BACTERIAL PRESENCE IN THE OPTOMETRIC EXAM ROOM

By

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ABSTRACT

Background: It is of utmost importance in an optometric practice to minimize or eliminate the potential for bacterial presence and transmittance to the patient. The purpose of this project is to evaluate whether the current acceptable standard in exam room sterilization is adequate or if, by not routinely sterilizing selected commonly touched surfaces between patient examinations, we are putting every patient at risk for bacterial infection. *Method:* Ten items were chosen to evaluate bacterial presence in the optometric exam room. The ten chosen surfaces are commonly touched by the examiner and/or the patient. Five of these items (slit lamp chin rest, cover paddle, phoropter head rest, slit lamp head rest, keratometer chin rest) are routinely cleaned and sterilized with an alcohol pad according to current acceptable standards between each patient encounter. The other five chosen items (mydriatic bottle, examiner's pen, slit lamp toggle, exam chair arm rest, faucet handle) are cleaned at the practitioner's discretion. Samples were taken from randomly chosen exam rooms in an optometric practice and used to inoculate two different growth media. *Results:* Results show bacterial presence on a multitude of items. *Conclusion:* Through quantitative and comparative analysis, this research illustrates that the University Eye Center and its equipment, though showing a presence of bacteria on both routinely "sterilized" and "non-sterilized" exam room items, yielded numbers that did not show a significantly high bacterial colony growth on any of the surfaces commonly in contact with practitioner and patient.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF CHARTS

BACKGROUND

This controlled experiment will quantify and qualify the amount of bacterial growth on inanimate objects in the optometric exam room. This will be performed by culturing swabs onto agar plates from carefully chosen inanimate objects commonly touched by examiner and/or patient in an optometric examination room. In 1865 the British surgeon Joseph Lister was the first to begin sanitizing his exam room[1]. The result of this was a marked decrease in the number of secondary infections and death. In the last 150 years there has been a vast increase in knowledge of bacteria, sanitization, the spread of bacteria, and the transmission of disease[1]. Some of the most recent studies of microbial prevalence show many common pathogenic strains of bacteria can persist on dry surfaces for months at a time[2]. The goal of this research is to evaluate the relative effectiveness of today's current cleaning procedure in keeping the optometric exam room and its inanimate objects free from bacterial growth. This topic was systematically reviewed in PubMed and Vision Net without language restrictions. Also, a search was done in textbooks and journals and currently no information has been published concerning bacterial presence in the optometric exam room.

METHOD

To determine which items were going to be used for experimentation, two exam rooms with known recent use were chosen at random for sample plating in a multiple exam room clinic. Ten items commonly touched by examiner and/or patient in each room were chosen to evaluate bacterial presence. Swabs of the same approximate surface area (approx. 1 in^2) on each item were collected in a likewise manner and were used to inoculate a plate of brain/heart infusion agar (BHI), each with an identical amount of strokes. BHI is a general-purpose liquid medium used in the cultivation of fastidious and nonfastidious microorganisms, including aerobic and anaerobic bacteria, from a variety of clinical and nonclinical materials[4]. The plates were then stored at 35^0 for 48hrs for incubation after which the bacterial colonies produced were counted. The five items producing the most colonies on this test run were then chosen for comparison to the five items routinely disinfected between patient encounter. The five control items (slit lamp chin rest, cover paddle, phoropter head rest, slit lamp head rest, keratometer chin rest) are routinely cleaned and sterilized with an alcohol pad according to current acceptable standards between each patient encounter. The five experimental items (mydriatic bottle, examiner's pen, slit lamp toggle, exam chair arm rest, faucet handle) are cleaned at the practitioner's discretion. Samples were taken at the conclusion of each day from randomly chosen exam rooms with known recent use in the same optometric practice at the conclusion of six different business days. In each room two similar samples were collected in a likewise manner from each of the ten surfaces, one swab was used to inoculate a mannitol salt agar plate (MSA) and the other swab was used to inoculate a brain/heart infusion agar plate. Due to its high concentration of sodium chloride that is toxic to most bacteria, MSA is primarily used for the

