

Maintaining Intact Skin During Handwashing: The First Line of Defense Against the Chain of Septic Flow

By Thomas L. Kovach, MA

Intact Skin: The First Line of Defense.

Infection control professionals conclude that proper handwashing by nursing staff, physicians, and patients is the single most effective method for controlling cross-contamination potential in healthcare institutions-especially in acute care areas of the hospital.^{1,2,3} Most patient handling episodes expose the healthcare worker to potential infection by opportunistic microorganisms establishing and moving into a "chain of septic flow." A chain of septic flow is defined as the movement of possible disease-causing, opportunistic, transient microorganisms moving from surface to surface (*i.e.*, nursing staff hand-to-hand; from the patient to the hands of the nursing staff and back again to nursing staff hands; another patient; hospital equipment surfaces). Nursing professionals can manage this problem by establishing and maintaining an "intact aseptic link" to inhibit a chain of septic flow from occurring.⁴



A major challenge for the healthcare worker in managing this problem though is the ability to maintain moist and intact skin on hands during a patient care day. Since patient care protocols require handwashing episodes exceeding 25 times per day, this becomes a difficult task. Maintaining intact skin during handwashing is a natural "first line barrier defense" and helps to preserve an intact aseptic link in the chain of septic flow against this opportunistic and pathogenic microorganism threat. Maintaining intact caregiver skin could be disruptive to any potential chain of septic flow during patient handling episodes and would be an additional safeguard to the caregiver. Noted professionals in the field of infection control and handwashing have already discussed the problem of necessary skin integrity during daily-required handwashing.⁵

The Centers for Disease Control and Prevention (CDC) in Atlanta, Ga, and other professionals in the field of infection control suggest that individual caregivers represent the most effective control point to prevent the spread of opportunistic and pathogenic microorganisms.⁶ The normal approach in managing this cross-contamination problem is with proper handwashing using a healthcare personnel handwash/ antimicrobial skin cleanser or antimicrobial hand rinse before and after each patient-handling episode.

There are many handwash product formulations with a variety of active ingredients effective in breaking the potential "chain of infection." These handwashing products are generally known as a healthcare personnel handwash or hand rinse. Most active ingredients work to inhibit, to a more or less degree, opportunistic/pathogenic microorganism flow associated with the chain of infection. Most of these active ingredients have been available to the professional healthcare community for a number of years. However, despite their efficacy, many can have degrading and drying effects on hands.

A search of current literature suggests that no or few new active ingredients in handwashing formulation have come on the market during the last 20-plus years. In addition, nursing staffs have found that repeated use of active ingredients in handwash or hand rinse formulations can and do result in drying out their skin, which can become a source of skin irritation. Moreover, the use of powdered latex gloves together with the use of handwash formulations can result in rough, red, chapped skin, which can lead to broken skin conditions on the epidermis of caregiver hands.

Current handwashing and hand rinse products normally contain one of the following active ingredients: Chlorhexidine gluconate (known as CHG); Chloroxylenol (known as PCMX); Triclosan; isopropyl alcohol, ethyl alcohol, normal-propyl alcohol; and sometimes iodine. All of these active ingredients serve to inhibit

transient pathogenic microorganisms to some degree. Some are better than others in the ability to inhibit opportunistic microorganisms during the initial application and in the important characteristic of persistent log reduction over time.

Striving for Balance.

Historically and in general, effectiveness in log reductions of microorganisms has been achieved at the expense of harsh formulations that degrade the hands of the caregiver. There seems to have been a trade-off between antimicrobial effectiveness and gentleness. Increasingly, manufacturers are searching to find a "balance" between antimicrobial effectiveness (both in the initial and persistent log reduction) and mildness to the hands of the caregiver. Achieving both goals would represent a superior weapon in managing the problem of opportunistic microorganism flow and the transmission of disease inside of healthcare institutions. If achieving infection prevention did not involve degrading hands, there might be considerable less caregiver resistance to frequent handwashing protocols and thereby a reduction in nosocomial infection rates.



The ideal handwash or hand rinse should have good to excellent initial log reduction properties and demonstrate lasting persistence through log reduction capability during the patient care day against opportunistic gram positive and gram negative microorganisms. It should also be gentle to the caregiver's skin by not removing the moisture content of the skin after repeated use. If one accepts the notion that intact epidermis skin layers are a normal and natural line of defense against pathogenic microorganism flow, a handwash formulation that leaves the epidermis in a supple, moist and intact condition would be a superior weapon in managing this problem.

While many handwash and hand rinse products are effective to some degree, most formulations dry out the moisture content of the hands. This drying effect is likely a contributing cause of skin irritation and skin dryness that compromises intact epidermal skin layers and the natural barrier defense against the chain of septic flow. Dry, chapped, cracked, non-intact caregiver hands could be a difficult and even dangerous condition during patient handling episodes. If caregiver skin is compromised by a break in the epidermal or stratum corneum layers of the skin, the natural and normal first line of defense against the chain of septic flow can also be compromised. Intact, moist and supple skin condition also contributes to the ability of the caregiver to maintain their hands in a fit condition to perform demanding procedures.

