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A REVIEW OF SOME METHODS OF CONTROL
AND PREVENTION OF CARIES FOR A DENTAL
HEALTH PROGRAMME FOR SCHOOL-CHILDREN

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TABLE OF CONTENTS

Title page i
Acknowledgements ii
Table of Contents iii

I. INTRODUCTION 1

II. CONTROL AND PREVENTION 6
   (1) Treatment of Caries
   (2) Diet:—
       (a) Restriction of Refined Carbohydrates 31
       (b) Phosphate Supplement 43
   (3) Fluorides:—
       (a) Fluoridation 50
       (b) Dietary Supplement of Fluorides 54
       (c) Topical Fluoride Therapy 63
   (4) Other Agents:—
       (a) Ammonia and Urea Compounds 74
       (b) Antibiotics 78
       (c) Anti-Enzymes 83
   (5) Tooth brushing and Oral Hygiene 86
   (6) Dental Health Education 98

III. DISCUSSION - Including Application to Singapore School Dental Service 111

IV. SUMMARY 117

V. CONCLUSION 121

VI. REFERENCES 123
I. INTRODUCTION

Dental caries has troubled man for thousands of years, and today still remains one of the most widespread of human afflictions. A World Health Organisation Technical Report series¹ published in 1958 states: "Dental caries is one of the most prevalent and widespread diseases in the world. It is not restricted to any specific age, sex or economic status, nor is it peculiar to any country or race. In countries where dental surveys have been carried out, it has been found that almost the entire population is affected by dental caries and its consequences."

It was, however, only in the last century that dental caries became a major problem leading to wholesale loss of teeth. The incidence in Britain,² for instance, is high and has risen considerably since the end of the Second World War. 34% of 5-year old children now have decayed teeth and over one third of the teeth of the 13-year old children have been damaged by caries. In 1964,³ over six and a half million permanent teeth of school children were filled and another million had to be extracted. In Hawaii,⁴ a three year dental caries
survey was completed in 1959 on 96,000 school children aged from 5 to 16 years. The percentage of erupted permanent teeth having decay was found to vary from 7.6% at the age of 5 years to 47.7% at 16 years. The average number of carious teeth per person at 16 years was 13.36.

It is quite apparent that the widespread great prevalence of the disease poses a tremendous problem. This can be expected to increase in magnitude, since it is unlikely that the present high consumption of sugar in most western countries will decrease. In fact, even in many Asian countries like Japan, Singapore and Hong Kong, where there is basically a different diet, national consumption of sugar has risen significantly over the years.

Dentistry has made great advances within the last few decades. However, it is still true to say that once caries has developed, restorative dentistry remains the most effective means of control. During
the early days of organised dentistry, relief of pain was the common service sought and rendered. Today, however, the thinking on dental care is towards an incremental care programme, both at Government and individual levels.

It is a well accepted fact that refined carbohydrates are very closely related with the formation of dental caries. An easy way of preventing caries would be the prohibition of refined sugars. However, this would be quite unacceptable. Any change in an individual's diet that results in an addition, rather than a deprivation, will be more likely to be accepted. In this regard, various compounds of phosphates have been found to be significantly effective in preventing caries when added to the diets of rats. The mode of action is thought to be a local influence on the tooth surfaces, though a systemic influence has not been ruled out. Human trials in which phosphates had been added to the sugar and flour consumed have produced conflicting findings, but there seems to be a basis for hopeful expectation for the future.
Fluoridation of the communal water supply in areas where there is no natural fluoride is undoubtedly the cheapest and most practical method of fluoride therapy. Various studies have shown that the addition of approximately 1 ppm fluoride in the drinking water can give as much as 60% in caries reduction. Where fluoridation of the water supply has not been undertaken, dietary supplement with fluoride tablets accords good protection. Then there is the method of topical application of fluorides on erupted teeth, either clinically by the dentist or at home by the patient himself.

Other agents have been tried, notably ant-enzymes, antibiotics and ammonia and urea compounds. However, results with these agents have not been encouraging.

While the old belief that "a clean tooth never decays" may not necessarily be true, a perfectly clean mouth is usually a healthy mouth and a dirty mouth
never is. The importance of regular toothbrushing and good oral hygiene cannot be over-emphasised. It is the one single procedure which, if carried out conscientiously by the individual, can make an immense contribution to good dental health.

The best planned preventive programme will come to nought, if not acceptable to the public or the patient. Dental Health Education is therefore not a luxury but a necessity. Not only is there ignorance among the public on matters pertaining to oral health, but there is also indifference and apathy towards dental care. The aim of dental health education should thus be to inform as well as to motivate the individual.

In this thesis, a review of literature with reference to the above methods of control and prevention, and an evaluation of these methods, will be made.
II. CONTROL AND PREVENTION

1. Treatment of Caries

Brauer et al\textsuperscript{5} feel that the most successful and certain method of controlling or arresting the progress of active decay through the dentine is removal of decay. They state further that the most effective means of preventing its recurrence in that area is to restore the resulting defect by means of a suitable filling material. This simple idea may seem to be rather elementary, but it deserves reiteration today, since restorative dentistry still remains the most effective means of control of dental caries. Frequent and regular dental attention most assuredly halts the progress of dental caries, and controls the ravages of dental decay in the form of pulpal and periapical infections, as well as the loss and malocclusion of the teeth.
Bernier and Muhler\textsuperscript{7} say that the removal of carious tooth material and replacement with zinc oxide and eugenol cement, disrupts the caries process, protects the pulps of still vital teeth, and provides comfort for patients with early pulp involvement. They also believe that ridding the mouth of all evidence of active caries is accompanied by a reduction in the oral Lactobacillus count, altering conditions in the mouth in such a way that involvement of additional tooth surfaces may be less likely to occur.

Minimum standards of dental care for children were formulated by the American Society of Dentistry for Children,\textsuperscript{8} at the request of the Council on Dental Health of the American Dental Association. It was considered that in order to meet minimum requirements for growth, development and health, dental services for children should include, among other treatments:
(a) Periodic examinations, including X-ray diagnosis.
(b) Dental prophylaxis.
(c) Restoration of carious teeth with silver amalgams or silicate fillings, or with metal castings if necessary.
(d) Pulp treatment, including cappings, partial or total pulpectomies when indicated.

The principles of cavity preparation have remained basically the same since Black first postulated them. Hampson\textsuperscript{9} is of the opinion that cavity preparation refers to those operations which prepare the tooth for filling in such a way that the margins are in relatively immune areas, all caries is removed, and the remaining tooth substance is able to resist the forces of mastication. The form of the cavity is governed by the amount of caries, by the structure of the tooth substance, and the physical and chemical properties of the material chosen to fill it.
Referring specifically to the deciduous dentition, Davies\textsuperscript{10} is of the opinion that restorations in the primary dentition must be capable of withstanding the forces of mastication for periods ranging from a few months to eight to ten years. Accordingly, many of the principles governing the preparation of cavities in permanent teeth also apply to primary teeth. The modifications required for the primary dentition are determined by the morphology of crowns, the size and shape of pulp chambers, and the thickness of enamel and dentine.

In cases of rampant caries, Sumnicht\textsuperscript{11} recommends that the examination of the rampant caries patient requires, among other procedures, obtaining radiographs adequate to determining the extent of tooth destruction, caries susceptibility tests as a basis for evaluating the effectiveness of subsequent corrective and control measures, determination of any use of drugs that may contribute to the condition, initiation of a diet record, and a physical examination to identify possible systemic aetiological factors. In the treatment of rampant caries,
Muhler and Hine\textsuperscript{12} suggest that all the teeth which are decayed beyond repair should be removed. This is particularly important in young children in order to prevent eruption of the permanent teeth into such an environment, which will favour their early caries involvement. It is advisable in as short a period of time as possible, to excavate the dental caries from all the decayed teeth and restore them temporarily with zinc oxide and eugenol. By so doing the caries process will be retarded and the mouth made more self-cleansing. Following this, the second round of treatment may be started by restoring each tooth to its normal contour.

From the point of view of normal occlusion of the permanent dentition, it is important that good care be taken of the deciduous dentition. Waugh\textsuperscript{13} says that dental caries must be detected early and given prompt treatment. This is because dental caries of deciduous teeth, when neglected or when not given proper dental care, is an important cause of malocclusion of the permanent dentition. Dental restorations of
the deciduous teeth must replace the full mesiodistal dimensions of the natural teeth, and space maintainers must hold the full space of any prematurely lost teeth. The reason for this is that maintenance of the full arch length from the second deciduous molar around to the one of the opposite side is imperative for the natural development of normal occlusion of the permanent teeth. The primitive Eskimo, having no sugar and, therefore, no tooth decay, also has the highest percentage of normal occlusion of any known race.

Malocclusion could have an effect on caries experience. Miller and Hobson\(^{14}\) say that a malocclusion usually results in an increase in the number of stagnation areas in the mouth. The dysfunction of occlusion or malocclusion often results in less efficient cleansing of the teeth by the passage of food over them and by the action of the lips and cheeks. Dental caries is usually associated with areas of stagnation. They conducted an investigation into dental conditions in children over a period of ten years. The report presents findings relating malocclusion to dental caries and gingival conditions. For instance, in
one hundred and fifty-seven children aged fourteen years with a normal occlusion, the average D.M.F. was 8.27, whereas in one hundred and thirteen children of the same age with either class I, II or III malocclusion, the D.M.F. rate was 9.49. This was significant and indicated the effect of a malocclusion on caries rate.

Adler,\textsuperscript{15} however, in his study on malocclusion and caries in five Hungarian cities conducted on adolescents, found that patients with "covered bite" showed less caries than did patients with normal occlusion. He also found that patients with class II division II malocclusion showed no difference in caries experience from the normal occlusion group.

In dental care programmes for children, the adoption of the system of incremental care should be seriously considered. Dunning\textsuperscript{16} describes incremental care as the treatment of children at the earliest age at which they are available, and maintenance care through periodic treatment of caries increments
thereafter. The object, of course, is to achieve prevention and control of caries at the earliest possible age, and to keep the child within the area of maintenance care, so that only yearly increments of dental disease will have to be dealt with thereafter at any one time. He feels that another advantage of this type of dental care is that incremental care educates children and parents at a logical time, to the value of periodic visits to the dentist. It helps prevent premature loss of deciduous teeth with consequent possible malocclusion and it permits effective handling of fissure caries on the occlusal surfaces of first permanent molars, as these lesions usually appear about the age of seven.

Frankel is of the opinion that the incremental approach permits beginnings on a small scale, with gradual expansion of the programme's size, and permits anticipating administratively the manpower and cost requirements in advance of budget deadlines. When the desired age spectrum has been covered, manpower
and cost requirements become relatively stable. The application of the incremental principle permits an orderly system of accomplishing the main objective of regular and complete dental care for as large a segment of the nation's population as is possible. When such a system begins with the treatment of a child's first caries and continues with treatment of successive new lesions as they appear, there is never any large accumulation of unmet dental needs. He says further that one of the established values of a public dental programme on an incremental basis is the opportunity to measure the impact of the programme on the oral health of the population served.

