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A subjective evaluation of current contact lens wetting solutions

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Abstract

There have been many studies made as to the importance of the use of wetting solutions in the wearing of contact lenses. It is generally concluded that proper wettability of lenses is a significantly important factor in the improvement of wearing comfort. Wettability basically refers to a physio-chemical mechanism by means of which tears spread evenly over the lenses to form a coherent film. The compositions of the individual wetting solutions contribute in varying degrees to the wettability and wearing comfort. It is the purpose of this study to subjectively evaluate the variability in degrees of comfort and desirability of a number of wetting solutions currently available.

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by

Robert F. Haynes
William B. Petersen

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INTRODUCTION

ABSTRACT

There have been many studies made as to the importance of the use of wetting solutions in the wearing of contact lenses. It is generally concluded that proper wettability of lenses is a significantly important factor in the improvement of wearing comfort. Wettability basically refers to a physio-chemical mechanism by means of which tears spread evenly over the lenses to form a coherent film. The compositions of the individual wetting solutions contribute in varying degrees to the wettability and wearing comfort.

It is the purpose of this study to subjectively evaluate the variability in degrees of comfort and desirability of a number of wetting solutions currently available.

SURVEY OF THE LITERATURE

The optometric profession has generally accepted the concept that lens wettability is important in providing comfort for the contact lens wearer. Wetting solutions are capable of making the surface of contact lenses hydrophilic; this produces a more uniform tear dispersion which enhances vision and comfort. This wettability is a mechanism by which a capillary layer of tears spreads over the lens surface. Wettability is based upon the contact angle between a solid

and a droplet of liquid upon it; as this angle is reduced the wettability is increased. There are additional reasons for the wetting solution's need; it acts as a buffer or cushion for the lens, it minimizes friction of the contact lens against the conjunctiva and cornea, and acts as an antimicrobial agent to clean the lens before placing it on the eye or storing it in the soaking kit.

Since contact lens wetting solutions are exposed to far greater degrees of contamination than other ophthalmic solutions, they should contain an effective concentration of bactericidal elements. Some of these bactericidals have an irritating effect upon the posterior surfaces of the cornea, iris, and tissues lining the anterior chamber. It is mandatory that only nonharmful agents are used in these solutions, but they must be effective bactericidals.

The essential characteristics of an ideal contact lens wetting solution are that it must:

a) conform to the standard professional specifications of all non-medical ophthalmic solutions; this includes being isotonic, buffered, and preserved.

b) be capable of wetting methyl-methacrylate resin so that tears can spread evenly over all lens surfaces.

c) be formulated so that it can be instilled directly into the eye without causing irritation; it must be non-sensitizing.

d) not leave any solid residue on the eyelids which could interfere with blinking.

e) be sterile and contain a preservative.

The primary function of the various solutions which have been developed for use with contact lenses is to prevent discomfort. Even contact lenses which fit well mechanically and have well polished surfaces and edges may irritate the eye. This is particularly true if the solutions used are not compatible with the wearers body chemistry.

It has been reported in the literature that patients have been known to achieve comfortable full-time wear, then suddenly report symptoms usually attributed to a tight lens. Upon examination of the "fit" of the lens there is no evidence for this complaint. "In certain instances, the shifting of solutions seemed to help, but we were never certain why this shift assisted....if it truly did assist."[1] In summarizing, we may conclude that; when there is no evident explanation for a patients complaints regarding the wearing comfort of his lenses, a change in wetting solutions should be considered.

STATEMENT OF PROBLEM

In establishing comfortable wear of contact lenses there are often many factors which cannot be explained by the mechanics of fitting procedures. All aspects such as design and type of lens used, physical fit of the lens, and patient selection may appear satisfactory, and yet full-time

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[1]Lynn W. Brawner, Jr., O.D. A Review of Contact Lens Solutions, Contacto, Vol. 6 (2); p. 49, (February 1962).

comfortable wear is not achieved. It is felt by the experimenters that the proper selection of a wetting solution can be of significance in such cases, and in many instances aid toward the attainment of comfortable full-time wear.

