Acrylic Nail and Native Nail Bacteria

Pelenita M. Tuupo, Saint Martin’s University, 5300 Pacific Avenue SE, Lacey, WA 98503. This work was supported by Saint Martin’s University.

Abstract

The purpose of my senior seminar experiment was to compare bacterial growth in both acrylic and native nails when they are unwashed and washed. My hypothesis was that in both instances, acrylic nails would contain more bacteria than native nails. I used two types of methods for my research. The first type of method I used was the Counting of Bacterial Colonies Method. The second type of method I used was the Spectrophotometer method. I tested for bacteria in both methods followed by recording my data for analyzing results. After all the data were collected, I used an ANOVA to compare bacterial growth between acrylic nails and native nails when unwashed and washed. I found no statistically significant difference in bacterial growth from acrylic nails and native nails (unwashed and washed). An uneven number of participants and the hand washing techniques of some people may have had an effect on why my results failed to support my hypothesis. It was odd that acrylic nails and native nails had more bacteria when washed than unwashed, because it is known that soap can reduce the amount of bacteria. It seems that the hand washing technique increased bacteria, as it lifted the bacteria from areas the water and soap couldn’t reach. I suggest more participants and better hand washing techniques if this experiment was to be repeated in the future, for better results regarding the comparison of bacteria in acrylic nails and native nails, unwashed and washed.

Introduction

In today’s society treatment of nails, such as nail cosmetics and acrylics, are increasingly used, especially by young women. Nail health is a health concern because the growth of bacteria within the nails causes unhealthy, thin, and brittle nails. Acrylic is a chemical used in nail cosmetics to fasten artificial nails to the natural nail, and contains methyl methacrylate (Gallagher et al., 2003). Items such as finger nail polish contain formaldehyde or toluene (chemicals used to harden nails) and can deteriorate nail beds over time (Eastburn, 2002). Acrylic nails are also associated with allergies that occur at the time of application to the nail itself, and distant allergic contact dermatitis (when small amounts of nail cosmetics are transferred by the hand to other areas of the body) (Orton and Wilkinson, 2004).

A recent epidemiologic survey by Orton and Wilkinson (2004) revealed that 23% of women experience some sort of adverse reaction to a personal care product (i.e. nail cosmetics) over the course of a year. Although most of these reactions may be due to subjective sensory irritation, some dermatologic patients who are patch tested are allergic to cosmetic products or their constituent ingredients (Orton and Wilkinson, 2004). Causative products include deodorants and perfumes, skin care products, hair care products, and nail cosmetics (Orton and Wilkinson, 2004). Not only will the chemicals in nail cosmetic products harm nails and cause allergic reactions, but nail cosmetic tools used in nail shops also contribute to complications with
nail health.

In nail salons the warnings about manicures exist, but some women tend to ignore them. It is important to consider these warnings in order to maintain healthy nails. Cuticle cutters that haven’t been sanitized properly can cause serious complications, ranging from an inflamed cuticle to hepatitis (Kurtzweil, 1995). Also the chances of developing parenchyma (abnormal growth in the supporting framework or tissue of an organ) are increased (Kurtzweil, 1995). Dirty instruments also contribute to infection by blood borne diseases such as HIV or hepatitis (Kurtzweil, 1995). Getting a manicure or pedicure can break the skin, therefore creating openings that allow contagious germs to enter and infect the body (Kurtzweil, 1995). Unclean equipment is also dangerous if the skin around the nail is broken. Infectious agents can move into the area around the nail if too much cuticle is cut, pushed back too far, or separated from the fingernail (Kurtzweil, 1995). Infections from bacteria (i.e. \textit{Staphylococcus}; fungi such as \textit{Candida} (also known as yeast); and skin viruses such as warts) are common problems associated with nails. Bacterial and fungal infections can result from artificial nails, regardless if they are applied at the salon or by one’s self at home. Any hard collision to artificial nails; i.e., a bump or knock, can lift the natural nail at the base, and present an opportunity for dirt and bacteria to enter. Bacteria and fungi can also grow in between the nails, and extend to the natural nail if the nail being re-glued isn’t properly cleaned (Kurtzweil, 1995).