Incremental care is defined by Young and Striffler\textsuperscript{18} as treating defects as they occur and thus avoiding a pyramiding of needs. This, they feel, is one of the basic objectives of dentistry. In private practice, incremental or maintenance treatment can be provided readily if patient co-operation can be obtained. This objective, however, is not always as easily attainable in public care programmes or in
plans for the group purchase of dental care. The high costs of providing initial care to meet accumulated needs may exceed the funds available for the programme or require premiums or contributions large enough to discourage contribution. Furthermore, the initiation of a programme which offered services to a significant segment of the population in an area would probably overwhelm the available professional manpower. They state further that this approach allows a programme to start on a limited scale and expand gradually. During the developmental period, the financial and manpower requirements can be estimated relatively easily, and once the desired age groups have been included, these requirements become stable.

The findings from factual studies of specific incremental care programmes show the immense benefits that can be expected. The comprehensive and detailed studies in Richmond and Woonsocket by Waterman were conducted in order to throw light on the problem of accumulated and maintenance dental needs of school children. The investigation was made on about 5,000
children aged between 5 and 16 years in each of two chosen study sites. The studies consisted of four consecutive treatment series, each of which included an examination, a prophylaxis, topical fluoride applications and the treatment of all carious defects.

In the first examination, approximately three-fifths of the Richmond children had from 1 to 5 decayed teeth and one-fifth had a similar number of filled teeth. The proportions had shifted by the final examination to 25% with 1 to 5 decayed teeth and 71% with 1 to 5 filled teeth. Similarly, for children with 6 to 10 filled teeth, the proportion rose from 2.5% to 18%. The eleven year olds with 6 to 10 decayed teeth decreased from 25% to 2% at the end of the study period. In Woonsocket, 85% of the seven year old children had D.M.F. initially, but only 6% had filled teeth. Seven years later, 47% of the same age group had filled teeth. Although all of the fifteen year old children had D.M.F. teeth when first examined, only 54% had filled teeth compared with 98% at the conclusion of the study. The average fifteen year old had almost 12 carious teeth and only
2-1/3 filled teeth, compared with 3 1/2 carious teeth and more than 11 filled teeth at the end of the study. Waterman explains that the prevalence rates of carious teeth were influenced considerably by the influx of new children and by the fact that a certain number of children refused dental care from any source.

With the exception of those of new patients, permanent teeth required only maintenance care during the last treatment series. The influence this exerts on the patient load per dentist for which completed services could be provided annually was evident from the fact that an average of 1,343 and 848 children per dentist at Richmond and Woonsocket respectively, had their work completed on an annual basis during the final treatment series. Corresponding figures obtained during the initial treatment series were 530 for Richmond and 384 for Woonsocket.
In terms of dentist-time per patient required to complete the case, at Richmond it was an average of 2 hours 50 minutes during the initial series and only 45 minutes during the final treatment series. In Woonsocket, it was 3 hours 18 minutes for the initial and 1 hour 20 minutes for the final treatment series. Waterman concludes that the unmet dental care needs that existed initially in the school population at Richmond and Woonsocket were practically all corrected in the periods covered by the studies.

In the New Zealand school dental service maintenance care, that is regular and periodical treatment, is considered to be the basic ingredient of dental care for children. Fulton made a close study of the New Zealand system of dental care for school children. Briefly, he found that the prevalence of dental caries is high in the average New Zealand school child, but much of it has been treated. For instance, at the age of seven, more than 5 of his deciduous molars have been attacked by decay, yet 95% of these attacked teeth have been filled. Two of his permanent teeth have also been
attacked but 75% of them filled. At fourteen years, the number of attacked permanent teeth is 10 and 86% filled. With reference to the tooth mortality rate, Fulton found that including teeth present but indicated for extraction, the average permanent tooth mortality at the age of 14 was 0.4 per child, and this he thought was strikingly low.

In any review of methods of control of dental caries, a mention needs to be made of prophylactic odontotomy. According to Brauer et al, the term refers to the elimination of a precarious pit or fissure by a standard cavity preparation, and the filling thereof to prevent the inception of decay. Hyatt, in discussing prophylactic odontotomy, says that it is intended to prevent the inception of decay in precarious pits and fissures. Elaborating further, Brauer et al are of the opinion that many well-calcified and developed teeth have deep pits, grooves or fissures that are vulnerable to decay. The removal of such an area is true preventive dentistry from a mechanical point of view. These
deep fissures or pits must be removed although no decay is evident, because caries may be initiated deep down in these hidden recesses without any external breakdown and without the patient's knowledge.
2. **Diet**

(a) **Restriction of Refined Carbohydrate Intake**

Dental caries is primarily the result of bacterial action upon the tooth surface. The organisms are mainly acidogenic and they depend upon a carbohydrate substrate for acid formation. In 1925, Bunting\(^{21}\) suggested that carbohydrates, particularly refined sugars and *Lactobacillus Acidophilus*, were directly related to the progress of caries. He also suggested that caries activity might be reduced by the removal of this carbohydrate substrate. This stimulated further studies by other workers, and in 1936 Jay\(^{22}\) and his workers showed conclusively that fermentable or refined carbohydrate, in the form of refined sugars, is related to the caries process.

Subsequent studies have confirmed these findings and present concepts of the relationship of carbohydrates and dental caries are founded on the same premise. Shaw\(^{23}\) says that carbohydrate-containing foods contribute to undesirable oral environments
and to increased proneness to oral disease. The incidence of dental caries is closely related to the retention of carbohydrate residues on caries-susceptible areas of the teeth. Complete elimination of all carbohydrates from the diet would prevent dental caries. However, the widespread use of carbohydrate-free diets or very low carbohydrate diets is impossible. The goal should be the drastic restriction of those dietary items that contain carbohydrates that are readily fermentable and readily retained on and about the protected surfaces of the teeth.

Bibby\textsuperscript{24} believes that the physical nature of the carbohydrate carrier or food has a most important influence on caries production. Sugar taken in a liquid form initiates less caries than comparable amounts of sugar taken in a solid form or in combination with other adherent substances. The frequency of eating carbohydrates or sugar containing food s is a most important factor in determining the caries activity of foods.
Rovelstad\textsuperscript{25} feels that the amount of sugar is not as important as the time and method of consumption. If sugar-containing foods are consumed at mealtimes, together with other foods, making up a well-balanced and adequate diet, there will be little effect upon the teeth. The other foods, the act of mastication and an adequate supply of saliva will eliminate, dilute and neutralise the products of metabolism injurious to the teeth. On the other hand, if a small amount of sugar is consumed regularly between meals, there is a greater possibility for damage.

He goes on to say that dietary management should be regarded as a fundamental approach to true caries prevention. To achieve this, he suggests the keeping of a chart-like record of everything that is eaten or enters the mouth during the typical week, as it will help in the recognition of the regular sources of sugar that are causing the trouble.
The Council on Research of the Canadian Dental Association recently stated that the presence of bacteria in the mouth and a suitable local substrate for bacterial metabolism, generally carbohydrates, are two pre-requisites without which dental caries cannot exist. Studies on "germ-free" animals indicate that caries cannot occur in spite of a high carbohydrate diet, when bacteria are not present. Experimental introduction of bacteria to germ-free animals permits caries to occur. Furthermore, the substrate for metabolism of the bacteria must be present around the teeth. Rats that are highly susceptible to caries do not develop lesions when fed a high sugar diet by stomach tube, although the teeth of litter-mates eating the same diet for identical periods of time do become carious. Evidence from studies on human beings also indicts refined carbohydrates in the carious process. The occurrence of dental caries among "primitive" people, although variable, is less than in so-called "civilised" people. As primitive people adopt the diet of the "civilised" people, their caries rate increases.
One of the major changes in diet is the consumption of much increased amounts of refined carbohydrates. Furthermore, if excessive sugar is reduced in the diet of caries-active individuals, their caries rate decreases. Finally, the marked reduction in caries rate noted in many countries during World War II directly paralleled the reduction in the availability of refined sugar.

In the animal studies by Kite et al., rats of a caries-susceptible strain were entirely tube-fed a caries producing diet for 16 to 25 weeks. None of the 13 rats which were tube-fed had tooth decay, while all but one of the 13 control litter-mates had caries. The results suggest that tooth decay is reduced in caries-susceptible rats when the direct effects of food in the oral cavity are eliminated.

In a study in Ghana, MacGregor related the caries experience of an individual to his standard of living. In a group of 485 mixed adults, he found an average caries rate of 28%. In a group of 107,
more Europeanised in their diet, however, the rate was 58%. Also, 60% of a group of 1576 individuals with a good living standard had dental caries compared with 22% among those with a poor living standard. Of 974 individuals with an average caries rate of 38%, the caries rate among those regularly eating sweets was 62% as compared with 24% among those not eating sweets. Forty-two per cent severe caries was found among those regularly eating sweets compared with 10% among those not eating sweets. These figures suggest that changing diet is having a marked effect on the incidence of dental caries. The main staple carbohydrates in Ghana are cassava, yam, maize and millet. Refined carbohydrates including sweets, are luxuries only the more affluent families can afford. Thus, it can be seen that the major factor in this alteration of diet appears to be the increase in the consumption of refined carbohydrates.
In the comprehensive Vipeholm Study, Gustafsson and his co-workers carried out clinical tests on children in Vipeholm, Sweden. They attempted to show which carbohydrates were the most harmful with respect to the teeth. Carbohydrate supplements were fed in solution, in bread and in popular forms of candy. In addition the supplements were tested at mealtimes and between mealtimes. They found that all supplements were less harmful at mealtimes than when given in between meals. Sugar in aqueous solution or sugar in firm Swedish bread was relatively harmless. When the sugar was consumed in the form of caramels and toffees which adhered readily to the tooth surfaces, major increases in the amount of tooth decay occurred during the observation periods. Whenever high caries activity was observed during the feeding of the supplements, return to the control diet led to a lower caries activity.
Muhler\textsuperscript{30} in a study on 200 high school students aged 13-14 years, who had an abnormally high dental caries experience, found that the average boy's frequency of eating per day was 11.3 times and the girl's was 8.8. The average dental caries prevalence for the boys was 15.66 D.M.F.'s, and the girls' was 13.94. Fenega,\textsuperscript{31} adopting a somewhat similar approach, made a survey of the dietary habits of 9 year old pupils in some Amsterdam elementary schools. Three hundred and fifty-seven children were divided into two groups as follows:

(1) 192 with severe carious lesions;

(2) 165 children either free from caries or with comparatively mild carious lesions.

