Cost-benefit of Water Fluoridation in the Prevention of Dental Caries in Australia.

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INTRODUCTION

Dental caries is one of the most prevalent and widespread diseases in the world today. It has been found in countries where dental surveys had been carried out, that almost the entire population is suffering from dental caries and its consequences. The high prevalence of this disease imposes a heavy burden on dental services as well as communities in many countries. Even in countries with the most highly developed dental health system, it is not feasible to provide the dental manpower needed to restore all the dental caries that occur. Many countries, which together represent a large proportion of the world's population, do not have these highly developed dental health systems and the dentist / population ratio is extremely low. It is, therefore, inconceivable that the control of dental caries by treatment methods alone can be accomplished on a world-wide basis in the foreseeable future. Consequently preventive measures seem to be an ideal solution. Efforts towards the prevention of dental caries have been in progress for some time now and several methods have been found effective on an individual basis but their application on a public health basis leaves a lot to be desired.

The only known well-tested preventive method that has resulted in a substantial reduction in dental caries at present is the controlled application of fluorides, particularly water fluoridation. Studies into the relationship between fluoridation and dental caries have been in progress long enough, for the full effect of fluoride on a whole generation of children, to give reasonably accurate data on the effect of water fluoridation as a public health preventive measure.

The benefit of water fluoridation in terms of reduction in dental caries has been well established but there has been little documentation in the dental literature to point out the economic benefits which occur as a result of water fluoridation. It is the purpose of this paper to look further into the economic benefits of water fluoridation, especially in terms of savings and particularly cost savings in dental treatment for the individual, community and the dental profession.

1. Dental Caries

Dental caries as defined by World Health Organization is "a local, post-eruptive, pathological process of external origin involving softening of the hard tooth tissue and proceeding to the formation of a cavity". As already mentioned earlier, dental caries is one of the most widely occurring diseases and its prevalence has been observed in many countries to be increasing in direct proportion to the amount of refined carbohydrate consumed. With this alarming increase in the prevalence of dental caries and the constantly rising cost of dental services, it would be very hard, if not impossible, for many people to have dental care even if they wanted to.

1.1. Permanent Dentition

The impact of water fluoridation on dental caries is usually expressed in terms of the difference in the number of DMFT/dmft from a controlled group. The reduction in DMFT is shown in tables I, II and III.

TABLE I. A general comparison of DMFT/child and MT/child for specified age group (U.S.A.). (Ast and Fitzgerald, 1962).[3]

Age (yr)			DMFT/ child	% difference	MT/ child	% difference
12-14	Grand Rapid	1944-1945	9.58	-55.5	0.84	-65.5
		1959	4.26		0.29	
12-14	Evanston	1946	9.03	-48.4	0.19	-68.4
		1959	4.66			
12-13	Sarnia	1959	7.46	-56.7	0.75	-70.7
	Brantford	1959	3.23		0.22	

In 1944-1945, just before fluoridation, Grand Rapids was found to have 9.58 DMFT/child. In 1959 it was 4.26 DMFT/child, a reduction of 55.5%. Similar reduction also occurred in Evanston and Brantford, and Newburgh with Sarnia and Kingston as control respectively.

TABLE II. A comparison of caries prevalence rate in permanent teeth of Hastings children in 1954-1964 (N.Z.) (Ludwig, 1965)[27]

	HASTINGS 1954				HASTINGS 1964				
Age	No. children	No perm. teeth present	DMFT	DMFT/ child	No. children	No perm. teeth present	DMFT	DMFT/ child	% Reduction
6	216	1254	304	1.41	171	976	40	0.23	84
7	246	2170	677	2.75	168	1537	125	0.74	73
8	202	2247	754	3.73	186	2075	231	1.24	67
9	145	1921	645	4.45	143	1924	298	2.08	53
10	157	2665	861	5.48	213	3942	523	2.46	55
11	122	2385	869	7.12	168	3412	571	3.40	52
12	139	3047	1316	9.47	166	4172	856	5.16	46
13	147	3819	1738	11.82	148	3943	1067	7.21	39
14	128	3455	1837	14.35	165	4481	1458	8.84	38
15	88	2404	1478	16.80	118	3217	1152	9.76	42
16	41	1100	681	16.61	65	1783	753	11.58	30

The reduction in DMFT in Hastings after 10 years of fluoridation range from 30% in the 16 years old to 84% for the 6 years old. It can be seen that the greatest benefit of water fluoridation occurs among the younger age groups who were born after fluoridation commenced.