selective isolation and enumeration of staphylococci from clinical and nonclinical materials[4]. It is also a differential medium, containing mannitol and the indicator phenol red, which turns the media yellow in the presence of acid produced as a result of mannitol fermentation by certain clinically significant bacteria, such as Staphylococcus aureus[4]. The surface with the limiting size appeared to be the examiners pen with an average surface area of 5 in^2, so the sample collection area on any surface did not exceed 1 in^2. Each plate was inoculated with an identical number of strokes covering an equal area. The plates were then stored at 35^0 for 48hrs for incubation after which the bacterial colonies produced were counted. After the data was collected key values such as the mean, confidence intervals, minimum values, and rank percentiles were calculated using basic statistical analysis. The Shapiro-Wilk Normality Test was applied to the data. Most authors agree that this is the most reliable test for non-normality for small to medium sized samples[3].

RESULTS

Results indicate that there is a bacterial presence in the optometric exam room on the surface of most of the items tested. The results are illustrated in Table #1 (Number of Individual Colonies Cultured on MSA Plates) and Table #3 (Number of Individual Colonies Cultured on BHI Plates). The amount of colonies found on each surface varied from plate to plate but show some obvious trends. There was considerably higher growth on the BHI agar compared to the MSA agar. Also, the five items (slit lamp chin rest, cover paddle, phoropter head rest, slit lamp head rest, keratometer chin rest) that are routinely cleaned and sterilized seem to have on average more bacteria present than the other five items tested (mydriatic bottle, examiner's pen, slit lamp toggle, exam chair arm rest, faucet handle).

DISCUSSION

It is not surprising that there is bacteria present in the exam room, even on recently sanitized surfaces. Bacteria is found virtually everywhere in the environment. What were surprising are the levels of contamination on the materials tested. This experiment showed an interesting trend. It showed the surfaces that were most often cleaned according to current accepted protocol actually had the greater number of bacterial colonies present on them. Several observations made while conducting this experiment offer probable explanations leading to this finding. First, most of the control surfaces come in direct contact with the patient's facial structures which have more surface area and contain a greater number of sebaceous and sweat glands than do the examiner's hands. Second, these surfaces are made of different types of plastic that seems to attract and hold moisture differently. However, without further analysis, it is difficult to determine if this trend can be explained by the given reasons. Another possibility is the surfaces in question were not cleaned thoroughly according to the standard protocol. Based on the information gathered and the variation of the quantity of bacteria present on any given item from room to room, this trend is most likely a combination of many factors, giving credence to the fairly large confidence interval seen in table #2 and table #4. For example, when looking at the slit lamp chin rest, the mean +/- 95% confidence interval is greater than 20 colonies (from 45.69 colonies to 22.39 colonies). When applying the Shapiro-Wilk Test to the overall data, the test statistic was clearly significant at $P = 0.05$ which rejects the null hypothesis that these data are from a normal distribution. This is not to say that the data are "normally distributed". The Shapiro-Wilk test provides evidence for certain types of "non-normality" it does not guarantee "normality". The slit lamp chin rest is the only item that did not pass the Shapiro-Wilk test.

In order to asses significance in the sample size of colonies produced, ASTM provides countable ranges of 20-80 CFU/membrane, 20-200 for spread plates and 30-300 for pour plates[6]. For the comparative purpose of this experiment, though, every colony was counted and thus deemed significant.

