

**The Germicidal Effectiveness of Antibacterial Soap
vs. Alcohol-Based Hand Sanitizer**

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Abstract

Waterless hand sanitizers are seen everywhere especially in the medical field and they do have some advantages. They are quick, simple, they require no water, they cause less skin irritation, less dryness compared to soap and they are an effective way to kill bacteria. Nevertheless, are they still better than washing with antibacterial soap and water? We wanted to prove that the Alcohol-based hand sanitizer is more effective than antibacterial soap. To obtain this answer we set out to get a randomized sample of forty people, half of them were tested with the Alcohol-based hand sanitizer and the other half were tested with the antibacterial soap and distilled water. What we found was that the alcohol-based hand sanitizer was more efficient at removing the microbes than the antibacterial soap.

Introduction

Hand washing is an important aspect of our everyday routine, and is of particular importance in the routines of health care professionals. This is primarily because “Nosocomial pathogens are mostly transmitted via the hands of health care workers and hand hygiene is considered the leading preventative measure to reduce cross-transmission in health-care settings” (1). Boyce and Pearson found that “Compared with soap and water hand washing, these products [alcohol-based, waterless hand sanitizers] require less time to use, can be more accessible than sinks, cause less skin irritation and dryness, ... and when made widely available within an institution, have been shown to improve hand hygiene practices among health care workers” (2). In a study of the use of alcohol-based sanitizers in a long-term-care facility, Lona Mody agreed that making alcohol-based, instant sanitizers available “increased compliance” with hand washing among health care professionals (3). Since using a waterless hand sanitizer is more convenient than finding a sink and scrubbing with soap, we tested whether the more expedient Purell is as effective or more effective, health care workers and other can enjoy the convenience without worrying.

It has been shown that hand hygiene with unmedicated soap and water removed some of the transient flora mechanically, but preparations containing antiseptic or antimicrobial agents killed contaminating and colonizing flora (4). “Alcohols have excellent activity and the most

rapid bactericidal action of all antiseptics; they are preferred agents for hygienic hand rubs” (4). “Simple hand washing before patient care, without hand disinfection, was also associated with higher colony counts ($>53\text{cfu}$, $p=.03$), which suggests that hand antisepsis is better than standard hand washing. These findings suggested that intervention trials should explore the role of systematic hand disinfection as a cornerstone of infection control to reduce cross-transmission in hospitals” (4).

Alcohol-based hand sanitizers promise a certain antibacterial effectiveness, as do the soaps, and thesis study sought to determine whether there is any validity to these claims. Antibacterial effectiveness is important in daily hand washing and is especially important in the health care field, where it is easy to spread bacteria from patient to patient. Our hypothesis is that the alcohol-based hand sanitizer is more effective than washing with antibacterial soap. The Purell alcohol-based hand sanitizer should be more efficient than the antibacterial soap in reducing the amount of bacteria on the hands.

Material and Methods

Prior to doing the experiment we applied for exempt status through the GVSU Internal Review Board. Approval was obtained on March 17th, 2004. The materials that were used in this experiment included Blood Agar Plates (BAP), sterilized swabs, antibacterial soap, alcohol-based hand sanitizer, sterilized distilled water, and an incubator set at thirty-six degrees Celsius. We received help from Dr. Daniel Herman, and Maria Weidenfeller, who provided the materials and incubation space. The dominant hand of about 40 individuals, selected from the Grand Valley microbiology labs, was swabbed before and after contact with the sanitizing agent to compare the ability of each cleanser to remove microbes present on the hand. The swabbing was accomplished by the experimenter via dipping the swab into the sterilized distilled water then taking the moistened swab and rubbing it over the subject's palm, in-between their fingers, and underneath their nails.

To prepare, the BAPs were divided in half, and each side was labeled “Before” and “After”. The top of the plates were marked with the number 1 or 2, corresponding to the variable being used on that sample: 1 = antibacterial soap, 2 = alcohol-based hand sanitizer.

This number also corresponds to the number placed at the top of each consent form, which was handed out arbitrarily for randomization purposes at random as students walked in the door they were handed the consent form (Appendix).

