Economic Evaluation of a Pit and Fissure Dental Sealant and Fluoride Mouthrinsing Program in Two Nonfluoridated Regions of Victoria, Australia

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Abstract

Objectives: *This study assessed the cost effectiveness of a three-year school-based pit and fissure dental sealant and fluoride mouthrinsing program in two nonfluoridated regions in Victoria, Australia.* ***Methods:*** *The analysis was based on a community intervention in five schools comparing an intervention group receiving the pit and fissure dental sealant, a weekly fluoride mouthrinsing, and an annual oral hygiene education session, with a control group receiving oral hygiene education only. The study measured mean differences in DMFS increments between study groups.* ***Results:*** *The mean discounted DMFS difference in increment (DMFS avoided) between study groups was 1.22 DMFS over three years. The incremental cost-effectiveness ratio comparing intervention to control group varied between a net savings of $7.00 to a cost of $35.60 per DMFS avoided, depending on assumptions used in the analysis. Results were sensitive to assumptions on program effectiveness, dental examination rates, and baseline DMFS of students. The program became more cost effective with each successive year of the program.* ***Conclusions:*** *The introduction of such a preventive program in nonfluoridated regions of Victoria will represent an efficient use of community resources. Policy issues that need consideration include whether to target areas where adolescents have a history of high dental disease experience, and whether dentists or auxiliaries are used as service providers. The need exists for a systematic evaluation (including an economic evaluation component) of dental prevention and treatment programs in Australia. [J Public Health Dent 1998;58(1):19-27]*

Key Words: dental caries, prevention, pit and fissure sealants, fluoride, economic, cost effectiveness.

A significant improvement in the dental health of children and adolescents in Australia and other industrialized countries has occurred since the mid-1970s. The mean DMFT score in 12-year-old children in Australia has declined from 3.0 in 1982 to 1.2 in 1992, a reduction of 60 percent (1). In addition, the decay-free rates (DMFT score of 0) of 12-year-olds has increased from 22.2 percent to 53.8 percent over the same time frame (1).

Not all groups in the Australian community have benefited to the same extent from this improvement in oral health. Characteristics of children still having a high burden of dental disease include: being members of low-income families, having low educational status parents, being Aborigines and Torres Strait Islanders, being recent immigrants, and residing in areas with nonfluoridated water supplies (2,3).

In particular, the dental health experience of children in nonfluoridated areas is significantly compromised compared to children residing in fluoridated regions. Brown et al. (4) found a 31.4 percent difference in DMFT (3.5 vs 2.4) in 8-year-old children in the fluoridated metropolitan area of Melbourne compared to the nonfluoridated Geelong region. Similarly, Slade et al. (5) reported that a greater exposure to fluoridated water was associated with significantly lowered DMFS scores in South Australia and Queensland. Given that 33 percent of Australians do not have access to a fluoridated water supply, children in these areas provide an important target group for the implementation of dental prevention programs (6).

The aim of this paper is to estimate the cost effectiveness, from a societal viewpoint, of a three-year, school-based, dental pit and fissure sealant (PFS) and fluoride mouthrinsing (FMR) program versus control in a single cohort of year 7 adolescents (first year of secondary school; 12–13-year-old students) from low-income families residing in areas surrounding Geelong and Ballarat, two nonfluoridated cities in rural Victoria. Since the 1970s, the municipalities of both Geelong and Ballarat have been resistant to the introduction of fluoride into reticulated drinking water supplies.

The rationale for the current study is that both prevention and treatment services are extremely limited for low-income adolescents in nonfluoridated regions of Victoria. Further, the school-based dental public health program that provides restorative and preventive care terminates at the completion of primary school education (5–12 years of age). Previous research in Victoria has highlighted the need for primary prevention strategies, including PFS and FMR programs, to be introduced into Victorian secondary schools (7-10).

The current study represents the first Australian economic evaluation of a pit and fissure dental sealant and fluoride mouthrinsing program aimed at reducing dental caries in the population. As such, it will inform decision

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makers on the value of introducing a similar program into the public dental health services in rural Victoria. This economic evaluation has particular policy relevance in Victoria, as the state government has recently announced plans to expand the School Dental Service for primary school-aged children to include secondary school-aged children.

Methods

Economic evaluation is a form of analysis that compares alternative forms of action (either prevention or treatment) in terms of both their costs and benefits (often termed program outcomes or effectiveness). Such an analysis can assist policy makers in determining which dental health intervention (or mix of interventions) — either prevention or treatment — maximizes improvements in oral health within available community resources.

