

# DENTAL CARIES

*Mechanism and Present Control Technics  
as Evaluated at the University of  
Michigan Workshop*

Edited by

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## PREFACE

As one of the earlier pages which follows points out, myths, the folk-ways of primitive people, still persist and motivate activities in many modern communities. Many health myths not only still are accepted by nonprofessional people, but some are given added credence by the frequent repetition of non-critical practitioners. Some have been freshly propagated by each edition of certain textbooks. People in the health professions have been known to "take sides" in research feuds, accusations of persecution have been made when conclusions were questioned on the basis of statistical evaluation, and cold objectivity often has encountered heated emotion. It has been found a bit difficult at times for truth or fact to prevail when emotional individuals will to *believe* rather than to *conclude*.

A conference is reported in the next 220 pages which was planned to sift out fact from myth in one of the major areas of concern of the dental profession. This conference, utilizing the workshop technic in which "faculty," consultants and "students" all study together in a university situation, attempted to appraise the present scientific status of information regarding the technics available to control dental caries. The idea of such a conference grew from the demand by the Councils on Dental Health and Dental Therapeutics of the American Dental Association, members of the American Association of Public Health Dentists, many health educators and many practicing dentists for a critical summary of the information that is scientifically valid in the field of caries control.

This conference was sponsored jointly by the School of Public Health and the School of Dentistry at the University of Michigan as an inservice training course during the second week of September, 1947. It was financed largely by funds which resulted from the efforts of the W. K. Kellogg Foundation of Battle Creek, Michigan, to promote a better dissemination and utilization of past and current research in the health sciences. It was planned months in advance by a group representing the Headquarters Office of the American Dental Association, dental research, public health practice, dental health education, biostatistics and library science. Nineteen persons, principally dental caries research workers, participated in the lectures and 114 people in all participated in the discussions and evaluations. These participants gathered from different parts of Canada and the United States because of a variety of interests—private dental practice, public health practice, dental research, health education, dental education, biostatistics, nutrition, bacteriology, biochemistry and pediatrics.

Lectures were presented during the morning sessions only, after the first day's proceedings, with a question and discussion period following each lecture. The afternoon periods were devoted entirely to "committee" activities in discussion rooms or in the dental library, critically checking the validity of the



## PREFACE

The well-appointed stacks of the library. Six evaluating committees had been organized well in advance with chairman, secretary and technical assistants to help appraise the available information and draw conclusions about the prepared questions which concerned particularly (1) the mechanism of the caries process, (2) the relationship of systemic conditions to the caries process, (3) the effectiveness of prophylaxis, toothbrushing, chewing gum, dentifrices and mouthwashes in the control of caries, (4) the utilization of fluorides and silver salts in the control of caries, (5) the relationship of ingested vitamins and minerals to dental caries, and (6) the contribution of various types of caries control. The conclusions of these six committees were reported, discussed and adopted in a general session during the final day of the conference. In retrospect, a week-long conference of this type appears, very definitely, to provide a device to evaluate research critically, to help disseminate this information promptly and thereby reduce the lag between discovery and utilization and to note clearly the areas for new or substantiating research. Without doubt, an intriguing method has been demonstrated that can be employed to reduce conjecture by fact.

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KENNETH A. EASLICK, A.M., D.D.S.

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## Proceedings of the University of Michigan School of Public Health and School of Dentistry Inservice Training Course for the Evaluation of Dental Caries Control Technics

## INTRODUCTORY REMARKS

DR. KENNETH A. EASLICK

You people have been called together in this Auditorium of the School of Public Health to do a job that seems desirable and very much needed. How much needed you may expect to learn from the second morning speaker. The job is, as you know, the evaluation of the scientific information which is available on the process of dental caries and its control, as far as it is humanly possible as of September 8-13, 1947.

A job to be completed successfully calls for effort and rolled-up sleeves. Sometimes, as you may recall, it calls for blood, sweat, and tears; I hope that we do not go that far at this meeting. As I assess this week of planned activity, all of us are going to have to work hard and quite continuously for six days, but I think that all of us are going to like it.

