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The home use of antibacterial hand soap among women in Clark County, Nevada

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THE HOME USE OF ANTIBACTERIAL HAND SOAP

AMONG WOMEN IN CLARK COUNTY, NEVADA

By

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ABSTRACT

The Home Use of Antibacterial Hand Soap Among Women in Clark County, Nevada

By

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The use of antibacterial products in the home is increasing. The broad-based use of these products may lead to antibiotic resistance and adverse health effects of the user due to exposure to the active ingredient(s). A cross-sectional study of Clark County, Nevada women was conducted to examine the relationship between the use of antibacterial soap in the homes of women who reside in Clark County and their knowledge regarding the negative side effects that could result from the use of antibacterial products, especially those containing triclosan.

A survey was used to determine: 1) the reason women are using antibacterial products in their homes, 2) if they are aware of the negative outcomes that can result from

and if they are under the impression that all bacteria are bad.

The survey was distributed to participants at four Nevada Department of Motor Vehicle facilities in Las Vegas. The dependent variable was the use (yes or no) of antibacterial soap. Independent variables were the age (older than 30 or 18-30 years old), the economic status (more than $46,000 annual household income or less), and the participants' awareness of the real facts about the antibacterial soap including having side effects, causing bacterial resistance, being ineffective against viral infections, and not being a cost effective infection control measure. The majority of the variables are reported as categorical data. SPSS version 13 was used to calculate descriptive statistics from both quantitative and qualitative questions.

A large majority of participants used antibacterial soap in their home. Most of the participants who claimed to use antibacterial soap felt that it offered better protection from germs than regular soap. A majority of participants who used antibacterial soap also claimed that it protected them from a cold and the flu.

Antibacterial soap is does not offer any additional protection against germs than regular soap. The purpose of

hand washing is to rid the skin of potentially harmful bacteria, not to destroy all the bacteria that are present.

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I would like to thank Brian for being brave enough to move to Las Vegas so that I could pursue this degree.

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CHAPTER 1

INTRODUCTION

For more than one hundred years people have been using ordinary soap and warm water to clean their hands (Boyce et al 2002). This combination has proven successful in restricting the growth of bacteria and preventing the spread of disease. However, within the last ten years, there has been an emergence of antimicrobial products that claim to be the best at stopping unwanted disease-causing microorganisms from entering our homes and our bodies. The question "Are these products really helping us stay healthy or are they threatening the delicate balance of organisms that we have become accustom to in our environment?" has arisen because of the vast quantity of antimicrobial products now available to the consumer. The overuse of antibacterial products containing triclosan within homes of healthy individuals has been evaluated and cause for concern has developed for numerous reasons (Aiello, et al 2003). "Studies have increasingly linked triclosan to a

range of health and environmental effects, from skin irritation, allergy susceptibility, bacterial and compounded antibiotic resistant, and dioxin contamination to destruction of fragile aquatic ecosystems"(Glaser 2004).

A cross-sectional study that examined the relationship between the use of antibacterial soap in the homes of women who reside in Clark County, NV, and their knowledge regarding the negative side effects that could result from the use of antibacterial products, especially products containing triclosan was conducted. Women were selected as the target population for this study due to the assumption that they are the primary decision makers for which household cleaning products to purchase, including antibacterial products. A survey was used to determine: 1) the reason women are using antibacterial products in their homes, 2) if they are aware of the negative outcomes that can result from using antibacterial soap, 3) if they are aware of the difference between a viral and a bacterial infection, 4) and if they are under the impression that all bacteria are bad.

This study was designed to demonstrate that if women are unaware of the harmful outcomes that can occur with

the use of antibacterial products then education can be designed to help increase awareness regarding the unnecessary use of antibacterial soap. It was expected that the women surveyed would be unaware that a majority of diseases transmitted by our hands are viral in nature, thereby rendering antibacterial soaps useless in the fight against infection.

CHAPTER 2

BACKGROUND

Antimicrobial pesticides are substances or mixtures of substances used to destroy or suppress the growth of harmful microorganisms whether bacteria, viruses, or fungi on inanimate objects (Glaser 2004). These products are registered and regulated by the U.S. Environmental Protection Agency (US EPA) for use as pesticides in gardening. However, because of a loophole in the federal law, these same chemicals are used in products such as soap, toothpaste and lotion. When used in these ways, the chemical active ingredients are not considered pesticides, and are regulated by the U.S. Food and Drug Administration (FDA).

Between the years of 1997 and 1999, more than 700 products were introduced claiming to be "antibacterial" or "disinfectant" (Levy 2001). These antimicrobial products contain approximately 275 different active ingredients and come in a variety of formulations: sprays, liquids, concentrated powders, and gases (Glaser 2004). Of these

active ingredients, there is one that is raising serious concern. This chemical is triclosan.

Triclosan has been on the market for over 30 years. Initially it was confined to health care settings where it was introduced to the health care industry in a surgical scrub in 1972 (Glaser 2004). Thirty-five years later, triclosan is now the most common antibacterial agent used in household products. Over 75% of liquid soaps and nearly 30% of bar soaps (45% of all soaps on the market) contain some type of antibacterial agent (Glaser 2004). Triclosan was the most common agent found; nearly half of those list triclosan as the active ingredient. Triclosan is not only found in soap. It is also added to cleansers, toothbrushes, cosmetics, deodorants, kitchenware, plastics, fabrics, toys, computer equipment, and numerous other items. It is believed that the increase in consumer products containing triclosan that have recently flooded the market is due to the public's fear of communicable bacteria (Schweizer 2001).

