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## A comparison of conjunctival bacterial populations of contact lens wearers vs. non-contact lens wearers

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### **Abstract**

Conjunctival swab samples were taken from each eye of 42 contact lens wearers and 60 subjects who don't wear contacts. From the questionnaire that each subject filled out, it was found that the majority of the subjects were male students between the ages of 23-30. Concerning the contact lens wearers' habits and hygiene, they responded that the majority had worn their lenses 3 years or more and currently wore their lenses above 14 hours per day. The bulk of the wearers either often or always washed their hands before handling their lenses, used separate solutions, and stored their lenses wet. From the samples that were taken, a lower incidence of bacterial growth was found among the contact lens group (although the difference was found to be statistically insignificant for  $p = 0.025$  and  $Z = 1.96$ ). The conclusion from this study was that if proper contact lens hygiene and care was maintained, there would be no increase in bacterial conjunctival flora in the contact lens wearer.

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### **Degree Name**

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John R. Gerke

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A Fourth Year Optometry Project

Presented to the  
College of Optometry  
Pacific University

A COMPARISON OF CONJUNCTIVAL  
BACTERIAL POPULATIONS OF  
CONTACT LENS WEARERS VS.  
NON-CONTACT LENS WEARERS

In partial fulfillment  
for the requirements for the degree  
Doctor of Optometry

by

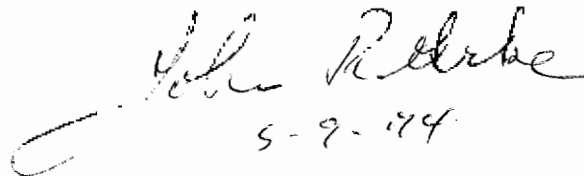
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May 1974

  
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P.B.

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A.S.

A COMPARISON OF CONJUNCTIVAL BACTERIAL POPULATIONS  
OF CONTACT LENS WEARERS VS. NON-CONTACT LENS WEARERS

Abstract

Conjunctival swab samples were taken from each eye of 42 contact lens wearers and 60 subjects who don't wear contacts. From the questionnaire that each subject filled out, it was found that the majority of the subjects were male students between the ages of 23-30. Concerning the contact lens wearers' habits and hygiene, they responded that the majority had worn their lenses 3 years or more, and currently wore their lenses above 14 hours per day. The bulk of the wearers either often or always washed their hands before handling their lenses, used separate solutions, and stored their lenses wet. From the samples that were taken, a lower incidence of bacterial growth was found among the contact lens group (although the difference was found to be statistically insignificant for  $\alpha = 0.025$  and  $Z = 1.96^{15}$ ). The conclusion from this study was that if proper contact lens hygiene and care was maintained, there would be no increase in bacterial conjunctival flora in the contact lens wearer.

Introduction

From the time that contact lenses first came into practical use with the Tuohy lens in 1948 until fairly recently, little concern has been given to the dangers of possible bacteriological contamination of

the normal flora of the eye by the lens. Doctors, optometrists and ophthalmologists alike, were concerned more with the comfort and visual acuity of the patient. Today with over 8 million Americans wearing contact lenses, the dangers of bacterial infection have to be carefully studied and analyzed. Fortunately over the last years, more attention has been paid to these small unsterile foreign bodies that are worn by so many people and many improvements have been achieved.

Considering the large number of wearers, the incidence of serious ocular infection is relatively small -- which is probably due to the natural defense mechanisms of the normal eye and conjunctiva: i.e. the continuous washing action of the tears, the lysozymes present in those tears that attack bacteria, the resistance of the intact corneal epithelium, and the rapid regeneration of that tissue layer. However, since the wearing of a contact lens presents a continuous possibility of a corneal abrasion, any presence of possible pathogens could have a very rapid and disastrous outcome.

