STRATEGIES TO PREVENT DENTAL CARIES IN CHILDREN AND ADOLESCENTS

Evidence-based Guidance on identifying high caries risk children and developing preventive strategies for high caries risk children in Ireland

Feidhmeannacht na Seirbhíse Sláinte
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Contents

What is an evidence-based guideline?

Evidence-based clinical practice guidelines are systematically developed statements containing recommendations for the care of individuals by healthcare professionals that are based on the highest quality scientific evidence available. Guidelines are designed to help practitioners assimilate, evaluate and apply the ever-increasing amount of evidence and opinion on current best practice, and to assist them in making decisions about appropriate and effective care for their patients. Their role is most clear when two factors are present: (a) evidence of variation in practice that affects patient outcomes, and (b) a strong research base providing evidence of effective practice.[1] It is important to note that guidelines are not intended to replace the healthcare professional's expertise or experience, but are a tool to assist practitioners in their clinical decision-making process, with consideration for their patient's preferences.

To assist the reader of this guideline, the key to the grading of evidence and recommendations is presented below.

LEVELS OF EVIDENCE	
1++	High quality meta-analyses, systematic reviews of randomised controlled trials (RCTs), or RCTs with a very low risk of bias
1+	Well conducted meta-analyses, systematic reviews or RCTs with a low risk of bias
1-	Meta-analyses, systematic reviews or RCTs with a high risk of bias
2++	High quality systematic reviews of case-control or cohort studies High quality case-control or cohort studies with a very low risk of confounding or bias and a high probability that the relationship is causal
2+	Well conducted case control or cohort studies with a low risk of confounding or bias and a moderate probability that the relationship is causal
2-	Case control or cohort studies with a high risk of confounding or bias and a significant risk that the relationship is not causal
3	Non-analytic studies, e.g. case reports, case series
4	Expert opinion
GRADES OF RECOMMENDATIONS	
A	At least one meta-analysis, systematic review, or RCT rated as 1++, and directly applicable to the target population OR A body of evidence consisting principally of studies rated as 1+, directly applicable to the target population, and demonstrating overall consistency of results
B	A body of evidence including studies rated as 2++, directly applicable to the target population, and demonstrating overall consistency of results OR Extrapolated evidence from studies rated as 1++ or 1+
C	A body of evidence including studies rated as 2+, directly applicable to the target population, and demonstrating overall consistency of results OR Extrapolated evidence from studies rated as 2++
D	Evidence level 3 or 4 OR Extrapolated evidence from studies rated as 2+
GPP **Good Practice Point**	Recommended best practice based on the clinical experience of the Guideline Development Group

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Summary of Recommendations

The recommendations in this guideline take into account the statutory role of the public dental service in both the prevention and treatment of dental caries in children and adolescents in Ireland. The focus of the recommendations is early identification of high caries risk children in order to initiate early preventive measures. This represents a reorientation of dental services from its present target group of school-aged children towards a younger – i.e. preschool and early school age – target group. The Guideline Development Group acknowledges the resource restrictions facing all public health services, but also recognises that the preventive strategies outlined here for high caries risk children need to be underpinned by a regular, background, systematic dental service for all children, regardless of caries risk. For the purposes of this guideline, the term "high caries risk" refers to children who are at risk of developing high levels of dental caries, or who are at risk from the consequences of caries, including those who are at risk by virtue of their medical, psychological or social status, i.e. at risk *of* or *from* caries.

Identification of high caries risk individuals	Grade of recommendation
Public Health Nurses, practice nurses, General Practitioners and other primary care workers who have regular contact with young children should have training in the identification of high caries risk preschool children	**D**
An oral assessment should be incorporated into each child's developmental visit from age 8 months and recorded in the child's health record	**D**
Referral pathways should be developed to allow referral of high caries risk preschool children from primary, secondary and social care services into dental services	**GPP**
Children should be offered a dental assessment during their first year in primary school	**D**
A formal caries risk assessment should be done for children attending the dental clinic for dental assessment or emergency care, using the Caries Risk Assessment Checklist	**D**
The Caries Risk Assessment Checklist should be integrated into the electronic patient record	**GPP**

Identification of high caries risk populations	Grade of recommendation
An agreed set of oral health indicators for the planning, targeting and evaluation of dental services should be developed. Methods of measurement and reporting of these indicators need to be decided	**GPP**
Data should be collected at local level, but standardised and co-ordinated nationally	**GPP**
Electronic patient record systems should be designed to produce small area data on the agreed oral health indicators for children	**GPP**
The use of Health Atlas Ireland and the All Ireland Health and Well-being Data Set (AIHWDAS) should be explored as a means of using area based information and demographics to identify populations in small geographic areas who are likely to have high caries levels	**GPP**

Preventive strategies for preschool children (age 0–4 years)		Grade of recommendation
POPULATION STRATEGIES		
Oral health education and diet advice should be incorporated into each child's developmental visits from age 8 months and at any appropriate opportunity that arises		**D**
Oral health messages should be incorporated into relevant general health promotion interventions for young children, as part of a common risk factor approach to improving oral health		**D**
Age <2	Parents/carers should be encouraged to brush their child's teeth as soon as the first tooth appears, using a soft toothbrush and water only	**D**
Age 2–4	Parents/carers should be encouraged to brush their child's teeth, or help them to brush:	
	• with fluoride toothpaste containing at least 1,000 ppm F	**A**
	• twice a day	**B**
	• at bedtime and at one other time during the day	**GPP**
	• using a small pea size amount of toothpaste	**D**
	Children should be encouraged to spit out toothpaste and not rinse after brushing	**B**
INDIVIDUAL STRATEGIES FOR HIGH CARIES RISK CHILDREN		
A formal caries risk assessment should be done for children attending the dental clinic for dental assessment or emergency care, using the Caries Risk Assessment Checklist		**D**
Age 0–4	Parents/carers of children who are assessed as being at high caries risk should be encouraged to brush their child's teeth:	
	• with fluoride toothpaste containing at least 1,000 ppm F	**A**
	• twice a day	**B**
	• at bedtime and at one other time during the day	**GPP**
	• using a small pea size amount of toothpaste	**D**
	Children should be encouraged to spit out toothpaste and not rinse after brushing	**B**
Oral health education for parents/carers should encourage healthy eating, in line with national dietary guidelines		**D**
Parents/carers of children who use a baby bottle should be advised never to put sweet drinks, including fruit juice, into the bottle		**C**
Parents/carers should be advised not to let their child sleep or nap with a baby bottle or feeder cup		**GPP**
Parents/carers should be encouraged to limit their child's consumption of sugar-containing foods and drinks, and when possible, to confine their consumption to mealtimes		**D**
Parents/carers should be advised that foods and drinks containing sugar substitutes are available, but should be consumed in moderation		**D**
Sugar free medicines should be used when available		**D**
Resin-based fluoride varnish application (22,600 ppm F) should be offered to children who are assessed as being at high caries risk, at intervals of 6 months or 3 months		**A**
The use of chlorhexidine for caries prevention is not recommended		**D**
Recall of high caries risk children should be based on the clinician's assessment of the child's caries risk status using the Caries Risk Assessment Checklist, and should not exceed 12 months		**D**

Preventive strategies for school-aged children (age 5–15 years)	Grade of recommendation
POPULATION STRATEGIES	
Oral Health Education should be incorporated into the Social and Personal Health Education (SPHE) programme of the school curriculum	**D**
Oral health messages should be incorporated into general health promotion interventions for children and adolescents, as part of a common risk factor approach to improving oral health	**D**
All children should be encouraged to brush their teeth:	
• with fluoride toothpaste containing at least 1,000 ppm F	**A**
• twice a day	**B**
• at bedtime and at one other time during the day	**GPP**
• using a small pea size amount of toothpaste (up to age 7)* *Over the age of 7, the risk of ingesting toothpaste is greatly reduced, and a pea size amount or more of toothpaste can be used	**D**
Children under the age of 7 should be supervised by an adult when brushing their teeth	**B**
Children should be encouraged to spit out toothpaste and not rinse after brushing	**B**
INDIVIDUAL STRATEGIES FOR HIGH CARIES RISK CHILDREN	
A formal caries risk assessment should be done for children attending the dental clinic for dental assessment or emergency care, using the Caries Risk Assessment Checklist	**D**
Children who are assessed as being at high caries risk should have resin-based fissure sealant applied and maintained in vulnerable pits and fissures of permanent teeth	**A**
Resin-based fluoride varnish application (at least 22,600 ppm F) should be offered to children who are assessed as being at high caries risk, at intervals of 6 months or 3 months	**A**
The use of chlorhexidine for caries prevention is not recommended	**D**
There is insufficient evidence on which to base a recommendation on the use of remineralising products (CPP-ACP) for caries prevention	
Oral health education for parents/carers and children should encourage healthy eating, in line with national dietary guidelines	**D**
Parents/carers should be encouraged to limit their child's consumption of sugar-containing foods and drinks and, when possible, to confine their consumption to meal times	**D**
Children should be advised to limit their consumption of sugar-containing foods and drinks and, when possible, to confine their consumption to meal times	**D**
Parents/carers and children should be advised that foods and drinks containing sugar substitutes are available, but should be consumed in moderation	**D**
Sugar free medicines should be used, when available	**D**
Recall of high caries risk children should be based on the clinician's assessment of the child's caries risk status using the Caries Risk Assessment Checklist, and should not exceed 12 months	**D**
Targeted population strategies (All ages)	
Community-based interventions involving the use of fluoride toothpaste, varnish or mouthrinse should be considered for targeted populations of children who are at high risk of developing dental caries, in line with the recommendations of the Topical Fluoride guideline (Appendix 1)	

1. Background

Summary

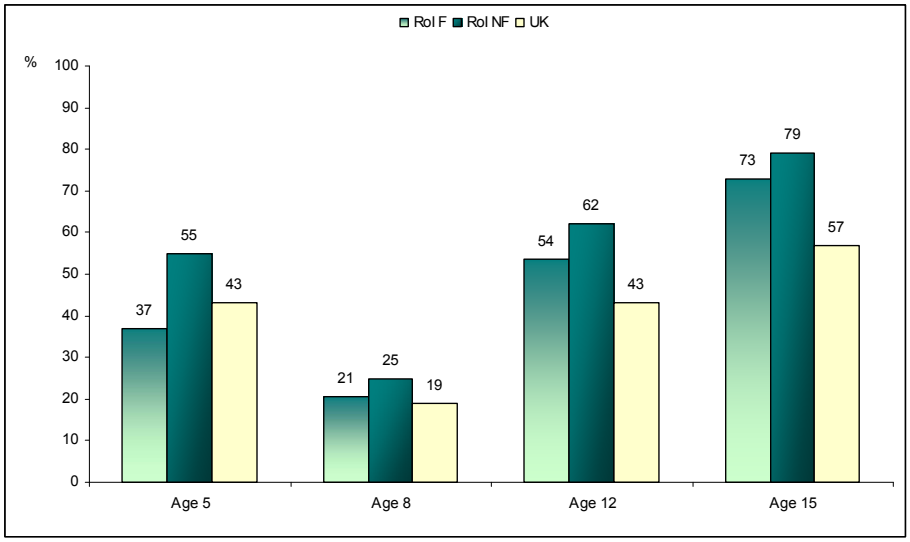
- Dental caries is very common in Irish children. Among 5-year-olds, 37% of children in fluoridated areas and 55% in non-fluoridated areas have experienced decay. More than one-fifth of 8-year-olds, half of all 12-year-olds and three-quarters of all 15-year-olds have experienced decay in their permanent teeth. There are no national data on caries levels in preschool children.
- The oral health goals for children, which were set by the Department of Health to be achieved by the year 2000, were not met for 5-year-olds or for 12-year-olds in fluoridated areas.
- There is considerable geographic variation in the prevalence and severity of dental caries, at regional (former Health Board) and local (former Community Care Area) level.
- State-funded dental services for children under the age of 16 are provided mainly by the public dental service. The services provided can be considered under 3 headings: the School Dental Service (SDS), targeted at specific classes; an emergency service, which is available to all eligible children; and an oral health promotion (OHP) service, which, for children, is predominantly school-based. There is considerable variation across Ireland in the number and choice of target classes, the setting (school-based or clinic-based) for assessing children, and the balance between the emergency service relative to the SDS and OHP services.
- There is evidence to suggest that public dental services for children do not operate against a background of regular private dental attendance, and that many parents perceive the public dental service as the main (or only) service for children.