Triclosan is a synthetic broad-spectrum antimicrobial agent (Schweizer 2001). Other antimicrobial chemicals have multiple target sites within the microbial cell and the overall damage to these target sites results in a bactericidal effect (Maillard, 2002). However, the mode of

action and target site in which triclosan destroys bacteria is very similar to the method used by some antibiotics. Triclosan was originally described as a non-specific biocide, meaning that microbial membrane structure and function were affected. "Triclosan was recently shown to target a specific bacterial fatty acid biosynthetic enzyme, enoyl-[acyl-carrier protein] reductase (ENR), in gram-negative and gram positive bacteria, as well as in the *Mycobacteria*" (Schweizer 2001). Once the ENR has been inhibited, the cell is no longer able to synthesize fatty acids. Fatty acid synthesis is necessary for building cell membranes and reproduction. If this process cannot occur, the organism will die. It is this practice that has researchers concerned about the possibility of emerging antibiotic resistance due to the increased use of triclosan (Aiello, et al 2003).

The antibacterial substances added to diverse household cleaning products are similar to antibiotics in many ways. When used correctly, they inhibit bacterial growth. However, in contrast to antibiotics, their purpose is not to cure disease, but to prevent transmission of disease-causing microorganisms to non-infected persons. Like antibiotics, these products can select for resistant bacterial strains. Therefore, overuse of antimicrobial

products in the home can be expected to propagate resistant microbial variants (Levy 2001). Unlike antibiotics, which are either found in nature or mimic the action of natural substances, antibacterial soaps contain synthetic chemicals (e.g. triclosan) that manufacturers once claimed could wipe out all bacteria (Gorman 2002). However, the notion that all bacteria are bad and need to be destroyed is a misconception.

CHAPTER 3

SIGNIFICANCE

Many studies have been performed to determine the effect that the chemical agent triclosan is having on humans and the environment resulting from the sudden increase of antibacterial products being used daily in the homes of healthy individuals (Levy 2001).

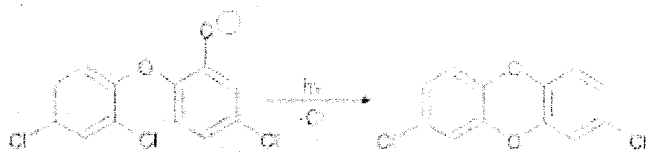
Triclosan has not been found to have any carcinogenic, mutagenic, or teratogenic effects (Glaser 2004), but there is some anxiety associated with the fact that triclosan will bioaccumulate in fatty tissues because of its lipophilic nature (Glaser 2004). A study done in Sweden indicated that triclosan does get absorbed into the body (Adolfsson-Erici, et al 2002). The researchers found high quantities of triclosan in the breast milk of 60% of the women who participated in the study. Another fear is that triclosan can interfere with the body's thyroid hormone metabolism. This idea led to a study that found that triclosan had a marked hypothermic effect, lowering the body temperature, and over all caused a "nonspecific

depressant effect of the central nervous system" of mice (Miller 1983). This research concluded that triclosan can be a possibly dangerous chemical, but the chemical alone is not the only problem as the byproducts of triclosan have the potential to cause harm as well.

Recently a startling link between triclosan and its link to dioxin has been discovered. The US EPA defines dioxins as "a group of chemical compounds that share certain chemical structures and biological characteristics. Several hundred of these compounds exist and are members of three closely related families: the chlorinated dibenzo-*p*-dioxins (CDDs), chlorinated dibenzofurans (CDFs) and certain polychlorinated biphenyls (PCBs). Sometimes the term dioxin is also used to refer to the most studied and one of the most toxic dioxins, 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD). CDDs and CDFs are not created intentionally, but are produced inadvertently by a number of human activities." Natural processes also produce CDDs and CDFs. It is important to note that different dioxin compounds have different toxicities and dioxins are most often found in mixtures rather than as single compounds in the environment.

Evidence published in 2003 demonstrated that sunlight converts triclosan into 2, 8-dichlorodibenzo-p-dioxin (Latch et al 2003). Figure 1 demonstrates the conversion.

Figure 1 Conversion of triclson to 2,8-dichlorodibenzo-p-dioxin when exposed to sunlight (Latch et al 2003)



This transformation is naturally occurring, but the conversion can also occur during the manufacturing process.

Dioxin can be found in triclosan as synthesis impurities and it can be formed with the incineration of triclosan (Kanetoshi, et al 1988). Dioxins are hormone-disrupting chemicals that mimic the action of natural oestrogen (Thomas 2005). Oestrogen levels in the body are generally low and well balanced. Too much oestrogen is recognized as a carcinogen. The US Department of Health and Human Services in 1998 concluded that dioxins can also cause severe health problems such as; weakening of the immune system, decreased fertility, altered sex hormones, miscarriage, birth defects, and cancer.

A team of researchers found that chlorine in tap water and the triclosan in some soaps and toothpastes can react together and form a harmful chloroform gas that can be absorbed through the skin or inhaled (Rule, et al 2005). Inhalation of large quantities of chloroform gas could result in depression, liver problems, and possibly cancer (Thomas 2005).

Another concern with the increased use of antimicrobial products is the "hygiene hypothesis." This theory suggests that there is a direct correlation between too much hygiene and increased allergies and asthma (Strachan 1989). This hypothesis is based on studies that have been done that conclude that people raised in an environment overly protective against microorganisms have a higher frequency of allergies, asthma, and eczema. In order for the body's immune system to function properly, it needs to be challenged and exposed to different microorganisms. If this exposure does not occur, the immune system is prevented from developing and maturing properly, and the weakening of the immune system could lead to more serious health concerns. While a weakened immune system is a serious condition, another concern regarding the rise in the use of antibacterial is development of antibiotic resistance.