A detailed discussion of economic evaluation methodology is found in texts by Drummond (11) and Drummond, Stoddart, and Torrance (12). The application of economic evaluation to dental health programs has been discussed in the dental literature (13-17). The form of economic evaluation methodology used for the current study was cost-effectiveness analysis.

The economic evaluation was based on a secondary analysis of outcome data collected as part of a recently completed three-year community intervention described below (18). The purpose of the community intervention was to investigate the effectiveness of a preventive dental program rather than prospectively collect economic data alongside the trial. The cost data used in the economic evaluation was a combination of a retrospective analysis of resource use associated with implementing and operating the community intervention, and an estimate of the difference in dental treatment costs associated with the differential oral health outcomes between the intervention and control groups over the three years of the trial.

Intervention Design. The PFS and FMR intervention study design was a school-based, three-year (1989–91) prospective nonrandomized trial consisting of an intervention group (n=256 subjects) and a control group (n=266 subjects). The intervention group received, in addition to routine dental care from private dental practitioners, the PFS and FMR program, which also included an annual oral hygiene instruction session. The control group received the oral hygiene instruction and routine dental care from privately practicing dentists only.

The sample of year 7 children was drawn from five schools with known high levels of dental caries experience (as determined by School Dental Service records) from the nonfluoridated regional cities of Geelong and Ballarat in rural Victoria. All year 7 children within those schools (approximately 930) were invited to participate in the study. Each school was then randomly assigned as intervention or control. All schools were classified by the Ministry of Education as being in the lowest 20 percent of the Australian Bureau of Statistics' Index of Socioeconomic Advantage and Disadvantage (19). The age group was chosen primarily because the second permanent molar teeth would on average have just erupted, or would be erupting during the trial period and, therefore, would be at the most appropriate stage for dental sealing. In addition, subjects had entered secondary school and consequently no longer had access to the free School Dental Service that had been available in primary school. Finally, we thought subjects of this age would be able to carry out the mouthrinsing effectively.

Each subject's oral health status was recorded using the DMFS index at an annual dental examination (20). Subjects on a portable dental chair or school table were given a standardized dental examination by two calibrated examiners. The kappa coefficient for inter- and intraexaminer reliability of surface scores ranged between 0.94 and 0.99 — values indicating excellent agreement beyond that explained by chance (21). The dental examination was undertaken using a sickle probe and mouth mirror attached to a fiber optic light source. No radiographs were taken.

The dental sealant application was undertaken by a dentist (aided by a chairside assistant) independent of the research team, but who was not masked to the purpose of the research. Sealants were placed on all second molar teeth and appropriate first permanent molars based upon the morphology and sealant retentiveness predictors of Bader et al. (22). The dental sealants were placed, repaired, or replaced at each 12-month interval on the basis of individualized treatment plans established at the time of the annual dental examinations.

The FMR component comprised a supervised, weekly, 60-second mouthrinse with 0.2 percent neutral sodium fluoride. A community health center, also independent from the research team, was employed on a sessional basis to provide staff to supervise the weekly FMR activities. Staff from the center traveled to the schools and were responsible for mixing and distributing the FMR liquid, directly supervising the activity, and keeping records.

Program Efficacy and Effectiveness. The primary outcome measure used in the economic evaluation was intervention effectiveness based on the difference in total DMFS (and components) increment between the intervention and control group from baseline to the completion of the trial. DMFS increments also were calculated annually. Individuals who withdrew from the trial were not followed up to measure their subsequent dental experience due to demands of confidentiality by participating schools and the logistic difficulties of students moving to other localities.

Outcomes were available for individuals who completed the trial. These "efficacy" results were recalculated (based on assumptions about the outcomes of student withdrawals) to provide estimates of program "effectiveness," based on "intention-to-treat" (outcomes for individuals to whom the program was offered). The analysis assumed that students who withdrew from either arm of the trial received (in the year they withdrew) the average outcome of their respective group for students for whom a measure was available at the annual examination. In years subsequent to withdrawal, students in both the intervention and control groups were assumed to incur the same DMFS increment as the control group for whom a measure was available. This approach is considered a "worst-case scenario." In practice one could expect that students in the intervention group would, subsequent to their early withdrawal from the trial, receive better outcomes than the control group because they should receive some clinical benefit from that "partial" treatment. As such, the measurement of program effectiveness is considered a conservative estimate of the true program effect. The concept of intention-to-treat, and the effect on study outcomes of making different assumptions about individuals lost to follow-up is discussed in a number of recent papers (23-25).