1.1. Epidemiology

1.1.1. Caries experience in school-aged children

Dental caries (tooth decay) is the single most common chronic disease of childhood.[2] In the Republic of Ireland, 37% of 5-year-olds in fluoridated areas and 55% in non-fluoridated areas have experienced decay, i.e. they have one or more teeth that is decayed, filled or extracted because of decay. More than one-fifth of 8-year-olds, half of all 12-year-olds and three-quarters of all 15-year-olds have experienced decay in their permanent teeth.[3] Compared to the UK[4], the prevalence of decay is slightly higher for Irish 8-year-olds and considerably higher for Irish 12- and 15-year-olds in both fluoridated and non-fluoridated areas (Figure 1.1).

Figure 1.1: Percentage of children with caries experience (mean $d_{3vc}mft/D_{3vc}MFT>0$) in the Republic of Ireland (RoI) 2002 by fluoridation status (F: fluoridated, NF: non-fluoridated)[3], and in the UK 2003[4]



The severity of decay experienced by Irish children is also of concern. The average number of decayed, missing or filled teeth ($d_{3vc}mft/D_{3vc}MFT$) at age 5, 12, and 15 is shown in Table 1.1, along with the percentage of children with 5 or more decayed, missing or filled teeth, which represents higher than average caries experience for all age groups. A substantial proportion of children, particularly in non-fluoridated areas, experience high levels of caries; this proportion varies considerably across the country. For example, nationally, 10% of all 5-year-olds in fluoridated areas have 5 or more decayed, missing or filled teeth but this varies from 4% to 16% across the 10 former Health Board areas (Table 1.1). Similar variation in the prevalence of high caries levels across Health Boards is also seen in other age groups. Various regional oral health surveys have also found variation in caries levels among smaller geographic areas.[5–11]

Table 1.1: Average decay experience (mean $d_{3vc}mft/D_{3vc}MFT$), percentage of children with 5 or more decayed missing or filled teeth and range of prevalence of severe caries in the Republic of Ireland, by fluoridation status (published and unpublished data from the North South Survey of Children's Dental Health 2002)[3]

	Age 5		Age 12		Age 15	
	F	Non F	F	Non F	F	Non F
Average decay experience	1.3	2.2	1.4	1.8	2.6	3.8
% of children with 5 or more decayed, missing or filled teeth	10	18	6	10	20	36
Range across health boards for % of children with 5 or more decayed, missing or filled teeth	4–16	17–26	4–11	7.5–13	16–29	23–46

Oral health goals for 5- and 12-year-olds were set by the Department of Health in the first national health strategy *Shaping a Healthier Future* in 1994.[12] Three out of the four goals were not achieved by 2002[3] (Table 1.2).

Table 1.2: Oral health goals for 5- and 12-year-old children

	Age 5		Age 12	
	F	Non F	F	Non F
Oral Health Goal in the Dental Action Plan 1994 [12]	At least 85% free of dental caries	At least 60% free of dental caries	No more than 1 decayed, missing or filled tooth	No more than 2 decayed, missing or filled teeth
Outcome measured at cavitation level in the North South Survey 2002[3]	70%	53%	1.2	1.4
Outcome measured at visual and cavitation level in the North South Survey 2002[3]	63%	45%	1.4	1.8

1.1.2. Caries and disadvantage

The link between general health and socio-economic status is well established.[13-15] There is also a body of evidence showing that poor oral health is associated with low socio-economic status or deprivation.[16-21] In Ireland, ownership of a means-tested medical card is used as an indicator of disadvantage. The North South survey of children's dental health found that caries levels were significantly higher among the less well off, having controlled for fluoridation status ($p<0.0001$ for 5-, 8- and 12-year-olds, $p=0.0082$ for 15-year-olds). The impact of disadvantage on dental health was greatest in the two younger age groups, where, with the exception of 5-year-old children in non-fluoridated areas, the percentage difference in caries scores between disadvantaged and non-disadvantaged groups was just over 40%.[3]

1.1.3. Caries experience in preschool children

There are no national data on the oral health of preschool children in Ireland, but the high prevalence of caries in 5-year-olds suggests that the burden of dental disease experienced by preschool children must be considerable. Tooth decay in young children is of particular concern for a number of reasons:

- It is painful for the child, disturbs eating and sleeping patterns and is distressing for both child and parent;
- Treatment is challenging and often requires secondary and specialist care under conscious sedation or general anaesthesia;
- It may impact on the developing permanent dentition, self esteem and aesthetics;
- It highlights that an opportunity has been missed to prevent what should have been preventable.

Only three small-area oral health surveys of Irish preschool children have been conducted.[22-24] The most recent of these[24], found that approximately one in four 3-year-olds (27.4%) had decay. The prevalence and severity of decay was significantly higher among disadvantaged preschool children (where disadvantage was measured as parental medical card ownership) compared to those who were not disadvantaged (prevalence: 41.5% vs 18%, $p<0.001$; mean dmft: 1.31 vs 0.76, $p<0.05$). This finding is consistent with the results of the North South survey for school-aged children.[3]

1.1.4. Caries experience in children with special care needs

Good oral health is important for all children, but is particularly important for children and young people who have a disability. Oral disease and its management can expose a child or adolescent with disabilities to potentially life-threatening events. Caries levels in Irish children with special care needs tend to be similar to or lower than those of children attending mainstream schools; the level of untreated decay also tends to be lower. However, considerable variation in caries experience exists between groups with different types of disabilities.[25,26]

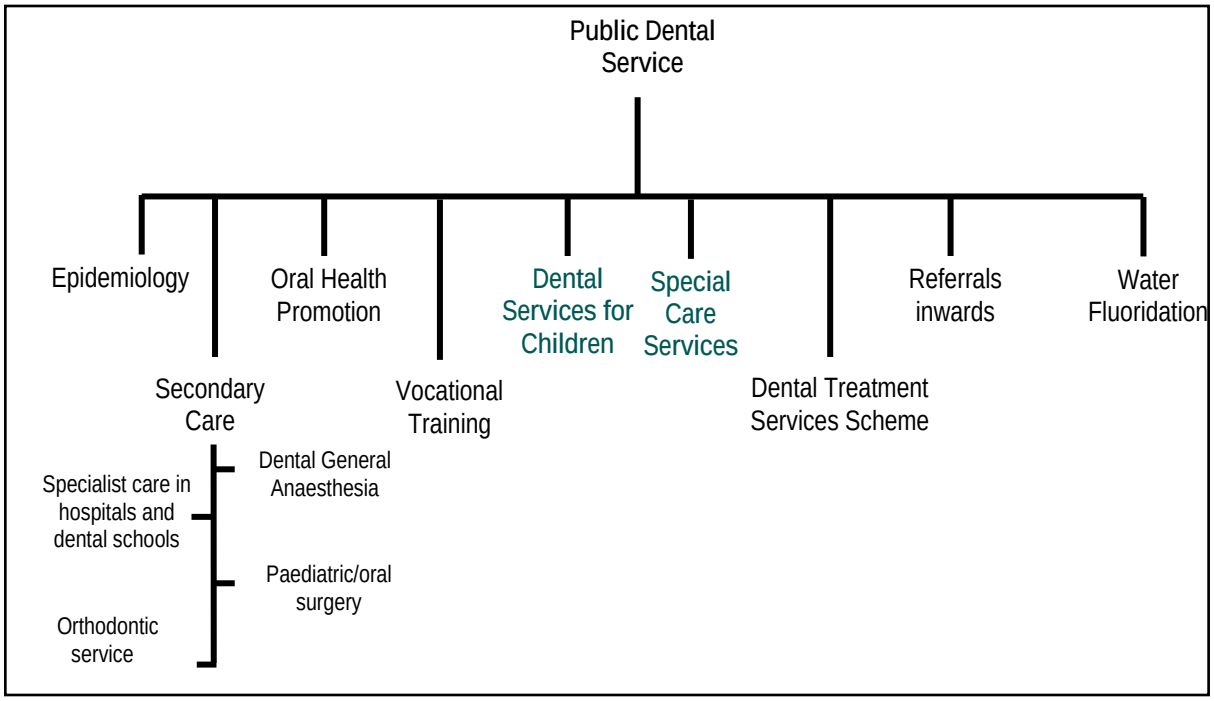
The prevention of caries is of particular importance for children with disabilities, and yet Irish studies show that fewer children with special care needs have fissure sealants on their teeth compared to children in mainstream schools.[25,26] However, one survey conducted in the greater Dublin area (ERHA) found that the prevalence of fissure sealants was higher among children attending special schools in the ERHA area compared to other studies of children attending special schools.[25] An unpublished Irish study found that one in three children aged 12 and 15 with special care needs had already undergone general anaesthesia for dental treatment.[26]

1.2. Public dental services for children in Ireland

In the Republic of Ireland, dental services for children form part of the defined "core" health services provided free of charge to the public, which include childhood immunisations, developmental and school health services. The Health Service Executive (HSE), which is the national authority responsible for health and personal social services, has statutory responsibility to make free dental services available to all children up to the age of 16. These services are provided, with few exceptions, by the salaried public dental service, which is part of the HSE. The aim of the public dental service is to improve the level of oral health of the whole population[27] and the functions of the public dental service (Figure 1.2) reflect this broad remit.

Since the introduction of the first national oral health strategy – *The Dental Health Action Plan* – in 1994, the focus of the public dental service has been to provide *"oral health and treatment services to children and "special needs" groups, with an emphasis on preventive programmes".*[27] Although all children under the age of 16 are entitled to free dental services, the public dental service concentrates on providing services to school-aged children. Structured dental services for preschool children are rare.

Figure 1.2: Functions of the public dental service



Dental services for eligible adults are outsourced to contracting private dentists through the Dental Treatment Services Scheme (DTSS). In areas with few contracting dentists, the public dental service is responsible for providing services to eligible adults. The public dental service also acts as the gatekeeper for access to the publicly-funded orthodontic service.

It is important to note that the public dental service is the only source of free basic dental care for children in Ireland. Parents who wish to bring their child to a dentist outside the public dental service must do so at their own expense.

1.2.1. Structure of the public dental service

The public dental service operates from 32 Local Health Offices (LHOs) across the country. Each LHO dental service is led by a Principal Dental Surgeon. There is currently no Chief Dental Officer in the Department of Health and Children, or Dental Director in the HSE, to lead and co-ordinate dental services in Ireland. This lack of central leadership has resulted in a fragmentation of public dental services, with resulting variation in the availability of services across different areas.

Although the number and type of staff vary from area to area, the basic composition of the public dental service staff for each area is as follows:

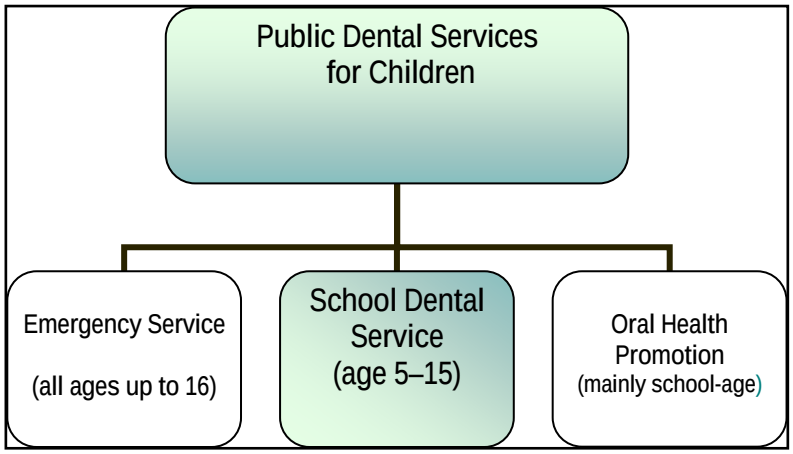
- Principal Dental Surgeons;
- Senior Dental Surgeons, who have duties ranging from administration to specific clinical duties (e.g. providing services for patients with special needs);
- General Dental Surgeons, who are mainly responsible for providing dental services for children;

- Hygienists, who work in both the children's service and the special care service. Some hygienists also work exclusively in the HSE orthodontic service;
- Dental Nurses, who have both clinical and administrative duties;
- Oral Health Promoters, who work in clinical settings as well as non-clinical settings (e.g. schools, residential homes, in the community).