TABLES

Table #1: Number of Individual Colonies Cultured on MSA Plates

	Mydriatic Bottle	Examiner's Pen	Slit Lamp Toggle	Chair Arm Rest	Faucet Handle	Slit Lamp Chin Rest	Cover Paddle	Phoropter Head Rest	Slit Lamp Head Rest	Keratometer Chin Rest
1	0	48	0	51	1	1	5	0	1	3
2	0	1	2	8	0	35	0	28	0	0
3	1	2	0	3	22	15	7	18	1	0
4	1	1	0	0	0	0	4	0	0	0
5	1	4	0	12	0	8	13	0	6	56
6	6	19	4	11	2	58	10	51	1	30
7	0	17	1	2	0	2	17	0	0	1
8	0	2	1	6	0	23	41	0	1	0
9	3	11	4	3	0	16	45	20	13	21
10	0	3	0	30	2	61	30	6	24	6
11	0	3	0	2	11	1	0	0	0	82
12	1	28	0	0	0	76	23	19	5	0
13	5	13	0	1	0	65	73	0	3	53
14	0	1	0	12	5	44	5	135	108	0
15	0	3	20	5	2	5	11	6	11	47
16	0	7	0	10	3	60	38	53	2	3
17	0	10	0	2	8	16	14	7	1	4
18	20	28	2	47	16	75	73	55	22	1
19	0	3	30	90	14	25	0	1	30	1
20	20	90	1	30	18	55	76	3	35	5
21	2	1	14	7	18	18	13	20	35	100
22	0	10	10	17	9	90	11	33	4	42
23	0	8	10	45	3	27	40	30	22	11
24	10	25	19	28	3	41	30	16	1	30

Table 2: Statistical Interpretation of Findings on MSA Plates

	Mydriatic Bottle	Examiner's Pen	Slit Lamp Toggle	Chair Arm Rest	Faucet Handle	Slit Lamp Chin Rest	Cover Paddle	Phoropter Head Rest	Slit Lamp Head Rest	Keratometer chin Rest
Minimum	0	1	0	0	0	0	0	0	0	0
25% Percentile	0	2.5	0	2.5	0	11.5	6	0	1	0.5
Median	0	7.5	1	9	2.5	26	13.5	11.5	3.5	4.5
75% Percentile	2.5	18	7	29	10	59	39	29	22	36
Maximum	20	90	30	90	22	90	76	135	108	100
Mean	2.917	14.08	4.917	17.58	5.708	34.04	24.13	20.88	13.58	20.67
Std. Deviation	5.8	19.95	8.129	21.97	7.018	27.59	23.61	30.11	23.33	28.63
Std. Error	1.184	4.072	1.659	4.485	1.433	5.631	4.82	6.145	4.762	5.844
Lower 95% CI of mean	0.4674	5.659	1.484	8.306	2.745	22.39	14.15	8.162	3.733	8.578
Upper 95% CI of mean	5.366	22.51	8.349	26.86	8.672	45.69	34.1	33.59	23.43	32.76
Shapiro-Wilk normality test*										
W	0.5653	0.6624	0.6754	0.7623	0.7949	0.9232	0.8458	0.6957	0.6037	0.757
P value	P<0.0001	P<0.0001	P<0.0001	P<0.0001	0.0002	0.0688	0.0018	P<0.0001	P<0.0001	P<0.0001
Passed normality test (alpha=0.05)?	No	No	No	No	No	Yes	No	No	No	No
P value summary	***	***	***	***	***	ns	**	***	***	***
Sum	70	338	118	422	137	817	579	501	326	496

*(The Shapiro-Wilk normality test is a comparative used to test the null hypothesis that a given sample was taken from a normally distributed population.)