Cost Analysis. The estimate of resource use associated with the intervention, for the purposes of the economic evaluation, was restricted to those costs likely to vary between study groups. Thus, the cost associated with the oral hygiene component of the intervention was not included, as it was common to both study groups. The cost analysis was restricted to resource expenditure associated with operating the PFS and FMR program, and the costs of dental treatment. Thus, total costs in the intervention group were specified as program costs plus dental treatment costs. For the control group, total costs were those associated with dental treatment. The difference between the total costs of the intervention group and the control group is termed the incremental (or additional) costs (or savings) associated with the PFS and FMR intervention. Resource use associated with the 1989–91 intervention was inflated by the use of the dental services price index to reflect 1994–95 prices.

In determining resource use associated with the PFS and FMR program, estimates were based on those costs that would be expected to occur under "usual" practice conditions. Clinical trials and community interventions are often protocol driven, resulting in resources being consumed solely for the purpose of evaluating and analyzing trial data. The current study excluded resource use associated with such activities. Judgments on which cost categories to include were made in consultation with senior management from the Victorian School Dental Service. The study focused on measuring direct costs, with the cost of "unpaid" teacher time assisting in organizing the children to participate in the intervention also included. Indirect costs — including worker absenteeism due to parents taking time off work to take their children to a dentist for treatment — were not included in this analysis. Cost categories included in the analysis and assumptions used in their estimation are summarized in Table 4.

As mentioned previously, the study was not designed to collect economic data. Thus, information from children or parents on dental treatment costs incurred by either study group was not collected directly. The cost of treatment for both study groups was estimated by multiplying the annual incremental change in the individual components of the DMFS index by the average charge for each procedure based on 1994 average Victoria statewide dentist fees (26). We assumed that all students received dental care from private practice dentists. Thus, the cost would include both the consumer copayment and any cost of treatment that would be reimbursed if patients were covered under private health insurance. We also assumed that the treatment costs associated with increases in the decayed component of the DMFS score occurred in the year of the increment.

In addition, the study assumed that each student in the intervention group received (and was charged for) a dental examination once every three years, and those in the control group every two years. This assumption is considered conservative because students in the control group incurred twice the increment in dental caries experience as the intervention group, and thus were more likely to receive and be charged for a dental examination associated with dental care. The observation that individuals in a nonsealant group incurred more dental examinations has been shown in a recent dental sealant study (27).

Form of Economic Evaluation. The form of economic evaluation used was cost-effectiveness analysis. The incremental cost-effectiveness ratio — that is, the additional costs and difference in effectiveness rates between the intervention group compared to the control group expressed as a cost or savings per DMFS averted — was defined as:

$$(C1 - C2) / (E1 - E2) = \Delta C / \Delta E$$

where

C1=total cost associated with the PFS and FMR intervention, plus cost of dental treatment in the intervention group;

C2=total cost associated with dental treatment in control group;

E1=DMFS increment in intervention group; and

E2=DMFS increment in control group.

To estimate the incremental cost-effectiveness ratio and for ease of analysis, we assumed that a cohort of 250 students entered both study groups. Years 2 and 3 costs and outcomes were discounted to their present value using an annual discount rate of 5 percent. Usual practice in economic evaluations is to discount future costs and benefits to reflect the social preference for the present over the future, whereby money spent or benefits gained immediately are given a higher value than those that occur some time in the future.

Sensitivity Analysis. Many of the assumptions used in the primary analysis are subject to a degree of uncertainty. A one-way sensitivity analysis modifying key assumptions in relation to both costs and study outcomes was undertaken. Additional analyses included using lower and upper boundaries of the 95 percent confidence interval for program effectiveness, using a zero and 10 percent discount rate, varying the assumptions on dental checkup rates, and varying the assumptions on the dental health outcomes of students lost to follow-up.

With respect to the assumptions on dental examination rates, the sensitivity analysis provides cost-effectiveness estimates by first assuming that students in both study groups received and were charged for the same rate of examinations and, second, that the control group received and was charged for twice the annual rate as the intervention group.