1.2.2. Structure of public dental services for children

Public dental services for children (other than those with special needs) can be considered under three inter-related headings: the School Dental Service (SDS), the emergency service and oral health promotion programmes (Figure 1.3).

Figure 1.3: Structure of dental services for children provided by the public dental service



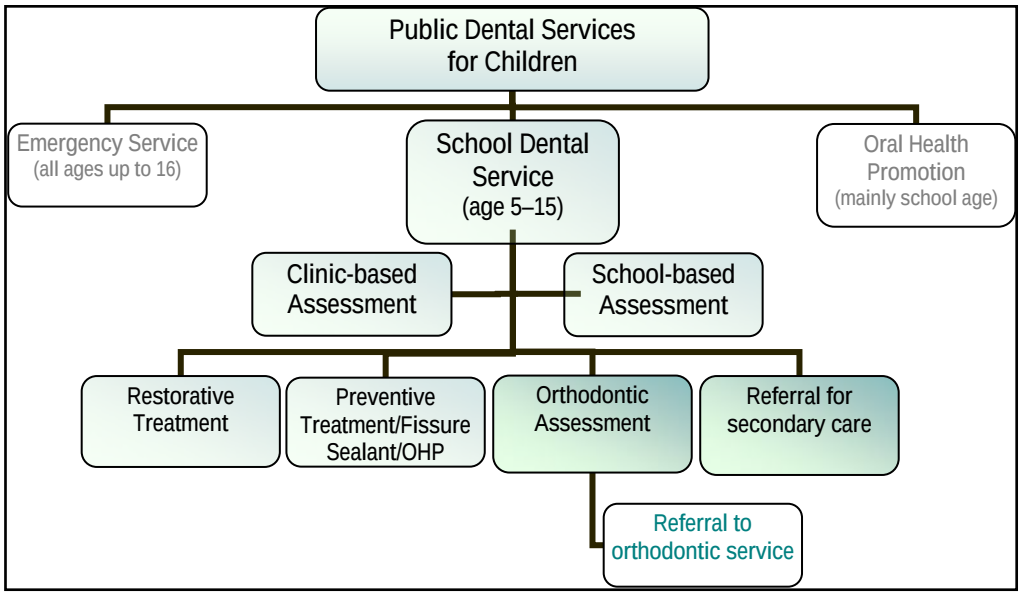
The School Dental Service (SDS) satisfies the HSE's statutory obligation to provide the following services to school-aged children:

> *"(a) a dental health screening service,*
> *(b) a preventive dental treatment service, and*
> *(c) a primary care dental treatment service in respect of defects noted during a screening examination carried out under paragraph (a)."*
>
> **Health (Dental Services for children) Regulations, 2000**

The SDS is a structured service that targets children in specific classes in primary school each year for dental screening/assessment and treatment. There is no nation-wide agreement on which classes should be targeted, which has led to considerable variation across the country in the classes that are targeted. In most areas, the choice of target class is influenced by the time of emergence of the first and second permanent molar teeth, and the most common combination of primary classes targeted is 1st or 2nd class and 6th class (corresponding to age 7 or 8 and 12 years respectively). Children in 3rd or 4th class and – where resources permit – children in secondary school, may be targeted in some areas. The number of classes targeted in a particular dental area depends on staff levels, which vary

across the country. The structure of the SDS, showing its role in the assessment, treatment and referral of children in target classes is described in Figure 1.4. Dental assessment is the gateway to the receipt of dental services from the SDS. Currently, two methods are used to screen/assess children in target classes: school-based assessment and clinic-based assessment. A situation analysis conducted for this guideline found that 14 out of 29 dental areas used clinic-based assessment, 4 areas used the school setting and 11 areas used both. An important feature of the SDS is that the assessment *and* treatment of the children in target classes is conducted by the same unit within the HSE – the public dental service.

Figure 1.4: Structure of the School Dental Service



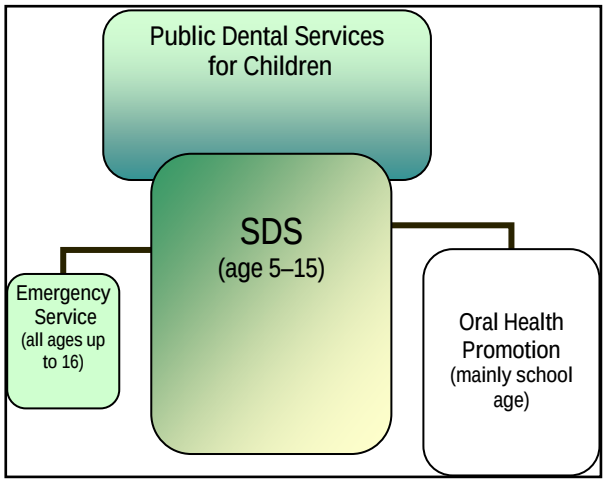
1.2.3. The emergency service

In addition to the SDS, the public dental service also provides an emergency service for all eligible children. Emergency treatment is generally the only public dental service available for preschool children, because, with the exception of children with special needs, this age group has rarely been prioritised for service delivery. A report, commissioned by the Department of Health and Children on specialisation in dentistry, stated*: "It is a disgrace that, in this day and age, the introduction to dentistry for many young children is still the extraction of teeth under a general anaesthetic".*[28] Emergency treatment is also often the only treatment available to children who are not in a target class, which includes most children at school entry age and most secondary school pupils.

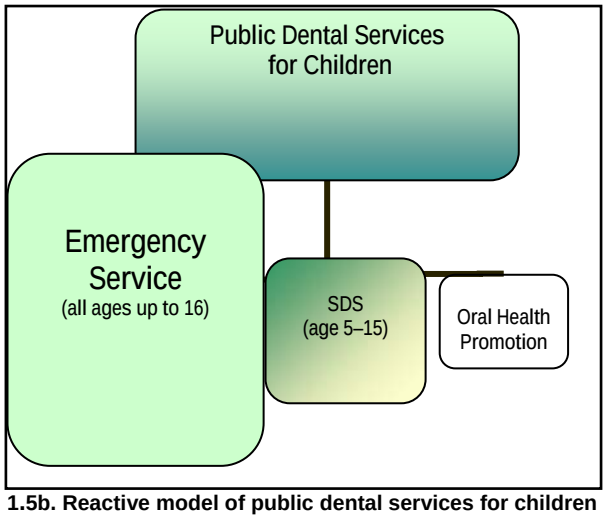
A fine balance exists between the emergency service and the other elements of the public dental service for children. The more classes targeted by the SDS, and the more consistent and effective its preventive service, the lower the demand on the emergency service will be. Similarly, effective oral health promotion strategies should reduce both the level of treatment required through the SDS and should also reduce the demand for emergency services. This is illustrated by Figure 1.5a. On the other hand, if the SDS is diminished so that fewer classes are targeted, the demand on the emergency service will grow, which further impacts on the sustainability of the SDS. This is illustrated by Figure 1.5b.

Children attending for emergency treatment will often have other unmet dental needs. The provision of additional treatment for children presenting with an emergency is often left to the discretion of the individual dentist. In some cases, the commitment to maintaining a targeted SDS, however limited, can take priority over meeting the additional treatment needs of these children, if they are not in a target class. Oral health promotion activities are also affected, as clinical duties invariably take precedence over non-clinical oral health promotion activities, and staff assigned to oral health promotion duties may be recalled from these duties to work in the clinic (Figure 1.5b).

Figure 1.5a & b: Effect of changes in the focus elements of public dental services for children



1.5a. Proactive model of public dental services for children



1.5b. Reactive model of public dental services for children

1.2.4. Utilisation of public dental services for children

The limited data available on the dental attendance of Irish children suggest that private dental attendance, as an alternative or as a supplement to the SDS, is low. Estimates of the percentage of children using the SDS range from 80%[29] to 91%.[30] Among 5-year-olds, fewer than one in five children (19%) attend privately and overall dental attendance is low, with only 31% of 5-year-olds ever having been to the dentist.[11] This is in stark contrast to the UK, where 94% of all 5-year-olds have visited the dentist.[31] The low figure for dental attendance among Irish 5-year-olds in mainstream schools is undoubtedly influenced by the lack of public dental services for this age group. For children with special needs, who are a priority group for the public dental service, 65% of 5-year-olds had been to the dentist[26], which is still far below the dental attendance figure for the UK.

The North South survey found that among 8-year-olds, a group that is targeted by the public dental service, 68% had their first visit to the dentist between the ages of 5 and 8 years.[3] Almost two-thirds (65%) of parents said their child normally used the public dental service. Only 22% normally attended a private dentist and 13% had never been to the dentist. Utilisation of the public dental service was higher among 8-year-olds who were disadvantaged (75.5%) compared to the less disadvantaged (62%). Among those who had received dental treatment from the public dental service, 59% received routine treatment, 21% received emergency treatment and 20% received both routine and emergency treatment. There was little difference between the disadvantaged and advantaged groups in their utilisation of the emergency service (20.3% vs 20.5% respectively), but a higher proportion of

disadvantaged children received both emergency and routine treatment (25% vs 19%). Over two-thirds of 15-year-olds reported that they had mainly used the public dental service.[3]

The lack of information on dental attendance for children in other age groups limits the conclusions that can be drawn from these data but, for younger children at least, these findings suggest that public dental services for children do not operate against a backdrop of regular private dental attendance, and that many parents perceive the public dental service as the main (or only) service for children.

1.2.5. Oral health promotion

The oral health objectives of the National Health Promotion Strategy 2000–2005 include the promotion of the use of fluoride toothpaste, education of parents and carers in the appropriate use of fluoride toothpaste for young children, prioritisation of initiatives for special needs groups and working in partnership with other agencies to develop and implement health promotion programmes that take a common risk factor approach to promoting oral health.[32] A review of oral health promotion in Ireland – *Oral Health in Ireland*[33] – found a lack of a strategic, co-ordinated approach at regional and local level to the provision of oral health education/promotion through the public sector. While there was a range of initiatives in progress across a number of settings and population groups, some of which had been evaluated based on sound scientific criteria, the report noted that there was a volume of activity that was being undertaken *"without apparent strategic direction, planned outcome or evaluation".* Most of the oral health promotion initiatives described were school-based educational initiatives, aimed at improving knowledge and raising awareness of oral health issues. Some preschool initiatives were also reported. Barriers to the development of oral health promotion in Ireland included changing a cultural orientation away from curative/treatment services towards oral health promotion, overcoming resistance to change and improving a relatively lean skills base in oral health promotion. Although the last of these has been addressed through the introduction of the Specialist Certificate in Health Promotion (Oral Health), both *Oral Health in Ireland* and a subsequent evaluation of the Specialist Certificate in Health Promotion (Oral Health)[34] identified a lack of support for those who had completed the certificate in applying their skills.

1.3. Current preventive strategies and rationale for guideline

Two main approaches to disease prevention have been advocated: the population approach and the "high risk" approach.[35] The concept behind the population approach is that a large number of people at low risk may give rise to more cases of disease; thus, a small reduction in risk for a large number of people has the potential to have a greater impact at reducing population disease levels.[35] The population approach can also incorporate "upstream" interventions that tackle the societal, economic, structural and political factors that are known to be the main determinants of health.[36] A population approach aims to reduce the incidence of disease, i.e. the number of new cases occurring.