TABLE III. Comparison of caries prevalence rate in Tamworth children in 1963 and 1973, 9½ years after fluoridation (Australia). (Martin and Barnard, 1973).[30]

	DMFT/child			DMFS/child		
Age (yrs)	1963	1973	% Reduction	1963	1973	% Reduction
6	1.3	0.4	69	2.1	0.5	76
7	2.5	0.7	72	3.3	0.8	76
8	3.2	1.2	63	5.2	1.6	69
9	3.8	1.9	50	6.7	2.6	61
10	5.1	2.2	57	9.9	3.2	68
11	5.9	3.1	48	9.3	4.8	48
12	8.3	3.9	53	15.3	6.4	58
13	9.6	4.9	49	19.0	7.9	58
14	10.6	5.9	44	21.4	9.7	55
15	12.3	6.6	46	25.7	11.6	55

The reduction in DMFT per child in Tamworth after 9½ years of fluoridation range from 44% to 72% which is similar to the results obtained from the studies of Hastings children after 10 years of fluoridation. The greatest benefit is again shown to have occurred among the younger age groups.

1.2. Deciduous Dentition

Studies were also carried out for the caries rate of the deciduous dentition. The results from the Hastings and Tamworth children were comparable as shown in Tables IV and V.

TABLE IV. Comparison of caries prevalence in deciduous teeth of Hastings children in 1954 and 1964 (N.Z). (Ludwig, 1965).[27]

	HASTINGS 1954.				HASTINGS 1964.				
Age yrs	No. children	No. deciduous present	deft	mean deft/ child	No. children	No. deciduous present	deft	mean deft/ child	% reduction
5	193	3679	1621	8.40	163	3152	661	4.06	52
6	259	4317	2359	9.11	205	3512	937	5.57	50
7	248	3421	2114	8.52	171	2336	937	5.48	36

TABLE V. Comparison of caries prevalence in deciduous teeth of Tamworth children in 1963 and 1973 (Australia). (Martin and Barnard, 1973).[30]

	dmft			dfs		
Age (yrs)	1963	1973	% Reduction	1963	1973	% Reduction
4	5.6	1.3	67	8.9	1.5	83
5	5.7	2.8	51	8.6	4.1	52
6	7.4	2.8	62	11.0	4.3	61
7	7.3	3.1	58	11.3	4.9	57

The results obtained from the Hastings and Tamworth studies have been in general agreement with those obtained in studies from other countries at about the same length of time since water fluoridation started.[2,4,18,27] It would be an unnecessary repetition, therefore, to reproduce them here. It must be realized however, that fluoridation though the most effective and practical caries preventive method at present, other preventive as well as curative methods are still essential in order to achieve maximum dental health.[29]

1.3. Tooth Surfaces (DMFS/dfs)

The Tamworth surveys in 1963 and 1973 showed results (Tables III & V) which are similar to those obtained from Hastings,[28] that is the reduction in DMFS/dfs range from 48%-76% and 52%-83% respectively. Vederoni, Stenberg and Davies in 1976 reported similar findings in their study on the effect of caries experience of lifetime residents of Townsville, Australia after 10 years of water fluoridation which started in 1965.[33] They compared the caries experience of children aged 6, 8, 10, 12 and 14 years in Townsville in 1975 and 1969, and with 16 low-fluoride towns and 4 naturally fluoridated towns. At 6 years of age the mean number of df per child was higher in children from the 16 low-fluoride towns (5.3) than in lifetime residents in Townsville in 1979, (2.3). The four naturally fluoridate areas had 3.5 df and Townsville in 1969 was 3.4. The differences in per cent are shown below:

1 Townsville 1975	-	(1)	16 low-fluoride town	- 57%
		(2)	4 naturally fluoridated town	- 34%
		(3)	Townsville 1969	- 36%

For the permanent dentition the mean number of DMF teeth per child in Townsville, 1975 was lower than in children in the 16 low-fluoride towns by 0.8 (73%) at age 6, 1.7 (59%) at age 8, 2.6 (54%) at age 10, 4.0 (50%) at age 12 and 5.3 (45%) at age 14.