Two current reports cite potential hazards to patients that might result from acrylic nails worn by health care workers. In one study (Parry \textit{et al.}, 2001) researchers identified a cluster of three post-laminectomy (chronic lower back and or leg pain) patients who were found to have osteomyelitis (bone (infection of the bone and the bone marrow) and diskitis (an inflammation, irritation, and swelling of the invertebral disk space between the bones) due to identical isolates of \textit{Candida albicans}. The infections were traced to an operating room technician who wore acrylic nails, and the implicated yeast was isolated from her throat. Acrylic nails here also been known to promote subungual (beneath a fingernail or toenail) growth of gram-negative bacilli and yeast (Parry \textit{et al.}, 2001).

In the second experiment there were 41 health care workers used to compare the reduction of microbial colonization, by either antimicrobial soap or alcohol based gel. McNeil \textit{et al.} (2001). Twenty-one of the health care workers had acrylic nails, and 20 had native nails. More pathogens were isolated from a majority of the health care workers with artificial nails than those with native nails. According to McNeil \textit{et al.} (2001) gram-negative bacilli were the most common pathogen isolated from the majority of the health care workers. Health care workers with acrylic nails are at high risk of being infected by gram-negative bacilli, \textit{Staphylococcus aureus}, or yeasts.

In 2000, an outbreak of \textit{Mycobacterium fortuitum} (\textit{M. fortuitum}) furunculosis, a disease associated with rapidly growing bacteria occurred in salons. Vugia \textit{et al.} (2005) studied infected customers who had used whirlpool footbaths at a nail salon. Researchers swabbed approximately 30 footbaths in 18 nail salons from 5 California counties. Researchers found Mycobacteria in 29 (97%) of the whirlpool foot baths. Of those footbaths tested, \textit{M. fortuitum} was the most common bacteria. Researchers also found that customers using whirlpool footbaths at a nail salon were more likely to contract \textit{M.fortuitum} furunculosis. Mycobacteria may pose an infectious risk for pedicure customers (Vugia \textit{et al.}, 2005).

Another outbreak of \textit{M. fortuitum}
Furunculosis occurred at a nail salon (Winthrop et al., 2002). In September of 2000, a physician in Northern California studied 4 patients. The physician described that these four patients had persistent culture-negative boils on the lower extremities, such as around the knees, or below the knees. All four patients described by the physician received pedicures at the same nail salon. From this news Winthrop et al. (2002) conducted a study using a control group of 48 patients infected with M. fortuitum and 56 unaffected friends and/or family (customers) who had a pedicure at the same salon. In the research, the M. fortuitum was cultured from 13 of the salon footbaths, and the toenails of 56 customers were compared by pulsed-field gel electrophoresis (Winthrop et al., 2002). As a result, 110 customers were identified with M. fortuitum furunculosis; 34 customers tested positive for rapid growing mycobacterium, and most of the infected patients had more than one boil, and all infected patients had footbaths done. Thirteen footbaths at the nail salon yielded M. fortuitum. Another factor that contributed to the infection was shaving. Shaving the legs prior to getting a pedicure increased the risk of infection. Winthrop et al. (2002) also concluded that the outbreaks of M. fortuitum were associated with surgical or clinical devices contaminated with water from a hospital or municipal water system.

Although acrylic nails may be enjoyed by many women, the negative effects often are ignored. Acrylic nails are hazardous in a hospital environment because the transmission of pathogens in nails, even after washing hands thoroughly, poses a health risk to patients under the care of a health care worker. Acrylic nails can also pose a risk to the customer getting her nails done because acrylic nails contribute to the growth of gram-negative bacilli and yeast (Perry et al., 2001). In most cases unsanitized salon tools such as footbaths, cuticle cutters, cuticle pushers, nail cutters, and nail files often cause customers to undergo bacterial infections such as M. fortuitum furunculosis. Winthrop et al. (2002) revealed that nail cosmetics in nail salons were hazardous to nail health and to the body. These studies focused on the importance of nail health, negative effects of nail cosmetics, and bacteria found on the tools used in the nail salons.

