

Is caries prevention cost-effective? Does anybody care?

Eli Schwarz

Faculty of Dentistry, University of Hong, Hong Kong Special Administrative Region of China

Schwarz E. Is caries prevention cost-effective? Does anybody care? *Acta Odontol Scand* 1998;56:187–192. Oslo. ISSN 0001-6357.

The aim of this article is to review current issues concerning the cost-effectiveness of caries prevention. Several decades after considerable improvements in the oral disease situation were documented in Scandinavia, doubts are still expressed about whether preventive measures are cost-effective. An analytic model is suggested to explore the relationships between the dental profession, which provides the prevention, the research and development activities, which provide the material and data basis for prevention, and political/societal responses to the professional input. The four elements considered were the definition of prevention, the practical perception of effective prevention, the appropriateness of traditional cost-effectiveness analysis, and the time factor with regard to when a preventive effect should be evaluated. The main arguments of the discussion are that caries prevention is not uniformly defined by the profession, that dental research is casting doubt on the effectiveness of traditionally accepted preventive measures, that political pressures on health care are motivated by economic pressures, but that traditional cost-benefit/effectiveness analyses have not been able to help the decision-makers choose wisely. Often the time perspective for the real effects of prevention lies beyond the interests of decision-makers. Although caries prevention may be viewed as an investment in health by the profession, this contention may not be acceptable to a society with very short-term perspectives. □ *Cost-effectiveness; dentists; fluoride*

Eli Schwarz, International Association for Dental Research, 1619 Duke Street, Alexandria, VA 22314-3406, USA

Comments in the two Danish dental journals have indicated that a certain frustration was felt among public health-oriented dentists who questioned the lack of appreciation or acceptance of oral health preventive activities (1, 2). They indicated that there might be a dearth of evaluation data to prove the effectiveness or efficiency of caries prevention, as well as little understanding that prevention is an investment. Further, it was argued that the lack of appreciation of the inherent value of prevention should be alleviated by a more complete evaluation. The comments were intriguing in that Denmark and the other Scandinavian countries are among those that have used the most public resources to establish and maintain oral health programs, especially prevention-oriented child oral health programs (3). The purpose of this article is 1) to explore the various factors that affect the cost-effectiveness of caries-preventive activities and 2) to consider whether caries prevention has been proven to be cost-effective or whether our general assumptions concerning the observed improvements in the oral health picture across populations can be questioned. Although the comments alluded to above were taken as a prompt for this analysis, no special hypothesis regarding their correctness was assumed.

Analytic model

An assessment of the cost-effectiveness of caries prevention takes place in a complex society where different groups of players may perceive the same factual observation very differently, and seemingly simple questions may have

complex answers. Three groups of players are illustrated in Fig. 1. The dental profession, including practicing dentists (in private or public clinics), dental hygienists, and oral health education practitioners, is responsible for carrying out preventive activities at the individual and community levels. The research and development group comprises dental researchers and basic scientists, in either a university or an industrial setting, who are involved in the development and testing of new or known preventive methods and devices. The third group is society in its broadest sense, comprising politicians, administrators, and the public. Obviously, there are not extremely stringent borders between these groups, which can at times vacillate in their positions. Superficially speaking, cost-effectiveness of prevention must be based on the following conditions: 1) that there is agreement on the definition of prevention; 2) that the most effective preventive methods are chosen in a given context; 3) that these measures are applied in an economical way; and 4) that we are prepared to wait long enough for their effect. Fig. 1 illustrates the involvement of the three groups of players in defining the conditions that form the context of preventive activities.