He was able to show that the children with severe carious lesions consumed far more sugar and various sweets than those free or almost free from caries. These findings suggest that the between-meals eating of sweets or sugar is an important factor in the high experience of caries in these children.
McDonald\textsuperscript{32} reversed the order of approach in his study of the relationship between frequency of eating and dental caries. From a 7-day diet record of 200 children, the frequency of eating was determined, and the total sugar intake and the between-meal sugar was calculated to its carbohydrate equivalent of teaspoons of sugar. The dental caries experience was determined by clinical and radiographic examination and recorded as D.M.F.'s. The average total sugar intake of these children was 164 teaspoons while the average between-meal sugar was 55 teaspoons. He found the correlation between the total sugar consumed and the D.M.F.'s not statistically significant. However, a high correlation between total between-meal sugar intake and increased D.M.F.'s was observed.

Using a similar approach, Weiss and Trithart\textsuperscript{33} studied the effect of increased sugar intake on the deciduous dentition in 783 children 5-6 years of age. They used a method based on two gross determinations; the 24-hour recall and the def score. Children who reported eating no items of high sugar content or
carbohydrates with a high degree of adhesiveness between meals, the day before the examination, exhibited a def of 3.3 teeth per child. Those who reported eating four or more such items between meals the day before, had a def of 9.8 teeth per child. The average frequency of eating between meals was 1.75 items per day and the average number of def teeth, 5.88. The most popular type of between-meal items consumed were found to be gum, candy, soft drinks, pastries and ice-cream. These findings were confirmed by Tank and Storvick in their study on children aged one to six years. They found that in the 61% of the study group of children who consumed sweets 26 to 50 times a week, there was an increased caries rate of the deciduous dentition. These findings show a direct and consistent relationship between caries prevalence of the deciduous dentition and the frequency of eating items of high sugar content between meals.

Bradford and Crabb in their pilot study aimed to find out whether a low caries incidence might be associated with a restriction in the consumption of
sweets and biscuits between meals and at bedtimes. For their study group, they were able to obtain children of members of the teaching staffs of dental schools, who were on a restricted diet. The results were quite significant, for they found that the proportion of sound deciduous teeth for each age group was remarkably high, in this group of children. For instance, in the 4-6 years of age group, the percentage was over 70%, compared to about 35% in the control group. In the 7-10 years age group, it was about 40%, compared to nil per cent in the control group.

One study which revealed the close relationship between caries experience and refined carbohydrates was conducted by Toverud on Norwegian pre-school and school children, during World War II. He was able to show that there had been a reduction of 35 to 60 per cent in D.M.F.T. and of 60 to 80 per cent D.M.F.S. during the war years in this group of children. He attributed this to the rationing of sugar that was in force then. Consequently, sugar cakes, puddings and
different kinds of sweets were scarce, and between-meal eating of refined carbohydrate and sweets was limited. During the years 1946 and 1947, an increase in caries frequency was noticed and it corresponded to the return of dietary condition in Norway to what it was before the War.
(b) **Phosphate Supplement**

It is well known that dietary changes have a marked effect on the incidence of caries in such animals as rats and hamsters. Much evidence has been accumulating during the past decade or so which indicates that phosphates can bring about a significant reduction in carious lesions when they are added to the diet of rats. These encouraging findings obtained from animal studies stimulated trials on humans to be conducted, but the results were varied and inconclusive. A few of these studies will be reviewed.

Muhler et al\textsuperscript{37} in their study used golden Syrian hamsters. The animals were fed on a high sucrose cariogenic diet, containing 1% of sodium hydrogen phosphate and 25 ppm F, provided as stannous fluoride, for sixty days. The results show that dental caries was reduced by 77%. Barnard and Johannsen,\textsuperscript{38} were able to show the same positive results. Two per cent of calcium hydrogen phosphate and low concentrations of sodium fluoride were added to the diet of 172, separately and in combination.
They found that the addition of 10 ppm F or 25 ppm F to the 2% CaHPO₄ diet resulted in statistically significant reductions in dental caries. By itself, however, CaHPO₄ was ineffective. It would appear that the positive findings in these studies could be due to the fluoride supplement.

The organic phosphates were tested for any possible cariostatic influence. McClure carried out experiments on white rats with the use of sodium phytate. He showed that there was a very significant anti-caries effect by this supplement when present in an otherwise cariogenic diet. Sodium phytate is an organic phosphate occurring in many cereals as the calcium-magnesium salt. Its phosphate is made available by enzymatic hydrolysis by phytase. This would suggest that organic phosphates, especially phytates remaining in unrefined carbohydrates, and perhaps in certain unprocessed cereal foods, may be responsible for the reduced cariogenic activity of these foods. This view seems to be reinforced by Harris, in his analysis of the excellent results obtained when the phosphorus content of rodent diets had been
doubled by the addition of 2% sodium dihydrogen phosphate. He says that in terms of human diets this amount is similar to restoring the phosphorus content of sophisticated diets to natural or unrefined level. It is to be remembered that phytate phosphorus has been shown to have an anticaries influence, and most of the phosphorus removed from cereals during milling is in the form of phytate. Whole-wheat flour and brown rice, for instance, contain about three times as much phosphorus as white flour and white rice.

Combinations of different types of phosphates have been shown to have an additive or a synergistic anti-caries effect. Harris et al.\textsuperscript{41} raised the phosphorus content of a caries-producing diet to 0.8 per cent by the additions of sodium orthophosphate, metaphosphoric acid, or sodium tri-metaphosphate, either singly or in combinations. The diets were fed to groups of rats for 13 weeks beginning when they were eight days old. The following caries scores were obtained: control 17.3, orthophosphate 9.1, metaphosphate 5.5, and tri-metaphosphate 0.8.
When fed in combinations, the phosphate pairs were more effective as cariostatic agents.

Attempts have been made to lessen the cariogenicity of candy bars by the addition of various levels of phosphate supplements to these items of food. One such study was by Dalderup and Dirks Backer on the effect of various phosphate concentrations on the aerobic and anaerobic breakdown of glucose by lactobacillus casei and streptococcus mitis. They found that even with a dose that interfered in rats with growth, cariogenicity was not reduced to a level that allows recommendation of the phosphate supplemented candy bars.

Various trials on humans have been made, with the phosphates added to different items of food in the diet. Stralfors carried out tests on Swedish children aged 8-10 years. Dicalcium phosphate in the amount of 2% was added to the flour, sugar and bread used during one meal each day during the school
year. At the end of the study period, the control group had 0.38 and 0.31 new carious or filled surfaces, respectively in the boys and girls. In the phosphate group, the caries increases were 0.15 and 0.13 respectively. This was a 60% reduction. Based on X-ray findings, the reduction was found to be 40%.

Bibby and Averill on the other hand conducted co-ordinated studies on children in New York, a temperate region, and in Brazil, a tropical region. They obtained results that showed caries increments of 5.8 per child in the phosphate group and 5.9 in the control. In terms of new carious surfaces, it was 9.6 in the phosphate and 9.0 in the control group. Similar findings of negative correlation were obtained by Ship in his 3-year study on 732 children aged 7-14 years. He found no differences in the D.M.F.S. or D.M.F.T. rates of the control and experimental groups, based on clinical and radiographic examinations.
Harris et al.\textsuperscript{46,47} added calcium sucrose phosphates to carbohydrate foods in the diet of children aged 5-17 years, at the average rate of 4.3 gm. per day. In the first year of study, they obtained a caries reduction of 1.42 surfaces per child in the 5-8 years age group. For the 9-12 years, the reduction was 1.97 surfaces and for the 13-17 years it was 1.25 surfaces. They feel that the reduction was significant for children in the 5-12 years age group. At the end of the second year, there was an overall reduction of 25\% in caries increment. They were able to show that this reduction was mainly in the proximal surfaces of posterior teeth, which showed more than 50\% less caries. They found that the effect of calcium sucrose phosphate was additive to that noted from fluoridated water.

Stookey et al.\textsuperscript{48} in their study on 500 children aged between 5 and 16 years, added sodium dihydrogen phosphate to a variety of presweetened ready-to-eat breakfast cereals. At the end of two years, they
were able to obtain a lower incidence of caries in the experimental group as compared to the control group that received the same cereals, but without phosphate. Based on clinical and radiographic examinations, statistically significant reductions of 20–40% in D.M.F.S. were recorded. (P<0.001). Carroll et al.⁴⁹ using the same method, extended the age group to 527 adults aged 16–62 years. At the end of one year, caries reductions of 42.3% in D.M.F.T. and 21.8% in D.M.F.S. were obtained. These findings suggest that sodium dihydrogen phosphate may exert a post-eruptive anticariogenic effect in adults.
3. **Fluorides**

(a) **Flouridation**

The supplementation of otherwise deficient communal water supplies with the optimal amount of fluoride, is without question the most effective, practical, convenient and economical means of providing the public a partial reduction in the incidence of dental caries. That fluoridation reduces the prevalence of dental caries is well accepted today by the dental profession, since studies during the past 25 years have all shown this to be so. The extent of fluoridation in countries throughout the world shows the wide and almost universal acceptance of this measure as a public health method of caries reduction. In America, in 1966, over 65 million people were receiving the benefits of fluoridation, while in Canada it was over 5 million. In Australia, in 1968, the figure was over 4 million, while in New Zealand, the figure was over 1,200,000. An extensive review of the literature to determine the correlation between optimal fluoride in communal
drinking water and the prevalence of dental caries will, therefore, not be made in this thesis. The early and well known experiment in fluoridation in Grand Rapids, Michigan, North America\textsuperscript{50} in 1945 is of historical interest and will be briefly mentioned. The results from this study obtained after ten years and for the older age groups after fifteen years, show that for children of all age groups studied, the caries reductions in general are from 50–60\% in populations born after the initiation of fluoridation. For those born before the fluoridation programme, reduction in caries is between 30–50\%. One significant finding of this study is that caries experience of children under 12 years in Grand Rapids came down to the level of that in the standard endemic community of Aurora, Illinois. It is apparent, therefore, that since the community of Grand Rapids will have a continuing experience with water fluoridation, caries reductions to a level as high as 60\% may be expected in the ever-widening proportion of the population born after the onset of fluoridation.
The effectiveness of fluoridation has been dramatically shown in Hartford, Connecticut, where the city closed one of its pre-school dental clinics because of a significant decrease in the children's caries incidence. Before the introduction of fluoridation, the clinic's waiting list used to be 400 children regularly. In Easton, which has had fluoridated water since 1952, it was shown that among the children who had lived their entire lives in the town, for every 100 erupted teeth there were 15 D.M.F.T. compared with 32 D.M.F.T. in children in a comparable town with a non-fluoridated water supply. In New Zealand, too, the benefits of fluoridation are now revealing themselves. Dental nurses find that they can cope with greater numbers of patients than were ever dreamed of. A dental nurse once treating 450 patients a year can now cope efficiently with 800, 900 or even 1,000 patients.

