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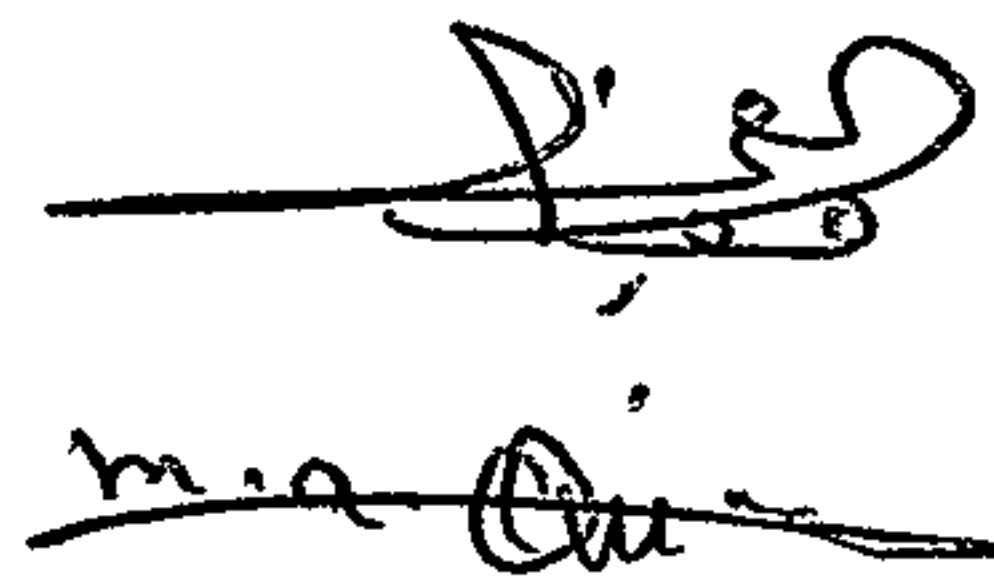
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RAMPANT DENTAL CARIES

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Two handwritten signatures in black ink. The top signature is more stylized and cursive, while the bottom signature is more legible and appears to read 'M. Al-Omishi'.

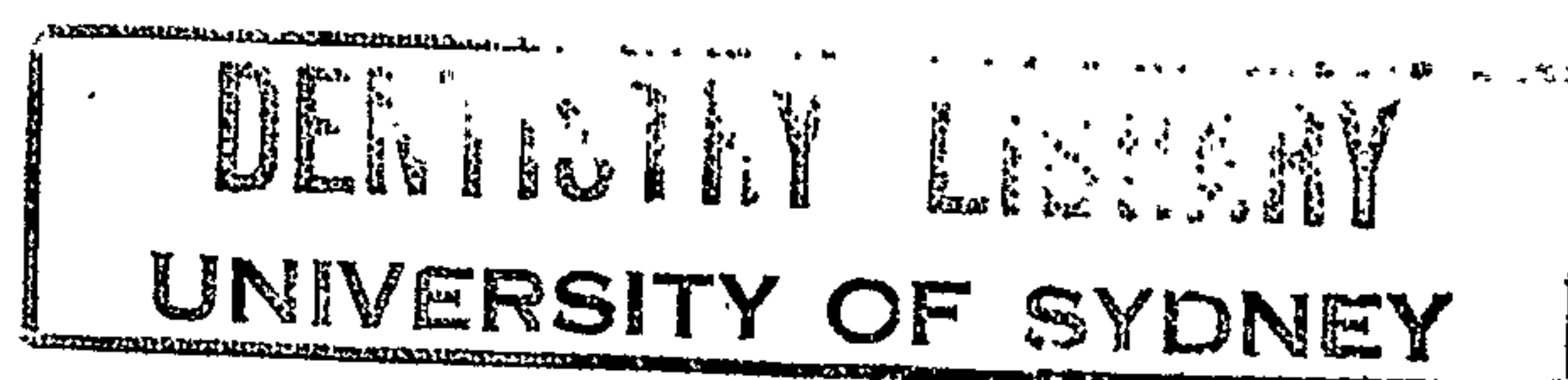
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SUMMARY

Rampant dental caries can be described as a lesion of acute onset involving many surfaces of teeth. This condition can rapidly destroy the coronal tissues leading to infection of the pulpal tissues.

Rampant caries in young children aged 1-5 years has been well covered by many studies throughout the world. The prevalence varies from 3.1 per cent in South African urban white children (Cleaton-Jones et al 1978) to 60-65 per cent in Eskimo children of the North West Territories of Canada (Albert et al 1988). It is of importance to note that the prevalence of rampant caries in Western industrialized communities has decreased in recent years in line with the general decrease in caries trends observed in these nations. A study in the United Kingdom has shown a fall in the prevalence of rampant caries in pre-school children from 10 per cent in 1966 to about 4 per cent in 1982 (Holt et al 1982).

Most epidemiological surveys have dealt with prevalence of dental caries in children and young adults. Few surveys have been directed towards the subject of rampant caries prevalence in adults. The prevalence of rampant caries in the age group 45 years and over is considered very high among patients who have been treated by radiotherapy. The prevalence of rampant caries in fluoridated areas is much less than in non-fluoridated areas (in the ratio of about 1 to 3.6), and a reduction of about 60 per cent in a fluoridated area was shown by Silver in England (1974).

The relationship between rampant caries and socio-economic strata has been well established through many studies. Winter et al (1971) in their study of 602 children aged 12-60 months in London found that there was a significant social gradient, the lower the social group the higher the caries ($p < 0.001$).

It is now well accepted that caries is brought about by the generation of organic acid in the bacterial plaque which is present on most tooth surfaces. The most common factor described in the aetiology of rampant "bottle" caries is prolonged feeding of sweet fluids from a nursing bottle particularly during sleep times. As salivary flow decreases during sleep, the sweet fluids from the bottle pool around the teeth.

Most studies of bottle caries indicate that the children affected had "at-will" exposure to the bottle during the day and went to bed at night with a bottle. For example Winter et al (1971) in a study of rampant decay in young children found that 83 per cent of all children with rampant decay had a sweetened nursing bottle. Furthermore, most studies have indicated that affected children tended to be weaned much later than unaffected control children, usually at about two years as opposed to one year of age.

The presence of cariogenic plaque on the tooth predisposes it to caries. It has been established that *S. mutans* is an important aetiological agent. Work by Houte et al (1982) demonstrated that *S. mutans* comprised around 60% of the total cultivable flora of dental plaque obtained from white spot margins of carious lesions. In contrast, *S. mutans* usually comprises less than 1 per cent of the flora in children with little or no caries. The same study also showed the concentration of *S. sanguis* and *S. salivarius* in the dental plaque to be very low compared to the concentration of *S. mutans*.

A relationship has been shown between the flow of saliva and the incidence of dental caries. A decreased flow necessarily decreases the diluting, buffering, and neutralizing capacity of saliva. A decrease in the quality and quantity of the saliva may be due to radiation or action of drugs. Dental defects acquired after irradiation develop in teeth which are outside or inside the field of irradiation when the salivary glands have been irradiated. Some drugs affect the flow and quality of saliva. Antidepressant drugs cause reduction in the salivary flow and this results in an increased incidence of dental caries, especially if the drugs are used over long periods of time.

Tooth morphology and composition are other factors in rampant caries. As the most frequent sites for caries are in pits and fissures, so morphology is probably a factor in caries experience. Food stagnation areas may also be determined by tooth morphology and the occlusion. Where teeth are imbricated the tendency to increased plaque predisposes to increased local cariogenicity. Resistance of tooth surfaces to bacterial attack also has a role in caries development. The presence of fluoride during enamel maturation increases the resistance of the enamel.

A dietary analysis is an essential part in the determination of the carbohydrate intake for the control of rampant caries. A dietary analysis makes it possible to determine the nature and quantity of the substrate. A diet chart should be given to the patient or parent to enter a description and quantity of all food and drinks consumed each day. The dentist should analyse the chart and advise which foods require to be decreased and which should be increased. In general, reduction of excessive sugar consumption and the elimination of in between meal sugars, especially varieties which stick to the tooth surfaces for long periods of time, results in a marked slowing down of carious lesions.

As for oral hygiene, there is no conclusive evidence that good oral cleanliness reduces caries experience. But the use of fluoride toothpastes is capable of reducing the incidence of caries, and their regular and frequent use is recommended.

Determination of salivary flow is an important step in the control of rampant caries. The buffering capacity of the saliva is the most acid neutralizing mechanism in the mouth. A reduction in the salivary flow may be of a temporary or permanent nature. When only the quantity is reduced, the oral structures may appear normal. A marked reduction or complete absence of saliva, however, will result in rampant caries. Control of the existing caries at this stage is important to relieve symptoms and to prevent pulpal involvement in symptomless teeth with large cavities. Extractions are often necessary to relieve pain and infection in deciduous dentitions where extensive operative treatment is not possible because of the infant's age and unfamiliarity with dentistry. The use of silver fluoride - stannous fluoride at Westmead Hospital as a way to chemically control caries has met with great success, as there is no pain with this treatment. Although the caries turns black most parents do not object as there is no pain and use of the drill is avoided for their child.

Treatment of rampant caries depends to a great extent on the co-operation of the patient and the parent. The importance of selecting patients carefully for a particular program cannot be over-emphasised. There is no standard caries program suitable for every person, rather the program should fit the patient. A high risk patient with active caries needs more attention so that all available home and office procedures can be marshalled effectively.

Treatment can be divided into:

1. Radical - treatment by extraction of all remaining teeth.
2. Conservative - treatment of the effects of the disease by the extraction of unsalvageable teeth and the filling of all other teeth.
3. Conservative and preventive - treatment of both the effects and cause of the disease.

Treatment of rampant caries as a result of radiation therapy is by keeping up the flow of saliva as much as possible to help maintain the integrity of the teeth. Pilocarpine has a great effect on the salivary gland and has been shown to increase the flow of the saliva. Also, the use of artificial saliva, especially at night, for patients who have radiation therapy for cancer treatment has been recommended.

Prevention of rampant caries is the important direction which the patient must follow. This can be achieved by increasing patient education and awareness as to the cause and effect of the disease. Education of the general public and of individual patients to develop sound oral health practices is of fundamental importance.

Maximum preventive benefit can be achieved by adopting the following measures:

1. Fluoride administration. The only proven dietary substance to be of anticariogenic benefit for humans. It is most beneficial where it is available during enamel development. The best and most effective way is water fluoridation which also has its effect on newly erupted teeth and continues to have a significant effect on reduction of root caries. Topical fluorides are also effective. Fluoridated toothpastes reduce caries incidence by 15-30 per cent and are the most cost-effective daily topical application. Mouthrinses with either 0.2% NaF weekly, or 0.05% NaF daily are indicated for patients wearing orthodontic appliances or prosthesis, those with xerostomia, and children who lack motivation or manual dexterity.
2. A microbiological approach to the prevention of dental caries. Chlorhexidine has been shown to reduce the number of *S. mutans* in saliva of subjects highly infected with this organism.
3. Pit and fissure sealants. Pits and fissures are sites of accumulation of bacteria creating the right atmosphere for dental caries. Blocking these sites will help to prevent this caries. With the use of Glass Ionomer Cement (GIC), which also releases fluoride ions, substantial reductions in dental caries have been achieved.

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1 INTRODUCTION

The writer of this thesis, M Al-Omishi, is an Iraqi dentist who graduated from Baghdad University, and has worked most of the time as a general practitioner in private clinics in Iraq and Saudi Arabia. Through these years the writer came in contact with many patients having *Rampant Dental Caries*. These patients were of all ages, but very many were children of low socio-economic class. The disease affected all the teeth and all the surfaces of each tooth, and this situation caused a lot of trouble to the patients as they had pain, difficulty in eating, their appearance was affected, plus many long visits to the dental clinic.

Rampant caries has been observed to occur suddenly in mouths in which the teeth were for many years relatively immune to the decay process. This would lead one to believe that some factor in the caries process acted in some cases to accelerate the process to the extent that it became uncontrollable. One of these factors, excessive sugar consumption, has long been associated with rampant caries. There have been many studies and much research, related to the problem of rampant caries, which could have assisted the writer and other dentists to deal with the situation.

Rampant Caries has been defined as "*suddenly appearing, widespread, rapidly burrowing type of caries resulting in early involvement of the pulp and affecting those teeth or dental surfaces usually regarded as immune to ordinary decay*" (Massler 1945).

A shorter description by Massler and Zwemer (1952) was "*a soft, rapidly burrowing type of caries affecting surfaces of teeth normally considered highly resistant to caries attack*".

Webster's dictionary defines rampant as "*overleaping restraint or natural bounds*", which suggests that rampant caries is a widespread or rapidly developing form of caries.

Winter, Hamilton and James (1966) described rampant caries as "*a lesion of acute onset involving many or all of the erupted teeth, rapidly destroying coronal tissues, often on surfaces normally immune to decay and leading to early involvement of the dental pulp*".

"Rampant dental caries is that condition in which the incidence of caries attack is much higher than that which normally occurs. For any particular age it is manifest by an abnormally high level of caries experience." (Jackson, Murray, Fairpo 1974)

In all of the above definitions rampant caries has three characteristic features:

1. Rapid onset.
2. Rapid progression.
2. Affects teeth and surfaces of those teeth usually considered immune to caries.

Dental caries is a disease of the calcified tissues of the teeth, which is characterised by a destruction of the tissues, beginning on the surface of the tooth in areas of predilection (pits and fissures and interproximal contact areas) and progressing inward toward the pulp.

The destruction involves:

- Decalcification of the inorganic portion; and
- Disintegration of the organic substance of the tissue.

The decalcification is caused by acids resulting from the action of acidogenic bacteria (lactobacilli, aciduric streptococci, diphtheroids, and others) on carbohydrate material.

Dental caries remains one of the most widespread of human afflictions. 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.

The estimations of prevalence of rampant caries in groups of children will obviously be affected by the criteria employed for diagnosis of the disease. Unfortunately, these criteria have not been standardised and it is difficult to compare different studies. Using the criteria developed by Winter et al (1966) *"rampant caries exists only when at least two maxillary incisors are affected by lesions on the labial or palatal surfaces"* a study of 602 pre-school children in London found a prevalence of 8 per cent. (Winter, Rule, Mailer, James 1971). The same study showed that 83 per cent of children with rampant caries had been given a sweetened comforter. An equally important statistic was the fact that only 13 per cent of children who were pacified by sweetened comforters developed rampant caries.

This was confirmed by Silver (1974) who used similar criteria and found 14 per cent of children given sugared comforters developed the disease. The fact that not all children who are given sweetened comforters develop rampant caries may be partly due to some innate resistance and partly to differences in the frequency and duration of use of the comforters.

The difference in social class which was noted earlier for the use of sweetened comforters is also reflected in the levels of disease with the lower social classes showing a significantly higher level of rampant caries (Winter et al 1971). Two reports from the USA note rampant caries in the deciduous teeth as being associated with "at will" breast feeding over periods of 14-31 months (Gardner, Norwood, Eisenson 1977, Kotlow 1977) are of great interest because:

1. They demonstrate a return to a more traditional form of comforting babies in an advanced society; and
2. support claim that lactose in human breast milk may be cariogenic.

Dental caries is a multifactorial disease in which there is an interplay of four principal factors: the host (the saliva and the teeth); the microflora; the substrate, or diet; and the fourth factor of time. All these factors must be considered in any discussion of the aetiology of dental caries.

A severe reduction in the salivary flow (*xerostomia*) is one of those factors which may affect rampant caries. Xerostomia may be the consequence of a variety of different pathological conditions:

1. Therapeutic radiation of the head and neck leads to xerostomia if glands are within the primary beam;
2. Surgical removal of salivary glands for neoplasms may cause localized xerostomia; and
3. Chronic use of anticholinergic or parasympatholytic drugs can produce clinical manifestation of xerostomia.

In all of these conditions a marked reduction in the quantity of saliva causes greater food retention and reduces the buffering effect of the saliva, and causes alterations in both the amount and bacteriological composition of the plaque. These factors will accelerate the dental caries process (generally increasing the susceptibility or risk for dental caries).

Rampant caries in the deciduous dentition (bottle caries) has mainly been associated with prolonged bottle feeding and continuous use of a comforter with sugar containing drinks, such as honey, fruit juices or even carbonated drinks.

The added sugar in these fluids is usually sucrose, one of the most cariogenic sugars. In addition, Winter et al (1971) have mentioned that the high acidity of fruit juice and vitamin C syrups can also contribute to decalcification. Also in the same study Winter et al found a significant association between caries and the duration of the use of a feeding bottle ($p < 0.001$). Children with caries had been given a feeding bottle for a mean period of 18.0 months and caries free children for a period of 14.2 months.

Rampant caries of the permanent dentition which affects patients aged 11-19 years has a relation with the amount and frequency of dietary refined carbohydrate intake.

The abuse of sucrose-containing acidic fruit beverages may lead to a destruction of tooth tissue by combined erosion and dental caries. This condition is usually seen in adults and may be increasing in prevalence (Levine 1972).

Management of rampant caries can be divided in to three stages:

1. Assessment and diagnosis;
2. The initial treatment; and
3. Reassessment and definitive treatment plan.

In the past, courageous attempts to restore the natural dentitions often met with failure. Recent progress in the development of methods to control caries calls for a reappraisal of the problem. An essential preliminary procedure in the treatment of rampant caries is the assessment of the patient's (or parent's) motivation towards dental health and their wish to conserve their natural dentition.

Rampant Caries must be distinguished from ordinary extensive caries resulting from neglect. Rampant Caries often occurs in relatively clean mouths and can therefore be distinguished from the more commonly encountered neglected caries by the amount of materia alba and debris present in the latter. The most distinguishing characteristic of rampant caries is the fact that tooth surfaces ordinarily immune to decay (such as proximal surfaces of the lower anterior teeth; cervical areas of the anterior teeth) are affected.

Several studies have described the association of the nursing bottle with the type of Rampant Dental Caries in the deciduous dentition. This type of rampant caries has a variety of descriptive names such as *"nursing bottle mouth"*, *"milk bottle caries"*, *"nursing bottle caries"*, *"nursing bottle syndrome"*, *"bottle propping caries"*, *"baby bottle syndrome"*, *"bottle mouth caries"*, and *"comforter caries"*.

The aim of this thesis is to review the literature and put together a summary of the work which has been done in this field, and make this information available to the dentist who has interest in this vital field.

2 PREVALENCE

2.1 AGE

2.1.1 Pre-school Children Aged 1-5 years

Rampant caries at this age may be described as "*nursing bottle mouth*", "*milk bottle caries*", "*nursing bottle syndrome*", "*night-bottle syndrome*", or "*baby-bottle caries*".

The estimations of prevalence of rampant caries in groups of children will obviously be affected by the criteria employed for diagnosis of the disease. Unfortunately, these criteria have not been standardised and it is difficult to compare different studies.

The prevalence of bottle caries as reported in various studies from several countries varies widely from 2.5 per cent to a high of 15 per cent as shown on **Table 1** (Seow 1987).

Table 1

Prevalence of bottle caries described in various studies.

Source: Seow (1987)

Author	Country	Prevalence %
Beltrami and Romieu (1939)	France	2.5
Winter et al (1966)	UK	12.0
Kroll and Stone (1967)	USA	15.0
Goose (1967)	UK	6.8
Goose and Gittus (1968)	UK	5.9
Winter et al (1971)	UK	8.0
Bernick (1972)	USA	6.0
Silver (1974)	UK	8.0
Currier and Glinka (1977)	USA	4.9
Cleaton-Jones et al (1978)	S. Africa	13.7 Rural 3.1 Urban
Richardson et al (1981)	S. Africa	11.7 Rural black 4.0 Urban black 12.0 White
Derkson and Ponti (1982)	Canada	3.2

Using the criteria developed by Winter et al (1966) that rampant caries exists only when at least two maxillary incisors are affected by lesions on the labial or palatal surfaces, a study of 602 pre-school children in London showed a prevalence of 8 per cent for the disease (Winter et al 1971). There was no significant difference in the dental caries prevalence between the sexes so the results have been combined. This finding is similar

to the 7.9 per cent noted by Toth and Szabo (1959) in Hungarian children aged 1-6 years. The Winter et al (1971) study showed a significant social gradient, the lower the social group the more the caries ($P < 0.001$). The distribution of the population in this study, skewed in the direction of the higher social groups, means that the prevalence of rampant caries is probably higher than the mean figure of 8 per cent and may possibly affect as many as 10 per cent of pre-school children for the country (UK) as a whole.

Silver in his 1974 study of 263 3-year-old children in a market town in south east England was in agreement with the study of Winter et al (1971), i.e the prevalence was 8 per cent. The sample of children obtained was representative of the town's population as far as sex distribution was concerned but was weighted slightly in favour of the higher socio-economic groups. However, the total number examined represented a high 80 per cent of the 3-year olds and consequently the mean deft figure and proportion caries-free are probably close to the true population figures. The mean deft of 1.37 (at mean age 40.7 months) found in this study is similar to the figure of 1.41 found by Winter et al (1971) in their Camden 3-year olds. Also, the proportions caries-free of 67 per cent and 64 per cent respectively are comparable.

Silver (1974) found no difference revealed in the brushing habits between the social groups with regard to frequency of brushing, or the age when brushing commenced. Seventy per cent of those who brushed daily were caries-free compared with 57 per cent of those who brushed occasionally or never. This difference is on the borderline of significance ($0.05 < p < 0.1$).

In a study carried by Noah (1988) on 4 and 5-year-old children at an Ibadan private school in Nigeria a total of 819 children comprised of 395 4-year-old and 424 5-year-old children were examined. Of these 438 were girls and 381 were boys. The examinations were carried out under natural lighting conditions outdoors. The mouth prevalence of rampant dental caries in this study, for the 4 and 5-year-old children was found to be 3.80 per cent and

4.25 per cent respectively, following the definition used by Jackson et al in 1974 (The presence of anterior labial caries on at least one incisor tooth was considered indicative of rampant caries). When the sexes were analysed separately, more 4-years-old boys than girls had rampant dental caries with the figures being 4.76 per cent and 2.91 per cent. For the 5-year-old children, there was no significant difference between the sexes (4.16% boys, 4.31% girls). When the dmft values for anterior and posterior teeth were analysed separately for those with rampant caries and those without, almost all dmft was contributed by the posterior teeth in the group without rampant caries, so that anterior teeth caries was virtually nil. In the group with rampant dental caries, the anterior and posterior teeth contributed almost equally in both age groups, with the posterior teeth having slightly higher values.

The prevalence of rampant caries of white children aged 1-5 years in Johannesburg, South Africa was studied by Cleaton-Jones et al (1978). A total of 499 children aged 1-5 years were examined with almost equal number of boys and girls. As no statistically significant differences were found between them in any sections of the study, results have been pooled. Dental caries was common and increased in prevalence with age. There was a gradual decrease in the number of caries-free children but there were less caries-free 3-year-old children than 2 and 4-year-olds, an unexplainable difference found to be significant at the 5 per cent level. Most of the dmft index was made up of carious teeth; few missing teeth or restorations were seen.

In the absence of a universally accepted definition of rampant caries the authors found it difficult to compare the results of this study with those of others workers. They have used different definitions, firstly, based on the presence of caries on the labial surface of at least one incisor tooth, or at least two maxillary incisors; and secondly, a dmft value of either 5 or more, or 10 or more. Applying all these definitions to the results obtained in this study "*prevalences*" of rampant caries were 11.4 per cent; 8.6 per cent; 28.9 per cent; and 8.4 per cent respectively.

