

The Comparison of Bacteria Populations under Artificial and Natural Nails, and the Effect of Hand Cleansing with Alcohol Based Gels and Antibacterial Soap

Mallory M. Griggs

ABSTRACT

The objective of this experiment was to measure the microbial populations that grow under natural nails and compare that outcome to the number of populations that grow under artificial nails. After this was recorded then a hand cleansing test was administered, and the effectiveness of removing colonies with antibacterial soap or an alcohol based gel was measured. There were a total of 16 volunteers. Eight had their natural nails and eight wore salon applied artificial nails. The experiment was done on all fingers of the dominant hand, and the volunteers were not permitted to wash their hands before the experiment. The area underneath each nail was swabbed with a long handle cotton swab. The swab was stirred around in a test tube of nutrient broth to dilute the concentration of the bacteria. Then some of the bacterial solution was put into another test tube of sterile broth to dilute the concentration even more. A small amount of the second diluted solution was measured and transferred onto plates of nutrient agar. Afterwards the groups were divided again to test the hand cleansing methods. Eight wearing artificial nails tested the Soft-soap® antibacterial soap and water, and eight tested the Purell® antibacterial gel. The natural nails were separated in the same way, and the samples after the hand washing were also plated. The cultures incubated for 24 hours and the plate's colony growth were counted. The results showed that there was a higher quantity of bacteria present in the artificial nails and the Purell® is better at eliminating bacteria than antibacterial soap and water. The average Percent Reduction are as follows: Purell® 91% for artificial nails and 84% for Natural nails, and Soft-soap® 82% for artificial and 52% for natural nails. I also calculated to Colony Forming Units which are the amount of bacteria that were originally on the cotton swab. The CFUs are as follows: Before wash; Purell® group artificial nails 2.9×10^5 CFUs, Natural nails 1.3×10^5 CFUs. Soft-soap® group artificial nails 1.5×10^5 CFUs, natural nails 1.4×10^5 CFUs. After wash; Purell® group artificial nails 2.6×10^4 CFUs, natural nails 1.8×10^4 . Soft-soap® group artificial nails 7.5×10^3 , natural nails 6.6×10^4 CFUs. All of these variables are based off of how clean of a person the volunteer is in the first place and how well your dilutions work.

Keywords: *Bacteria and nails, bacterial populations under nails, bacteria and artificial nails, nails and bacterial colonies*

INTRODUCTION

This study tests the growth of bacterial populations under artificial nails and under natural nails, and evaluates the effects of hand washing. The most common method of using soap and water will be one variable, and the second will be the most convenient method of using an alcohol based gel. Eliminating pathogens from your hands calls for the proper cleaning agents and thorough washing.

Regions beneath fingernails are one of the locations on hands that harbor microorganisms. Higher populations of microorganisms frequently occur beneath nails, and they are more difficult to remove than other locations (Chia-min et al 2002). Long fingernails tend to harbor more microorganisms than short nails, and artificial nails harbor higher microbial populations than natural nails.

Potentially pathogenic organisms such as *Staphylococcus aureus*, gram negative bacilli and yeast are associated with artificial nails. Organisms acquired in this manner are implicated as nosocomial pathogens and causes of food borne diseases (Wachukwu et al 2007). Education about this matter

is critical because poor personal hygiene has been the cause of many illnesses and the spreading of diseases. Every moment of every day we are using our hands, and most of the time we are not conscious of where our hands have been and what we are going to do with them next. Creating the habit of becoming more sanitary will help lessen our chances of falling ill. Even when our hands are washed, microbes still exist beneath the fingernails, and maybe even more so under artificial nails.

The promotion of fungal and bacterial carriage by sculptured nails may be partially related to the increased hydration of the false nail due to the high permeability of acrylic monomers (Baran 2003). When acrylic nails begin to grow out, the acrylic may start to lift from the natural nail. This opening appeals to any and all bacteria that your hands may come across. Once the bacteria are stuck in between the artificial nail and the natural nail, the only way to remove the bacterial population is to remove the nails. Even a five minute surgical scrub would not remove all of the colonies.

To be sure one is not supporting any more bacterial growth than needed; it is best to avoid wearing artificial nails, and to keep one's natural nails trimmed to less than 2 mm beyond the fingertips (Wachukwu et al 2007). So many harmful things can result from not taking adequate care of one's nails. If fungal growth goes too far it can lead to gangrene and the amputation of that finger. Letting the bacteria from around one's nails enter the body can cause an infection. This knowledge needs to be made available for more people because a lot of women wear artificial nails, and a lot of people don't take the proper steps to take care of themselves. The purpose of this study is to better self care awareness among the general public, especially those who wear artificial nails.

MATERIALS AND METHODS

Study design.

