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BEHAVIORAL RESEARCH IN PREVENTIVE DENTISTRY: EDUCATIONAL AND CONTINGENCY MANAGEMENT APPROACHES TO THE PROBLEM OF PATIENT COMPLIANCE

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This study examined the effects of reinforcement on compliance with an oral hygiene education program. Patients 18 years of age or older who enrolled in an ongoing program at a periodontal practice received 3-5 sessions of instruction in preventive dental care. Using a between-subjects design, patients who entered the program during alternating months also had a portion of their fees refunded contingent upon improvements in their dental plaque scores. Pre- and posttreatment data showed that all subjects exhibited lower plaque levels following the program, but that greater improvements were seen in patients who were exposed to the fee reduction contingency. Plaque scores taken at a 6-month follow-up revealed some relapse for the Fee Reduction subjects. However, their scores were still substantially better than pretreatment, and better than those of the Education only subjects, whose data differed little from untreated Controls. Methodological and practical issues related to behavioral research in preventive dentistry are discussed.

DESCRIPTORS: Behavioral community psychology, behavioral medicine, compliance, dentistry, health-related behavior, prevention

Dental problems associated with personal neglect affect a large number of American children and adults. It has been estimated that close to 99% of the U.S. population exhibits dental caries, the leading cause of tooth loss among children, and that the cost of dental repair due to caries alone exceeds $4 billion per year (National Dairy Council, 1978). An equally serious problem is that of periodontal disease which leads to a gradual deterioration of tooth supporting gum tissue and bone. It affects over 80% of American adults and is the leading cause of tooth loss among that group (National Dairy Council, 1978). The combined effect of dental caries and periodontal disease is that one-third of the population 35 yr of age and older and over half of the population 55 yr of age and older have lost all natural teeth (Katz, McDonald, & Stookey, 1976). These findings are disturbing, especially in light of repeated assurances in both the professional and popular literature that tooth loss is not a natural by-product of increasing age but, rather, an outcome that is largely preventable.

Attempts to control dental disease through prevention have focused primarily on either large-scale managerial programs, such as water fluoridation or public education. Data from numerous sources have shown that the former approach can have a significant clinical effect (Forrest, 1967; McKay, 1948; Moss & Wei, 1976; Russell & Elvolve, 1951). However, such regulatory mechanisms are still limited in

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that they have little or no impact on personal life-style, a major determinant in the course of chronic disease and one that is most difficult to control (Saward & Sorensen, 1978; Task Force Report of the National Conference on Preventive Medicine, 1976; Williams & Wynder, 1976). While the educational approach does focus on individual change, it assumes that information and/or prompting per se will serve as adequate sources of motivation. Results of a recent survey conducted by the Bureau of Health Education of the American Dental Association (Craig & Montague, 1976) suggest that this assumption may be untenable. Less than 50% of the sample had ever used dental floss, less than 5% flossed on a daily basis, and over 40% reported that instruction alone had no effect whatsoever on their subsequent oral hygiene practices.

A behavioral approach to dental disease prevention would not be incompatible with current regulatory and educational practices. However, it would also include an analysis of the contingencies that either promote or inhibit personal dental care. Casual observation would suggest that the reinforcing consequences associated with regular oral hygiene are primarily of a delayed nature, and that the effects of even long-term neglect are not fatal (although data are not readily available, it would seem unlikely that many persons have died from dental disease). In addition, it is apparent that a complete oral hygiene regimen (i.e., brushing and flossing) is time consuming and somewhat difficult to master, due to physical properties of the oral cavity and dental plaque (Derbyshire, 1968). Thus, a number of authors have recently emphasized the potential value of providing more systematic reinforcement for continued personal hygiene (Aldeman, 1976; Hassett, 1978; Levy, Weinstein, & Milgram, 1977; Rosenberg, 1974; Thornberg & Thornberg, 1974).