2. Dental Treatment Needs

The actual need for dental treatment cannot be completely solved even in the developed countries with the present manpower,[3,18,22,23,34] without utilization of some preventive measures. The fact that water fluoridation reduces the prevalence of dental caries up to 60% would make it reasonable to expect that the dental treatment need in a fluoridated area would be less than in a non fluoridated area.

2.1. Number of Patients Treated in a Non-fluoridated Area

Danby and Hollis, 1966 [15] reported in their studies of the effect of fluoridation on a dental public health program, that at the end of March 1965, in New Zealand, 12 dental nurses were required to provide routine needed dental treatment to 5702 children in Gisborne, whose water supply was fluoride-deficient. This would mean that one dental nurse was required to provide regular treatment for 475 children in Gisborne.

2.2. Number of Patients Treated in a Fluoridated Area

From the same studies by Danby and Hollis, 1966, it was also reported that 5.5 dental nurses were able to provide similar treatment, provided by dental nurses in Gisborne, to 3,798 children in Hastings which had been fluoridated for ten years at that time, or one dental nurse in Hastings was able to provide regular treatment to 690 pre-school and school children which is 215 more children than a counterpart in Gisborne. This could mean a reduction in the need for dental manpower or more time for present dental personnel to spend on other treatment such as orthodontics or to extend dental services to more people or all of them together.

2.3. Number of Needed Extractions in Fluoridated and Non-fluoridated Areas.

Reporting the effect of ten years of fluoridation on dental treatment, Davies, 1973 [10] showed that the mean number of extractions per child was 0.06 in Hastings, compared to 0.15 in non-fluoridated Gisborne.

In the Tamworth fluoridation survey, Martin and Barnard, 1973 [30] reported that in 1963, a 6 year-old child had an average of 2.1 teeth extracted or needed extraction and in 1973, a 6 year-old child had an average of 0.6 teeth extracted or needed extraction.

2.4 Number of caries-free Patients.

With the decrease in dental caries, there is also an increase in the number of children who are caries-free as a result of water fluoridation. It has been pointed out that a very small percentage of children examined in fluoridation studies were free of dental caries in non-fluoridated areas or before fluoridation but this percentage has been observed to be increasing with time after fluoridation.

Martin and Barnard in 1973 [30] reported that 18%, 5% and 8% of children aged 5 years, 7 years and 9 years old respectively were found to be caries-free in 1963, and in 1973 the same age groups of 5, 7 and 9 years-old were found to have 40%, 26% and 29% caries free respectively. These were similar to results of other studies.

3. Cost Related to Dental Treatment Required.

The cost of dental treatment is constantly rising and it may vary from one community to another and from one country to another depending on such items as living cost, office rental rate, personnel and the quality of services provided. In order to standardize or at least minimize the variations in dental fees, many countries are using the fee-for-services schedule rather than the fee-per-unit of time schedule. In Australia, Facts and Figures, Australian Dentistry, 1978[16] gives the dental fee schedule for selected items of treatment for Australia, and its states in 1978 which was effective 31st December 1977. It is shown partly in Table VI.