METHOD

This experiment employed the use of six wetting solutions and ten subjects. Each subject used each solution for a period of two days, with all subjects using the identical solution over the same two day period. Five of the subjects were male and five female, and all were full time wearers of contact lenses, and were directed to wear the same pair of lenses throughout the experiment.

Each subject was provided with a kit of materials, included in which were identical: 1) wet type soaking kit, 2) soaking solution, 3) hand soap for use prior to insertion or removal of lenses, 4) notebook of explicit instructions and recording forms (see Appendix C). The containers of each of the different solutions was covered with a different colored tape to eliminate identification by the subject and influencing of his evaluation of the solutions. The subjects were revisited each week to re-enthuse their participation and to answer any general questions they might have concerning their part in the experiment.

At the end of each test wearing day the subjects

answered a series of ten questions concerning their evaluation of the solution used that day. The nature of the questions regarded such items as burning upon insertion, cloudy vision, general comfort, injection, and necessity to clean lenses during the wearing day. Following each question was a choice of five ranked responses from which the subject was to select one which most nearly described his evaluation with regard to the specific question.

CHART I

TOTAL POINTS PER SOLUTION

BY INDIVIDUAL SUBJECTS

	Solutions*					
SUBJECT	W_1	W_2	W_3	W_4	W_5	W_6
1	77	84	56	89	85	83
2	77	73	68	66	66	67
3	87	92	95	94	93	93
4	90	87	51	67	72	72
5	70	53	67	70	41	37
6	92	90	81	61	52	22
7	85	56	59	82	79	80
8	83	82	92	83	78	66
9	98	86	95	84	92	84
10	92	94	86	76	58	88
Σ	850	797	750	772	716	692

Note: Total number of points possible per solution is 100.

* See Appendix A for the trade names of these solutions.

CHART II

QUESTION RANKING

PER SOLUTION

	Questions									
SOLUTIONS	Q_1	Q_2	Q_3	Q_4	Q_5	Q_6	Q_7	Q_8	Q_9	Q_{10}
W_1	94	87	92	79	82	80	69	85	91	91
W_2	77	88	85	73	79	72	61	88	86	88
W_3	89	87	73	75	74	60	56	76	82	78
W_4	93	83	79	78	76	63	56	82	80	82
W_5	90	70	72	76	70	55	53	70	75	85
W_6	73	72	76	77	67	59	52	69	76	71
Σ	496	487	477	458	448	389	347	470	490	495