Several studies have used behavioral interventions with various aspects of dental care. It has been shown that toothbrushing can be taught via shaping and chaining (Horner & Keilitz, 1975), and maintained through reinforcement contingencies (Lattal, 1969; Martens, Frazier, Hirt, Meskin, & Proshek, 1973). Similar procedures have been used in motivating institutional staff to provide daily toothbrushing for residents unable to perform the skill independently (Iwata, Bailey, Brown, Foshee, & Alpern, 1976).

Additional research has examined the use of modeling and/or reinforcement to reduce the disruptive behavior of children undergoing dental treatment (Adelson & Goldfried, 1970; Kohlenberg, Greenberg, Raymore, & Hass, 1972; Melamed, Hawes, Heiby, & Glick, 1975; Stokes & Kennedy, 1980; White, Akers, Green, & Yates, 1974). Such "fearful" reactions are a serious problem in that they increase potential dangers caused either by interference with the practitioner or by the use of sedation, and perhaps lead to the development of chronic avoidance behavior.

Finally, attempts have been made to improve patient attendance through the use of behavioral techniques. Reiss, Piotrowski, and Bailey (1976) found that a single written communication plus a $5 incentive was superior to a multiple prompt procedure for encouraging lower-income parents to bring their children in for needed dental visits. Similar results were obtained with child participation in either toothbrushing or mouth rinse programs implemented through the school, where it was found that relatively inexpensive reinforcers produced higher levels of attendance when compared to control, information, or group discussion procedures (Kegeles, Lund, & Weisenberg, 1978; Lund, Kegeles, & Weisenberg, 1977).

The present study attempted to extend behavioral research in dentistry in several respects. First, since one of the most likely points of contact between therapeutic agent and client is the practitioner's office, there is a need to examine more closely personal prevention programs being implemented at the community level. This study compared the effects of an ongoing oral hygiene education program with those of the same program plus a reinforcement

contingency for improved dental status in a community periodontal practice. Second, most behavioral research in the area of dental disease prevention has focused upon either attendance or direct observation of performance as dependent variables. Although both are undoubtedly important, these data may not be accurate indicators of actual dental health. Outcome measures in the form of dental plaque scores were therefore used in the present study. Finally, in addition to examining short-term treatment effects, 6-month follow-up data were collected in order to assess maintenance.

METHOD

Subjects and Setting

The study was conducted through a private periodontal practice which had been in operation for 3 yr. The practice was located in an office adjacent to a general group dental practice, and approximately 90% of the patients seen were referred by these and other local practitioners. Informal data taken prior to the beginning of the study indicated that approximately 30 new patients were seen each month, the majority of whom were from the lower middle income bracket to the upper middle income bracket.

Subjects consisted of all patients 18 yr of age or older who enrolled in an ongoing dental education program at the office over a 4-mo period (experimental subjects), and all persons referred from other offices who declined participation in the program but who were willing to undergo a free oral examination during two successive 6-mo checkups (control subjects). Additional criteria for the selection of experimental subjects were that no major dental work would be required and that no more than two fillings were needed at the time of the initial visit. These criteria minimized the possibility that short-term changes in oral hygiene measures might be influenced by either oral surgery or extensive fillings.

Dependent Variable

Evidence clearly indicates that dental plaque, a soft bacterial deposit forming on the tooth surface, is the major contributing factor in the developmnet of both caries and periodontal disease (Bohannan, 1968; Leach, 1970; Loe, 1970; Russell, 1968). For example, research by Loe and his colleagues (see Loe & Schiott, 1970) has shown that cessation of oral hygiene aimed at plaque removal can lead to the appearance of carious lesions and/or clinical gingivitis (a precursor to periodontal disease) within 3 wk.