In relation to dental outcomes for students in the intervention group lost to follow-up, it was assumed that each individual withdrawal achieved the same annual DMFS increment in years subsequent to withdrawal as their average annual increment incurred up to the year of withdrawal (average of previous measurements carried forward). For example, if a student withdrew from the trial in year 3, we assumed that the year 3 increment was the average of the annual DMFS increment incurred in years 2 and 3. For student withdrawals in year 1, we assumed that they received the same DMFS increment as the mean annual value for students in the intervention group who were available for measurement at the end of year 1. These assumptions are considered the upper scale of program effectiveness based on intention-to-treat, in contrast to the most conservative estimate provided in the primary analysis.

In addition to the above sensitivity analysis, the paper also provides estimates of the relative cost effectiveness for students with different baseline DMFS scores (levels of oral health prior to commencement of the study).

Results

A total of 931 children (431 for intervention group and 500 for control group) were invited to take part in the study. Of these, 256 experimental subjects and 266 control subjects agreed to participate, giving a response rate of 59.4 percent and 53.2 percent for the intervention and control groups, respectively. Table 1 summarizes retention rates and loss to follow-up for each year of the program. The final number of students available for examination (i.e., those who completed three years of the study) was 207 intervention and 237 control subjects. These numbers are 80.9 percent and 89.1 percent of the subjects who commenced the trial in the intervention group and control group, respectively. No statistically significant differences in retention rates between study groups were observed. The average age in both the control and intervention group was 12.5 years, with approximately equal numbers of males and females. The mean baseline DMFS did not differ significantly between the intervention (3.66, SD±4.30) and control groups (3.70, SD±4.30). In addition, no group differences existed in any of the components of the DMFS index.

Table 2 presents annual and overall three-year mean DMFS increment per student for both study groups. Outcome data is presented first as efficacy (based on those completing the trial) and second as effectiveness (based on assumptions of intention to treat). In addition, both nondiscounted and discounted estimates are presented, the latter being used in the cost-effectiveness anlaysis. At the end of the three-year program the mean DMFS increment in the intervention group was 0.93 (SD±2.50) surfaces compared to 2.35 (SD±4.05) surfaces in the control group for those individuals who completed the three-year program. The difference of 1.42 DMFS (or 1.33 DMFS discounted value) between the two study groups was statistically significant ($P<.001$). Pit and fissure surfaces, and smooth surfaces accounted for differences of 1.0 (70 percent of total increment) and 0.42 surfaces, respectively.

TABLE 1
Number of Trial Participants and loss to Follow-up by Year of Trial

	Intervention Group		Control Group	
Year	No. Available for Exams	Loss to Follow-up	No. Available for Exams	Loss to Follow-up
Commencement	256	—	266	—
1	228	28	248	18
2	209	19	240	8
3	207	2	237	3
% completing trial	80.9	19.1	89.1	10.9

TABLE 2
Program Efficacy and Effectiveness as Measured by DMFS Increment by Year and Overall

	Year 1	Year 2	Year 3	All Years
Efficacy				
Intervention	0.26 (SD=1.55)	0.31 (SD=1.63)	0.36 (SD=1.37)	0.93 (SD=2.50)
Control	0.43 (SD=1.62)	0.81 (SD=2.07)	1.11 (SD=2.64)	2.35 (SD=4.05)
DMFS difference in increment				
Nondiscounted	0.17	0.50	0.75	1.42
Discounted(d=5%)	0.17	0.48	0.68	1.33
Effectiveness				
Intervention	0.26	0.36	0.50	1.12
Control	0.43	0.81	1.11	2.35
DMFS difference in increment				
Nondiscounted	0.17	0.45	0.61	1.23
Discounted(d=5%)	0.17	0.43	0.55	1.15

TABLE 3
Three-year Program Effectiveness as Measured by DMFS and DMFS Component Increments

DMFS Component	Intervention	Control	Difference (Nondiscounted)
DS (decayed)	0.11	0.25	0.14
MS (missing)	0.21	0.35	0.13
FS (filled)	0.80	1.74	0.96
Total	1.12	2.35	1.23

Adjusting the efficacy estimates to account for student withdrawals resulted in overall program effectiveness being reduced to 1.23 DMFS (or 1.15 discounted value). Almost 77 percent of this difference was attributable to filled surfaces (FS), with missing surfaces (MS) and decayed surfaces (DS) contributing equally to the remaining dental caries experience (Table 3).