The main source of the normal flora of the eye is the skin, with the bacterial types being almost identical. As stated by Axenfeld<sup>7</sup>, "It is only to be expected that all those organisms can be found in it which occur in air, in washing water, in the skin around, or on anything with which the eye may come in contact". The normal non-pathogenic residents of the conjunctiva include non-hemolytic *Staphylococcus albus*, the diptheroids, *Corynebacterium xerosis*, *Corynebacterium hoffmani*, and sarcinae and other micrococci. Possible pathogens that may be frequent conjunctival inhabitants are *Staphylococcus aureus* (gram

positive cocci), Haemophilus species (Koch-Weeks Bacillus), Diplococcus pneumoniae, Neisseria gonorrhoeae, alpha and beta Streptococcus, Herellea, and of course Pseudomonas aeruginosa (gram negative motile rods). Fungi such as Candida albicans, Aspergillus, Nocardia, Cephalosporium, and Mucor are also capable of surviving in the conjunctival environment.

There have been many varied and often contradictory theories and studies to determine how to reduce any possible pathogenic dangers to the eye. As an example of the often questionable bases for these attempts, Filderman and White<sup>9</sup> state the example where bacteriostatic and fungistatic agents have been polymerized into contact lenses to reduce bacterial contamination. However, because it seems that these agents are incorporated so that they do not leach out, their efficacy is extremely doubtful. Lenses from which bacteriostats could leach would be considered drugs by the FDA and would have to receive drug approval for ocular application.

In a study of 63 contact lens patients before incorporation of effective anti-microbials in contact lens solutions, Kapetansky, et al.<sup>12</sup>, found (from cultures of the eye, carrying case, and wetting or soaking solutions), that 65% exhibited no growth or non-pathogenic growth, and that 35% showed the presence of potential pathogens (the potential pathogens were found in the eyes of 14 of the 63 subjects), with P. aeruginosa being the most common. They also concluded in their study, that the longer the subject wore lenses (6 months or more), the higher was the incidence of bacterial growth. One of their recommendations was the



elimination of soaking solutions. Other studies, also before effective anti-microbials, have found that wet storage may have been a possible source of pathogens<sup>16</sup> and have suggested ventilated dry lens cases.

Today it has been found that the cause of many of these earlier storage contaminations was the design of lens cases and the use of sponge or other materials in the construction that deactivated the bacteriolytic and bacteriostatic components of the solutions and acted as an ideal reservoir and surface for bacterial growth. The apparent decrease in severe ocular infections of contact lens wearers in the last few years is probably due to three main factors<sup>1</sup>: (1) contact lens storage cases have been designed to eliminate foreign material; (2) soaking solutions are more effective in their bacteriocidal action, with the increase in preservative concentrations and the use of additional preservatives (EDTA); (3) both patients and the vision care specialist have become increasingly aware of the possible bacteriological dangers and have realized the importance of good contact lens hygiene -- i.e. washing of hands frequently, discarding and replacing soaking solutions regularly, and the use of smaller dosage dispenser bottles to avoid solution contamination.

It is the purpose of this study to see if these new concepts and designs for the contact lens wearer can, coupled with his own natural ocular defense mechanisms, reduce the possibility of serious ocular infection. A questionnaire has been designed to see just what methods the contact lens wearers are using (or aren't) for their own protection. Then the main objective is to compare conjunctival samples taken from a group that do not wear contact lenses, with those taken from contact

lens wearers, and determine the incidence of bacterial growth and obtain a general picture (gram negative or positive, rod or cocci) of the type of bacteria that do grow.

### Methods

The original goal of the study was to have 100 contact lens wearers and 100 non-contact lens wearers as the subjects. Approval was obtained from Dr. Hunter and Dr. West to use clinic patients as subjects if they agreed to participate. Every subject was assigned a patient number and was then instructed to complete a brief case history questionnaire (see Figure 1 for a sample of the questionnaire). The non-contact wearers only had to fill out questions 1-5 and 11. The contact lens subjects were to fill out the entire form. We arbitrarily decided that for this study, all subjects had to be within the ages of 13-65. Also all contact lens wearers had to have worn their lenses for at least one month, and had to be up to at least 6 hours per day wearing time.