Plaque is recognizable with or without the aid of disclosing agents within 24 hr of thorough cleansing (Loe, 1970), its accumulation is only partially reduced through dietary changes such as the chewing of fibrous foods (Lindhe & Wincen, 1969), and brushing alone will not completely control its development (Loe, 1970). Thus, the amount of plaque present on dental surfaces is a very good indicator of oral hygiene, and the maintenance of low plaque levels requires both frequent care and the use of mechanical aids such as dental floss.

Measurement. Several indices have been developed to measure plaque accumulation. Two of the more frequently used are the Simplified Oral Hygiene Index or OHI-S (Greene & Vermillion, 1960) and the Patient Hygiene Performance Index or PHP (Podshadley & Haley, 1968). Both measures are numerical derivations based on an examination of six preselected teeth. The major difference between the two is that the OHI-S uses a 4-point rating scale for the entire tooth (where "0" equals "no plaque," and "3" equals "the presence of plaque on over ⅔ of the tooth surface") whereas the PHP scores the presence or absence of plaque on five divided surfaces of each tooth. A recent comparison of these two methods has indicated that the PHP is more sensitive as a measure of the effects of flossing (Anaise, 1977).

The present study thus used a variation of the PHP to assess plaque accumulation. All teeth were divided into five surfaces each, and

were scored for the presence or absence of plaque following the application of a standard disclosing solution. The percentage of surfaces containing plaque was obtained by dividing the number of stained surfaces by the total number of surfaces and multiplying by 100. Each patient in the present study underwent examination by either a dental hygienist or a trained observer, and the resulting plaque indices constituted the dependent variable of interest. Experimental subjects were examined on three occasions (pre- and posttreatment, follow-up), while no-treatment control subjects were examined twice (pretreatment, follow-up). On 22% of the examinations, the observer was blind both to type of patient and experimental sequence.

Reliability. Independent observations were conducted by having a second observer perform an examination immediately following the primary observer. These checks were conducted at least once for each patient evenly distributed across visits. At least two checks were made for 37% of the patients, and three checks were made for 9% of the patients. Two agreement indices were calculated for each check. Total agreement was computed by dividing the smaller number of stained surfaces by the larger and multiplying by 100. Surface-by-surface agreements were also calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100. Total agreement averaged 93% (range = 87%-100%), and surface-by-surface agreement averaged 86% (range = 77%-95%).

Procedures

Educational program. Patients assigned to this condition received a program aimed at teaching appropriate daily oral hygiene. The format was similar to that described by Katz et al. (1976), and consisted of the following: All treatment throughout the program was performed by the periodontist or a dental hygienist. Each patient was initially scheduled for three visits spaced approximately 1 wk apart. During the first visit, the patient received information regarding the detrimental effects of plaque, the importance of plaque control in preventing caries and periodontal disease, and various recommended means of plaque control and removal. The patient's teeth were then examined to determine special individual needs. Following the examination, the teeth were stained and an initial plaque score was taken. Finally, the teeth were cleaned thoroughly, and the patient was given a supply of staining tablets to take home and use each day as a means of self-checking the adequacy of brushing. The second and third visits were devoted to instruction, guided practice, and feedback in proper brushing and flossing technique. If during the third visit it appeared that the patient had not yet learned correct techniques (i.e., was not performing appropriately in the office), additional visits were scheduled. During the final visit, a posttreatment plaque score was obtained, and the patient's teeth were again cleaned. Although costs varied somewhat, a patient was usually charged $80 for a three-visit program, with an additional $20 for each visit beyond three.

Education plus contingent fee reduction. Patients assigned to this condition received an educational program identical to that described above. In addition, however, they were informed that as an inducement for continued home practice of correct brushing and flossing, a portion of their fees would be refunded according to the following schedule: If on the final visit, a plaque index of 20% or better (less) was achieved, the total fee was reduced by 10%. A final index of 10% or better resulted in a fee reduction of 25%.