Target mutations, increased target expression, active efflux from the cell, and enzymatic inactivation/degradation are mechanisms that are used by bacteria to develop triclosan resistance (Schweizer 2001). These are the same types of mechanisms that can be found in antibiotic resistance and some of them account for the observed cross-resistance with antibiotics in laboratory isolates (Schweizer 2001). "Therefore there is a link between triclosan and antibiotics, and the widespread use of triclosan-containing antiseptics and disinfectants may indeed aid in the development of microbial resistance, in particular cross-resistance to antibiotics" (Schweizer 2001). There have been numerous studies involving different organisms have shown resistance to triclosan in the laboratory.

Pseudomonas aeruginosa is a gram-negative bacterium that is a clinically significant pathogen, especially in immunocompromised hosts (Chaunchuen et al 2001). It is difficult to treat infections caused by this organism because of its many antibiotic resistances. However, *Pseudomonas* spp. have reported to be intrinsically resistant to triclosan because of their high efflux capacity with respect to triclosan, because the bacteria possess an alternative triclosan-resistant enoyl-acyl

carrier protein reductase, and because of the ability of the bacteria to degrade triclosan (Moretero, et al 2005).

Another study investigated the resistance of triclosan-adapted *Escherichia coli* K-12 and *E. coli* O55 to antimicrobial agents and compared these to *E. coli* O157:H7 (Braoudaki & Hilton 2004). Previous research with *E.coli* O157:H7 demonstrated that resistance to triclosan could be achieved following only two sub-lethal exposures (Braoudaki & Hilton 2003). The 2004 study showed that "Resistance in *E. coli* K-12 and *E. coli* O55 was readily achieved by repeated passage in sub-lethal concentrations of triclosan" and that exposure to relatively low concentrations of triclosan led to a high-level of resistance within four passages for both strains tested. Previous studies done by Braoudaki et al (2003) also demonstrated that triclosan-resistant strains of *E. coli* O157:H7 were resistant to a wide panel of antimicrobial agents including chloramphenicol, tetracycline, amoxicillin, amoxicillin/clavulanic acid, and trimethoprim as well as to biocides benzalkonium chloride and chlorhexane. However, this study concluded that cross-resistance in *E. coli* K-12 and *E. coli* O55 was observed, but at a lesser extent than in *E. coli* O157:H7.

Once these organisms develop resistance, they will be able to survive when exposed to triclosan. Triclosan will reduce the numbers of "good bacteria," leaving the space and nutrients available for resistant and possibly dangerous bacteria to flourish (Glaser 2004). Gorman (2002) believes that prudent consumers, for their own good, not to mention the good of the planet, should keep triclosan products out of the house. If bacteria become resistant to antibacterial products like triclosan, these products will be rendered useless to those who actually need them, such as people with compromised immune systems. Regrettably, laboratory studies have demonstrated organisms that have already become resistant to triclosan due to the overuse of antibacterial products (Aiello, et al 2003).

Community-associated methicillin-resistant *Staphylococcus aureus* (CA-MRSA) has become an increasing problem around the globe. There are laboratory findings that suggest a link between this resistance in CA-MRSA and the use of antibacterial products (Levy 2001). Resistance will continue to increase as long as the product persists, especially at low levels (e.g. residues, such as soap scum or film) for long periods of time (Levy 2001). It is important to note that antibacterial resistance is not a problem with products that do not leave residues such as

alcohols, bleaches, and peroxides (Levy 2001). Once these products have evaporated, there is no risk for the development of resistant organisms.

Unfortunately, triclosan is being added to many consumer products besides hand soap. When triclosan is incorporated into polymers it is sold under the trade name Microban. A study conducted in Norway looked at the effectiveness of triclosan incorporated in industrial flooring materials that have been introduced to the food industry in order to improve hygiene (Moretro, et al 2005). A poultry processing plant was visited and samples were taken on two different occasions. The first sample was taken during production in the cold cuts department. The second sample was taken after cleaning and disinfection. A wide variety of both gram-negative and gram-positive bacteria were isolated from a triclosan floor, and these organisms exhibited a wide range of sensitivity to triclosan.

Humans are not the only species being affected by triclosan as this chemical has found its way into the environment and the consequences there are alarming. Over 95% of the uses of triclosan are in consumer products that are disposed of in residential drains (Reiss et al 2002). In a U.S. Geological Survey study of 95 different organic

wastewater contaminants in U.S. streams, triclosan was one of the most frequently detected compounds, and was found in some of the highest concentrations. However, the study by Kolpin et al (2002) that surveyed triclosan in 139 streams across 30 US states, including stream sites flowing into the southern regions of Lake Michigan and Erie, reported maximum and median concentrations of 2300 and 140 ng/L, compared to 2,500 µg/ml that is the concentration in soap(Levy 2001). Water treatment facilities are not removing the chemical from the water and the compound is highly stable for long periods of time. Given that triclosan is found in such high concentrations it has been found to be highly toxic to different types of algae (Tatarazako, et al 2004). The presence of triclosan affects both the structure and the function of algal communities in stream ecosystems (Wilson, et al 2003). Algae are first-step producers in aquatic ecosystems, so if high levels of triclosan are found in the environment, there could be a possible destruction of the balance of aquatic ecosystems.

CHAPTER 4

MATERIALS AND METHODS

It is hypothesized that if women in Clark County, NV are unaware of the negative side effects that can occur by using antibacterial soap, they are more likely to use it in their home on a daily basis. It is also hypothesized that if these women were aware of the following three points:

1. Possible negative outcomes that can result from using antibacterial soap containing triclosan as the active ingredient,
2. The difference between a viral and a bacterial infection,
3. That not all bacteria are harmful

then they would be more likely to discontinue routine use of antibacterial hand soap in their home.

