

Cost Analysis of Hand Hygiene Using Antimicrobial Soap and Water Versus an Alcohol-Based Hand Rub

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Abstract

Proper hand hygiene is acknowledged as the most critical element of an adequate infection control program in the oral healthcare setting. However, adherence to proper hand hygiene protocols is often lacking. Poor compliance with hand hygiene protocols has been attributed to such factors as lack of time, hand irritation, hand dryness, forgetfulness, skepticism over importance, understaffing, perceived low risk of cross-infection, inconvenience, and the belief gloves alone offer protection. In the medical environment the use of alcohol-based hand rubs now represent the preferred method of performing hand hygiene when delivering non-surgical care. In this study we compared the costs associated with traditional hand washing against an alcohol-based hand rub protocol in the dental setting. The results indicate an alcohol-based hand rub protocol is less costly and less time consuming when compared to traditional handwashing in the dental setting, creating a new paradigm for hand hygiene in the dental office.

Keywords: Hand hygiene, handwashing, alcohol hand rub, infection control

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Introduction

Hand hygiene (e.g., hand washing, hand asepsis, or surgical hand asepsis) substantially reduces the number of potential pathogens on the hands, and it is considered to be the cardinal element of a strategy intended to reduce the risk of disease transmission in healthcare settings.^{1,2,3,4} It has also been documented as adherence to recommended hand hygiene measures improves, the prevalence of cross-infections in the healthcare setting decreases.^{5,6,7} The preferred method for hand hygiene depends on the type of procedure to be performed, the degree of contamination, and the desired persistence of antimicrobial action on the skin.⁸ For routine dental examinations and non-surgical procedures, the hand hygiene protocol may include either a plain or an antimicrobial soap and water technique, or, if the hands are not visibly soiled, an alcohol-based hand rub. Acceptable alcohol-based hand rub products contain 60% to 95% ethanol or isopropyl alcohol.⁸ In selecting an antiseptic agent for hand hygiene clinicians must take into consideration its spectrum and persistence of activity, its availability in a practical delivery system, reliable vendor support, and cost. Considering the average number of patients seen in a typical week by general practitioners is 82.6 and by specialists is 105.5, the cost associated with hand hygiene can be substantial.⁹ The objective of this study was to compare the cost of hand hygiene practices using an antiseptic soap and water versus an alcohol-based hand rub technique.



Methods and Materials

Two experienced general dentists participated in this time and cost analysis study over a period of two weeks. The principal investigator obtained a signed informed consent from both clinicians prior to enrollment in the study (per US Code of Federal Regulations, Title 21, Parts 50, 27, and ICH-GCPs, Chapter 4, subpart 4.8). During the first week, each clinician used a Food and Drug Administration (FDA)-cleared antiseptic soap (Dial®, Dial Corporation, Scottsdale, AZ, USA) in accordance with the manufacturer's instructions for hand-hygiene and according to published

Centers for Disease Control (CDC) guidelines for routine non-surgical dental care according to the following protocol:⁴

- Step 1:** Wetted the hands with running cool water
- Step 2:** Applied manufacturer recommend amount of antiseptic soap to the hands
- Step 3:** Vigorously rubbed the hands for 15 seconds to ensure coverage of all surfaces of the hands and fingers
- Step 4:** Rinsed thoroughly with running cool water
- Step 5:** Dried the hands thoroughly with disposable paper towels



Hand washing was performed before powder-free glove placement and after glove removal, and the following parameters were measured and logged:

- Step 1:** Number of hand washing events per day
- Step 2:** Time from initiation of hand washing to donning of gloves (measured for each event)
- Step 3:** Number of paper towels used to dry hands (measured for each event)
- Step 4:** Amount of soap dispensed (measured as amount used during test week/number of hand washings)
- Step 5:** Water usage per hand wash (measured as an average of samplings obtained during three hand washings)

During the second week, an FDA-cleared alcohol-based hand rub (TriSeptin™, Healthpoint Surgical, Fort Worth, TX, USA) was used in accordance to the manufacturer's instructions and according to

published CDC guidelines for routine non-surgical dental care according to the following protocol:⁴

- Step 1:** Applied alcohol-based hand rub to the hands
- Step 2:** Vigorously rubbed the hands for at least 15 seconds to ensure coverage of all surfaces of the hands and fingers and until the hands were dry



Alcohol-based hand rubbing was performed before glove placement and after glove removal, and the following parameters were measured and logged:

- Step 1:** Number of alcohol-based hand rubbing events
- Step 2:** Time from initiation of hand rub to donning of gloves (measured for each event)

A comparison of the cost of material and the time required to implement acceptable hand hygiene by the two techniques was undertaken. Since both test products were available on the market, other staff members (hygienists, assistants, doctors) were given the opportunity to use the products at their discretion. While they were

not monitored for the measured parameters, they were asked to complete a questionnaire assessing practitioner acceptance of the products.