By contrast, the "high risk" approach aims to identify individuals or groups of individuals at highest risk of developing disease, and to target interventions at them in order to reduce their risk or to prevent progression of their disease. The rationale behind "high risk" targeting is that it is likely to be more cost

effective, as resources are targeted at those who are most likely to benefit from the intervention. An inherent problem of the targeted approach, however, is the need to identify those who are at risk, and as we will see in Section 3, predicting caries risk is not straightforward. The prevalence of high risk individuals in the target population also influences the decision to take a high risk approach: It has been suggested that where the proportion of high caries risk individuals exceeds 30%[37] or 40%[38] of the target population, individual caries risk assessment becomes impractical and in such circumstances, preventive strategies should be targeted at the entire population.[37,38] The cut-off of 30–40% has been used by other researchers when assessing the usefulness of caries risk prediction models.[39,40]

A third strategy, known as the directed population approach[41], or geographic targeting[42], has been suggested as an efficient compromise between the population and high risk approaches, and uses socio-demographic or epidemiological data to identify subgroups or geographic areas that may benefit from caries-preventive interventions. In reality, a mixture of the three approaches is required to tackle caries, with individual care and geographic targeting built on a base of population strategies.[42] While preventive strategies reduce disease levels in the population, adequate treatment services must also be available to deal with cases of existing disease.

In Ireland, water fluoridation, a population preventive strategy, has been the foundation of caries control since the 1960s, and continues to provide a benefit in terms of reduced caries levels for those who reside in fluoridated areas.[3] The use of fluoride toothpaste can also be considered a population strategy in that most people brush their teeth and 95% of toothpastes sold in Ireland contain fluoride.[43] However, whereas water fluoridation is a passive intervention, the use of fluoride toothpaste requires individual compliance in order to be effective, and this is least likely to occur in those who would benefit most from the intervention. The recent WHO survey of health behaviours in school-aged children (HBSC survey)[44] found that, in most countries, including Ireland, children from less affluent backgrounds were less likely to brush more than once a day. Marked gender differences in tooth brushing frequency also exist, with approximately two-thirds of 11- and 13-year-old Irish girls brushing more than once a day, compared to just over half of boys of the same age. Although the proportion of Irish children brushing more than once a day increased between 2001/02[45] and 2005/06[44], Ireland still ranked in the bottom half of the countries surveyed. The oral health objective of the National Health Promotion Strategy to encourage the use of fluoride toothpaste remains as relevant now as when the strategy was published in 2000.[32]

Fluoride mouthrinsing programmes, which are provided in some non-fluoridated areas of Ireland, are an example of geographic targeting. Cross sectional studies of the effectiveness of fluoride mouthrinse programmes have shown that at age 12, caries levels of children who use mouthrinse are comparable to those of children resident in fluoridated areas[46-48], but that the benefits are lost when the programmes stop.[49]

The fissure sealant component of the School Dental Service (SDS) could be considered a high risk preventive strategy, in that the selection of classes to be targeted is based on the eruption of the first and second molar teeth, which are the teeth at highest risk of developing caries, and sealants are

offered to children considered to be at risk of developing caries. The fissure sealant programme is the key caries-preventive strategy currently provided by the public dental service, and accounts for the greatest input of staff and resources. Yet, in spite of actively targeting the most vulnerable teeth, particularly the first permanent molar, 54% of all 12-year-olds and 72% of 15-year-olds have experienced decay on pit and fissure surfaces (North South survey, unpublished data). Among those with decay, pit and fissure caries accounts for over 80% of caries experience in 8-year-olds, and over 75% of caries experience in 12-year-olds.[3] A report commissioned by the Department of Health and Children highlighted the variability of eruption times of permanent molar teeth among Irish children and concluded that: *"the current Health Board system of targeting three classes in primary school for both preventive (fissure sealants) and treatment services is not in line with current best evidence."* The report added: *"in view of the fact that targeting particular primary school classes was unlikely to result in the selection of appropriate at risk groups for dental services generally including fissure sealing, an alternative method for selecting children for treatment is necessary."*[50]

Most oral health promotion interventions for children tend to be school-based and educational and aim to improve knowledge.[33] These interventions may be targeted at certain disadvantaged or special needs groups, but most activity takes place in mainstream schools. Our situation analysis for this guideline found that over half of all dental areas provided school-based oral health education (DHE) involving over 40,000 children in 614 primary schools. While systematic reviews have concluded that oral health education is effective at increasing knowledge levels[51-54], increases in knowledge are short lived[53] and likely to fade over time.[54] There is disagreement as to whether changes in knowledge can result in changes in behaviour. The review by Sprod et al.[54] concluded that knowledge can bring about behaviour change, whereas the review by Kay and Locker[51] highlighted the lack of validated and consistent methods for measuring 'knowledge' and also questioned the reliability of self-reported behaviour change as an outcome measure. The reviewers concluded that *"the balance of evidence is that the case for a causal relationship between knowledge and behaviour is 'not proven'."* However, they added that there was an ethical responsibility to disseminate scientific knowledge to the public.

Oral health promotion interventions for preschool children or for children in their early school years are limited in Ireland. Given that the oral health targets for 5-year-olds were not achieved by 2002, the authors of the North South survey recommended that new caries preventive programmes would be needed if progress towards lower levels of decay were to achieved in this age group.[3] The need for earlier intervention was echoed in a report on specialisation in dentistry, which stated: *"If prevention of oral disease is to be taken seriously in Ireland, it must be provided for this [preschool] age group".*[28]

One of the key principles of the national health strategy in the Republic of Ireland is equity: that health inequalities are targeted and that people are treated fairly according to need.[55] The varying caries levels by age group, disadvantage status and geographic location suggest that current preventive strategies in Ireland need to be reviewed, and guidance is required on effective preventive strategies to achieve optimum outcomes. This guideline seeks to fill this gap.

2. Methodology

2.1. Scope of the guideline

This guideline has been developed for the public dental service in Ireland, which is the main provider of state-funded dental services to children under the age of 16. For the purposes of this guideline, the term “high caries risk” refers to children who are at risk of developing high levels of dental caries, or who are at risk from the consequences of caries, including those who are at risk by virtue of their medical, psychological or social status, i.e. at risk *of* or *from* caries.

The upper age limit of 15 covered by this guideline is based solely on the age at which universal eligibility for public dental services ends, and does not imply that the guideline recommendations are not valid for older adolescents.

2.1.1. What the guideline covers

The guideline covers approaches to identifying “high caries risk” children at both the individual and the population level and addresses effective strategies to prevent caries, at individual and population level, in high caries risk children under the age of 16.

2.1.2. What the guideline does not cover

The following areas are not covered by this guideline:

- Restoration and re-restoration of carious teeth
- Dental erosion
- Systemic fluoride delivery systems.

2.2. Aim of the guideline

The aim of this guideline is to:

- Encourage early identification of high caries risk children
- Assist clinicians in making decisions on preventive strategies for individual high caries risk children and adolescents
- Assist policy makers and those responsible for planning public dental services for children and adolescents in making decisions on the provision of caries prevention programmes for high caries risk children.

This guideline is of relevance to all clinical staff working in the public dental service, those responsible for the planning and management of public dental services, oral health promoters, the primary health care team (Public Health Nurses, GPs, practice nurses etc.), parents and children, teachers and other social, health and education services dealing with children. Although developed for the public dental service, this guideline will also be of interest to general dental practitioners and their dental teams.

2.3. Guideline methodology

This guideline was developed in line with international best practice, as specified by the AGREE Collaboration and described in the AGREE Instrument.[56] A Guideline Development Group (GDG) was established which represented key stakeholders in the guideline (see Appendix 2). All GDG members were asked to declare any interests that might be in conflict with the development of the guideline and none were declared. Stakeholder groups who were not represented within the GDG were invited to contribute comments when the scope of the guideline was being planned, and to comment on the consultation draft of this guideline.

2.3.1. Key questions

The Guideline Development Group identified the questions that the guideline needed to address. These questions fell into two categories:

Background questions – Background questions related to the epidemiology of dental caries in Irish children, risk factors for dental caries, age of eruption of permanent teeth, caries risk assessment for individuals, area-based deprivation indices for identifying high caries populations. We consulted relevant textbooks, systematic reviews where available, narrative reviews by key researchers in the field, and relevant Irish studies to answer these questions.

Key questions – Key questions related to the effectiveness of non-dental personnel at identifying high caries risk children, and the effectiveness of caries-preventive interventions, namely fissure sealants, remineralising products, anti-microbials (e.g. chlorhexidine), and sugar substitutes, either individually or in combination. The full list of questions posed by the Guideline Development Group can be found in Appendix 3.

2.3.2. Search strategy

Separate searches were conducted to answer key questions relating to the effectiveness of individual preventive agents (i.e. antimicrobial agents, fissure sealants, remineralising products and sugar substitutes). The searches were run in Pubmed, all databases of The Cochrane library and Embase. We searched for systematic reviews published between 1995 and 2008. Where a systematic review was identified, the search for subsequent randomised trials was conducted from the last search date of that review to the end of 2008. A separate search was conducted to identify randomised trials, quasi-randomised trials or longitudinal studies of any health promotion intervention which had caries as an outcome measure. This search strategy was developed by Sylvia Bickley, Trials Search Co-ordinator of the Cochrane Oral Health Group in Manchester, and was run from 1995 to 2007 in the Cochrane Central Register of Controlled Trials (CENTRAL), Medline (Ovid), Embase and CINAHL. The search was updated by Anne Littlewood (Cochrane Oral Health Group) to August 2008 (for Medline) and September 2008 (for all other databases). All searches were limited to the English language. The full oral health promotion search strategy (as used for MEDLINE), the number of records retrieved in this search, the number of full text articles obtained and the number of studies from this search included in the review are presented in Appendix 4. The quality of the identified

systematic reviews, randomised trials and cohort studies were appraised by two reviewers using the appropriate methodology checklists developed by the Scottish Intercollegiate Guideline Network (SIGN) and a quality score was assigned according to SIGN criteria (Table 2.1). The reviewers conferred when there was any doubt about the evidence level to be given to a particular publication, and a quality score was agreed by discussion. The websites of key guideline organisations, dental professional organisations, and electronic guideline databases (TRIP, National Guideline Clearing House) were also searched to identify relevant guidelines. A full list of websites searched for guidelines is given in Appendix 4. The quality of relevant guidelines was appraised using the AGREE instrument.[56]

A summary of the evidence to answer each of the key questions was presented to the Guideline Development Group in structured abstracts and evidence tables. These were discussed and informal consensus methods were used to formulate recommendations. Recommendations were graded according to the level of evidence on which they were based, using the SIGN criteria (Table 2.1).

Table 2.1: Levels of evidence and grades of recommendations

LEVELS OF EVIDENCE	
1++	High quality meta-analyses, systematic reviews of randomised controlled trials (RCTs), or RCTs with a very low risk of bias
1+	Well conducted meta-analyses, systematic reviews or RCTs with a low risk of bias
1-	Meta-analyses, systematic reviews or RCTs with a high risk of bias
2++	High quality systematic reviews of case-control or cohort studies High quality case-control or cohort studies with a very low risk of confounding or bias and a high probability that the relationship is causal
2+	Well conducted case control or cohort studies with a low risk of confounding or bias and a moderate probability that the relationship is causal
2-	Case control or cohort studies with a high risk of confounding or bias and a significant risk that the relationship is not causal
3	Non-analytic studies, e.g. case reports, case series
4	Expert opinion
GRADES OF RECOMMENDATIONS	
A	At least one meta-analysis, systematic review, or RCT rated as 1++, and directly applicable to the target population OR A body of evidence consisting principally of studies rated as 1+, directly applicable to the target population, and demonstrating overall consistency of results
B	A body of evidence including studies rated as 2++, directly applicable to the target population, and demonstrating overall consistency of results OR Extrapolated evidence from studies rated as 1++ or 1+
C	A body of evidence including studies rated as 2+, directly applicable to the target population, and demonstrating overall consistency of results OR Extrapolated evidence from studies rated as 2++
D	Evidence level 3 or 4 OR Extrapolated evidence from studies rated as 2+
GPP **Good Practice Point**	Recommended best practice based on the clinical experience of the Guideline Development Group

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2.4. Funding for the guideline

The development of this guideline was funded through a Strategic Health Research and Development Research Award from the Health Research Board (HRB). The Guideline Development Project is a collaboration between the Health Service Executive (Public Dental Service), the Oral Health Services Research Centre (University College Cork) and the UK Cochrane Centre. The development of this guideline – from scoping to final recommendations – was not influenced in any way by the funding body.