To further examine definitions and the prevalence of "rampant" caries, all four definitions, were tabulated in two tables providing percentages of false positives (i.e. overdiagnosis) and false negatives (underdiagnosis). The lowest numbers of false negative diagnoses were associated with the dmft criteria and the lowest numbers of false positives with the labial caries criteria. It would perhaps be reasonable to combine both criteria. Rampant caries would then be defined as a dmft value of at least 5, of which two are incisor or canine teeth with labial caries. On the other hand, children may have caries lesions on the labial surface of one or more of these maxillary teeth, and yet have no other caries present; or, have much caries with no labial surface involvement.

A study carried out by Albert et al in 1988 on 260 pre-school Eskimo children in eight communities of the Keewatin District of the Northwest Territories of Canada covered 37 per cent of the total population of children age three months to five years in those communities. It was found that by 18 months, 20 per cent of the infants had both anterior and posterior caries and by 49 months over 80 per cent had caries requiring treatment. In the study group, 79 per cent were bottle fed and 86 per cent in this category slept with the bottle in the mouth. The substrate was found to be condensed milk or fruit juice.

The prevalence of rampant caries in the study population was 50-55 per cent by 30 months and 60-65 per cent by 48 months, five times more prevalent than in any previous study group. Clearly the caries prevalence in these children is high; less than 19 per cent remained caries free by 60 months. The findings appear to agree with those of Titly and Bedard (1986) for four- and five-year-old Indian children of Sious Lookout, Ontario. In the latter study, 90 per cent of the central incisors and 67-86 per cent of the lateral incisors were decayed and accounted for 25 per cent of the total def. It seems possible that at age two years their population had nursing caries with a prevalence similar to the children in the Albert et al study (1988).

2.1.2 Mixed Dentition Children Aged 6-12 years

The WHO target for the year 2000 is 3 DMFT for 12-year-old children in developing countries. This target seems to be possible as many countries adopted different plans to reduce DMFT for this age group. A report from a working group convened jointly by the Federation Dentaire Internationale and the World Health Organization (1985) stated that for some populations, especially where water fluoridation was widespread, large reductions in mean DMFT occurred prior to the 1973-83 decade with the exception of Japan where caries increased in the period 1957-1975. However, where comparisons can be made over that decade, DMFT figures have declined remarkably at age 12 in most industrialized countries. There are exceptions for France and Japan where the figures had remained virtually unchanged. There is also some evidence that Brazil's figures have levelled off during that period whereas figures for Thailand and Nigeria showed very marked increases.

While it might be considered unreasonable to regard an average per annum figure of declining severity taken over a long period of years as being meaningful, it is nevertheless a useful measurement when comparing changes over a ten year period. **Table 2** from FDI (1985) lists nine countries in descending order of average per annum figures expressed as a percentage decrease of DMFT at 12 years.

Table 2
Decrease in DMFT at 12 years
Source: FDI (1985)

Country	Decrease % p.a.	Period	Latest DMFT
Norway	-12.2	1978-1982	4.4
New Zealand	- 9.5	1973-1983	3.3
Denmark	- 9.3	1978-1981	4.7
Finland	- 7.2	1975-1982	4.1
Netherlands	- 7.0	1973-1982	3.9
Australia	- 6.5	1975-1983	2.8
USA	- 6.1	1974-1980	2.6
United Kingdom	- 4.4	1973-1983	3.0
Sweden	- 3.4	1972-1982	3.4

Ludwig, Keen and Pearce (1964) studied a Maori population in Tiki Tiki-Rangitukia approximately 90 mile north of Gisborne, New Zealand. Dental examinations were carried out on 411 subjects, representing over 90 per cent of the available residents aged from 2 to 75 years and beyond. Ludwig et al found that 11 children aged 12 years had a DMFT of 5.9. They stated that although pre-european Maori may have enjoyed a high standard of dental health, their modern counterparts seemed to be subject to widespread dental disease and extensive loss of permanent teeth early in life. It was noted that 106 children of the same age group of rural European children resident throughout the North Island of New Zealand had a very high mean DMFT of 11.6.

Saliva plays a vital role in prevention of dental caries through its buffering capacity. Surgical desalivation in humans who have an intact dentition and who have not received radio-therapy is unusual. A case was reported by Hill (1972) in the Turner Dental School, Manchester. The patient was a girl aged 12 years who had been referred by a dental practitioner for treatment. Two years previously she had received surgical treatment for a muco-epidermoid carcinoma of the right parotid gland. The striking feature was rampant caries of unusual distribution. On the right side caries was widespread, affecting upper and lower quadrants. The lesions were extensive, involving much of the coronal tissue and not confined to fissures or proximal stagnation areas.

Massler (1945) in a study of teen-age caries stated that pedodontists believe that most cases of rampant caries occur in children between 5-8 years of age. Massler, however, found that only 12 out of 35 rampant caries cases were between 5 and 8 years.

2.1.3 Teen-Age Children Aged 13-19 years

Adolescence is a period of rapid growth and development. Since the adolescent boy may double his weight between the ages of 10 and 17, it is easily understandable that his nutritional requirements are high. In addition to accelerated physical growth, adolescence is characterised by complicated social and emotional growth. The teenager's choice of food during this period reflect this metamorphosis, skipping meals and snacking. It has been estimated that 80 per cent of the lesions and restorations present in adults result from caries processes which began during the adolescent years (Forrester 1981).

Baume (1969) in a study on 12,344 schoolchildren, 4-19 years in French Polynesia found that polynesian boys aged 15 years had 3 teeth missing, the girls 6 missing teeth. One fifth of all decayed teeth needed to be extracted. This high and early tooth mortality was shown to be a consequence of a rampant smooth-surface caries affecting highly deficient tooth structures of "yellow teeth". The average numbers of DMF teeth in Iles Du Vent island was 12 for girls at the age of 15 years (out of 26 permanent teeth), while the boys scored 9 DMF teeth out of an average of 25 teeth present. Baume (1969) also noted that a different pattern of rampant decay was seen in Chinese which affected primarily the approximal surfaces, including those of the lower permanent anteriors, which in Polynesians were rather resistant. There is little doubt that particular food and eating habits may have been responsible for these racial differences in the caries-attack pattern. The DMF teeth for the female chinese 14-19-years was 11.4.

Massler (1945) in a study on 35 cases of rampant teen-age caries, found a definite correlation between the circumpubetal spurt in growth and the sudden appearance of rampant caries ($r = 0.82$). If a spurt in growth occurred early (10 to 12 years), the caries also appeared early (11 or 12 years). If the spurt in growth was delayed until the age of 15 or 16, the spurt in the carious process was also delayed to about 15 or 16. Out of the 35 cases of rampant caries 23 were at 11-16 years. The changes in life style of the teen-ager coupled with elimination of some meals and an increased appetite usually necessitates an increase in snacks and soft drinks. The change in the quality and frequency of eating is a predisposing factor for caries.

2.1.4 Adults Aged 20-44 years

At this stage people start to be more conscious about their oral health. A very few (and limited) studies are available for this age group. Ludwig et al (1964) in a study on 411 subjects of a rural Maori population aged from 2 to 75 years, found that in the age group 20-24 years the M (missing teeth) became the largest component in the DMF index. This trend developed so rapidly with age that in the 35-44-year-old group, the mean number of extracted teeth was 25.2 per person. Thus most of the Maori adults were edentulous or nearly so. In fact, 55 per cent of the adults aged 20 years and over were fully edentulous, and a further 9 per cent edentulous in one jaw. Twenty nine of the 411 in the study group aged between 35-44 had a mean DMF of 27.2. This shows wide-spread dental caries and extensive loss of permanent teeth early in life.

Prevalence of dental caries among workers in the sweet industry in Israel was studied by Anaise in 1980. This study showed a high caries prevalence in the sweet industry workers compared to a control group in the textile industry. In this study there were 423 participants, while in the control group there were 812 participants. The mean DMFT value recorded for two groups of workers from the confectionery industry were clearly higher than those recorded for workers in the textile industry ($p < 0.001$). Such a distribution was found between the groups in the mean number of decayed teeth (D), and teeth having undergone treatment (F) ($p < 0.001$). The mean DMF teeth for the sweet factory worker in the production line was 16.2 (Standard Deviation ± 5.9) for the age group 30-44, compared to 9.1 (SD ± 4.6) respectively for the same age groups in the textile industry.

Most epidemiologic surveys have dealt with the prevalence of dental caries in children, youth and young adults. Only a few surveys have been directed towards the subject of caries prevalence and rampant caries in adults.

2.1.5 Adults Aged 45 years and over

Rampant caries at this age most is likely associated with xerostomia as a result of radiotherapy of the oral regions. Some populations may have very high levels of dental caries in the community or among particular community groups.

In a study carried by Ludwig et al (1964) on a rural Maori population in the Tiki Tiki-Rangitukia, 411 subjects representing over 90 per cent of the available residents were examined. They ranged in age from 2 to 75 years and beyond. Ludwig found that 11.5 per cent of the sample or 48 had a mean DMF teeth of 27.1 at age 45-54 years. At age 55 years and over, 48 had a mean DMF teeth of 31.0.

Karmioli and Walsh (1975) presented five cases of dental caries after radiation therapy. Widespread dental caries has been a frequent complication of radiation therapy for treatment of carcinomas of the oral regions. If the jaws and teeth were irradiated without inclusion of the salivary glands, dental lesions did not develop. They found that irradiation of the salivary glands reduced the amount of saliva and changed it qualitatively so that it became a viscid, acid mixture with an abnormally high amount of organic material. The teeth, usually protected by the salivary flow, become covered by a sticky material that provides an excellent substrate for bacterial attack. The most obvious feature is a massive, widespread loss of tooth structure, beginning initially with the enamel and then proceeding to softening and loss of dentine. The buccal or labial and lingual surfaces, and the incisal and occlusal surfaces are all involved. Normally immune areas, such as the tips of the cusps of the posterior teeth are affected as well. The last areas that seem to be affected and lose their enamel are those at and just below the contact points, and these areas are usually the first areas affected in ordinary smooth-surface dental caries. Furthermore, the mandibular anterior teeth which are usually the most resistant to caries are equally, if not more, affected by this process and may be affected earlier than are the other teeth.

Frank, Herdly and Phillipe (1967) studied 61 patients, 59 of whom had been treated by a cobalt teletherapy unit for carcinomas of the oral cavity. Two patients with carcinomas of the floor of the mouth had radium implants combined with external roentgen-ray irradiation. Of the 61 patients, 28 were completely edentulous and the remaining 33 patients had all their teeth or, more often, were partially edentulous. In the latter group, twenty two (66 per cent) had typical lesions related to irradiation; these patients stated categorically that the defects appeared after the beginning of the radiation therapy and progressed rapidly thereafter. In all of these patients, the salivary glands were completely or, in a few patients, partially in the field of irradiation, whereas the teeth of 20 patients were outside the irradiated field, and the teeth of two patients were inside the irradiated field. Clinically, three types of lesions were observed. A classic type of decay was localized at the cervical region of the teeth and from this region, it progressed superficially all around the neck of the tooth, sometimes involving large surfaces. This annular lesion proceeded toward a complete amputation of the crown. The second type of the lesion observed was a heavy, brown-black discoloration of the whole tooth. The third type of lesion most frequently encountered after irradiation were generalized, superficial defects that first affected the buccal and later the palatal or lingual surfaces of the tooth crowns.

The prevalence of dental caries in this age group is considered to be very high among patients who have been treated by radiotherapy. There are very few studies available for persons 45 years and over.

2 OTHER VARIABLES

2.2.1 Fluoride

Fluoride plays a vital role in the prevention of dental caries through improving tooth resistance, remineralization and antibacterial actions, yet its importance in rampant caries has not been properly studied. Jackson et al (1974) conducted a study on rampant caries in 5-year-old children from a fluoride and from a non-fluoride community. In this study the presence of labial caries on at least one deciduous incisor was taken to be indicative of rampant dental caries. All available 5-year-old children at school and who had been continuous residents in Hartlepool (F^- 1.5 to 2.0 ppm) were included in the study ($N = 500$). In York (F^- 0.2 ppm), a sample of local authority schools was taken, and 527 children examined. Of the 527 children in York, 61 or 11.6 per cent had rampant dental caries. The prevalence in boys was similar to that in girls. In the rampant caries group, the mean dmf together with its standard error was 9.85 ± 0.507 . In the rest of the children the comparable value was 3.34 ± 0.146 . Caries experience in the rampant caries group was therefore almost three times that in the remaining children. Of 500 Hartlepool children examined, 23 or 4.6 per cent had rampant caries. As in York, the prevalence of rampant caries in girls was the same as in boys. In those children with rampant caries the mean dmf was 4.78 ± 0.555 and in the remaining children it was 1.33 ± 0.097 , the ratio of these two values being 3.6 to 1.

Table 3 shows the comparisons made by Jackson et al (1974) of the dmf caries experience of the 5-year-old children in these areas, and **Table 4** the caries experience specifically for the deciduous molars.

The most important finding of this investigation is that in the fluoride community, Hartlepool, the mouth prevalence of rampant caries in 5-year-old children was 60 per cent less than it was in children of the same age from the non-fluoride community, York. Further, in the Hartlepool children with rampant caries, the number of the teeth attacked was approximately half that in York children with rampant caries. It appears therefore that fluorides in drinking water not only reduce the mouth prevalence of rampant caries (by 60

per cent) but also the number of attacked teeth in those with rampant caries (by 50 per cent). It is a striking feature of these data that 95.4 per cent of Hartlepool 5-year-old children (that is those without rampant caries) have on average only fractionally more than 1 decayed deciduous molar whereas in York the comparable value is almost 3.

Table 3

Caries experience of 5-year-old children with and without rampant caries: York and Hartlepool data compared.

Source: Jackson et al (1974)

	York (F ⁻ 0.2 ppm)			Hartlepool (F ⁻ 1.5-2.0 ppm)		
	No.	dmf	± S.E.	No.	dmf	± S.E.
<i>With Rampant Caries:</i>						
Boys	29	9.93	0.721	12	4.75	0.897
Girls	32	9.78	0.724	11	4.82	0.617
Combined	61	9.85	0.507	23	4.78	0.555
<i>Remainder:</i>						
Boys	238	3.35	0.212	225	1.32	0.149
Girls	228	3.32	0.200	252	1.34	0.127
Combined	466	3.34	0.146	477	1.33	0.097

Table 4

Caries experience of deciduous molars of 5-year-old children with and without rampant dental caries: York and Hartlepool data compared.

Source: Jackson et al (1974)

	York (F ⁻ 0.2 ppm)			Hartlepool (F ⁻ 1.5-2.0 ppm)		
	No.	dmf	± S.E.	No.	dmf	± S.E.
<i>With Rampant Caries:</i>						
Boys	29	6.10	0.416	12	2.08	0.500
Girls	32	5.81	0.366	11	2.55	0.623
Combined	61	5.95	0.274	23	2.30	0.390
<i>Remainder:</i>						
Boys	238	2.89	0.170	225	1.07	0.107
Girls	228	2.93	0.170	252	1.16	0.106
Combined	466	2.91	0.120	477	1.12	0.075

Dental caries prevalence in 286 5-year-old children in Barnsly, England (a low fluoride area) was studied by Clerehugh (1977), as part of a baseline study prior to fluoridation. The mean dmft value (with standard error) was 4.5 ± 0.2 . Of the children examined, 32 (11.2%) had a dmft value of 10 or more. Twenty-five children (8.7%) had rampant caries with a mean dmft of 11.3 ± 0.9 . The remaining children had a dmft of 3.8 ± 0.2 . Labial incisor caries was taken to be indicative of rampant dental caries. The results of this study are similar to those of Jackson (1974) for York children (F^- 0.2 ppm)

Johnsen et al (1984) compared background information for children with carious primary incisors versus caries-free children in four different geographic and practice locations. Data reported by parents showed that the mean age when cavities were first noticed by the parent was almost identical for the four study sites. Data on use of additional fluorides (except toothpaste) were available from three of the sites. At two sites caries-free children were more likely to have additional fluoride than those with incisor caries ($p < 0.01$).

A study to determine the prevalence of nursing bottle syndrome in the non-fluoridated city of Vancouver, Canada and to investigate possible aetiology was undertaken by Derkson and Ponti (1982). Children ($N=592$) were randomly selected from public health clinics and community center activities, and were between 9 months and 6 years of age. The prevalence of nursing bottle syndrome was 3.2 per cent. The data indicated that fluoride supplementation of the diet was followed in a more conscientious manner, more frequently, in the non-nursing bottle syndrome group (Table 5).

Table 5

Fluoride supplementation and nursing bottle syndrome.

Source: Derkson and Ponti (1982)

Fluoride supplementation	Non-NBS	NBS
1-2 times/week	4.5%	31.6%
3-5 times/week	12.7%	5.3%
5-7 times/week	60.9%	36.8%
never	21.9%	26.3%

NBS = nursing bottle syndrome

2.2.2 Social Class

That mothers and fathers of caries-free children were more likely to have attended college than counterparts of children with caries incisors was found by Johnsen et al (1984) and this was true at all four study sites. The difference was statistically significant for mothers ($p < 0.01$) and for fathers ($p < 0.01$).

Silver (1974) in a survey of 263 3-year-old children in a market town in south east England found that 70 per cent of children living in dwellings where there were few people per room (0 to 1) were caries-free, compared with 51 per cent in houses with excess of this number. This difference was significant ($p < 0.001$) although there was no relationship between social class and size of family, or between caries prevalence in large families (3 or more children) and smaller families (2 or fewer children). Although there is a social gradient the difference failed to gain statistical significance ($0.1 < p < 0.2$).

A study on the various characteristics of children with rampant caries and their families was carried out by Dilley, Dilley, and Machen (1980). Over 50 per cent of families were in the lower socio-economic strata, as measured by the Hollingshead Index (USA). In accord with national norms, a majority of the families had either one or two children. The educational levels of the mother and father were at the high school graduate level or lower, in the majority of cases.

Johnsen (1982) in his study *"Characterstics and backgrounds of children with nursing caries"* found that parents of caries free children were more likely to have attended college than parents of children with incisor caries (mothers $p < 0.01$; fathers $p < 0.01$). Johnsen also found parental obesity to be a feature of children with incisor caries.

In a study of 14 Sri Lankan children with rampant caries, Amaratunge and Ekanayake (1984) found all the 14 belonged to the middle or lower socio-economic groups.

In a study on 18 Nigerian children aged 3-6 years with rampant caries the conclusion of Adenubi (1982) was different from most other studies, as the parents in most cases were middle class and belonged to the higher income group. Both parents were wage-earners and amongst them were accountants, engineers, physicians, a high court judge, senior civil servants and businessmen. Only one child came from the low income group and the special feature was that this child took a lot of gari (assava fresh: *manihot Esculanta*). Adenubi thought the finding different from others because only the more affluent Nigerian family was able to afford the refined carbohydrates prominent in the dietary habits of these children who presented with rampant caries.

Silver (1987) in a longitudinal study of infant feeding practice, diet and caries, found they were related to social class in children. A socio-dental investigation was commenced in 1973 when the children were aged 3-years, in a market town 30 miles north of London. Children still living in the area were re-examined in 1979, when they were about 9-years-old. Analysis of the caries experience of the cohort by social class showed that the pronounced class gradient, so evident at age 3-years, was still discernible 6-years later in the deciduous teeth, but not in the permanent teeth. However, there were statistically significant class differences when caries experience in the permanent teeth was analysed by broader class groupings. The proportion of the 76 children in the combined non-manual social classes who had caries-free permanent molars was 51 per cent, compared to 35 per cent of the 84 children in manual classes ($p < 0.05$) and the mean DMFT of their first permanent molars was 1.00 (± 1.34) compared to 1.43 (± 1.36) in the manual group children ($p < 0.05$). Treatment patterns varied more by social class in the treatment of the deciduous teeth than was evident in treatment of the permanent teeth. Although similar proportions of the dmft or DMFT in each social class could be accounted for by decayed teeth (25% of dmft and 55% of DMFT), children in lower social classes tended to have had a greater number of deciduous molars extracted. In social classes I+II 63 per cent of dmft of deciduous molars was accounted for by filled teeth and 13 per cent by extracted teeth, whereas in classes IV+V, the corresponding figures were 46 per cent and 26 per cent.

There has been an increasing interest in the health of ethnic minorities over recent years (WHO 1986). Prendergast, Williams and Curzon (1989) in their study *"An assessment of dental caries prevalence among Gujarati, Pakistani and white Caucasian five-year-old children resident in Dewsbury, West Yorkshire"* examined 633 children, of whom 419 were "Asian". Of the latter, 242 were of Pakistani Muslim and 159 of Indian Muslim origin (18 who could not be classified into either group were excluded from the results). Rampant caries was present in 4.8 per cent of White, 13.2 per cent of Pakistani and 21.4 per cent of Indian children. There were significant differences between the White and Asian groups ($p < 0.01$), and also between the Indian and Pakistani children ($p < 0.05$). The group with more children having extensive decay came from the Indian Muslim community, although overall, the proportion with caries (or caries free) was the same as for the Pakistani group. The proportion of children caries free ($dmft = 0$) and with rampant caries ($dmft \geq 10$) in each ethnic group with sexes combined is shown on Table 6.

Table 6

Proportion of children caries free and with rampant caries in each ethnic group.

Source: Prendergast et al (1989)

	Sample size(n)	Caries free		Rampant caries	
		No	%	No	%
White Caucasian	210	105	50.0	10	4.8
Pakistani	242	84	34.7	32	13.2
Indian	159	50	31.4	34	21.4
		$p < 0.001$		$p < 0.001$	
White Caucasian v Pakistani		$p < 0.001$		$p < 0.001$	
White Caucasian v Indian		$p < 0.001$		$p < 0.001$	
Pakistani v Indian		NS		$p < 0.05$	

Probability values given using Chi squared tests for significance

Social class is known to be related to dental health in young children. However, factors associated with ethnicity appear to be an additional variable since the study sample included white Caucasian children who were resident in the same areas of deprivation, and yet still had less caries. Ethnicity identifies groups on the basis of a number of variables, including geographical or racial origin, skin colour, language, religious beliefs and practices and dietary customs. In all these attributes, Asian families will differ from Caucasians.

2.2.3 Medical History

Abnormality during pregnancy, labour and delivery, prematurity and recurrent minor illness during the early years of life were shown to be significantly related to rampant caries by Winter et al in 1966. Prematurity of birth ($p < 0.025$), and early childhood illness ($p < 0.001$) were also shown to be significantly related to all forms of caries in a sample of 602 pre school children in another Winter et al study (1971). These illnesses consisted mainly of exanthematous fevers, upper respiratory tract infections and asthma. Winter et al (1971) suggested that it was not the illness itself which led to caries, but the parental reaction to the illness, probably by the young sick child being given sweetened comforters for longer periods of time and by an increased consumption of sugary substances between meals.

Table 7

Number and per cent of children caries-free with prematurity of birth or illness during infancy or early childhood.

Source: Winter et al (1971)

	Prematurity of birth		Illness in infancy or early childhood	
	Yes	No	Yes	No
Number with caries	19	133	93	59
Number caries-free	31	419	186	264
Per cent caries-free	62	76	67	82

Silver (1974) found that 44 per cent of a sample of 263 three-year-old children had had childhood illnesses, mainly upper respiratory tract infections and exanthematous fevers. There was no difference in the prevalence of caries between these children with, and without, a history of illness. Also there was no social class difference in the prevalence of these illnesses. When, however, the figures for caries-free children amongst those who were ill were broken down by social class a definite gradient emerged. Of the 22 per cent (58 children) with abnormality in pregnancy, labour or delivery 57 per cent were caries-free compared to 70 per cent of those who were not exposed to these conditions. This difference, however was only on the border-line of significance ($0.05 < p < 0.1$).