One interesting observation of the cariostatic effects of fluoridation was made by Dirks Backer. In his comparison of the findings of various fluoridation projects in different studies, he is
able to show that the greatest reduction of caries is in the smooth buccal and labial surfaces and the proximal surfaces. Even in children who were 4-5 years when fluoridation started, the reductions in lesions in these surfaces were still at the maximum. Caries reductions on fissures and pits, however, are less than that on proximal and smooth surfaces. This difference in caries-preventive effect of water fluoridation in regard to the various surfaces is of practical importance. The larger caries reduction for smooth and proximal surfaces than for occlusal surfaces, will result in an easier treatment of those cavities which do arise.
(b) Dietary Supplement of Fluorides

In areas where communal water supplies do not exist, or where fluoridation is not yet in operation, or where the fluoride concentration in the drinking water is less than 0.7 ppm, alternative methods of fluoride administration should be considered. From a public health standpoint, home administration of fluoride is not a dependable substitute for communal fluoridation of drinking water, since the former requires an extensive period of exacting and intelligent co-operation in the individual household. However, there is now sufficient information regarding fluoride supplements and caries prevention to conclude that such supplements, when properly used, will reduce the incidence of caries in children.

In the study by Knychalska-Karwan and Laskowska, sodium fluoride tablets were administered daily for four years to 134 grammar school children in Poland. An equal number of control children matched in sex and age received no fluoride tablets. The local
water supply contained almost no fluoride. At the end of four years, the average values, with a tooth as a unit of caries, were 5.62 in the treated group and 6.10 in the control group. The average values with a tooth surface as a unit of caries were 12.43 in the treated group and 13.02 in the control group. Judged by loss of teeth due to caries, the average values were 15.03 in the treated group and 15.55 in the control group. The study shows a negative correlation between fluoride tablets and a reduction in caries. A similar finding was obtained by Kamocka et al, who showed that the def rate of pre-school 6-year old children who had received fluoride tablets daily for three years was not significantly different from the def rate in a control group who had not received a dietary supplement of fluoride tablets. Among the 7-year olds, however, the D.M.F. rate in permanent teeth was 0.36 in the experimental group, compared with a D.M.F. rate of 0.9 in the control group. This is significant. The only significant finding Stones et al were able to show in their study was a reduction in the incidence of new caries among boys in the group
receiving a tablet daily of sodium fluoride. This study was conducted on 250 children aged between 3 and 14 years in the National Children's Home at Fordsham. One tablet of sodium fluoride daily, with a fluorine content of 1.5 mg, was given the children in the experimental group.

Ziemnowicz-Glowacka, in an extensive study, used 4,434 children aged between 3 to 5 years of age. One half of this group serving as the experimental group, received sodium fluoride tablets, while the other half in the control group did not. At the end of two years, the experimental group had 38.5% less caries than the control. This difference went up to 42.4% at the end of three years of study.

In a comparative two-year study on 549 pupils aged 7-11 years, Grissom et al supplied one group of children with a sodium fluoride tablet containing 2.21 mgm sodium fluoride daily, during school term. This amounted to 180 tablets each year. Children of another group received a topical application of an
8% solution of stannous fluoride at 6 monthly intervals during the 24-month study period. The control group of children were issued with a placebo tablet daily, five days a week, for the two nine-monthly school years. The results show a reduction of 34.1% in D.M.F.S for the fluoride tablets group and 16.2 for the topical stannous fluoride group.

In a similar study De Paola and Lax conducted, over two school years, a double blind study on 327 children in a non-fluoridated area. Children in the experimental group were given a chewable fluoride tablet daily containing 2.2 mg sodium fluoride and 70 mg sodium biphosphate. At the end of the study period, there was an overall caries reduction of 20-23% in permanent teeth. These children also had a two to one advantage in caries reduction in the teeth erupting during the course of the study. These two studies conducted during school terms confirm the belief that systemic sodium fluoride need not be taken continuously the year round in order to provide a significant degree of caries protection.
Sodium fluoride has been combined with various vitamins to test for its efficacy in caries prevention. In a three-year study by Pollak in North Rhine, Mulgatum F tablets containing 1 mg fluorine were given daily to 500 kindergarten pupils and 500 school children aged 6-7 years. One thousand children of the same ages served as controls. Each child received a bitewing examination as well as a clinical examination at the initial visit and thereafter annually. One year after the initial administration of fluorine tablets, there was 24% less dental caries when evaluated by the def index in the experimental group than in the control group. After three years, the difference between these two groups increased to 38%. The newly formed cavities were also less serious in the experimental group than in the control group. Mulgatum F tablets contain sodium fluoride together with vitamins A (cod liver oil), D (egg yolk) and E (wheat germ oil).
These findings were confirmed by Hennon et al.\textsuperscript{61} In this study, a series of vitamin products containing sodium fluoride were given to one group of children, while another group of children received the same vitamin products but without fluoride. After 36 months of product usage the after deft and defs values were 6.81 and 12.38 for the control group and 3.04 and 4.56 for the experimental group. This is a reduction in dental caries prevalence of about 55 per cent in teeth and 63 per cent in surfaces for the primary teeth. In permanent teeth, average D.M.F.T. and D.M.F.S. values were 2.57 and 4.30 for the control and 1.65 and 2.47 for the experimental subjects. This represents a reduction in dental caries of about 36\% in teeth and 43\% in surfaces for the permanent teeth.

Alternative means of providing fluoride to the teeth with the use of different vehicles have been tried and advocated. Fluoridated milk and fluoridated table salt are two notable methods of supplying fluorides. In the study by Kopel,\textsuperscript{62} for instance, 1 mg of fluoride was added to half a pint
of milk and this was provided to children aged 6-10 years of age with the school lunch. He claims to have achieved an 80% reduction in the incidence of dental caries. Similarly, Rusoff et al.⁶³ in their study over four years reported a marked reduction in caries incidence in cuspids and bicuspids in children who received milk containing 1 ppm of fluoride.

Muhlemann⁶⁴ feels that there is no clinical evidence to support the addition of fluoride to milk. It would appear, however, from the studies conducted by the Americans and the Swiss, that a professionally supervised programme of providing fluoride with milk to children seems feasible. Nevertheless, at the present, milk fluoridation cannot be recommended without restriction.

Domestic salt, fluoridated to an appropriate level, has been on sale in some countries for several years. However, little data can be found in the literature about this method of fluoride supplementation. In a five year clinical study on 662 children aged 8
to 14 years of age, Marthaler\textsuperscript{65} was able to show only a small reduction in dental caries. The level of fluoride in the salt used was 280 mg sodium fluoride per kilogram sodium chloride. He feels that the reason for this slight reduction in caries obtained in the study was due to an insufficient amount of fluoride ingested in the salt. Hardwick\textsuperscript{66} is of the opinion that the pattern of caries reduction with fluoridated salt closely follows that observed with water fluoridation. Thus, approximal and bucco-lingual surfaces show the greatest reduction and occlusal surfaces the least. He feels that this method is not as effective as fluoridation of water supply, the reason being the lower fluoride intake with fluoridated salt.

As marketed in Switzerland, the level of fluoride in the salt probably provides a mean daily supplement of 0.5 mg for an adult Swiss. This is a low level of fluoride intake. It may be that in the future the level of fluoride in salt may be raised with reasonable safety. A pre-requisite before this can be done is the need for more precise
information about the variability in the consumption of domestic salt. For the present, this method cannot be considered to be satisfactory. Fluoridation of domestic salt, however, has three advantages:

(1) Freedom of the individual to accept or reject this preventive measure.

(2) The slight effort it demands of the patient in following the regime.

(3) Its extreme cheapness.
(c) Topical Fluoride Therapy

Topical fluoride application is a well accepted and widely practised method of providing additional protection against dental caries to the child patient. Innumerable studies and experimentation on this particular aspect of fluoride therapy can be found in the literature. It will not be possible to review all the various approaches to the question that have been attempted and advocated by the different proponents. A review of a few of these studies will be made in this section.

The first topical fluoride agent to be used was sodium fluoride. One of the first clinical studies was by Knutson, who described a particular method of application. Knutson's technique of topical application of sodium fluoride consists of four steps:

1. The teeth are given a thorough prophylaxis using a motor-driven rubber cup and pumice.
2. The teeth are isolated from saliva by cotton wool rolls.
3. Compressed air is used to dry the isolated teeth.
4. Application of the 2% sodium fluoride solution which should wet all surfaces including interproximal surfaces. The applied solution is allowed to dry in air for about three minutes.

The second, third and fourth applications are made at intervals of one week. A prophylaxis before these applications is not necessary. It is suggested that a series of applications be given at ages of 3, 7, 10 and 13 years.

With the use of a 2% solution of sodium fluoride 20-40% reduction in caries of permanent teeth in children in non-fluoride areas can be expected. Various clinical studies have come up with confirmatory results. Hewat and Rice used the half-month technique on 97 children aged 5-13 years. At the end of one year, they obtained reductions in caries of 18.8% in D.M.F.T. and 36.4% in D.M.F.S. Harris, using the whole month technique on 429 children aged 6-11 years, obtained a reduction of 33.4% in D.M.F.T.
The beneficial effect of sodium fluoride on deciduous teeth has been shown to be minimal. In fluoride areas, results obtained have been negative. On adults, no effect can be expected with the use of sodium fluoride.

With the success obtained with sodium fluoride, a search was made for other related agents which would be easier to use and yet still be as effective in the partial prevention of dental caries. One such agent which has attracted great attention is stannous fluoride. Dudding and Muhler\textsuperscript{70} recommended in their technique the application of the freshly mixed stannous fluoride solution to the isolated, dried teeth. Timing of the treatment to be started only after the teeth are completely saturated with the solution. The teeth must be kept wet at all times with the stannous fluoride solution for four minutes with repeated applications. Use of a stop-watch or timer is suggested. At the end of the four minute period, the patient is allowed to expectorate but not to rinse. The patient is reminded
not to drink, rinse or eat for thirty minutes. With this technique, it is important that the operator should treat no more teeth at any one time than he can keep free of saliva.