TABLE VI. Dental Fees for Selected Items of Treatment for Australia. (Mean fees as at 31st December 1977).[16]

Items of Services	N.S.W.	Vic.	Qld.	S.A.	W.A.	Tas.	Australia
	$	$	$	$	$	$	$
1. Examination only	6.11	6.60	7.02	6.93	8.60	6.33	6.93
2. One X-ray	6.83	7.74	7.48	6.59	9.23	7.80	7.61
3. Two X-rays	11.27	11.73	12.00	10.03	13.78	11.62	11.74
4. Simple Extraction	12.94	13.75	12.55	10.37	16.21	12.62	13.07
5. Surgical Removal	31.71	34.01	29.89	28.54	28.63	32.47	30.88
6. Amalgam - 1 Surface	12.81	14.34	12.64	10.72	15.58	13.52	13.27
7. Amalgam - 2 Surfaces	16.16	17.11	14.91	14.04	18.92	16.77	16.32
8. Amalgam - 3+ Surfaces	21.92	21.73	19.43	18.72	23.52	20.23	20.93
9. Composite - 1 Surface	15.61	16.09	14.81	15.25	16.72	15.77	15.57

The figures in Table VI are in Australian currency, and it can be seen from them just how expensive such routine items of treatment as are shown, are. Studies are going on into ways and means of reducing the cost of dental treatment[8] but until something is found, dental fees will keep on rising. If dental fees can not be reduced directly without ill-effect, it would be worth looking for ways which can be used to reduce them indirectly. One way is to reduce the rate of dental diseases.

Dental literature indicates a number of preventive measures against dental disease, particularly dental caries. Some of these measures are effective to some extent and others still need more studying. At present water fluoridation has been proven and is widly accepted as the most effective and economical measure against dental caries.

3.1. Dentition in Fluoridated Areas

The tremendous reduction in the incident and prevalence of dental caries as a result of water fluoridation in a community[26] would result in less need for curative dental treatment and therefore, less dental bills. Ast et al, 1970,[5] reported that cost of dental care for children in Newburgh who drank fluoridated water from infancy was half that for children in Kingston who did not have fluoridated water. Results of their six year study of 5 and 6 year-old children in terms of mean number of services and cost per child are shown in Tables VII and VIII.

TABLE VII. Mean number of services per child (initial and incremental) for children 6 years old at initial examination in 1962. 5

	Examination	Age	No. Children	RESTORATIONS				EXTRACTION
				One surface	Two surfaces	3 or more surfaces	Total	
NEWBURGH	initial	6	182	0.85	0.91	0.11	1.87	0.33
	2nd	7	133	0.34	0.53	0.03	0.90	0.12
	3rd	8	160	0.12	0.41	0.05	0.58	0.10
	4th	9	135	0.16	0.43	0.03	0.63	0.01
	5th	10	67	0.15	0.23	0.03	0.41	0.09
	6th	11	54	0.36	0.24	0.00	0.60	0.03
KINGSTON	initial	6	182	0.91	2.40	0.85	3.88	0.61
	2nd	7	151	0.61	0.90	0.09	1.61	0.19
	3rd	8	141	0.52	1.04	0.11	1.67	0.15
	4th	9	106	0.64	0.95	0.06	1.66	0.10
	5th	10	64	0.43	0.58	0.00	1.00	0.20
	6th	11	45	0.33	0.43	0.00	0.76	0.07

TABLE VIII. Mean cost per child (per child year for incremental care years).[5]

Examination	Age	Cost	
5 yrs old		Newburgh	Kingston
initial	5	$13.86	$33.73
2nd	6	6.85	13.65
3rd	7	8.55	15.90
4th	8	5.44	13.41
5th	9	8.62	13.30
6th	10	5.18	6.34
6 yrs old			
initial	6	$16.93	$40.78
2nd	7	8.14	14.64
3rd	8	6.09	15.54
4th	9	6.19	14.26
5th	10	3.97	9.10
6th	11	4.41	6.34

The costs of dental treatment in Table VIII are in U.S. currency, calculated from the 1966 New York State dental fee schedule which provided $5.00 per surface of restoration and $6.00 per extraction.[5] These tables show that both the initial and incremental services as well as the mean cost per child per year were consistently lower in the fluoridated area than the non-fluoridated one.