Table 4 summarizes the estimated cost of operating the PFS and FMR program for 250 students from the five schools. A present value of $24,750 was estimated for the three-year program. This estimate is equivalent to approximately $33 per annum per child. Salaries contributed to almost 72 percent of total program costs with consumables and other overheads accounting for most of the remaining costs. While not shown in Table 4, the weekly FMR accounted for approximately 36 percent of the total costs of the intervention. This value of $12 per child per annum for the weekly FMR program is significantly higher than US estimates because the current study used community health workers to supervise the FMR and inclusion of the opportunity cost of teachers' time in the analysis. In contrast, most US state programs use noncosted volunteer labor to supervise the mouthrinsing and most do not include teacher's time in the analysis (14,28).

The estimated cost of dental treatment over the three years for the intervention and control groups is shown in Table 5. Dental treatment costs were 84 percent higher in the control group ($46,750 or $62.30 per child per annum) than in the intervention group ($25,400 or $33.90 per child per annum). Tooth restorations and dental examinations accounted for the majority of costs in both study groups. The cost of restorations in the control group was over twice that of the intervention group.

Combining estimates of the operating costs of the prevention program with dental treatment costs and comparing this cost to the dental treatment

TABLE 4
Summary of Total Program Costs over Three Years Associated with Mouthrinsing and Fissure Sealant Program*

Cost Category	Amount $(1994)	% of Total
Capital equipment		
Dental light	550	2.2
Salaries		
Dentist†	7,150	28.9
Chairside assistant†	3,550	14.3
Community health worker†	6,200	25.1
Teachers' time‡	850	3.4
Consumables		
Rent mobile dental unit	1,600	6.5
Building rent¶	1,200	4.8
Travel	1,000	4.0
Program consumables§	1,150	4.6
Office expense+	1,500	6.1
Total	24,750	100.0

*Cost of running annual oral hygiene instruction session not included in the analysis, as it was common to both study groups.
†Dentist salary component based on an hourly wage rate of $30 per hour (includes 25% on-costs) with an estimate of 20 minutes of dentist time per student per annum (includes travel and any administrative duties). Chairside assistant salary: $15 per hour. Community health worker wage rate including on-costs: $18 per hour, 3 hours per week for 40 weeks of school year.
‡Valued at average wage rate with on-costs ($20 per hour). Total cost based on 3 hours of teacher time per school per annum to organize children to participate in program.
¶No rent was paid for use of school building for purposes of mouthrinsing program. This value is imputed and is an estimate of what rent would have cost to organize program.
§Includes mouthrinse, sterilizing solution, fissure sealants, and other disposable equipment.
+Includes heat, light, power, stationery, telephone/fax, postage, cleaning services, and other expenses associated with program.

TABLE 5
Summary of Costs of Dental Treatment in Intervention and Control Groups over Three Years of Program

	Intervention $(1994)¶§				Control $(1994)¶§			
Treatment Items*	Year 1	Year 2	Year 3	Total	Year 1	Year 2	Year 3	Total
Restorations	2,900	3,010	4,480	10,390	4,540	7,730	10,230	22,500
Extractions	450	860	1,630	2,940	750	1,290	2,860	4,900
Decayed†	140	1,180	130	1,450	690	1,570	1,000	3,260
Examinations‡	3,710	3,540	3,370	10,620	5,630	5,400	5,060	16,090
Total costs	7,200	8,590	9,610	25,400	11,610	15,990	19,150	46,750

*Costs for treatment items: $55,$60, $55, and $45 for restorations, extractions, decay (restorations required), and examinations, respectively.
†Assumes potential cost associated with unmet needs (decayed teeth requiring restorations) accrued in year of examination.
‡Assumes 50% of children in control group and 33% of children in intervention group receive and are charged for one examination each year.
¶Cost estimates calculated by multiplying DMFS component increment in each year by average 1994 dental charge.
§Costs discounted at 5% per annum.

TABLE 6
Total Costs, Total Benefits, and Incremental Cost-effectiveness Ratios for Each Additional Year of Program Intervention

(A) Year of Program	(B) Total Cost Intervention $(1994)*	(C) Total Cost Control $(1994)	(D) Net Cost (or Savings)† $1994)	(E) Incremental Benefits (DMFS Avoided)‡	(F) Incremental Cost (or Savings) $(1994) per DMFS Avoided¶
1	15,900	11,610	4,290	43	99.80
2	16,840	15,990	940	107	8.80
3	17,410	19,150	(1,740)	138	(12.60)
Overall	50,150	46,750	3,400	288	11.80

*Total cost in the intervention group per annum is the sum of the costs of the program ($8,700 in year 1; $8,250 in year 2; and $7,800 in year 3) plus the annual treatment costs from Table 5. The annual cost in the control group is the cost of treatment from Table 5.
†Net cost is the difference between the treatment and control costs (column B minus column C). A bracketed number indicates a net savings.
‡The incremental benefits are estimated by multiplying the annual DMFS difference in increment between the intervention and control group (from Table 2) by the 250 participants in the intervention group.
¶Incremental cost-effectiveness ratio (column F) is calculated by dividing column D by column E.