Research Question

What is the relationship between the use of antibacterial soap in the homes of women who reside in

Clark County, NV and their knowledge regarding the negative side effects that could result from the use of antibacterial products containing triclosan?

Hypothesis

The hypothesis for this study is that not being aware of the harmful side effects of antibacterial soap is associated with its use.

Study Design

The study was a cross-sectional design of women in Clark County, NV. A survey was developed and approved by the UNLV Institutional Review Board (IRB) to gather data from volunteers on the use of antibacterial products and their effectiveness.

Study Sample

Eligibility and exclusion criteria

- Adult women (≥18 years old) who are residents of Clark County, NV and are English speakers were included.
- Men were excluded from participation. Women who are non-English speakers were excluded from the study as it would be difficult to communicate with non-English speakers. Non-Clark County, NV residents were excluded

as the site of the survey was limited to offices of the Department of Motor Vehicles, Clark County, NV.

Recruitment Approach

The survey was distributed through three Nevada Department of Motor Vehicle (DMV) facilities across the Las Vegas valley. The DMV was chosen for the study because it is a place where a population with diverse backgrounds can be found and the DMV is a site focused on individuals establishing residency in the county.

Intervention

Adult women (≥ 18 years of age) at the various DMV facilities were asked to complete an IRB approved five-to-ten minute survey. Informed consent was obtained prior to participation in the survey.

Outcome Measure

The dependent variable is the use or nonuse of antibacterial soap.

Predictor Variables

Independent variables are the age (18-30 years old and older than 30), the economic status (more or less than

$46,000 annual household income), and the participants' awareness regarding the facts about antibacterial soap. These facts include: side effects, bacterial resistance, ineffectiveness against viral infections, adverse health effects (e.g., rashes), and being not a cost effective infection control measure. The majority of the variables are reported as categorical data (Table 1).

Table 1 Predictor Variables

Variable	Data/Operation	Question
Education	Categorical	What is the highest level of education you have completed?
Income	Dichotomous	Is your annual household income less or more than $46,000?
Age	Categorical	Your age is?
Caregiver	Dichotomous	Do you have children under the age of five in your care?
Possible side effect	Dichotomous	Do you know what antibacterial resistance is?
Protection from disease	Categorical	The use of antibacterial soap protects me better than regular soap against the flu?
Infection etiology	Categorical	The use of antibacterial soap protects me against germs that cause the most common household infections?
Consequences from soap use	Dichotomous	Do you think there are harmful side effects that can come from the use of antibacterial soap in your home?

Statistical Analysis

Descriptive statistics were calculated from both quantitative and qualitative questions. SPSS 13 was used for data analysis.

Protection of Human Subjects

Approval for the study was obtained from the UNLV IRB. All the answer sheets were coded with numbers and not linked to any personal identification. Data are stored in a safe and locked cabinet in the Principal Investigator's office and the data will be stored for 3 years after the completion of this study.

CHAPTER 5

RESULTS

Two hundred surveys were distributed and 164 were returned completed. In an effort to obtain 200 completed surveys, 50 more surveys were distributed and 31 were returned completed. One was filled out by a participant who was under 18 years of age, so a total of 194 surveys were used for analysis.

Out of the 250 surveys that were distributed, 194 qualified women completed the survey. Eighty seven percent (169) of these women claimed to use antibacterial hand soap in their home. Only twenty five participants reported that they did not use antibacterial soap in their home.

Demographic Information

Four different categories were used to establish the education level of respondents. Forty two percent completed college (Table 2).

Table 2 Education level of survey participants

Level of education	Frequency (# of participants)	Relative frequency (%)
High school	73	37.6
Voc/Tech school	17	8.8
College	82	42.3
Graduate school	18	9.3
No response	4	2.1
Total	194	100.1

Almost 10% of the participants are employed in the health care industry. Table 3 is a listing of the occupational breakdown of the survey participants.

Table 3 Occupation breakdown of survey participants

Occupation	Frequency (# of participants)	Relative frequency (%)
Customer Service	16	8.2
Disabled	1	0.5
Education	13	6.7
Financial	13	6.7
Food/Beverage Industry	11	5.7
Gaming	7	3.6
Health Care	19	9.8
Housewife	11	5.7
Legal	3	1.5
Management	15	7.7
Other	34	17.5
Retired	13	6.7
Self employed	3	1.5
Student	5	2.6
No response	28	14.4
Unemployed	2	1.0
Total	194	99.8

The greatest numbers of participants (21.1%) were between ages 30 and 39. Only 3.1% were above 70 years old (Table 4).

Table 4 Age category of survey participants

Age	Frequency (# of participants)	Relative frequency (%)
18-24	35	18.0
25-29	27	13.9
30-39	41	21.1
40-49	37	19.1
50-59	29	15.0
60-69	15	7.7
70 and above	6	3.1
No response	4	2.1
Total	194	100.0

Fifty one percent of participants had a household annual income of $46,000 or more. Almost ten percent did not respond to the income question. One hundred and forty one (72.7%) participants do not have a child under the age of five in their home (Table 5).

Table 5 Children under age 5 in the homes of participants

Children in home	Frequency (# of participants)	Relative frequency (%)
Yes	47	24.2
No	141	72.7
No response	6	3.1
Total	194	100

Disease Protection from Antibacterial Soap

One hundred thirty nine participants (71.6%) responded that they believe that antibacterial bacteria soap protected them better against germs than regular hand soap. Thirty eight participants (19.6%) said there was no difference between antibacterial and regular hand soap. Only 6.7% of participants responded that regular soap provided better protection against germs than antibacterial soap. There were four participants that did not respond to this question (Table 6).