Because of some pointed questions overheard, "What is an inservice training course, anyhow?" it seems particularly appropriate that the Planning Committee selected for the "kick-off" speaker this morning the man that it did, and I personally should like to congratulate Dr. Henry Vaughan on his attendance. The last time that I presided at an Inservice Training Program in this auditorium, Dr. Vaughan, at the very last minute, begged to be excused from speaking—he had an appointment with his dentist. Sometimes it is a real achievement to secure Dr. Henry F. Vaughan, Dean of the School of Public Health, and to find him willing to speak briefly on the subject which our Planning Committee assigned to him, "The Inservice Training Program at the School of Public Health." Dr. Vaughan, we appreciate the keeping of your appointment this time with 70, or 80, or 100 dentists instead of just one.



# THE EFFECTIVENESS OF THE TOPICAL APPLICATION OF SILVER SALTS IN THE CONTROL OF CARIES

ELMUT A. ZANDER, D.D.S., M.S., ASSOCIATE PROFESSOR OF CLINICAL DENTISTRY,  
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There isn't anything new about the topical application of silver salts, or as it is now called, "impregnation." It was described in 1897 by Frank. Since that time, its use has been continued with reports of both success and failure to accomplish protection of teeth against dental caries. Quoting myself from a paper in 1941, "Too many times in the past, forceful personalities and wishful thinking have been the substitutes for carefully controlled experimentation. Somewhere in dentistry can this be better seen than in careful examination of the available literature on silver nitrate and its application in the treatment of dental caries." This statement still holds. Therefore, if your Committee, after having made such a statement, still asks me to discuss this subject, I hope you won't be too surprised if I disregard the literature connected with the names of Brooks, Bryan, Cleary, Hoffman, and Prime, and a good many others. The reason for not considering them is found in the statement I read.

I should like to discuss the subject under two headings: 1. Does topical application of silver salts protect tooth substance against caries? 2. If it does, what is the mechanism of this protection?

Miller treated dentin and enamel of extracted teeth with a saturated silver nitrate solution. He then suspended the teeth in a glucose-saliva mixture and found that the area of dentin treated with silver nitrate did not show as much decalcification as did the untreated areas. This he could not duplicate with enamel. Miller's experiments were repeated by Hill and Arnold in 1936. They observed that enamel treated with silver nitrate did not decalcify as rapidly as untreated enamel when it was exposed to 5 per cent lactic acid. This is the laboratory evidence which I should like to present and discuss later.

Now, for clinical data. Hoffman subjected fifty-six case records of Prime's practice to statistical analysis. Prime had applied a solution of ammoniacal silver nitrate to etched tooth surfaces; the interval between individual applications varied from three to more than six months. The number of etched areas treated were 887, and the total number of treatments, 5304, which gives about six treatments for each surface. According to Prime, "Caries was arrested in each case." Hoffman studied Prime's record cards and recalled those patients who had had silver nitrate applications at one time or another and examined these surfaces, which he found to be caries free. I hope Hoffman will discuss his study later. There is no control in this study. However, one can say that the author's figures indicate that, at least in the hands of Prime, silver nitrate impregnation was extremely successful in the prevention or control of dental caries.

After Dr. Wallace's excellent paper on the appraisal of dental literature and Dr. Knutson's objective report with such statistically significant results, it is easy to see that the available reports concerning silver nitrate and dental

in complete contrast with Prime's work are the findings of Klein and Knutson in a well-controlled clinical study of 700 children 5 to 12 years of age. They used the same technic as Prime on the right maxillary first permanent molar and the left mandibular first molar. The other two first molars were used as controls. Once a year the teeth were re-treated, and they were re-examined after 3½ years.

Table I (from Klein and Knutson) shows in detail the condition of the teeth after three and one-half years. Let us look at the "caries-free" in 1937 (column); by 1941, one or more surfaces became carious in 246 treated and 236 untreated maxillary first molars, and in 194 treated and 225 untreated mandibular first molars. On a percentage basis, 79 per cent of the treated and 77 per cent of the untreated molars became carious. Thus, the treated and untreated teeth suffered approximately the same caries incidence.