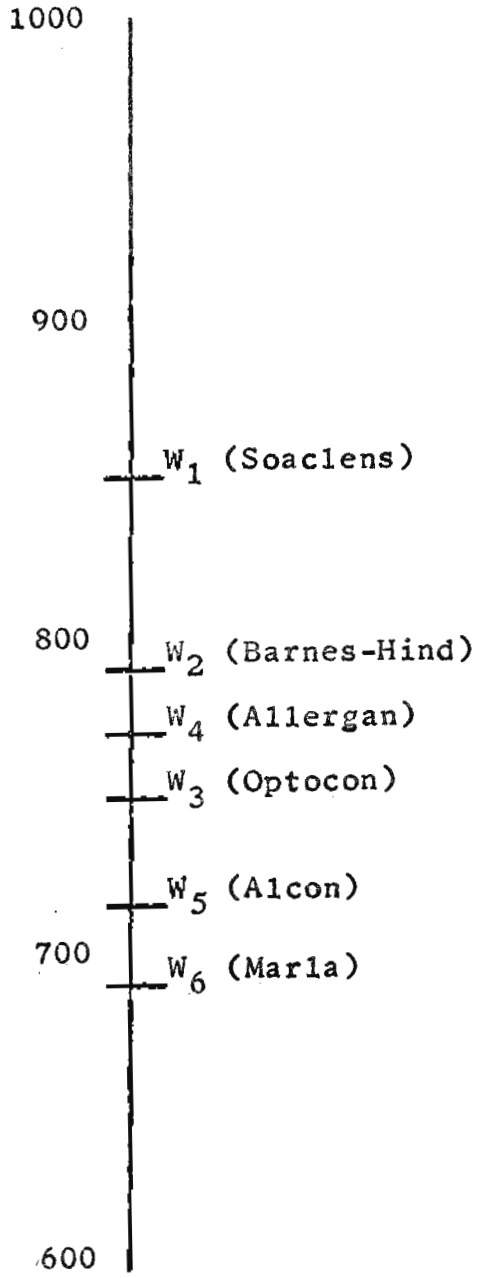
CHART III

MEAN RESPONSES TO QUESTION SEVEN (Q_7) FOR THE SUBJECTS' HABITUAL, MOST PREFERRED AND LEAST PREFERRED SOLUTION (W)

S	$W_{habitual}$ Name	Resp.	$W_{most\ preferred}$ Name	Resp.	$W_{least\ preferred}$ Name	Resp.
1	Optocon	2.0	Allergan	4.0	Soaclens	2.0
2	Barnes-Hind	2.0	Soaclens	3.0	Allergan & Alcon	1.5 2.0
3	Barnes-Hind	3.5	Optocon	3.5	Soaclens	2.5
4	Barnes-Hind	4.0	Soaclens	4.0	Optocon	2.0
5	Soaclens	2.5	Soaclens & Allergan	2.5 2.0	Alcon	1.0
6	Barnes-Hind	4.0	Soaclens	3.5	Marla	1.0
7	H_2O	---	Soaclens	4.5	Barnes-Hind	2.0
8	Optocon	4.0	Optocon	4.0	Marla	1.5
9	H_2O	---	Soaclens	5.0	Allergan & Marla	1.5 3.0
10	Optocon	3.0	Barnes-Hind	5.0	Alcon	2.0