3.2. Dentition in Non-fluoridated Areas.

The data from Table VII and VIII show that the 5 and 6 year old children in the non-fluoridated area have more restorations and extractions per child than those in the fluoridated area. The cost of these treatments per child per year, both the initial and incremental treatment, is also greater in the non-fluoridated area than the fluoridated area. It was also pointed out in the same study[5] that the mean amount of chair time required to provide both initial and incremental care per child per year is greater in the non-fluoridated than the fluoridated area.

3.3. Cost of Treatment in Fluoridated and Non-fluoridated Area.

The Tamworth fluoridation surveys did not give any indication as to the types of restorations required to fill the cavities each child was reported to have had. It would not be possible to calculate the exact cost of restorative treatment required per child either before fluoridation or after. However, by extrapolation of the given figures, very reasonable estimates can be made.

The cost of restorations, one surface, two surfaces, three or more surfaces amalgam and one surface composite resin are shown in Table VI for Australia in 1978. The average of these figures would give an average cost of one restoration of medium size at $16.52. An average or a medium size restoration here would include the classical occlusal, mesio-occlusal, disto-occlusal and class III restorations. This reasoning is based on the fact that the reduction of dental caries in terms of tooth surfaces, as a result of water fluoridation occurs where delicate, extensive and expensive operations are involved,[18,28] that is, in descending order, smooth surfaces (buccal and labial), followed by the interproximal surfaces and then the occlusal surfaces. Calculation on this basis will give an estimate of the cost of required restorative treatment and extraction per 6 year old child in Tamworth before and after 9½ years of fluoridation.

Martin and Barnard in 1973[30] reported that:

(1) In 1963, a 6 year old child had 10.1 surfaces to be filled and 2.3 teeth to be extracted, and

(2) In 1973, a 6 year old child had 3.4 surfaces to be filled and 0.6 teeth to be extracted.

If the annual incremental rate for the 9½ years of fluoridation is taken to be 1.06 surfaces and .24 extraction per child in the non-flooridated area and .36 surfaces and .06 extractions per child in the fluoridated area the estimated cost of curative treatment per child would be about \$21.00 for the non-flouoride area and about \$7.00 for the fluoridated area. This would be a saving of about .7 surface and .18 extraction or about \$14.00 per child.

Children aged 15 years and younger who were born and lived in Tamworth since fluoridation started in 1963 have been exposed to fluoride all their lives. The 1973 Tamworth Fluoridation Survey shows a substantial reduction in dental caries in the Tamworth children in 1973. It is reasonable to expect that the rate of dental caries in Tamworth in 1979 would be lower than either in 1963 or 1973. Data from the 1979 Tamworth Fluoridation Survey are not yet available. According to preliminary data from the Dental Survey of Tamworth School in August 1979,[17] there were 17 schools involved with a total enrolment of 7770 but only 6540 would participate. The saving in the cost of restorations and extraction per child was estimated to be \$14.00, so the total saving in the cost of treatment for 6540 children would be \$91,600.00.

4. Cost of Water Fluoridation

The cost of a water fluoridation scheme depends on a number of factors which can be grouped under two major headings: (1) Capital Costs and (2) Operational costs.

4.1. Capital Costs

The capital costs of a fluoridation scheme include such items as building, fluoridating equipment, analytical equipment and the training of operators. Another important factor is the number of fluoridation plants required in the scheme. Some communities have single sources of water supply and require single fluoridation plant. Others may have more than one water source and therefore need more than one fluoridation plant in which case it would cost more.

4.1.1 Building

A building is required to house the fluoridation plant including an analytical laboratory with its equipment. A building was estimated to cost about $4,200 in 1971.[1]

4.1.2 Analytical Equipment

One analytical laboratory is sufficient to take care of more than one fluoridation plant. The cost of equipment for one analytical laboratory is estimated at about $900.00 in 1971.[1]

4.1.3 Fluoridating Equipment

Various types of fluoridating equipment are available on the market and the price varies according to the sophistication of the unit. The more sophisticated ones will naturally cost more.

4.1.4 Training of Operators

The training of operators may not be part of the capital equipment but cost involved has to be considered somehow because it is part of the total cost of the procedure.

4.2. Operational Costs

The operational cost of a fluoridation scheme would include such items as chemicals used, power usage, staff wages and maintenance of the plant.