Table 6 Response of survey participants when asked about antibacterial soap compared to regular soap

Disease Protection	Frequency (# of participants)	Relative frequency (%)
No difference	38	19.6
Antibacterial soap better	139	71.6
Regular soap better	13	6.7
No response	4	2.1
Total	194	100.0

Feelings Regarding Germs

A majority of participants (62%) disagreed when asked if all germs were bad. Nine participants did not respond to this question. When responding to the question regarding whether killing all germs keeps one healthy, one

hundred fourteen (58.8%) participants disagreed. Thirteen participants did not respond to this question.

Thirty six (18.6%) participants indicated that antibacterial hand soap kills all germs. Nineteen participants opted not to answer this question. One hundred twenty three participants (63.4%) responded that bacteria can be good.

Antibacterial Resistance

Fifty nine percent of respondents did not know what antibacterial resistance was. Seventy two participants said that they knew what antibacterial resistance was and most of these participants provided a definition. The following are some of the definitions that were provided:

- "Your body does not have the ability to fight infection"
- "Will not protect sometimes"
- "Your body resists bacteria"
- "The ability for our immune systems to properly fight germs-infections"
- "It kills bacteria (good & bad)"
- "Some of the bacteria have become resistant to antibiotics"

- Bacteria that can get more and more aggressive because they are resistant to more agents usually used to destroy them"

Based on these definitions, it seems that the participants who responded to this question had some knowledge regarding antibacterial resistance.

Possibility of Harmful Side Effects

One hundred thirty nine out of 189 participants (75%) claimed that there was no potential for harmful side effects to occur with the use of antibacterial hand soap in one's home. Forty seven participants (24.2%) who used antibacterial soap were concerned that negative side effects could occur. Out of those who claimed not to use antibacterial soap, one-half felt that potential harmful side effects were a concern.

Antibacterial Soap Use

A large majority of the participants claimed to use antibacterial soap in their homes. There were six responses that participants could have selected when asked the reason for antibacterial soap. Participants were allowed to pick more than one reason, so there were a total of 249 responses. One hundred forty seven (87%)

participants said that they used antibacterial soap for protection from germs. The next highest response was 43 (25.4%) which indicated that antibacterial soap was used because it smelled good. Not one participant replied that they used the soap because it was the only option available at the store (Table 7).

Table 7 Reasons for antibacterial soap use among participants

	Frequency (# of Responses)	Relative frequency (%)	Percent of cases
Smells good	43	17.3	25.4
Affordable	28	11.2	16.6
Protection from germs	147	59.0	87.0
Color	21	8.4	12.4
Only soap available	0	0	0
Other	10	4.0	5.9
Total	249	100.0	147.3

One hundred participants (76.3%) who claimed to use antibacterial soap for disease protection felt that they were protected from the flu. One hundred nine participants (80.7%) stated that they received protection from a cold. Almost 45% of participants claimed that antibacterial soap would not protect them from food poisoning. Only 43

participants (37.7%) felt that the use of antibacterial soap would provide some protection from food poisoning.

Antibacterial Soap Non-use

Only 25 participants claimed not to use antibacterial hand soap in their home. Seven participants (25.9%) claimed that antibacterial hand soap was not used because there was no additional protection from germs. The same number felt that possible side effects could occur from its use (see Table 8).

Table 8 Reasons for not using antibacterial soap among participants

	Frequency (# of responses)	Relative frequency (%)	Percent of cases
Too expensive	4	14.8	17.4
No additional protection from germs	7	25.9	30.4
Potential for harmful side effects	7	25.9	30.4
Not aware of product existence	3	6	11.1
Other	6	22.2	26.1
Total	27	100.0	117.4

CHAPTER 6

DISCUSSION

Due to the fact that the sample sizes from the soap use and non-use groups were not distributed equally, the independent and dependent variables were not used in the final analysis of the data.

A Chi square test was not an appropriate tool for analysis due to the uneven distribution of the responses from participants, so significance was not calculated. Frequencies were used instead to draw conclusions.

A majority of the participants felt that there is better protection from germs and disease by using antibacterial soap in their homes. However, the Centers for Disease Control and Prevention (CDC) stated that antibacterial soap is not better at protecting individuals from disease and all one needs for disease protection is to wash hands with warm water and regular soap.

Antibacterial soap is only effective against bacterial infections. The soap does not offer protection

from viral infections such as influenza or the common cold. Part of the hypothesis stated that participants used antibacterial soap because they were unaware of the difference between bacterial and viral infections and these data would indicate that this is likely true.

According to the CDC, the most commonly recognized foodborne infections are caused by the bacteria *Campylobacter*, *Salmonella*, and *E. coli* O157:H7, so antibacterial soap should provide additional protection against these types of infections.

However, antibacterial soap does not distinguish between good and bad bacteria, so even bacteria that could be beneficial are potentially washed away with the use of antibacterial soap.

Education would be the best way to inform people of the negative outcomes that could occur from the continued use of antibacterial hand soap in healthy homes. People need to be informed about the side effects that can occur and they also need to be given more of a choice when buying hygiene products. Perhaps the manufacturers of antibacterial soap need to be educated as well.

It is important to note that the purpose of hand washing is not to kill germs, but simply to get them off the skin. This can be accomplished just by placing one's

hands under running water. The notion that bacteria need to be killed is misconceived and perhaps education could be done to eliminate this perception.

