Hand Hygiene Products and Their Effect on Skin Condition at High Compliance: The Need for Better Product Formulations

Anthony V. Rawlings, Todd J. Cartner, Amanda J. Copeland, Megan J. DiGiorgio

GOJO®

Key Points:

- Changes to Centers for Medicare and Medicaid payment policies for hospitals has resulted in an intensified focus on reducing healthcare-associated infections, which can include efforts to increase hand hygiene compliance.

- Hand hygiene is widely accepted as one of the most important measures for preventing the transmission of pathogens in healthcare facilities.

- As hand hygiene compliance increases, skin health can decrease. Soap is usually the culprit, and changing practice to use hand sanitizer the majority of the time can help significantly, but only up to a point.

- Current formulations may not adequately address skin health needs that arise in very high compliance environments. There is a need to develop products that adequately address skin health needs in these situations.

Introduction

In the U.S. there have been significant efforts around reducing healthcare-associated infections (HAI), which are a major cause of morbidity and mortality. At any given time, about 1 in every 25 inpatients has an infection related to hospital care.[1] HAIs cost the U.S. healthcare system billions of dollars each year and lead to the loss of tens of thousands of lives.[2] As discussed in a previous whitepaper, the Centers for Medicare and Medicaid (CMS) payment policy has further encouraged hospitals to identify ways to prevent certain Hospital-Acquired Conditions (HAC) which include select HAIs that are not present on admission. CMS will no longer pay hospitals for the additional costs associated with the care and treatment of these conditions. Also, hospitals in the lowest-performing quartile with respect to the overall rate of certain HAI will see their payments reduced by one percent, providing an incentive for hospitals to reduce the burden of HAIs in their facilities.

At any given time, about 1 in every 25 inpatients has an infection related to hospital care.[1] HAIs cost the U.S. healthcare system billions of dollars each year and lead to the loss of tens of thousands of lives.[2]

As a result of intense pressure to improve quality of care and avoid financial penalties associated with HACs, hospitals have amplified efforts around HAI reduction, including increasing hand hygiene compliance. Hand hygiene has long been accepted as the single most important measure one can take to prevent the spread of infection,[3] so it is not surprising that hand hygiene compliance is an area of focus for most U.S. hospitals. The importance of providing healthcare workers (HCW) with efficacious hand hygiene products that have low irritancy potential and soliciting input regarding feel, fragrance, and skin tolerance is outlined by the Centers for Disease Control and Prevention (CDC) in their guidelines for hand hygiene. Product acceptability is an important driver of hand hygiene compliance; that is, if HCW do not like the product because it is irritating to their skin, they may be less likely to use it, consequently affecting hand hygiene compliance. There is still belief among HCW that an alcohol-based hand rub (ABHR) is more damaging to the skin than soap and water for hand hygiene, despite the many proven advantages of ABHR, such as superior efficacy, speed of procedure, better compliance, and skin health benefits.[4] In a recent study, researchers in the United Kingdom examined whether interventions focusing on improving hand hygiene coincided with trends in incidence of irritant contact dermatitis (ICD) in healthcare workers. Using a national reporting scheme, they found that there were significant increases in incidence of ICD in HCW attributed to hand hygiene alone, specifically a 4.5-fold increase in ICD reports from 1996 to 2012.[5] This is the only study of its kind to examine ICD attributed to increased hand hygiene compliance, and it underscores the need for properly formulated hand hygiene products that will have a positive effect on HCW acceptance, skin condition, and ultimately hand hygiene compliance. Other published studies support the concept that as skin irritation increases, hand hygiene compliance decreases.[6,7] The purpose of this whitepaper is to review how soap and water and ABHR affect the skin, to review the effect of different hand hygiene regimens on skin health outcomes, and highlight the need for products designed for very high compliance environments.

As a result of intense pressure to improve quality of care and avoid financial penalties associated with HACs, hospitals have amplified efforts around HAI reduction, including increasing hand hygiene compliance.

In a recent study, researchers in the United Kingdom examined whether interventions focusing on improving hand hygiene coincided with trends in incidence of irritant contact dermatitis (ICD) in healthcare workers. Using a national reporting scheme, they found that there were significant increases in incidence of ICD in HCW attributed to hand hygiene alone, specifically a 4.5-fold increase in ICD reports from 1996 to 2012.[5]

Soap and Water and Alcohol-Based Hand Rub Affect the Skin Differently

Hand hygiene in the healthcare environment consists of a combination of washing hands with soap and water and using an ABHR. According to nationally accepted guidelines from the Centers for Disease Control and Prevention (CDC), the majority of hand hygiene events should be performed using

an ABHR; however, there are circumstances when soap and water is required, such as when hands are visibly soiled or contaminated, before eating, and after using the restroom.[3] Despite clearly defined instances when soap and water is warranted, some HCW have a preference for soap and water over ABHR as discussed in the previous whitepaper, setting themselves up for significant negative effects that soap and water can have on their skin.