Given this background, there is recent research that documents the effectiveness of current formulations on the market in both initial and log reduction persistence and evidence on how these various formulations moisturize caregiver skin.

Comparison Testing Data: Effectiveness and Skin Moisture Levels of Various Active Ingredients Now on the Market.

An independent testing laboratory (BioScience Laboratories, Bozeman, Mont) recently tested the effectiveness of seven known active ingredients along two criteria:

1. Initial and continued log reduction of standard ATCC microorganisms after the initial application (initial log reduction-1st handwash) and the seventh daily handwash episode (continued persistent log reduction over time);
2. Incidences of both observed skin irritation and measured moisture content after repeated use on hands.

The following seven healthcare personnel handwash and hand rinse formulations were evaluated for initial and continued log reduction capability of standard ATCC microorganism strains. These seven active ingredient formulations were also evaluated for the ability to preserve intact skin by retaining or adding moisture content on the hands of the caregiver. This moisture retention study involved 35 test subjects using five test subjects per handwash product formulation. All subjects' hands were free from clinically evident dermatitis, open wounds, and hangnails.

Finally, users were asked to rank the product attributes for fragrance level, fragrance type, residue left on skin, sticky/tacky feeling after use, skin dryness, skin irritation, the degree of clean feeling on skin, and how clean the skin felt.

Serriatia marcescens (ATCC #14756) was used as a marker microorganism to challenge the antimicrobial efficacy for each of the above named seven active ingredients used on the market today. (See Bioscience Laboratories' white paper description of detailed methodology titled "A Second Look at Quaternary Ammonium Compounds as Topical Antimicrobials in the Medical Field," Daryl Paulson, PhD, BioScience Laboratories, Inc., Bozeman, Mont⁷) Table 1 illustrates both initial log reduction levels and mean log reductions levels obtained after the 7th handwash episode. The higher the number the better the product worked after the 1st and 7th handwash episode in Table 1.

Table 2 illustrates test results for skin irritation/skin dryness for each of the seven handwash/hand rinse formulations. During this phase, 35 subjects were used for 100 handwash episodes over five days. Both visual assessment evaluations and retained skin moisture content measurements were performed on one through five test days using the transepidermal water loss (TEWL) technique employing a Corneometer that measures the moisture level in epidermal skin layers. Visual assessment consisted of "0" being assigned to "no visible damage or perfect skin" to a high value of "6" assigned to hand skin conditions observed as bleeding cracks, deep open fissures, or generalized erythematic skin conditions.

Table 1 Results:

All seven formulations demonstrated significant ability to reduce microorganism loads on the initial application. Table 1 clearly shows CHG 4%, 7.5% povidone iodine, CHG 0.75% and benzethonium chloride 0.2% demonstrated superior ability of both initial log reduction and persistence build-up over time. Please note observed log reductions after the initial log reduction in the first handwash compared to the observed log reductions after the seventh handwash episode. Typical of alcohol gels, alcohol achieves an excellent initial log reduction of microorganisms on the initial application but once evaporated, alcohol loses the characteristic of having persistence in log reductions of microorganisms over time.

Two of the most widely used active ingredients (Triclosan and PCMX) in healthcare personal handwash and hand rinses did not achieve the log reduction levels obtained with CHG 4%, 7.5% povidone iodine, CHG 0.75% or benzethonium chloride 0.2%. The 62% ethyl alcohol gel product did not demonstrate improved persistent log reduction over time. Both CHG formulations of 4% and 0.75%, 7.5% povidone Iodine and benzethonium chloride 0.2% achieved significant initial and persistent log reductions. The benzethonium chloride 0.2% formulation also performed almost as effective in both the initial and persistent log reduction measurements as CHG and povidone iodine.

Table 2 Results:

There are two clear winners in the observed skin irritation data. The 62% ethyl alcohol formulation and the benzethonium chloride 0.2% formulation actually added observed moisture to the epidermis of the 35 test subjects over five days. These two active ingredients performed better than either of the CHG formulations, Triclosan, and PCMX, with povidone iodine irritating the hands to a significant degree.

In addition to the above visual assessment, skin conditions of test subjects were monitored using the Skin Monitoring Centre TC350 Corneometer and compared to a baseline measurement of pre-handwash moisture content of the epidermis for all 35 test subjects over five days. All seven formulations and active ingredients were evaluated 14 times over five days. Table 3 is an average of baseline adjusted Corneometer values for all tested products. Higher values mean improved moisture content levels after use over five days and 14 evaluations.

When evaluating Tables 2 and 3, the reader is reminded that handwash and hand rinse formulations can be formula dependent. For example, different manufacturers using the same active ingredient will vary in the actual impact on the skin epidermal layers for skin dryness and skin irritation levels after repeated use. For example, some active ingredients are well known to cause skin dryness or skin irritation. However, a number of manufacturers offer formulations with emollients using the same active ingredient that significantly differ in the impact on the caregiver's epidermal skin layers after repeated use.