Table #3: Number of Individual Colonies Cultured on BHI Plates

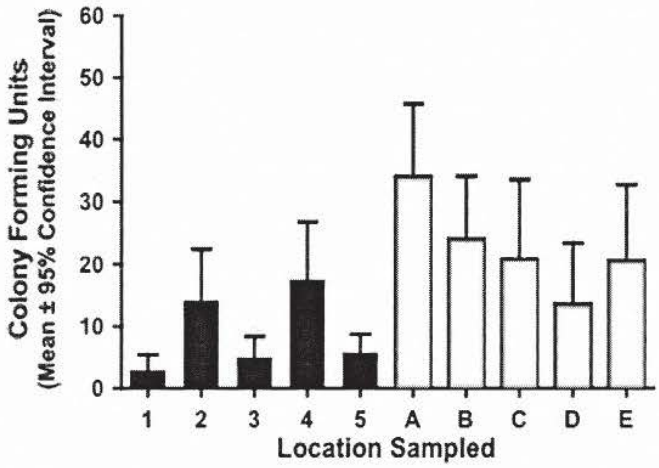
	Mydriatic Bottle	Examiner's Pen	Slit Lamp Toggle	Chair Arm Rest	Faucet Handle	Slit Lamp Chin Rest	Cover Paddle	Phoropter Head Rest	Slit Lamp Head Rest	Keratometer Chin Rest
1	0	10	3	0	15	26	20	16	1	0
2	4	1	0	10	5	0	3	0	0	0
3	3	7	3	13	3	22	2	0	23	1
4	0	8	2	19	0	33	3	18	1	24
5	5	0	0	5	0	1	35	6	0	75
6	21	30	13	12	0	31	55	0	0	0
7	21	65	12	40	0	23	90	38	60	28
8	20	57	0	35	1	80	48	0	75	5
9	18	52	35	6	0	0	42	0	0	37
10	6	56	5	0	0	115	78	10	8	35
11	0	0	0	8	2	65	85	1	40	25
12	18	26	6	10	1	35	200	35	65	0
13	20	50	30	2	30	12	11	11	30	2
14	10	20	2	37	1	40	20	120	1	0
15	0	3	0	25	20	50	10	24	2	0
16	20	30	6	47	10	65	32	52	4	2
17	18	52	12	63	16	40	42	40	35	0
18	18	52	60	18	6	30	42	28	89	20
19	33	41	60	52	61	49	15	37	45	112
20	0	5	4	15	12	26	10	47	25	60
21	0	5	5	55	7	41	20	33	10	20
22	21	23	30	12	55	26	15	2	60	33

Table #4: Statistical Interpretation of Findings on BHI Plates

	Mydriatic Bottle	Examiner's Pen	Slit Lamp Toggle	Chair Arm Rest	Faucet Handle	Slit Lamp Chin Rest	Cover Paddle	Phoropter Head Rest	Slit Lamp Head Rest	Keratometer Chin Rest
Number of values	22	22	22	22	22	22	22	22	22	22
Minimum	0	0	0	0	0	0	2	0	0	0
25% Percentile	0	5	1	7	0	22.5	10.5	0.5	1	0
Median	14	24.5	5	14	4	32	26	17	16.5	12.5
75% Percentile	20	52	21.5	38.5	15.5	49.5	51.5	37.5	52.5	34
Maximum	33	65	60	63	61	115	200	120	89	112
Mean	11.64	26.95	13.09	22	11.14	36.82	39.91	23.55	26.09	21.77
Std. Deviation	10.04	22.46	18.36	19.24	17.14	27.08	44.31	27.64	28.52	29.15
Std. Error	2.14	4.789	3.914	4.102	3.654	5.773	9.447	5.893	6.081	6.214
Lower 95% CI of mean	7.187	16.99	4.952	13.47	3.537	24.81	20.26	11.29	13.44	8.849
Upper 95% CI of mean	16.09	36.91	21.23	30.53	18.74	48.82	59.56	35.8	38.74	34.7
Shapiro-Wilk normality test										
W	0.8562	0.8857	0.712	0.8883	0.6842	0.9126	0.7407	0.7786	0.8496	0.7656
P value	0.0044	0.0155	P<0.0001	0.0175	P<0.0001	0.0536	P<0.0001	0.0002	0.0033	0.0002
Passed normality test (alpha=0.05)?	No	No	No	No	No	Yes	No	No	No	No
P value summary	**	*	***	*	***	ns	***	***	**	***
Sum	256	593	288	484	245	810	878	518	574	479