Howell et al\textsuperscript{71} in their study on 194 children aged 6-16 years in a non-fluoride area obtained caries reductions of 83.1\% in D.M.F.T. and 58.8\% in D.M.F.S. after two years. Using the whole mouth technique with prophylaxis, a two per cent solution was applied for four minutes during each of four applications. Mercer and Muhler\textsuperscript{72} reduced the number of applications to one with the use of an 8\% solution. They were able to obtain caries reductions of 50.0\% in D.M.F.T. and 51.0\% in D.M.F.S. on 154 children aged 6-14 years. Subsequent studies have shown that not only is one single application sufficient to obtain satisfactory results, but that the length of the application can be reduced to 30 seconds or even 15 seconds. Topical stannous fluoride application has been shown to be effective in optimal fluoride areas as well. On 232 children aged 6-17 years, Muhler\textsuperscript{73} obtained reductions of 35.0\% in D.M.F.T. and 36.0\% in D.M.F.S., with the use of an 8\% solution.
The effectiveness of stannous fluoride has been shown to be increased with the addition of soluble phosphates, by Muhler et al.\textsuperscript{74} About 250 children between the ages of 6 and 13 years received a single one minute topical application of a freshly prepared solution of 8% stannous fluoride and 2% sodium hydrogen phosphate. Reductions in caries obtained at the end of twelve months were 84.9% in D.M.F.T. and 80.1% in D.M.F.S. In another comparable group of 250 children, using the stannous fluoride solution only, the caries reductions obtained were 51% in D.M.F.T. and 52% in D.M.F.S.

Fluoride dentifrices are now widely used and a minimum of 20% reduction in caries can be expected from regular use. Fanning et al.,\textsuperscript{75} in a two-year study on 2500 children aged 12-14 years in Adelaide, tested the effectiveness of two separate dentifrices. One of these contained 0.4% stannous fluoride and the other 0.76% sodium monofluorophosphate. The results,
based on clinical and X-ray examinations, were a reduction of 27% in D.M.F.T. and 21% in D.M.F.S. There was no difference in the effectiveness of the two agents. Stannous fluoride caused significantly more staining of the tooth surfaces. Moller et al.\textsuperscript{76} obtained almost similar findings in their study on 678 children aged 10-12 years. The results from this double-blind study show that fluoride dentifrice reduced the caries incidence by 18.9% in D.M.F.S. over thirty months. In a long study over 7 years, Marthaler\textsuperscript{77} used a dentifrice containing two amine fluorides (fluoride content of 0.125%). He obtained caries inhibition of 32% in D.M.F.S. and 28% in D.M.F.T., based on clinical and X-ray examinations. The findings from these studies would suggest that the home use of fluoride dentifrices should be recommended.

In the study by Bullen et al.\textsuperscript{78} an acidulated fluoride-phosphate solution was applied by means of a tooth-brush by the patient. Six year old children were divided into the control or experimental group,
with the control group receiving a placebo solution. At the end of one year, during which period there were five supervised brushings, the experimental group had 38.5% less new carious lesions than the control. In a similar study by Goaz et al.,\textsuperscript{79} children aged 6-14 years brushed a 6% mono-fluorophosphate solution on to the teeth daily and unsupervised. They were told to continue their usual brushing habits, but not to use a dentifrice containing a fluoride or have a topical fluoride treatment during the period of study. At the end of 21 months, a reduction of 50% was obtained.

Multiple fluoride therapy has been steadily gaining prominence in the last few years. In fact, at the present time many workers in the field of multiple stannous fluoride treatment are of the opinion that it comes close to the goal of complete caries protection. Bixler and Muhler\textsuperscript{80} in their study in a non-fluoride area used a compatible lava-pumice-stannous fluoride prophylactic paste, an aqueous solution of stannous fluoride for topical
application and a stannous fluoride-calcium pyrophosphate dentifrice for home use. They obtained, after six months of treatment, 88.8% reduction in D.M.F.T. and 97.4% reduction in D.M.F.S. in children aged 6-14 years. Gish and Muhler\textsuperscript{81} in a similar study on children aged 6-14 years born and raised in an optimal fluoride area obtained comparable high reductions of 83.5% in D.M.F.T. and 89.2% in D.M.F.S. Perhaps the most dramatic findings in this regard are those by Scola and Ostrom,\textsuperscript{82} from their study on 650 Navy personnel aged 20 years. They used a combination of 17.5% stannous fluoride lava-pumice prophylaxis paste, 10% aqueous solution for topical application and a 0.4% dentifrice for home use. At the end of two years, the percentage of subjects in the experimental group who had no new D.M.F.T. was 70%, as compared to 32% in the control. The percentage of subjects who had no new D.M.F.S. was 37% for the experimental group and 6% for the control. The percentage of subjects who had more than three new D.M.F.T. was 5% in the experimental and 10% in the control. For D.M.F.S., it was 29% in the experimental and 64% for the control. One
very striking finding is that, in the subjects who received the combination of the three agents, there is no difference in results, whether the topical fluoride was applied for 15 second or for 4 minutes.

Mouth-washes that contain fluoride are a popular method of topical application of fluoride in Sweden. Torell and Ericsson\(^8\) made a two year study on various methods of fluorine application. Ten year old children of Goteburg, where the drinking water contained less than 0.3 ppm of fluorine, constituted the study group. The rate of caries of this group was high. Applications as mouth-rinses were performed either daily and unsupervised with a 0.05% sodium fluoride solution, or fortnightly and supervised with a 0.2% solution. For the unsupervised rinsing, 10 ml of the solution was used every evening after toothbrushing. The fortnightly mouth-rinses were performed at school, and were supervised by specially trained dental nurses. The rinsing lasts for two minutes and the children are asked not to eat or drink for at least half an hour.\(^8\) At the end of two years, it was found that
the daily mouth-washing group had acquired significantly fewer new D.M.F.S. than any of the other groups. Significant caries reductions were also obtained in the groups given mouth-washes with a 0.2% sodium fluoride solution fortnightly or four topical applications of a 2% solution of sodium fluoride. The difference between these two groups was insignificant.

A new concept in fluoride therapy has been proposed by Muhler with his method of self-application by the patient using a new prophylactic stannous fluoride-zirconium silicate paste. In this study, which was on school children, each child was given 5 grams of the anticariogenic paste. Under the supervision of the dentist or hygienist, the children applied the paste to each quadrant by means of a toothbrush, using a suggested brushing technique. No rinsing was allowed before brushing of a quadrant was completed, though there was no restriction on expectoration. The results at the end of one year, in a non-fluoride area, was a mean increment of 2.43 D.M.F.S. in the experimental group and 6.63 in the control group. This was a caries reduction of 63.3%.
In the optimal fluoride area, a caries reduction of 35.0% over and above the effect produced by the benefit of the children using the fluoridated water was obtained. These results were based on clinical and X-ray examinations and would suggest that this technique was effective in reducing quite markedly the incidence of dental caries. A big advantage of such a method is the saving of chairside time and the fact that it could be applied as a "mass" treatment technique. From the public health point of view, such a method can be a great asset in preventive programmes for a community.
4. Other Agents

(a) Ammonia and Urea Compounds

These are agents that have active ammonia compounds or compounds that are converted into active ammonia in the mouth, resulting in less acid being formed in the dental plaque. A great number of clinical trials were conducted on these compounds. Grove and Grove, using Snyder's colorimetric method, with glucose-agar as the medium and brom-cresol green as the indicator, showed the inhibitory effect of the ammonia on the activity of lactobacilli. They were also able to show the solvency of salivary mucin in an ammoniacal solution comparable in strength to that found in the mouth. They feel that if ammonia can be present in saliva in sufficient quantities to keep the salivary mucin in solution and to inhibit the growth of lactobacilli, it could be a means of reducing the incidence of dental caries.
Wach et al.\textsuperscript{87} in their clinical study on more than 70 patients used a solution of quinine-urea, which was used as a mouth rinse three times a day. They found that in every instance the total bacterial count was markedly reduced after the rinse had been used for fourteen days, but rose again sharply after the rinse had been discontinued. They also found that the salivary pH rose and the amount of total titratable acidity fell approximately 50\%. These clinical findings were confirmed by Kesel et al.\textsuperscript{88} who investigated the use of dibasic ammonium phosphate as a mouth rinse and a dentifrice in caries active persons. They were able to show a marked reduction in the salivary lactobacillus counts. A further observation of this study was that the teeth were notably free from materia alba and bacterial plaques.

Various investigations were also carried out to study the effect of these agents on caries prevention. Kerr and Kesel,\textsuperscript{89} in a two-year study involving more than 1700 children in the 10–11 year age group, tested the effectiveness of brushing with
an ammonia-urea combination dentifrice containing 5% dibasic ammonium phosphate and 3% urea. Brushing of the teeth was done in the classroom and was under close supervision. They found that in the experimental group of children there was a 16.7% reduction when compared to the control group. In a similar study on the supervised use of a high-urea ammoniated dentifrice, Cohen and Donzanti produced confirmatory results on children aged 9-13 years. Their findings show that the average number of new carious lesions in the experimental group of 169 children after two years was 1.70, compared with the average of 2.27 new lesions in the control group of 137 children. This represented a reduction of 25.2% in new carious teeth in the experimental group. Henschel and Lieber were able to show a high average caries reduction of 37.5% from an unsupervised use of a 27.5% ammonium dentifrice by the experimental group. These results were obtained after the dentifrice had been used for over 35 months. They point out, however, that some proportion of the apparent caries reduction may be attributed to enthusiastic oral hygiene heightened by the knowledge of the possible therapeutic benefit of the dentifrice.
Davies and King, 92 at the end of a two year study on 401 high school children and young adults, found that there was no significant difference between the lactobacillus counts of the control and the experimental groups. They were able to show that the unsupervised brushing with an ammonium ion tooth-powder failed to reduce the annual increment of dental caries when compared with the control group. They went on further to state that any evidence in favour of an ammonium ion dentifrice must be viewed with some circumspection.
(b) **Antibiotics**

The use of antibiotics in the prevention of dental caries was based on the known fact that these agents kill bacteria. Thus, the assumption was that they should destroy bacteria that produced acid in the dental plaque. Although results from animal studies were impressive, human studies produced inconclusive findings. Today antibiotic dentifrices are not available commercially because it has been shown that some people may become sensitized by the small amount of penicillin in the dentifrice, making it dangerous, and in some cases fatal, to use the drug when it is critically needed.

Webman et al,\(^9\) in a study on rats, added 5 units of penicillin per cc of water supplied for drinking. At the end of 110 days, 70% of control rats and 50% in the experimental group developed caries. When weighted value was given to the carious lesions on the basis of tooth structure destroyed, the control rats had a weighted value of 0.154 and the experimental 0.135.
McClure and Hewitt\textsuperscript{94} fed experimental rats with a caries-inducing diet of corn-meal containing 75 units of penicillin per gram and supplied drinking water containing 75 units per ml. Matched litter mates served as the control group, and these rats received no penicillin in the same diet. After 125 days, it was found that 50% of the control rats had carious teeth, whereas rats on the experimental diet had no carious lesions.

Stephan et al\textsuperscript{95} compared the effectiveness of penicillin, bacitracin, aureomycin, chloromycetin and streptomycin in reducing experimental dental caries in the albino rat, by adding them to a coarse particle diet. Penicillin at a concentration of 50,000 units per cent was most effective, followed by bacitrocin (5,000 units per cent), aureomycin, chloromycetin and streptomycin. The last three agents were used at the level of 50,000 micrograms per cent.