Experimental Design

Initial treatment effects. Because patients were seen a maximum of five times, it was impossible to conduct within-subject replications using standard reversal or multiple baseline methodology. Thus, the only means of conducting a comparison between the Education versus

Education Plus Fee Reduction procedures was to assign some patients to the Education condition and others to the Education Plus Fee Reduction condition. In the present study, patient assignment was accomplished so as to approximate a reversal design similar to the type used in settings where the subject sample varies in composition across experimental conditions (e.g., Turner & Vernon, 1976). For the first month of the study, all patients meeting the criteria for subject selection were exposed to the Educational (baseline) program. During the second month, eligible subjects were exposed to the Education Plus Fee Reduction program. This sequence was repeated during the third and fourth months. The differences between plaque scores taken on the initial and final visits were used as indicators of patient improvement in comparing the effects of the two treatments on compliance with the oral hygiene regimen.

Long-term maintenance. In order to determine whether any differences observed immediately following the program would endure over time, patients' initial plaque scores were compared to those obtained at a 6-mo recall visit. The initial and 6-mo scores for both treatment groups were further compared to scores for a group of persons who received neither program, during two successive 6-mo visits. The latter comparison was made in an attempt to assess the effects of both treatments relative to an untreated (albeit self-selected) control.

RESULTS

Initial Treatment Effects

Figure 1 shows individual plaque scores obtained on initial and final visits during treatment. Initial visit scores were quite variable across all conditions, and improvement (reduction in plaque from initial to final visit) was seen in all patients, regardless of condition assignment. However, patients receiving the Education Plus Fee Reduction program reduced their plaque scores to levels lower than subjects receiving only the Educational program. Of the 17 patients assigned to the former condition, 15 met the final visit criterion of 10% plaque or better, and the other two patients were well below 20%. Of 14 patients assigned to the latter condition, only one achieved a final visit plaque score lower than 10% and only five were below 20%. Fee Reduction patients also completed the program in fewer visits (mean = 2.9) than did the patients in the Education condition (mean = 3.3).

Table 1 provides a summary of individual data (means, ranges, and improvement scores), grouped by treatment condition. Due to an overlap in the data across conditions, a two-factor ANOVA was performed on the initial and final scores obtained by the patients (grouped by treatment). Results indicated that posttreatment plaque scores were significantly lower than those obtained during pretreatment, $F(1, 58) = 237.82$, $p < .001$. In addition, a significant interaction was evident, $F(1, 58) = 30.55$, $p < .001$. A post hoc Scheffé test ($p < .05$) revealed that both treatments led to significant improvement in plaque scores, and that the improvement seen in the Education Plus Fee Reduction group was significantly greater than that of the Education only group.

Long-Term Maintenance

Six-month recall scores were obtained for 14 of the 17 Fee Reduction patients and for 12 of the 14 Education patients. These scores, along with pretreatment (initial visit) data, were compared to scores obtained on two 6-mo recalls for 11 individuals who underwent neither of the treatment programs. Results combined by treatment group are presented in Figure 2 and summarized in Table 1. Plaque scores obtained at 6 mo for the Fee Reduction patients average 13% less than Education patients and 19% less than patients receiving no treatment. By examining the ranges of improvement (Table 1), it can further be seen that the Fee Reduction group was the only one for which all patients received lower plaque scores at fol-