First, each subject's dominant hand was swabbed by one of the experimenters who wore gloves throughout the experiment. Wetting a sterilized swab in sterilized distilled water to moisten it and swabbing the subject's palm, between their fingers and under their fingernails, accomplished this. The swab was then used to streak the "Before" side of the BAP using the three distinct lines. The experimenter then pumped the cleanser into the subject's hand. The subject then sanitized his or her hands with the cleanser type indicated by the number on their consent form.

Hand washing with soap was standardized as follows: the hands and clothing were kept away from the sink's surface; if anything touched the sink's surface, the subject was directed to rewash their hands. In addition, the subjects were asked to keep their hands and forearms lower than their elbows to prevent flow back of the water. Each subject began by wetting their hands and the experimenter applied 3-5mL (one pump) of liquid soap and lathering. Each subject was to wash their hands for an approximate of 15 seconds (one song of their ABC's) but no longer than 30 seconds, while they scrubbed their palms, the back of their hands, in-between their fingers, under their fingernails, and at least an inch up their wrists. After this, the subjects rinsed their hands and wrists thoroughly, still keeping their hands and forearms down. Then an ordinary clean paper towel (which was not sterilized or autoclaved) was given to and used by the patients to dry their hands, starting with their fingers and working towards their wrists and forearms (Hand Hygiene). For the individuals washing with hand sanitizer, they received one pump of Purell and they were instructed to rub their hands until dry getting in between their fingers, under their finger nails, their palms and the back of their hands.

After the subject had washed and dried their hands, the dominant hand was re-swabbed. This was done by wetting a new sterilized swab with the distilled water and again swabbing the subject's palm, in between their fingers and underneath fingernails. The "After" side of the BAP was then streaked with this swab again using three distinct lines. After inoculating both sides, the plates were set in an incubator at 36 degrees Celsius for 24-48 hours. After incubation, the

plates were carefully inspected. The “Before” and “After” sides were examined for reduction in the amount of growth obtained. Results for the antibacterial soap's efficacy at reducing bacteria were compared to the efficacy of the alcohol-based sanitizer based on the amount of colonies present on the plates. The results of the data were analyzed by counting the number of colonies presented on the plates. Plates that contain 120 colonies or more were classified as being too numerous to count.

Results

Antibacterial Soap (generic): Active Ingredient: Triclosan

Of the 40 random students cultured, 20 were subjected to a pre-wash hand culture, as well as a post contact with soap culture. Of these 20 students, only 6 showed a decrease in microbial growth after contact with the antibacterial soap. The remaining 14 showed an increase in the microbes present after washing with soap. This data can easily analyzed in figure 1.0

[Figure: Colonies cultured off hands before and after contact with soap]

data is further broken down into degrees of removal. These categories are: complete removal, no colonies present in post wash culture 0%; significant removal 25%, (decrease of >20 colonies); slight removal 10% (decrease of <20 colonies); significant increase 65%, (>20 colonies increase on post wash culture). For these categories the results are shown below in figure 1.1.

[Figure: Antibacterial soap]

Purell: Alcohol-based Waterless Hand Sanitizer: 62% Ethanol

Of the 40 randomly assigned students, the second group n=20 was subjected to a hand swab prior to contact with the waterless sanitizer and a post contact culture. Of the 2- students sampled, 18 culture samples showed a decrease in microbial growth. The remaining 2 samples showed an increase in microbes present after contact, with sample two showing the greatest

increase. This data is summarized in figure 2.0.

[Figure: Colonies cultured off Hands Before and After Contact with Purell]

The results are then broken down into the same degrees as the antibacterial soap. The results for Purell are as follows: complete removal 40%, significant removal 45%, slight removal 5%, and significant increase 10%. These results are summarized in figure 2.1

[Figure: Purell (Alcohol-based sanitizer)]

Statistical Analysis

The results were then put into the statistical analysis program SPSS 12, available on most computers at GVSU. By entering the differences from pre-contact vs. post-contact count of microbial growth, it was determined that the mean difference for Purell was 38.4 and -29.85 for antibacterial soap confirming that on average more microbes were present after contact with the soap compared to Purell. A two-tailed hypothesis test was then run with the alpha set at 0.05. A value of 4.456 was determined with a P value of 0.00/2, was still equaled 0. Upon further analysis it was determined that the null hypothesis was incorrect. For a true statistical analysis to be done the correct H_0 should have been $H_0: M_s = M_p$. In words, this states that there is no difference between using Purell and antibacterial soap to remove microbes. The H_a should have been $H_a: M_s \neq M_p$. In words this states that there is a difference between using Purell and antibacterial soap to remove microbes from the hand. If the correct H_0 was chosen, with the P value being 0 and the t value being 4.456, this would provide enough evidence to reject the H_0 . Since this is not the case and the H_0 and the H_a are switched this provides us only with enough evidence to fail to reject the H_0 . This information is summarized in figure 3.0 and 3.1.