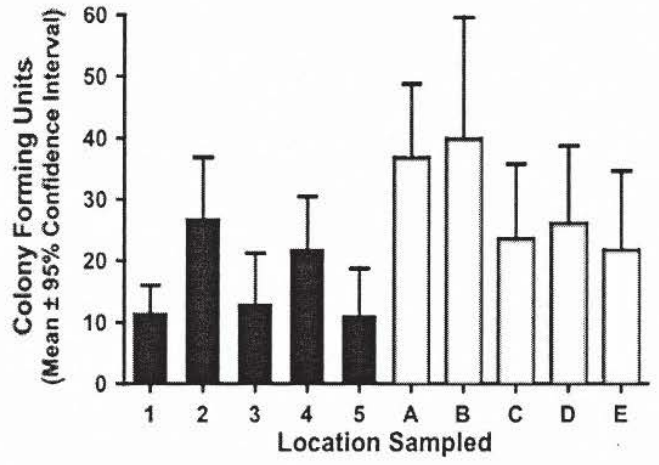
CHARTS

Chart #1: Comparison of Bacterial Contamination Using MSA Agar



(1-Mydriatic Bottle, 2-Examiner's Pen, 3-Slit Lamp Toggle, 4-Chair Arm Rest, 5-Faucet Handle, A-Slit Lamp Chin Rest, B-Cover Paddle, C-Phoropter Head Rest, D-Slit Lamp Head Rest, E-Keratometer Chin Rest)

Chart #2: Comparison of Bacterial Contamination Using BHI agar



(1-Mydriatic Bottle, 2-Examiner's Pen, 3-Slit Lamp Toggle, 4-Chair Arm Rest, 5-Faucet Handle, A-Slit Lamp Chin Rest, B-Cover Paddle, C-Phoropter Head Rest, D-Slit Lamp Head Rest, E-Keratometer Chin Rest

CONCLUSIONS:

Through quantitative and comparative analysis, this research illustrates that the University Eye Center and its equipment, though showing a presence of bacteria on both routinely "sterilized" and "non-sterilized" exam room items, yielded numbers that did not show a significantly high bacterial colony growth on any of the surfaces commonly in contact with practitioner and patient. The surfaces tested on average contain far fewer bacteria than what is found on the human hand minutes after washing them[7]. However, the research also pointed out the amount of bacteria present on a surface varies day to day. There are multiple factors that contribute to the number of bacteria present on a surface. Some of these include the sheer number of patients seen in room in which the surface is located, the cleanliness of the involved practitioner and patient, the surface material and the sterilizing technique and thoroughness of the practitioner. These all contribute to the room surfaces being sterile or not sterile. Another issue not addressed by this study was the fact that some bacteria harmful to patients do not grow on either of these media. This could lead to an underestimation of certain types of bacteria. It is important to understand this research only studied bacteria growth; the presence/quantity of other pathologic microorganisms like protozoans, viruses and fungus was not studied and therefore the surfaces are termed "relatively sterile from bacteria".

REFERENCES

1. Modern History Sourcebook: Joseph Lister (1827-1912) Antiseptic Principles of the Practice of Surgery, (1997). Retrieved April 19, 2008 from http://www.fordham.edu/halsall/mod/1867lister.html

2. How long do nosocomial pathogens persist on inanimate surfaces? A systemic review, BMC Infectious Diseases 2006, 6:130

3. Shapiro, S. S. and Wilk, M. B. (1965). "An analysis of variance test for normality (complete samples)", *Biometrika*, 52, 3 and 4, pages 591-9.

4. U.S. Food and Drug Administration. 1995. Bacteriological analytical manual, 8th ed. AOAC

5. USP. 2006. <1227> Validation of Microbial Recovery from Pharmacopeial Articles. USP 29. United States Pharmacopeial Convention. pp. 3053-3055.

6. ASTM. 1998. D5465-93(1998) Standard Practice for Determining Microbial Colony Counts from Waters Analyzed by Plating Methods

7. Fischler GE, Fuls JL, Dail EW, Duran MH, Rodgers ND, Waggoner AL: Effect of hand wash agents on controlling the transmission of pathogenic bacteria from hands to food. Journal of Food Protection. 2007 Dec;70(12):2873-7.