In my proposed study, I will study bacterial growth in the nails of female college students. Beautifying nails are the “fad” (the “in” thing) in today’s society. But what lies beneath the nails are the potential danger that puts their health at risk. The warnings are often told, but women often don’t ever take these warnings into consideration until they are affected. I am interested to find out the potential danger that lurks within the nails of the college females I will be testing. My hypothesis is that those with acrylic nails will harbor more bacteria underneath their nails than females with native nails, because infections from bacteria (i.e. Staphylococcus; fungi such as Candida (also known as yeast); and skin viruses such as warts) are common problems associated with nails. My rationale for this hypothesis are the many studies that show bacterial and fungal infections can result from artificial nails, usually in higher percentages than with native nails.

Methods

My study required 20 college female students (participants) – 10 participants had acrylic nails and 10 had native nails. However, I was only able to recruit 10 participants with native nails, and 8 with acrylic nails. College female students were chosen for this research, because it is common to find college female students...
with nail cosmetics. My goal was to compare bacteria in both acrylic and native nails, as well as observe which type of nail contains the most bacteria.

**Quantitative Plating**

The techniques for this method of research are taken from Brown (2005). The materials I used to prepare the Petri dishes were: Ward’s nutrient agar (80 ml, containing the ingredients of 3g/L Bacto peptone, and 15 g/L of Bacto agar) for testing the growth of bacteria on, 40 Petri dishes to pour nutrient agar in for testing of the growth of bacteria, an incubator, a hot plate for boiling the agar mixture, and an autoclave to sterilize the nutrient agar. I mixed the 80 ml of nutrient agar for 40 Petri dishes. Then I sterilized the nutrient agar by putting it into the Tuttnauer 2540E autoclave at 121°C, 15 psi for 15 minutes. After the agar had cooled slightly, it was poured into the Petri dishes, and allowed to solidify. I collected samples from my participants from 11 am to 2 pm on Wednesday, March 1, 2006. All the nails on the left hand of my participants were swabbed with cotton swabs, and then the cotton swabs were used to streak a Petri dish.

Next, I swabbed underneath all the nails of their right hand, and transferred the entire swab to the test tubes containing nutrient broth, described in method 2. Finally, I asked my participants to wash their hands. Upon returning from washing their hands, I gently swabbed underneath all the nails of both their left and right hand, using the swab from the left hand to swab the Petri dish and placed the swab from the right hand in a test tube with nutrient broth. These were my samples for washed hands.

These data I collected after counting the bacterial colonies was analyzed by using the Minitab program (Minitab, Inc., 2005) (ANOVA; Tukey’s family error rate) to get statistical analysis.

**Optical Density**

This method of quantifying bacteria in both acrylic and native nails also is from Brown (2005). It refers to the spectrophotometer, in which the concentration of bacterial cells is measured using light. Nutrient broth was prepared by adding 100 ml of distilled H2O to 80 grams of Bio Pro Premium nutrient broth which contains beef extract, and bio-gel peptone. The broth was poured into 45 test tubes, with 4 ml in each tube. The tubes were sterilized in an autoclave for at least 15 minutes at 121° C, and 15 psi. The broth was then removed from the autoclave and stored in a refrigerator at 4° C until needed for optical density measurements. I collected bacteria from participants with acrylic and native nails for this method by swabbing underneath all the nails on their right hand. After the nails were swabbed, the swab was transferred to the test tube containing nutrient broth. The culture collected in the test tubes was incubated at 37°C for 24 hours to allow bacteria to grow. Bacterial growth was then measured by using the Spectronic 20 Bausch & Lomb spectrophotometer, and recording the optical density for each sample at 480 \( \lambda \). Afterwards, I took my data that I recorded, and used the Minitab program (Minitab, Inc., 2005) (Anova; Tukey’s family error rate) for statistical analysis.

**Results**

As a result of using the Counting Bacterial Method (method 1) and Spectrophotometer method (method 2) to gather my data, I found there was no
difference in bacterial growth between acrylic nails and native nails. Table 1 shows the numbers of bacterial colonies found when participant’s native and acrylic nails of both hands were swabbed while unwashed, and washed.

