygiene products in colonizing flora on the hands with and without sterile sheep blood and found that both liquid-based alcohol products (70% isopropyl alcohol and 70% ethanol alcohol plus 0.5% chorhexedine gluconate) led to greater reduction in colonizing flora of hands exposed to blood when compared with detergent-based products.[9] Another study used artificial contamination on the hands with *Escherichia coli*

to test 6 liquid-based alcohol products, with and without sterile sheep blood in different exposure times (30 seconds and 1 minute), showing that longer exposures to hand hygiene products improved bacterial reduction in hands with and without blood.[10]

Both studies found that alcohol-based products have antimicrobial activity when blood is present, but they did not test a gel-based alcohol product. Although there is some concern on the limited efficacy of gel-based product containing alcohol up to 70%,[15] our study did not show any significant difference between 70% liquid-based alcohol and 62% gel-based product ($P = .614$).

In conclusion, alcohol-based products, including the gel based, have activity against *S marcescens* even in the presence of blood and could be used when hands have contact with blood or OM and handwashing is not possible.

References

1. WHO guidelines on hand hygiene in health care. First global patient safety challenge: clean care is safer care. World Health Organization 2009. Geneva. Available from: http://whqlibdoc.who.int/publications/2009/9789241597906_eng.pdf. Accessed May 15, 2009.
2. Boyce JM, Pittet D; Healthcare Infection Control Practices Advisory Committee; HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. Guideline for hand hygiene in health-care settings: recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. MMWR Recomm Rep 2002;51(RR-16):1-44.
3. Pratt RJ, Pellowe CM, Wilson JA, Loveday HP, Harper P, Jones SRLJ, et al. Epic 2: National Evidence-Based Guidelines for Preventing Healthcare-Associated Infections in NHS Hospitals in England. J Hosp Infect 2007;65(Suppl 1):S1-64.
4. Shimokura G, Weber DJ, Miller WC, Wurtzl H, Alter MJ. Factors associated with personal protection equipment use and hand hygiene among hemodialysis staff. Am J Infect Control 2006;34:100-7.
5. Mathews R, Leiss JK, Lyden JT, Sousa S, Ratcliffe JM, Jagger J. Provision and use of personal protective equipment and safety devices in the National Study to Prevent Blood Exposure in Paramedics. Am J Infect Control 2008;36:743-9.
6. Madan AK, Raafat A, Hunt JP, Rentz D, Wahle MJ, Flint LM. Barrier precautions in trauma: is knowledge enough? J Trauma 2002;52:540-3.
7. Harris SA, Nicolai LA. Occupational exposures in emergency medical service providers and knowledge of and compliance with universal precautions. Am J Infect Control 2010;38:86-94.
8. Siegel JD, Rhinehart E, Jackson M, Chiarello L, and the Healthcare Infection Control Practices Advisory Committee. 2007 Guideline for isolation precautions: preventing transmission of infectious agents in healthcare settings, June 2007. Available from: http://www.cdc.gov/ncidod/dhqp/pdf/isolation2007.pdf. Accessed May 15, 2009.
9. Larson E, Bobo L. Effective hand degerming in the presence of blood. J Emerg Med 1992;10:7-11.
10. Renner P, Unger G, Peters J. Efficacy of hygienic hand disinfectants in the presence of blood. Hyg Med 1993;18:153-8.
11. European Standard EN 1500. Chemical disinfectants and antiseptics—hygienic handrub—test method and requirements (phase2/step2). Brussels, Belgium: Secretariat Central office; 1997.
12. Kampf G, Ostermeyer C. Intra-laboratory reproducibility of the hand hygiene reference procedures of EN 1499 (hygienic handwash) and EN 1500 (hygienic hand disinfection). J Hosp Infect 2002;52:219-24.
13. Kampf G, Ostermeyer C. Inter-laboratory reproducibility of the hand disinfection reference procedures of EN 1500. J Hosp Infect 2003;53:304-6.
14. Sickbert-Bennett EE, Weber DJ, Gergen-Teague MF, Rutala WA. The effects of test variables on the efficacy of hand hygiene agents. Am J Infect Control 2004;32:69-83.
15. Dharan S, Hugonnet S, Sax H, Pittet D. Comparison of waterless hand antisepsis agents at short application times: raising the flag of concern. Infect Control Hosp Epidemiol 2003;24:160-4.