Despite clearly defined instances when soap and water is warranted, some HCW have a preference for soap and water over ABHR as discussed in the previous whitepaper, setting themselves up for significant negative effects that soap and water can have on their skin.

The epidermis is the thin, but tough, outer layer of the skin. The outermost layer of the epidermis is the stratum corneum (SC), which is often described as a "brick wall" because of the sturdy cellular structures that comprise it. The SC is the interface between the deeper layers of the skin and the external environment. Among other functions, it controls the selective influx and outflux of materials in the skin and regulates transepidermal water loss (TEWL). It is well known that washing with soap, specifically surfactants, can damage the SC by dissolving lipids causing a total disruption of the "mortar" between the "bricks" in this SC system. With the lipids removed or reduced, the barrier is compromised and natural moisturizing factors are extracted from the SC, reducing its water-holding capacity. With the lowered water content of the SC, reduced enzyme activities then lead to reduced degradation of proteins found in the protein structures that hold the "bricks" together. Reduced maturation of the "bricks" and their accumulation in skin result in the appearance of dry and flaky skin. Once compromised, the impaired SC barrier then leads to inflammation in the living epidermis. There is also interference with the events around normal development in the epidermis and SC. As a result, a less mature SC is generated that is even more permeable. This sets up a vicious dry skin cycle that worsens with each soap insult or wash. Finally, any insult to the SC barrier then leads to an increase in epidermal nerve density that can lead to sensations of stinging, burning, itching, tingling and tightness. This is often recognized during contact with ABHR, but it is the soap, specifically surfactants, that created the condition.

Ethanol, isopropanol and n-propanols are all used at varying concentrations in ABHRs, although in the United States, ethanol is the only alcohol considered a safe and effective active agent for ABHR by the Food and Drug Administration Over-the-Counter Drug Monograph for Healthcare Antiseptic Hand Hygiene Products. Studies have shown that single or even limited repeat interaction with these alcohols on skin has little impact on the SC. The influence of alcohols on the SC lipids is controversial, and if anything, only have a minimal effect on the SC system. However, there is a void in published research regarding how soap and ABHR interact with the skin at very high levels of hand hygiene compliance. Nevertheless, when compared to soap usage, ABHRs are milder to the skin. As a result, it is important to significantly reduce the incidence of ICD by shifting hand hygiene behaviors from soaps to ABHRs as indicated by the CDC guidelines for hand hygiene, and in general provide hand hygiene regimens most suited for increasing hand hygiene compliance.

As a result, it is important to significantly reduce the incidence of ICD by shifting hand hygiene behaviors from soaps to ABHRs as indicated by the CDC guidelines for hand hygiene, and in general provide hand hygiene regimens most suited for increasing hand hygiene compliance.

Hand Sanitizer Regimens Affect the Skin Differently

Considering how improper hand hygiene regimens can create a vicious cycle of injury and insult, it is critical to maintain and repair the skin's barrier and not expose the nerves in the skin in the first place. Healthcare workers should primarily use an ABHR for hand hygiene, except when hands are visibly soiled or contaminated, in which case soap and water are required. Hand hygiene products that are not properly formulated for high compliance environments, such as healthcare, may adversely impact hand hygiene compliance as a result of skin damage. Previous reports of national averages for hand hygiene compliance report that average compliance rates are less than 50%.[8] One published study documented 7.5 hand hygiene opportunities per hour in an adult intensive care unit.[9] At 40–50% compliance this equates to 3–4 hand hygiene events per hour. This means that a HCW working three 12-hour shifts may be exposed to 100–140 hand hygiene events at 40% compliance and extrapolates to about 280 hand hygiene events at 100% compliance.[10] The tremendous pressure facing

healthcare facilities as a result of payment policies is potentially creating situations where healthcare workers are being expected to more than double the number of hand hygiene events, which means more exposure to hand hygiene products, and potentially more opportunity for skin damage.

The tremendous pressure facing healthcare facilities as a result of payment policies is potentially creating situations where healthcare workers are being expected to more than double the number of hand hygiene events, which means more exposure to hand hygiene products, and potentially more opportunity for skin damage.