A significant medical history (prolonged illness, birth defect or adoption) was not found to be associated with differences in caries prevalence in a study by Albert et al (1988) in the Keewatin district of the Northwest Territories of Canada. Albert et al also found that children who had received three or more antibiotic courses had a greater prevalence of anterior caries than those subjected to fewer antibiotic courses. Half of the children had received vitamin supplements without any decrease in caries prevalence.

Dilley et al (1980) in a study of 75 children aged 6-36 months found that 18 per cent had a history of illness, which included chicken pox, measles, ear infections, croup, and bronchitis. All parents considered their child's level of development either normal or advanced.

Johnsen (1982) found that children of 3 years 6 months or less with incisor lesions (N= 47) were more likely to have a significant medical condition than 20 caries-free children ($p < 0.01$). Examples of these conditions included heart conditions, bowel obstruction requiring surgery, asthma, seizures, histiocytosisX, premature birth, hydrocephalus etc. Nursing caries children averaged 2.2 hospitalisations and 13 days in the hospital. When parents were asked about awareness of the potential cariogenicity of the child sleeping with the bottle, a common response was, "*But (the child) has been through so much and should have something to enjoy*".

2.2.4 ORAL HYGIENE

Oral hygiene does not appear to play a major role in the aetiology of rampant caries in the deciduous dentition. This was shown by Noah (1988) in his study on 819 school children aged 4 and 5 years in Nigera. Noah (1988) found that the proportion of children who had good oral cleanliness in the non-rampant-caries group was only slightly higher than in the rampant-caries group, and the proportions with poor oral were the same in each of the two age groups. The prevalence of children with good oral cleanliness for the 4-year-old children was 93 and 94 per cent for those with rampant caries and those without respectively and 89 and 89 per cent for the 5-year-old children.

Silver (1974) in a study of 263 3-year-old children in a market town in south east England found that 210 parents (80%) said their children cleaned their teeth at least once a day, 47 (18%) cleaned "occasionally" and only 4 (2%) "never". No difference was revealed in the brushing habits between the social groups with regard to frequency of brushing, or the age when brushing commenced. Seventy per cent of those who brushed daily were caries-free compared with 57 per cent of those who brushed occasionally or never. This apparent difference was on the borderline of significance ($0.05 < p < 0.1$).

Adenubi in a study (1982) of 18 Nigerian children with rampant caries aged 3-6 years, found that the oral hygiene habits suggested a high degree of awareness amongst the parents. Fourteen of the 18 children used toothpaste and 11 used a toothbrush. In addition, only 1 of the 18 did not have his teeth cleaned at least once every day (Table 8).

Table 8

Oral hygiene habits; Methods used and frequency of cleaning the teeth.

Source: Adenubi (1982)

Methods used:	No. of children
Cotton wool + toothpaste	3
Toothbrush + toothpaste	11
Cotton wool + H ₂ O ₂	4
Frequency of cleaning the teeth:	
Once daily	15
More than once daily	2
Not every day	1
Not at all	0

Winter et al (1966) in an investigation of 100 children with rampant caries, and a control group (n=100) all aged 1-5 years, found that 85 per cent of the study cases and 72 per cent of the control group claimed to be cleaning, or having their teeth cleaned with a tooth-brush. The mean age for the onset of this practice was 1 year 6 months in the study group and 1 year 10 months in the control group. Tooth cleansing was claimed to be carried out 1.5 times per day in both the study and control groups.

Amaratunge and Ekanayake (1984) in a study on 14 Sri Lankan children with rampant caries aged between 1-7 years found that 11 out of 14 children used a toothbrush with or without tooth paste. Awareness of oral hygiene was not satisfactory as the parents also did not clean their own teeth properly.

After reviewing most of the studies related to rampant caries it has been found that there is no direct relationship between rampant caries and oral hygiene.

2.2.5 Marital Status

Marital status of families seems to have no direct effect as most rampant caries children come from married families with normal number of children. Dilly (1980) in a study on 75 children under 60 months of age who had rampant caries (**Table 9**) found that 86 per cent of the children came from married households (similar to national norms), and the majority of families had either one or two children.

Table 9

Demographic data of family.

Source: Dilly et al (1980)

	Per cent	Number
Marital status:		
Married	86	64
Divorced	8	6
Never married	6	5
Number of children in family:		
One	21	15
Two	53	38
Three	13	9
More than 3	13	9

Marital status of the mother did not differ significantly when all four locations were considered collectively ($\chi^2 = 0.0009$ NS) in the study of Johnsen et al (1984). A significant difference was found at one site (Akron) for marital status. Mothers of caries-free children were more likely to be married than mothers of children with carious incisors ($p < 0.01$). This was the only instance in the study where two suburban sites differed significantly. No overall significant difference was found between caries-free children and those with carious incisors regarding supervision by someone other than a parent. At three of the sites, caries-free children were supervised more frequently by another person than were the children with carious incisors.

In an earlier study also carried out by Johnsen (1982) no significant differences were found for marital status or parent ages ($N = 60$ children at three and a half years). Most of the children with rampant caries came from intact families with a mode of two children, and there was lack of significance for sibling rank.

2.2.6 Hereditary Factors

None of the studies available about prevalence of rampant caries mention a relationship between hereditary factors and rampant caries. Winter (1980) in his article *Problems involved with the use of comforters* stated "*Hereditarily determined factors almost certainly govern to some extent the predisposition of children to rampant caries in early childhood; examples of this may be seen when rampant caries occurs on one of a pair of dizygotic twins on comparable diet and comforter habits*". The exact mechanisms by which these genetic influences operate in individual children is difficult to assess.

3 AETIOLOGY

It is accepted that caries is brought about by the generation of organic acid in bacterial plaque present on tooth surfaces. The acid is produced when refined carbohydrate is taken into the mouth, diffuses into the plaque, and is taken up by bacteria capable of metabolising it, producing acid as a by-product. The acid lowers the plaque pH and calcium ions in the enamel surface are liberated and diffuse into the plaque and then into the saliva.

Caries is a disease which can only develop with:

1. Bacterial agents - Bacteria in the dental plaque capable of producing acid as one by-product of their metabolism;
2. A suitable substrate - The acid-producing bacteria require a suitable substrate to metabolize in the dental plaque, refined carbohydrates, especially sucrose and other sugars, are the most favourable substrate;
3. A susceptible host - Dental enamel susceptible to dissolution by plaque acids;
4. Time - Clinical caries only develops after repeated and undisturbed acid action has led to sufficient demineralization to allow further bacterial invasion of the tooth and eventual permanent loss of tooth substance.

Only if all four factors are present will clinical caries become evident and demineralization proceed. The aetiology of rampant caries is due to these factors. As rampant caries is at much higher levels than normal there must be increased acid production, more frequently, and/or a more susceptible host.

3.1 BACTERIA AND DENTAL PLAQUE

Information about the composition of the dental plaque flora associated with rampant caries is lacking. Such data may provide further clues about the identity of the bacterial aetiological agents of dental caries, as well as help to clarify the relationship between the diet and the plaque flora.

Houte, Gibbs and Butera (1982) in a study on the oral flora of 6 children with nursing bottle caries, and aged between 27-42 months, found that the mean (range) of the concentration of *Streptococcus mutans* enumerated on blood agar and expressed as a percentage of the total counts on that medium for the plaque samples from the anterior and posterior teeth were 61 (5-98) and 27 (0.3-78), respectively. These figures were 51, 68, and 63 per cent for the samples from the caries lesions, white spot margins and clinically-sound areas of anterior teeth, and 56 and 23 per cent for the samples from caries lesions and clinically sound areas of posterior teeth, respectively. Only the differences between the mean concentrations of *S. mutans* in the samples from the three different locations on the upper anterior teeth and its mean concentration in the samples from the clinically-sound posterior teeth were significant (t test $p < 0.001$). The unusually high prevalence of *S. mutans* in these subjects was also evident from high salivary concentrations.

Lactobacilli were detected in nearly all plaque samples as shown in **Table 10**. The mean percentage in the case of cavities (4.0) was higher than that in the case of either white spot areas (0.5) or clinically-sound tooth surfaces (0.1) (t test $p < 0.001$). The concentrations of *S. sanguis* and *S. salivarius* in dental plaque were very low compared to those of *S. mutans* (**Table 11**). The levels of *S. sanguis* (t test $0.5 > p > 0.1$), but not of *S. salivarius*, were somewhat higher in samples from posterior than in those from anterior teeth. *S. salivarius* was not detected in four of five subjects, i.e. it comprised less than 1 per cent of the streptococcal population enumerated on mitis salivarius agar, and less than 0.1 per cent of total cultivable flora enumerated on blood agar. Other organisms, presumably mostly other streptococci, followed a trend similar to that of *S. Sanguis*.

Table 10
Proportions of *S. mutans* and *Lactobacilli* in dental plaque and saliva.
Source: Houte et al (1982)

Subject Organism	Agar Medium	Upper Anterior Tooth Surfaces					Posterior Tooth Surfaces					Saliva					
		Caries Lesion		"White Spot"	Clinically Sound	Caries Lesion	Clinically Sound										
		IR ⁺⁺	IL ⁺⁺				IR	IL	Approx.	dL	Other						
M.G.	<i>Strep. mutans</i> ms*	46	11	56	80	IR 85	76	71	14	8							
	blood ⁺	53	10	76	78						40	15	8				
	<i>Lactobacillus</i> Rogosa	7.0	1.6	0.1	0.3						0.1	0.3	0.1	0.002			
J.M.	<i>Strep. mutans</i> ms	IR	IL	IR	IL	IR 33	26	4	dL	2							
	blood	51	68	56	67						79	86	5	7	2		
	<i>Lactobacillus</i> Rogosa	1.3	3.6	0.4	0.1						0.2	0.4	0.03	0.01	0.01		
C.R.	<i>Strep. mutans</i> ms	IR	IL	IL	IL	III _R	IV	deL	IV _R	d _R							
	blood	41	38	45	81						59	40	58	11	10	23	
	<i>Lactobacillus</i> Rogosa	0.1	0.1	0.5	0.1						0.04	0.06	0.01	8	10	27	
L.B.	<i>Strep. mutans</i> ms	III _R	III _L	II _R	III _L	III _L	29	13	21	11	ND						
	blood	88	79	81	76							71	80	36	12	ND	
	<i>Lactobacillus</i> Rogosa	0.1	0.1	0.7	5.6							0.7	0.3	<0.0002	<0.0003	<0.0003	ND
S.H.	<i>Strep. mutans</i> ms	IR	IL			IV _L d _L	56	38	d _L	0.2	8						
	blood	31	11									72	40	0.3	11	0.4	
	<i>Lactobacillus</i> Rogosa	10.7	14.4									6.6	10.0	0.01	III _R	V _L	
S.O.	<i>Strep. mutans</i> ms	IR	IL	IR	IL	IR 52	63	75	61	39	41	8					
	blood	63	51	71	60								38	56	34	28	14
	<i>Lactobacillus</i> Rogosa	0.35	0.04	0.007	0.0003								0.001	0.004	0.0001	0.0002	0.0002

* Colony number of *S. mutans* on *Mitis salivarius* agar or blood agar, respectively, expressed as a percentage of the total colony number on blood agar.
++ Abbreviations for deciduous dentition: I, II, III, IV, V, right (R), or left (L) upper teeth and a, b, c, d, e, right (R), or left (L) lower teeth designate the central incisor, lateral incisor, canine, first molar, and second molar, respectively, in each of the four quadrants.

Table 11

Proportions* and detection frequency of different Streptococcal species in plaque and saliva.

Source: Houte et al (1982)

	Upper Anterior Teeth			Posterior Teeth			Saliva		
Organism	Mean	Median	%Detect	Mean	Median	%Detect	Mean	Median	%Detect
<i>S. mutans</i>	57	(57)	100	26	(17)	100	9	(8)	100
<i>S. sanguis</i>	<3	(0)++	53	<13	(2)	70	8	(1)	100
<i>S. salivarius</i>	<0.1	(0)	13	<0.1	(0)	10	<0.1	(0)	20
Other	<9	(4)	81	24	(14)	100	30	(23)	100

* Colony number of different streptococci on Mitis salivarius agar expressed as percentage of the total colony number on blood agar.

+ Arithmetic mean. ++0 = Undetectable.

The finding of this study provides further support for the role of *S. mutans* in the initiation of human dental caries.

Boue, Armau and Tiraby (1987) in a study on 19 children harboured progressive lesions at various stages and the control group consisted of five caries free subjects. None of the children had received fluoride supplements or topical applications of fluoride, nor had they received long-term antibiotic therapy. Samples were divided into three groups: samples obtained from sound surfaces (Group A); samples obtained from upper and lower black-pigmented caries (Group B); and samples consisting of unstained caries (Group C). ***Streptococci*** represented the predominant type among the counted and isolated bacteria, with about 40 per cent of the total flora. A highly significant difference was seen between the values obtained from sound surfaces as compared with those obtained from black-pigmented caries ($p < 0.00001$), as well as with those obtained from unstained carious surfaces. *Streptococcus mutans* was the one for which the value of p was the lowest. On MSCP medium, various colonies representative of different morphological types were checked for identification by AP1 20 Strep. system. No colony was identified as *S. mutans*, some colonies belonged to *S. mitis* or *S. sanguis* 1 or 11 species, and a few responses were doubtful.

Actinomyces were recovered on a medium supplemented by various antibacterial and antifungal compounds. A greater number of *Actinomyces* colonies was recovered from the sound sites than from the carious ones.

Veillonella represented a group with numerical importance equivalent to that of *Actinomyces*, but conversely, they were more numerous over the carious sites than on the caries-free surfaces.

Lactobacilli constituted a negligible part of the flora colonizing sound surfaces, whereas on black-pigmented lesions, they represented 14.5 per cent of the total flora and were with *S. mutans*, the major members of the flora.

Table 12 presents the distribution of specific micro-organisms from sound surfaces, black-pigmented and unstained carious surfaces. From the statistical analysis of data, two types of flora were observed: one present on the sound surfaces, regardless of the state of the neighboring teeth; and another associated with the lesions.

The relationship of *Streptococcus mutans* and *lactobacilli* to incipient smooth surface dental caries in man was studied by Duchin and Houde (1978). Two groups of human subjects were used. In Group 1 there were five children aged 6-11 years with multiple decayed teeth. Three of these had incipient enamel caries located on buccal surfaces of recently-erupted first or second permanent molar teeth. In Group 2 five children, aged 7-12 years had multiple decayed teeth. Eight incipient smooth-surface caries lesions on recently-erupted permanent incisor teeth, canines or premolars were studied. The proportions of *S. mutans* in plaque over carious areas were higher than those in plaques from sound surface areas; the geometric means of the samples from each lesion ranged from 0.01 to 63.2 per cent, and of the samples from the sound surfaces from 0.002 to 0.7 per cent. The gingival region of a tooth has been regarded as more susceptible to colonization by *S. mutans* than areas more distant from the gingiva. Consequently, the 97 samples from sound surfaces were divided into 2 groups; 42 samples from less than 2mm from the gingiva and 55 samples from further away. Higher *S. mutans* proportions were present in the samples from close to the gingiva (median test $p < 0.01$). As carious lesions might have been located closer to the gingiva than sound surfaces from which samples were taken, it is possible that the higher *S. mutans* proportions within the lesions might reflect the normal pattern of colonization on the tooth surface. However, comparison of the

Table 12

Pooled microbiological data presenting the distribution of specific micro-organisms from sound surfaces (group A) or black-pigmented (group B) and unstained carious surfaces (group C).

Source: Boue et al (1987)

	Group A (23 samples)	Group B (15 samples)	Group C (10 samples)
Aciduric flora	2.5 ^a ± 3.6 ^b	27.5 ± 29.1	24.4 ± 17.5
Total Streptococci	37.1 ± 24.0	40.1 ± 22.3	41.5 ± 29.5
<i>S. mutans</i>	0.7 ± 1.8	17.1 ± 14.1	21.0 ± 26.0
EPS Streptococci other than <i>S. mutans</i>	13.4 ± 16.0	4.1 ± 7.7	2.1 ± 3.1
Actinomyces	18.0 ± 17.9	9.5 ± 11.1	3.0 ± 4.5
Veillonella	2.9 ± 4.3	8.6 ± 11.9	7.7 ± 5.9
Lactobacilli	0.3 ± 0.7	14.5 ± 16.0	2.7 ± 2.9
Bacteroides	10.7 ± 14.9	4.1 ± 4.2	6.2 ± 7.0
Pigmented Bacteroides	0.28 ± 0.53	0.07 ± 0.1	0.37 ± 1.0
Fusobacteria	0.2 ± 0.3	0.09 ± 0.1	0.6 ± 0.8

^aMean percentage of the total viable bacteria.

^bStandard deviation.

S. mutans proportions in the 95 samples from carious lesions with only those samples from sound surfaces near the gingiva, revealed that the proportions in the samples from the carious lesions were significantly higher (median test $p < 0.005$).

In the second series of samples, lactobacilli were not recovered from any of the lesions, although the subjects had salivary lactobacillus counts ranging from 3.0×1000 to 3.0×1000000 cfu/ml. Lactobacilli were only present in 3 samples obtained from the sound tooth structure surrounding lesion No.6; they comprised 0.02, 0.08 and 0.003 per cent of the total cultivable flora.

Strep. mutans also was proved to be an initiative factor in rampant caries in a study carried by Berkowitz, Turner and Hughes (1984). Plaque samples were taken from caries lesions, white spot margins of these lesions, and caries free smooth enamel surfaces, from seven subjects with nursing bottle caries. *S. mutans* was present in each sample from every subject (**Table 13**). The mean of the concentrations of *S. mutans* determined on MSB agar and expressed as a percentage of the total colony count on blood agar was 30.3 (3.5-75.4).

Lactobacilli were present in all the plaque samples (**Table 13**). The mean of the concentration of lactobacilli enumerated on Rogosa SL agar and expressed as a percentage of the total colony count on blood agar was 14.7 for caries lesions, 0.9 for white spot margins of caries lesions, and 0.07 for smooth enamel surface of caries-free teeth. This result also shows that lactobacilli have a limited involvement in the initiation of dental caries.

By reviewing all the above studies it has been shown that *S. mutans* is the important aetiological agent. *S. mutans* comprised around 60 per cent of the total cultivatable flora of dental plaque obtained from carious lesions in the rampant caries patients. In contrast, *S. mutans* comprises less than 1 per cent of the flora in children with little or no caries.

Table 13

Proportion of *S. mutans* and lactobacilli in dental plaque.

Source: Berkowitz et al (1984)

Subject	Organism	Sound enamel		Sample site		Caries lesion	
		White spot					
A.R.	<i>Strep. mutans</i>	3.51*	14.28	69.49	73.85	16.2	13.4
	<i>Lactobacillus</i>	0.003†	0.015	0.15	0.24	17.05	22.46
S.G.	<i>Strep. mutans</i>	13.5	15.8	48.84	55.34	15.20	11.27
	<i>Lactobacillus</i>	0.001	0.004	0.32	0.85	5.6	7.15
J.W.	<i>Strep. mutans</i>	19.34	13.68	49.31	72.21	17.48	3.24
	<i>Lactobacillus</i>	0.006	0.007	2.09	1.25	10.07	16.44
M.R.	<i>Strep. mutans</i>	17.99	—	43.28	61.93	25.11	—
	<i>Lactobacillus</i>	0.82	—	1.51	1.36	38.01	—
L.B.	<i>Strep. mutans</i>	19.7	5.1	75.4	48.0	45.7	22.3
	<i>Lactobacillus</i>	0.001	0.001	0.0003	0.035	11.6	4.6
A.T.	<i>Strep. mutans</i>	14.6	8.8	62.4	65.3	13.2	—
	<i>Lactobacillus</i>	0.0001	0.0004	0.0001	0.0006	23.3	—
M.L.	<i>Strep. mutans</i>	6.1	5.6	49.5	45.2	15.9	13.0
	<i>Lactobacillus</i>	0.0002	0.0003	3.20	1.27	10.1	9.45

*Colony number of *Strep. mutans* on MSB agar expressed as a percentage of the total colony number on blood agar†Colony number of *Lactobacillus* on Rogosa SL agar expressed as a percentage of the total number on blood agar.

3.2 LOSS OF SALIVARY PROTECTION

Saliva, a fluid produced by three pairs of salivary glands and numerous smaller mucous glands found in the oral cavity, constantly bathes the teeth in the normal mouth. Under ideal conditions saliva washes the substrate from the teeth, dilutes, buffers, or neutralizes acids formed in the decay process. The saliva is saturated with respect to calcium and phosphate, and thus by reason of solubility constants prevents the dissolution of the teeth. The first line of defense against dental caries is saliva. When the flow of saliva is altered or the composition is changed, a disruption in this defense results. As saliva becomes more viscous, its ability to wash the teeth is decreased. Its ability to penetrate into the caries susceptible areas, such as the pits, the fissures and the interproximal areas declines. Any decreased flow necessarily decreases the diluting, buffering, and neutralizing capacity of saliva. A decrease in the quality and quantity of the saliva may be due to radiation or action of drugs.

3.2.1 Radiation

Many reports indicate an increased caries incidence with a decrease in the amount of saliva and the ability of the saliva to flow. Rampant caries will follow the destruction of the salivary glands by radiation therapy to the oral region.

Karmioli and Walsh (1975), in their study reported five cases of dental caries after radiation therapy of the oral regions for treatment of carcinomas. The most obvious feature of three cases was the massive, widespread loss of tooth structure, beginning initially with the enamel and then proceeding to softening and loss of dentine. The buccal or labial and lingual surfaces, and the incisal and occlusal surfaces were all involved. The mandibular anterior teeth, which are usually the most resistant to caries, are equally if not more affected by this process and may be affected earlier than the other teeth. The mandibular anterior teeth, which are so extensively involved in this process, were not in the field of radiation of any of these patients.

The significant common factor in all the cases presented, however, was inclusion of the major salivary glands in the field of radiation, with resultant substantial decreases in salivary flow and a change in the character of the remaining saliva to a thick viscid, ropy mixture.

The other two cases (Karmioli & Walsh 1975) showed rather minimal destructive changes in the teeth considering the amount of radiation that was delivered to the salivary glands and the time interval since radiotherapy was delivered. These two cases demonstrated that the rampant lesions seen in the first three cases do not always develop. The patient's susceptibility to caries before irradiation, his ability to maintain adequate oral hygiene, the degree of dietary alteration, and the severity of xerostomia are factors in determining the final severity of the lesions.

Frank et al (1967) in a study on 61 patients, 59 of whom had been treated by a cobalt teletherapy unit for carcinomas of the oral cavity, oro-and nasopharynx, hypopharynx and larynx. Two patients with carcinomas of the floor of the mouth had radium implants combined with external roentgen-ray irradiation. In this study it appeared that, in all patients who had dental defects acquired after radiation therapy, the salivary glands were in the field of irradiation. Of the 61 patients examined, 28 were completely edentulous and the remaining 33 patients had all their teeth or, more often, were partially edentulous. In the latter group of 33 patients, 22 (66 per cent) had typical lesions related to irradiation; these patients stated categorically that the defects appeared after the beginning of the radiation therapy and progressed rapidly thereafter. In all of these patients, the salivary glands were completely or, in fewer patients, partially in the field of irradiation, whereas the teeth of 20 patients were outside the irradiated field, and the teeth of 2 patients were inside the irradiated field. There were no dental defects in 11 patients with teeth. Five of these patients were examined between 8 days and 4 weeks after the beginning of the radiation therapy, and there probably had not been time for the lesions to develop. In the other six patients, the salivary glands were completely outside the radiation field or only one side had been irradiated.