Results

The costs for material presented in Table 1 were obtained directly from the manufacturer for Triseptin and from randomly chosen commercial sources for all other products. Water cost calculations were derived from published rates that would apply to a small private dental practice in San Antonio, TX, USA. It should be noted the raw cost of water was negligible (\$0.0009/gallon), but the sewer fee was almost five times higher (\$0.0044/gallon), resulting in an overall water cost of approximately 1/2 cent per gallon. For convenience and accuracy, the antiseptic soap and alcohol-based hand rub was measured in grams, thus, the cost per gram was determined for comparison. The cost for Dial soap was \$3.15 per 7.5 ounce dispenser. The weight of 7.5 ounces of soap was 223 grams, resulting in a per gram cost of approximately \$0.014. The cost for the Triseptin alcohol-based hand rub was \$8.25 per 16 ounce dispenser. The weight of 7.5 ounces of Triseptin alcohol-based hand rub was 211 grams, resulting in a per gram cost of approximately \$0.018.

The time-motion results for hand hygiene using traditional hand washing and the alcohol-based hand rub are presented in Tables 2 and 3, respectively. Each clinician was closely monitored to ensure he/she performed hand hygiene in accordance with both the established CDC guidelines and the manufacturer's instructions for product use. The scope of practice varied among the two practitioners; practitioner A performed 146 hand washes and 140 hand rubs, while practitioner B performed

Table 1. Cost for material.

Material	Cost	Unit Cost
Dial soap	\$3.15 / 7.5 ounce dispenser	\$0.014 / gram
Water		\$0.005 / gallon
Paper towels	\$23.93 / 4000 towels	\$0.006 / towel
Triseptin alcohol rub	\$8.25 / 16 ounce dispenser	\$0.018 / gram

Table 2. Material-time averages per hand washing event.

Participant	Soap use	Towel use	Water use	Time to glove	Cost
A (n=146)	1.12 gram	6 sheets	0.273 gallon	79 seconds	\$0.054
B (n=101)	1.56 gram	4 sheets	0.405 gallon	65 seconds	\$0.049
Average	1.34 gram	5 sheets	0.339 gallon	72 seconds	\$0.052

Table 3. Material-time averages per alcohol hand rub event.

Participant	Alcohol-based hand rub use	Time to glove	Cost
A (n=140)	1.06 gram	34 seconds	\$0.020
B (n=92)	1.29 gram	45 seconds	\$0.025
Average	1.18 gram	40 seconds	\$0.023

101 hand washes and 92 hand rubs. While practitioner A had larger hands and, thus, used more towels in drying the hands, practitioner B used more soap and water and alcohol-based hand rub per hand hygiene event than practitioner A. It was noted initially practitioner B was expending more product than was necessary, thus, partially accounting for the discrepancy. It is also possible the individual dispensers utilized in the study may have exhibited some variability in the amount expressed.

Discussion

In the United States healthcare-associated infections contribute to the death of almost 90,000 hospital patients per year and incur annual medical costs of approximately \$4.5 billion.¹⁰ Proper hand hygiene represents the single most critical measure in breaking the chain of infection.^{4,8,11-14} The goal of hand hygiene is to incur a sufficient reduction of microbial counts on the skin to prevent cross-transmission, and it is generally accepted compliance with hand hygiene protocols reduces cross-transmission and spread of antimicrobial resistance.¹³⁻¹⁵

Several studies have demonstrated poor compliance with performing adequate hand hygiene in a variety of healthcare settings, with lack of compliance estimates ranging from