TABLE I

CRUIER CONDITION, IN 1941, OF TREATED (T) AND CONTROL (C) FIRST PERMANENT MOLARS, SHOWING SPECIFIED CONDITIONS IN 1937, NUMBERS AND PERCENTAGES BASED ON DENTAL EXAMINATIONS OF 474 SCHOOL CHILDREN\*

CRUIER CONDITION IN 1937	NUMBER OF SURFACES ATTACKED BY CARIES IN 1941	FIRST PERMANENT MOLARS											
		NUMBER						PERCENTAGE†					
		MAX.		MAND.		BOTH		MAX.		MAND.		BOTH	
		T.	C.	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.
Unrupted	One	42	32	19	21	61	53	54.5	42.1	29.2	31.8	43.0	37.3
	Two	13	7	17	15	30	22	16.9	9.2	26.2	22.7	21.1	15.5
	Three	0	1	5	4	5	5	1.3	7.7	6.1	3.5	3.5	3.5
	Four or five	1	0	8	7	9	7	1.3	12.3	10.6	6.3	5.0	5.0
	One or more	56	40	49	47	105	87	72.7	52.6	75.4	71.2	73.9	61.3
Caries free	One	149	163	78	97	227	260	49.5	50.9	30.8	35.1	41.0	43.6
	Two	73	51	64	78	137	129	24.3	15.9	25.3	28.3	24.7	21.6
	Three	11	11	23	22	334	33	3.6	3.4	9.1	8.0	6.1	5.5
	Four or five	13	11	29	28	42	39	4.3	3.4	11.5	10.1	7.6	6.5
	One or more	246	236	194	225	440	461	81.7	73.8	76.7	81.5	79.4	77.3
Caries, one surface	Two	15	13	23	15	38	28	19.7	21.3	21.1	15.8	20.5	17.9
	Three	13	7	7	10	20	17	17.1	11.5	6.4	10.5	10.8	10.9
	Four or five	20	18	61	60	81	78	26.3	29.5	56.0	63.2	43.8	50.0
	Two or more	48	38	91	85	139	123	63.2	62.3	83.5	89.5	75.1	78.8
	Three	1	3	1	1	2	4	6.3	20.0	3.1	4.3	4.2	10.5
Caries, two surfaces	Four or five	8	8	28	18	36	26	50.0	53.3	87.5	78.3	75.0	68.4
	Three or more	9	11	29	19	38	30	56.3	73.3	90.6	82.6	79.2	78.9

\*From Klein and Knutson: Studies on Dental Caries. XIII Effect of Ammoniacal Silver Nitrate on Caries in the First Permanent Molar, J. A. D. A. 29: 1420, 1942.

†The number of teeth showing specified conditions in 1937, and on which the percentages are based, are shown in Table II (of Klein and Knutson).

‡Thirty-five molars, nineteen among the T group and sixteen among the C group, have been omitted from the analysis, since they showed carious lesions on three or more surfaces or were filled or extracted.

The latest proponent of the silver impregnation theory is Gottlieb. His clinical evidence is based upon the studies by Younger published in Gottlieb's book, *Dental Caries*. Twenty-nine children between the ages of 7 and 12, who had an average of 10.8 cavities per child, were selected for the experiment. All teeth with clinically visible carious lesions were then restored. Twenty-four children received an impregnation with 10 per cent silver nitrate solution pre-



d of one year, the children were re-examined and at the same time re-nated. At the end of two years, nineteen children of the experimental and five of the control group were re-examined. Now, ordinarily we simply state that such a clinical study should not be discussed at all because obviously the number is insufficient. Because of the extreme interest in this work, and because of the publicity which it has received in the past months, I have studied these figures in detail. I found out how many cavities Child No. 1 had, Child No. 2, and so on down the line; the age of each child; and then, with the kind help of Miss Hall, we took these figures and tried our best to see whether there were some statistical significance. I will just bear with me, I shall present some of those figures on the basis of realizing of course, that the data actually do not merit discussion.

*Year of Experiment:*

Control group	4.20	±	0.38 new cavities
Experimental group	0.46	±	0.23 new cavities
Difference	3.74		0.44
Critical ratio = $3.74 \div 0.44 = 8 +$			

*Year of Experiment:*

Control group	5.20	±	0.38 new cavities
Experimental group	0.68	±	0.21 new cavities
Difference	4.52		0.43
Critical ratio = $4.52 \div 0.43 = 10 +$			

These are the figures for the first and second years. In the first year, the incidence for the control group was 4.20 cavities plus or minus 0.38, while the experimental group had 0.46 plus or minus 0.23, with a difference of 3.74 plus or minus 0.44; the critical ratio, 8 plus. I am not much of a statistician, but they think this is significant, if you are satisfied with those figures.