In animal studies, tetracycline has been found to reduce dental caries activity. This has been found to be true not only when the tetracycline was administered post-eruptively, but also when fed to
the mother animals prenatally and in the pre-weaning period, dental caries in the offspring is reduced. Zipkin et al.\textsuperscript{96} added 2.5 mg tetracycline per ml in the drinking water of pregnant caries-susceptible rats during the following periods:

(1) Gestation.

(2) Gestation and 14 days of lactation.

(3) Conception to weaning.

The offspring were fed a caries test diet and distilled water for 60 days. All the rats whose mothers had received tetracycline showed a marked inhibition of caries.

Human trials that had been conducted were in the main concerned with the efficacy of penicillin dentifrice as a caries preventive agent. Fitzgerald and Zander,\textsuperscript{97} in their investigation on the effects of a penicillin dentifrice on oral lactobacilli, found that the salivary lactobacillus counts of children using a penicillin dentifrice for a year and a half, and the control group using the same dentifrice without penicillin, showed no differences. They also found that the incidence of penicillin-fast lactobacilli was not significantly greater in the group using the penicillin dentifrice.
Zander\textsuperscript{98} tested the effectiveness of penicillin in reducing clinical caries in school children aged 6-14 years. He used a tooth-powder containing 500 units of potassium penicillin per gram of tooth-powder for the experimental group. At the end of the study, he found that the daily use of the penicillin dentifrice reduced considerably the incidence of dental caries, with reduction of 59.6\% in D.M.F.S. obtained. He mentioned that the only adverse effects found were dryness and cracking of the lips at the corners of the mouth. Hill and Kniesner\textsuperscript{99} obtained a negative result in their experiment on 240 institutionalised children aged 8-15 years, despite the use of a tooth-powder containing a higher level of penicillin of 1000 units per gram. At the end of the study, they were not able to show any significant difference in the number of new carious surfaces or in the progress of existing carious teeth.

Studies are being carried out both in the United States and in Australia to investigate the dental caries activity of human subjects who have been receiving antibiotic therapy over long periods,
particularly those with rheumatic heart disease, to determine the effects of antibiotics on both flora and caries activity. The results of these investigations when they are finally published should prove interesting and perhaps antibiotics will have a new role to play in the light of these findings.
(c) **Anti-Enzymes**

The next group of anti-cariogenic agents to be tried, after the ammoniated agents and antibiotics in that order, were the anti-enzymes. These anti-enzyme dentifrices were thought to act in a manner similar to the antibiotic dentifrices in principle. However, instead of interfering with bacterial growth they were thought to effect the enzyme systems required for the breakdown of foods by bacteria to form acids. There is very little clinical evidence of their effectiveness in the literature, and interest in them today can be said to be merely academic. The Council of Dental Therapeutics of the American Dental Association has stated that there is not sufficient clinical evidence available upon which to make an adequate evaluation of these dentifrices.

Zipkin and McClure,\textsuperscript{100} using white rats, studied the effect of sodium lauroyl sarcosinate and dehydroacetic acid on sulcal caries induced by a cornmeal-sugar diet and on smooth surface caries
induced by an autoclaved skim-milk powder diet. They found a significant reduction in the severity of carious lesions of the occlusal sulci from an addition of 0.5% of the sarcosinate. Carious lesions on both the lingual and buccal surfaces were also significantly inhibited. Dehydroacetic acid, however, had no effect on incidence of sulcal caries and only a potentiating effect on the severity of buccal and lingual caries.

Frasher and Hein conducted a 27 months investigation on three hundred and sixty-five Mexican children. The 181 children of the experimental group, with an average age of 8.23 years, were supplied with a dentifrice containing 2.0% sodium-N-Lauroyl sarcosinate as the detergent. The 184 children of the control group, average age 8.35 years, were supplied with a dentifrice containing as a detergent a 2.0% sodium salt of sulphated glyceride of coconut fatty oil. They noted a significant reduction in the incidence of dental caries. In terms of D.M.F.T., there was a 48%
reduction and in D.M.F.S., 43%. However, the drinking water of the area had 0.9 ppm natural fluorides, and the reductions obtained could have been from the fluorides in the drinking water.

In a similar study, Brudevold et al.\textsuperscript{102} found that there was no detectable acid reducing effects, after the subjects had brushed their teeth for one week with a dentifrice containing 2% sodium lauroyl sarcosinate. Weill\textsuperscript{103} in his study on the activity of enzymes in the pathogenesis of dental caries concludes that the mechanism of enzymatic activity, depolymerising the carbohydrate-protein complex of carious dentine, has not been determined. It is therefore not justified to incriminate the enzymes for swelling, softening and final solution of the ground substance of carious dentine. He says, however, that it seems possible that the use of specific anti-enzymes could be an effective method of changing the bacterial flora, thereby interfering with the enzymatic assimilation of micro-organisms suspected as being caries producing or promoting factors.
5. **Tooth-brushing and Oral Hygiene**

Dental caries and most periodontal diseases are caused by micro-organisms associated with food debris, plaque and calculus. Despite this fact, it is probably true to say that instruction in oral hygiene is rarely given and when it is given, is more often than not thrown in as a perfunctory formality. Yet there is no single service that a dentist can render his patient which is more important in the long run. This is because toothbrushing is generally accepted as an effective method for the treatment and prevention of dental diseases. The two most important benefits of proper tooth-brushing are cleaning of the teeth and gingival massage.

Many tooth brush designs and various tooth-brushing techniques have been advocated. Although each has its disciples, thoroughness of brushing rather than technique or the type of brush used determines the results of tooth-brushing. However,
whichever the technique preferred, it should be simple and not prolonged. This is because the difficulty in carrying out an intricate method results in many patients becoming frustrated, ending in the instructions not being followed.

Manson and Forrest recommend a small-headed medium nylon multi-tuft brush in the average mouth. Each quadrant may be divided into three sections: posterior, middle and anterior. Brushing starts at the most posterior tooth. The side of the brush must be placed firmly against the buccal aspect of the teeth and gingiva, with the back of the brush at the level of the biting surfaces of the teeth. Then the brush is rotated (down in the upper jaw and up in the lower jaw) so that the side of the bristles firmly sweeps the surface of the tooth and gingiva. The points of the bristles are not used. The brush must be used as a broom and not as a scrubbing brush. Eight strokes are given to the buccal aspect and then to the lingual. The brush is moved methodically from one section to the next. Anterior palatal and lingual surfaces in narrow arches may be cleaned with the brush held vertically. When all buccal and lingual surfaces
are brushed, the biting surfaces can be cleaned with a rotary movement. Complete brushing of both jaws will therefore take about two hundred strokes.

Information on oral hygiene matters and instruction in proper toothbrushing should be given to the patients by the dentist in his practice. There appears to be great ignorance among the public in this field. This ignorance is vividly shown in the study by Fanning and Henning\textsuperscript{105} on the toothbrushing habits of 615 adult Australian dental patients. They found that the cleaning pattern was once daily in 23% of the group. Another 59% brushed their teeth twice daily, and 18% more than twice daily. There was a lack of relationship between eating and cleaning. Consideration of all daily toothbrushing occurrences shows that 54% of cleaning is performed in relation to rising and retiring. Very little attention seems to be paid to cleaning after the mid-day or evening meals. The point to note in this study is that the study group consisted of regular patients from whom one would have expected a better knowledge and practice of oral hygiene.
Toothbrushing has been shown to decrease acidogenic micro-organisms in the oral cavity. In the study by Toto et al.,\textsuperscript{106} one group of 193 school age children received instruction in a chosen technique of toothbrushing while 89 children in the control group received the same toothbrush but no toothbrushing instructions. Using Snyder's test, it was found that acidogenic micro-organisms were significantly reduced in the oral cavity after toothbrushing and that this was obtained without the aid of any dentifrice. One other significant finding of this study was that the uninstructed control group had a greater quantity of debris on their teeth before brushing than did the instructed group. Furthermore, children in the instructed group had less debris in their mouths after brushing than did children in the control group.

Hitchin et al.\textsuperscript{107} examined 2905 Dundee school children. This group was from a random sample obtained from school registers, by taking those born within the first ten days of each month who would be thirteen years of age at the time of the
examination. They were questioned about tooth-brushing habits, their oral hygiene was assessed by a modification of Greene and Vermillion's methods, and the numbers and distribution of decayed, missing and filled teeth were noted. One third of the children stated that they brushed twice or more per day and one third brushed less than once a day. Girls brushed more than boys and tended to have cleaner mouths. A highly significant correlation between frequency of brushing and oral hygiene was shown. Also children with better oral hygiene had fewer D.M.F.T. than those with poor oral hygiene.

These observations were also obtained by Muhler. In his investigation on 112 boys and 136 girls in high school aged between 13-14 years, he found that the boys had an average frequency of eating 7.1 times a day. They brushed on the average of 0.6 times a day for an average of 40 seconds. The girls had an average of frequency of eating 6.2 times a day, and brushed their teeth 1.1 times a day for 72 seconds on the average. The caries
prevalence for the boys was 13.25 and for the girls 11.10, using the D.M.F.S. index. From these findings, Muhler feels that more frequent toothbrushing can help reduce the incidence of dental caries.

In the only study of its kind ever recorded in the literature, Fosdick\textsuperscript{109} observed a reduction in dental caries of 50\% by a regimen of after-meal brushing using a non-therapeutic dentifrice, when compared to another group not practising similar brushing habits. Although these findings have not been corroborated by any other worker, present day knowledge and understanding of the caries process suggests that such a procedure could be effective.

An interesting study by Elliott\textsuperscript{110} showed that even in the same individual there was a difference in the cleaning by the toothbrush, in different areas in the mouth. Basic fuchsin disclosing agent was used to discolour the teeth of ten male freshmen dental students before the commencement of brushing. He was able to show that:
(1) The larger the amount of stain on the teeth, the greater the number of stain units removed in toothbrushing.

(2) The effectiveness of toothbrushing was significantly greater on the facial surfaces than on the lingual surfaces.

(3) The effect of toothbrushing was significantly greater for the maxillary teeth than for the mandibular teeth.

(4) There was no significant differences in cleaning when comparing left and right quadrants of both jaws.

Ever since electric tooth brushes were introduced some years ago, the use of these appliances has steadily increased. While it is difficult to say one way or another about the usefulness of these brushes, it can be said that these products lessen the physical effort required for proper toothbrushing. Ash et al. in their evaluation of manual and motor-driven toothbrushes found that on the average these brushes were equally effective. In some individuals
the electric brush was more effective, while in other individuals the manual brush was more effective.

This seems to be the view also of Farleigh,¹¹² who says that an electric toothbrush is no more or no less effective than a conventional manual brush. He goes on to say, however, that an electric toothbrush provides the same result in far less time than the manual type. Since patients are more likely to co-operate in a programme of oral hygiene if the time required is not too long, an electric toothbrush should make adequate home care more feasible.