Figure 1 demonstrates the effects of handwashing versus hand sanitizing regimens on skin by evaluating changes in skin barrier, as measured by transepidermal water loss (TEWL). As a reminder, the SC controls the entrance and exit of materials in the skin and regulates TEWL. Early indicators of TEWL and potential damage to hands manifests as redness and erythema. Unlike measuring hydration, lower TEWL results are better because it means less water is leaving the skin. In this pilot study, soap and typical sanitizer (ABHR) regimens were evaluated. The soap regimen entailed washing hands with a typical soap and water three times per day. There were two typical sanitizer regimens, which included the previously defined wash regimen in addition to use of either a typical sanitizer at 20 times or 100 times per day. These regimens were used multiple days in a row, and changes in TEWL were measured in the participants. On day 3, the use of the ABHR at 20 times per day plus washing 3 times per day was no more damaging to the skin than the washing regimen alone. However, once use of the sanitizer increased to 100 times per day, there was a marked increase in TEWL, meaning that substantially more water was leaving the skin, resulting in damage to the SC. When considering that as stated above, there is potential for 280 opportunities for hand hygiene in an intensive care unit HCW over the course of 3 days when 100% compliance is achieved, this study demonstrates that ABHR helps the skin only to a point, after which the benefit of ABHR may be lost. Some ABHR formulations may not be equipped to address the skin damage that may be a result of very high compliance environments. This impact is further exacerbated by some HCWs' preference for handwashing over hand sanitizing.

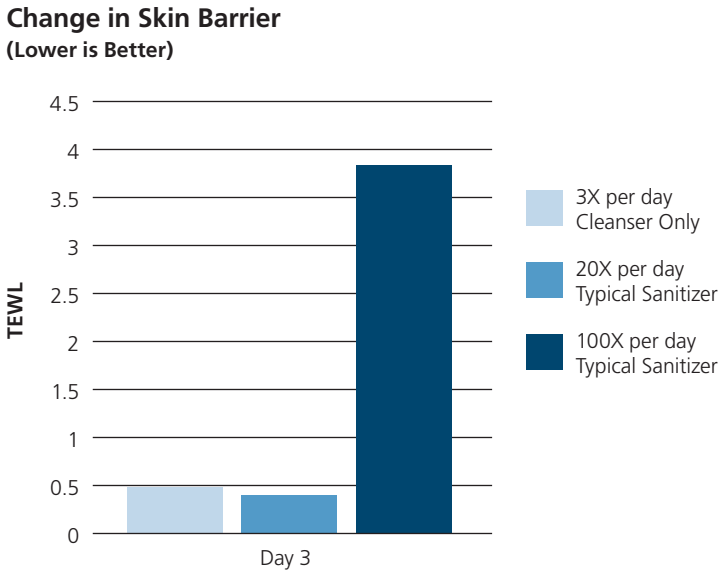
Conclusion

Hand hygiene is a primary means for reducing HAI and is the cornerstone of infection prevention activities. However, new evidence demonstrates that intensified efforts to reduce HAI may be adversely impacting the skin health of HCW. Our study found that a typical sanitizer used at 20 times per day plus washing with soap and water was no more damaging than handwashing with soap and water alone. However, once hand sanitizing events increased 5-fold, there was significantly more TEWL, with resulting skin damage in study participants. In very high compliance environments, i.e., hand hygiene events in excess of 100 times per day, it is important to select product formulations better suited to meet the skin health needs of HCW. There is also need to further study individual hand hygiene products, regimens, and their impact on HCW skin.

Our study found that a typical sanitizer used at 20 times per day plus washing with soap and water was no more damaging than handwashing with soap and water alone. However, once hand sanitizing events increased 5-fold, there was significantly more TEWL, with resulting skin damage in study participants.

Figure 1

Cartner, T. Skin Care Science Study 10369. GOJO Industries, Inc. April 2014.



Reference List

[1] Centers for Disease Control and Prevention. Healthcare-associated infections (HAI): data and statistics. http://www.cdc.gov/HAI/surveillance/index.html. Updated January 12, 2015. Accessed March 1, 2015.

[2] Scott RD. The direct medical costs of healthcare-associated infections in U.S. hospitals and the benefits of prevention. http://www.cdc.gov/HAI/pdfs/hai/Scott_CostPaper.pdf. Accessed March 1, 2015.

[3] Centers for Disease Control and Prevention. Guideline for hand hygiene in healthcare settings: recommendations of the healthcare infection control practices advisory committee and the HICPAC/SHEA/APIC/IDSA hand hygiene task force. *MMWR* 2002;51:RR-16.

[4] Widmer AF. Replace and washing with use of a waterless alcohol hand rub? *Clin Infect Dis.* 2000;31:136-43.

[5] Stocks SJ, McNamee R, Turner S, Carder M, Agius RM. The impact of national level interventions to improve hygiene on the incidence of irritant contact dermatitis in healthcare workers: changes in incidence from 1996–2012 and interrupted time series analysis. Br J Dermatol. 2015 Feb 5. doi: 10.1111/bjd.13719. [Epub ahead of print]

[6] Patarakul K, Tan-Khum A, Kanha S, Padungpean D, Jaichaiyapum OO. Cross-sectional survey of hand-hygiene compliance and attitudes of health care workers and visitors in the intensive care units at King Chulalongkorn Memorial Hospital. *J Med Assoc Thai.* 2005;88:S287-S293.