Definition of prevention

The traditional terminology for prevention by the World Health Organization defines primary, secondary, and even tertiary prevention. This might indicate that there is worldwide agreement on what prevention is, and that it has also been applied to dentistry. Primary prevention consists of those measures that are instituted before any

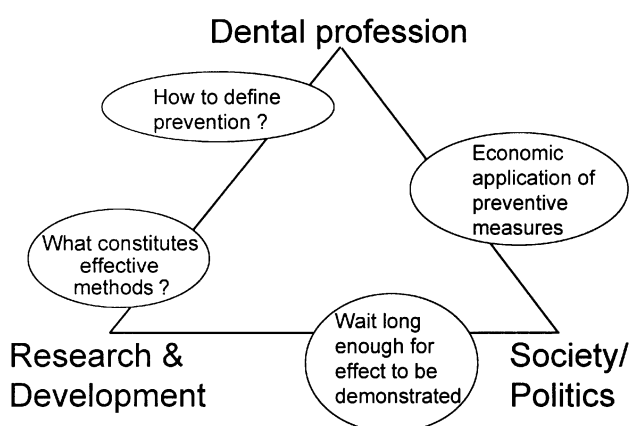


Fig. 1. Analytic model outlining interrelated factors for the assessment of caries prevention and its cost-effectiveness.

signs of disease have developed, with secondary prevention being intervention measures to promote recovery and avoid terminal consequences. As indicated in the figure, conceptually, the definition of prevention would take place somewhere on the continuum between the dental profession itself and those who are carrying out the research and development in this field. One would normally not expect disagreement about what prevention is or what we are doing when we are carrying out prevention. However, even terminology can be debated, as exemplified by a renowned cariology professor who stated that 'caries cannot be prevented—caries can be controlled' (4). Even though the quote may be taken out of context, it is nonetheless interesting. 'Internal' academic discussions have implications for the way outsiders look at the work being carried out in dentistry. For instance, if caries 'cannot be prevented', why pay for preventive programs? To many health administrators 'control' would imply a more active intervention, such as treatment. To my mind these discussions are detractors; they can become counter-productive for getting a message across to the uninformed public or for attracting resources, because decision-makers as well as professionals are confused about what is what.

Effectiveness of prevention

How do we apply the most effective preventive measures? Usually, 'effective' in this context will indicate the measures that will bring about the largest reduction in caries incidence within a given time frame. Table 1 illustrates a range of measures in caries prevention that have been applied for many years. Even though water fluoridation may be controversial in Scandinavia, there is no doubt that it must still be considered the most effective and comprehensive population-based preventive measure that we have against caries (5). Because this program is not an option in many countries, including the Scandinavian countries, its effectiveness is often downplayed vis-à-vis

Table 1. Examples of caries-preventive programs

Water fluoridation
Toothbrushing (with or without toothpaste, fluoride)
Fluoride varnish
Fluoride mouthrinsing
Fluoride tablets
Fissure sealant
Oral health education
Dietary counseling
Oral hygiene instruction
Public lectures
Campaigns

alternative fluoride-based programs, which are more demanding in terms of personnel and other resources. A multitude of studies have shown that various fluoride combinations have been effective in reducing caries incidence (6–8). Nonetheless, very little—except circumstantial—evidence seems to exist that can explain the dramatic reductions in caries prevalence during the last 10–15 years, especially among children and young adults (9).

A specific problem in relation to effectiveness is illustrated by Fig. 2, which represents the decline in dental caries prevalence among Danish children during the period 1974–96. For all three child populations, three relatively well-defined periods are depicted. From the early 1970s to around 1980 a stable and high level of caries was evident. From around 1980 to 1990 a sharp decline in caries prevalence took place. However, from 1990 onward very little further reduction has taken place at the national level. When going through the literature in preparation for this presentation, I realized that there is nothing or very little on the effectiveness of preventive programs in the last 10 years. The existing literature on cost-effectiveness of preventive programs mostly comes from studies conducted around 1980. This implies that most of the calculations on the cost-effectiveness of preventive programs are based on clinical studies done when caries levels were relatively high compared with the current levels. Almost any prevention would have been effective in reducing these earlier high levels of caries, but during the last 8 years it would seem that whatever has been done has had very little effect on caries prevalence.