Clinically, three types of lesions were observed (Frank et al 1967). A sticky and sloughy material was usually present on the surfaces of the teeth.

A classic type of decay was localized at the cervical region of the teeth. From this region, it progressed superficially all around the neck of the tooth, sometimes involving large surfaces. This annular lesion proceeded toward a complete amputation of the crown.

The second type of lesion observed was a heavy, brown-black discoloration of the whole tooth.

The third lesion most frequently encountered after irradiation were generalized, superficial defects that first affected the buccal and later the palatal or lingual surfaces of the tooth crowns.

It appears clearly from all these studies that dental defects acquired after irradiation developed whether the teeth are outside or inside the field of irradiation. In all patients having such lesions, the salivary glands had been irradiated.

3.2.2 Drug Reactions

Many drugs have the side effect of dry mouth, and it has been pointed out that prolonged medication with these drugs may result in rampant caries. Aldous (1964) in a paper titled *"Induced Xerostomia and its relation to dental caries"* mentioned that if a positive relation between the amount of saliva produced and susceptibility to caries exists, then it is possible to increase the caries susceptibility through the use of certain medicaments. Some commonly used drugs such as the belladonna alkaloids, antihistamines, tranquillizers, amphetamine, and ephedrine are reported to cause drying of the mouth. The belladonna alkaloids, antihistamines, and tranquillizers may attribute this effect to their parasympatholytic properties. These drugs are often used as a chronic medication even for children. Antihistamines are frequently used for long periods of time in relieving the distress of allergies. The tranquillizers are also often utilised in some psychic disorders for long periods. A decreased ability of saliva to act as a defense against decalcification of the tooth structure from acids, might add greatly to the already increased susceptibility of the child patient to dental caries. Frequently prescribed prior to meals, these medications cause a decrease in saliva at the time of critical need to prevent caries and help in the mastication and digestion of the food.

The caries process is not a continuous dissolution of the substance, but a series of assaults which causes the end result. When these medicaments are used, the responsibility rests with the practitioner in alerting the patient to the need for good oral hygiene, whether or not the patient complains of a dry mouth.

Newbrun (1983) in his book *Cariology* mentioned that many drugs have a side effect of dry mouth, and it has been pointed out that prolonged medication with these drugs may result in rampant caries. Drugs with xerostomia potential are anticholinergics, antihistamines, antiparkinsonian drugs, antiemetics, narcotic analgesics, nonbarbiturate sedative hypnotics, tricyclic antidepressants, and many of the psychotropic drugs. Tranquillizers are widely used for long periods of time in some psychic disorders to relieve anxiety, tension, and agitation. Diazepam is the drug most frequently used by psychiatrists, followed by chlorpromazine. Long-term use of lithium carbonate, to prevent the manic episodes of manic-depressive illness, causes decreased salivary function and has been associated with cervical caries. Amphetamines and similar sympathomimetic amines are taken as anoretics in attempting to control obesity. Prolonged use of these drugs may cause dry mouth and extensive caries.

Winer and Bahn (1967) reported a case of teeth loss with antidepressant drug therapy. The patient was a 61-year-old man admitted to a locked psychiatric ward of the West Haven Veterans Administration Hospital with a diagnosis of severe depressive reaction. The patient was on antidepressant drugs (Tofranil 50mg t.i.d, trihexyphenidyl 2mg t.i.d, diphenhydramine 25mg t.i.d). Dental examination at admission revealed that only one of the patient's 12 remaining teeth was carious and this was repaired. For the next 8 months the patient complained of dry mouth and irritation caused by his upper denture. After that he lost two teeth because of advanced caries, and two months later all remaining teeth had developed deep carious lesions and full mouth extraction was considered.

It is known that most of the antidepressant drugs cause reduction in the salivary flow and this results in increased incidence of dental caries, so patients must be advised of the precautions and measures to prevent this incident.

3.3 TOOTH COMPOSITION AND ANATOMICAL FACTORS

Composition of the tooth, and its shape, govern the intrinsic resistance of the tooth surface to acid attack. Randolph and Dennison (1981), in their book *Diet, Nutrition and Dentistry* wrote on the host resistance as follows:

"The mesenchyme of the dental papillae is thought to contain the genetic sequences determining tooth size, shape, and chemical content. Environmental changes during formation of the matrix of dentin and enamel may be responsible for tooth morphology and mineral composition. Similar caries experiences in twins point toward the genetic component of caries development. Deep pits and fissures on the occlusal surfaces as well as tooth position and alignment in the dental arch are factors in bacterial plaque retention and caries production. Mineral content may be influenced during development by maternal systemic fluoride, vitamin D, calcium, and by salivary factors and topical fluorides. In Guatemala and Nigeria dental dysplasia is generally observed in the primary teeth of children of lower socio-economic classes, where protein-calorie malnutrition is prevalent".

Johnsen and Nowjack-Raymer (1989) in a study titled *Baby bottle tooth decay: issues, assessment, and an opportunity for nutritionist* stated that:

"The only condition differentially diagnosed from baby bottle tooth decay is enamel hypoplasia. However, because enamel hypoplasia occurs during tooth formation, the presence of "ring" defects at the time of emergence is a differentiating factor. Children with cleft lip and palate are more likely to have enamel hypoplasia and are at risk for incisor caries at sites common for hypoplasia".

Levine (1977) in a study on the aetiology of dental caries said that one of the earliest suggestions for the variability in caries experience was that enamel varied greatly in the degree of mineralization, there is little analytical evidence for a difference between the mineral content of sound teeth and carious teeth. So we must conclude that apart from a few isolated cases of gross developmental disturbance, variation in enamel mineralization is not an important aetiological variable. Of the other inorganic components of enamel, there is evidence that a few are of some minor importance. The carbohydrate content of enamel does show a fair variability and a high concentration is associated with reduced

enamel acid-solubility. Numerous trace elements whose concentration in enamel varies greatly have been shown to affect enamel solubility. As for the relationship between trace element concentration and caries experience, fluoride shows an inverse relationship to a remarkable degree. While there is little doubt that the fluoride concentration within the enamel surface is one of the most important factors determining caries susceptibility, it should be noted that the reduction in enamel solubility and caries experience does not appear to be directly proportional to enamel fluoride concentration.

Levine (1977) also mentioned that the presence of microstructural defects in the enamel surface is well recognised to be a variable phenomenon. It is possible that the presence of numerous surface defects may predispose a tooth to caries and this may constitute a minor factor in our present problem.

Levine (1977) also states that there is a relationship between tooth morphology and caries prevalence. He stated that as the most frequent site for caries is in pits and fissures of the dental crown and as the extent and depth of these vary enormously, pit and fissure morphology is probably a factor in caries experience and is genetically determined. It is convenient to include the food stagnation factor, as it is determined by both tooth morphology and the occlusion. Where teeth are imbricated the tendency to increased food stagnation predisposes to increased local cariogenicity.

It is important to mention here that the host factor (tooth composition) is always considered one of the factors which affect the progress of dental caries.

3.4 FERMENTABLE CARBOHYDRATE

Eating patterns develop early in infancy when milk is provided on demand to satisfy the hungry infant. Later, taste and appetite may play a role in the choice of foods, but adults are generally responsible for establishing eating patterns in infants. Food habits represent a complex sum of cultural, social and emotional attitudes, experiences, physiologic needs and food availability. Disturbances in any of these areas may lead to unusual food habits, which in turn may be detrimental to the individual. Rampant caries is an example of this.

Drinkard and Dilly (1982) reported a case of a preschool child in whom a bizarre food habit resulted in total destruction of the primary dentition. The child, a three-year eight-month white male, was referred to the Department of Pedodontics at the University of North Carolina School of Dentistry. The caries process was most likely initiated by the prolonged use of the nursing bottle until 18 months of age. At the time of weaning, the nursing bottle was replaced by bananas, which were retained in the child's mouth day and night. This led to severe destruction of teeth, even obliterating the typical pattern of nursing caries.

Abdullah (1984) reported a case of rampant caries due to an uncommon medical problem. The patient, a 14-year-old boy, was referred to the University of British Columbia dental school because of a *"remarkably high tendency towards developing caries"*. The patient had an esophageal stricture, which had influenced his eating habits and selection of foods, and he preferred liquids and semi-solid foods, ate slowly and chewed his food carefully. His morning meal consisted of cereals and milk, and only orange juice or milk was taken for lunch. His mother said that he snacked constantly and often ate plain sugar. Regarding the caries picture, the most striking observation was the large number of chalky enamel lesions. These lesions occupied a considerable part of the facial and lingual surfaces and some encircled the teeth, and frank lesions were found on both facial and lingual surfaces. The second premolars had been extracted and all remaining teeth were either decayed or filled (DMFT = 28). Composite resin restorations covered major parts of the facial surfaces of his anterior teeth.

Parents are often shocked to learn that prolonged, and frequent, breast feeding is the main reason for the dental caries in their child. The lactose content of human milk is higher than bovine milk or milk formula, and can produce dental caries if left stagnant long enough on the tooth surface. Many studies have reported a relationship between prolonged breast feeding and rampant dental caries.

Gardner et al (1977) reported four cases in a study *"At-will breast feeding and dental caries"*. The children aged between 20 months to 31 month were all breast fed and the feeding continue day and night. Most of the time the child slept with his mother and was allowed to nurse all night.

Kotlow (1977) in a study on breast feeding as a cause of dental caries in children reported on two children. Case 1 was a two and a half year old male. Dental history revealed the child was breast fed until two years of age. The parent allowed the child to nurse and sleep on breast, three times a day for one or two hours, and at night for many more hours. Clinically, both upper central incisors were grossly carious with pulp involvement. Case 2 was a fourteen-month-old female. Dental history revealed breast feeding and that the child often slept with the mother. The caries in both upper anterior teeth was deep.

Another case which was reported by Curzon and Drummond (1987) was of rampant caries in an infant related to prolonged on-demand breast feeding and a lacto-vegetarian diet. The child was an 18-month-old boy. Oral examination revealed areas of decalcified enamel affecting the gingival third of the enamel of the four maxillary incisors, only the primary incisors were fully erupted. The dietary history revealed that the child was still being breast fed both day and night. The parents were in the habit of having the baby sleep with them, so that suckling occurred frequently during the night. Little attempt had been made to wean the child, and the only solid foods given were mashed fruits and vegetables. The parents were committed lacto-vegetarians and believed that breast feeding should be prolonged as long as possible.

Prolonged nocturnal bottle feeding appears to be a prime aetiologic factor in rampant caries of the infant and young child. The condition may be found as early as age 16 months. Milk in particular, is responsible for a major amount of the damage.

Ripa (1978) wrote:

"Bovine milk and milk formula contain the carbohydrate lactose. Laboratory studies have shown that lactose, a disaccharide composed of glucose and galactose, will enhance the oral implantation of cariogenic bacteria in animals, will produce dental decay when fed to animals and will produce decalcification of tooth enamel when acted upon by bacteria".

Bovine milk and milk formulas are thus implicated in the "*nursing bottle caries*" syndrome by virtue of their lactose content. Ripa (1978) also stated that under usual dietary conditions, milk is probably not conducive to decay, because, being liquid, it is rapidly cleared from the oral cavity and contact with the teeth is minimal. In fact, some laboratory studies have even demonstrated that bovine milk contains substances which can act to prevent dental decay. The habit of prolonged use of the nursing bottle, especially at night, is the important factor in the development of gross decay in infants and young children.

Kroll and Stone (1967) studied nocturnal bottle-feeding as a contributory cause of rampant dental caries in the infant and young child. Seventy nine patients were selected as they presented in a general dental practice. Their age was up to 7-years so that the condition of the anterior teeth could be properly evaluated. The relationship of caries to nocturnal milk feeding is summarized in **Table 14**. Of the entire group, 72 per cent did not exhibit rampant caries, 13 per cent showed a typical rampant caries, and 15 per cent showed typical rampant decay.

Table 14

History of rampant caries.

Source: Kroll and Stone (1967)

Nocturnal nursing bottle habit	None	Atypical*	Typical@	Total
Not at all	44	6	1	51
Less than one hour	12	2	3	17
All night	1	2	8	11

@Typical - all teeth except the 6 lower anterior teeth are affected by decay.

*Atypical - any other pattern of rampant decay.

Of those 51 patients (Kroll & Stone 1967) who were not on prolonged nocturnal milk bottle feeding 86 per cent had no rampant caries, 12 per cent showed an atypical pattern, and 2 per cent showed the typical pattern of decay. These figures are highly significant in pointing out the relationship of prolonged nocturnal bottle feeding to rampant caries.

Johnsen (1982) studied the characteristics and backgrounds of children with nursing caries. Seventy seven children aged 3 1/2 years or less were in the study. Inclusion in the study was based on dental caries pattern, and not nursing history. Children were included in the incisor caries group if three incisors had carious lesions which had progressed beyond the white spot state to cavitation.

Nursing habits of children as reported by are shown in **Table 15**.

Ninty-six percent of children with incisor caries had either slept with the bottle overnight or for naps, or had the bottle removed after going to sleep with it. None of the caries-free slept overnight with the bottle, 45 per cent had the bottle removed after falling asleep.

Table 15
Nursing habits of children as reported by parents.
Source: Johnson (1982)

Nursing habits:	Carious Incisors		Carious-Free	
	Number	Per cent	Number	Per cent
Naps/overnight	31	66	0	0
To sleep then remove	14	30	9	45
Breast fed	2	4	11	55

Derkson and Ponti (1982) in a study on 594 children, all between nine months and six years of age, found 19 had a nursing bottle syndrome. The data for bottle feeding indicated a tendency for the nursing bottle group to have had the bottle ad libitum more frequently than the non-nursing bottle group. Their results are shown on **Table 16**. The habit of taking the bottle at every nap and night time is more frequent in the nursing bottle syndrom group. Fourty per cent of the non-nursing bottle group never had a bottle at night or nap time as compared with 10 per cent for the nursing bottle group.

Table 16
A comparison between nursing bottle syndrome with non-nursing bottle syndrome.
Source: Derkson and Ponti (1982)

Bottle Feeding					Breast Feeding				
		Non-NBS		NBS			Non-NBS		NBS
Bottle feeding habits:					Percentage of babies breast fed		73%		74%
on schedule		41.2%		36.8%	Bottle supplementation of breast feeding		31%		21%
ad lib		43.8%		63.2%	Feeding method after weaning:				
no bottle feeding		15.0%		0%	bottle		79%		85.7%
Frequency of bedtime bottle:					cup		15%		7.1%
every nap & night		40.2%		57.9%	bottle and cup		6%		7.1%
every nap		0.6%		0%	Breast feeding habits				
every night		13.4%		21.1%	schedule		12.5%		7.1%
4-5 x/ week		1.0%		5.3%	ad lib		87.5%		92.9%
occasionally		5.3%		5.3%	Prolonged breast feeding at 6 months age				
never		36.6%		10.5%	night		5.7%		21.1%
Nipple in mouth all night:					day		2.3%		0%
yes		10.7%		47.1%	night & day		4.3%		5.3%
no		86.9%		52.9%	neither		87.7%		73.7%
Prolonged daytime bottle									
Yes		20.2%		55.6%					
no		79.6%		44.4%					
	mean	range	mean	range		mean	range	mean	range
Frequency of bottle feeding at 9 months (times/day)	4.4	1-23	4.2	1-10	Hours of breast feeding at 6 months	2.2	1-14	1.6	1-2
Total hours spent with bottle at 9 months	2.2	0.5-24	8.3	0.5-24	Age of weaning from breast feeding	7.0	1-32	7.9	1-36
Age at time of weaning	17.7	2.0-48.0	21.4	11.0-35.0					

The frequency of keeping the nipple of the bottle in the mouth all night was greater in children with nursing bottle than without nursing bottle (Derkson & Ponti 1982). Using the bottle for prolonged periods of time during the day occurs more frequently in the nursing bottle group. The average number of hours spent with access to the bottle was 8.3 hours for the nursing bottle syndrome group and 2.2 hours for the non-nursing bottle group. However, 30 children without nursing bottle syndrome had prolonged access to the bottle of over eight hours per day. There was also a tendency for the nursing bottle syndrome group to have been weaned from the bottle when they were older.

The relationship of nursing bottle syndrome to specific aetiological factors was not conclusive. The use of a nursing bottle as a pacifier seems to be at the root of the problem. It is interesting to speculate on the reason why a proportion of comforter suckers escaped caries. The substance placed in a comforter bottle is no doubt of great importance.

A study of 602 pre-school children in London (Winter et al 1971) showed that 83 per cent of children with rampant caries had been given a sweetened comforter. An equally important statistic was the fact that only 13 per cent of children who were pacified by sweetened comforters developed rampant caries. This was confirmed by Silver (1974) who used similar criteria and found that 14 per cent of children given sugared comforters developed the disease. The fact that not all children who are given sweetened comforters develop rampant caries may be partly due to some innate resistance and partly to difference in the frequency and duration of use of the comforters.

Another important factor in the aetiology of rampant caries is fruit juice erosion. There is evidence that the consumption of fruit juice is increasing and a greater proportion of the public is exposed to the potential risk of erosion from beverages and foods containing acid or chelating agents. Dental erosion may be defined as "*a chemical dissolution of the clinical crown of a tooth which is independent of microbial action*" (Levine 1972). The importance of citrus-fruit-based beverages and foods and natural fruit juice in dental

erosion is due to their popularity and the relative efficiency of citric acid as a decalcifying agent by virtue of its hydrogen ion concentration and chelating ability. Two cases of fruit juice erosion were described by Levine (1972). The first case was that of an Australian girl aged 24 years. The labial surfaces of her upper central incisors showed several small enamel defects 1-2 mm in diameter. The palatal enamel of all upper anterior teeth was missing except for a narrow cervical rim. The occlusal enamel of upper premolars on both sides, together with the cuspal dentine, was largely missing. The lower posterior teeth displayed similar defects. The patient admitted to drinking a glass of fresh orange juice three times a day with her meals, with each glass containing the juice of 6 oranges.

The second case was a 22-year-old girl complaining of pain from her upper anterior teeth on taking hot or cold drinks. On examination the upper right central incisor was found to have a shallow smoothly contoured oval defect of labial enamel measuring 3x2 mm. The exposed dentine was smooth, hard, and of normal colour and was sensitive to probing and thermal change. The patient had increased her consumption of fruit juice 6 months previously to include approximately 10 fl oz of bottled natural orange juice per day as well as 2 whole oranges or apples, and about 2 lb of stewed rhubarb per week.

Individual susceptibility to dental caries is dependent upon the severity and frequency of the acid insult and the ability of the saliva to dilute and buffer the acid as well as intrinsic resistance of the enamel to attack. Any fermentable carbohydrate, such as sugar, high-fructose corn syrup, or lactose, when taken in the nursing bottle can contribute to rampant caries. Commonly reported bottle contents are juice, soda pop, and sugar sweetened soft drink, as well as milk. Several authors have suggested that rampant caries can occur with excessive ad libitum breast feeding but that the occurrence is less likely than with bottle-fed children.

4 INITIAL CONTROL OF RAMPANT CARIES

The control of dental caries refers more specifically to the slowing down or even arrest in the progress of the carious lesion already present in the tooth. For the most part, this involves a consideration of dentine caries rather than more superficial enamel caries.

Caries control is the problem and concern of patient and practitioner, since it involves the treatment of an active disease process. It is necessary to distinguish between caries control and caries prevention so that a clear distinction may be made between the ultimate objectives of the therapeutic procedures proposed by dental scientists. The control of caries involves arresting the progress of active decay in the dentine.

This may be achieved by:

- Sugar control;
- Oral hygiene measures;
- Determination of salivary flow and viscosity; and
- Arrest of caries.

4.1 DETERMINATION OF SUGARS

Dental caries is primarily the result of bacterial action upon the tooth surface. The organisms are primarily acidogenic and they depend upon a carbohydrate substrate for acid production, refined carbohydrates are broken down and metabolised into acids upon the surface of the tooth with extraordinary rapidity. Brauer (1964) wrote in his book *Dentistry for Children* that the pH on the surface of the tooth drops from 7.0 to 5.0 within 1 1/2 minutes of the ingestion of a sugar. If a person were to consume sugars only at mealtimes, such caries attacks could very well be neutralized by the buffering action of the saliva and also the neutralizing action of concomitantly ingested alkaline foodstuffs. However, when refined sugars are ingested between meals and at frequent intervals, the teeth are subjected to an almost continuous series of assaults by acids formed on the tooth surface. The caries attack rate thus becomes enormously increased by the habitual consumption of sugars between meals.

Brauer (1964) also stated that it is not so much the total quantity of sugars consumed during one day that is so important as the number of times a sugar meal is taken.

Thus, 20 tsp of sugar consumed at one sitting is much less injurious to teeth than 5 tsp consumed four times a day in the form of between-meal sweets. The latter produces four separate carious attacks, the former only one. The cariogenic potentialities of various foods containing equivalent amounts of sugar may vary considerably, depending upon how long each tends to stick on the surface of the enamel. Foods such as cookies, dates, chocolates, caramels and ice cream stick to the tooth surfaces for long periods of time, because they are made adhesive by the presence of highly refined starches (glutens), have a high decalcification potential. Foods such as orange juice and carbonated beverages which contain equivalent amounts of sugar but are not adhesive to the tooth structure are quickly removed from the mouth and have much lower cariogenic potential.

During the analysis of diet for the purpose of caries control, it is therefore important to consider also the adhesiveness of the sugar-containing foods consumed between meals, since this markedly affects their cariogenic properties. Between-meal snacks consisting of sticky cookies and caramels are highly cariogenic and should be replaced by foods such as potato chips, or orange slices.

Bjarnason, Finnbogason and Noren (1989) carried out a study on the sugar consumption and caries experience in 12 and 13-year-old Icelandic children. They studied the dietary habits with regard to sugar consumption and caries experience in a group of 275 children. The pattern of meals and sugar-containing food intake frequency were assessed by means of a dietary questionnaire. Only 75 per cent of the children had three regular meals daily. Breakfast and lunch were the most frequently omitted meals. Sweet buns were consumed by 32 per cent of the children with meals and by 58 per cent between meals, whereas soft drinks were consumed by 42 and 46 per cent respectively. Eighty-three per cent of the children reported eating sweet products daily. The most popular sweet products included confectionery, bun, cakes, and soft drinks, which constituted 53 per cent of the intake with meals and 68 per cent of that between meals. A higher caries incidence was associated with more frequent intake of buns and cakes with meals and confectionery. This study was

performed with the emphasis on the intake of a rather limited range of sucrose-containing products. The exposure to other sugars known to be implicated in caries aetiology and the intake of products containing "hidden" sugars were not recorded.

Becks, Jensen and Millar (1944) studied the effect of reducing the intake of refined carbohydrates on the *Lactobacillus acidophilus* index and subsequent caries experience in a large number of individuals with rampant dental caries. Through the cooperation of dentists and physicians who referred their most problematic cases, more than a thousand individuals with rampant caries were observed in this five-year interval. From these, a total of 790 one-year observations were made, 499 being observed for one year, 111 for two, 15 for three, and six for four years. Their ages ranged from 4 to 60 years for the 272 males and 359 females in the sample.