Conjunctival samples were taken from all subjects by pulling the lower lid down, and swabbing the inside of the lid with a moistened Swube 2009 disposable applicator (a single cotton applicator in a 17x 100 mm tube from Falcon: Div. Becton, Dickinson & Co., 1950 Williams Drive, Oxnard, CA., 93030). A sample was taken from each eye and recorded separately. These swabs had been previously prepared by the researchers by injecting 1 cc. sterile saline solution in each to moisten the swab, thus reducing patient discomfort. Standard aseptic techniques were observed at all times.

Patient No. \_\_\_\_\_

- 1) Name: \_\_\_\_\_
- 2) Age: 13-18      19-22      23-30      30-+
- 3) Sex:      Male      Female
- 4) Occupation:  
                    Manual              Office              Industrial          Clerk  
                    Housewife          Student              Other
- 5) Do you wear contacts?      Yes      No
- 6) How many hours a day do you wear them?  
                    6-8      8-10      10-12      12-14      above 14
- 7) How long have you worn contact lenses?  
                    6 mos.      1 year      2 years      3 years or more
- 8) Do you wash your hands before inserting your lenses?  
                    Never      Seldom      Often      Always
- 9) What type of solution do you use?  
                    All purpose (3 in 1)      Separate sol'ns      None
- 10) Do you store your lenses?  
                    Wet      Dry
- 11) Have you had any past eye problems?      Yes      No  
                    Itchiness      Dryness      Red-eye      Red lids      Other

-- Figure 1 --

After the sample was taken, it was plated on Trypticase Soy Agar without dextrose for the growth media. The choice of this media was to be a general all purpose media for a large bacterial population growth. There are some species of bacteria that are not culturable by this media selection however, such as some non-fermenting types, some types of gram negative rods and diplococci (Neisseria), Haemophilus, and some types of Streptococci. However, such exclusions would apply to both wearers and non-wearers, and would not therefore invalidate the results of this study. The plates were then incubated for 48 hours and then examined for any colony growths. A general description of the major colonies was recorded. Samples were taken from colonies, gram stained, and then examined and evaluated by an outside observer (Mrs. Lynn Rainer, MT (ASCP) ).

All questionnaires were then evaluated as to the number and responses to each question. The results of the bacterial growths and types were also tabulated and analyzed for percentage comparisons. These proportions were then further analyzed for statistical significance by the procedure given by Walpole<sup>15</sup> ( $\alpha = 0.025$  and  $Z = 1.96$ ).

### Results

When the data collection was cut off for the study, 60 subjects had been tested for the non-contact wearer group and 42 subjects had been tested for the contact lens wearers -- thus resulting in 119 samples (1 was contaminated before plating) and 84 samples respectively. Due to clinic scheduling conflicts between researchers in the study, the time involved in studying for National Boards (both the researchers and many

of the subjects), and the lack of expected clinic contact lens subjects, only about 50% of our projected subject goal was attained. As a comment to any readers considering a follow-up study on this project or area, it would be very beneficial to begin taking samples from the subjects during the first semester, at least, of the senior year in order to escape the conflicts and the busy season of the final semester.

An analysis and compilation of the responses to the questionnaire are shown as follows:

<u>Question</u>	<u>Lens Wearers</u> (42 subjects)	<u>Non-wearers</u> (60 subjects)
#2) Age:		
13-18	0% (0)	0% (0)
19-22	33% (14)	15% (9)
23-30	64% (27)	77% (46)
31-65	3% (1)	8% (5)
#3) Sex:		
Male	88% (37)	95% (57)
Female	12% (5)	5% (3)
#4) Occupation		
Manual	0% (0)	0% (0)
Office	5% (2)	3% (2)
Industrial	0% (0)	0% (0)
Clerk	0% (0)	0% (0)
Housewife	0% (0)	2% (1)
Student	90% (38)	92% (55)
Other	5% (2)	3% (2)
#6) How many hours a day do you wear them?		
6-8	10% (4)	
8-10	5% (2)	
10-12	17% (7)	
12-14	28% (12)	
above 14	40% (17)	