Alternatives to fluoride programs, such as oral hygiene practice programs, have also been used in the prevention of caries (Table 1). A recent meta-analysis examined several oral hygiene practice studies over a number of years (10). The analysis concluded, however, that there was no evidence that oral hygiene consisting of plaque removal by a toothbrush, flossing, and the professional prophylaxis that often precedes a routine dental examination would lead to reductions in the incidence of caries. A similar analysis of some of the studies in the area of health education was performed by Kay & Locker (11). Through the use of qualitative and quantitative review techniques, the authors showed that dental health education interventions had a small, positive, but temporary effect on plaque

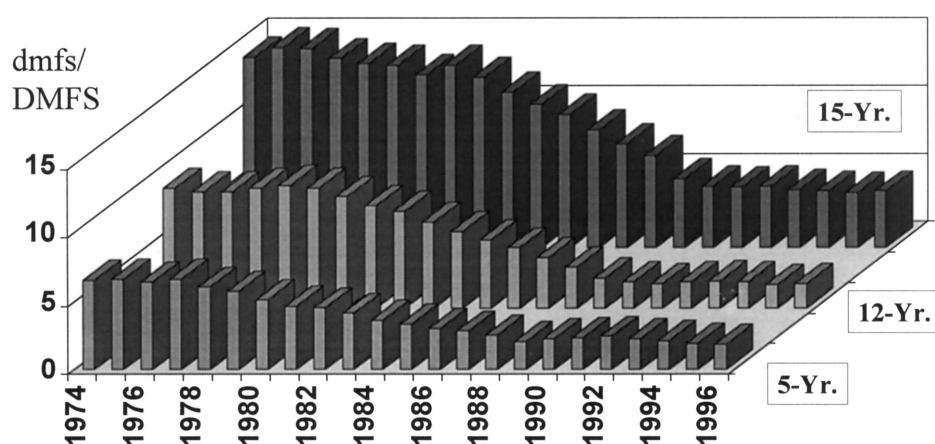


Fig. 2. Caries decrease in Danish children, 1974–96 (nationwide National Board of Health data).

accumulation, no discernible effect on caries incidence, and a consistent positive effect on knowledge levels. So we can make people more knowledgeable, but we cannot give them less caries. There are indications that more and more studies in the public health field are increasingly critical of our own methods and results.

This leads to another aspect of effectiveness—namely, who should carry out prevention? Traditionally, the list comprises dentists, dental hygienists, dental nurses and therapists, dental surgeons, and preventive assistants. Lately, the patient has been defined as an active partner in prevention by performing oral self-care (12), which is probably the least expensive prevention of all, albeit not yet the most effective. There are no studies to show that the dentist is better than anyone else in preventing caries. A number of studies do show that the dentist is approximately as good as the others. However, in most places dentists are still regarded as the core professionals in caries prevention. Recently, Riordan asked whether organized dental care for children can be both good and cheap (13). He argued for the increased use of dental therapists and pointed out that at the beginning of the 20th century, when caries levels were high, the professional skills needed to treat children were also quite high. Over the years as caries has declined, less skill has been required for routine child dental care. Meanwhile, new dental graduates are produced with ever higher levels of skills brought about by changes in the dental curriculum and an emphasis on broader biologic issues.

This analysis is contradicted by a Danish demonstration project to evaluate the appropriateness and effectiveness of an individualized and alternative treatment strategy in a public child dental health clinic (14). Two fascinating points arise from this report. First, *dentists* used around 60% of the total treatment time on non-operative caries treatment (diagnosis, risk assessment, plaque removal, toothbrushing training), while 25% of their time was used on operative caries treatment. Second, the research team argues forcefully that this is appropriate use of dentists.

This raises the question whether some of the incompatibilities between dentists' skills and evident treatment needs, especially among children, will present problems regarding not only effectiveness but also the future job satisfaction of dentists.

Economics of prevention

Fig. 1 suggests that the question of applying preventive methods economically is already not in the hands of the professionals alone. Rarely do professionals decide on the framework of their activities, although they do sometimes have an influence on its establishment. As an example, there is no doubt that professional organizations were influential in setting up the national dental health and insurance programs in the early 1970s in Denmark and Sweden. Later they were also active in the modification of these programs through inclusion of preventive activities, but most subsequent alterations and budget cuts were carried out by politicians and administrators despite professional objections. The hottest issue in American health care is the conflict between health care professionals and the growing industry of for-profit health maintenance organizations that seem to undermine the professionals' influence on their own working conditions in the quest to curb growing costs.