5% - 80%.⁴ In the dental setting hand hygiene is indicated when the hands are visibly soiled; after barehanded touching of inanimate objects likely to be contaminated by blood, saliva, or respiratory secretions; before and after treating each patient; before donning gloves; and immediately after removing gloves.⁸ When rendering routine non-surgical dental care, hand hygiene for visibly clean hands can be accomplished by either washing the hands with soap and water or by using an alcohol-based hand rub. Few studies address the issue of hand hygiene compliance in dentistry. In a survey of 171 dental hygienists and 153 dental assistants, Wood reported 73% of assistants and 76% of hygienists washed their hands prior to donning gloves and 84% and 87%, respectively, washed their hands after removing gloves.¹⁶ McCarthy and colleagues surveyed over 1600 Canadian dentists in 1995 and noted a compliance rate of 74% for washing hands before patient treatment and 62% for washing hands after removing gloves.¹⁷ Gershon and associates reported 59% of 392 dentists surveyed washed their hands after glove removal.¹⁸

Poor compliance with hand hygiene protocols has been attributed to such factors as lack of time, hand irritation, hand dryness, forgetfulness, skepticism over importance, understaffing,

perceived low risk of cross-infection, inconvenience, and the belief gloves alone offer protection.¹³ Lack of time was singled out as the leading cause of noncompliance.¹⁵

While specific activities and measures to improve hand hygiene compliance in the healthcare setting continue to evolve, the use of an alcohol-based hand rub for disinfecting visibly clean hands has become the standard of care in the medical setting.^{15,19-21} Numerous studies have concluded the use of an alcohol-based hand rub in lieu of hand washing saves time, reduces skin irritation, reduces microbial load, and improves compliance.^{11,13,21} Consequently, the alcohol-based hand rub technique has emerged as the preferred method for performing hand hygiene on visibly clean hands.^{4,14,22,23}



In our study both practitioners were strictly monitored to ensure hand hygiene compliance. The average time required to perform the hand washing technique and donning gloves was 72 seconds, and the time to donning gloves using the alcohol-based hand rub technique was 40 seconds. These data compare favorably with the findings of other investigators who reported proper hand hygiene requires 1-2 minutes using the hand washing technique and 15-30 seconds using the alcohol-based hand rub technique.^{14,24} A busy general practitioner seeing 17 patients per day will conservatively need to wash his/her hands 25-35 times per day. This equates to a time expenditure of 30-42 minutes for using the hand washing versus 17-23 minutes for using an alcohol-based hand rub technique. In addition the alcohol-based hand rub may be applied while going from treatment room to treatment room, allowing for further time savings when compared to hand washing, which typically occurs at the sink. No attempt was made to assign a dollar value to the time associated with the two hand hygiene protocols. However, a minimum of 45% time saved when using the alcohol-based hand rub technique can be a substantial savings.

We were admittedly surprised by the cost comparison of the expendable items used in this study. While the cost of water was negligible and

the cost of the tested antiseptic soap and alcohol-based hand rub were very close, the cost of paper towels dramatically increased the expenditures associated with hand hygiene with soap and water compared to hand hygiene with an alcohol-based hand rub. Overall, the use of the alcohol-based hand rub was half as costly as conventional hand washing. In a recently published study comparing the costs of traditional hand washing against an alcohol-based hand hygiene protocol, Cimiotti and associates concluded the alcohol-based hand rub protocol was less costly, mainly as a consequence of the timesavings observed.²⁵ It is notable the authors did not include the cost of water and paper towels in their analysis and still reached their conclusion.

It is a commonly held belief alcohol based hand rubs cause increased skin dryness and irritation when compared to soap and water.^{12,13} While this assumption may have been true with earlier hand hygiene products which contained harsh detergents, newer formulations contain suitable emollients to render a product that is less drying and damaging to the skin than soap and water.^{13,14,20,21,23,26,27} In a recently published study, Cimiotti and associates studied the skin conditions of 58 nurses who utilized an alcohol-based hand rub in lieu of soap and water over a ten month period.²² Seven nurses (12%) experienced some form of dermatitis and two had to stop using the alcohol-based product. Of the remaining five, four were able to resume using the test product after several days. The authors were unable to distinguish between allergic and irritation reactions. However, the fact four out of the seven nurses who experienced irritation were able eventually to resume using the test agent, argues against a significant rate of allergenicity associated with alcohol-based hand rubs. By comparison, when the frequency of hand washing exceeds 35 times per day, the rate of dermatitis approaches 70%.²⁸ Hand washing has been shown to remove lipids from the skin, while alcohol-based hand rubs only redistribute them.¹⁴