Questionnaire responses continued:

<u>Question</u>	<u>Lens Wearers</u> (42 subjects)	<u>Non-wearers</u> (60 subjects)
#7) How long have you worn contact lenses?		
6 months	17% (7)	
1 year	19% (8)	
2 years	5% (2)	
3+ years	59% (25)	
#8) Do you wash your hands before inserting your lenses?		
Never	2% (1)	
Seldom	5% (2)	
Often	33% (14)	
Always	60% (25)	
#9) What type of solutions do you use?		
All purpose (3 in 1)	21% (9)	
Separate solutions	79% (33)	
None	0% (0)	
#10) Do you store your lenses?		
Wet	95% (40)	
Dry	5% (2)	
#11) Have you had any past eye problems?		
No	69% (29)	80% (48)
Yes	31% (13)	20% (12)
Itchiness	2.0% (1)	5.0% (3)
Dryness	9.5% (4)	5.0% (3)
Red-eye	9.5% (4)	3.3% (2)
Red lids	5.0% (2)	3.3% (2)
Other	5.0% (2)	3.3% (2)

Note: The differences in the proportions of populations in question #11 were found to be statistically insignificant for the size of the populations involved<sup>15</sup> ( using the values of  $\alpha = 0.025$  and  $Z = 1.96$ )

The results of the number of no growths and growths (broken down as to gram positive or negative, rod or cocci) from the samples taken are given below:

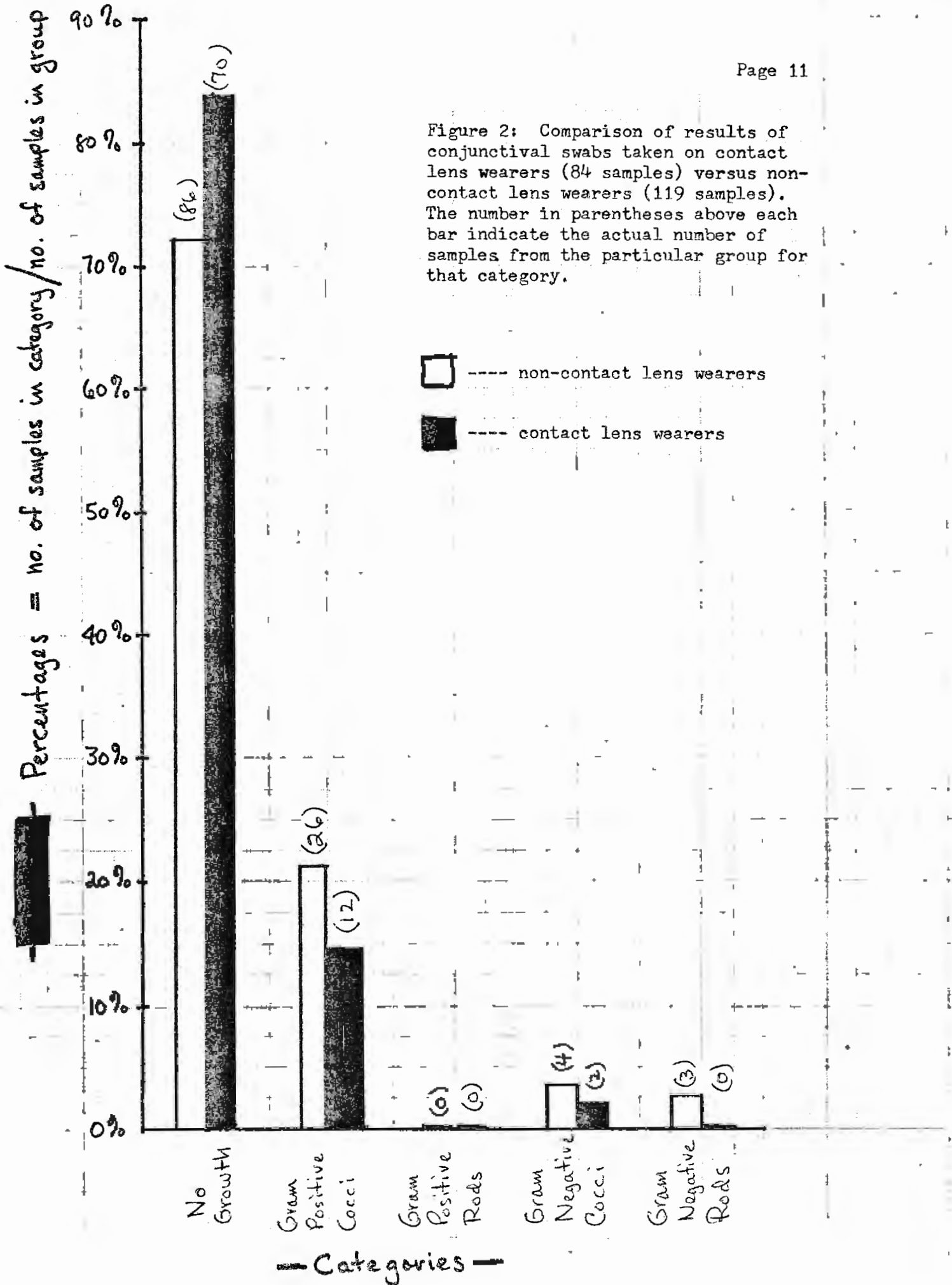
<u>Bacterial Results</u>	<u>Lens Wearers</u> (84 samples)	<u>Non-wearers</u> (119 samples)
No Growth	83.3% (70)	72.3% (86)
Growth	16.7% (14)	27.7% (33)
gram positive cocci	14.3% (12)	21.8% (26)
gram positive rods	0.0% (0)	0.0% (0)
gram negative cocci	2.4% (2)	3.4% (4)
gram negative rods	0.0% (0)	2.5% (3)