This study was meant to determine if more bacteria grow under artificial nails than under natural nails. Volunteers were identified among the students on the McPherson College campus and from customers at Creative Hairlines salon in McPherson. A total of 16 volunteers were chosen. Eight of the volunteers wore permanent acrylic artificial nails (salon-applied), and eight just had their natural nails. The fake nails were on for one to two weeks so that the volunteers could adjust to them and know how to function normally. Females were the group considered for this study because of the artificial nails and because longer nails are more common on females.

Volunteers were able to wash their hands as they would usually do on the day of the study, but washing their hands immediately before the sampling was not permitted.

Samples were taken from the dominant hand, and all five fingernails were used for one culture. After sampling, the volunteers washed their hands. For hand washing the volunteers were divided into two groups. Of the eight subjects with artificial nails, four washed their hands with Soft-soap® Antibacterial soap and water, and the other four used Purell® antibacterial gel. The subjects with natural nails were divided the same way. Cultures were then repeated after the cleansing process.

Sample collection.

Samples were collected during the afternoon which is a time of day at which hand washing would be less likely (not before eating or in the morning). The areas underneath the five fingernails of the dominant hand were moistened with sterile isotonic saline solution. The solution was to loosen the dirt and bacteria so that they would stick to the swab. The saline solution was sprayed onto the swab using an aerosol can. After this, the swab was stirred around in a tube with 10 mL of nutrient broth to dilute the concentration of

bacteria. To dilute the sample again and ensure a countable sample, a serial dilution was done where 0.2 milliliters of the bacteria broth was then transferred into 9.8 milliliters of sterile nutrient broth. The cultures were made by putting 0.2 milliliters of the diluted solution (from tube 2) on to the plate's surface; which were made of nutrient agar. The cultures were then incubated at 37° C for 24 hours.

Hand washing procedure.

When the volunteers washed their hands with the Soft-soap® Antibacterial soap and water the volunteers used the following method: Using warm water, they wet their hands and then applied the soap as the label recommends. For 10-15 seconds they rapidly rubbed their hands together creating lather, making sure to cover all surfaces of their hands while washing underneath their nails. Then they thoroughly rinsed their hands with distilled water and dried them with disposable towel.

When washing their hands with the Purell® antibacterial gel, the volunteers applied the recommended amount of gel to their hands. They continuously rubbed their hands together covering all surfaces of the fingers and underneath their nails until their hands were dry.

Microbial isolation.

The surface underneath the five fingernails on the dominant hand had samples collected. Culture plates that showed different types of growth were selected for staining. A heat fixed smear of the culture was prepared on a slide, and the bacteria were then stained to show if they were gram negative or gram positive and their shape (cocci, rod etc).

RESULTS

The experiment showed that before the hand washing process; the volunteers wearing the artificial nails had a higher number of isolated bacterial colonies than those with the native nails because there was a higher quantity present. Also, the fake nail cultures had a far more significant growth level than the natural nail cultures (Wachukwu, et al., 2007).

The cultures showed similar types of bacteria in both types of samples, but there were many recognizably different colonies as well. For the artificial nails, a large portion of the bacteria are found where the real nail was growing out from underneath the acrylic. Both sample types showed Gram- negative and gram- positive bacteria before washing their hands (McNeil, et al., 2001). After hand washing, the native nails had low amounts of remaining bacteria, but it was not as significant as the decrease with the artificial nails because the artificial nails initially had much more bacteria. The average Percent Reduction are as follows: Purell®

91% for artificial nails and 84% for Natural nails, and Soft-soap® 82% for artificial and 52% for natural nails. I also calculated to Colony Forming Units which are the amount of bacteria that were originally on the cotton swab. The CFUs are as follows: Before wash; Purell® group artificial nails 2.9×10^5 CFUs, Natural nails 1.3×10^5 CFUs. Soft-soap® group artificial nails 1.5×10^5 CFUs, natural nails 1.4×10^5 CFUs. After wash; Purell® group artificial nails 2.6×10^4 CFUs, natural nails 1.8×10^4 . Soft-soap® group artificial nails 7.5×10^3 , natural nails 6.6×10^4 CFUs.

After using the Soft-soap® antibacterial soap for washing their hands the amount of microbiota left underneath the nails proved to be higher from the false nails then from the natural nails. The same result occurred with the Purell® antibacterial gel, except the Purell® showed a more drastic reduction. This process confirmed that washing their hands with the soap and warm water was not as effective as the Purell®. Although washing with soap and water seems more thorough, the alcohol content in Purell® is at a level that effectively kills germs and bacteria. This is not to say that using soap and water is less effective, but Purell® showed the most growth prevention in these trials.