4:2.1 Chemicals Used

The chemicals commonly used in fluoridation in Australia are: sodium fluoride, sodium silicofluoride and fluosilicic acid. The cost of these chemicals as reported by Altree William, in 1971 were as follows: Sodium fluoride was \$380.00 per ton; sodium silicofluoride was \$180.00 per ton and fluosilicic acid was \$4.oo per 50 litre drum. Most of the fluoride chemicals used in Australia are imported from overseas and therefore the freight, packaging and delivery costs would be included in the total cost of the chemical.

4.2.2 Power Usage

The electricity used in a fluoridation scheme will depend on the number of fluoridation plants required. The cost may be calculated as the number of kilowatts times the cost per kilowatt hour.

4.2.3 Staff Wages and Maintenance

The Water Fluoridation Act of 1957,[1] required that a fluoridation plant must be attended once every operating day including Saturdays and Sundays, to do analytical tests, check and calculate fluoride addition and prepare chemicals for refilling feeders plus general maintenance of the plant, which was estimated to require 2 man-hours per day or 1500 man-hours per year for one fluoridation plant.[1]

4.3 Total Cost of Water Fluoridation

In 1968 the total cost of water fluoridation in the Sydney area was reported to be 20 cents per head per year for a population of 3 million which is about $548,500.00.[32] From 1st July 1978 to 30 June 1979, the total cost of fluoridation in Sydney was $480,000.00, or about 15 cents per head per year.[9] Tamworth fluoridation scheme was reported to have a total cost of $15,400.00 in 1968, which is about 77 cents per head per year for a population of 21,180.[32] Data on the present total costs of water fluoridation in Tamworth is not available at the moment but an esimate was given in a lecture to the DPH students on 27 July 1979 by the Fluoridation Officer. His estimate was about $40,000.00 for the year. It would come to about $1.35 per head for the 30,000 (29,395)[6] people in Tamworth.

In Townsville, which started fluoridation in 1965, the actual capital cost of implementation from 1967-1977 was estimated to be $22,300.00 and the running or operational cost for the same period was about $6,000.00-$7,000.00 per year.[19] The actual total cost of implementation, which includes all capital and operational costs for the period from 1967-1977 was about $46,000.00. Amortizing it for the 10 year period would cost about 5 cents per head per year for a population of about 85,000 [19]people.

5. Cost-benefit Analysis of Water Fluoridation

Methods of determining Cost-benefits and Cost-effectiveness

Cost-benefit analysis is defined as a systematic method of measuring the present value of all the costs and benefits of a program while cost-effectiveness may be assessed in terms of the number of hours of professional time to achieve a stated benefit.[11] Cost-effectiveness analysis in the case of water fluoridation is not applicable since it does not require the time of dental professional personnel for implementation.[11] For cost-benefit analysis the simplest method of assessment is to determine the ratio of the cost of implementation to the savings in the cost of dental treatment.

5.1. Cost of Implementation

The actual cost of fluoridation includes the total capital and annual operational costs which are customarily amortized and assessed as an annual cost per capita.[11]

5.2. Savings in the Cost of Dental Treatment

The financial benefit from water fluoridation is assessed in terms of the total savings in the cost of dental treatment. Only the savings in terms of individual items of treatment and the savings in terms of salaries of dental operators not required in a fluoridated area will be dealt with here. Danby and Hollis, 1966[15] reported that one dental nurse in Hastings can provide all needed routine dental treatment to 690 children while one dental nurse in Gisborne can provide similar treatment to only 470 children. In 1974 the Australian Dental Services Advisory Committee recommended that the school dental therapist to patient ratio should be about 1:600 for non-fluoridated areas and about 1:900 in areas where fluoridation had been in operation for some time. It would, therefore, require about 10.9 dental therapists to provide routine needed dental treatment to 6540 school children in a non-fluoridated area and about 7.2 therapists to do similar treatment to the same number of school children in a fluoridated area. This would give a difference of 3.7 dental therapists. Calculation from data given in Facts and Figures, Australian Dentistry, 1978,[22] give a dental therapist an average salary of $10,000.00 per annum in Australia. This would give a total saving in salary alone of dental therapists not required in fluoridated area of $37,000.00.