There was some bias to this study in the fact that only women were surveyed. A different result might occur if men had been included in the study. There was also some bias with the survey being distributed at the DMV. Those people who do not have a car or a driver's license would have been excluded. Fifty six women took surveys, but did not return them. This could possibly lead to selective bias due to the fact that the results from this study could have been affected the outcome.

More research is needed in this area. The effects of triclosan have been tested on a few organisms, but there are many more that could be affected by triclosan. Education of the public should be a priority. People need to be aware of the difference between a bacterial and a viral infection and know what to do to prevent both. People also need to know about the possible harmful side effects that are not only affecting humans, but the environment as well. Bacteria are essential to daily life and help in protecting humans as well. If this concept is not understood and an antimicrobial war is

declared on bacteria, both good and bad, then the harmful side effects will only continue to worsen.

CHAPTER 7

FUTURE LABORATORY RESEARCH

A laboratory experiment was developed that could be used to test the effectiveness of triclosan in hand soap. A test method designed to determine the ability of an antimicrobial hand washing agent to reduce transient microbial flora (contaminants) when used in a hand washing procedure was published by the American Society for Testing and Materials (ASTM 1993). This test method was designed to determine the effectiveness of antimicrobial hand washing agents used by health care personnel.

Triclosan products were first used in the health care industry, but now that they are used commonly in households and are intended to reduce the level of contamination acquired through contact with contaminated objects or people, the ASTM method was used as a model to develop an experiment that could test consumer hand washing soap that contains triclosan.

A group of volunteers would be asked to refrain from using topical antimicrobials for at least one week prior to

the initiation of the test. In the ASTM method, "Activity is measured by comparing the number of a marker bacteria recovered from artificially contaminated hands after use of the hand washing formulation to the number recovered from contaminated unwashed hands." In the proposed method, a broth culture of *Staphylococcus epidermidis*, a non-pathogenic, gram-positive cocci would be used as the contaminant bacteria. Results would be recorded following 1, 3, 5, and 7 hand washings.

The following apparatus would be needed for the experiment:

- Hand washing sink that is big enough that participants would not touch the sink surface or other participants while washing.
- Water faucets that will enable the participant's hands to be held higher than the elbow during the washing procedure
- Tap water temperature regulator and monitor
- Colony counter
- Incubator
- Sterilizer
- Timer (Stop-clock)

Materials and Reagents for this experiment are:

- Bacteriological pipettes
- Water dilution bottles
- Erlenmeyer Flask-2 liter capacity
- Baseline control soap-a liquid soap containing no antimicrobial agent
- Test formulation of a triclosan-containing hand soap that can be easily obtained by a consumer
- Gloves-latex, unlined
- Sampling Solution-Dissolve 0.4 g KH_2PO_4, 10.1 Na_2HPO_4 and 1.0 g isoctylphenoxypolyethoxyethanol in 1-L distilled water. Adjust pH to 7.8 with 0.1 *N* HCl or 0.1 *N* NaOH. Dispense in 75-ml volumes and sterilize for 20 minutes at 121°C (ASTM 1993)
- Dilution fluid-sterile phosphate buffered water adjusted to pH 7.2 with suitable inactivator for the antimicrobial (ASTM 1993)
- Agar-Mannitol Salt agar
- Broth-Nutrient Broth

Twelve healthy adult volunteers would be recruited with characteristics mimicking the ASTM method of "no clinical dermatosis, open wounds, hangnail or other skin lesion." Participants would be instructed to avoid

antimicrobial products for one week prior to the test and during the duration of the test as well. Volunteers would be provided with a kit of personal care items to be used throughout the test period that would be free of antimicrobial agents. Rubber gloves would be provided to the participants for protection from the antimicrobial product if contact could not be avoided.

Once it has been established that participants have refrained from using antimicrobials for at least seven days, they will perform a 30 second practice wash. This will be done using a non-antimicrobial soap using the same method that is described for the test. Any oils and dirt present on the hands would be removed and the participant will be familiar with the hand washing technique.

The participants' hands will be contaminated with the marker organism prior to the baseline bacterial sample collection and prior to the 1^{st}, 3^{rd}, 5^{th}, and 7^{th} washes with the test material. According to the ASTM test method, "a baseline sample is taken after contamination to determine the number of marker organisms surviving on the hands."

Five milliliters of a liquid suspension containing a concentration of at least 10 *S. epidermidis* organisms per

mL will be dispensed onto the hands of each participant. The participant would rub his/her hands together, not reaching above the wrist, for 45 seconds. The hands would then be held away from the body to air dry for one minute.

Hands will be washed and rinsed in the same manner for all washes with the test formulation whether or not they are preceded by artificial contamination of the hands. The amount specified by the manufacturer of the consumer product would be dispensed onto the hands and rubbed over all surfaces. After the soap is spread, a small amount of water is added from the tap and hands are lathered for 30 seconds. Hands are then rinsed for 30 seconds under 40 ± 2°C water.

After the 1st, 3rd, 5th, and 7th washes, rubber gloves are placed on the right and left hand. Seventy five mL of the sampling solution is added to each glove and are then secured above the wrist. The hands are then uniformly massaged for one minute. After massaging, a sample is aseptically taken from the fluid of the glove.

Membrane filter or surface inoculation techniques could be used to enumerate the *S. epidermidis* in the sampling solutions. Sample dilutions would be made and then plated onto Mannitol Salt agar. The prepared plates

would be incubated for 48 hours at 32 ± 2°C. *S. epidermidis* colonies would then be counted.

Sampling interval changes would be determined by comparing sampling solutions to baseline counts obtained with test material.