Conroy,¹¹³ in his comparison of the cleansing effectiveness of an automatic and a manual toothbrush, concludes that the automatic brush is superior, since more plaque is removed with the use of an electric brush. This finding is corroborated by what would appear to be a very significant study. Derbyshire and Mankodi,¹¹⁴ in a clinical comparison of the cleansing effectiveness of a manual and an electric toothbrush, chose as their subjects a group of
students of dental hygiene. They found that the electrically powered brush was superior to the manual brush in overall cleansing effectiveness. It is noteworthy that the subjects in this study provided a rigorous test for comparison of the two types of brushes, as these girls were thought to be the best motivated and trained group in the use of manual brushes available. That the electric toothbrush was proved superior in this select group of subjects emphasises its potential value for the general population. Perhaps this potential can be fully realised by developing a systematic brushing technique with the electric toothbrush.

Many dentists recommend the use of a disclosing agent in order to aid a person's ability to brush the teeth in the most efficient way. These disclosing agents are also particularly useful in patients who do not have a proper toothbrushing habit or who are indifferent to good oral hygiene. The dental plaque is light coloured and well nigh invisible. Disclosing agents, however, are highly coloured and will stain the areas on the teeth where plaque accumulates, so
that the patient may learn or be shocked into brushing such areas carefully.

Many substances can be used for this purpose. Four drops of 6% basic fuchsin in a tablespoon of water, rinsed for 30 seconds, followed by a rinse with plain water to wash away the excess, will stain plaque and debris red. Basic fuchsin has been put out commercially in lozenge form. Although very effective for staining plaque, such mouthwashes or lozenges also stain the tongue and lips, and their use may not be tolerated by the patient. In such cases, iodine solutions applied to the teeth are effective disclosing agents and may be more acceptable to the patient. Even simple tincture of iodine which most people have in their home medicine cabinets makes an acceptable disclosing agent.

Henning and Fanning\textsuperscript{115} feel that the use of disclosing solutions allows patients to evaluate the standard of care in their own homes. This
opportunity for self-appraisal by the patient promotes more interest in the results of cleaning, leading to better oral hygiene habits.

Thus it can be said that with the use of disclosing agents, an apparently clean mouth may frequently be shown to have masses of plaque covering the teeth. This can create quite an impression on the patient on the need for a good oral hygiene habit.

It may not always be possible or convenient to brush one's teeth after each meal. Coykendall advocates vigorous rinsing of the mouth after eating whenever it is not possible to use the toothbrush. Using urine sugar test tablets, he found that after eating one candy orange slice most individuals' first rinse contained 0.15 to 0.3 grams of sucrose. This is equivalent to a 1 to 2 per cent solution. The second and third rinse showed greatly reduced sugar concentrations. By the fourth and fifth rinse most subjects had no detectable sugar in their rinse
water. These tests have indicated that three or four rinses immediately after eating can eliminate appreciable amounts of retained sugar. It would appear from this study that this is a beneficial measure which could be adopted by an individual as part of his oral hygiene habit. It is a fact that in 1963, the American Dental Association began offering educational material advising oral rinsing after eating, whenever brushing was impossible.
6. Dental Health Education

Dental health education may be defined simply as the provision of dental health information to people in such a way that they apply it in everyday living. The important word to note in the definition is "apply", because mere knowledge is not enough. There needs also to be a motivating influence sufficiently strong to change behaviour, if dental health education is to be effective. The need for motivation shows up in attitude surveys in the United States which have revealed that close to 90% of the adult population believe that they should see the dentist at least once a year, whereas only one third do. It is clear that there is a great deal of known or perceived need in dental care which is not acted upon. Hence motivation should be one of the main objectives of dental health education.

Sandell\textsuperscript{117} says that the purpose of dental health education is to effect change in the behaviour of the individual so that improved dental health will result. Simply knowing what to do is not enough.
The knowledge must be translated into effective action or behaviour. All behaviour is motivated. Motivating people to develop proper attitudes towards dental health and to practise acceptable dental health procedures is not easy. The prevention and control of dental diseases depends on what the individual can and will do for himself. Very often, what he must do is time consuming, interferes with his usual way of life and may be expensive and even painful. He suggests that dental health education should aim to bring about a higher level of appreciation for good dental health in the individual. This is because an individual's scale of values will influence his health behaviour. He will do those things first and buy those things first which to him have greatest value. Therefore, if certain luxury items are higher on an individual's scale of values than dental care, then it is possible that dental health could be neglected.
Teutsch\textsuperscript{118} feels that both the child patient and the parent must be motivated to act favourably on the knowledge they have received. He suggests that with a child, the objective should be to build up in him a sense of "tooth pride" and the parent be motivated to want the prescribed treatment and the programme of preventive dentistry for the child. He goes on to say that dental health education is the very foundation of good dentistry and is an obligation that every dentist has to his patients. Anderson\textsuperscript{119} is of the opinion that motivation of the child patient could be achieved by the sense of aesthetics and good grooming as well as by certain health standards. He points out that people's health practices are embedded in the social matrix of their particular societies. Thus, dentists need to learn more about the relationship of the group to the individual, if they are to achieve the best strategy in the control and prevention of dental diseases.

A motivational study of dental care was conducted for the American Dental Association\textsuperscript{120} by social scientists. 'In depth' interviewe
conducted, in which the subjects were encouraged to talk freely about their feelings on dentistry and dentists. The report concludes "dental health requires considerable redefinition in the public mind. Dental care at present is largely defined as a serious, demanding, uninteresting and repetitive experience. There is little notion of reward connected with it, but much of punishment. These types of association need to be altered and in their place emphasis given to the favourable implications of pleasant and rewarding personal and professional dental health practices. The basic rules of good dental care are well understood by almost all people. Since this knowledge is better known than acted upon, the objectives are now to give more impetus to carrying through on these rules."

The methods of presenting dental health education can be divided into two general headings:--

1. Personal or face-to-face education.
   The outstanding example is the treatment situation in the surgery. Included in this category are lectures, talks, and
discussions given to associations, organisations and school children.

2. Indirect method of education:
This refers to the various audio-visual aids like models, posters, charts, slides and feature films. It includes the mass media - pamphlets, newspapers, radio and television.

In the clinic situation, every practising dentist has a golden opportunity to participate positively in advancing the aims of dental health education. He has this opportunity at the time when education can be most vital and valuable. Renson\textsuperscript{121} says that the man-in-the-street's idea of dentists and dentistry is governed not so much by what he reads, or hears, or sees in the news media but by the individual practitioner or practitioners he comes into contact with. To him, the practitioner is dentistry. It is therefore incumbent upon every practitioner to cultivate the art of communication with the patient. The busy dentist may feel that he simply has not the time to answer questions or pass
on dental health information. He may feel that a little knowledge is a dangerous thing and that the less the patient knows the better. In taking this attitude, he ignores the fact that the public is more sophisticated today and in withholding information, he may be creating ill-will.

A symposium on dental health communication was held in 1965 at the Ciba Foundation, England. The purpose of the symposium was to obtain the opinion of experts in communication on current methods of dental health education. Cawson and Naylor in their summary of the proceedings at the symposium, report that one of the fundamental difficulties in trying to change public attitudes towards dental care is the widespread prejudice against dentists and fear of dentistry. The dental profession must consider the reasons for the public's attitude towards it, and seek ways in which this image can be improved. In the long run the feeling of the public towards dentistry is moulded by the skill and consideration with which dental practitioners handle their patients. The attitude of the public
towards dentistry is largely determined by the
dentists' own attitude towards their work. A
sympathetic and considerate attitude towards
the patient and an obvious interest in dental
health is a valuable form of dental health
education.

The important role of the individual
practitioner in dental health education is also
emphasised by Martin,\textsuperscript{123} in his investigation of
the dentist/patient relation. One of the con-
clusions of this study is "that the nature of the
relation between the dentist and his patient is
crucial for the effective performance of dentistry,
and for the advancement of dental health education
in the community. In general, this relation
leaves a great deal to be desired and, that because
of the present state of this relation, a number of
undesirable conditions have arisen in dental health
education".
Goulding\textsuperscript{124} considers the speaker's platform an important and highly effective medium for motivating the public and changing its attitudes. In this face-to-face communication, the dentist should play the key role. This means that we should have not only more planning and research on chairside education, but also we should concentrate much more on getting the dentists into the communication-pipelines of the community. One such major pipeline is the lecture or the talk delivered to parent groups, civic and fraternal organisations and classrooms.

Williford et al\textsuperscript{125} conducted a study aimed at measuring the effectiveness of a dental health education programme organised by a dentist to motivate high school students to practise proper oral hygiene. The study was made on two groups of high school students aged 13-15 years. The experimental group received six lectures given by a dentist who used slides, movies and textbooks, as well, to stimulate and encourage interest. The results after six months, or three months after the
education phase of the study, indicated that the experimental group compared with the control group showed an improvement of 38.9% in the oral debris index, 56.4% improvement in the calculus index, a 42.4% in the O.H.I.S. index, and a 75.1% in the P.I.

Johns and Muhler\textsuperscript{126} found that the loss of permanent teeth in Bloomington, Indiana, in children was reduced from 1948 to 1964. They feel that several factors were responsible and one of these was the institution of a dental health education programme. This was in the form of a series of dental health lectures for grade and high school children in Bloomington. At the end of the programme, the children were subjected to a quiz, "What is your dental I.Q.?" The average third grade child obtained a score of 80, whereas not until seventh grade did children in the control town of Indianapolis have comparable scores. Johns and Muhler feel that the teaching of dental health should be evaluated by dental I.Q. quiz, besides the comparison of the oral hygiene and gingival health before and after the course.
With the use of the various media in the promotion of dental health education, Hyde\textsuperscript{127} feels that the selection of the material most needed in a particular community is important. In his study on the parents of 200 children at a metropolitan health committee dental clinic in Vancouver, he asked these parents certain questions designed to discover some of their ideas on dental health. He found that only 3\% of the parents considered the primary teeth important for mastication of food. Also, 31\% knew the age at which their children would lose all their primary teeth, but the remaining 69\% thought their children would lose their primary teeth much earlier than the normal exfoliation age of 12 years. Parents of six year old children were often unaware that their children had permanent molars in their mouths.

Starkey\textsuperscript{128} evaluated four different methods of presenting dental health information to parents of patients. In this study, he separated 125 parents into five different groups:
Group I - read printed material

Group II - read the material and viewed slides illustrating the material

Group III - listened to a recording of the material

Group IV - listened to a recording and viewed the slides

Group V - control, received no information.

He concluded after testing the parents, that each of the four methods was of definite value in presenting dental health information. Also, that the simpler methods of presenting the information were just as effective as the more complicated ones.