In the second year, the incidence of decay in the control group was 5.20 plus or minus 0.38; in the experimental group, 0.68 plus or minus 0.21; the difference, 4.52 plus or minus 0.43. The critical ratio equals 10 plus.

There were five subjects in the control group. In the first year those subjects had 4.2 cavities, and in the second year they had on top of that, 5.2 cavities. In other words, in two years, they got 9.4 cavities. The age group is 8 to 12 years.

Those figures are way out of range of the figures which we know are the incidence of caries for that age group. I don't think that having just five subjects in the control group justifies statistical analysis. We do know something about the incidence of caries in such an age group, maybe not exactly for this group.

In Texas, where those figures come from, but for the nation as a whole, according to Klein, those figures are something like 1.4 cavities per year. To make a rigid statistical analysis of Younger's finding of  $0.46 \pm 0.23$  new cavities per year in the silver nitrate-treated group, let us double the standard error and add this to the average, which gives us 0.92. This compared with Klein's national average of 1.4 is a little more in line, but still significant.

The problem is the interpretation of these studies by Younger, Klein, and Robinson, and also the data reported by Hoffman. On the surface, these studies

they may have arrived at their conclusions; Klein and Knutson, that there is no value to impregnation with silver nitrate; and Younger and Gottlieb, that it has value as a caries control measure. The age group is the same for both of these studies. One difference is that Klein and Knutson used only two first permanent molars for impregnation. Younger impregnated all teeth. Yesterday I asked the question of Dr. Arnold why there existed in endemic areas a difference in the reduced incidence of caries for some teeth when compared with others. A similar question was asked again today: which teeth and which surfaces apparently have a reduced incidence of dental caries? Robinson's answer applies also for the studies on silver nitrate. Klein and Knutson, I believe, devised too difficult a task for silver nitrate by expecting it to protect the first permanent molar. The incidence of caries is so much greater for this tooth than for any other tooth in the mouth that even in a relatively caries-immune mouth, this tooth often shows a carious lesion, although none of the other teeth have any evidence of decay. Silver nitrate impregnation may afford the tooth some resistance to caries, but not complete resistance. As far as the first molar is concerned, that increased resistance is not sufficient. To illustrate, let us assume that silver nitrated enamel is five times more resistant to decalcification than untreated enamel. Then it would take possibly five times as long for the carious process to get started, or the process has to be five times as strong. Now, these figures and this whole principle are just empirical for the sake of illustration. Klein and Knutson impregnated the first permanent molar once a year. The last impregnation was in the fall of 1939; the examination was made in the spring of 1941. A year and a half intervened between the last impregnation of silver nitrate. It is indeed possible that the caries attack rate for the first permanent molars may far exceed any artificial caries immunity. Perhaps an experiment in which sodium fluoride was applied to the permanent molars only would give comparable results. I am thinking now of the over-all 60 per cent reduction in dental caries due to sodium fluorides which is probably an average of 90 per cent effectiveness in the anteriors, and 30 per cent or less in molar teeth. Therefore, it seems logical that while for the first molar the silver nitrate impregnation was not sufficient protection, it may have been sufficient for some of the other teeth. The caries mechanism in all its complexity is more acute for the first molar than for any other tooth.

Younger certainly used much too small a group to stand up under critical examination. However, his work gives an indication that the impregnation method may have some value in reducing the incidence of caries. Much larger groups must be studied before Younger's and Gottlieb's claims can be accepted.

Now, a few words as to the mechanism by which the impregnation method might protect the tooth. Prime, Ross, and Gottlieb believe that it forms a barrier to the organic invasion roads of dental caries, and that brings us back to the mechanism of dental caries. In previous discussions at this meeting (according to Miller's hypothesis), it has been agreed that in caries of dentin a proteolytic action occurs, while for caries of enamel it is primarily an acid