There are some possible drawbacks to this test method. The first would be obtaining IRB approval. Even though *Staphylococcus epidermidis* is considered to be part of the skin's normal flora there is still some risk that would be associated with its use in this experiment. According to the CDC, *S. epidermidis* is an opportunistic pathogen, meaning that if the host becomes stressed an infection could result. If a participant was immunocompromised during the experiment, a possible serious infection could occur. There would also be concern due to the fact that *S. epidermidis* is often resistant to a variety of antibiotics, so treatment might be difficult if an infection were to occur.

Once, IRB approval was obtained, it might be difficult to find volunteers who would be willing to participant. If participants were obtained, it would probably be difficult for them to avoid using antimicrobial products for 7 days prior to the test due

to the number of consumer products today that claim to be antimicrobial.

Due to the fact that it could be difficult to obtain the needed permission and volunteers for the hand washing experiment, a different, less invasive test method might be more appropriate. A test method that would measure the effectiveness of triclosan by measuring zones of inhibition on bacterial cultural plates is another possible laboratory research project.

The Kirby-Bauer disk diffusion method would be used to measure the effectiveness of triclosan against the following organisms: *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Staphylococcus epidermidis*. Bacterial suspensions for each organism would be prepared. Using a sterile cotton swab, each test organism would be diluted into a sterile saline solution until the optical density matches the 0.5 McFarland standards. These dilutions would then be used to streak a lawn of bacteria that would be used to test the Kirby Bauer disks impregnated with triclosan. Each organism will be subjected to five rounds of exposure, to each concentration of triclosan. After each round, a colony closest to the disk will be selected for another round of exposure.

Materials and Equipment needed:

- At least 16 nutrient (Mueller Hinton) agar plates
  - 4 plates will serve as controls, with no antibacterial agents
  - 12 plates will serve as test plates, with antibacterial disks
- Live *E. coli* (strain K-12), *S. aureus*, *P. aeruginosa*, and *S. epidermidis* cultures obtained from the American Type Culture Collection in Manassas, Virginia, United States
- Sterile swabs
- Filter paper
- Hole punch
- Forceps
- Permanent marker
- Triclosan test solution-Dissolve triclosan powder (Alpha Chem, Inc., Lexington, MA) in a solution of 17.5% ethanol and 82.5% distilled water to a final triclosan concentration of 500 µg/mL (Bittel and Hughes 2003)

- 1 mL automatic pipettor with disposable tips
- 1.5 mL disposable Eppendorf tubes
- Distilled water

When inoculating plates, it is important to use the exact same procedure for each plate in order to obtain a uniform distribution of bacterial colonies. A serial two-fold dilution of the triclosan test solution would be done. Five hundred µL of distilled water would be pipetted into 3 labeled Eppendorf tubes. Five hundred µL of full strength triclosan test solution would be dispensed into the first tube and mixed thoroughly. Using a fresh tip, 500 µL from the first tube would be dispensed into the second tube and mixed thoroughly. Using a fresh tip, 500 µL from the second tube would be dispensed into the third tube and mixed thoroughly.

Sterile filter disks would be prepared by using a paper hole punch to make circular disks from filter paper. Four disks will be needed for each concentration. The disks would be wrapped in aluminum foil and sterilized in a 300° oven for 30 minutes.

A permanent marker would be used to label each plate with the dilution to be tested and the organism being plated. The control plate would be labeled "no triclosan."

Plates would be inoculated uniformly using aseptic technique. A sterile swab would be dipped into the prepared bacterial solution and then gently spread across the plate. The swab would be rubbed in three different directions to ensure complete coverage of the plate. The plates would then be covered (to avoid contamination) and allowed to dry for five minutes.

For the test plates, sterile forceps would be used to hold a single disk that would be dipped into the triclosan solution (a different concentration for each test plate). The disk would be touched against the side of the tube to allow any excess liquid to drain off. A single disinfectant disk would be placed in the center of each of test plate. The test disks would be pressed into the agar to ensure good contact. For the control plates, sterile disks dipped in sterile water would be placed in the center of each plate.

Plates would be incubated overnight and the results would be read. The zone of inhibition would be measured around each disk. Four separate measurements will be done for each organism. Johnson and Case (1995) developed the values that would be used to evaluate the bacterial response to the triclosan solution (Table 9).

Table 9 Diameter of zone inhibition (mm) used to determine the bacterial response to the triclosan solution (Johnson and Case 1995)

	Diameter of zone of inhibition (mm)
Resistant	10 or less
Intermediate	11-15
Susceptible	16 or more

In order to determine if bacteria are resistant to triclosan, the most resistant organism from each plate would be selected and exposed again to the diluted triclosan solution. This selection process would be repeated 4 times.

For each plate, a sterile swab would be used to pick up bacterial colonies growing closest to the triclosan-impregnated disk. The swab would be swirled in a tube containing 10 mL of sterile water. The tube would be covered and agitated. This solution would then follow the above mentioned plating process.

It would be expected that all four organisms would show sensitivity or resistance to the triclosan solution.