TABLE 7
Analysis of DMFS Avoided, Total Costs and Benefits, and Cost-effectiveness Ratio by Quartile of Baseline DMFS

Baseline DMFS Score	Total Costs $(1994)		Net Cost (or Savings) $(1994)	Total Benefits DMFS Avoided	Net Cost (or Savings) $(1994)	
	Intervention	Control			DMFS Avoided	Per Child
Primary analysis	50,150	46,750	3,400	288	11.80	13.60
Bottom quartile	43,100	35,100	8,000	203	39.40	32.00
Top quartile	85,300	91,950	(6,650)*	460	(14.50)*	(26.60)*

*( ) Refers to an overall savings.

costs in the control group resulted in an overall net cost of $3,400 (or $13.60 per child) attributable to the prevention program over the three-year study (refer to column D, Table 6). Thus, a public investment of $33 per annum per child resulted in an approximate $28.40 reduction per child per annum in dental treatment costs [i.e., ($46,750–$25,400÷250÷3=$28.40].

Table 6 (Column F) summarizes the incremental cost-effectiveness ratio for the intervention group compared to the control group, both for the overall program and for each year of the program. The overall ratio was estimated to be $11.80 per DMFS averted over the three-year period [i.e., ($50,150–$46,750)÷288=$11.80]. The incremental cost-effectiveness ratio (additional net cost divided by additional benefits from one year to the next) becomes more favorable with time. This finding was due to the increasing cumulative DMFS gain between the intervention and control group over the course of the program. For example, in year 1 of the program each DMFS averted was achieved at a relatively high cost of $99.80. In year 2 the additional cost was $8.80 per DMFS avoided. Year 3 of the program produced a net savings of $12.60 per DMFS prevented — that is, not only was there a significant difference between the intervention and control groups in dental caries increment, but the program demonstrated a net cost saving to the community. This net incremental savings per DMFS probably would occur in years after program completion because no additional program costs would be incurred, but significant residual benefit associated with the PFS and FMR intervention would occur.

A significant positive relationship between the baseline DMFS of students and subsequent dental caries increment was found. In addition, program effectiveness as measured by differences in DMFS increment between the two study groups was significantly higher in students in the top quartile of baseline DMFS compared to students in both the bottom quartile of DMFS and the intervention group overall. DMFS gain in the intervention group compared to the control group was 1.88 and 0.81 for the top and bottom quartiles of baseline DMFS, respectively. The average incremental cost-effectiveness ratio for students with the top quartile of baseline DMFS in the intervention versus control group was an overall savings of $26.60 per DMFS averted, compared to a cost of $32.00 per DMFS averted in the bottom quartile (Table 7).

The sensitivity analysis (Table 8) found that the cost-effectiveness ratio was particularly sensitive to assumptions of mean effectiveness rates, frequency of dental examinations, and the assumptions on dental outcomes for patients lost to follow-up. The results showed less sensitivity to the use of zero and 10 percent discount rates. For example, the most favorable results were obtained when we assumed that the control group received, and were charged for, twice the annual examination rate as the intervention group (a net savings of $6.10 per

TABLE 8
Sensitivity Analysis: Summary of Costs, Outcomes, and Cost Effectiveness of Mouthrinsing and Fissure Sealant Program Under Various Assumptions

Variation of Assumption	(A) Program Cost Intervention $(1994)	(B) Cost of Treatment Intervention $(1994)	(C) Cost of Treatment Control $(1994)	(D) Net Cost (or Savings) $(1994)*	(E) Net Benefits (DMFS Avoided)	(F) Net Cost (or Savings) $(1994) DMFS Avoided†	(G) Net Cost (or Savings) $(1994) per Child‡
Primary analysis¶	24,750	25,400	46,750	3,400	288	11.80	13.60
Use of dental therapist	18,900	25,400	46,750	1,050	288	3.70	4.20
Effectiveness (95% CI)							
Lower boundary	22,650	17,050	36,100	5,770	244	23.40	22.80
Upper boundary	22,650	35,100	57,200	2,650	300	8.80	10.60
Discount rate							
0%	23,100	26,800	49,500	2,950	308	9.60	11.80
10%	21,450	24,150	44,350	3,340	271	12.30	13.40
Dental examination§							
Same (33%/annum)	22,650	25,400	41,250	8,900	288	30.90	35.60
Control (66%/annum, intervention 33%)	22,650	25,400	51,900	(1,750)+	288	(6.10)+	(7.00)+