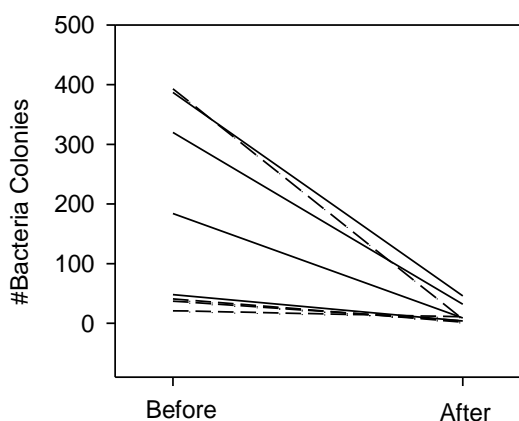


Figure 1. The numbers of bacterial colonies (gram-negative and gram-positive) that were found underneath the volunteers' artificial acrylic nails. These numbers represent the populations present before washing and after washing with both Purell® (bold) and Soft-soap® antibacterial soap (dashed).

DISCUSSION

The hands of an average member the McPherson community or of a student at McPherson College are always contaminated from their daily routines and surroundings. The organisms that are obtained can be easily removed with proper hand washing, but the reason the level of contamination is so high is failure to cleanse and cleanse often. Several previous studies, including mine, have found that those wearing artificial nails had more pathogens and bacteria than those with natural nails (McNeil et al

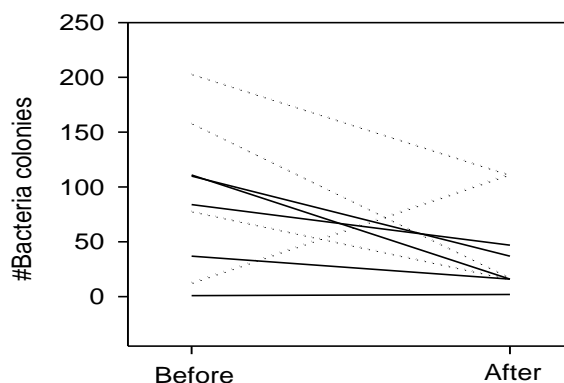


Figure 2. The numbers of bacterial populations (gram-negative and gram-positive) that were found underneath the volunteers' natural nails. These lines represent the populations found before washing and after washing with either Purell® (dotted) or Soft-soap® antibacterial soap (bold).

2001). This could be due to the characteristics of the acrylic, or just due to the fact that when hand washing, more attention is paid to the bulk of the hand rather than under the nail.

In this experiment, the number of bacteria killed in the hand washing process was higher with the alcohol based gel. The volunteers who washed with soap and water were told to wash their hands for 10-15 seconds covering all surfaces, but one error I experienced was that while I was preparing the next step of the experiment the volunteers would regress back into a lazy and quick method. They were rushing, and sometimes they wanted to preserve their manicure. The possibility of the antibacterial soap not working as efficiently could be due to an inefficient hand cleansing method. Another error that I encountered was that even though the dilutions were consistent, the sample depended on two things, the level of cleanliness of that individual, and the random chance of what bacteria end up in the pipette. It is inevitable that a dirtier hand will produce a higher number of colonies than a clean hand, and when the bacteria are mixed in solution the number of bacteria in the area of the pipette is uncontrollable. For this reason I wound up with a sample that had more bacteria in the after wash sample, than in the before wash. I also encountered plates growth had overtaken the plate in the after wash and the before wash produced only a few colonies.

For the next researcher who tries this experiment, they should try to eliminate the error from random chance if at all possible. People who choose to wear artificial nails should be better informed about the high levels of bacteria that fake nails harbor, and about how complicated it is to thoroughly clean them. The next step is to emphasize the importance of thorough hand washing and proper technique so that these types of realizations will not be an issue in the

future.

ACKNOWLEDGEMENTS

The nail technicians and customers of Creative Hairlines, Dr. Jonathan Frye, The McPherson College Science Department and the volunteers from the student body of McPherson College.

LITERATURE CITED

- Baran, R. 2003. Pathogen carriage in health care workers wearing nail cosmetics. *Dermatology Online Journal* 9 (1): 17-20
- Chia-min Lin, Fone-Mao Wu, M. Doyle, B. Micheals and K. Williams. 2002. Removal of *Escherichia coli* on Hands with Natural or Artificial Fingernails. Poster presentation, IAFP Annual Meeting pp 1-4.
- McNeil, S, C. Foster, S Hedderwick and C. Kauffman. 2001. Effect of Hand Cleansing with Antimicrobial Soap or Alcohol-Based Gel on Microbial Colonization of Artificial Fingernails Worn by Health Care Workers. *Clinical Infectious Diseases* 32: 367-372
- Wachukwu, C.K, S.D. Abbey, A.O. Ollor and N.L. Obilor. 2007. Public Health Implication of Artificial Finger Nails Used by Health Workers and Food Handlers in Port Harcourt, Nigeria. *Journal of Applied Sciences* 7 (22): 3580-3583.