APPENDIX I

ANTIBACTERIAL SOAP SURVEY

Antibacterial Soap Survey

1. Do you use antibacterial soap in your home?
   ☐ Yes ☐ No (If no, skip to question #3)
2. If yes, why do you choose to use antibacterial soap in your home? (Check all that apply)
   ☐ Smells good
   ☐ Affordable
   ☐ Protection against germs
   ☐ Color of soap matches kitchen or bathroom
   ☐ Only option at store
   ☐ Other_____
3. If you do not use antibacterial soap in your home, why not? (Check all that apply)
   ☐ Too expensive
   ☐ No additional protection from germs
   ☐ Potential for harmful side effects
   ☐ Not aware of product existence
   ☐ Other_____
4. Do you think for disease protection: (Check only one)
   ☐ Antibacterial soap is better than regular soap
   ☐ Regular soap is better than antibacterial soap
   ☐ There is no difference between the two
5. The use of antibacterial soap protects me better than regular soap against germs that cause the following (Check only one):

Flu	☐ Yes	☐ No	☐ Don't Know
Cold	☐ Yes	☐ No	☐ Don't Know
Food poisoning	☐ Yes	☐ No	☐ Don't Know
Skin Infections	☐ Yes	☐ No	☐ Don't Know
HIV/AIDS	☐ Yes	☐ No	☐ Don't Know

Sexually Transmitted Infections ☐ Yes ☐ No ☐ Don't Know

6. All germs are bad ☐ Agree ☐ Disagree
7. Killing all germs keeps me healthy ☐ Agree ☐ Disagree
8. Antibacterial soap kills all germs ☐ Agree ☐ Disagree
9. Bacteria can be good ☐ Agree ☐ Disagree
10. Do you know what antibacterial resistance is?
    ☐ Yes ☐ No
    If, yes what is your definition_____
    _____
    _____
11. Do you think there are harmful side effects that can come from the use of antibacterial soap in your home?
    ☐ Yes ☐ No

12. What is the highest level of education you have completed? (Check only one)

☐ High school diploma/GED ☐ Technical/Vocational
☐ College/University ☐ Graduate School

13. What is your occupation?

_____

14. Your age is?

☐18-24 ☐25-29 ☐30-39 ☐40-49 ☐50-59 ☐60-69☐70 or older

15. Your household income is?

☐ Less than $46,000/yr ☐ More than $46,000/yr

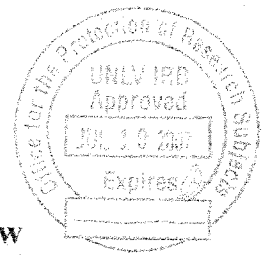
16. Do you have children under the age of 5 in your care?

☐ Yes ☐ No

APPENDIX II

IRB APPROVAL FORM

UNLV
CELEBRATING FIFTY YEARS



Social/Behavioral IRB – Exempt Review
Approved as Exempt

DATE: July 20, 2007

TO: **Dr. Linda Stetzenbach**, Public Health

FROM: Office for the Protection of Research Subjects

RE: Notification of IRB Action by Dr. Paul Jones, Co-Chair
Protocol Title: **The Home Use of Antibacterial Hand Soap by Women in Clark County, NV**
OPRS# 0705-2352

This memorandum is notification that the project referenced above has been reviewed by the UNLV Social/Behavioral Institutional Review Board (IRB) as indicated in Federal regulatory statutes 45CFR46.

PLEASE NOTE:
Attached to this approval notice is the **official Informed Consent/Assent (IC/IA) Form** for this study. The IC/IA contains an official approval stamp. Only copies of this official IC/IA form may be used when obtaining consent. Please keep the original for your records.

The protocol has been reviewed and deemed exempt from IRB review. It is not in need of further review or approval by the IRB.

Any changes to the exempt protocol may cause this project to require a different level of IRB review. Should any changes need to be made, please submit a **Modification Form**.

If you have questions or require any assistance, please contact the Office for the Protection of Research Subjects at OPRSHumanSubjects@unlv.edu or call 895-2794.

Office for the Protection of Research Subjects
4505 Maryland Parkway • Box 451047 • Las Vegas, Nevada 89154-1047

APPENDIX III

FREQUENCY TABLES

1. Use of Soap

Use of Soap	Frequency	Relative frequency
Yes	169	87.0
No	25	13.0
Total	194	100.0

4. Disease Protection

Disease Protection	Frequency	Relative frequency
No difference	38	19.6
A.B. soap better	139	71.6
Regular soap better	13	6.7
No response	4	2.1
Total	194	100.0

6. All germs are bad

Germs are bad	Frequency	Relative frequency
Agree	65	33.5
Disagree	120	61.9
No response	9	4.6
Total	194	100

7. Killing all germs keeps me healthy

Kill all germs	Frequency	Relative frequency
Agree	67	34.5
Disagree	114	58.8
No response	13	6.7
Total	194	100

8. Antibacterial soap kills all germs

A.B. soap kills	Frequency	Relative frequency
Agree	36	18.6
Disagree	139	71.6
No response	19	9.8
Total	194	100

9. Bacteria can be good

Ba can be good	Frequency	Relative frequency
Agree	123	63.4
Disagree	50	25.8
No response	21	10.8
Total	194	100

10. Knowledge of antibacterial resistance

Know of A.R.	Frequency	Relative frequency
Yes	72	37.1
No	114	58.8
No response	8	4.1
Total	194	100

11. Harmful side effects could come from antibacterial soap use

Side effects	Frequency	Relative frequency
Yes	47	24.2
No	139	71.6
No response	8	4.1
Total	194	100

12. Level of education

Level of education	Frequency	Relative frequency
High school	73	37.6
Voc/Tech school	17	8.8
College	82	42.3
Graduate school	18	9.3
No response	4	2.1
Total	194	100.1

14. What is your age?

Age	Frequency	Relative frequency
18-24	35	18.0
25-29	27	13.9
30-39	41	21.1
40-49	37	19.1
50-59	29	15.0
60-69	15	7.7
70 and above	6	3.1
No response	4	2.1
Total	194	100.0

15. Household annual income

HH annual income	Frequency	Relative frequency
Below $46,000	75	38.7
Above $46,000	100	51.5
No response	19	9.8
Total	194	100.0

16. Children in home under the age of 5

Children in home	Frequency	Relative frequency
Yes	47	24.2
No	141	72.7
No response	6	3.1
Total	194	100

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