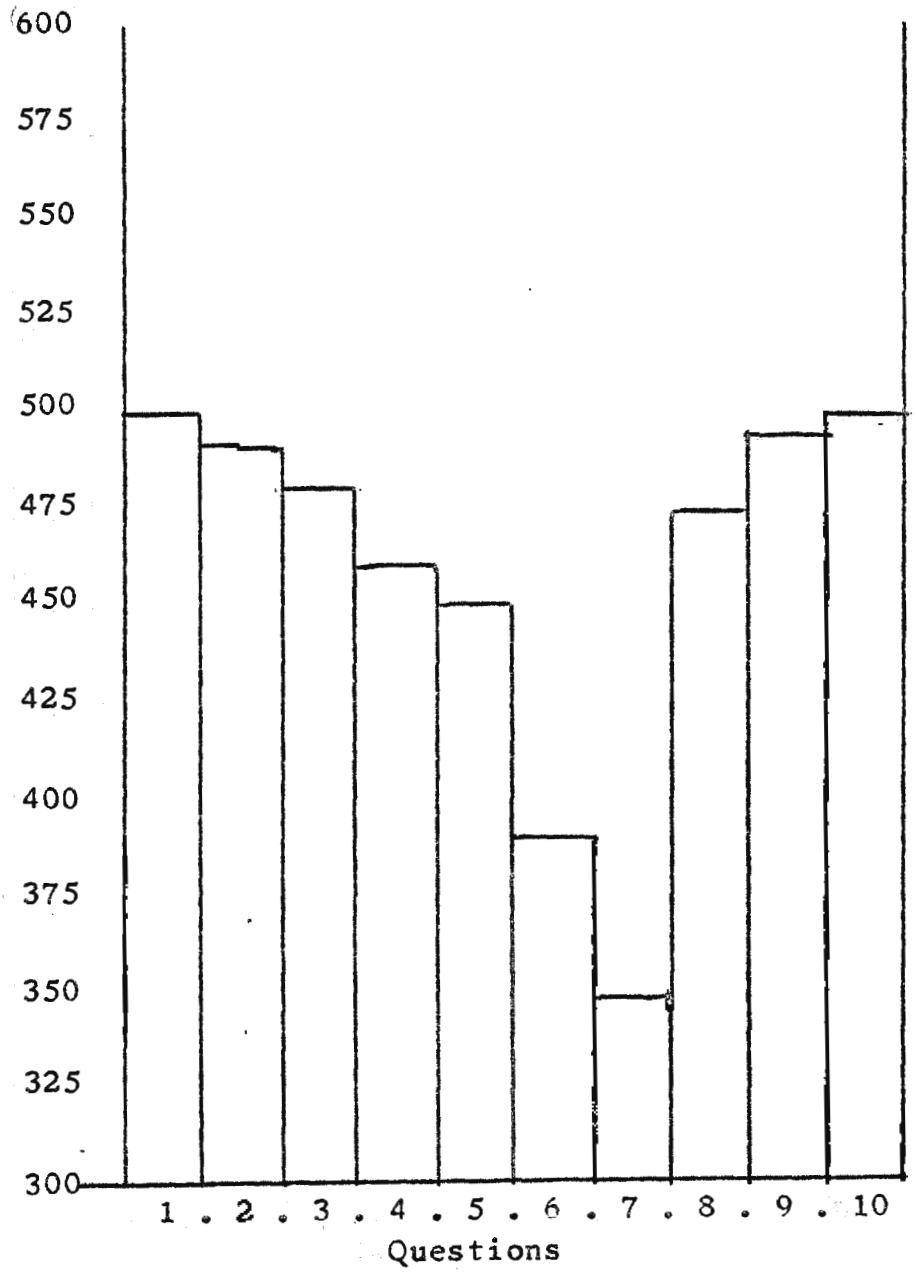
CHART IV

SOLUTION RANKING
(Based on totals from Chart I)



COMPOSITE GRAPHICAL PROFILE

OF QUESTION RANKING



STATISTICAL ANALYSIS

It is our desire to analyze the data obtained from this experiment to statistically determine the significance and variability of its results. The method of analysis of variance (ANOVA) has been utilized for this purpose. We are testing the data of this experiment with three hypotheses to determine if they are acceptable at the .05 confidence level.

The three Null Hypotheses are:

1) There is no significant difference among wetting solutions.

2) There is no significant difference among the questions asked.

3) There is no significant interaction between the question (Q), and the wetting solutions (W).

STATISTICAL SUMMARIES

Solutions

		W_1	W_2	W_3	W_4	W_5	W_6	$\Sigma\Sigma X$	$(\Sigma\Sigma X)^2$
Q_1	Σx	94	77	89	93	90	73		
	Σx^2	888	649	813	809	826	585	516	266256
	$(\Sigma x)^2$	8836	5929	7921	8649	8100	5329		
Q_2		87	88	87	83	70	72		
		787	790	779	715	556	606	487	237169
		7569	7744	7569	6889	4900	5184		
Q_3		92	85	73	79	72	76		
		862	761	587	657	584	628	477	227529
		8464	7225	5329	6241	5184	5776		
Q_4		79	73	75	78	76	77		
		637	563	575	620	598	635	458	209764
		6241	5329	5625	6084	5776	5929		
Q_5		82	79	74	75	70	67		
		692	663	604	585	556	513	447	199809
		6724	6241	5476	5625	4900	4489		
Q_6		80	72	60	63	55	59		
		662	568	424	453	345	415	389	151321
		6400	5184	3600	3969	3025	3481		
Q_7		68	61	56	56	53	52		
		477	445	356	344	325	334	346	119716
		4624	3721	3136	3136	2809	2704		
Q_8		85	88	76	82	70	69		
		745	806	654	708	592	567	470	220900
		7225	7744	5776	6724	4900	4761		
Q_9		91	86	82	85	75	78		
		737	774	708	735	613	682	497	247009
		8281	7396	6724	7225	5625	6084		
Q_{10}		91	88	78	82	85	73		
		747	792	662	700	739	583	497	247009
		8281	7744	6084	6724	7225	5329		
$\Sigma\Sigma X$		849	797	750	776	716	696	4584	2126482
								$(\Sigma\Sigma\Sigma X)$	$\Sigma(\Sigma\Sigma X)^2$