for enamel caries. Gottlieb states, and I should like to quote from his "In case of invasion of a lamella, where the yellow pigmentation forms spearhead, the possibility of any preparing action by acid is out of the question. Only when invading along the prism sheaths does acid form the spearhead. Here the situation merits discussion. Although exceptions may be found, acid alone rarely penetrates to the dentin through thick enamel without any yellow pigmentation. It appears more probable that the proteolytic action in the already invaded enamel parts facilitates progressing penetration of additional acid producers. This is true only for enamel. In unhampered attacking dentin caries, the signs of acid action make the spearhead as a rule. In other words, Gottlieb, who uses yellow pigmentation and proteolysis interchangeably, believes that this is the first sign of caries which starts at a lamella. In other types of beginning caries, acid action is of prime importance. He feels that the difference is that the lamella organic invasion roads, as he repeatedly repeats, are the more common beginning areas of caries. Therefore, obstruction of these roads by an insoluble salt is his explanation of the mechanism of silver impregnation. I should like to point out that he now recommends a 50 per cent solution of zinc chloride followed by a 10 per cent solution of potassium ferrocyanide instead of the silver impregnation we are talking about. The principle of its action he claims to be the same as in the use of silver nitrate. Now, the action of silver nitrate solutions is not just one on the organic substance of the enamel. Arnold and Hill demonstrated, on powdered enamel, that the silver combined principally with the inorganic material of the enamel; only a small fraction of the silver salts were found in combination with the organic substance. While these experiments carried out on powdered enamel are not directly applicable to the intact enamel of human beings, they indicate that we do not just simply obstruct "the organic invasion roads," as Gottlieb's terminology.

Therefore, in summary, the mechanism by which the application of silver nitrate on enamel affords protection may be an obstruction of the organic material and alteration of the inorganic material to make it more resistant to decalcification by acids.

Now, before I conclude, I believe I have about two or three minutes more?

R. EASLICK.—Yes, go ahead.

R. ZANDER.—I should like to make a plea for silver nitrate. After you have heard the fine studies on topical applications of sodium fluoride, this, as I mentioned, is anticlimax. My job would be much more pleasant if I were able to show you a lot of good data and a controlled experimental setup to prove that silver nitrate is something or is not worth something. Considering the available evidence, I, for one, can conclusively state that silver nitrate solution affords protection to the enamel of teeth. On the other hand, I would not completely discard the theoretical approach of Arnold and Hill, the thorough work of Klein and others, nor Hoffman's observations of Prime's work. What we need is a comprehensive study comparing the relative value of topical applications of silver nitrate and sodium fluoride. Once and for all, silver nitrate should have

here; perhaps one of them will go home with the possibilities of silver nitrate in mind as well as the actualities of sodium fluoride.

Thank you.

#### DISCUSSION

DR. EASLICK.—Thanks very much, Dr. Zander. And I should like to assure you, for whatever the evidence is worth, my shirt never had dental caries.

Dr. Zander's presentation is now open for discussion.

DR. J. M. WISAN (New Jersey State Department of Health).—I should like to ask a question of both Dr. Zander and Dr. Knutson. In the light of their studies, do they consider that the filling of pits and fissures, which a sharp explorer detects, without observable decay is a justifiable procedure?

DR. ZANDER.—My answer to this question is not based upon scientific experiments. This is an opinion made after seeing hundreds of child patients, that one is not justified in letting pits and fissures go with just applications of drugs. I do believe that they should be filled. This is a good point which you brought out, and I am glad I have a chance to speak for one more second. Looking over this program on the "Control of Dental Caries," we see much about many drugs, but no mention of good operative dentistry and some of the procedures of careful diagnosis, which in many an office have controlled dental caries to such an extent that for many years the people haven't lost their teeth.

DR. EASLICK.—Dr. Knutson, do you want to get on the record, too, since this question was directed to both of you?

DR. JOHN W. KNUTSON (United States Public Health Service).—Even before topical fluorides came on the scene, I was of the opinion that if children, or individuals, got to the dentist at regular intervals, as determined by the dentist, one wouldn't have to worry about filling pits and fissures which might not become carious. Certainly if children did get to the dentist at regular intervals, there would be plenty of teeth to fill that were actually carious.

DR. EASLICK: Dr. Hoffman?

DR. OLIN E. HOFFMAN (Iowa State Department of Health).—I should like to say at the onset that Dr. Zander certainly gave a very fine presentation and was very fair with all the contestants. Dr. Zander did not, however, bring out the fact that the techniques used by Dr. Prime and Dr. Knutson were different. He had the impression that the technique of the use of silver nitrate to arrest caries was the same. Now, as I understand Dr. Knutson's technique, he merely applied the silver nitrate to the portion of the tooth with cotton, isolating the quadrant with cotton rolls. Is that right, Dr. Knutson?