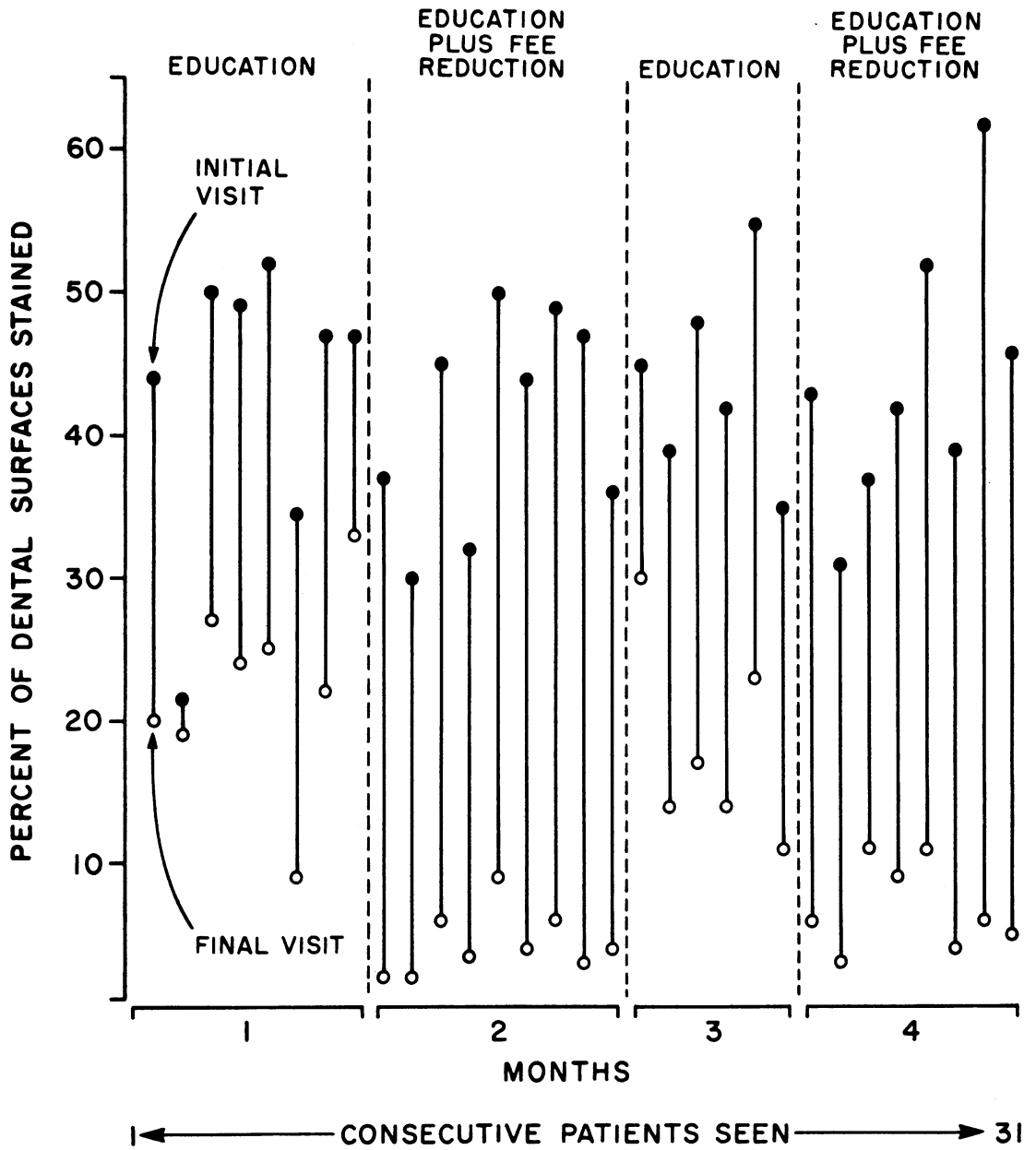

Fig. 1. Percentage of dental surfaces containing plaque at initial and final visits during treatment, across subjects, and experimental conditions. For each patient, a vertical line connects the initial (closed circle) and final (open circle) plaque scores.

low-up. A two-factor ANOVA was performed on the initial and follow-up scores of the three groups, and revealed significant effects for trials, $F(1, 68) = 63.45$, $p < .001$; groups, $F(2, 68) = 7.74$, $p < .001$; and interaction, $F(2, 68) = 9.74$, $p < .001$. Results of a post hoc Scheffé test ($p < .05$) indicated that, compared to pretreatment plaque scores, improvement at follow-up was significant only for the Fee Reduction group, and that this group's follow-up performance was significantly better than that of the Education only and Control groups.