Table 3 Results:

From measured moisture content results, three formulations did best-62% ethyl alcohol was superior, followed by benzethonium chloride and CHG 4% PCMX, 7.5% Povidone iodine, 0.75% CHG, and 0.3% Triclosan all removed the moisture content of the epidermal skin layers.

Conclusions.

We conclude from Tables 2 and 3 that both benzethonium chloride and the 62% ethyl alcohol formulations consistently improved the epidermal layer of the skin leaving this layer on the hands of the caregiver in a moisturized and intact condition when compared to other handwash alternatives. In terms of effectiveness, Table 1 shows the benzethonium chloride formulation achieved almost the same log reductions at the 7th wash level as did the CHG 0.75% and 7.5% iodine formulations. It is also important to note that benzethonium chloride had superior log reductions compared to PCMX 1% and Triclosan 0.3% by the 7th wash and was almost as good as CHG 4% after the initial first wash episode and delivered a significant increase in persistent log reduction versus 62% ethyl alcohol. Finally, overall average subjective evaluations by users for fragrance level and type, residue left on skin, less sticky/tacky, low skin dryness, irritation levels and skin feeling after use suggests users preferred the benzethonium chloride 0.2% formulation slightly more than the 62% ethyl alcohol formulation and the 0.75% CHG formulation as well as other active ingredient formulations evaluated.

Overall, the better handwash formulation for initial and persistent log reduction seems to be CHG 4%, CHG 0.75%, povidone Iodine and benzethonium chloride 0.2%.

However, both CHG formulations and especially povidone iodine illustrated skin irritation characteristics. Overall, the 62% ethyl alcohol formulation offered high moisturization capabilities and excellent initial log reduction of microorganism loads, but like all alcohols did not perform well in demonstrating persistent log reduction of microorganisms over time and after repeated daily use.

It is understood that most alcohol gel formulations are used as a convenient hand rinse, and they do not possess significant "persistent log reduction" capability once evaporated on caregiver skin. While the tested brand of alcohol gel performed very well, in general, alcohol can dry out the skin epidermis of the caregiver. This particular formulation has significant emollients added by the manufacturer--hence its high rating on both moisture retention measures.



Taking all things into consideration, including both the properties of good initial and persistent (over time) log reduction capabilities and for leaving caregiver hands in a moist, intact and supple condition after repeated use, and user overall ratings, the benzethonium chloride 0.2% formulation seems to offer the best overall balance of the alternative formulations. It had antimicrobial effectiveness on the initial application and had persistent log reduction capability over time. It was almost as effective as CHG 4% and the CHG 0.75% formulations for both initial and persistent log reduction and was consistently ranked in the top two categories for leaving caregiver hands in a moist, supple, and intact condition. In addition, users rated the benzethonium chloride formulation as having the best overall ratings for handwash characteristics.

Thomas Kovach is President of Kovach & Associates Inc., St. Louis, Mo, a management consulting firm that specializes in handwashing, infection control, skin care, and wound care topics.

For a complete list of references visit www.infectioncontrolday.com

TABLE 1⁸

Log Reduction for Seven Active Ingredients for Antimicrobial Healthcare Personnel Handwash and Hand Rinse Active Ingredients. 1st Initial Handwash and Ranked by Log Reduction after 7th wash (Higher Numbers Indicate Higher Log Reduction Levels of Microorganisms)

	Ingredient	Initial Log Reduction-1st Wash	Log Reduction-7th Wash
1.	CHG 4%	2.80	4.28
2.	7.5% povidone iodine	3.49	3.43
3.	CHG 0.75%	2.30	3.39
4.	0.2% benzethonium chloride	2.40	3.35
5.	62% ethyl alcohol gel	3.16	3.06
6.	PCMX 1%	2.44	2.59
7.	Triclosan 0.3%	2.14	2.31

TABLE 2⁹

Average Assigned Values for Skin Irritation for Seven Test Products Low to High Ranking After 14 Evaluations During Five Days. Scale: 0 = No Visible Damage/Perfect Skin, 6=Bleeding Hands-High Irritation

	Active Ingredient	Average Observed Assigned Value
1.	62% ethyl alcohol	-0.29
2.	0.2% benzethonium chloride	-0.01
3.	0.75% CHG	+0.69
4.	4% CHG	+0.75
5.	1% PCMX	+0.79
6.	0.3% Triclosan	+1.21
7.	7.5% povidone iodine	+2.07

TABLE 3¹⁰

Average Corneometer Values for Tested Products During Five Days of Use and 14 Evaluations High to Low Rankings.

Higher + Numbers Indicate Higher Moisture Content. Lower Numbers Indicate Lower Moisture Content

	Ingredient	Average Measured Value
1.	62% ethyl alcohol	+13.97
2.	benzethonium chloride 0.2%	+3.74
3.	CHG 4%	+3.72
4.	PCMX 1%	+1.09

5.	7.5 % povidone iodine	-1.55
6.	0.7 5% CHG	-2.94
7.	0.3% Triclosan	-8.75

Copyright © 2001 by [Virgo Publishing, Inc](#)