For the purpose of listing the food taken, a record form was made available to the patient with careful instructions to record food intake for a typical one-week period. The first recommendations for a change of food intake were based on the number of *L. acidophilus* present and the amounts of refined carbohydrates consumed. In general, this required restriction of the following foods: sugar in and on foods; all concentrated sweets such as jam, jelly, syrup, honey, raisins, dates, figs, prunes, currants, canned fruits, candy, chewing gum, confections, pastries and sweet beverages. A reduction of the *L. acidophilus* index was obtained within a period of a few weeks by reducing the intake of refined carbohydrates and replacing the calories derived from these foods by increasing the intake of meat, eggs, vegetables, milk and milk products. The reduction of the *L. acidophilus* index resulted in a drastic decrease in dental caries frequency. In the group of 790 rampant caries cases (ten or more new cavities in the preceding year), the prevention of new cavities was achieved along with the reduction of the *L. acidophilus* index to the extent of 80 per cent. Of these, 62.3 per cent were arrested completely, while an additional 17.7 per cent developed only one or two cavities during the following year. This incidence of favorable response establishes the definite relationship between the reduction of the sugar intake, the *L. acidophilus* index and the reduction of dental caries activity.

In contrast to the previous study, a more recent study was carried by Kristoffersson, Axelsson, Birkhed and Bratthall (1986) in Sweden on 388 13-year-old school children from Karlstad. The study aimed to find the relationship between caries prevalence, salivary *Streptococcus mutans* and dietary scores. Significantly lower DFS values were found in the group with no detectable *S. mutans* ($p < 0.01$). No differences were found between the DFS values of individuals with high, moderate or low dietary scores. There was no statistically significant association between dietary scores and levels of *S. mutans*. During the last decades changes in eating habits have occurred. For example, the ingestion of sugar-containing snack-food like sweets, soft drinks and ice cream has increased. Several factors have been considered to explain the reason for the decreasing caries prevalence in Sweden although the sugar consumption still remained high. The widespread use of topical fluoride and improved oral hygiene have been suggested as the two main reasons.

A dietary analysis is an essential part in the determination of the carbohydrate intake for the control on the rampant caries. A dietary analysis makes it possible to determine the nature and quantity of the substrate. The simplest type is a qualitative diet analysis. From it, sufficiently comprehensive information can be obtained to enable the dentist to undertake replacement diet therapy. The procedure is as follows:

1. The parent or patient is given an instruction sheet and a series of blank charts.
2. On the diet charts the parent or patient enters a description and the quantity of all food and drink consumed each day. This list should include everything taken between meals as well as at the main meals of each day.
3. When the completed diet sheets are returned, the dentist compares the amounts of each food eaten with the quantities recommended for a person of that age.
4. From the results of this analysis the dentist can quickly see which foods require to be decreased and which should be increased.

Davies (1954)

Conclusions. It has been demonstrated by means of direct clinical observations that the reduction of excessive sugar consumption to normal requirements and the elimination of between-meal sugars, especially varieties which stick to the tooth surfaces for long periods of time, almost invariably result in a marked slowing down of the incidence of dental caries.

4.2 DETERMINATION OF ORAL HYGIENE

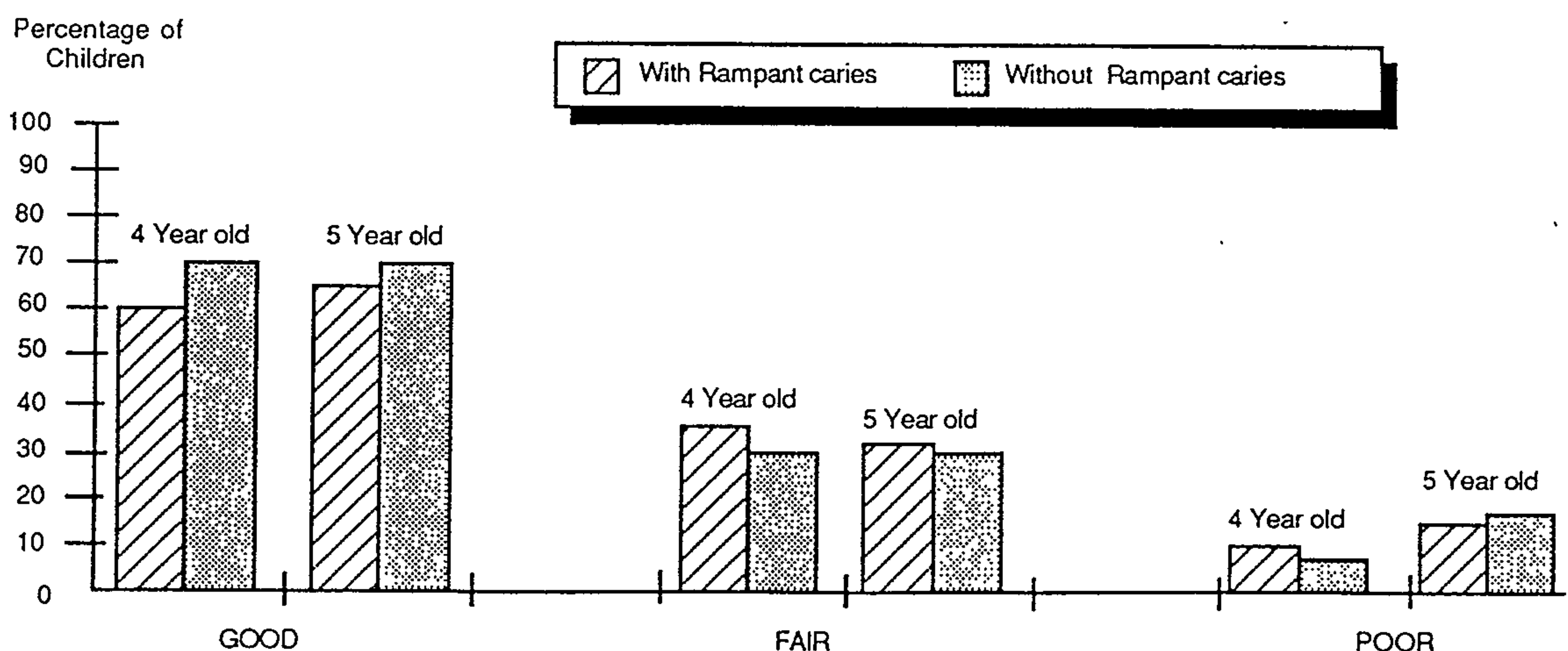
The aim of cleaning the teeth thoroughly at least once each day is to control plaque. To achieve this in the deciduous dentition the parent is taught to clean the child's teeth using a small toothbrush and a simple scrub technique. In the early permanent dentition group, the children are usually able to brush for themselves under parental supervision. Disclosing tablets can often be valuable at this age. Older children and adults with rampant caries are taught a suitable method of brushing and how to use a disclosing technique to test their brushing efficacy. Other oral hygiene aids such as floss and the interspace brush are introduced to make possible the cleansing of otherwise inaccessible stagnation areas. (Hill & Levine 1978)

Winter et al (1966) studied the role of the comforter as an aetiological factor in rampant caries of the deciduous dentition. Two groups of 100 children aged 1-5 years were investigated over an 18-month period in 1963-64. One group contained all children who presented in the Children's Department, Eastman Dental Hospital, with rampant caries. The control group consisted of children attending a child welfare center for a routine medical examination. Eighty five per cent of the study cases and 72 per cent of the control group claimed to be cleaning, or having their teeth cleaned, with a toothbrush. The mean age for the onset of this practice was 1 year 6 months in the study group and 1 year 10 months in the control group. Tooth cleaning was claimed to be carried out for a mean of 1.5 times per day per case in both the study and control groups. This study proved that the oral hygiene habits practised by the child were not statistically significantly associated with rampant caries.

Noah (1988) in a study on rampant caries prevalence and the role of oral cleanliness in its aetiology in the deciduous dentition, examined a total of 819 children comprising 395 4-year-old and 424 5-year-old children. The proportion of children who had good oral cleanliness in the non-rampant-caries group was a little higher than the rampant-caries

group although the proportion of those scoring "poor" were almost the same in each of the two age groups. The distribution is shown diagrammatically in Figure 1. When those with good and fair oral cleanliness were pooled, the figures for the groups were only slightly different in both age groups. The results for oral cleanliness in the two groups indicated that oral hygiene does not play a major role in the aetiology of rampant caries.

Figure 1
Percentage of children with rampant caries.
Source: Noah (1988)



Karmioli and Walsh (1975) in a study on dental caries after radiation therapy stated that:

"the development of these destructive lesion can be prevented or minimized in cooperative patients by vigorous methods of oral hygiene and the use of fluoride. Those patients with reasonably good dentitions should have a thorough prophylaxis and complete restorative dentistry and should be instructed in adequate toothbrushing with a soft brush as well as the use of oral rinses."

Berenie, Ripa and Leske (1973) studied the relationship of frequency of toothbrushing, oral hygiene, gingival health, and caries-experience in school children. A total of 389 children, 9-13 years of age, and residents of a fluoride-deficient community in western New York

(Geneva) participated in the study. Berenie et al (1973) found that the most noticeable effect of increased frequency in daily brushing relates to the oral hygiene of the children. The results demonstrate, as daily brushing increases, the mean Oral Hygiene Index decreases. The differences in mean Oral Hygiene Index between the different brushing groups for the boys-girls combined category are all statistically significant, except for the comparison between the twice-daily versus the more than twice-daily group. This finding appears to indicate that brushing more than twice daily does not improve oral cleanliness significantly, whereas the maximum benefits are obtained with a regimen of brushing twice daily. Particularly significant are the comparisons between the oral debris of those children who brushed less than once a day and all of the other groups. The oral hygiene of these children, as reflected by the OHI index, is significantly worse than all other groups in which brushing is performed on a daily basis. This finding was maintained when the sexes were evaluated either independently or together. The absence of routine daily habits of brushing produced a state of poor oral hygiene which is clinically demonstrable and statistically significant.

James, Parfitt and Falkner (1957) studied the aetiology of labial caries of the deciduous incisor teeth in small children. Fifty eight children were reviewed, 30 boys and 28 girls aged between 8 and 47 months. James et al (1957) found that if oral hygiene is bad, and a high carbohydrate diet taken, the surfaces of the teeth will be coated with a carbohydrate film to a greater or lesser extent according to inclination of teeth and individual muscle action. This film acts as a sponge, picking up concentrates and retaining them on the tooth surface with a consequent fall in hydrogen-ion concentration and dissolution of the enamel.

The studies reviewed show there is no unequivocal evidence that good oral cleanliness reduces caries experience, nor is there sufficient evidence to condemn the value of good oral cleanliness as a caries preventive measure. Fortunately there is no conjecture about the advice that may be given to patients to use Fluoride toothpastes which are capable of reducing the incidence of caries, and their regular and frequent use is recommended.

4.3 DETERMINATION OF SALIVARY FLOW AND VISCOSITY

Under normal conditions, whole saliva usually has a liquid consistency with a slightly cloudy appearance. The pH value of normal saliva in a resting state ranges from 5.6 to 7.6, with an average of 6.75, a value close to neutrality. Salivary secretion decreases in all humans during sleep because the salivary glands do not secrete spontaneously. Since there is no saliva to buffer and wash away fermentation products of plaque during sleep, the most important time for plaque removal is just before bedtime. Saliva is necessary to maintain the integrity of the teeth.

Newbrun (1983) wrote on the relation between salivary composition and caries:

"A major problem in studying saliva is that its composition varies with flow rate, nature of stimulation, duration of stimulation, plasma composition, the time of day at which samples are collected, and the serial dependency of saliva samples, i.e. the effect of previous stimulation on the composition of saliva collected subsequently. Unfortunately, in many studies these variables have not been adequately controlled. Another difficulty in interpreting results of studies on salivary composition is that saliva is a mixture of the secretions from the three pairs of major salivary glands with contributions from numerous minor mucous glands. The secretion of each type of gland has a unique composition. For example, the secretion of the submandibular salivary glands contains about 50% more calcium (6.8mg calcium/100 ml) than that of the parotid glands (4.1 mg calcium / 100 ml). Such regional differences may, in part, account for the observed relative immunity of the lower anterior teeth to caries and the higher frequency of calculus deposits. An inverse relationship between salivary flow rate and caries may exist. The flow rate itself influences the salivary $\text{Na}^+/\text{HCO}_3^-$ ratio; at higher flow rates there is an increased buffer capacity. Patients whose saliva has a higher buffer capacity tend to have less caries. Further evidence of the importance of saliva as a buffer was demonstrated when the pH of carious lesions and of dental plaque was studied. Within active carious lesions (dentine), a pH gradient exists. The deep advancing edges of such lesions are more acidic than the shallower layers, which have a pH similar to that of saliva. In enlarged and exposed cavities that are emptied of their contents, the carious layer is shallower and the pH closer to neutrality probably because of the better access to saliva".

Frank et al (1967) studied acquired dental defects and salivary gland lesions after irradiation for carcinoma in 61 patients. Patients with salivary glands in the field of irradiation showed a drastic depression of salivary flow during the first days of treatment. In these patients, it was difficult to collect saliva and, in several persons, no saliva at all could be obtained after 10 minutes. This reduction in saliva has been observed in the great majority of patients. Depression in salivary flow has been observed as long as 5 years after irradiation; however, it seems that after a certain amount of time, varying from 2 to 6 months, the salivary flow can increase again in certain patients. A typical change in the consistency and colour of the saliva also has been seen. After irradiation of the salivary glands, the saliva becomes a thick, viscid, white or yellow-to-brown solution. Immediately after the saliva has been collected, it begins to foam intensely. Patients also complain of loss of taste and sometimes mouth bitterness.

The total nitrogen content of normal saliva varies over a wide range from 25.9 mg/100 ml to 99.0 mg/100 ml. The total nitrogen content of the saliva in patients with irradiated glands was determined with the micromethod of Kjeldahl. An important increase in the total nitrogen content, which was greatest in patients with dental defects, was seen. After 2 years of irradiation in one patient, the saliva, though normal in rate of flow and appearance still had an increased total nitrogen content. Frank et al (1967) also stated that the fact that the thick yellow-to-brown saliva collected in the study could not be dissolved in distilled water suggests that the high organic content is not related to necrotic cells, which would have dissolved easily.

In strong contrast to the patients with irradiation of salivary glands, patients who received cobalt teletherapy for carcinomas of the oral cavity or the hypopharynx and larynx, with salivary glands outside the field of irradiation had saliva that was normal in flow, consistency and aspect, and their saliva pH was near neutral or higher. (Frank et al (1967))

Levine (1977) in his article on the aetiology of dental caries wrote about the role of saliva in dental caries as follow:

"The importance of saliva in the complex of factors determining caries experience has assumed greater importance in the past two decades although its importance was obvious much earlier with the recognition of the form of rampant caries which follows post-radiation desalivation. There are four characteristics of saliva which are relevant to the present problem. Firstly flow rate, which varies greatly not only between individuals but in an individual from hour to hour. A high flow rate will tend to wash away food debris and dilute acid in the mouth. "Radiation caries" provides the most dramatic demonstration of this factor. However a direct relationship between caries experience and flow rate is difficult to prove. Secondly, the viscosity of saliva must again be considered. Although there is little evidence it is often suggested that watery saliva may help cleanse the oral cavity and dilute acid better than viscous saliva and this may have some bearing on the variability of caries attack. The next characteristic is the presence of antimicrobial agents in saliva such as urea and lysosyme. These are known to be present to a variable degree and again may be of some relevance. The final characteristic of saliva and probably the most important is the salivary buffering capacity, its ability to neutralise acid. This is largely due to the carbonate- bicarbonate system and the buffering capacity of saliva has been found to vary greatly. Again although there is little supporting evidence, many workers believe that this variable is of importance in determining caries experience".

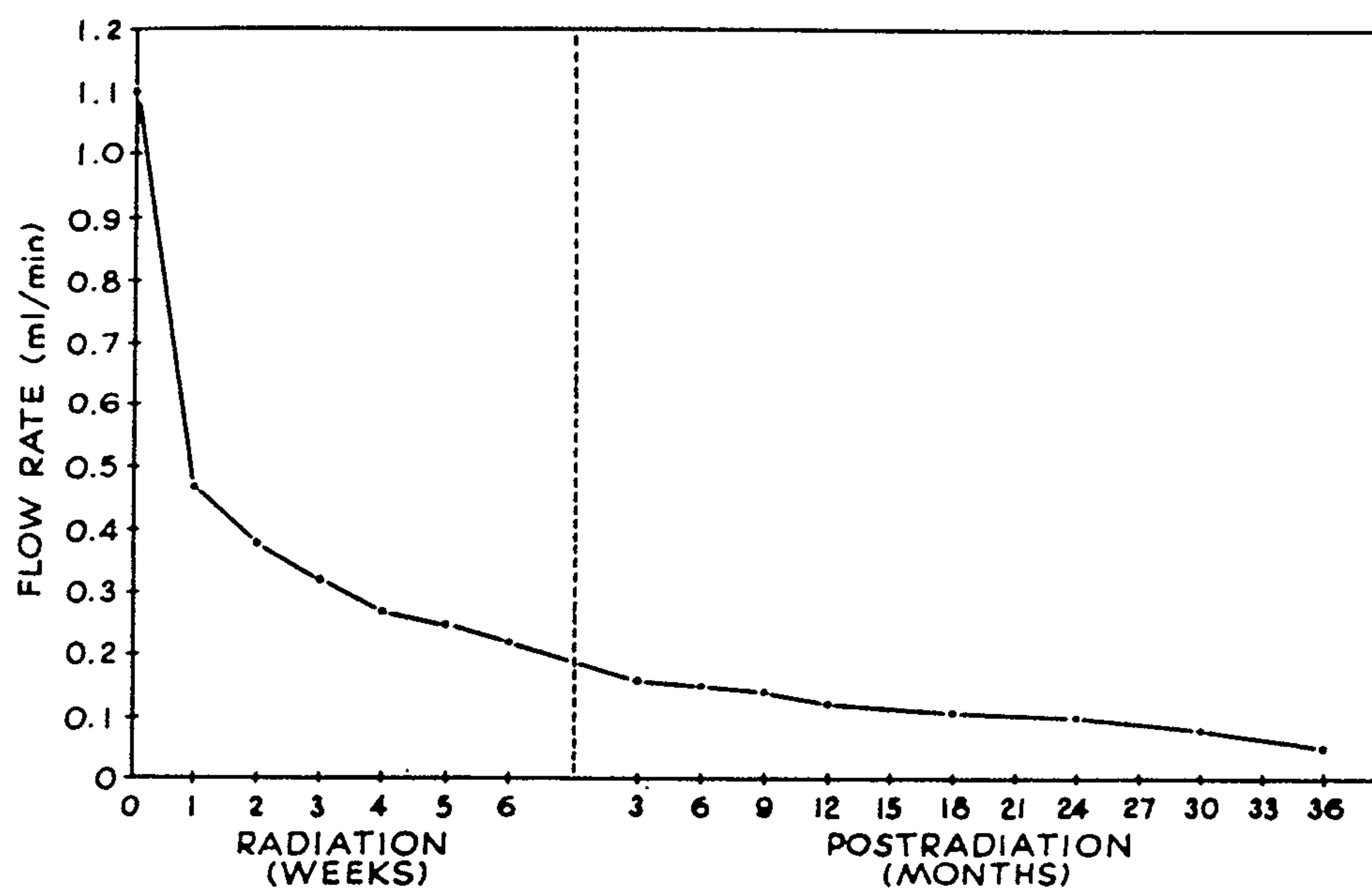
Dreizen, Brown, Daly and Drane (1977) in a study on the prevention of xerostomia-related dental caries in irradiated cancer patients examined 42 patients at the University of Texas. The mean age of the 27 men and 15 women was 51.8 years. The mean flow rate of stimulated saliva was 1.1 ml/minute before radiation. This dropped sharply to 0.47 ml/minute after the first week of radiation and declined steadily to 0.22 ml/minute by the end of radiation. The reduction in mean flow rate persisted throughout the postradiation period reaching levels of 0.12 ml/minute at one year postradiation, 0.10 ml/minute at two years postradiation, and 0.05 ml/minute at three years postradiation. The long term flow rate clearly show that the loss of the saliva-producing potential in the irradiated glands was essentially irreversible (Figure 2).

Reduction in salivation began very early in the course of radiotherapy, and intensified throughout the postradiation period (Dreizen et al 1977 **Figure 2**). Although some of the xerostomia patients experienced subjective improvement in mouth dryness in the months after radiation treatment, there was no increase in saliva output when the flow rates were measured objectively. The flow rate changes parallel the dose-related increase in the number of acinar cells that undergo non regenerative destruction resulting in the complete loss of most acini and substantial damage to the remaining few.

Figure 2

Mean flow rates of stimulated whole saliva in 42 patients with cancer before, during, and after radiotherapy.

Source: Dreizen et al (1977)



McDonald (1956) in Muhler and Hine's *Symposium on Preventive Dentistry* stated that weekly quantitative analysis should be made of the saliva to determine if dietary improvement is accompanied by an increased flow. This has been observed to happen in many cases and, coincident with it, a loss of excess weight and the acquiring of a general feeling of well-being. The normal or increased salivary flow aids in the solution of food

debris on which microorganisms thrive. The saliva manifests a variety of antibacterial and other anti-infectious properties. These have been ascribed to mucus, lysozyme and other bacteriostatic inhibitors and bacteriolytic and bacteriocidal substances. If the salivary glands have not undergone degenerative or metaplastic changes, and if the nerve pathways between the central nervous system and the salivary glands are still intact, pilocarpine hydrochloride is capable of stimulating salivary flow. Pilocarpine when prepared as in the recommended prescription is a tasteless liquid that can be added to water or milk at mealtime. In about twenty minutes the salivary glands will secrete quantities of saliva which may exceed two or three times their normal output.

Conclusion. The stimulated salivary flow should be determined in every case of rampant caries. The buffering capacity of the saliva is the most important acid-neutralizing mechanism in the mouth. Areas that are well washed by the action of saliva are practically immune to dental decay.

4.4 ARREST OF RAMPANT CARIES

The most effective means of stopping the progress of a carious lesion through the tissues of the tooth is to remove the decayed enamel and dentine, while 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 appear to be rather elementary, but it deserves reiteration, since even with improved modern methods of caries control and caries prevention, restorative dentistry still remains the most effective means of control. Frequent and regular dental attention, while it may not prevent the initiation of new carious lesion, most assuredly halts its progress and controls the ravages of decay in the form of pulpal and periapical infections, as well as the subsequent loss and malocclusion of the teeth. It is significant that there is a marked and precipitous drop in the lactobacilli count when all active carious lesions are excavated and filled. In children with extensive or rampant caries, the first visits should be devoted to reducing the caries activity and arresting the disease by eliminating all active carious lesions and placing temporary sedative dressings before attempting permanent restorations. Placement of permanent fillings before the disease is under control will result in failure because of recurrent attacks. (Brauer 1964)

Cox et al (1948) in their study on the effect of carbohydrates on experimental rat caries demonstrated that those factors which determine caries initiation are not identical with those factors that promote the rate of its progress once the lesion is present. Cox et al (1948) showed that in the rat, sugar ingestion may not play any role in caries initiation, but that it is certainly important in determining the rate of its progress through the dentine. However, in children who consume excessive amounts of sugar, once caries is initiated in the enamel, the decay progresses with remarkable rapidity through the dentine and quickly involves the pulp.