Note: The difference in the proportions of populations in the bacterial growth categories were found to be statistically insignificant ( $z = 1.83$ ) for the size of the populations involved<sup>15</sup> (using the values of  $\alpha = 0.025$  and  $Z = 1.96$ )

Bar charts are shown in Figure 2 of the bacterial growth data to aid further in the visualization and comparison of the results of the contact lens wearers versus the non-contact lens wearers.

### Analysis and Discussion

As was noted earlier in the beginning of the "Results" section, we were not able to obtain as many subjects as we had originally hoped to, but the number that was obtained should be enough to give at least an estimated comparison of the bacterial populations in the two study groups. Obtaining a larger subject sample would have been much easier had the study been started at the beginning of the academic year and if





the clinic and academic schedules of the researchers would have been more complimentary.

In studying the results of the questionnaire, several observations can be made from both the non-contact lens wearers and the contact lens group. As to the subject backgrounds, it can be seen in both groups that the majority of the patients were male students between the ages of 23-30. On these points, the study population has a very narrow range, so a comparison between this narrowed range increases the validity of the results, since many extraneous factors (i.e. age, environment, sex, etc.) are screened out. In accordance though, any conclusions or generalizations made must be limited to this restricted group.

One other question on the questionnaire where the groups can be compared is #11, the one concerning any ocular complaints or symptoms. Here, a higher percentage of the contact lens wearers (31%) had more problems than the non-wearer group (20%), especially concerning dryness and red-eye. This difference was found to be statistically insignificant ( $z = 1.39$ ), though, for  $\alpha = 0.025$  and  $Z = 1.96^{15}$ . It may be interesting to keep this in mind when the comparison of bacterial populations is discussed later on.