2.5. Updating the guideline

It is essential that recommendations in guidelines are reviewed and updated, where necessary, in a timely fashion as new evidence becomes available. Two years after the publication of this guideline, the project team will re-run the main search strategy for the period since the previous searches were conducted. Relevant systematic reviews and randomised trials will be identified and critically appraised. The opinion of the original Guideline Development Group will be sought on whether an update is needed and whether any new evidence impacts on the guideline recommendations. In general, the process for updating this guideline will follow that used for the development of the original guideline.

3. Identification of high caries risk individuals

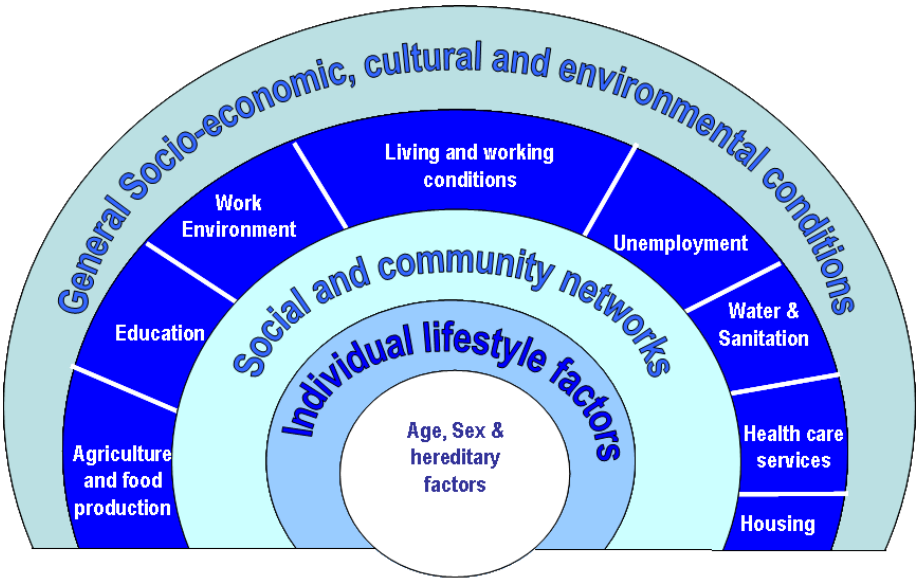
3.1. Introduction

Dental caries is a multifactorial disease which has been described as *"a simple process in concept, but complicated in detail."*[57] The basic prerequisites for caries to occur are:

- A microbial biofilm (plaque)
- Fermentable carbohydrate (e.g. sugars) from the diet
- A susceptible tooth surface.

However, these factors are themselves influenced by other variables such as genetics, lifestyle, education, and socio-economic, cultural and environmental conditions, many of which lie beyond the control of the individual (Figure 3.1). It must be borne in mind that any preventive approach needs to address the underlying determinants as well as the immediate causes of ill health.[58]

Figure 3.1 Determinants of Health. Taken from: Dalhgren and Whitehead, 1991[59]



Teeth are covered by a microbial biofilm, i.e. a community of micro-organisms, often referred to as dental plaque, which produces acids as a result of metabolising fermentable carbohydrates in food. These acids diffuse through the plaque and into the enamel, where they dissolve the calcium phosphate mineral of the enamel. The loss of these minerals from the tooth is known as demineralisation. Bacteria in the biofilm are always metabolically active, causing minute fluctuations in pH. The saliva plays numerous roles, including buffering (neutralising) the acid and providing minerals that can replace those dissolved from the tooth during demineralisation. This replacement of mineral is called remineralisation.[60] It is now understood that the caries *process* (demineralisation/ remineralisation) is an ubiquitous, natural process.[61] It is only when the cumulative result of the demineralisation and remineralisation processes leads to net loss of mineral from the tooth, that there is the potential for a clinically detectable caries lesion to develop. The current understanding of the

caries process is that it is essentially a balance between the factors that promote remineralisation and those that cause demineralisation.[62]

3.2. Risk factors/indicators for dental caries

Because dental caries is a dynamic process that can progress, reverse or remain inactive depending on the balance of factors that promote demineralisation and remineralisation, the ideal preventive strategy would target patients at a stage when the caries process is still reversible, thus avoiding the need for restorative or surgical treatment. However, accurately identifying children who are at risk of developing caries has proved to be difficult, not least because of the multifactorial nature of the disease. Caries risk has been defined as *"the probability of an individual developing at least a certain number of carious lesions reaching a given stage of disease progression during a specified period."*[38] This definition incorporates the concepts of the quantity and *activity* of carious lesions as an outcome. Prediction of an individual's risk of developing caries has been based on the assessment of risk factors (variables causally related to the disease, where the relationship has been established by prospective studies), and risk indicators or risk markers (variables where risk is imputed from cross sectional studies).[63]

In general, most risk factors/indicators for caries fall into the following categories:

➢ Social history

- A systematic review which evaluated the evidence regarding the association between caries and socio-economic status, found fairly strong evidence for an inverse relationship between socio-economic status and caries in children under 12, but relatively weak evidence for the same inverse relationship in older children.[16] **2+**

- Cross-sectional surveys in Ireland, which used medical card status as an indicator of disadvantage, found significantly higher levels of caries in school-aged children who were disadvantaged compared to those who were not disadvantaged.[3,11] The impact of disadvantage on dental health was found to be greatest in the younger age groups (5- and 8-year-olds)[3], a finding that is consistent with that of the systematic review. A similar relationship between medical card status and higher caries levels was also found in Irish preschool children.[24] **3**

➢ Medical and other conditions

Medical and other conditions can increase the patient's risk of developing caries. For example:

- Conditions which cause a marked reduction in salivary flow, either as a result of the disease itself or as a side effect of medication or treatment.[64]

- Conditions that impair a person's ability to maintain their own oral health, such as physical or mental disability can impact on oral health.[65] Dependence on others for basic oral health care can also have a negative impact on oral health.[66]

- For some medical conditions, the consequences of developing caries and/or the treatment of caries could put the patient's general health at risk (e.g. bleeding disorders such as haemophilia, immunosuppression).

- Longterm use of sugar-containing medicine may increase caries risk. One case control study from the late 1970s found that children aged 6 years or younger, who had chronic medical conditions and who took sucrose-containing liquid medicine on a daily basis (n=44) had significantly higher caries levels than those who received no medication or took their medication in tablet form (n=47) – mean dmfs 5.6 vs 1.3 respectively.[67] A more recent study compared the caries experience of children on longterm medicine with that of their healthy siblings, while controlling for possible confounders such as dietary habits, exposure to fluoride and socioeconomic status. While exposure to longterm medication (containing sugar or sugar free) was associated with significantly higher caries experience in primary incisors and canines (p=0.046), significant associations were also found between age and caries experience in the primary and permanent dentition (p=0.013 for dmfs and p<0.01 for DMFS) and between exposure to fluoridation and caries experience in the permanent dentition (p<0.01).[68] **3**

➢ Dietary habits

The evidence that frequent consumption of fermentable carbohydrates is associated with the prevalence of dental caries is overwhelming,[69] but the relationship between dietary factors and caries is far from straightforward.

- A systematic review of 36 studies, most of which were cross sectional in design, evaluated the relationship between sugar intake and caries experience in the current environment where fluoride exposure is widespread.[70] The authors concluded that the relationship between sugar consumption and caries is much weaker in the modern age of fluoride exposure, but added that controlling the consumption of sugar is a justifiable part of caries prevention. **2+**

- A systematic review of 73 studies that investigated risk factors for caries in children under the age of 6 years found 29 dietary factors, most of which related to the consumption of sugar – either its amount, frequency or timing of consumption – that were significantly associated with early childhood caries. This review also found that the balance between "good" (i.e. toothbrushing) and "bad" habits (i.e. highly cariogenic diet) appears to be important with regard to caries.[71] **2+**

- A systematic review of 42 studies, most of which were cross sectional in design, examined the association between baby bottle use and dental caries in young children. The review found weak and inconsistent evidence that prolonged bottle use or use of the bottle at bedtime significantly affect caries risk. However, the five studies that employed a longitudinal design found that the contents of the bottle could influence the risk of caries: Milk with added sugar or juice, increased the risk.[16] **2+**

- Consumption of sugar-containing drinks is associated with a significantly increased risk of developing caries. A longitudinal study of children from mainly high-income, well-educated families (Iowa Fluoride Study), measured fluoride exposure and dietary intake at regular intervals from the age of 6 weeks up to 5 years of age.[72] Children who had a high intake of regular soda pop or regular beverages from powder during years 1 to 5 (n=396) were twice as likely to have caries when aged 4 to 7 compared to children who had low or no intake of these drinks (odds ratio (OR) for regular soda pop: 2.2 (95% CI, 1.4–3.6); OR for powdered beverages: 2.0 (95% CI, 1.2–3.4)). Another longitudinal study, conducted in a low-income, African-American population of children aged 3–5 at baseline, found that children with high consumption of soft drinks at baseline and follow-up, and those who increased their soft drink consumption during the study period, had more than twice the risk of receiving new fillings (incidence rate ratio: 2.68 and 2.67 in the 2 groups, respectively) compared to children who had high intake of milk or pure fruit juice at baseline and follow-up.[73] **2+**

- Cross sectional studies have also found an association between consumption of soft or sweet drinks and caries in the primary[74-76] and the permanent dentitions.[77-81] **3**

- A longitudinal study of 510 three-year-old Brazilian children found that children attending nurseries which had adopted guidelines to reduce sugar consumption had significantly lower caries increments after one year compared to children attending non-guideline nurseries ($p<0.001$, actual increment difference not reported). Children attending non-guideline nurseries were 3.6 times more likely to have a high caries increment compared to those attending guideline nurseries, after controlling for other variables such as family income, baseline age, dmfs, daily sugar intake at home, tooth brushing, use of fluoride gel and visiting the dentist.[82] **2+**

- Cross sectional surveys from Ireland have identified a number of diet-related indicators significantly associated with increased caries levels in 5-[11,83], 8- and 15-year-old children.[3] These include:

  - Taking a baby bottle to bed[83]
  - Drinking juice from a baby bottle[11]
  - Weaning from the baby bottle after 2 years of age[11]
  - Consumption of sweet snacks or drinks between meals more than twice a day.[3.11] **3**

- A systematic review of 28 mostly low quality studies that investigated the association between breastfeeding beyond the time of emergence of the first teeth and Early Childhood Caries (ECC) was unable to draw any definitive conclusions due to the contradictory findings and the weak methodologies of the included studies.[84] Subsequent research has failed to find a consistent association between breastfeeding and ECC.[85-87] **3**

- A large population survey of 5-year-old Irish children found that breastfeeding was significantly associated with lower caries levels, after adjustment for possible confounders such as medical card status and fluoridation status.[11] **3**

➢ Bacteria

- Two systematic reviews found that the presence of Strep Mutans in preschool children was significantly associated with an increased risk of caries.[71,88] **2+**
- The results of studies in older age groups suggest that the predictive power of salivary mutans streptococci testing is consistently modest and the test cannot be considered useful for the assessment of the risk of developing cavities.[38] **4**

➢ Fluoride (Protective factor)

Exposure to fluoride is a protective factor for dental caries.