Hill and Levine (1978) in their article on *Rampant caries and its management* stated that the initial treatment plan is first to relieve symptoms and secondly to prevent pulpal involvement in symptomless teeth with large cavities. In addition, it may be necessary to extract permanent teeth of doubtful prognosis at this early stage in order to achieve a satisfactory occlusion later. Extractions are often necessary to relieve pain and infection in the deciduous dentition where extensive operative treatment is not possible because of the infant's youth and unfamiliarity with dentistry. For such patients it is usually prudent to extract under general anesthesia those teeth which show evidence of probable pulpal exposure or periapical infection, before beginning the preventive program.

The loss of permanent teeth is to be avoided except in the case of the first permanent molars, for which planned extraction based on sound orthodontic principles is usually preferable to conservative treatment of uncertain prognosis. The treatment of painful teeth which are not to be extracted should be the simplest which will relieve the symptoms. Pain of pulpal origin is treated by placing dressings usually of zinc oxide and eugenol, although a corticosteroid preparation may be helpful when severe pulpitis pain is present. Such palliative treatment generally eliminates the need to undertake endodontic treatment during the initial treatment plan. However, when periapical infection is diagnosed as the cause of pain, root canal therapy must be commenced. Operative treatment during this initial phase may also be undertaken to slow the progress of caries towards the pulp in symptomless teeth with large cavities. The technique of indirect pulp capping is employed, in which, after the removal of all peripheral caries, carious dentine overlying the pulp is covered with calcium hydroxide and a zinc oxide eugenol dressing. This procedure is best performed under local analgesia and is of greatest value in immature permanent teeth whose open apices probably contribute to a successful result in which secondary dentine is deposited beneath the cavity. If the pulp is inadvertently exposed during this procedure, direct pulp-capping with calcium hydroxide may be tried as a temporary measure to delay root canal therapy. Dressing both for pain relief and pulp protection must be placed with care to avoid edges and consequent difficulties in plaque removal. A matrix band should be used when necessary, and stainless steel bands are valuable to support dressings in extensively carious teeth.

The use of silver fluoride-stannous fluoride as a way to arrest caries in deciduous teeth has been developed by Professor G Graig, of the University of Sydney (Craig et al 1990), and adopted at the Westmead Hospital Dental Clinical School. It is designed to arrest the caries by the formation of a diffusion barrier over carious dentine after the AgF/SnF_2 treatment. This barrier prevents diffusion of substrates or acids into dentine and free calcium phosphate ions out of it i.e the decay is arrested. The method which is followed is to place a pledget of cotton wool moistened with AgF into the cavity. The entire cavity should be wet with the solution and the pledget should stay in place for 3 minutes. The cavity is then moistened with SnF_2 20% solution. The cavity should turn black, but if not the AgF treatment should be repeated again. A temporary filling is placed and the patient returns after 2 weeks. If there has been no pain at all, the tooth will be restored with GIC or any recommended filling material.

The aim of arresting the caries is mainly to relieve pain and to have control of the patient's remaining teeth so that caries does not progress.

5 METHODS OF MANAGEMENT

At this stage the patient should have been seen for at least a month during which time full control has been established, with no sign of new carious lesions. Cooperation of the parent and the patient is essential before further treatment is started. At the Paediatric Dentistry Department of Westmead Hospital, patients have 3-4 visits before extensive operative procedures and permanent fillings placed. During this time the patient is assessed so that the correct treatment plan is drawn up, and this time is also devoted to arresting the disease and allowing the pulp to produce as much reparative dentine as possible. Each year this Paediatric Dentistry Department, which serves a population of around 2 million people treats about 400-450 rampant caries patients under general anaesthesia, and a further 800 for control and prevention with treatment under local anaesthetic.

The importance of selecting patients carefully for a particular management program cannot be overemphasised. There is no standard caries program suitable for everyone, rather, the program should fit the patient. High-risk patients with active caries need more attention so that all available home and office procedures can be marshalled effectively. Persons who are fatalistic or disinterested in their dental health will not institute adequate home oral hygiene or modify their diet. However, for interested and cooperative patients a rewarding service can be provided. The management of rampant caries has been divided into the two major areas of *Treatment, and Prevention*.

5.1 TREATMENT

It is sometimes tempting to "*clean up the mouth with the forceps*" when a child presents with neglected and rampant decay, especially if he is fearful and uncooperative. Most of the teeth have deep carious lesion, many near exposures. Some are obviously exposed and painful, and a few are apparently hopelessly involved with periapical rarefactions. However, many of these teeth can be preserved and the patient rehabilitated if a definite plan of caries control is outlined and treatment followed in an orderly fashion. (Brauer 1964)

The treatment of rampant caries in children is expensive because of the number of teeth affected, the extent of decay for individual teeth, and the need for management aids beyond routine behavior guidance. In many cases, the maxillary anterior teeth must be extracted because of the severity of the decay. Behavior management adds to the difficulty of treating the child, for virtually all afflicted children are too young to cooperate for extended periods in the dental chair. The long-term psychological impact of treatment on the child has not been assessed. Some form of management aid is anticipated, such as physical restraint, sedation, or general anaesthesia. Thus, the treatment of baby bottle tooth decay is more costly and riskier than an extensive dental procedure for an older, more cooperative child. (Johnsen et al 1989)

In general terms there are three alternative methods of treating a patient with rampant caries: *Radical*; *Conservative*; and *Conservative and Preventive* (Davies 1954).

Although these methods were established many years ago they are still followed.

Radical: Treatment by extracting all remaining teeth which will result in the prevention of future lesions, not by treatment of the disease but, by removal of the tissues likely to be affected by the disease.

Drinkard and Dilley (1982) describe a case in which they used this philosophy in their treatment. The case was a preschool child in whom a bizarre food habit resulted in total destruction of the primary dentition. The diet history was unremarkable, except for the prolonged bottle habit until 18 months of age, at which time the bottle was discontinued. However, the child cried and continued to ask for it at night. When the bottle was refused, he began requesting bananas. In order to quiet him, a piece of banana was placed in his mouth. It was retained during sleep and thrown away, uneaten, the following morning. The habit continued during the daytime. The child requested a banana after meals which he held in his mouth. This routine lasted for a period of two years; the parents were unaware that this could cause problems with the teeth.

The child, a 3-year 8-month-old white male, was referred to the Department of Pedodontics at the University of North Carolina School of Dentistry. The treatment plan called for

removal of the entire primary dentition. Evaluation for placement of complete dentures was delayed until the child's behaviour improved. The state of the child's general health and his coagulation status were obtained from his pediatrician. In preparation for the extraction of the ten maxillary primary teeth under local anesthesia, a cardiac cocktail premedication (meperidine, promethazine, and chlorpromazine) and nitrous oxide/oxygen analgesia were administered first. Two weeks later the ten mandibular primary teeth were extracted in a like manner; the procedures were accomplished without complications. A decision was made then to fabricate complete dentures with distal guide planes. This was done in order to improve the child's appearance and masticatory function, to possibly improve his speech, and to guide the erupting first permanent molars into their proper positions. The patient experienced only minimal problems with the dentures and appeared pleased with them. Further more, a marked improvement in behaviour and responsiveness were noted. The permanent lower incisors and first molars began to erupt at 4 years 9 months, and the dentures were relieved to allow for their eruption. On a recall visit, 5-months later, the child was without his dentures and had not worn them for several weeks. The mother had removed them because she stated, "*the child didn't want to wear them*"; furthermore, she decided he no longer needed dentures because "*he was getting so many new teeth*". This is a case of a child in whom a food habit resulted in total destruction of the primary dentition. This had led to the implementation of a radical way of treatment.

Conservative: The treatment of the effects of the disease by the extraction of unsavable teeth and the filling of all other teeth.

Curzon and Drummond (1987) reported a case of a child, first seen when 1 1/2 years-old, who had rampant caries affecting all maxillary primary incisors and first primary molars. When the child seen again when he was 2-years of age. Cavitation was present on the buccal surfaces of all maxillary incisors as well as on the occlusal surfaces of the maxillary first molars. Under endotracheal anaesthesia it was found that the maxillary incisors as well as the maxillary first molars had extensive caries. In the incisors the caries was found to involve the pulps. When all affected dentine and enamel had been removed the teeth were

found to be unrestorable and were therefore extracted. Nickel-Chromium crowns were placed on the maxillary first molars after removal of all caries. The mandibular first molars were restored with glass ionomer cement because the patient's mother had insisted that amalgam should not be used. Recovery was uneventful. One week after treatment, healing of the extraction sockets was progressing normally. Since the second primary molar teeth were soon to erupt, dietary practices were discussed, but it was quite clear that the mother was convinced that prolonged breast feeding was an entirely natural process. To help remineralization of early carious lesions, a toothpaste containing fluoride was recommended. Fluoride drops were also recommended and a prescription was offered. However, the use of fluoride in any form was rejected by the parents, who believed strongly in homeopathic medicine. The safety and efficacy of fluoride was pointed out, but they remained unconvinced. The parents were keen and co-operative to apply the treatment plan but as they believed strongly in homeopathic medicine, they resisted the professional advice and refused all preventive measures.

Conservative and preventive: Treatment of both the cause and the effects of the disease. This philosophy is that adopted at the Paediatric Dentistry Department at Westmead Hospital. When the patient passes the control stage, and a complete treatment plan has been drawn up, the patient is given an appointment and instruction as to whether the treatment will be under local or general anaesthesia. If it is under general anaesthesia all the treatment done in one session, teeth which are badly affected and the operator thinks are indicated for extraction will be extracted and the teeth which can be saved by conservative treatment will be suitably prepared. Attempts are made to retain deciduous teeth rather than to extract them, as the early loss of these teeth may lead to abnormal tongue function and speech, in addition to the effect on aesthetics.

This method of conservation and prevention is also adopted by Wei (1988) as he describes this case in his book: a white girl aged 9 years 7 months presented with a chief complaint of "pain in lower left tooth for 2-3 weeks." This was the first time this patient had seen a

dentist. The initial oral finding revealed an obvious draining fistula at the base of maxillary right first primary molar. The patient had 32 carious surfaces, including extensive caries in her first permanent molars. Her chief complaint of pain in the lower left quadrant was due to an over-retained primary canine root tip. Restorative care which included amalgam restorations, stainless steel crowns, root canal therapy, and a temporary restoration in a tooth near exfoliation was completed over the next 3 months. In conjunction with the restorative care, a comprehensive preventive program including diet counselling, oral hygiene instruction, and professional and home fluoride therapy was initiated. The patient and parent were very co-operative with the preventive programs, as demonstrated by both excellent oral hygiene scores and reported use of fluoride mouthrinses at home. Following the initial therapy the patient returned for recall examinations including preventive services. Sealants were placed on the occlusal fissures of the second molars and premolars. For the next 3-years she had not had a new carious lesion. Comparison of the dentition of the patient to that seen 3-years earlier at initial presentation revealed that most of the teeth that were affected by high caries prevalence had now exfoliated and had been replaced by healthy succedaneous teeth. A permanent cast gold crown was planned to replace the temporary stainless steel crown covering the endodontically treated molar.

Restorative treatment for the grossly carious teeth with extensive cavitation can be divided according to *no pulp involvement* or *involvement of the pulp*.

Extensive cavitation with no pulp involvement. In the posterior teeth the most common material, which had been used for many years, is amalgam. This material has limitations, and the color is not suitable for anterior teeth. Over the past 20 years, composite resins have periodically been suggested as esthetic replacement for amalgam restorations. Recent improvements in composite materials, such as smaller filler particles, increases in material strength, and introduction of dentine bonding agents, have led to improved clinical results.

Resin restorations offer the advantages of improved esthetics, elimination of mercury and galvanic shock, and low thermal conductivity. Disadvantages of the resin materials include an exacting technique, potential marginal leakage, postoperative sensitivity, and a tendency toward open or loose contacts.

The other recent restorative material is glass ionomer cement which is the material of choice for the filling of both anterior and posterior teeth especially in children attending the Paediatric Dentistry Department at Westmead Hospital. The release of fluoride from glass ionomer materials is one of the most important features of this material, and remineralization effects of this phenomenon have been documented.

Berg, Farrell and Brown (1990) have written:

"glass ionomer can provide properties not inherent to any other restorative material. The addition of silver particles to glass ionomer has allowed the creation of a glass ionomer restorative material which may withstand the forces of occlusion over considerable periods of time. Potentially, fluoride release from glass ionomer materials could provide resistance to marginal carious break-down via two distinct mechanisms. First, previous work has shown that glass ionomer restorations are more resistant to marginal carious breakdown in the Silverstone caries-like lesion system. Second, glass ionomer materials have been shown to exert inhibitory growth effects on streptococcal microorganisms. This growth attenuation effect has been demonstrated on the surface of glass ionomer restorations and within cavity preparations when glass ionomer was used as a lining agent."

Extensive cavitation with pulp involvement: If the pulp is involved then the treatment depends on the operator whether to keep the tooth vital or non-vital. In the tooth which has been excavated, either deliberately or accidentally, until there is an actual exposure of the pulp, and if preservation of pulp vitality is to be attempted there are two possible courses of action, direct pulp capping and pulpotomy.

Shovelton (1967) writing on the treatment of grossly carious teeth stated that:

"If there was some positive stimulus needed to cause the pulp to heal rather than merely protection and conditions to permit healing, calcium hydroxide gave

significantly better result than inert material. It has been pointed out by several writers that if the pulp is to heal successfully, not only must inflammatory processes be suppressed if they are present, but also any bacteria must be destroyed. This follows on the demonstration by several authors that the pulp will recover from quite severe insults in the absence of infection, but that where bacteria are present healing is much less likely to occur. This provides a background against which the use of corticosteroid-antibiotic mixtures such as Ledermix should be considered. The Ledermix does give pain relief but it does not give consistent healing in the form of a dentine bridge. Other writers have suggested that dentinogenesis ceases altogether following the use of steroids and that areas of chronic inflammation may still persist in the pulps of such teeth. It appears that pulp capping is only really indicated in those teeth where the exposure is very small and is potentially not contaminated by caries or saliva".

The last category of treatment in which an attempt is made to preserve the pulp vitality is the operation of pulpotomy. There is ample evidence of the success of pulpotomy in the teeth with open apices and it is the method which is widely adopted at the Paediatric Dentistry Department at Westmead Hospital. The most popular material is zinc oxide eugenol with formocresol. When the pulp is grossly contaminated, the entire pulp is taken from the pulp chamber, the tooth is cleaned and dried completely then a mix of zinc oxide eugenol with formocresol is prepared. With a plastic instrument a portion of the mixture is placed in the pulp chamber which completely seals the pulp horns. The tooth is then left for a while until the mixture is set then the tooth is finished by placing a permanent filling material according to operator choice.

Restoration of teeth with extensive carious lesions, sometime cannot be achieved by filling materials alone simply because the tooth is badly damaged. In this case the tooth must be prepared for a crown. For the anterior teeth veneer or polycarbonate crowns are used, and for the posterior teeth porcelain or stainless steel crowns. The stainless steel crowns are widely used at the Paediatric Dentistry Department at Westmead Hospital for the primary teeth following pulpotomy or pulpectomy procedures.

The wide range of materials available, and the different schools of teaching help to make treatment mainly dependant on the operator and on the cooperation level of the patient.

Treatment of rampant caries due to radiation therapy

Treatment of rampant caries as a result of radiation therapy is by boosting the flow of saliva as much as possible to help maintain the integrity of the teeth. Stimulation of the salivary gland has shown some effectiveness. The use of pilocarpine in postradiation xerostomia was studied by Greenspan and Daniels (1987) over a six month period.

Pilocarpine and placebo tablets were administered in a double-blind, sequential cross-over trial to 12 patients with postradiation xerostomia. Six patients initially received pilocarpine and the others received placebo. Each preparation was used for 90 days, and then each patient was crossed over to the other preparation for another 90 day period. The patients received a supply of tablets and took from 2 to 3 tablets, three to four times each day. The difference between salivary flow in patients taking placebo tablets or pilocarpine at 30 days and 60 days was not significant but it was significant at 90 days ($p < 0.005$). The results of this study justify the use of pilocarpine, under careful supervision, for patients with postradiation xerostomia.

Chronic xerostomia creates many clinical problems for affected patients. They find it very difficult to chew, swallow, or enjoy food, to talk for any length of time without needing water, or to wear removable dentures with comfort. Current therapy for postradiation xerostomia includes topical fluorides to retard caries, and saliva substitutes (water, artificial saliva). Taking frequent small sips of water relieves the symptoms for some patients, but imposes upon them the inconvenient, and possibly embarrassing, necessity of carrying around a small bottle of water. Particularly troublesome was the fact that most patients were awakened by intraoral dryness several times during sleeping hours.

There is a specific need for an artificial saliva that would give several hours of relief from dry-mouth symptoms. Shannon (1982) mentioned a commercial product which contains 20 mEq 1 K, 27.4 mEq 1 Cl, 22 mEq Na, 1.5 mg 100 ml Mg 6 mg 100 ml Ca, 21.7 mg 100 ml P, and 2 mg liter F. The specific gravity is 1.0054 and the pH is 7. The formula also includes a preservative, a binding agent, coloring and flavor. This formula has been

approved by the Council on Dental Therapeutics of the American Dental Association and produced by Scherer Laboratories, Inc., Dallas, TX (Xerolube). The problem with the artificial saliva was the adjustment of viscosity to the point that a relatively extended period of relief could be provided. In general, the goal was to set the viscosity as high as possible, but not high enough for the material to form plaques on the introral soft tissues. The product has proven very valuable and use at bedtime allow the patient to sleep throughout the night.

Conclusion. Treatment of rampant caries has witnessed great changes in the last two decades. Rapid development in the material used is one of the main factors. The introduction of glass ionomer cement and the addition of silver to it, to make glass ionomer /silver cermet, has allowed the creation of a material which withstands the forces of occlusion and has the added advantages of fluoride release from the material.

The availability of a wide range of fluoride and the effective and efficient ways of using it have added another dimension to the treatment of rampant caries. The use of artificial saliva helps to some extent to keep the integrity of teeth and give relief from dry mouth.

5.2 PREVENTION

Dentistry is moving toward a preventive orientation in many countries. Such a trend is to be encouraged everywhere, even where dentists feel themselves overwhelmed by the need to treat existing disease, because the global problems of oral disease will never be adequately controlled by reparative treatment alone. In addition, current methods available for prevention of oral disease are both simple and effective. Even if it is utopian to think in terms of preventing all oral disease, current methods of prevention and control are effective enough to prevent wide scale loss of teeth. These methods are easier to apply in the economically developed countries because resources are usually available; indeed, there are encouraging signs in many of these countries that dental caries prevalence is declining, as a result of successful preventive efforts. The application of preventive procedures in many developing countries presents problems, but much is still possible. Caries prevalence is rapidly increasing in many of their cities. Financial and personnel resources to treat existing disease are seriously deficient. But with some help where necessary from developed countries and from international agencies such as WHO, it is possible to train personnel to carry out straight forward procedures required for prevention of caries and periodontal disease. Education of the general public and of individual patients to develop sound oral health practices is of fundamental importance. There should be an education component for all individual patients. Considerable public education is required to achieve acceptance of water fluoridation, school-based prevention program and the use of non-cariogenic sweeteners. Motivation in some individuals may be enhanced by the encouragement of a dentist or hygienist to the extent where these patients can prevent further oral disease largely by their own efforts. Continued behavioural science research is still needed to make dentistry's education activities more productive. (FDI 1984)

Maximum preventive benefits for dental caries can be achieved by adopting one of the following measures: Fluoride administration; microbiological approach to the prevention of dental caries; and pit and fissure sealants.

5.2.1 Fluoride Administration

The fluoride ion (F^-), the only proven dietary substance to be of anticariogenic benefit for humans, is found as a trace element in deep artesian wells, in seawater at levels of 1 to 1.5 ppm, and in small amounts in various plant and animal substances.

Fluoride administration can be either: *Systemic or Topical*.

5.2.1.1 Systemic fluoride

Fluoride is most beneficial when it is available during enamel development. Its effects were first noticed in caries-free children in cities where fluoride existed naturally in the water supplies. The protective benefit of F^- reaches beyond the exchange of ions in developing tooth enamel; it extends into adult life. Persons living in cities where fluoridation has been discontinued experience more dental caries than do persons who have continuously lived in optimally fluoridated areas.

There are many ways to use fluoride systematically and these are now described.

Water fluoridation

Water fluoridation is the upward adjustment of the fluoride concentration of a community's central water supply to the optimum level for the prevention of tooth decay. For those countries with established public water supply systems, fluoridation is the most efficacious and cost-effective measure available to prevent tooth decay in the community. It has been estimated that some 170 million people in 38 countries are receiving fluoridated water in the homes (FDI Technical Report 1984).

Communal water fluoridation is an axiom of caries prevention, it is effective, inexpensive, and non-discriminatory. Children and adults of both sexes, all races, and all socioeconomic classes benefit thereby, and its dental benefits extend throughout the lifetime of residents of optimally fluoridated communities. The optimal concentration of fluoride in the water depends upon the annual average maximum daily air temperature in the community, as temperature influences the amount of water ingested. In concentrations between 0.7 and 1.2 parts per million (ppm), fluoride reduces tooth decay experience by 50-60 per cent in

population groups consuming such water continuously from birth. This range of concentrations allows for the fact that people in warmer climates drink more water, on average, than do people in cooler climates.

"Studies have demonstrated that lifelong residence in a fluoridated community leads to a significant reduction of root caries in adults of all ages in comparison to the prevalence found in non-fluoridated communities" (FDI Technical Report 1984).

The cost of water fluoridation is low; the per capita cost tends to vary inversely with the size of the population served. United States data from 1981 indicate that the annual cost of fluoridation was around 35 cents US per person per year. Annual per capita costs in smaller communities are usually higher. Cost-effectiveness ratios between 1:25 and 1:50 may be expected for water fluoridation.

There is a need for continual monitoring of water fluoride concentrations because of the tendency, particularly in smaller communities, for unreported interruptions to occur in adding the fluoride to the water, chiefly through human inertia or mechanical failure. Only a carefully controlled routine for monitoring fluoride concentrations in the drinking water will assure that the community receives the maximum dental benefit.

In the United Kingdom, after an extensive review of all the available findings on water fluoridation, the Royal College of Physicians of London concluded:

1. Fluoride in water, added or naturally present, at a level of approximately 1mg/liter over the years of tooth formation substantially reduces caries throughout life.
2. The consumption of water containing approximately 1mg/liter of fluoride in a temperate climate is safe, irrespective of hardness of the water.
3. In comparison with fluoridation, systemic fluoride supplements such as tablets, drops and fluoridized salt have not been shown to be as effective on a community basis.
4. Fluoridation does not harm the environment.

Since 1958 the World Health Organization has supported water fluoridation and has recommended that, where practicable, member states introduce fluoridation of water supplies in communities where the concentration is below optimal. (Newbrun 1986)

School water fluoridation

Because central water supplies are not available to large segments of the world's population, other methods of caries prevention have been sought. Schools that have no central water system usually have private wells which can readily be fluoridated. Studies in such schools have used 2.5 to 6.3 ppm fluoride in an attempt to approximate the total fluoride intake of children who drink optimally fluoridated water on a full-time basis. No objectionable dental fluorosis has resulted. After 12 years of school water fluoridation at 5 ppm, children at a rural school had a 40 per cent reduction in dental caries, as compared with pre-fluoridation figures, and a 65 per cent reduction in the rate of extration between 1958 and 1970. Findings after 12 years of school fluoridation at 6.3 ppm have shown a slightly greater protection (48%) against decay.