Burt & Warner (15) very pointedly illustrated the relationships between costs and benefits in prevention, as shown in Fig. 3. They suggested that costs rise at an increasing rate while benefits rise at a decreasing rate. That is, marginal costs are rising while marginal benefits are falling. At E on the horizontal axis of Fig. 3, the largest excess of benefits over costs is attained (maximum net benefit), whereas for preventive activity exceeding F, the costs incurred would exceed the benefits obtained. It is still not unusual to find health service administrators who believe that the purpose of prevention is to save money, in the long run at least. Cohen, however, pointed out that the

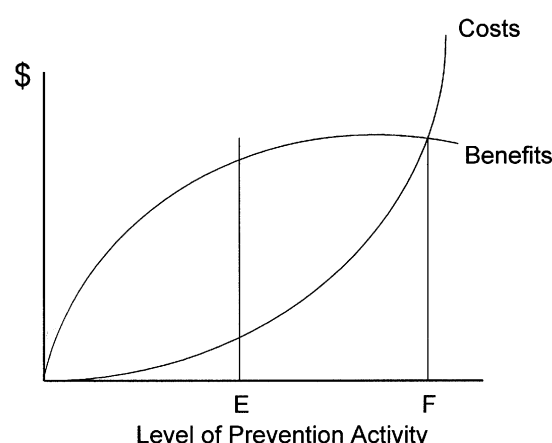


Fig. 3. Hypothetical relationship between costs and benefits in prevention activities (after Burt & Warner (15)).

main object of health promotion is not to save money but to produce health gains and that these gains are achieved at a positive cost (16).

It is relevant at this stage to summarize the two main analyses that have been used to study health care programs: cost-benefit and cost-effectiveness analyses. The principle of the cost-benefit analysis (CBA) is to find the program that would give the greatest benefit in terms of monetary value per unit of invested resources. Fig. 4 (after Holst (17)) exemplifies this principle by indicating an investment of, say, USD 1 million allocated to several programs that have specific stated objectives. In principle, it may not matter whether one does rehabilitative work for seniors or periodontal surgery in adults or caries prevention for preschool children—they may all have their special interest groups. What does matter is that the chosen program gives the greatest benefit in terms of monetary value. One of the major problems in this type of

Table 2. Benefits of caries prevention that are rarely evaluated in a cost-benefit analysis

Freedom from pain
Dentition completely free from decay
Improved occlusion
Social acceptability
Psychologic value of retaining teeth
Fewer unsightly restorations
Less time missed from school or work
Fewer extractions
Less anxiety

analysis has been that whereas costs are automatically expressed in monetary terms, a reasonable translation of benefits into monetary values has not been easy. Table 2 lists some of the benefits that cannot be easily evaluated in terms of money (18). Economists might argue that these factors cannot be quantified in economic terms, so they are ignored. However, if benefits that are of real value to the individual are left out, a whole section of the equation may be invalidated, making it difficult to use cost-benefit analysis as such (19).

Alternatively, the principles of cost-effectiveness analysis (CEA) are illustrated in Fig. 5 (after Holst (17)). The CEA attempts to identify the most effective and least expensive way to achieve a specific objective. If the objective of a specific exercise were to achieve a 50% decrease in caries prevalence in 5 years, one would need to find out which of the identified programs would achieve this objective in the least expensive way. The benefit is not calculated as a monetary value but reckoned in terms of the objective—for instance, the reduction of caries.

Both the CBA and the CEA have been used to evaluate caries prevention, especially various fluoride programs (5, 20, 21). However, the principles of these economic analyses were intended to be an aid to systematic thought about the relative merits of different health care programs