$(\Sigma\Sigma X)^2$ = 720801/635209/562500/602176/512656/484416

STATISTICAL COMPUTATIONS

$$A = \Sigma\Sigma\Sigma X^2 = 37815$$

$$B = \frac{\Sigma\Sigma(\Sigma X)^2}{n} = \frac{356918}{10} = 35691.80$$

$$C = \frac{\Sigma(\Sigma\Sigma X)^2}{nc} = \frac{2126482}{60} = 35441.36$$

$$D = \frac{\Sigma(\Sigma\Sigma X)}{nr} = \frac{3517758}{100} = 35177.58$$

$$E = \frac{(\Sigma\Sigma\Sigma X)^2}{nrc} = \frac{21013056}{600} = 35021.76$$

$SS_t = A - E$

$= 37815 - 35021.76 = 2793.24$

$SS_{(within\ cells)} = A - B$

$= 37815 - 35691.8 = 2123.2$

$SS_{(rows)} = C - E$

$= 35441.36 - 35021.76 = 419.60$

$SS_{(col)} = D - E$

$= 35177.58 - 35021.76 = 155.82$

$SS_{(rxc)} = B - E - SS_{(rows)} - SS_{(col)}$

$= 35691.8 - 35021.76 - 155.82 - 419.6 = 94.62$

r = rows 10
c = columns 6
n = number of subjects 10

ANOVA TABLE

	Source	Sum of Squares	Degrees of freedom	Mean Square (var. G-2)	F
1 H_o	Column (solutions)	155.82	5	31.16	*
2 H_o	Row (question)	419.60	9	46.62	*
3 H_o	Interaction (WxQ)	94.62	45	2.1	NS
	Error (within cells)	2123.20	540	3.93	
	Total	2793.24	599	4.74	

* Significant at .05 confidence level

NS Not significant

Null Hypotheses (H_o)

1 There is no significant difference among wetting solutions

2 There is no significant difference among the questions asked

3 There is no significant interaction between the questions (Q), and solutions (W)

DISCUSSION

The experimental results reveal that there is a substantial difference is patient desirability of the contact lens wetting solutions utilized in this project. According to null hypotheses 1 H_o, this was found to be significant at the .95 level. At the same level of significance, 2 H_o revealed there was a significant difference among the questions asked.

Each solution had a distinct range of acceptability as indicated by subjective evaluation. It may be noted in Chart I, that W_1 (Soaclens), had a narrow range (98 to 70) of subjective desirability, and W_6 (Marla) had a very wide range (93 to 22).

A composite total of all questions for all subjects for each solution reveals Soaclens to be significantly more desirable; Barnes-Hind, Allergan, and Optocon are relatively desirable; while Marla and Alcon are relatively less desirable. (See Chart II) In relating subjects habitual, most and least desirable solutions to question seven, significant relationships exist. (See Chart III).

Why were these differences found among the solutions and why did the rating of the solutions continually decrease from the first to the sixth solution, with the exception of solution number four? Was this effect due to the solutions

or was there a sequence effect? It is possible that the sequence and solutions were confounded.

If this experiment were repeated it would be advisable to utilize a control group which uses the same solution each day of the testing period, and the solutions used by subjects outside the control group should be presented in random sequence. This would aid in determining if there was a sequental interaction effect. It would also be desirable to have all solutions covered with the same color tape and coded by number, as this could have subjective influence.