DR. KNUTSON.—Yes.

DR. HOFFMAN.—You did not use the rubber dam in the application, did you?

DR. KNUTSON.—That is right.

DR. HOFFMAN.—Now, that is one of the chief points of difference, Dr. Zander. It will correct the large difference in the conclusions that were reached in those two presentations. Dr. Prime first gave a prophylaxis, and he did just the thing that Dr. Zander has been encouraging, which all of us wish to encourage; that is, good operative dentistry. Dr. Prime filled all of those occlusal surfaces. They were all filled; he did not depend on silver nitrate to take care of the occlusal surfaces. Dr. Atkins and I treated forty children, ranging in age from 4 to 17, over a five-year period of time. We treated both the proximal surfaces and the occlusal surfaces twice a year. We finished with twenty children; the proximal caries was arrested, but the occlusal caries was not. You can't stop occlusal caries with silver nitrate. You can slow it down, but you can't stop it. But Dr. Prime would give a prophylaxis and then under the rubber dam would apply silver nitrate to all of the



... into interproximal surfaces. He would rub in the silver nitrate on the surface both so that the silver nitrate would penetrate the plaque, or destroy the plaque, and the proximal surface. That is the reason why he obtained such good results over years that he used it in his practice, but he did not depend upon it to arrest occlusal

EASLICK.—Is there anything further, Dr. Knutson?

KNUTSON.—I am glad that you pointed out the differences in technic, Dr. Hoff. I came up until the time that that was pointed out, I rather objected to the comparison. We had 500 cases in our study, whereas Younger had only nineteen treated and five individuals in his study. Furthermore, it is clear that the five persons in his group had an extremely high caries attack rate, four to five decayed teeth per person, and a high average is one per year. We know from this that he had an individual control group. In spite of that extremely high rate, the application of statistical data to the data and the calculation of standard errors appear to have given additional weight to those figures to Dr. Zander, which I don't think is warranted. In making use of these data, it is important that we be familiar with the characteristics of caries in population groups. There is great variability in the number of carious teeth among individuals. The average incidence may be three-fourths to one decayed tooth per year for large groups, but in exceptional individuals, it may be five, six, or so that if we have a control group consisting of five individuals who are obviously all cases, we need to be very careful about our interpretations.

Another point that Dr. Zander brought out that I think one has to strain a little to follow or to agree with is that since our re-examinations were a year apart, sufficient time has elapsed to give the teeth treated with silver nitrate time to become carious to some extent as the control teeth. Any real difference in attack rates, as has been noted in studies concerned with topical fluorides and fluoride waters, is reflected in specific prevalence rates.

EASLICK.—Dr. Zander, do you wish to comment?

ZANDER.—Dr. Robinson is going to, I think.

HAMILTON B. G. ROBINSON (Ohio State University).—There is a very important point that is beginning to develop here, that there seem to be two groups of ideas about dental caries control. There is a group which thinks we are discussing dental caries control as a mass control measure only; and there is another group that has the concept of dental caries control for my individual patient? Now, the type of dental caries control which Dr. Knutson is talking about is mass control of dental caries. That is the way he is trained; that is the way he thinks; that is the way the Public Health people think it. I, for my part, am on neither side; I want to see both approaches developed. I am unable to tell a student in school how to take care of his patient individually and to reduce mass caries at the same time. The figures come out differently because of the different approaches. You, Dr. Knutson, want to find an approach that can be used on a mass of people and which will reduce the caries of that mass of people. When Dr. Knutson said that a 40 per cent reduction in caries with the use of topically applied sodium fluoride, that does not mean that if you use his method on a child in your office the child is going to have 40 per cent less caries. It means that in a mass of the population there will be a 40 per cent reduction. In a certain individual in your office it might not produce any reduction at all; in another one, it might entirely stop caries. The private practitioner has the ability to do more things. Every time a careful operator like Prime applies silver nitrate in an office, he not only applies silver nitrate, but he treats the patient and he takes care of the operative work. There still is no substitute for metal and plastics for filling teeth. You can't fill them with fluorine; you can't fill them with orange juice, nor with D. You have to fill them with gold, amalgam, cement, or plastic. We have to

very probably will, show a reduction in caries in those office patients. But the other group is looking for a method that can be applied to a mass of the population and bring down the caries rate without having to give all this type of individual care. So, I think that we have to think of two types of caries control: That which the men who are in the offices are going to take back to use, which might be far different from caries control as we think of it for a mass population purpose.