*Estimated by the difference between program and treatment costs of intervention, and treatment costs in control group (i.e., column A plus column B minus column C).
†Column F calculated by dividing column D by column E.
‡Column G calculated by multiplying column E by column F and dividing by 250 (cohort of children in intervention group).
¶Sensitivity analysis performed is one-way analysis — one assumption is varied, with all other assumptions remaining constant.
§Primary analysis assumes 50% of chidren in control group will be charged for a checkup each year compared to 33% in intervention group. Sensitivity analysis firstly assumes the 2 groups receive the same (33%) checkup rate, then subsequently assumes the control group receives twice the checkup rate (66%) as intervention group.
+Figures in parentheses represent net savings.

DMFS averted over the three years) — a realistic assumption, given that the control group showed twice the dental caries increment of children who received the PFS and FMR preventive program. Changing the assumption regarding the dental health outcomes of students in the intervention group lost to follow-up improved the cost-effectiveness ratio from a cost of $11.80 to a cost of $2.30 per DMFS averted. The least favorable result was found when it was assumed that the intervention and control group were charged for the same rate of dental examinations (a net cost of $35.60 per DMFS avoided over the three years of the program).

Discussion

The current study estimated that the incremental cost-effectiveness ratio for the three-year intervention compared to a control group varied between an overall savings of $6.10 to a net cost of $35.60 per DMFS averted, depending upon the assumptions used in the analysis. The primary analysis estimated a cost-effectiveness ratio of $11.80 per DMFS avoided. It is difficult to make a judgment as to whether the prevention program constitutes a rational use of scarce community resources on the basis of the results of this program because of the lack of Australian studies on the relative cost effectiveness of alternative dental prevention and treatment programs. Despite the low cost incurred per DMFS avoided ($11.80), the assumptions used in the analyses are based on imperfect data. A number of these assumptions warrant further discussion.

The effectiveness rates in the program were based on the results of a single prospective community intervention. Two aspects of this point need discussion. First, the care given in a trial may not reflect the pattern of care found in the "usual" practice setting. For example, extra care may be taken with the placement and repair of the dental sealants because of the high standards of research evaluation, thus resulting in higher effectiveness rates. The design of the current study tried to minimize this problem by employing a dentist independent of the research team who placed, repaired, and replaced the sealants. Second, the external validity of results could be improved by using efficacy and effectiveness data based on a meta-analysis or overview of a number of similar trials, rather than relying on a single study. Such studies have not been undertaken in Australia, and few studies of similar design have been reported in the international literature. For example, overseas studies have focused on either FMR or PFS with less emphasis on combined approaches, have targeted children of different ages, have been performed within communities with varying levels of water fluoridation, and have been undertaken in different time periods — thus limiting the generalizibility of the results. Those studies that most resemble the current study design have estimated (nondiscounted) DMFS gains of between 1.23 surfaces over two years to 1.90 surfaces over four years, results of similar magnitude to the current study (29-31). Further, although the schools selected for the current study were randomized into intervention or control groups, randomization of subjects within the same school into two groups was problematic.

A number of assumptions about dental treatment costs as used in the analysis also are subject to debate. First, the results were highly sensitive to the assumption of dental examination rates between the control and the intervention group. The cost-effectiveness ratio changed from a net cost of $11.80 per DMFS avoided under the assumption of 50 percent higher examination rates in the control group to a ratio of $30.90 per DMFS if examination rates were the same. This issue has not been examined extensively in the literature. We believe intuitively that, in practice, adolescents as a group who received more dental treatment would have been charged for more dental examinations. Second, the study assumed that the decay component of the DMFS index was restored in the year of the increment. There is no guarantee that the necessary dental treatment will be undertaken. The potential cost of treating decayed teeth was estimated to be approximately 6–7 percent of total dental treatment costs, and thus is unlikely to have any impact on the overall cost-effectiveness results. An alternative analysis could have been employed whereby a series of probabilities (ranging from, for example, 0.8 to 0.5) indicating the probability of treatment being undertaken in the year of increment were attached to costs.