Table 1. Summary of data for the number of bacterial colonies found cultured on Petri plates that were incubated at 37°C for 24 hours, acrylic and native nails both hands, unwashed and washed. Each number refers to an individual participant. Means and standard deviations are also listed.

<table>
<thead>
<tr>
<th></th>
<th>Unwashed</th>
<th></th>
<th>Washed</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Native Nails</td>
<td>Acrylic nails</td>
<td>Native Nails</td>
<td>Acrylic Nails</td>
</tr>
<tr>
<td>120</td>
<td>1144</td>
<td>320</td>
<td>312</td>
<td>1400</td>
</tr>
<tr>
<td>2600</td>
<td>680</td>
<td>2248</td>
<td>2288</td>
<td>2348</td>
</tr>
<tr>
<td>420</td>
<td>1336</td>
<td>164</td>
<td>3224</td>
<td>2696</td>
</tr>
<tr>
<td>2460</td>
<td>2096</td>
<td>3984</td>
<td>1184</td>
<td>1112</td>
</tr>
<tr>
<td>1500</td>
<td>1484</td>
<td>2348</td>
<td>3224</td>
<td>2696</td>
</tr>
<tr>
<td>1484</td>
<td>972</td>
<td>2096</td>
<td>1112</td>
<td>1248</td>
</tr>
<tr>
<td>312</td>
<td>2288</td>
<td>2348</td>
<td>3224</td>
<td>2696</td>
</tr>
<tr>
<td>1144</td>
<td>972</td>
<td>2096</td>
<td>1112</td>
<td>1248</td>
</tr>
<tr>
<td>784</td>
<td>292</td>
<td>376</td>
<td>3120</td>
<td>3224</td>
</tr>
<tr>
<td>1360</td>
<td>1164</td>
<td>516</td>
<td>3120</td>
<td>1128</td>
</tr>
<tr>
<td>3320</td>
<td>No participant</td>
<td>324</td>
<td>No participant</td>
<td>1128</td>
</tr>
<tr>
<td>884</td>
<td>No participant</td>
<td>376</td>
<td>No participant</td>
<td>3224</td>
</tr>
<tr>
<td>1080.8</td>
<td>1169.5</td>
<td>1738.8</td>
<td>1992</td>
<td></td>
</tr>
</tbody>
</table>

Figure 1. The average number of bacterial colonies grown on a Petri dish for 24 hours at 37°C found on native nails and acrylic nails (unwashed and washed) on both hands. The number of participants in the native nails group was 10, and the number of participants for the acrylic nails group was 8. Each error bar represents one standard deviation about the mean. No significant difference was seen between the groups (F=1.66; d.f.=3; P=0.195).
Contrary to expectation, native nails that were washed had the highest average, and nails that were unwashed had the lowest average. When comparing acrylic (washed and unwashed) nails, washed acrylic nails had the highest average and unwashed acrylic nails had the lowest average. An analysis of variance (Minitab; Anova) showed that there was no significant difference between the number of bacterial colonies grown on a Petri dish from samples taken from the four groups (native nails unwashed, acrylic nails unwashed, native nails washed, and acrylic nails washed) (F=1.66; d.f.=3; P=0.195). In Figure 1, it is contrary to expected results that both washed native and acrylic nails contained more bacteria than both sets of nails unwashed. The error bars, which denote one standard deviation, demonstrated a large variation within each group between the number of bacterial colonies found on nails when they were unwashed, or washed. Figure 1 indicates that all nails after being incubated for 24 hours at 37°C yielded a minimum of 1,000 bacterial colonies on a Petri plate with nutrient agar.

Figure 2 refers to the spectrophotometer method, in which the concentration of bacterial cells was measured with light (transmittance, a set wavelength, and absorbance). The higher absorbance means more bacteria, and lower absorbance means fewer bacteria to absorb the light. The mean absorbance for acrylic nails was 0.4570, and the mean absorbance for acrylic nails was 0.223. The mean absorbance for acrylic nails was higher than the mean absorbance for acrylic nails. Since the error bars denoting the standard deviation overlap, there was no significant difference between the two groups of nails. Statistically, my null hypothesis is accepted. This means that there is no significant difference in bacterial growth between native and acrylic nails when absorbance was measured, even though the mean absorbance of both groups of participants appeared different (F=1.68; DF=1; P=0.214).