DR. KNUTSON.—I am sorry I must disagree again this morning, this time with the point that Dr. Robinson was trying to make. I don't think we are talking about different things at all. If a procedure is effective for the individual, then it should be effective for numbers of individuals. If it is a partial control procedure, such as the use of penicillin in the treatment of osteomyelitis, it might be effective in only 80 per cent of the cases and, therefore, you can't assure a given patient who has the disease that you are going to cure his osteomyelitis. The use of topical fluorides is a partial preventive, and we can't predict which individual is going to get the greatest benefit from it. As I see it, there is no real difference between effective public health procedures and effective procedures used by the private practitioner. What difference there is, is based wholly on practical considerations. From a public health standpoint, procedures that don't cost too much and that can be applied effectively to the mass population are most likely to be adopted for use. I wonder if Dr. Hall might want to shed some light on this point of disagreement.

DR. EASLICK.—Dr. Hall, you have the floor.

DR. MARGUERITE F. HALL (University of Michigan).—Well, I think it is sort of wonderful to be a statistician on the outside and to be working with these professional people. I should like to point out that both Dr. Knutson and Dr. Robinson are right. It is wonderful to encourage the private practitioner to have a little research attitude and to try to analyze his data, even though the data are limited. And the value of some of the statistics, as Dr. Zander pointed out, is excellent to indicate that there is something in small samples when you have faith in the comparative value within the sample itself. And the professional man comes to the foreground in his consideration of that control group made up of the Texas people by saying "sure, those five cases are absolutely ones." It would be just as though in the height illustration we selected all the Alton, Illinois, giants. And that is what happened. But Dr. Zander tried to do something with the material by taking the large sample of control individuals, through some of the work that has been previously done, and still show that even though the control group on the large sample produced the 1.4, Dr. Younger from Dallas had an experimental group which still might be of some value. Now, there are other statistical interpretations that Dr. Zander didn't give which would come in if the material were really played out by the statistician, but usually the statistician drops from the scene as soon as the professional man has received the help that he has taken from the use of statistics as a tool. I definitely have been appreciating this work this week in seeing the recognition that the professional man is giving to all the tools that he can have at his disposal, and statistics happens to be one of those tools.

DR. EASLICK.—Now, Dr. Wisan, you requested the floor.

DR. J. M. WISAN.—I should like to suggest that we suspect the figure of one cavity per year in children. My basis for suspecting these data is the experience that we have had in New Jersey with approximately 10,000 children treated by approximately 100 different dentists who found an average of three fillings per year required per child.

DR. ZANDER.—I should like to get into this apparent dissertation between Dr. Robinson and Dr. Knutson. I actually let Dr. Robinson speak when I should have answered you in the first place, but I thought he could do it just as well, or probably better. Now, as I said, statistics are fine, but I also have some logic. I am a human being; I am a dentist and see certain things. If I go home from this conference, as it has been developed, my clinic



can be reduced." Now, how it looks in the individual case is of some importance from a public health point of view and also from the private practitioner's point of view. If you apply this to a very susceptible patient, don't worry at all about the causes of susceptibility. Don't worry at all about the mechanism of caries in his or in any case. All you do in such a case is apply topically sodium fluoride. I don't believe in this particular individual you will find that he has 40 per cent less decay one year later. If you would take the individual whose caries susceptibility, as indicated by past dental experience, lactobacillus count, and so on, are fairly low, that individual who is on the other side of the statistics and only gets one or two cavities per year, you may find in that particular individual an eradication of dental caries. The reason for this may be in the mechanism by which sodium fluoride protects the tooth and/or the caries process. While this factor may not be so important to the statistician who studies a number of figures for the whole population, it is very important to the individual dentist and to the individual patient. Perhaps some day we shall be able to predict those individuals in which sodium fluoride will and will not be effective. This point, up to now, hadn't been brought out too well, and that is what I believe Dr. Robinson and I are driving at.

DR. KNUTSON.—I just want to rise to point out that I finally arrived at the conclusion that I was wrong. I misinterpreted the meaning of Dr. Robinson's remarks. My understanding was on the point of essential difference between the interest of the public health worker and the private practitioner in the patient. I am sorry I made that misinterpretation of your remarks.