5.3. Cost-benefit Ratio

The cost-benefit ratio is defined as the total cost of implementation over the total savings in the cost of dental treatment. The total cost of implementation in Tamworth was estimated at present to be about $40,000.00. The total savings in dental treatment is about $129,000.00. The cost benefit ratio is therefore:

$$\text{cost-benefit ratio} = \frac{\text{cost of implementation}}{\text{savings in cost of treatment}}$$

$$= \frac{\$40,000.00}{\$129,000.00}$$

$$= 1 : 3.2$$

Although the cost to he community for the implementation of fluoridation can readily be determined, data on the savings in the cost of dental treatment are confined to restricted age ranges. Even though these results are extrapolated to provide an estimated potential saving for all children who participated in the Tamworth survey, the cost-benefit ratio is an underestimate because it did not include all children in Tamworth who have had the benefit of water fluoridation.

However, the estimated results here appear to be reasonably similar to results obtained in other countries. It would be reasonable to say that water fluoridation, where practical, would be a very effective and economical method of dental caries prevention for a community, country or nation. In his series on tentative cost benefit analysis, Davies[10,11,12,13,14] pointed out that the practicability and effectiveness of school water fluoridation, fluoride tablets and professionally administered topical application of fluoride solution, though encouraging, they still need further studies before comparison can be made as to which is a better method. Meanwhile water fluoridation appears to be the most effective and economical method as a public health measure.

6. SUMMARY

Dental caries is recognized as one of the most common diseases in the world today. Its prevalence is still on the increase in many countries, especially the developing countries whose dietary habits have changed towards increased sugar consumption.

The cost of dental treatment is constantly rising. Attempts are being made to control the cost of dental treatment but even now many people do not seek dental treatment because they can not afford it.

Dental preventive measures have been developed during the past years and several are in use with varying degrees of success. Water fluoridation, at present, is accepted widely as the most effective preventive measure. It reduces the rate of dental caries up to 60%.

One of the good things about water fluoridation is that it can reach a great number of people and it requires very little, if any, effort on their part. The cost of water fluoridation could decrease as the population served increases. It must be realized that water fluoridation does not completely cure or prevent dental caries and its effect is not immediate but takes some time to be noticed and therefore, other measures including curative methods still play important roles in the battle against dental caries.

The financial benefits of water fluoridation have been assessed favourably in many countries; figures given here as the cost-benefit ratio seem to indicate that water fluoridation is a worthwhile project.

There are other benefits of water fluoridation which are difficult to express in terms of money but nevertheless are definite benefits. Such items as:

(1) Time lost from school or work because of dental appointments would decrease as a result of fluoridation;

(2) Pain and discomfort from dental decay would decrease as a result of fluoridation;

(3) The opportunity to enjoy the comfort and feel of caries-free mouths which has been reported in growing numbers in fluoridated areas.

(4) There is evidence that fluoridation may help in decreasing malocclusion by decreasing the rate of extraction of teeth, especially the first permanent molars.

7. CONCLUSION

The effect of water fluoridation on dental caries has been established. Its financial benefits in terms of savings in the cost of dental treatment and salaries of dental operators not required as a result of fluoridation have also been assessed together with the cost of implementation of water fluoridation. The estimated results shown here seem to be in general agreement with similar studies in other countries. It is therefore felt by the writer that although firm conclusion can not be made based on the data cited here, it would be only a repetition of what has been done if further investigation is suggested into the cost benefit of water fluoridation as it has been shown to be the most effective and economical preventive method at present.

Some of the benefits of water fluoridation such as the savings in time a dental operator has as a result of water fluoridation as well as other benefits not easily expressed in terms of money are not included in the cost benefit ratio calculation and so contribute to the under-estimate of the actual total cost of dental treatment. The estimated result for the cost benefit analysis of water fluoridation in Australia would in all probability be in the same order as those done in other countries.

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