SUMMARY

It is generally accepted that proper lens wettability is of paramount importance in insuring comfort and safety in the wearing of contact lenses. Due to the differences in composition of various wetting solutions there have been reported in the literature differences in patient acceptability of these solutions. There have been cases of subjective complaints regarding contact lens discomfort which was alleviated by a change in wetting solutions. In such cases the discomfort could not be explained by the physical fit of the lenses.

The author's ten subjects evaluated six currently available wetting solutions using each solution for a period of two days. Upon removal of the lenses at the end

of each day the subjects would give a ranking response to each of the ten questions asked, which were designed to evaluate the solutions. The evaluations of the solutions by the subjects indicate there is a significant difference in subjective desirability of the solutions.

The results of this project indicate Soaclens as the most preferable. There were sequence factors which possibly confounded the results and therefore the authors do not wish to state that this wetting solution is the most desirable in general, but only according to this study.

BIBLIOGRAPHY

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Brawner, Lynn W., Jr. O.D. A Review of Contact Lens Solutions, Contacto, Vol. 6 (2); February 1962.

Gould, Herbert L., M.D. Rationale in the Use of Contact Lens Solutions, Eye, Ear, Nose and Throat Monthly, May 1962.

Grosvenor, Theodore, P., Ph.D. Contact Lens Theory and Practice, Chicago: The Professional Press, Inc., 1963.

Hind, Harry W. Wetting and Hydration of Contact Lenses, Contacto, March 1959.

Kokoski, Charles S., Ph.D. A Study of the Effects of Various Soaking Solutions on the Wettability of Plastic Lens Surfaces, Contacto, May 1963.

Krezanoski, Joseph Z., Ph.D. What is Wetting?, Contacto, April 1963.

Rankin, Billy S., B.S. An Important Consideration for Contact Lens Solutions, Contacto, Vol. 6 (3), March, 1962.

Shpritz, Manuel, O.D. Problems Associated with Cleaning and Hydration of Contact Lenses, The Optometric Weekly, May 18, 1961.

Szekely, Ivan J., Ph.D. Contact Lens Solutions, The Dispensing Optician, February 1961.

_____, Contact Lens Solutions, The Optometric Weekly, August 1960.

_____, Hygienic Contact Lens Care and Patient Comfort, American Journal of Optometry and Archives of American Academy of Optometry, November 1960.

_____, The Eye, The Contact Lens, and the Contact Lens Solutions: The Role of Adjuctive Preparations in Contact Lens Practice and Wear, Transactions of the International Ophthalmic Optical Congress, 1961.

APPENDIX A

SUBJECT AND SOLUTION INFORMATION

Subject	Habitual Solution	How long worn contact lens	Average wearing*	Age	Sex
1	Optocon	5.84 years	17.0	23	M
2	Barnes-Hind	2.33	9.0	21	M
3	Barnes-Hind	5.58	15.0	20	M
4	Barnes-Hind	1.25	14.9	18	F
5	Soaclesn	1.50	15.1	27	F
6	Barnes-Hind	.84	11.1	20	F
7	Water	1.17	14.0	19	F
8	Optocon	1.17	14.9	23	F
9	Water	1.00	17.0	23	M
10	Optocon	4.33	14.2	22	M
	MEAN	2.50 years	14.22 hours	21.6 years	

Solution identification:

W-1 Soaclens
W-2 Barnes-Hind
W-3 Optocon
W-4 Allergan
W-5 Alcon
W-6 Marla

*Average daily wearing time during experiment.

APPENDIX B

PHOTOGRAPHS OF SUBJECT KITS

APPENDIX C

The five pages that follow contain an abbreviated form of an individual subjective evaluation notebook.

INTRODUCTION

To the Subject:

Thank you for consenting to be a subject in our evaluation of wearing comfort of current contact lens wetting solutions. In order that we may tabulate and analyze the results of the survey as accurately as possible, we ask that you follow very closely the instructions and procedures provided. You have been chosen to participate since you are currently wearing your lenses full time on a comfort basis. We wish to determine if there is a substantial influence upon this comfort level by the use of different wetting solutions. Your close cooperation is greatly appreciated.