While the previous discussion has focused on areas of uncertainty that can lead to the overstatement of the potential economic benefits of the prevention program, other assumptions were of a more conservative nature. For example, the three-year evaluation would significantly underestimate the potential economic benefits of the program because, while there are no ongoing program costs beyond the three years, there is evidence that a high proportion of dental sealants are retained for periods up to and beyond 10 years and that there is a residual beneficial effect of the FMR (32-34). Indeed, if the time frame of the assessment of costs and benefits were extended beyond three years, the program likely would produce a net savings in addition to improved oral health. In addition, for the purposes of estimating program effectiveness from efficacy results, a "worst case scenario" was used in the primary analysis for those students in the intervention group lost to follow-up. The outcomes for students lost to follow-up likely would lie somewhere between this value and the upper estimate provided in the sensitivity analysis. Further, the longer term potential savings due to reductions in secondary caries and/or maintaining restored tooth surfaces have not been considered in the analysis. While predicting the potential savings here is difficult, secondary caries and treatment costs can contribute significantly to the total dental services expenditure in Australia (35). Also, the intangible benefit of an improvement in a child's quality of life associated with reductions in dental caries and improvements in tooth survival has not been captured in the analysis.

On balance, weighing up the assumptions outlined above, we believe that implementation of the preventive program into the Geelong and Ballarat secondary school system would represent an efficient use of community resources. However, before introducing such a program, the governmental sponsoring agency will need to address a number of key issues.

First, a modeled economic evaluation (or desk-top analysis) should be undertaken to extrapolate the potential costs and benefits over a longer time frame (e.g., 10 years) to all students in the Geelong and Ballarat regions and to other nonfluoridated areas in Victoria.

Second, a decision will need to be made on the appropriate mix of service providers. For example, a dental auxiliary potentially can be substituted for a dentist to provide the preventive program. This action has the potential to reduce overall costs because of lower wages of dental auxiliaries and the common work practice of using one chairside assistant for two dental auxiliaries, whereas dentists generally work on a one-to-one basis with chairside assistants in Australia. Evidence suggests that the substitution of auxiliaries will not compromise patient quality of care (36,37). Dental auxiliaries currently provide total dental care to children attending primary schools in Victoria and are used extensively in the Secondary School Dental Service in South Australia.

Third, because the program clearly demonstrated that the higher the caries risk of students, the more favorable the cost-effectiveness ratio, consideration will need to be given to the need for targeting. Arguably, the program should be directed at all students in these nonfluoridated regions or alternatively targeting individuals (or schools) with the highest risk profiles in addition to high-risk individuals (or schools) in both fluoridated and nonfluoridated areas.

A final issue that will warrant evaluation is the worth of the combined PFS and FMR compared to a PFS program alone. Studies have questioned the additional benefit of an FMR intervention (38,39). The results of our small-scale program also raise doubts as to the worth of the combined approach. While the FMR accounted for approximately 35 percent of total program costs, smooth surfaces (most likely to be affected by FMR) accounted for only 30 percent of the DMFS averted. However, the effectiveness of the fissure sealants depends to an extent on the need for the smooth interproximal surfaces to remain intact.

A need exists in Australia to evaluate systematically the costs and outcomes of alternative means to achieve improvements in the community's oral health in nonfluoridated areas and in other high-risk groups. Since dental caries is a slowly progressing disease, program analysis must be continued for several years to measure the true costs and benefits. Programs that need to be evaluated include community water fluoridation, as well as existing, publicly funded, school-based programs and community dental health programs. Particularly because of the recent declines in caries rates, such evaluations must include the incremental costs and benefits of expanding the program to different age groups and subjects at risk.

Incorporation of economic evaluation alongside future dental treatment and prevention programs also is needed. While the historic aim of dental prevention programs has been to ascertain program efficacy, care and attention must be given to estimate the costs and benefits to all those who are offered the program (effectiveness). This approach requires the often resource-intensive task of following up program dropouts. In addition, it would be appropriate to prospectively collect information regarding actual treatment costs alongside the intervention. In the current study, for example, knowing whether those with poorer oral health received, and were charged for, more frequent oral examinations would have been helpful. In addition, with extra effort devoted in measuring costs and outcomes of study withdrawals, a more reliable intention-to-treat analysis can be undertaken. It is also important that the results of future programs are generalizable to other targeted groups and to the wider community setting. Thus, the target groups, the setting, and treatment provided (e.g., examinations, etc.) must reflect usual practice patterns. This requirement would ensure that protocol-driven program costs are separated more easily from those that would occur under normal practice conditions.

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