[7] Pittet D. Improving compliance with hand hygiene is hospitals. *Infect Control Hosp Epidemiol.* 2000;21(6):381-386.

[8] World Health Organization. WHO guidelines on hand hygiene in healthcare. First global patient safety challenge: clean care is safer care. http://whqlibdoc.who.int/publications/2009/9789241597906_eng.pdf. Published 2009. Accessed March 1, 2015.

[9] Steed C, Kelly JW, Blackhurst D, et al. Hospital hand hygiene opportunities: where and when (HOW2)? The HOW2 benchmark study. *Am J Infect Control.* 2011;39:19-26.

[10] Visscher MO, Wickett RR. Hand hygiene compliance and irritant dermatitis: a juxtaposition of healthcare issues. *Int J Cosmet Sci.* 2012;34:402-415.

Biography

Anthony V. Rawlings, BSc (Hons), Ph.D., FRSC, FSB, HonMSCS
Director, AVR Consulting, Ltd.

Professor Rawlings brings over 25 years of experience in research and development and research in skin biology at several senior management levels in food and personal care companies in the UK and USA. He is the author/co-author of over 200 papers, book chapters, and abstracts and has filed over 50 patents in areas of skin and food science. He has received several literature awards from the dermatology and cosmetic communities.

He is ex-Chief Editor of the International Journal of Cosmetic Science, was the Co-Chair the Gordon Research Conference on Mammalian Barrier Function in 2007 and is visiting Professor at UCL. He is co-editor of the first and second edition of "Skin Moisturization" published in 2002 & 2009, respectively, and "Acne and its Therapy." He is an expert in skin biology and especially stratum corneum biology, the interactions of cosmetic ingredients and clinical together with objective testing methods.

He lives in Northwich with his wife Ann.

Todd J. Cartner, BSME
Senior Skin Care Scientist, GOJO Industries

Todd Cartner has worked in science, technology, and engineering for almost 30 years. He has lead GOJO Skin Bioengineering, Sensory Descriptive Testing, Consumer Acceptance Testing, and Dermatological Clinical Testing for over 10 years. Todd received his bachelor of science in Mechanical Engineering from the University of Akron and pursued post graduate studies in Computer Science with a focus on data modeling. He has a passion for photography and digital imaging which applies to numerous high throughput, noninvasive testing applications. His skill set includes method development to evaluate and screen hand hygiene products and regimens for long-term, high-frequency applications. Todd began working in Research and Development for GOJO in 1998.

Biography

Amanda J. Copeland, BS

Senior Product Development Scientist, GOJO Industries

Amanda Copeland has worked in the personal care industry for almost 10 years with the majority of her focus on developing new hand sanitizing products for the Healthcare industry. Amanda received her bachelors of science in Chemistry from Penn State Behrend. She has a passion for addressing the needs of healthcare workers that ladder up to the higher meaning of saving lives and making life better. Her skill set includes integration of innovative skin care technologies into products and development of new methods to deliver breakthrough claims. Amanda began working in Research and Development for GOJO 2006.

Megan J. DiGiorgio, MSN, RN, CIC

Clinical Specialist, GOJO Industries

Megan DiGiorgio has worked in infection prevention for 10 years, spending the last eight years at the Cleveland Clinic in Cleveland, Ohio. Megan received her bachelors of science in nursing and masters of science in nursing from Case Western Reserve University. Megan has a background in pediatric nursing in addition to her infection prevention experience. She has presented posters and oral abstracts at several national conferences, and is active in her local northeast Ohio Association of Professionals in Infection Control chapter, serving as president in 2012. Megan began working at GOJO in 2013 as a Clinical Specialist for Healthcare.

The best way to kill germs in one pump.

A single pump of PURELL® Advanced Instant Hand Sanitizer is all you need.*

That's because our new PURELL® ADX™ and PURELL® LTX™ dispensing systems are designed to release 1.1 mL of our hand sanitizer—enough to exceed FDA Healthcare Personnel Handwash efficacy requirements.[1] So every time you use PURELL® Advanced Instant Hand Sanitizer from one of these systems, you can be confident that you're getting enough product to help stop the spread of infection. That's exactly what you'd expect from the number one brand in hand hygiene.

Apply for a free trial at GOJO.com/healthcare-trial.

Purell®

*PURELL® Advanced Instant Hand Sanitizer exceeds HCPHW at 1.1 mL of product. ADX and LTX dispensers only. Fully primed pump through 95% of refill.

[1]Healthcare Personnel Handwash Study #111016-101, March 19, 2012, BioScience Laboratories, Bozeman, MT.

@GOJOHealthcare

Making hand hygiene easier than ever.

We had a hand in that.

GOJO®