- Several systematic reviews have shown that exposure to fluoride reduces caries experience. This association was found for
  - water fluoridation[89,90] 2+
  - topical fluorides (varnish, gel, mouthrinse, toothpaste).[91-95] **1++**
- Toothpaste is the most widely used method worldwide of applying fluoride. The effectiveness of fluoride toothpaste is influenced by the fluoride concentration of the toothpaste and also by the frequency of toothbrushing.
  - A Swedish systematic review of the effectiveness of fluoride toothpaste found that toothpaste containing 1,500 ppm F is more effective than standard 1,000/1,100 ppm F toothpaste at preventing caries in permanent teeth.[96] **1+**
  - A systematic review of 70 trials of the effectiveness of fluoride toothpaste at preventing caries found a 14% increase in the effect of fluoride toothpaste when teeth were brushed twice a day, compared to once a day.[94] **1+**
- In Ireland, the majority of the population receive fluoridated water through their public water supply. Irish cross sectional surveys have found that:
  - Children from fluoridated areas have significantly lower caries levels than children from non-fluoridated areas.[3,11,83]
  - Irish Children who brush their teeth twice a day or more have less caries than those who brush less frequently.[3,11] **3**

➢ Clinical Evidence

Tooth Factors

- The pit and fissure surfaces of teeth are the most susceptible to decay. A longitudinal, descriptive cohort study found that morphology of the occlusal surface, i.e. shallow, moderate or deep fissures, was a significant predictor of caries risk.[97] An observational study of plaque accumulation on the occlusal surface of erupting molar teeth identified tooth-specific anatomy as a factor contributing to plaque accumulation and demonstrated a positive correlation between demineralisation and plaque accumulation.[98] **3**

- Hypomineralisation of the permanent molar teeth or Molar Incisor Hypomineralisation (MIH) (the term used when incisors are also involved), is a condition of uncertain aetiology that is widely recognised as a clinical problem.[99,100] Caries can develop very rapidly in severely affected molars, even in otherwise caries free children, and the management of this condition is particularly challenging. **4**

Previous caries experience

- A systematic review of 43 studies employing multivariate caries risk prediction models found that previous caries experience was an important predictor of caries risk in both the primary and the permanent dentition.[101] **2+**

- A narrative review of caries prediction models concluded that the status of the most recently erupted or exposed tooth surface becomes the best predictor of caries for the newly emerging dentition.[102] **3**

3.3. Identification of high caries risk preschool children

The approach taken by the Guideline Development Group was that all children are at risk of developing caries, but some children are at increased risk. These are the children that need to be identified as early as possible, ideally before caries develops or when the caries process is still reversible, thus avoiding the need for restorative or surgical treatment. Dietary and oral hygiene habits are established early in life, and once established can be difficult to change.[103] Early identification of high caries risk children is therefore fundamental to preventing the disease.

With the current structure of primary health care services in Ireland, the greatest potential for early identification of high caries risk preschool children lies with trained non-dental health personnel. Child health services offer developmental assessments to children at 7–9 months, 18–24 months and 3.5 years of age, and young children have contact with a range of health professionals, including public health nurses, general practitioners and practice nurses, long before they have contact with dental services. Such professionals are ideally placed to identify very young children who are at high risk of developing caries and are likely to benefit from referral to dental services.

3.3.1. Effectiveness of non-dental health professionals at identifying high caries risk preschool children

Evidence for the effectiveness of non-dental health professionals at identifying high caries risk preschool children is limited. Of the four relevant studies we identified, three measured the accuracy of primary care clinicians at identifying preschool children who already had dental caries,[104-106] while one study attempted to develop a caries prediction model based on non-clinical data collected by Health Visitors when children were one year old.

A systematic review by Bader et al. evaluating the effectiveness of procedures applied by physicians and other primary care clinicians to prevent caries in preschool children assessed, among other things, the accuracy of primary care clinicians at identifying children aged 0–5 with dental caries requiring referral to a dentist.[107] The review identified two studies[104,105] in which primary care clinicians identified carious lesions with an accuracy approaching that of dentists. One of these compared the performance of a paediatrician with 4 hours training with that of a "gold standard" paediatric dentist at identifying the presence or absence of "nursing caries" (defined here as untreated decay anywhere but the lower primary incisors) in a subset of 61 children aged 18–36 months, who were participating in a study to identify risk factors for nursing caries (n=110).[104] The paediatrician detected nursing caries with a sensitivity of 100% and a specificity of 87% compared to the gold standard (i.e. all the children *with caries* were correctly identified and 87% of children *without caries* were correctly identified as being caries free). The prevalence of nursing caries in the full sample was 20%. In the other study[105], a nurse with 5 hours training in oral screening, using a flashlight and tongue blade, achieved a sensitivity of 92.2% and a specificity of 99.3% in the diagnosis of untreated decay in 219 children aged 5 to 12 years compared to visual tactile screening by a dentist. The prevalence of untreated decay recorded by the gold standard was 35.2%. In addition, the nurse achieved 100% sensitivity and 100% specificity in the identification of children requiring urgent treatment (defined as having one or more teeth with extensive destruction/history of pain/signs of infection), but was less accurate in identifying children with dental injuries and non-urgent treatment. **3**

A subsequent study[106] reported on the accuracy of 11 paediatricians and one nurse practitioner at screening and referring children aged less than 36 months for early childhood caries. The prevalence of cavitated caries in the study sample was 9.7%. The examiners received two hours of training, and examined the children in the knee-to-knee position with a dental mirror and a well-positioned light source, after drying the teeth with gauze. The paediatricians and nurse practitioner achieved a sensitivity of 76% and a specificity of 95% in the detection of children with one or more cavitated primary teeth, compared to a paediatric dentist. The nurse practitioner was said to have performed dental screenings and referrals with comparable sensitivity and specificity to that of the paediatricians, but the values were not reported. **3**

The Dundee Caries Risk Model (DCRM) study[108], conducted between 1995 and 2000, demonstrated that social and medical data collected by Health Visitors using a simple questionnaire when children were 1 year of age, could predict 65% of the children that would have a $d_3$mft ≥ 3 and 69% of those who would not have a $d_3$mft ≥ 3 at age 4 (sensitivity 65%, specificity 69%). In addition, Health Visitors'

subjective assessment of risk when children were aged 1 (which was made without any training) was a significant predictor of any caries experience when they were 4 years old. 4

The Guideline Development Group considered that early identification of high caries risk children was essential to improving the oral health of young children. Although the evidence of the ability of non-dental health professionals to identify high caries risk children is limited in both quantity and quality, the incorporation of an oral assessment into child developmental visits represents the most pragmatic approach to early identification of high caries risk children within the current Irish primary health care setting.

Recommendation

➢ ***Public Health Nurses, practice nurses, General Practitioners and other primary care workers who have regular contact with young children should have training in the identification of high caries risk preschool children***	**D**
➢ ***An oral assessment should be incorporated into each child's developmental visit from age 8 months and recorded in the child's health record***	**D**
➢ ***Referral pathways should be developed to allow referral of high caries risk preschool children from primary, secondary and social care services into dental services***	**GPP**

3.4. Caries risk assessment by dentists

Currently, children access public dental services through the structured School Dental Service (SDS) which is available to specific target classes, or through the emergency service, which is available to all children under the age of 16. It is important to note that dental assessments as part of the SDS also include evaluation of dental development, trauma, oral hygiene and need for orthodontic treatment. These aspects of dental assessment are beyond the scope of this guideline.

In many dental areas, the first school dental assessments start when children are in 1st or 2nd class (age 7 or 8 years) to coincide with the expected emergence of the first permanent molar teeth. Prospective studies of tooth emergence in children have shown consistent average ages of emergence for first permanent molars (6.0–6.3 years for girls, 6.3–6.5 years for boys)[109-113], but the age range for first molar emergence is wide – from 5 to 8 years of age.[110-112] Irish cross sectional data show a similar wide age range for emergence of the first permanent molar.[50] Unpublished data from the North South survey of children's dental health show that 16% of 5-year-olds (Junior Infant class) had one or more of their first permanent molar teeth already present in the mouth, while at age 8 years (2nd class), just over 20% of children had experienced caries in their permanent teeth.[3] 3

These findings suggest that children are not being assessed early enough to prevent caries in the first permanent molar teeth. Assessment of children during their first year in primary school (Junior Infants

class) allows an opportunity to identify early erupting first permanent molars, and to identify high caries risk children who may not have been identified through other health services.

Recommendation

- ***Children should be offered a dental assessment during their first year in primary school*** **D**

In recent years, there has been an increased emphasis on formal caries risk assessment to guide treatment planning decisions and recall intervals for individual patients, and various risk assessment tools and checklists have been developed for this purpose. [114-119]

The rationale for caries risk assessment is that the treatment and preventive measures received by the patient will be tailored to their individual needs, thus directing appropriate restorative and preventive care towards those at "high" risk and avoiding unnecessary treatments for those at "low" risk. With formal caries risk assessment, the factors that contribute to a child having caries are identified, and modifiable risk factors can be addressed. It has been suggested that such an approach not only benefits the patient, but also makes economic sense.[61] Recording caries risk status also allows changes over time to be monitored, and treatment and recall to be adjusted accordingly. Ultimately, the clinician hopes to see the patient's caries risk status improve over time. Caries risk assessment recognises that, just as the caries process itself is dynamic, so too is an individual's caries risk status. This means that caries risk assessment is an ongoing process.

Currently, formal caries risk assessment is not routinely practiced in the Irish public dental service, and treatment decisions for high caries risk children (other than those with special needs) are influenced by factors such as the primary school class the child is in, the prevalence of disease in the population and the resources available. For example, children who are not in a target class but who have high caries levels may only receive emergency treatment, although clinicians can use their discretion to decide whether or not to provide additional treatment for such high caries risk children.

The Caries Risk Assessment Checklist (CRAC) has been developed for the Irish public dental service to encourage a formal, risk-based approach to the management of caries in Irish school-children. The requirements of the checklist were that it would be simple and quick to apply in the dental surgery setting and that it would be appropriate to an Irish population. Given that the Guideline Development Group considered all children to be at risk of developing caries, it was decided at the outset that the checklist would only record high caries risk status (Figure 3.2).

Risk factors/indicators for dental caries were carefully reviewed, and those that were not considered appropriate in the public dental service setting, such as bacterial testing, were excluded. The presence of plaque as a caries risk indicator was not considered appropriate for an Irish population, due to the generally poor oral hygiene habits of Irish children and the considerable variation that occurs in plaque levels over time in children. The checklist went through a number of drafts and two pilot evaluations,

and evolved from being a prescriptive tool which tended to overestimate caries risk, to a checklist in which the child's caries risk status is recorded based on the dentist's assessment of the balance between caries risk indicators and protective factors for the individual patient. Feedback from the pilot evaluations suggested that integration of the checklist into the electronic patient record would greatly facilitate the process of caries risk assessment.

In the checklist, clinical risk factors/indicators are given greatest importance, based on the evidence that previous caries experience is the most consistent predictor of future caries in both the primary and permanent dentitions.[101]

Figure 3.2: Caries risk assessment checklist for children and adolescents

Risk Factors / Indicators **A "YES" in the shaded section indicates that the child is likely to be at high risk of or from caries**	Please circle the most appropriate answer	
• Age 0–3 with caries (cavitated or non-cavitated)	**Yes**	No
• Age 4–6 with dmft>2 or DMFT>0	**Yes**	No
• Age 7 and over with active smooth surface caries (cavitated or non-cavitated) on one or more permanent teeth	**Yes**	No
• New caries lesions in last 12 months	**Yes**	No
• Hypomineralised permanent molars	**Yes**	No
• Medical or other conditions where dental caries could put the patient's general health at increased risk	**Yes**	No
• Medical or other conditions that could increase the patient's risk of developing dental caries	**Yes**	No
• Medical or other conditions that may reduce the patient's ability to maintain their oral health, or that may complicate dental treatment	**Yes**	No
The following indicators should also be considered when assessing the child's risk of developing caries		
• Age 7–10 with dmft>3 or DMFT>0	**Yes**	No
• Age 11–13 with DMFT>2	**Yes**	No
• Age 14–15 with DMFT>4	**Yes**	No
• Deep pits and fissures in permanent teeth	**Yes**	No
• Full medical card	**Yes**	No
• Sweet snacks or drinks between meals more than twice a day	**Yes**	No
Protective Factors **A "NO" in this section indicates the absence of protective factors which may increase the child's risk of developing caries**		
• Fissure sealants	Yes	**No**
• Brushes twice a day or more	Yes	**No**
• Uses toothpaste containing 1000 ppm F or more	Yes	**No**
• Fluoridated water supply	Yes	**No / Don't know**

Is this child at high risk of or from caries?	**YES**	**NO**

The first shaded section of the checklist contains the factors/indicators that the Guideline Development Group considered most important in identifying high caries risk children. Evidence of any caries experience (cavitated or non-cavitated) in children aged 3 years or younger was considered to be a clear indicator of high caries risk status. The thresholds for caries experience in children aged 4 to 6 years (dmft>2 or DMFT>0) were reached by informal consensus.