Table 1

Summary of plaque scores and improvement scores on initial, final, and follow-up visits for experimental and control patients.

	CONDITIONS		
	Education Plus Fee Reduction	*Education*	*Control*
PLAQUE SCORES			
Initial Visit			
Mean:	41%	44%	41%
Range:	29%-62%	22%-57%	24%-56%
Final Visit			
Mean:	6%	21%	N/A
Range:	2%-11%	9%-33%	N/A
Six-Mo. F-U			
Mean:	18%	30%	36%
Range:	11%-32%	24%-46%	28%-50%
IMPROVEMENT			
Initial Visit–Last Visit			
Mean:	35%	23%	N/A
Range:	25%-56%	11%-35%	N/A
Final Visit–F-U			
Mean:	(−12%)	(−10%)	N/A
Range:	(−21%)-0%	(−23%)-4%	N/A
Initial Visit–F-U			
Mean:	23%	13%	5%
Range:	10%-39%	(−4%)-23%	(−16%)-21%

DISCUSSION

Present results suggest that reinforcement in the form of fee reductions serves an additional motivating function when combined with an educational program aimed at preventive dental care. Patients exposed to both treatment procedures showed more improvement than did patients receiving only the educational component, both immediately following treatment and at follow-up.

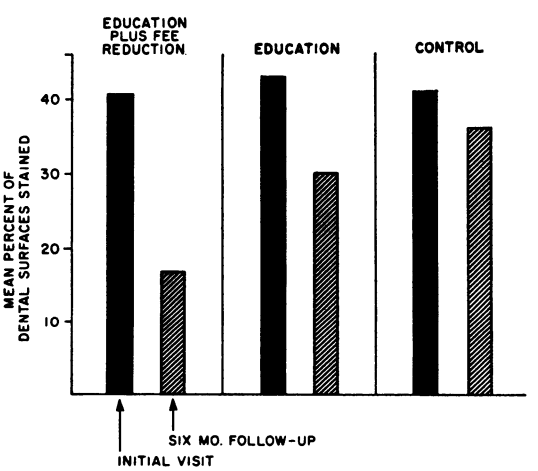

Fig. 2. Mean percentage of surfaces containing plaque at first visit and 6-mo follow-up for the two treatment groups, and at two, 6-mo follow-ups for the control group.

In light of the negative survey data on the effects of dental education (Craig & Montague, 1976), it was surprising to see that all but one patient assigned to the (Education) baseline condition showed noticeable reductions in plaque levels at the end of the program (see Figure 1). Several factors may have accounted for this finding. First, patients in the present study actively sought out a prevention program. They must certainly be viewed as having at least some initial motivation, and they may not be representative of the population in general. Second, Education patients were exposed to a remedial contingency upon entering the program—additional visits for poor performance. One-third of these

patients required an additional visit, and it is likely that their posttreatment scores would have been worse had they been provided with a constant, three-visit program. Third, it is possible that although the self-report data of Craig and Montague (1976) were correct estimates of current hygiene practice, they did not accurately reflect dental behavior immediately following exposure to some type of preventive program. Only through additional research could the relative contributions of these variables be assessed.

Regardless of what factors might have been responsible for the posttreatment improvement of patients in the Education group, it appears that short-term changes following instruction do not maintain. Education patients differed little from untreated Controls at follow-up. This result is most striking, because Control patients in the present study were self-selected on the basis of low motivation (i.e., they declined participation in the prevention program). One potential means of reducing posttreatment decrement would be to schedule more frequent dental checkups. Lerner (1976), for example, has recommended the use of 3-mo recalls instead of the usual 6-mo recall. Longitudinal studies will most likely be required to evaluate the merits of this proposal, and it can be expected that patient attendance problems will be a major obstacle in conducting that research. In addition, it is possible that the degree of initial change immediately following treatment is a factor related to maintenance (see below), in which case the development of improved instructional methods and/or effective reinforcement programs during initial treatment will be of critical importance.