To continue with a discussion of the questions answered by the contact lens wearers only, it can be seen that the majority of those in our study had worn their lenses for more than three years (59%) and wore them more than 14 hours per day (40%). Thus it would be a legitimate generalization to say that most of the subjects in this group were fully adapted wearers (chronologically at least). It can also be

observed that most wearers wash their hands either often (33%) or always (60%) before inserting their lenses. Separate solutions were also used by the majority (79%) and wet storage (95%) was generally utilized. All of these observations would tend to support the conclusion that the contact lens group follows most of the currently approved and recommended procedures in their personal hygiene and contact lens care.

Now in examining the bacterial growth occurrence in the 203 samples taken, it is interesting to note that the contact lens group had a lower percentage of growth than the non-contact lens group (16.7% occurrence of growth for the contact wearers versus 27.7% growth for the non-wearer group -- a difference of 11.0%)\*. By testing the difference between these two proportions statistically, however, it was found that for  $\alpha = 0.025$  and  $Z = 1.96$ , the difference was insignificant ( $z = 1.83$ ) and the two proportions could be considered equal<sup>15</sup>. Therefore it cannot validly be concluded that the contact lens wearer definitely will have less bacterial growth than the normal population. We can only say that there is an indication toward those possibilities for the particular group examined in this study.

There are, however, several important and meaningful conclusions that can be safely made from the results of this project. Firstly, it could be concluded that at least (with the type of subjects in this study population) contact lens wear does not increase the incidence of bacterial growth. This point is the most important piece of information to be found by this study. Since contact lens wear does always present an increased risk of corneal abrasion, it is very important that the

\* A difference of this proportion would have been significant at 95% confidence level, if the populations were increased to 120 subjects.

presence of this foreign body does not increase the incidence of bacteria in the normal conjunctiva.

The bacterial type of major concern for possible pathogenic reactions with a corneal abrasion are the gram negative rods. As can be seen from the data, there was no occurrence at all of this type in the contact group, while there were 3 subjects (5%) in the non-wearer group that did have this type dominant in the culture taken from them. While this difference is again statistically insignificant ( $z = 1.45$ ) for this size study, this comparison is of prime pathological importance and is one in which larger studies should pay close attention to.

As for recommendations for further studies concerned with this area, several suggestions could be offered. Most importantly a larger subject population should be attempted with also a less restricted background. It would be interesting to see the results from a more diversified subject population. Also, blood agar media with a candle jar incubator could be used in addition to a general purpose media (i.e. TSA) to increase the number of bacterial species that could be detected. Although it was not the purpose of this paper to determine the exact identity of the bacteria grown, this information would be very useful and valuable from future projects (e.g. it could have been useful to determine if the gram positive cocci for each group showed the same ratio of albus to aureus). Also if available, the small uniform sponges used by recent researchers (Hadley, Aronson, and Goodner<sup>10</sup>) might be a more efficient and more controlled method of collecting the conjunctival bacterial samples.

Summary

The purpose of this study was to compare the incidence of bacterial growth from the conjunctival samples taken from a group of contact lens wearers to a group who do not wear contacts. A total of 203 samples were taken from the two groups, with 42 subjects being in the contact lens group, and 60 subjects in the other. The subjects were all primarily male students between the ages of 23 to 30. Other background information on the contact lens group yielded by a questionnaire was that most of them were full-time wearers, and maintained current accepted contact lens hygiene recommendations (ie. washing hands frequently, using separate wetting and soaking solutions, and storing their lenses wet).

The results of the samples taken on T.S.A. media exhibited a lower occurrence of bacterial growth for the contact group than the non-contact group. A statistical evaluation of the differences in proportions of the two groups showed them to be mathematically equal for this study size. This was also true of the differences in gram negative rod growth proportions, as well as the percentages of past eye problems.

The primary conclusion from this study is that there appears to be no disruption of the normal conjunctival flora if good contact lens and personal hygiene guidelines are followed. There may even be some indication that some of the naturally occurring possible pathogens may be reduced or eliminated by these current methods of patient and product management<sup>1</sup>.

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