Thank you.

Robert F. Haynes
William B. Petersen
Experimenters

INSTRUCTIONS

A. Use of equipment provided:

1. Throughout the duration of this experiment, use the case and soaking solution provided for storage of lenses when not being worn.

2. Prior to inserting and removing lenses:
   a. Wash hands thoroughly with soap provided for this purpose.
   b. Rinse lenses.
   c. Clean lenses with wetting solution.
   d. Rinse lenses.
   e. Wet both surfaces with wetting solution and insert lenses in eyes.

3. Each evening, empty soaking case, rinse with hot water, and refill with soaking solution, marked S, before storing lenses in case.

4. Upon removal of lenses each evening, record as accurately as possible your responses to queries on recording sheet.

B. Wearing schedule:

Each wetting solution is to be used for a period of two days, and in the following order, as numbered:

1. Blue . . . . 1st two day period
2. Yellow . . . 2nd " " "
3. Green . . . 3rd " " "
4. Brown . . . 4th " " "
5. Red . . . . 5th " " "
6. Silver . . . 6th " " "

SUBJECT INFORMATION

_____ : _____ : _____
Name Address Phone

Sex _____ Age _____ Occupation _____

What wetting solution are you presently using? _____

Do you find present solution satisfactory? _____ If not, why? _____

Other solutions used, and reason for discontinuing.

1. _____

2. _____

3. _____

4. _____

Do you soak your lenses when not wearing them? _____ If yes, in what solution? _____

How long have you worn contact lenses? _____ years

_____ months

1st Day *

RECORDING SHEET

Place appropriate number in circle to right of choices.

1. Was there burning upon insertion of lenses?

   1) very severe
   2) strong
   3) moderate
   4) very slight
   5) none

2. Did you experience cloudy vision at any time during the day?

   1) a great deal
   2) fairly pronounced
   3) moderate
   4) slight
   5) none

3. Did lenses feel 'gritty' at any time?

   1) a great deal
   2) fairly pronounced
   3) moderately
   4) slightly
   5) not at all

4. When holding lenses up to the light immediately after removal, were you able to view mucoid deposits on the lenses?

   1) very abundant
   2) considerable
   3) moderate
   4) slightly
   5) none

5. Did you feel at anytime that there was 'something' in your eye, such as a foreign object?

   1) very frequently
   2) frequently
   3) occasionally
   4) very seldom
   5) never

6. Did you find wearing generally comfortable?

   1) not at all comfortable
   2) fairly comfortable
   3) comfortable
   4) quite comfortable
   5) exceedingly comfortable

7. How would you compare this solution with your regular wetting solution?

   1) much less desirable
   2) not as desirable
   3) about the same
   4) more desirable
   5) much more desirable

* Note: Identical sheets were provided for each day's use of each wetting solution.

Recording sheet, Continued.

8. For how long during your wearing day were your lenses comfortable?

   1) never
   2) morning only
   3) morning and afternoon
   4) early evening
   5) late evening

9. Did you find it necessary to take out and clean one or both lenses at any time during your wearing day?

   1) constantly
   2) many times
   3) fairly frequently
   4) only occasionally
   5) never

10. Throughout the wearing day, did you observe at any time, injection (bloodshotness) of the eyes?

    1) very severe
    2) severe
    3) moderate
    4) very slight
    5) none

SUMMARY

1. Which solution did you feel to be generally the most desirable and comfortable for you over the two day testing period? (circle the appropriate color below)

   Silver Yellow Blue Brown Red Green No preference

2. Which solution did you find least desirable? (circle appropriate color below)

   Yellow Blue Brown Red Green Silver

3. Was there any solution (s) which you found intolerable, and if so why? (circle appropriate responses (s) below)

   Yellow Blue Brown Red Green Silver

   Reason _____

4. General remarks: Include here any observations on your part not noted previously.

_____

_____

_____

_____

_____