Aside from the acute discomfort associated with dermatitis, healthcare providers with dermatitis are also more likely to harbor pathogenic bacteria such as *Staphylococcus aureus*¹⁴ and manifest an increased potential to develop sensitivity to other materials such as latex.²⁹⁻³¹ In reviewing the use of

alcohol-based hand rubs, Kamp and Löffler noted the dermatitis associated with an alcohol-based hand rub is usually related to its application to already damaged skin, possibly from frequent hand washing.²⁷ Providers planning to convert to using an alcohol-based hand rub need to be forewarned of this fact and assured this possible reaction is likely transitory. Instituting alcohol-based hand rub use after a non-working period such as after the weekend may reduce the likelihood of this reaction. Kamp and Löffler further emphasize an emollient-containing alcohol-based hand rub should be selected for use; it should only be applied to dry skin; skin care lotions or creams should be routinely used to help maintain skin integrity, especially at the end of the day; and traditional hand washing is not only unnecessary but should be avoided while using an alcohol hand rub.²⁷ It is interesting to note the test product utilized in our study is marketed as a water optional product; thus, allowing its use, if necessary, as a viable agent to remove visible debris.

Some providers complain of the residual feel associated with alcohol-based hand rubs, and we are unaware of any studies specifically addressing this issue. Our participants noted the alcohol-based hand rub did leave a residual feel that took a few days to get used to. However, it was readily observed glove donning was accomplished with greater ease when using the alcohol-based hand rub when compared to donning gloves after hand washing. In fact one participant routinely would have to use donning powder to assist in donning gloves after performing hand washing, but when using the alcohol-based hand rub, was able to easily slip on the same gloves. At the end of the study, both participants preferred using the alcohol-based hand rub. Additionally, the informal acceptability survey of three other dental workers revealed a preference for alcohol-based hand rub over conventional hand washing. The cited reasons were ease of use and the subsequent ease of glove donning associated with the alcohol hand rub.

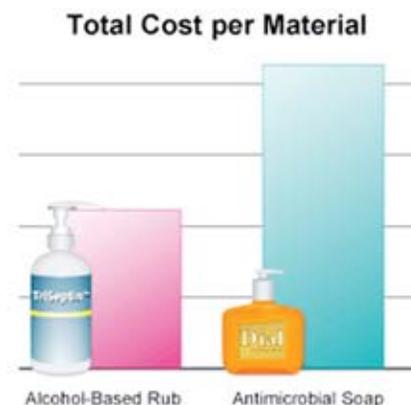
Concern has been expressed over the flammability of alcohol-based hand rubs. The flash point of commercially available alcohol-based hand rubs is between 21°C and 34°C. One fire incident attributed to the spark caused by the

removal of an isolation gown while the person's hands were still wet with the alcohol-based hand rub material has been reported.³² However, in a survey of 798 healthcare facilities, Boyce and Pearson reported no alcohol-based hand rub dispenser fires.¹⁹ As with any hazardous or flammable material, practitioners should ensure any and all applicable guidelines addressing the storage and dispensing of alcohol-based hand rubs.¹²

Powder-free gloves were used in this study, thus, we can not comment on any potential interactions related to the use of an alcohol-based hand rub and powdered gloves. We chose to use non-powdered gloves as their use likely reduces the risk of latex sensitization.³³ We know of no study addressing the effect of alcohol-based hand rub use and the potential accumulation of dead microbes, sweat products, and glove allergens on the hands during the day. However, the fact alcohol-based hand rubs are associated with greater residual antimicrobial effect and less dermal irritation compared to traditional handwashing appears to dampen such concerns.⁴

Conclusion

In this study we have demonstrated the use of a daily hand hygiene protocol for visibly clean hands using an FDA-cleared alcohol-based hand rub is less costly and less time consuming than traditional hand washing. Alcohol-based hand rubs are also superior to hand washing in terms of being convenient and easy to use. There exists a new paradigm for hand hygiene in the healthcare setting, and dental practitioners are strongly encouraged to establish office hand hygiene protocols centered on alcohol-based hand rubs when delivering non-surgical dental care.



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