In contrast to the Educational procedure, the combined Education Plus Fee Reduction program led to both large and relatively durable improvements. In addition to being statistically significant, we believe that results for the Fee Reduction patients represent clinical improvement as well. The 10% plaque criterion used during treatment was based on recommendations by several professionals. They felt that it would be virtually impossible to achieve a "zero" plaque score in light of the rather stringent scoring methods used, and that a level of 10% or better would be the most they could expect from persons who exhibit good-to-excellent hygiene. Similar conclusions regarding patients' ability to remove all dental plaque have been reported by Katz et al. (1976). Thus, upon completion of treatment, patients in the present study were performing at near perfect levels.

Perhaps the most important finding of the present study was the maintenance effect seen in the Fee Reduction patients 6 mo following the termination of treatment. Data obtained for these patients at follow-up were superior to their pretreatment scores, as well as the follow-up scores for the Education and Control groups, and were well below the mean plaque levels reported in a national dental health survey (Johnson, Kelly, & Van Kirk, 1965). Although it is not entirely clear why changes endured over time for the Fee Reduction group, comments made by patients suggested at least two possible variables. First, patients reported that the contingency motivated them to pay careful attention to their teeth each day during the program and that, upon completion, their flossing skill improved to the point where it required little additional time. Second, patients noted that they were surprised by the amount of debris that accumulated between the teeth in spite of daily flossing, and that this feedback served to maintain regular and thorough dental self-care. Thus, the main advantage of the reinforcement procedure may be that it promoted the sustained practice and subsequent development of a behavioral chain which, once acquired, was both relatively easy to maintain and automatically reinforcing (Skinner, 1969).

It is unfortunate that patients in the present study were not formally tested prior to the termination of treatment. For example, it would have been interesting to compare the two treatment groups under controlled conditions (i.e., in clinic) to determine if, in fact, Fee Reduction patients had acquired greater skills and could

complete the hygiene routine in less time than the Education patients. Future research should examine the importance of such variables to the maintenance process, including the use of more objective mastery criteria for successful program completion.

A final issue concerns the economic feasibility of implementing fee reduction systems to increase compliance with preventive health programs. In the present study, the decision to use monetary reinforcement was based solely on its high degree of predicted effectiveness and ease of application. It is quite conceivable that other forms of reinforcement (e.g., spouse contracts, self-recording, home-based token reinforcement procedures for children, and even systematic social praise) might enhance the effectiveness of current educational practices, and future research should seek to determine the range of useful reinforcers. However, it is also possible that patient fees constitute a significant barrier to participation in prevention programs, and that fees and refund schedules could be adjusted so as to promote participation, motivate compliance, and still be fairly cost efficient. For example, 15 of the 17 Fee Reduction patients in the present study qualified for the 25% refund (the other two received 10% refunds), and none of the patients required more than three visits. Because higher fees are generally charged for initial and final visits (during which teeth are cleaned and examined), a reduction in the number of visits required per patient might offset a loss of revenue by increasing the practitioner's capacity to treat more patients over a given period of time. It was not possible to perform such a cost analysis in the present study due to the relatively short amount of time during which the Fee Reduction procedure was in effect. However, given the obvious patient benefits demonstrated, more thorough and long-term examinations of monetary reinforcement programs seem warranted.

On a more global level, proposals have already been made to cover the cost of preventive services (including dental care) through health insurance programs (e.g., Ball, 1978; Breslow & Somers, 1977). These proposals have raised a number of questions regarding the identification of appropriate target behaviors (e.g., showing up for an annual appointment, completing a health education program, showing evidence of "healthy" behavior), the selection of suitable contingencies, and the evaluation of outcome. Each of these areas represents one to which continued behavioral research on all aspects of prevention may make a significant contribution.

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