[Figure: Group statistics]

[Figure: Independent samples test]

Discussion/Conclusion

The results of our study show that Purell hand sanitizer is more effective at removing microbes than antibacterial soap. After conducting the study, we found that there were many variables that may have affected the results. Some possible variables are contaminated soap and paper towels. This could have effected the results by introducing more bacteria to the subjects' hands during washing and while they were drying. Each subject's method of hand washing was slightly different. Less efficient hand washing could result in a decreased removal of microbes. Therefore, more microbes would be left on their hands. Methods of hand swabbing may have also varied. One investigator focused on swabbing the palm, between fingers, and especially under the fingernails. The other investigator focused primarily on the entire palm and deep in between the fingers. Another variation of swabbing was how much water was absorbed into each swab. The more water that is absorbed into the swab, the more bacteria you can pick up when swabbing. Some subjects did not allow their hands to dry completely before the investigators reswabbed the subject's hand. This may have resulted in the cleanser not being able to work properly. On the subject of not working properly, the soap itself may no have removed the bacteria, but rather pushed it around. So when the investigator re-swabbed, they may have picked up bacteria that was previously located in an area that the swab could not reach. This resulted in more microbes that were available to swab. Some of the locations included under rings, fingernails, and especially acrylic nails.

Another major variable may have been the type of media that was used. The media was a blood agar plate containing 5% sheep blood. The decision to use this type of media was based on the fact that sheep blood is an optimal environment for many types of bacteria to grow. This may have been an issue because it may have enhanced the rate of growth of most types of bacteria that are present on hands. The bacteria itself may have been opportunistic. Many of our plates grew yellow colonies on the before side and white colonies on the after side. After washing with the cleanser, the bacteria were able to grow because it was no longer inhibited and no longer competing with the other bacteria for nutrients.

If we were to do this experiment again, we would avoid these variables by having only one investigator do the swabbing, asking subjects to remove all rings, excluding subjects who

have long fingernails, and by demonstrating the proper techniques for hand washing. Other variables we could look at if we were to do the study again are the environment in which the study was conducted, larger sample size, gender of the subjects, and the subject's major. We would also be interested in finding out if the percentage of ethyl alcohol determines the bactericidal effects of the sanitizer.

Because Purell has been shown to effectively reduce microbial load on hands, we can agree with the manufacturer's label, which states, "This product removes 99.9% of bacteria when used properly." Previous studies have shown that "alcohol-based sanitizers containing 62% ethyl alcohol work well to kill bacteria" (6). The Purell used in this study also contained 62% ethyl alcohol. Based on our findings, 40% of our Purell samples resulted in complete removal of microbes. In addition to this, 45% of our Purell samples resulted in a significant decrease of microbial growth. A significant decrease refers to between one and four colonies that grew after sanitizing. About 5% of our samples decreased some, but not significantly. This leaves 90% of our samples showing a decrease of microbial growth. The other 10% of our samples resulted in significant increase of microbial growth. This is probably due to the confounding variables mentioned earlier. "Alcohols have excellent activity and the most bactericidal action of all antiseptics. Therefore, they are the preferred agents for hygienic hand rubs."

In another study, "subjects using antibacterial soap had 64% more bacterial colonies than those who used the alcohol-based hand sanitizer" (7). Our findings showed that 30% of our soap samples slightly decreased microbial growth. About 20% of our samples showed a significant increase in microbial growth. Approximately 50% of our results were either too numerous to count (>120 colonies) either on the before and after sides of the plate or only on the after side of the plate. The increased amount of microbial growth was probably due to the confounding variables mentioned earlier such as type of media used, hand washing procedure and swabbing techniques.

In conclusion, Purell hand sanitizer was more effective at removing microbial growth than antibacterial soap. Since Purell performed better at removal of bacteria and is more convenient, we feel that it would increase compliance with hand washing among health care

workers and students.

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[Appendix not included]