With regard to the use of the mass media in dental health education, Goulding\textsuperscript{129} is of the opinion that they cannot be expected to change attitudes or to motivate people to a new course of action. Radio and television spot announcements are just brief reminders. They will remind people of
something about which they are already convinced. For example, the person who believes he should have regular dental treatment but has put it off may be reminded to make an appointment. However, a spot announcement may also provide new information if it can be presented simply and briefly. Where the need goes beyond the limitations of spot announcements, feature programmes can be used quite effectively in the dissemination of health information. In Boston, for instance, the dental society covered 100 years of dentistry in a thirty minute dramatic programme. In St. Louis, a series was televised for dentists, but it was found that the public was watching it and benefiting from it. Live broadcasts of oral surgical operations were televised in Milwaukee. In Detroit, the dental society had a weekly question and answer radio programme that went on for five years. A short film, "Pattern of a Profession", was shown on television in America 800 times in five years and was viewed by an estimated audience of 20 million people.
That the use of mass media and conventional methods of publicity do not change behaviour in health matters is shown up in the 1965 study at Canowindra, N.S.W. 130 A highly organised campaign of dental health education, which included the use of a special supplement in a women's weekly magazine, newspapers, radio and television, was instituted. Other methods of publicity employed, some of which can be said to be most imaginative, included an essay and a poster competition among school children. There was also a "Give-me-a-name" competition and the use of a cartoon figure with a suitable message. Labels incorporating this cartoon were stuck on milk bottles and poker machines. The cartoon was also used in car stickers and in adhesive tapes used in stores. The dental health practices, dental attitudes and dietary habits of Canowindra and another control town, were studied before and after the programme. At the end of the twelve months long campaign, it was found that there was no significant change in dental health practices in the Canowindra community.
III. DISCUSSION

The principle behind incremental care is a sound one as studies have shown. The feature of such programmes is the complete treatment of accumulated needs, with regular recalls for any maintenance work on new lesions that may arise. Such a system of recalls ensures that the oral structures are maintained in an optimum state of health, which is the objective of good dentistry. With the limited finance within which most public health departments have to operate, an incremental care programme can be introduced in a select group on a small scale initially. From this nucleus, the programme can be expanded gradually, according to the funds and trained personnel that become available. This was the policy adopted in Singapore when the school dental health programme started with the establishment of fixed clinics in a few selected primary schools. The service gradually expanded as each batch of about 20 dental nurses graduating each year from the Dental Nurses' Training School were added on to the pool of trained auxiliaries in the School Dental Service. Today in the 55 fixed school
clinics, 35 school dental officers and approximately 100 school dental nurses are providing free and complete dental treatment, including dentures and specialist treatment, to primary school children aged 6 to 12 years. Children requiring specialist services, such as orthodontics, oral surgery, or treatment of clefts, are referred to the two main school dental centres or the hospital clinic.

The use of fluorides in the prevention of caries is an established practice today. For community dental health programmes, fluoridation of the water supply is the method of choice because of the many advantages of this method. The level of fluoridation will vary from place to place as it is related to the drinking habits of the community, which in turn is related to the average annual temperature.

The point to note about the caries reduction that results from fluoridation is that most of this reduction is in the proximal and smooth surfaces, with occlusal surfaces showing the least protection.
This difference in protection of the various surfaces is of practical significance, since the cavities that do arise will be easier and will require less time to treat.

In Singapore the entire reticulated water supply, which serves the entire population of just over two million people, was fluoridated in January 1958. The level of fluoridation was set at 0.7 ppm. Baseline surveys in dental caries experience of Singapore, Malay and Chinese children aged 7-9 years were conducted in 1957. Preliminary reports show that 10 years after fluoridation, caries reduction in the deciduous dentition in both racial groups was 30.8%, as compared to the baseline data. In the permanent dentition, caries reduction in Chinese children aged 7-9 years was 38.6% and in Malay children 27.6%. Mild form of mottling was observed in 5% of the children.

Although it is well accepted that topical application of fluorides is effective in reducing the incidence of caries, it is unfortunately true
that this method of prevention is not widely used. One possible explanation for this is the time required with the Knutson's technique of four applications, each of four minutes duration. However, with the newer techniques using more concentrated solutions of 8% to 10% stannous fluoride, even one application of fifteen seconds duration gives significant caries reduction. This advance in technique holds much promise for a wider use of topical fluorides by the profession in general. In the Singapore School Dental Service, topical fluoride is not used to any great extent. In general, it is used in selected cases where there is a special need for added protection, like in cases with rampant caries. It would appear that in this preventive aspect, the dental nurses represent an untapped source of dental manpower, which could be used effectively in any future preventive programme that may be implemented. One recent technique which seems to have a particular application to Singapore is the self-administered stannous fluoride-zirconium silicate prophylactic paste advocated by Muhler. This technique allows for "mass" application.
In all primary schools in Singapore, there is in operation today a toothbrushing programme. Children from primary I to primary III classes, aged 6-8 years, perform daily brushings in school class by class under supervision. Children from primary IV to VI perform this tooth brushing once a week. Tooth brushes and mugs are supplied to each child at a nominal price. With this practice existing, a preventive programme using Muhler's self-applied prophylactic paste could easily be launched. There are, however, a few questions with the use of this paste which remain unanswered. Not the least among these is the question of safety, and until more studies have been undertaken, this method cannot be recommended.

The role of dental health education in the removal of impediments to the desire and acceptance of good oral health by the public is well recognised by the dental profession. Ample evidence of this recognition can be seen in the increasing amounts of energy and resources that are expended in dental health education activities. Help from experts in the behavioural sciences, like sociologists and psychologists, had even been sought by the profession
in an attempt to better understand some of the psychological and social barriers hindering the wider acceptance of dentistry. However, the important role that each member of the dental profession has in promoting dental health needs to be emphasised. The average man's idea of dentistry is formed from his contacts with dentists. A sympathetic attitude and an obvious interest in dental health on the part of the dentist, dental nurse or hygienist is in itself a form of dental health education. In the school situation, it has been the experience in Singapore that fixed clinics in schools have contributed to the removal of some of the prejudice, fear and ignorance of dentistry among school children. Dentistry has come to be accepted by these children as part of their daily experience in school. During recess time, groups of children can be seen in the clinic busily engaged in various activities which may include the polishing of extracting forceps. This reveals the degree of acceptance and confidence that a fixed school clinic can generate in the children.
IV. SUMMARY

Reparative dentistry still remains at the present time an important and one of the most widely used methods of control of dental caries. With rampant caries the mouth should first be rendered free of sepsis, by inserting zinc oxide fillings in all carious teeth, before final restoration of individual teeth is attempted. In dental care programmes for children, the system of incremental care has been shown to have certain advantages. Studies of this type of programme reveal that the treatment requirement of patients decreases with each year of the operation of the programme.

Fermentable carbohydrates must be present around tooth surfaces before the caries process can be initiated. Sugar taken in liquid form is less harmful than highly adherent sugar-containing foods like toffee and caramel. Sugar taken at meal times has less effect on tooth surfaces than sugar in-between meals. Frequency of in-between meals consumption of sugar is a critical factor in the dental caries experience of the individual.
Various phosphates, notably sodium dihydrogen phosphate, have been shown to be effective in reducing caries in experimental rats. On humans, phosphates have been added to certain foodstuffs like bread, sugar, flour and presweetened breakfast cereals. Although results from these experiments are not conclusive they have been encouraging, and it is expected that phosphate supplemented foods might have an inhibitory effect on caries.

Fluoridation of the communal water supply is the cheapest, most effective and most practical method of supplying systemic fluoride to a community. Fifty to sixty per cent of caries reduction can be expected and most of this effect is in the smooth and the proximal surfaces of teeth.

The ingestion of sodium fluoride tablets is equally effective in lessening the caries experience of an individual but the method requires intelligent co-operation of the patient or the parent.
Topical application of both sodium and stannous fluoride is an effective cariostatic measure. With stannous fluoride even one application of 15 seconds duration is effective. Dentifrices containing stannous fluoride are effective in reducing caries. The use of multiple fluorides - a compatible lava pumice-stannous fluoride prophylactic paste, an aqueous solution for topical application and a stannous fluoride tooth paste - has resulted in the most significant reduction of caries and can be recommended. Mouth washes containing sodium fluoride could be useful in certain situations, if used under supervision. The self-applied stannous fluoride-zirconium silicate prophylactic paste appears to have a great potential as a mass treatment technique.

Antibiotics are effective in reducing caries in animals. In man, the results have been inconclusive. Clinical studies are going on to observe the effect on caries in patients who are on long standing antibiotic therapy because of medical reasons. Antibiotic dentifrices are no longer commercially produced because of the danger of sensitivity arising from their use.
Anti-enzymes as well as the urea compounds that were once added to dentifrices are of doubtful value, and interest in them today is merely academic.

Proper toothbrushing cleans the teeth and stimulates the gingiva. Comparison of the conventional and the electric tooth brush shows that both are equally effective. The use of disclosing solutions could be an invaluable aid in the teaching of proper oral hygiene habit. Vigorous rinsing after meals could be recommended, whenever brushing was not possible.

The attitudes of people towards dental care, in general, leaves much to be desired. Concerted efforts in dental health education is therefore a necessity. The aim of dental health education is to inform and motivate people so that they value and desire good dental health. The opportunity that is presented in the clinic situation for face-to-face education is ideal for the promotion of dental health. The importance of participation by practising dentists in the promotion of dental health, especially in their daily contacts with patients, is stressed.
V. CONCLUSION

The very magnitude of the dental caries problem presents a challenge to the health professions to find an effective means for the mass reduction or at least the control of dental decay. It is wellnigh impossible to solve the problem by reparative dentistry alone, for this will require enormous resources in terms of professional manpower and finance. It is fairly obvious that the problem of dental caries must ultimately be solved by an effective use of practical methods of prevention and of control. The dental profession in the United States, and in most other countries of the world, has long recommended that, because of the special nature of dental diseases, the development of a dental programme for school children should have priority call on the nation's resources. This is because the control and prevention of dental diseases in the younger age groups of any country would contribute quite substantially to the dental and total health of that country.
Dentistry today is on the threshold of a new era, in which a shift in emphasis towards the preventive approach is evident. Although total prevention of dental caries is not possible at the present time, a dental health programme for school children incorporating the accepted methods of prevention can be expected to reduce the incidence of new caries significantly. This would allow more energy and resources to be expended on lessening the backlog of accumulated needs, which could ultimately be reduced to a manageable proportion. Evidence available shows that the following methods of control and prevention to be effective:

(1) Clinical treatment based on an incremental care programme.
(2) Restriction of refined carbohydrates, especially in-between meals.
(3) Fluoridation of communal water supply.
(4) Topical multiple fluoride therapy.
(5) Brushing, failing which vigorous rinsing, immediately after eating.
(6) Sustained effort in dental health education, with participation by every practising dentist.
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