Children spend annually from 20 to 25 per cent of their total waking hours in school. To compensate for this part-time exposure to fluorides the currently recommended level for school water fluoridation is 4.5 times the optimum amount recommended for community water fluoridation in the same geographic area. By mid 1984, 554 schools in the United States with about 187,000 students were served by school water fluoridation. The main disadvantage of school fluoridation is that children are 5 to 6 years old before they begin attending school and drinking the water. Maximum caries prevention occurs when fluoridated water is consumed from birth. (Newbrun 1986)

In the mid-1970s the costs of school fluoridation ranged from 30 cents US to \$1.50 per schoolchild per year. Cost benefit ratios of school fluoridation are favourable. With the rather minimal equipment necessary, school personnel can readily be trained to operate the school's fluoridation equipment. This training can be carried out by personnel from a state or national health department. (FDI Technical Report 1984).

School water fluoridation is recommended only where community water fluoridation is not possible. The main disadvantage is that children do not start school before 5 or 6 years.

Salt fluoridation

The addition of fluoride to table salt has been practised in some parts of Switzerland since 1955 and has been tested in Columbia, Spain and Hungary. There is a precedent for this route of supplementation, in that iodized salt has led to the gradual disappearance of endemic goiter. In Switzerland, between 1955 and 1970 the salt contained 90 ppm fluoride (200 mg NaF per kg). Based on an average salt consumption of about 0.4 gm per adult per day, which is well below the desired level. In spite of this low dosage, a reduction of about 25 to 30 per cent in DMFT scores after 4 to 5 years of unsupervised use was found in 8 to 9 year-old children in Zurich and Wädenswil.

Since 1970 in Switzerland, and in Columbia and Hungary, the salt has been fluoridated at a higher concentration (200, 250 or 350 ppm F⁻). At these levels the urinary fluoride concentration of persons consuming the salt is between 0.7 to 0.9 ppm, which approximates the concentration found with an optimal fluoride content of water. After 8 years of using fluoridated salt, 8 to 10 year-old children in Colombia had about 60 per cent less DMFT, and 11 to 13-year-old children 48 per cent less DMFT, in comparison with baseline caries prevalence. In Hungary after 8 years of salt fluoridation, caries experience fell by about 50 per cent. In Switzerland, salt fluoridation, has been found to be equally as effective as water fluoridation, reducing caries prevalence by 50 to 60 per cent.

Unquestionably, fluoride ingested with salt as the vehicle prevents dental caries. Based on urinary excretion levels and on cariostatic effectiveness, 250 ppm F⁻ in the salt appears to be an optimal concentration in communities with less than 0.2 ppm F⁻ in the water supply. Salt intake varies; moreover, one of the national dietary goals in the United States has been to reduce salt intake. This represents a limitation to the wide spread use of fluoridated salt as a caries-preventive vehicle. (Newbrun 1986)

In the period 1958-1967, the production of fluoridated salt in Switzerland increased more than five times. This high degree of acceptance is remarkable, bearing in mind that it does

not include the citizens of Basal who were already consuming fluoridated water. The cost of marketing fluoridated salt, based on per person per year expenditure, is low. The technology for producing fluoridated salt is now well tested, and can be applied in most countries. To get the most benefit of fluoride it should start at birth, so it is not the best way for babies. As for adult, one of the national dietary goals in the United States is to reduce salt intake. However, the Federation Dentaire Internationale considers that:

"Salt fluoridation is probably the best method of systemic fluoridation in developing countries where piped water supplies are rare". (FDI 1984)

Milk Fluoridation

Milk has been tested as a vehicle for fluoride supplementation, usually in studies involving only small groups of children. The published results indicate a positive caries-preventive effect, however, much more clinical evidence is needed before this route is established as satisfactory, and milk has certain disadvantages. Water, bread and salt consumption during childhood increases fairly regularly with increasing age. Milk, on the other hand, is ingested in relatively large amounts during the first two years, but then consumption decreases. Furthermore, the addition of fluoride to milk in a fairly large number of dairies might create some technical difficulties. It is also difficult to separate distribution of such milk between neighboring fluoridated and non-fluoridated areas. The great variability and irregularity of milk consumption habits in different geographical regions, seasons of the year, and age groups are serious problems. Furthermore the cost-benefits of fluoridating milk can in no way be compared with those of water fluoridation. (Newbrun 1986)

Milk fluoridation cannot be considered as an effective community health measure, due to the cost, when compared to water or salt fluoridation.

Fluoride supplements

Millions of children do not have access to optimally fluoridated drinking water and are therefore deprived of the caries-preventive benefits of fluorides. The use of fluoride supplementation from birth through the teenage years should greatly benefit these children. Early studies have shown convincing benefits of fluoride supplementation and have subsequently been confirmed by a large number of studies carried out all over the world. The benefits derived from the use of fluoride drops and tablets are comparable to those from fluoridated water and, in some cases, they exceed that of water fluoridation, especially when their use has been continuous and conscientiously administered from early childhood and through the teenage years. (Newbrun 1986)

Steps to ensure an optimal dietary intake of fluoride should continue to be a primary concern for children 3-6 years of age. For children who do not have access to fluoridated drinking water, this means continuing to provide adequate fluoride supplementation. By age 3, most children will be able to chew and swallow tablets. Therefore, prescriptions for supplemental fluoride should be changed accordingly to reflect this change in developmental status. The recommended supplemental fluoride dosage schedule also requires an increase in the amount of fluoride that is prescribed once a child has reached 3 years of age. The recommended daily dosage of supplemental fluoride for children age 3-14 is 1.0 mg fluoride for children whose drinking water contains less than 0.3 ppm fluoride and 0.5 mg fluoride for children whose water contains between 0.3 and 0.7 ppm fluoride. Children whose drinking water contains more than 0.7 ppm fluoride do not require any supplementation. Although the potential for producing esthetically objectionable dental fluorosis will have diminished in this age group as a result of substantial crown formation of the anterior teeth, the practice of analyzing samples of each child's drinking water prior to prescribing supplemental fluoride should continue to be followed. (Nowak & Crall 1988). Supplying fluoride tablets for home use does not ensure that children and parent will follow instructions. A consistent daily regimen is needed for maximal caries prevention.

There is some variation in the dosage schedule recommended in different countries for dietary fluoride supplements. This variation reflects different opinions of authorities rather than different needs. The regimen in the United States (**Table 17**) is that recommended by the American Dental Association's Council on Dental Therapeutics (1979) and the American Academy of Pediatrics (1979). (FDI Technical Report 1984).

Table 17

Dosage levels of supplemental fluoride recommended in the USA. Adjusted allowance in total mg of fluoride per day for three ranges of concentration of fluoride in water (ppm). Source: FDI Technical Report (1984)

Age	<0.3ppm	0.3-0.7ppm	>0.7ppm
0-2 years	0.25mg	0	0
2-3 years	0.50mg	0.25mg	0
3-13 years	1.00mg	0.50mg	0

Studies have shown that few parents and children follow the consistent daily regimen necessary for maximal caries prevention with dietary fluoride supplements. Therefore, supplying fluoride tablets for children's use at home is not as desirable a public health method as community water fluoridation. Private practitioners may prescribe their home use for selected motivated patients

5.2.1.2 Topical fluoride therapy

Clear guidelines are emerging as to the best timing for topical treatment. A common finding from trials of topical fluoride agents in both low and optimal fluoride areas is that teeth during the erupting period receive the most benefit. A possible explanation is that the outer enamel of newly erupted teeth is quite porous, a large surface area would be available for enamel-fluoride reactions to take place.

The mechanisms of action of fluoride on tooth enamel have been explained as follows:

- a. Reduction in enamel solubility. F^- acts on the developing tooth enamel by substituting for the OH^- of hydroxyapatite, creating fluorapatite, which is stable and insoluble and larger than the hydroxyapatite crystal. During enamel development systemic F^- is incorporated into the enamel crystal as fluorapatite.

CaF_2 accumulates on enamel surfaces after topical application of high concentrations of fluoride. The enamel surface replacement of hydroxyapatite by fluorapatite occurs slowly and is enhanced by an acid pH. Topical fluorides are therefore often acidic.

b. Remineralization. The remineralization function of F^- is becoming more widely accepted. In the enamel environment, there is considerable demineralization and remineralization with changes in the pH. This phenomenon, rather than a reduction in solubility, may account for the reduced caries activities seen with the routine use of fluoride.

c. Activity against plaque bacteria. Studies show that the number of *S. mutans* is decreased after fluoride applications. With decreasing enamel solubility, the plaque bacteria are deprived of some required nutrients. The production of extracellular polysaccharides and the metabolism of sugar may be interrupted, possibly affecting the amount of acid produced. Bacterial plaque adheres to the enamel pellicle partly by the use of free Ca^{++} ions. When F^- is present, these Ca^{++} are bound in a calcium-phosphate complex.

(Randolph & Dennison 1981)

There are many ways for the use of topical fluorides and these are discussed.

Fluoride toothpastes

The daily use of a fluoride-containing dentifrice should form the foundation of a child's preventive dental activities. Although many toothpaste have fluoride in their formulations, only those products that have obtained approval by the Council of Dental Therapeutics of the American Dental Association (ADA) should be recommended. The formations of those toothpastes that have not obtained ADA approval may impede the release of fluoride from these products, thereby compromising their effectiveness. Currently approved fluoride toothpastes contain sodium fluoride (NaF) or sodium monofluorophosphate (MFP) as active ingredients. The maximum allowable concentration at this time is 1000 ppm.

(Nowak & Crall 1988)

If a fluoride toothpaste is to be effective, its fluoride must be present in a chemically reactive (ionic) and stable form. It is likely that early clinical tests of fluoride dentifrices produced negative results because the abrasive salt (calcium carbonate or calcium

phosphate) and fluoride agent used (sodium fluoride) were incompatible. Abrasive systems and fluoride agents vary widely in their reactivity. Abrasives, particularly those containing calcium, can combine with fluoride ions to form insoluble reaction products, or they may absorb or complex with soluble fluoride ions. Ideally, 100 per cent of the total fluoride added to a formulation should be available as soluble fluoride, which should remain fully active for prolonged periods, even when stored at elevated temperatures. Today, almost 95 per cent of all dentifrice sold in the United States contains fluoride and sales exceed the seven hundred million dollar mark. To provide proven caries protection, dental professionals should recommend only ADA-accepted products to their patients.

(Newbrun 1986)

Results of clinical trials have shown that fluoride-containing dentifrices reduce the incidence of caries in children and young adults. Reductions in caries incidence of around 15-30 per cent are obtained. Reduction in the incidence of dental caries has been clearly demonstrated only when the brushing is done with a fluoride-containing dentifrice. Use of a fluoride-containing dentifrice is therefore recommended. Many authorities believe that in areas of endemic fluorosis, fluoride toothpastes should not be recommended for children under 7 years of age. (FDI Technical Report 1984)

Winter (1989) conducted a clinical trial of a low fluoride toothpaste for young children. In this double-blind trial, the anticaries effectiveness of a test toothpaste formulated for young children with 550 ppm F⁻ was compared with that of a positive control toothpaste containing 1055 ppm fluoride. More than 3000 2-year old children were enrolled in the study and after 3 years of toothpaste use, 2177 (72%) were examined. More than half the children were found to be caries free, and only 32 (1.5%) had evidence of rampant caries. There appeared to be little or no difference between the effectiveness of the toothpastes with these different concentrations of fluoride.

The use of a fluoride containing dentifrice is recommended as the best and most cost effective way of daily topical fluoride application in addition to the systemic fluoride intake.

Fluoride mouth rinses

Many dentists now prescribe the use of fluoride mouth rinses for their patients at home. In some countries these products are also available from over the counter sale without prescription. Many dentally aware parents ensure that their children rinse with fluoride solutions as well as brush their teeth with a fluoridated toothpaste.

Whether or not an individual is receiving fluoridated water, fluoridated mouth rinses used at home can provide further protection. Daily rinsing with 0.05 per cent sodium fluoride is recommended for home use. Nowak and Crall (1988) stated that numerous clinical trials conducted in the 1960s and 1970s reported caries reductions in the 20-40 per cent range among children in non-fluoridated areas who rinsed with either 0.2% NaF on a weekly basis or 0.05% NaF on a daily basis. More recent studies conducted since the overall decline in dental caries in children become evident, have reported that:

1. The expected benefits from fluoride rinsing in terms of the actual number of tooth surfaces saved from becoming carious are generally less than previously reported.
2. Rinsing appears to have a greater effect in older children.
(10 years of age or older)

Nevertheless, the observation that fluoride rinsing provides greater protection to teeth erupting during the time when rinses are being applied would seem to provide a rationale for their use in the 6-to-12 year old age group. Mouth rinses would seem to be particularly indicated for individuals deemed to be at high risk to develop caries. Included in this category would be those children who lack the motivation or manual dexterity necessary to carry out effective oral hygiene procedures, patients wearing orthodontic appliances or prostheses, which may complicate the process of plaque removal, and patients with medical conditions that place them at increased risk for caries. Examples of individuals in the last group would be patients undergoing head and neck radiation therapy, which may compromise their salivary flow, and patients who are required to take frequent doses of liquid or chewable medications having a high sugar content.

Concentrated fluoride agents for professional application or home use

Topical fluoride is advocated for children who do not live in fluoridated areas, as well as for those who do. High caries risk patients, orthodontic patients, and patients with xerostomia due to head and neck irradiation during cancer therapy are encouraged to use a daily rinse or home topical application. Fluoride applied professionally is usually recommended twice annually. A 10% stannous fluoride or 1.23% acidulated phosphate fluoride (APF) solution is commonly used, although sodium fluoride 2% may be adequate. Stannous fluoride can cause staining of decalcified areas and has an unpleasant taste. APF on the other hand, avoids staining and usually has a more pleasant taste. The ion precipitates on the enamel surface as CaF_2 , which is not firmly bound to the enamel and is lost after a time. Some of it replaces the hydroxyapatite crystal to form a fluorapatite. Therefore long-term benefits of topical fluoride treatments cannot be assumed. The major advantage is the presence of the ion on the enamel surface for remineralization. Since the F^- is washed out by saliva, semi-annual topicals are suggested. As for the effectiveness of the topical fluoride applications, Nowak and Crall (1988) stated that numerous studies conducted prior to 1980 reported caries reductions averaging approximately 30 per cent for these agents. However, several more recent studies including a large-scale national demonstration program, have shown reductions of less than 15 per cent and savings, in terms of the actual number of tooth surfaces saved from becoming carious by semi-annual applications of these agents, that were much less than in earlier trials.

The use of topical fluoride as a preventive measure of xerostomia-related caries in irradiated cancer patients has been studied by Dreizen et al (1977). A total of 42 patients were divided into 3 groups. Fifteen patients were randomised to the single protective regimen of red plaque-disclosing dye, non-fluoridated gel, and an unrestricted diet. Fifteen patients were randomly selected for the double protective regimen of red plaque disclosing dye, 1% sodium fluoride gel and an unrestricted diet. Twelve patients were assigned to the triple protective regimen of plaque disclosing dye, 1% sodium fluoride gel, and a sucrose-restricted diet. The red plaque-disclosing dye was incorporated in each gel. The fluoride and nonfluoride gels were slightly acid in pH and differed only in fluoride content.

Each patient (in the Dreizen et al 1977 study) was instructed to apply the gel to the teeth via the plastic carrier for a minimum of five minutes per day throughout the period of radiation and continuing every day indefinitely thereafter. Sucrose restriction in group 3 was attained by supplying each patient with a list of foods high in sugar content to be assiduously avoided in their entirety (**Table 18**), and reinforced by daily admonitions by the clinic dietitian and by spot checks of food intake records. All of the patients were re-examined for dental caries at three-month intervals during the first postradiation year, and at six-month intervals thereafter. Any patient in group 1 evidencing the beginning of a postradiation caries upsurge at any of the three-month examinations was immediately transferred to the group 2 regimen.

Table 18

Foods deleted from diet of regimen 3 patients.

Source: Dreizen et al (1977)

Cakes	Puddings
Candy	Sugar-coated cereal
Cookies	Sugar-coated chewing gum
Cough drops	Sugar frostings
Doughnuts	Sugar-sweetened coffee and tea
Dried fruits	Sugared soft drinks
Fruits cooked in sugar	Sweet dessert sauces
	- butterscotch, chocolate
Ice cream	Sweet rolls
Jams	Sweetened condensed milk
Jellies	Sweetened cough medicine
Marshmallows	Vegetables cooked with sugar or molasses
Muffins	- Boston baked beans
Pastries	Vegetables glazed with sugar
Pies	- candied sweet potatoes

The results of this study are given in **Table 19**.

The inter-group differences in mean caries increments between regimen 1 and regimens 2 and 3 and the corresponding intergroup differences in subjects initially receiving regimen 1 and changed to regimen 2 were all statistically significant ($P < 0.01$).

There was no statistically meaningful difference in mean caries increment between the sucrose-restricted (Regimen 3) and non restricted (Regimen 2) group who used the fluoride

gel throughout the study ($P > 0.05$). In 150 (48.2%) of the 311 new caries lesions in the group following regimen 1 began in the incisal edges of the anterior teeth, cusp tips of the posterior teeth, and lingual surfaces of the anterior and posterior teeth. The caries extension in these areas ceased abruptly, shortly after the patients were transferred to regimen 2. In groups 2 and 3, the new caries lesions were almost invariably confined to the buccal, labial, occlusal and proximal tooth surfaces.

Table 19

Comparison of Xerostomia-related caries increments in irradiated cancer patients on the caries protective regimens.

Source: Dreizen et al (1977)

Regimen	No. of Patients	Postradiation		Total	DMFS Increase		
		Total (Mo)	Mean		Mean	Mean Rate/Mo	SD
1*	14	124	8.86	311	22.21	2.51	1.90
2†	13	339	26.08	42	3.23	0.21	0.35
1 → 2	9	199	22.11	33	3.67	0.16	0.21
3‡	11	146	13.27	6	0.55	0.04	0.30

* Plaque-disclosing dye: nonfluoride gel: unrestricted diet.

† Plaque-disclosing dye: fluoride gel: unrestricted diet.

‡ Plaque-disclosing dye: fluoride gel: sucrose-restricted diet.

Conclusion. Patients suffering from rampant caries develop ravaging dental caries unless stringent action is taken to protect the teeth. Caries development and progression in such patients is so greatly compressed in time that the preventive measures must be instituted as soon as possible. A program of daily sodium fluoride application and oral hygiene appears to be eminently caries inhibitory, both in the presence and absence of dietary sucrose restriction.

5.2.2 Microbiological approach to the prevention of dental caries

For smooth surface caries the suppression of *S. mutans* by chemotherapeutic agents is a promising approach to control the development of smooth surface caries. Topical treatments with the nonspecific antimicrobial, chlorhexidine, have been shown to reduce the number of *S. mutans* in saliva of subjects highly infected with this organism. Furthermore, the spread of *S. mutans* to infants is reduced if mothers who are highly infected with *S. mutans* receive oral topical chlorhexidine treatment. Chlorhexidine, however, has several disadvantages as it reduces the nonpathogenic as well as pathogenic flora, severely stains teeth, and has a disagreeable taste (Wei 1988).

The use of chlorhexidine rinse to reduce the counts of *S. mutans* and lactobacillus was studied by Epstein et al (1989). Patients were seen in the Dental Department of the Cancer Control Agency of British Columbia. Patients studied had xerostomia and demonstrated elevated levels of *S. mutans* and lactobacillus species, an indication of an increased risk of dental caries. Fifty patients were included in the study initially, and subsequent analysis was completed for 29 patients.

In the analysis of the data for the 29 patients the rinse schedule was found to be statistically correlated with a difference in the levels of *S. mutans* in saliva. There were no significant changes in the lactobacillus counts with use of the 0.2% chlorhexidine rinse. When only the patients who demonstrated a high caries risk were reviewed, the number of *S. mutans* were reduced from 6×10^8 to 9×10^4 , whereas the lactobacillus counts were only reduced from 5.9×10^8 to 5.1×10^8 with the use of chlorhexidine rinse. Chlorhexidine has been shown to possess a broad spectrum of topical antimicrobial activity. Its safety, effectiveness, and lack of serious side effects have allowed its extensive use for hand rinsing and as a mouth rinse. Chlorhexidine's action in the oral cavity is promoted by absorption to plaque, salivary pellicle, oral mucosa and hard structures that may result in slow release for up to 24 hours.

The use of fluoride and chlorhexidine for the prevention of rampant caries was studied by Katz (1982). His study was carried on a total of 71 cancer patients who were undergoing radiation treatment in five hospitals in Madrid, Spain. Of this total, 35 patients were followed for 6-10 months. The patients were divided into three groups as follows:

Group 1 received four topical applications with a 1% sodium fluoride/ 1% chlorhexidine digluconate solution. The applications lasted four minutes and were given once a week. In addition, the patients were instructed to rinse their mouths every night, for one minute by the clock, with a 0.05% sodium fluoride / 0.2% chlorhexidine digluconate solution.

Group 2 used the same rinse as group 1. No topical applications were given.

Group 3 received four topical applications of an acidulated phosphate fluoride gel (1.23% fluoride ion, equivalent to 2.7% sodium fluoride, and phosphoric acid to obtain a pH of approximately 3.5). Applications lasting four minutes were given once a week for 4 weeks. In addition these patients were instructed to rinse every night, for one minute, with a 0.05% sodium fluoride solution.

The patients in any group who started developing radiation caries, as evidenced by the development of 1.0 or more DMFT or 2.0 or more DFS were transferred to the most effective group.

The results of the study are shown in **Table 20** for the mean caries increments of patients in groups 1, 2 and 3 at the end of the study, and also as monthly increment rates.

Patients in Group 1 had negative caries increments of -1.44 DMFT and -1.81 DFS.

Those in Group 2 had no new affected teeth and 0.12 new DFS.

Patients in group 3 showed 1.45 new DMFT and 1.91 DFS.

Six patients were transferred from group 3 to group 1, after periods ranging from two to five months. During that time, mean caries increments of 2.0 DMFT and DFS had developed.

The conclusion of Katz (1982) was that fluoride alone can control the caries process, but not the existing oral infections. The negative caries scores suggests that if the continuously repeated acid attacks of the cariogenic flora is prevented, conditions are created for defence mechanisms of the mouth to become operative and allow remineralization to occur.

Table 20

Dental caries increments in patients receiving different treatments for the prevention of radiation caries.

Courtesy of Katz (1982)

Group	Preventive regimen	Caries increments through the entire study period		Monthly caries increments	
		DMFT	DFS	DMFT	DFS
1	Topical applications and rinses with fluoride and chlorhexidine	$\begin{bmatrix} -1.44 \pm 0.56^* \\ 0.00 \pm 0.89 \\ 1.45 \pm 0.45 \end{bmatrix}$	$\begin{bmatrix} -1.81 \pm 0.96 \\ 0.12 \pm 0.89 \\ 1.91 \pm 0.96 \end{bmatrix}$	-0.22	-0.27
2	Rinses with fluoride and chlorhexidine			0.00	0.02
3	Topical applications and rinses with fluoride only			0.26	0.35

*Standard error of the mean.

Note: Values within brackets are not significantly different at 0.05 (one-way analysis of variance, repeated t-tests).