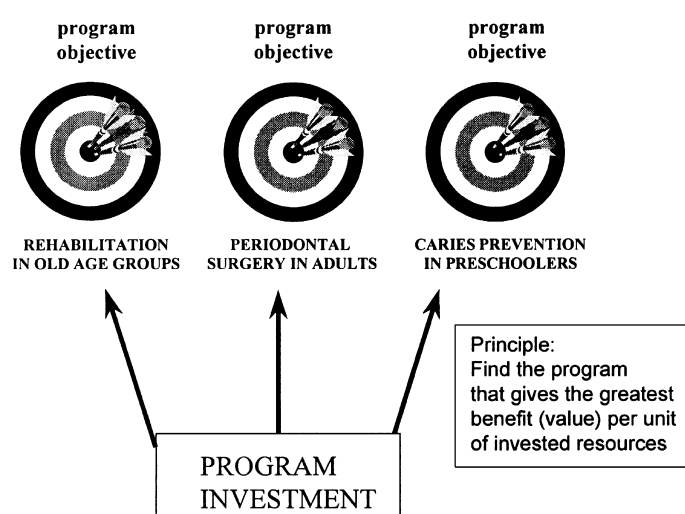


Fig. 4. Principles and examples of cost-benefit analysis in dentistry (after Holst (17)).

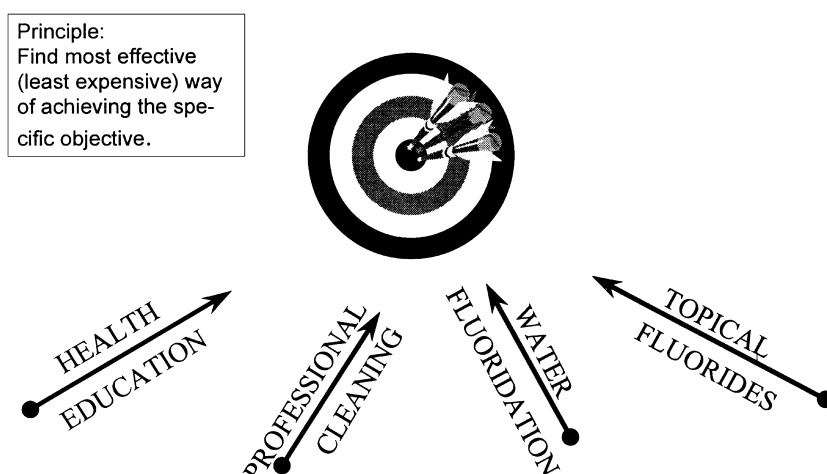


Fig. 5. Principles and examples of cost-effectiveness analysis in dentistry (after Holst (17)).

and what should be done with them. It is fair to ask why they have not had the expected impact on practical preventive activities. An explanation is put forward in an article from the Council on Dental Research of the American Dental Association, stating that neither cost-benefit analysis nor cost-effectiveness analysis gives all the answers for those seeking a course of action because neither one incorporates political or social factors nor puts a price on values (22).

The time frame for preventive effects

The final part of this discussion is illustrated at the bottom of Fig. 1: How long should we wait until a final assessment of prevention is made? This is rarely addressed because neither dental researchers nor administrators have the patience (or the resources) to wait and see. However, this is an important aspect when we are discussing preventive effects. As exemplified by Fig. 2, a considerable decline in dental caries has taken place over the last two or three decades. Many dentists will attest to the fact that the reductions are real and that the dental caries picture is now totally different from that years ago. With regard to dental caries experience in Denmark, 15-year-olds in 1996 were much better off (with an average of 4.1 DMFS) than 15-year-olds in 1975 (with an average of 14.7 DMFS). One way of assessing a final outcome of our preventive activities might be to study edentulousness in the Danish population, which goes to show, to a certain extent at least, that if we evaluate preventive programs according to whether people retain their teeth or become edentulous, there seems to be a certain success. Whereas 10% of 35-year-olds in 1975 were edentulous, only 1% of 35-year-olds in 1995 (15-year-olds in 1975) were in that deplorable state (unpublished data). This indicates that further long-term evaluations are warranted to capture the real effects of preventive activities.

Conclusion

An assessment of the cost-effectiveness of caries prevention takes place in a complex situation. Dental caries is perceived both by professionals and by the public to have decreased, and this change has at times gained some prominence. One of the reasons administrators and politicians are less enthusiastic about caries prevention now is that dental professionals are themselves ambiguous about it. During the years when it was perceived that caries had been eradicated, other preventive programs of more urgency and scope gained an advantage. To alleviate the concerns of those who believe that evaluation of preventive activities should get more attention, and thus a greater share of the available resources, a reconciliation within the dental profession and between researchers and practitioners must take place. A reconfirmation of the purpose of caries prevention is needed, including an admission that caries is by no means eradicated, but that the present approach is different from that taken when caries was a greater threat to public health.