The middle section contains other potential risk factors/indicators that should be considered when assessing an individual's caries risk status. The DMFT cut-offs for each age group in the checklist are based on the mean DMFT of the top one third of children with the highest caries levels from the North South survey.[3] Since the DMF index represents both past and current caries experience, the existence of a high DMF score may not indicate that the child is currently at high risk. Therefore caries experience in older children was not considered to be as accurate an indicator of current caries risk status as for younger children. The last section contains factors for which there is evidence from systematic reviews of a caries-preventive effect. The final assessment of caries risk status is based on the dentist's assessment of the balance between caries risk factors/indicators and protective factors for the individual patient. Full notes on completing the Caries Risk Assessment Checklist can be found in Appendix 5.

Recommendation

➢ ***A formal caries risk assessment should be done for children attending the dental clinic for dental assessment or emergency care, using the Caries Risk Assessment Checklist***	**D**
➢ ***The Caries Risk Assessment Checklist should be integrated into the electronic patient record***	**GPP**

3.4.1. School-based dental assessment (school screening)

School-based dental assessment is used in approximately half of all public dental service areas in Ireland as a pragmatic approach to providing dental services when faced with limited resources. The emphasis is on the identification of children with obvious needs – such as dental abscess, caries in permanent teeth or trauma – who can then be prioritised for dental treatment. A school-based dental assessment is, in essence, a caries risk assessment based on clinical data that can be observed under less than optimal examination conditions; it cannot assess children with the same diagnostic sensitivity as a clinic-based assessment and not all high caries risk children will be identified by this method.

3.5. Re-assessment of caries risk

Caries risk assessment is a continuous process, as an individual's risk status can change over time. A Cochrane systematic review of recall intervals for oral health in primary care patients[120] and a Health Technology Assessment of the clinical and cost-effectiveness of routine dental checks[121] found

insufficient evidence to support or refute the practice of encouraging patients to attend for dental check-ups at 6-monthly intervals. However, within the Irish public dental service, regular six-monthly checkups have never been the norm, and intervals between dental assessments for children are generally measured in years rather than months. Recall of children considered to be high caries risk, including children with special needs, is usually left to the discretion of individual clinicians. A guideline on dental recall intervals, which was developed for the NHS in the UK by the National Institute of Health and Clinical Excellence (NICE), recommended that the "*interval between oral health reviews should be determined specifically for each patient and tailored to meet his or her needs, on the basis of an assessment of disease levels and risk of or from dental disease."* The guideline also recommended that *"the longest interval between oral health reviews for patients younger than 18 years should be 12 months"* based on evidence that the rate of progression of dental caries can be more rapid in children and adolescents than in older people, and seems to be faster in primary teeth than in permanent teeth.[115] **4**

Recommendation

- ***Recall of high caries risk children should be based on the clinician's assessment of the child's caries risk status using the Caries Risk Assessment Checklist, and should not exceed 12 months*** **D**

4. Identifying high caries risk populations

National[3] and regional[5-9] surveys have shown that the prevalence and severity of caries varies considerably across Ireland, and that children living in non-fluoridated areas have significantly higher caries levels than children living in fluoridated areas. Thus, at national and regional level, non-fluoridated areas present an obvious target for preventive strategies. However, caries levels also vary at local level[10,11], and these small area variations are of particular relevance to those directly involved in planning and delivering services. The collection of oral health epidemiological data at small area level (e.g. the clinical catchment area of a dental clinic) is one way of identifying the dental health needs of a population to inform the planning and targeting of services. However, oral health surveys at small area level have rarely been conducted in Ireland.[10,11,122] In other countries, standardised data collection from school dental services has been used as an alternative way of monitoring oral health trends over time at national, regional and local levels.[123] **3**

The introduction of electronic patient records in the public dental service in Ireland will allow for the collection and analysis of data on oral health status at small area level. This should be exploited for further investigations of differences in caries risk across areas.

Recommendation

➢ ***An agreed set of oral health indicators for the planning, targeting and evaluation of dental services should be developed. Methods of measurement and reporting of these indicators need to be decided***	**GPP**
➢ ***Data should be collected at local level, but standardised and co-ordinated nationally***	**GPP**
➢ ***Electronic patient record systems should be designed to produce small area data on the agreed oral health indicators for children***	**GPP**

Public dental services for children are closely linked to schools, and the characteristics of Irish schools have been used as a means of identifying groups of children who are likely to be high caries risk. An Irish cross sectional study found that the prevalence and severity of dental caries was higher among 5-year-old children attending the most disadvantaged schools in the Dublin area compared to 5-year-olds attending schools that were less disadvantaged (mean dmft: 1.80 vs 1.11; prevalence: 51% vs 37%).[124] In another cross sectional survey, Irish children attending disadvantaged (DEIS) schools were found to be less likely to report positive health and more likely to consume sweets and soft drinks on a daily basis, compared to children in matched schools.[125] **3**

Because dental caries is strongly associated with deprivation, area based deprivation indices based on census data have been developed to categorise subgroups of the population which are likely to have greater health needs, and thereby lead to more appropriate allocation of resources. Studies from the UK have shown that area based indices can generally predict areas with high caries levels[126,127] but have limitations in their application. They do not appear to be reliable in rural areas,[128] and

although large differences in caries prevalence can be detected between deprived and affluent areas, the decline in caries prevalence from top to bottom of the ranking is gradual, with no obvious division between deprived and affluent areas.[129,130] This means that any area based targeting will inevitably include some children who are not high risk and will miss some who are.

An Irish deprivation index developed by the Small Area Health Research Unit (SAHRU) has been shown in two studies to have some potential for identifying sub-areas in Dublin with high caries levels.[131,132] Outside the Dublin area, deprivation was not well correlated with dental caries in primary or permanent teeth.[131] The authors of both studies concluded that further research was needed on the use of area-based indices as a tool for targeting resources. **3**

Two relatively recent developments in the spatial presentation of health data are Health Atlas Ireland and the All Ireland Health and Well-being Data Set (AIHWDAS). Both systems use existing health information to map the distribution of health conditions (Health Atlas), or to allow comparison of indicators from different indicator sets to obtain more comprehensive profiles of a particular area (AIHWDAS). The use of these area-based information systems to improve planning and targeting of dental services should be explored.

Recommendation

➢ ***The use of Health Atlas Ireland and the All Ireland Health and Well-being Data Set (AIHWDAS) should be explored as a means of using area based information and demographics to identify populations in small geographic areas who are likely to have high caries levels***	**GPP**

5. Preventive strategies

Summary of evidence on caries preventive strategies

Diet

- We found no trials of dietary interventions other than those involving sugar substitutes that measured effect using caries as an outcome.
- Evidence from a systematic review of the effectiveness of xylitol and sorbitol in chewing gum and candies/lozenges for caries prevention in children and adolescents is inconclusive.[145] Subsequent publications have not altered this conclusion.[147-150]
- Evidence for the effectiveness of maternal use of xylitol gum for the prevention of caries in their offspring through reducing or delaying mother-child transmission of mutans streptococci is insufficient. [198,200]

Topical Fluorides

- Topical fluorides are effective at preventing caries. A series of Cochrane systematic reviews found that topical fluorides (varnish, gel, mouthrinse and toothpaste), used either individually[91-94] or in combination[152], significantly reduced caries in children and adolescents compared to placebo or no treatment. No topical fluoride modality was found to be superior to another in head-to-head comparisons.[153] **1++**

Oral Health Education

- Trained non-dental personnel can effectively deliver oral health education.[137,181-183] **1+**
- The quality of evidence supporting the effectiveness of oral health education at preventing early childhood caries (ECC) is generally poor and the results are conflicting. However, there is a tendency for early and repeated contact with mothers, particularly in a non-clinic setting and commencing before children are 2 years of age, to be an important element in educational programmes to prevent caries in young children.[137,181,183]
- School-based oral health education alone has no impact on caries levels.[51,201,202] **2+**

Fissure sealants

- Fissure sealants are effective at preventing caries. A Cochrane systematic review of the caries-preventive effect of fissure sealants found that sealed permanent molar teeth had over 50% less caries than unsealed teeth after 4.5 years.[203] **1++**

- There is evidence to suggest that preventive programmes involving the use of fluoride or fissure sealants in combination with other interventions are effective at preventing caries in children.[233-235] **1+**

Chlorhexidine

- Evidence for a caries-preventive effect of chlorhexidine mouthrinse, gel or varnish is inconclusive.[197,210,211,215-219]

Remineralising products (CPP-ACP)

- Evidence for a caries-preventive effect of the remineralising product casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) is insufficient.

5.1. Introduction

Strategies to prevent dental caries can be targeted at the whole population, at subgroups of the population (e.g. geographic targeting or directed population targeting), or at specific individuals (e.g. those at high risk). This section describes the evidence for various preventive strategies, which can be applied at any of these levels. The principles of oral health promotion – defined as *'the process of enabling people to increase control over and to improve their health'* – should inform any preventive strategy that is implemented.

The key principles of health promotion, outlined in the Ottawa Charter[133] are as follows:

- Building healthy public policy
- Re-orienting the health services
- Creating supportive environments
- Strengthening community action
- Developing personal skills.

Health promotion involves actions aimed at the determinants of health that often are outside the control of the individual. These include social, fiscal and legislative measures, in addition to determinants of health within the direct control of the individual such as individual health behaviours. With the exception of water fluoridation, the body of evidence on the effectiveness of oral health promotion interventions to prevent caries in children centres almost entirely on interventions involving oral health education and on clinical interventions carried out in school or clinic settings involving caries preventive agents. The focus is on developing personal skills and creating supportive environments. Initiatives relating to the use of legislative, fiscal and social measures as a means to improve oral health remain underutilised.

5.1.1. The common risk factor approach

The common risk factor approach to health promotion recognises that a range of chronic conditions and diseases have one or more risk factors or indicators in common.[134] Diet, the main risk factor for dental caries, is also a risk factor for obesity, heart disease, diabetes and some cancers. The key concept of the integrated common risk factor approach is that by directing action towards those common risks and their underlying social determinants, improvements in a range of chronic conditions will be achieved more efficiently and effectively.[135,136] The common risk factor approach to managing and preventing oral disease is strongly advocated by the World Health Organisation as part of its Global Oral Health Programme.[136] **4**

As yet, there is only limited evidence that a common risk factor approach can reduce dental caries. A randomised trial from Brazil that was part of a larger study designed to assess the impact on children's feeding and general health of home visits to educate new mothers on breastfeeding and weaning, found that caries levels in the children at age 1 year were significantly lower in the intervention group compared to the control group.[137] **1+**

Recommendation

- ***Oral health messages should be incorporated into relevant general health promotion interventions for children and adolescents as part of a common risk factor approach to improving oral health*** **D**

5.2. Diet

The evidence that frequent consumption of food and drinks containing fermentable carbohydrates (sugars) is associated with dental caries is overwhelming.[69,71,73,74,138] The basis of much dietary advice for caries prevention comes from the Vipeholm study which was carried out in Sweden between 1945 and 1952.[139] This study, which would be considered highly unethical in modern times, was conducted on residents in a mental institution, who received a controlled diet containing refined sugars varying in amount, frequency, physical form, and time of consumption (i.e. with or between meals). This experimental study established that sugar consumption increases caries activity, and that the risk of increased caries activity is higher if the sugar is taken in sticky form, and if taken between meals. However, the relationship between dietary factors and caries is far from straightforward, particularly in the current environment where fluoride exposure is widespread.[70]

Dietary guidelines in Ireland are currently based on the food pyramid, which is designed to help people to eat a balanced diet combining several different types of food in the correct amounts. A major concern in the Irish diet is the overconsumption of foods high in sugars and fats, which is a risk factor not just for caries but also for diabetes and heart disease. Irish adults consume more than twice the recommended daily intake of these types of food (7.3 servings/day compared to the current recommendation of less than 3 servings/day).[140] A recent report on health behaviours in Irish school

children reported that 35% of boys and 39% of girls aged 10–17 years eat sweets or chocolate at least once a day.[141] The increase in prevalence of obesity and diabetes in Irish children and adults clearly indicates that, from a general and oral health perspective, dietary habits need to be tackled at population level. The first National Nutrition Policy, which is due to be published in 2009, will be important in providing a framework for dietary change in Ireland. The Nutrition Policy and healthy eating guidelines will be available on the website of the Department of Health and Children: www.dohc.ie.