The use of short-term Kanamycin treatment for the reduction of dental decay in rampant caries individuals was studied by Loesche, Bradbury and Woolfolk MP (1977). Forty five young individuals age from 4-17 years old with 10 or more carious surfaces were to participate in the study. Thirty one patients completed both weeks of gel treatment and 29 of these returned for recall appointments over the next 14-37 month period. The kanamycin gel lowered the levels of *S. mutans* in the plaque and saliva relative to the placebo gel. This difference between groups was significant for the fissure plaque. Within the kanamycin group, the antibiotic gel caused a significant fivefold decrease in the fissure level of *S. mutans*, but a slight decrease in the approximal and salivary levels of *S. mutans*. As for the dental caries there was a 46 percent reduction of new carious surfaces in the kanamycin group when compared with the placebo group. The initial bacteriological differences between groups did not persist as there was no apparent treatment effect in the plaque or saliva samples collected at any recall visit during the first year following treatment. This would seem to indicate that the changes brought by the kanamycin treatment were inadequate to eliminate *S. mutans*, and given no other perturbations in the ecosystem, such as dietary changes, the plaque levels of *S. mutans* returned with time and approached the placebo levels. It can be concluded that the use of a kanamycin gel suppresses the growth of *S. mutans* and results in reduction of new caries, but has no long term effect.

5.2.3 Pit and Fissure Sealants

In view of the declining caries prevalence in the teeth of children in industrialised countries throughout the world, and because pit and fissure surfaces are those that benefit least from systemic and topical effects of fluoride, the need for efficacious pit and fissure sealants has become increasingly important.

One of the main contra-indications for fissure sealants is that patients with rampant caries have many proximal lesions. Wei (1988) reported on treatment of two of his rampant caries patients with sealant. The first patient was a 5-year old boy, one year after completion of initial treatment. No new caries were detected during this time, with the rampant caries and high *S. mutans* levels controlled, so the next phase of treatment was fissure sealants of the first permanent molars. The second case was that of a girl aged 9-years 7 months. After the treatment was completely finished a comprehensive preventive program was implemented including diet counselling, oral hygiene instruction, and professional and home fluoride therapy was initiated. The patient and parents were very co-operative with the preventive programs. Following the initial therapy the patient returned for recall examinations including preventive services. Sealants were placed on the occlusal fissures of second molars and premolars.

Conclusion. The relationship between fissure sealants and rampant caries patients is very critical. In order to be sure of the success of the sealants the dentist should study the compliance of those patients to the preventive programs. If the patients follow the instructions properly and there has been no sign of new caries, and no proximal caries, then fissure sealants may be indicated.

6 DISCUSSION AND CONCLUSIONS

The lack of a universally agreed method for the evaluation of rampant caries makes it impossible to compare the present studies with those previously conducted, and to compare studies from different parts of the world.

Rampant caries was defined by Winter et al (1966) as *a lesion of acute onset involving many or all of the erupted teeth, rapidly destroying coronal tissues, often on surfaces normally immune to decay and leading to early involvement of the dental pulp.*

Earlier in 1945 Massler described rampant caries as *"suddenly appearing, widespread, rapidly burrowing type of caries resulting in early involvement of the pulp and affecting those teeth or dental surfaces usually regarded as immune to ordinary decay".*

Some studies have followed the definition of Winter et al (1966) that *rampant caries of the deciduous dentition exists only when at least two maxillary incisors are affected by lesions on the labial or palatal surfaces.* Other studies followed the definition used by Jackson et al (1974) where *the presence of anterior labial caries on at least one incisor tooth was considered indicative of rampant caries.* The presence of 5 dmft or more, or 10 dmft or more was another way of evaluating differences in rampant caries for different age groups, or in different communities.

PREVALENCE

The prevalence of dental caries in many developing countries is still high since most people seek dental treatment only when they experience discomfort or pain. Extraction is the usual treatment for dental caries. It must be understood, however, that it is difficult to obtain regular dental care at the nearest large town, and there is also the extra burden of the cost of the treatment.

The inspection of pre-school children needs to be instituted on a regular basis with priority given to the nursery schools, especially in the more working class areas where the greatest need is more likely to exist.

Dental manifestations associated with all forms of prolonged nursing habits are becoming well recognized. It appears that any liquid containing a fermentable carbohydrate, including human milk, may contribute to an increase in dental caries. The increased decay pattern is seen with the prolonged nursing habit, if the liquid is made available to a sleeping child, or if it is consumed for prolonged periods, during waking hours.

The following rampant caries pattern may occur in the deciduous dentition:

- Maxillary central incisors - facial, lingual, mesial and distal surfaces;
- Maxillary lateral incisors - facial, lingual, mesial and distal;
- Maxillary and mandibular first molars - occlusal surfaces;
- Maxillary and mandibular canines - facial, lingual, mesial and distal surfaces;
- Maxillary and mandibular second molars - occlusal surfaces; and
- Mandibular incisors.

The pattern is usually explained by the fact that the offending liquid pools around the exposed teeth, while the tongue, when in its sucking posture, protects the mandibular incisors. Except for the mandibular incisors, the earliest teeth to erupt are the most seriously affected.

To a major extent, the severity of the caries is a function of the liquid present in the mouth and the length of time the teeth have been exposed to the substrate. Because salivary flow and swallowing are decreased during sleep, clearance and buffering of the offending liquid are slowed and reduced respectively and the caries process is enhanced.

Most parents have reported that they did not know when weaning should occur, and when oral hygiene should be instituted, which indicates that at this particular stage dental education is needed for the expecting mothers. The need still exists for the instruction of expecting and nursing mothers regarding diet and oral hygiene, particularly the dangers of using sweetened bottles and comforters dipped in syrups and honey.

Teen-age dental caries is a clinical problem, and when the process becomes rampant, the problem is serious and often insoluble. Sharp and definite increase in the rate of caries progress occurs during the early teen-age years. The change in the dietary habits might be a causative factor in the production of teen-age caries. At this stage teen-agers tend to miss a lot of meals and snack most of the time, have a lot of soft drinks and ignore their own oral hygiene.

The rampant caries acquired after irradiation therapy develops, whether the teeth are inside or outside the field of irradiation, when the salivary glands have to be in the radiation field. On the other hand when the teeth and the jaws are directly in the irradiation field, but the salivary glands are not in the field, rampant caries will not develop.

The prevalence of rampant caries is reduced dramatically in communities where there is a fluoridated water supply. A reduction of about 60 per cent has been shown in a study by Jackson et al (1974).

Action of fluoride on tooth enamel has been proved for several mechanisms:

1. Reduction in enamel solubility. Fluorapatite of the enamel is more stable and insoluble and larger than hydroxyapatite crystals.
2. Remineralization. Increased remineralization occurs when F^- is present after acid dissolution of enamel.
3. Antibacterial action. Studies show that the numbers of streptococcus mutans are decreased after fluoride applications. With decreasing enamel solubility, the plaque bacteria are deprived of some required nutrients.

Where there is no water fluoridation, fluoride should be supplied in any of the other forms which are available either at an individual level, or community level. School water fluoridation is one form that is available. Tablets and mouth rinses are sometimes supplied to the parents for use at home, and if they are used properly could have the same beneficial results as water fluoridation.

The prevalence of rampant caries has direct association with socio-economic status where the prevalence increases in lower income families. This is true in developed countries, but it may not be directly related to income in some developing countries as shown in a study by Adenubi (1982) in Nigeria. The parents in his study in most cases were middle class and belonged to the higher income group. The poor families in the developing countries consume small quantities of sugar and refined carbohydrate and still eat their traditional (usually non-cariogenic) foods.

AETIOLOGY

The aetiology of rampant caries is the same as the four factors which cause dental caries i.e bacterial agents, suitable substrate, susceptible host with all these factors present for a certain time before the carious process starts. As rampant caries is at much higher levels, and more rapid than normal caries there must be an increase in acid production, more frequently produced, and/or a more susceptible host.

Plaque from carious and sound tooth surfaces, as well as saliva from children with nursing bottle caries contain unusually high levels of *S. mutans*, the levels of *S. sanguis* in plaque on anterior teeth and *S. salivarius* in saliva are unusually low. Lactobacilli can be detected in nearly all plaque samples.

Concentrations of organisms belonging to the *S. mutans* group in dental plaque regularly exceed 50 per cent of the total cultivable flora (Houte et al 1982). High *S. mutans* levels were not only found in association with carious lesions or white spot lesions, but also with clinically sound tooth surface areas near the lesions.

Clinically sound anterior tooth surface areas near the lesion should be expected to become carious if the bottle feeding were to be continued, whereas the clinically sound posterior tooth surface would become carious at a later time because of a less intense exposure to the bottle fluid and a lower concentration of *S. mutans* in these areas.

Lactobacilli concentrations were higher in the case of plaque from cavities than in that from sound tooth surfaces. In contrast, *S. mutans* usually comprises less than 1% of the flora in children with little or no caries. These results, confirmed by Berkowitz et al (1984), seem to indicate that only those infants who have been colonised by *S. mutans* are at high risk for rampant caries.

The first line of defense against dental caries is saliva. When the flow of saliva is altered or the composition is changed, a disruption in these defenses results. As saliva becomes more viscous, its ability to wash the teeth is decreased. Its ability to penetrate into the caries susceptible areas, such as pits, the fissures and the interproximal areas declines. The reduction in salivary flow could be as a result of radiation therapy or drug reactions. The rate of stimulated saliva flow can drop from 1.1 ml/minute before radiation to 0.12 ml/minute at one year post-radiation.

Patients exposed to xerostomia produced by radiotherapy inevitably develop ravaging dental caries unless stringent action is taken to protect the teeth. Caries development and progression in such patients is so greatly compressed in time that the preventive measures must be instituted as soon as radiation treatment is commenced.

Some drugs like antihistamine and tranquillizers reduce the salivary flow. Frequently prescribed prior to meals, these medications cause a decrease in saliva at the time of critical need to prevent caries and help in the mastication and digestion of the food.

Most of the time these medications are used for long periods for relieving the distress of allergies or for some psychic disorders. When medicaments are used, the responsibility rests with the practitioner in alerting the patient to the need for good oral hygiene whether or not the patient complains of a dry mouth.

Tooth resistance to caries attack is another important factor in the aetiology of dental caries. The morphology of the tooth can be a factor. If it has deep pits and fissures this will help food accumulation and bacterial stagnation which in turn helps to produce acid and decalcification of the tooth. The other variable is the chemical structure, fluoride is the single most important factor in tooth composition which has an effect on dental caries. This includes the amount of fluoride incorporated into the tooth during development and the amount of post-eruptive fluoride from the diet.

We now come to a factor of great importance which is the carbohydrate consumption. The major point here is that not only is the total daily intake of refined carbohydrate, and sucrose in particular, of importance but that the frequency of intake is of equal if not greater importance. The association of night or naptime nursing and the distinct pattern of caries involving primary incisors is reinforced by the results of the study by Johnsen (1982). While milk was the most common liquid, the variety of liquid usually involved suggested a pattern not only of excessive nursing but of excessive sweets. It is further suggested that the habit of excessive nursing is associated with the oral gratification of the sweet-tasting liquid and the need for sucking. This statement is derived from the high percentage of parents that attempted substitution with water but had it rejected by the child.

Another important factor in the aetiology of rampant caries is fruit juice erosion. There is evidence that the consumption of fruit juice is increasing and a greater proportion of the public is exposed to the potential risk of erosion from beverages and foods containing acid or chelating agents. Dental erosion may be defined as a chemical dissolution of the clinical crown of a tooth which is independent of microbial action (Levine 1972).

The importance of citrus-fruit based beverages and foods and natural fruit juice in dental erosion is due to their popularity and the relative efficiency of citric acid as a decalcifying agent by virtue of its hydrogen ion concentration and chelating ability. Two rampant caries cases were described by Levine (1972) as a result of excessive fruit juice consumption.

Brauer (1964) stated that it is not so much the total quantity of sugars consumed during one day that is so important as the number of times a sugar is taken. Thus 20 tsp of sugar consumed at one sitting is much less injurious to teeth than 5 tsp consumed four times a day in the form of between-meal sweets. The latter produces four separated carious attacks, the former only one.

The cariogenic potentialities of various foods containing equivalent amounts of sugar may vary considerably, depending upon how long each tends to stick on the surface of the enamel. Foods such as cookies, dates, chocolate, caramels and ice-cream stick to the tooth surfaces for long periods of time because they are made adhesive by the presence of highly refined starches (glutans) and have a high decalcification potential.

In Australia the high total sugar consumption has remained more or less the same since 1957/1958 where per capita consumption was 53 kg and in 1986/1987 50 kg per capita (Sivaneswaran & Barnard 1990). Dental caries has dropped dramatically over the past 25 years. The DMFT of 12 years old children in 1988 reduced about 90% from the base line data of 1963 (Barnard 1989). The form of the sugar intake has changed, with more hidden sugars now being consumed and more sugar being used in liquid form; eg sugar used in non-alcoholic beverages increased from 4.4 to 10.7 kg per person per year between 1958 and 1978. However, the decrease in dental caries has been ascribed to extensive fluoride preventive programs. (Sivaneswaran & Barnard 1990)

CONTROL

To have full control over refined carbohydrate intake, each patient with rampant caries must be supplied with a diet chart and asked to record all food and drink consumed for a week. Then the dentist or dietitian will analyse the chart and advise the patient of the best course of diet.

There were no studies which concluded there was a direct relationship between oral hygiene/toothbrushing and dental caries, but the regular use of fluoride toothpastes which are capable of reducing the incidence of caries is recommended.

The other important factor in controlling rampant caries is determination of salivary flow and viscosity. The stimulated salivary flow should be determined in every case of rampant caries and a weekly quantitative analysis should be made.

There are four characteristics of saliva which are of relevance to dental caries:

1. Flow rate - This varies greatly, not only between individuals but in the same individual from hour to hour. A high flow rate will tend to wash away food debris and dilute acid in the mouth.
2. The viscosity of saliva - It is often suggested that watery saliva may help cleanse the oral cavity and dilute acid better than the viscous saliva and this may have some bearing on the variability of caries attack.
3. The presence of antimicrobial agents in saliva - Such as urea and lysozyme.
4. The salivary buffering capacity, its ability to neutralise acid - This is largely due to the carbonate-bicarbonate system and the buffering capacity of saliva has been found to vary greatly. Many workers believe that this variable is of importance in determining caries experience.

Arresting the caries to relieve pain and to have control of the remaining teeth, so there is no more new caries, is the next step for the full control of rampant caries. Pain of pulpal origin is treated by placing a dressing, usually of zinc oxide and eugenol. Operative treatment during this initial phase may also be undertaken to slow the progress of caries towards the pulp in symptomless teeth with large cavities.

The more recent method of caries arrest developed by Professor G Graig of the University of Sydney University is by the use of silver fluoride-stannous fluoride. This method has been used successfully on a number of patients at Westmead Hospital. The method is to arrest caries by silver fluoride-stannous fluoride, with the tooth being filled at a later stage.

TREATMENT

The treatment of rampant caries in children is expensive because of the number of teeth affected, the extent of decay for individual teeth, and the need for management aids beyond routine behaviour guidance. The long-term psychological impact of treatment on the child has not been assessed. The treatment of baby bottle tooth decay is more costly and riskier than an extensive dental procedure for an older, more cooperative child.

There are three alternative methods for treatment and although the principles of these methods were established many years ago (Davies 1954) they are still followed:

- a. Radical by extraction of all remaining teeth. This will result in prevention of future lesion by removal of the tissue affected by the disease. Drinkard and Dilly (1982) described a case which they treated by this method.
- b. Conservative. The treatment of the effects of the disease by the extraction of unsalvageable teeth and filling of all other teeth. This method is applied to patients who cannot, or are not willing to, follow any preventive program at home. A case described by Curzan and Drummond (1987) was treated by this method. As the parents of the child believed strongly in homeopathic medicine, they resisted the professional advice and refused all efforts for preventive measures.
- c. Conservative and preventive. Treatment of both the cause and the effects of the disease. This method is widely adopted all over the world and also followed at the Paediatric Dentistry Department at Westmead Hospital. Treatment can be either under local or general anaesthesia. Teeth which are badly affected and thought by the operator as indicated for extraction will be extracted and those teeth which can be saved by conservative treatment will be prepared for a suitable way of repair. This method of conservation and prevention is also followed by Wei (1988) as he described the treatment of one of his patients. *"After the treatment a comprehensive preventive program including diet counselling, oral hygiene instruction and professional and home fluoride therapy was initiated. The patient and parent were very cooperative with the preventive programs, as demonstrated by both excellent oral hygiene scores and reported use of fluoride mouth rinses at home"*

There are different materials used for filling of the anterior and posterior teeth. Amalgam has been used for years for the posterior teeth. This material has the limitations that the colour makes it not suitable for anterior teeth. Over the past 20 years, composite resins have periodically been suggested as esthetic replacement for amalgam restorations. Recent improvements in composite materials, such as smaller filler particles, increased material strength, and introduction of dentine bonding agents, have much improved clinical results. Resin restorations offer the advantages of improved aesthetics, elimination of mercury and galvanic shock, and low thermal conductivity. Disadvantages of the resin material include an exacting technique, potential marginal leakage, postoperative sensitivity, and a tendency towards open or loose contacts.

The latest material, which is widely used at the Paediatric Dentistry Department at Westmead Hospital is glass ionomer cement (GIC). The release of fluoride from GIC is one of the most important features of this material. The colour shade of this material is not always accepted by adult patients. For the children, GIC can be used for anterior and posterior fillings. The addition of silver particles to GIC has allowed the creation of a glass ionomer restorative material which may withstand the force of occlusion over considerable periods of time.

If the pulp is involved, treatment depends on the operator whether to keep the tooth vital or non vital. If preservation of the pulp vitality is to be attempted there are two possible courses of action, direct pulp capping and pulpotomy.

Restoration of teeth with extensive carious lesions sometimes cannot be achieved by filling materials only, simply because the tooth is so badly damaged. In this case the tooth must be prepared for a crown. For the anterior teeth veneer or polycarbonate crowns are used, and for the posterior teeth porcelain or stainless steel crowns.

The wide range of materials available, and the different schools of teaching help to make treatment mainly dependent on the operator and on the cooperation of the patient.

In the treatment of rampant caries due to radiation therapy an attempt is made to stimulate the flow of saliva as much as possible. The drug which has been used for this purpose is pilocarpine. Greenspan and Daniels (1987) in their study on 12 patients justify the use of pilocarpine, under careful supervision, for patients with post-radiation xerostomia. The use of artificial saliva could help patients, especially at night. It is particularly troublesome when patients are awakened by intraoral dryness several times during sleeping hours. Xerolube is a commercial saliva produced by Scherer Laboratories, Inc., Dallas and approved by the American Dental Association. The product has proven very valuable and its use at bed time allows the patient to sleep throughout the night.

PREVENTION

The trend in developing countries is moving towards preventive dentistry, following the achievement of large reductions in the dental caries in most of the industrialised countries. This reduction is mainly attributed to the massive use of fluoride, increase in dental education and in the availability of services.

An early introduction to tooth brushing in a proper way with fluoride paste, at the proper time is another very important area which should be looked at in the dental education programs at nursery schools.

Modern equipment and materials have also helped in improving the preventive measures at community and individual level.

Fluoride is used either systemically or in topical form. Systemic fluoride is most effective, and the best and most cost effective way is water fluoridation. It reduces caries between 50-60 per cent and if water fluoridation continues through life it will also reduce root caries in the older patient. The cost:effectiveness ratio is about 1:50 depending on the size of the community, the larger the community the better the ratio.

Sometimes there is no main water supply in the community and school water fluoridation can be used, although this is not as cost:effective as water fluoridation.

Salt fluoridation is widely used in Switzerland and if the salt is optimally fluoridated at about 250 ppm, reduction in caries will be about 50-60 per cent. It is also used in Hungary and Columbia. The main disadvantages for salt fluoridation are that newborn babies do not consume salt and a lot of adults try to reduce salt intake.

Milk fluoridation has not been used as a community measure because the milk is ingested in relatively large amounts during the first two years, but then consumption decreases and there is great variability and irregularity of milk consumption habits in different regions, seasons of the year, and age groups.

Sometimes systemic fluoride supply on a community level cannot be achieved by the above methods, so fluoride supplements, in the form of tablets or drops, are recommended as an effective way of making use of fluoride. *"The benefits derived from the use of fluoride drops and tablets are comparable to those from fluoridated water and in some cases, they exceed that of water fluoridation, especially when their use has been continuous and conscientiously administered from early childhood and through the teen age years".* (Newburn 1986)

The most effective timing for the use of topical fluoride is during tooth eruption, the outer enamel surfaces of newly erupted teeth are quite porous, and a large surface area is available for the enamel-fluoride reaction to take place.

Fluoride toothpastes are a very common way of applying fluoride topically once or twice every day. Many clinical trials have shown that fluoride containing dentifrices reduce the incidence of caries in children and young adults by around 15-30 per cent (FDI 1984). About 95 per cent of dentifrices available are now fluoridated. Currently approved fluoride toothpastes contain sodium fluoride or sodium monofluorophosphate as active ingredients. The Fluoride ions should be in active form as some dentifrices may have an abrasive agent which is not compatible with the fluoride. The use of a fluoride containing dentifrice is recommended as the best and most cost-effective way of daily topical fluoride application.

Fluoride mouth rinses are recommended by some dentists even in fluoridated areas as an extra benefit, especially for the age group between 6 and 12 years old. Mouth rinses seem to be particularly indicated for individuals deemed to be at high risk to develop caries such as children with low manual dexterity, patients wearing orthodontic appliances or prostheses, and for patients with medical conditions such as patients undergoing head and neck radiation therapy, which may compromise their salivary flow. *"Mouth rinsing with fluoride solutions is a feasible and effective method for the prevention of dental caries in schoolchildren. The findings of more than 30 studies in several countries indicate that the incidence of dental decay can be reduced by about 35 per cent when this procedure is used daily, weekly or fortnightly. In most of these studies, children have rinsed either daily with 0.05% sodium fluoride or weekly with 0.2% sodium fluoride"* (FDI 1984).

The other way of topical fluoride use is through concentrated fluoride agents available for professional application or home use. Professionally applied fluoride is recommended twice a year with either 10% stannous fluoride or 1.23% acidulated phosphate fluoride (APF) solution. Daily topical fluoride application is recommended for irradiated cancer patients as a preventive measure for xerostomia related caries. The use of 1% sodium fluoride for five minutes per day was shown to be effective by Dreizen (1977).

The use of chlorhexidine has been shown to reduce the number of *S. mutans* in saliva of subjects highly infected with this organism. It has several disadvantages as it reduces the nonpathogenic as well as pathogenic flora, severely stains teeth, and has a disagreeable taste (Wei 1988). The advantages of chlorhexidine are safety, effectiveness and lack of serious side effects, and this has allowed its extensive use for hand rinsing and as a mouth rinse. The 0.2% chlorhexidine rinse has been recommended daily for patients who have xerostomia as a result of irradiation therapy.

Pit and fissure sealant is an effective way of prevention of dental caries, as pits and fissures are the least to benefit from systemic fluoride.

Glass ionomer cement is widely accepted as the best sealant due to the release of fluoride ions for a period of time. For this reason Craig (1984) prefers it to other methods for treating newly erupted posterior teeth and stated that these teeth are relatively porous and the ions released from glass ionomer cement should help in the maturation and protection of the enamel in the vicinity of the pit and fissure system. One of the main contraindications for fissure sealants is rampant caries, but if the patient is cooperative and follows the preventive program then fissure sealants should be used.

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