References

1. Østergaard P. Hvorfor måles forebyggelse ikke? Hvordan lønnes forebyggelse som investering? *Tandlaegebladet* 1997;101:304–5.
2. Wenneberg S. Varför utförs det inte en mer fullständig evaluering av preventiva program? *Tandlaegebladet* 1997;101:474–5.
3. von der Fehr FR, Schwarz E. Recording dental caries and health statistics in Europe. In: Thylstrup A, Fejerskov O, editors. *Textbook of clinical cariology*. 2nd ed. Copenhagen: Munksgaard; 1994. p. 193–208.
4. Bitsch HJ. Karies kan ikke forebygges. Kursusreferat. *Tandlaegegenes Nye Tidsskr* 1997;12:146–7.
5. Burt BA, editor. Cost effectiveness of caries prevention in dental public health. *Proceedings. J Public Health Dent* 1989;49(Spec Issue):251–344.
6. Koch G, Fejerskov O, Thylstrup A. Fluorides in caries treatment—clinical implications. In: Thylstrup A, Fejerskov O,

- editors. Textbook of clinical cariology. Copenhagen: Munksgaard; 1994. p. 259–82.
7. Clarkson JE, Ellwood RP, Chandler RE. A comprehensive summary of fluoride dentifrice caries clinical trials. *Am J Dent* 1993;6(Spec Issue):59–106.
 8. Richards A, Banting DW. Fluoride toothpastes. In: Fejerskov O, Ekstrand J, Burt B, editors. Fluoride in dentistry. 2nd ed. Copenhagen: Munksgaard; 1996. p. 328–46.
 9. Second International Conference on Declining Caries. *Int Dent J* 1994;44 Suppl 1:363–458.
 10. Lewis DW, Ismail AI. Periodic health examination, 1995 update. II. Prevention of dental caries. *Can Med Assoc J* 1995;152:836–46.
 11. Kay EJ, Locker D. Is dental health education effective? A systematic review of current evidence. *Community Dent Oral Epidemiol* 1996;24:231–5.
 12. World Health Organization Guidelines for self care in oral health. Copenhagen: WHO Regional Office for Europe; 1988.
 13. Riordan PJ. Can organised dental care for children be both good and cheap? *Community Dent Oral Epidemiol* 1997;25:119–25.
 14. Thylstrup A, Vinther D, Christiansen J. Promoting changes in clinical practice. Treatment time and outcome studies in a Danish public child dental health clinic. *Community Dent Oral Epidemiol* 1997;25:126–34.
 15. Burt BA, Warner KE. Prevention of oral disease. In: Kudrle RT, Meskin L, editors. Reducing the cost of dental care. Minneapolis (MN): University of Minnesota Press; 1983. p. 132–61.
 16. Cohen D. Health promotion and cost-effectiveness. *Health Promotion Int* 1994;9:281–7.
 17. Holst D. Dental health economics—an attempt to stand on our own two feet. In: Frandsen A, editor. Dental health care in Scandinavia. Chicago: Quintessence; 1982. p. 183–94.
 18. Horowitz HS, Heifetz SB. Methods for assessing the cost-effectiveness of caries preventive agents and procedures. *Int Dent J* 1979;29:106–17.
 19. Sheiham A. Cost-benefits and cost-effectiveness of dental care. *J Dent Assoc South Africa* 1979;34:749–50.
 20. Davies GN. Cost and benefit of fluoride in the prevention of dental caries. Geneva: World Health Organization; 1974.
 21. Klein SP, Bohannon HM, Bell RM, Disney JA, Foch CB, Graves RC. The cost and effectiveness of school-based preventive dental care. *Am J Public Health* 1985;75:382–91.
 22. Council on Dental Research. Cost-effectiveness of sealants in private practice and standards for use in prepaid dental care. *J Am Dent Assoc* 1985;110:103–7.