![Figure 2](image_url)

*Figure 2. The average absorbance found for unwashed native nails and acrylic nails (unwashed) when measured with the spectrophotometer. Each error bar represents one standard deviation about the mean. One bar represents 10 native nail participants, and the other represents 8 acrylic nail participants, whose left hand was swabbed unwashed. The nutrient broth used for this method was incubated at 37°C for 24 hours.*
Discussion

I hypothesized that acrylic nails would contain more bacteria when they were unwashed and washed as compared to native nails. However, my data failed to support my hypothesis. According to my data, there were no significant differences between native and acrylic nails in bacterial growth either washed or unwashed statistically (d.f.=3; F=1.66; P=0.195). The first set of my data was obtained by using method 1, the counting bacterial colonies method. The results indicated that washed native nails had a higher average and unwashed native nails had a lower average when comparing the number of bacterial colonies found in the Petri dish, though statistically there was no statistical difference between the groups.

On the other hand, washed acrylic nails had a higher average, and unwashed acrylic nails had a lower average when comparing the number of bacterial colonies found in the Petri dish, but again there was no statistical difference between the groups. I found it interesting that washed acrylic and native nails contained more bacteria than unwashed acrylic and native nails, because I expected the washing of the hands to reduce bacteria. Yet Figure 1 demonstrates that washed acrylic and native nails had a higher average in the number of bacterial colonies, and unwashed acrylic and native nails had a lower average. The error bars in Figure 1, specify a large variation within each group between the number of bacterial colonies found on nails when they were unwashed or washed, which could partially explain my results. My data were extremely variable between participants.

The next set of my data was obtained by using the spectrophotometer. After doing this method, results still lead to no significant differences between the two groups of nails. In Figure 2, bacteria from native nails absorbed more light than bacteria from acrylic nails. Statistically, there was no significant difference in bacterial growth here between native and acrylic nails when absorbance was measured (F=1.68; d.f.=1; P=0.214). Low sample sizes and high variability between participants may explain this outcome.

My data failed to support my hypothesis that acrylic nails would contain more bacteria when they were unwashed and washed as compared to native nails. The possible reasons for the results of my experiment could be due to a limited number of participants, and the effectiveness of the participant’s hand washing method contributing to the amount of bacteria, instead of reducing it. In other words, more acrylic nail participants would have, in my opinion, balanced out the number of participants, affected the results in a way that more data would have made the values more significant, leading to the possibility that my hypothesis would be correct. The effectiveness of the participant washing their hands is another possibility to why results showed that washed acrylic and native nails had the higher average in comparing the number of bacterial colonies found with in the Petri dishes.

If further studies were to be done, I would modify a few factors. Ways this study could be modified are recruiting more participants next time, such as 40 participants for both native and acrylic nails. I would also modify this study by having the participants improve their hand washing methods, and then compare the data to see if there were any changes.

Nail health is important and more warnings about nail cosmetics should be brought to the attention of many people, especially women. I would do this research after it has been modified; hoping that the information will contribute to women’s
safety and health, and that the results of comparing bacteria growth in acrylic and native nails will be meaningful, leading to the reduction of bacteria within nails and increase of nail health.

Acknowledgements

I am glad to give special thanks to the many individuals; my senior seminar research project would not have been successful without your help. First I would like to thank Dr. Mary Jo Hartman for helping me prepare nutrient agar and broth for my research, edit my papers, analyze my results statistically, and with my presentation. I thank Dr. Olney for also helping me prepare nutrient agar and broth for my research, and for helping me with questions that I had about my papers and presentation. I would like to thank Cheryl Guglielmo as well, for showing me where tools were around the biology lab room and providing me with hints on how to make my research in lab quick and safe. I thank my participants for volunteering their time to be a part of my research. I am glad to thank the following individuals for their time and company during the weeks I was doing my research. Last but not least, I thank the Saint Martin’s University Institutional Review Board for allowing me to do my research on the topic of comparing bacterial growth between native nails and acrylic nails. I appreciate all your help and guidance with gratitude.

Literature Cited


Minitab Inc, 2005.