DR. ROBINSON.—I was going to say that was my intent, and I also want to say I recommend that the individual dentist use topically applied sodium fluoride, but he is going to see the results the same way you do. You are seeing a 40 per cent reduction, I might see a 100 per cent reduction or zero reduction. He has to think of the individual patient, and you have to think as a public health man.

DR. KNUTSON.—That is right. The point should be brought out, too, that by and by dentists have not been accustomed to rendering preventive services. They don't know how to charge for preventive measures—charge their patients a fee for them. I agree with you with Dr. Gruebbel, who brought out the point earlier that several problems remain unsolved in connection with this whole matter of using a preventive agent, and particularly, that this is a partial preventive.

DR. EASLICK.—Along about this time on previous mornings we had a "wobble" period, some of you will keep your questions, although we are running far behind this morning we shall have a five-minute wobble period and then reconvene.

DR. EASLICK.—Ladies and gentlemen, if you will come to order, I should like to introduce the final speaker in this symposium on fluorine. He has arrived in Ann Arbor out of breath, because of a combination of problems which I understand arose from getting a new position, from house hunting, and from the arrival of the stork, which I think one could classify as house breaking!

Anyway, we certainly are glad to see you here, Dr. Bibby, and because of the effort that you have exerted to join this Workshop group, I think you are almost entitled to the ovation that the Massachusetts hygienists have given you in a recent article.

Dr. Bibby comes very, very recently from Rochester, New York, where he has achieved the position of Director of the Eastman Dental Dispensary. He has, however, stepped out of the Dean's office of Tufts College Dental School. The subject that I am presenting to him is "Fluoride Mouthwashes, Fluoride Dentifrices, and Other Uses of Fluorides in the Control of Caries." That about covers the field, I think, Dr. Bibby, and I will now present you to this group.

## FLUORIDE MOUTHWASHES, FLUORIDE DENTIFRICES, AND OTHER USES OF FLUORIDES IN CONTROL OF CARIES\*

BASIL G. BIBBY, D.M.D., PH.D., DIRECTOR, EASTMAN DENTAL DISPENSARY  
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I think probably the best way of introducing what I am going to report, a good deal of which is work which I have been instrumental in instigating, is to say that after the initial demonstration that there was a reduction in dental caries resulting from the application of sodium fluoride, it seemed to me that the important thing to do was to see if we could improve upon the effectiveness of the procedure which we had run upon purely in a hit or miss way. It happens that we had been associated for some time with investigations trying to determine the mode of action of fluorine in preventing dental caries. Out of those investigations we came to the tentative conclusion (perhaps we stated it more than tentatively) that fluorine was effective largely as the result of reducing the solubility of the enamel and thereby making it more resistant to an attack of dental caries. Obviously such an hypothesis has little value unless it has proof. Therefore, in starting the initial study on fluoride application, we had in mind two purposes. The first was to test the rightness of our theory on the mode of action. The second was that by chance we might strike something which would give rise to a new approach to caries control.

There were no guide posts; no one had ever before described a method for using fluorides in the mouth. Being cautious, we started off with one-tenth of one per cent solution of sodium fluoride. Since it was thirty miles to Brockton where we started our study, and since my car wasn't too reliable and the snows in New England are somewhat unpredictable, I arranged, as well as I could, to get down to Brockton in the better weather and at times convenient for the school system. That is why we gave treatments at intervals of approximately four months, or three times a year. The group of children was as large as we could conveniently collect. We started off with more than one hundred, and so had the mystic advantage of having crossed the century mark when we started. So this somewhat unscientific experiment was started and gave good results. From then on, my activities in the clinical fluorine studies have been rather unfortunate.

At this point we thought we would become scientific and make a laboratory approach to the problem and really find something which instead of reducing dental caries by 40 per cent as sodium fluoride does, might reduce it by 95 per cent, or even 96 per cent, and on up. Accordingly, we initiated laboratory studies with the idea of subsequently applying findings in clinical tests. That was one aspect of the problem. Another approach to improving the efficiency of fluoride therapy was based on the idea that since the somewhat casual method we employed in Brockton of bringing fluoride in contact with the tooth surfaces seemed to work, a modified clinical procedure might be much more effective. We envisioned a procedure which would not only be more effective but would also be