Recommendation

➢ ***Oral health education to parents/carers, children and adolescents should encourage healthy eating, in line with national dietary guidelines***	**D**

Dietary habits are established early in life. A systematic review of risk factors for caries in children under the age of 6 identified 29 dietary factors, most of which related to the consumption of sugar – either its amount, frequency or timing of consumption – that were significantly associated with early childhood caries. **2+**

While there is still some uncertainty about the relative importance of frequency of intake of sugars versus total sugars consumption in contemporary populations[142], it seems likely that both factors are important for caries development[69], and therefore it is reasonable to encourage a reduction in both the frequency and total amount of sugars ingested. **4**

Recommendation

➢ ***Parents/carers should be encouraged to limit their child's consumption of sugar-containing foods and drinks, and when possible, to confine their consumption to mealtimes***	**D**
➢ ***Children and adolescents should be encouraged to limit their consumption of sugar-containing foods and drinks, and when possible, to confine their consumption to mealtimes***	**D**

Cross sectional surveys from Ireland have identified a number of indicators related to baby bottle use that were significantly associated with increased caries levels at age 5 years. These include: taking a baby bottle to bed[83]; drinking juice from a baby bottle[11] and weaning from the baby bottle after 2 years of age.[11] **3**

However, a systematic review found that the duration of bottle use was not significantly related to caries risk, but that the content of the bottle was important. Milk with sugar, or juice given in the bottle increased the risk of caries.[16] **2+**

Recommendation

➢ ***Parents and carers of children who use a baby bottle should be advised never to put sweet drinks, including fruit juice, into the bottle***	**C**
➢ ***Parents and carers should be advised not to let their child sleep or nap with a baby bottle or feeder cup***	**GPP**

5.2.1. Sugar Substitutes

We found no experimental trials of dietary interventions, other than those involving sugar substitutes that used caries as an outcome.

Non-cariogenic sweeteners are increasingly used to replace sugar in foods, drinks and medicines. They can be divided into two categories: intense sweeteners, such as saccharin, acesulfame-K and aspartame; and bulk sweeteners, such as xylitol and sorbitol. They cannot be fermented by microorganisms to any great extent and so are considered non-cariogenic. It has been suggested that xylitol may have an anti-cariogenic effect by reducing the levels of mutans streptococci in the mouth.[143] However, the existence of an anti-cariogenic effect for xylitol remains controversial.[144]

We did not identify any studies on the effectiveness of intense sweeteners at preventing caries. However, the effectiveness of the bulk sweeteners xylitol and sorbitol in chewing gum and candies for preventing caries has been the focus of a number of clinical trials in dentistry.

5.2.2. Effectiveness of xylitol and sorbitol for caries prevention

One systematic review of dietary factors in the prevention of dental caries evaluated the use of sugar substitutes, principally xylitol and sorbitol, in the prevention of caries in school-aged children.[145] Of the 18 trials included in the review, none were considered to provide a high level of evidence. Only five studies involving the use of xylitol or sorbitol were graded as 'moderate level of evidence' (grade B) by the authors of the review. Although the remaining studies that evaluated the effectiveness of xylitol and/or sorbitol generally showed substantial reductions in caries, they were considered to present little value as evidence (grade C) due to methodological weaknesses in their design and conduct. Based on the results of the five grade B studies evaluating sorbitol or xylitol, the review concluded that the evidence for their caries-preventive effect was inconclusive, and the authors recommended the conduct of well-designed clinical trials with high compliance to demonstrate the role of sorbitol and xylitol in caries prevention. **1+**

Only one of the grade B trials included in the Lingstrom et al. review used a control chewing gum (sweetened with intense sweeteners).[146] This trial found little difference in the percent caries reduction in the xylitol group compared to the control group (35% vs 33%, respectively) in 9–14 year-old Lithuanian schoolchildren followed for 3 years. The researchers suggested that the caries-preventive effect of chewing sugar-free gum may be related to the increased secretion of saliva and the resulting

increase in salivary pH, buffer capacity and glucose clearance rather than to the effect of the xylitol/sorbitol. **1+**

We identified several clinical trials that were published subsequent to the Lingstrom et al. review. A study of the caries preventive effectiveness of xylitol candies found that the regular use of xylitol candies over an 18 month period by disabled school students (age range 10–27 years) had a significant preventive and remineralising effect compared to a control group of students who did not consent to participate in the trial.[147] This study provides very weak evidence for the effectiveness of xylitol candies in the prevention of caries due to the lack of randomisation and the questionable inter- and intra-examiner reliability. **2-**

A recent 2 year double-blind randomised trial[148] in high caries risk children (aged 10 to 12 years) found no significant difference in approximal caries increment between the two test groups that were provided with xylitol tablets or xylitol/fluoride tablets to be taken three times daily and a non-randomised reference group that received fluoride varnish applications, oral hygiene and dietary advice. Compliance with the prescribed regimen appears to have been a problem; only 41% of the participants in the test groups were classified as having good compliance with the regimen despite the efforts of the study co-ordinator, who reminded and encouraged them throughout the study. **2+**

Kovari et al.[149] conducted a cluster randomised community trial of the effectiveness of xylitol chewing gum for caries prevention in preschool Finnish children (aged 3 to 6 years) attending daycare centres over a three year period. The intervention group received a piece of xylitol chewing gum three times a day after eating, and the comparison group brushed their teeth with low fluoride toothpaste (225 ppm) daily after lunch. The interventions were delivered at the daycare centre and were interrupted during weekends and holidays. The researchers reported a statistically significant higher percentage of children caries free (primary and permanent dentition) at age 9 in the xylitol group compared to the brushing group (57% v 49% respectively, p value not reported). Baseline caries levels were not recorded and the examiners were not blinded to the group allocation of the children while the children were attending the daycare centres. **1-**

Oscarson et al.[150] investigated the influence of low-xylitol tablets on caries development in preschool children using a randomised controlled trial. The participants were aged 2 years at the start of the trial and for the first six months they were given a tablet containing 0.48 mg xylitol to suck at bedtime, after their teeth were brushed. After 6 months, they took a tablet morning and night. The control group received no intervention. After two years, the mean dmfs was lower in the test group compared to the control group but the difference was not statistically significant (0.38 versus 0.8, $p>0.05$). The researchers concluded that the findings did not support a low-dose xylitol tablet programme for caries prevention in preschool children. **1+**

The longterm use of sugar-containing medicines has been associated with increased caries levels.[151] Sugar free formulations of medicines have become more widely available in response to concern about the cariogenic potential of sugar-containing medicine.

The Guideline Development Group members recognised that sugar-free products were preferable to sugar-containing products for dental health, but were concerned that, given the high intake of sweet foods and drinks by Irish children, direct substitution of sugar-containing products with sugar-free products would do little to improve overall dietary habits. These concerns, coupled with the inconclusive evidence of a caries-preventive effect of xylitol and sorbitol, were considered by the Guideline Development Group in making its recommendation on the use of sugar substitutes.

Recommendation

➢ ***Parents/carers and children should be advised that foods and drinks containing sugar substitutes are available, but should be consumed in moderation***	**D**
➢ ***Sugar free medicines should be used, when available***	**D**

5.3. Topical fluorides

Fluoride has been at the forefront of caries prevention for over 60 years. A series of Cochrane systematic reviews found that topical fluorides (varnish, gel, mouthrinse and toothpaste), used either individually[91-94] or in combination[152], significantly reduced caries in children and adolescents compared to placebo or no treatment. No topical fluoride modality was found to be superior to another in head-to-head comparisons.[153] **1++**

5.3.1. Fluoride toothpaste

Fluoride toothpaste is the most widely used form of topical fluoride throughout the world. In Ireland, 95% of toothpastes contain fluoride.[43] It has been suggested that toothbrushing with fluoride toothpaste is close to an ideal public health method in that its use is convenient, inexpensive, culturally approved and widespread.[42] However, as with all self-administered interventions, it requires compliance to achieve optimum results.

Systematic reviews of the effectiveness of fluoride toothpaste at preventing dental caries in children and adolescents have found that:

- Fluoride toothpaste is effective at preventing caries in children and adolescents[94-96] **1++**
- Brushing twice a day is more effective than brushing once a day[94] **1+**
- Toothpaste containing 1,000 ppm F is more effective than toothpaste containing 250 ppm F at preventing caries in permanent teeth[154.155] **1+**
- Toothpaste containing 1,500 ppm F is more effective than standard 1,000/1,100 ppm F toothpaste at preventing caries in permanent teeth.[96] **1+**

Low fluoride toothpastes have been introduced specifically for young children who, because of their inability to spit, tend to swallow most of the toothpaste placed on the brush.[156,157] Evidence of the effectiveness of low fluoride toothpaste (containing less than 600 ppm F) at preventing caries in primary teeth is insufficient, as it is limited to 3 randomised controlled trials, which differ in quality, design, populations studied and results.[158-160]

Evidence that early use of fluoride toothpaste prevents caries is limited, and the definition of what constitutes "early" varies, making it difficult to draw any conclusions. Irish cross sectional studies have found that commencing tooth brushing before 12 months of age is significantly associated with lower caries levels in the primary teeth at age 5[11] and at age 8[3], after controlling for water fluoridation. Creedon and O'Mullane[83] found that children who started brushing after 24 months had significantly higher levels of caries at age 5 than those who started brushing before that age. A cross sectional study of 4,468 7-year-old Flemish children showed a significant odds ratio of 1.22 (95% CI, 1.14–1.30) for an increased risk of caries when age at start of toothbrushing increases by one year. The probability of remaining caries free at age 7 for children who started brushing before the age of 3 was 46%, compared to 36% for children starting after the age of 3.[75] **3**

Rinsing with a large volume of water after brushing can reduce the caries-preventive effect of fluoride toothpaste. Two randomised trials found that children who rinsed with a large volume of water had higher caries increments than those using smaller volumes.[161,162] **1+**

A European observational study of toothpaste use among preschool children noted that few Irish parents had received advice on toothbrushing from the dental team, and most Irish children rinsed during brushing. The authors surmised that rinsing during brushing appears to be a cultural habit encouraged by parents, because most of the Irish children rinsed and spat without having received advice form a dental professional.[163] **3**

An Irish cross sectional study also found that caries levels were significantly higher for 15-year-olds who used a glass of water for rinsing after brushing compared to those who used another method for rinsing (p=0.006).[3] **3**

5.3.1.1. Fluoride toothpaste and fluorosis risk

Age of commencing toothbrushing

Fluorosis is a disturbance in enamel formation which occurs when excess fluoride is ingested during tooth development. The severity of fluorosis is related to the timing, duration of exposure and dose of fluoride ingested from all sources.[164] The use of fluoride toothpaste, particularly during the first 2 years of life, has been associated with an increased risk of fluorosis.[165,166] **2+**

Fluoride concentration of toothpaste

The fluoride concentration of toothpaste has been associated with fluorosis. Follow-up of children in a non-fluoridated, high caries area of north west England, who had participated in a randomised trial involving the postal distribution of toothpaste containing 440 ppm F or 1,450 ppm F from age 12

months to age 5–6 years, found that, overall, the prevalence of more severe fluorosis (TF≥2 and TF≥3) was significantly higher at age 9–10 among children who had received the 1,450 ppm F toothpaste compared to those who had received 440 ppm F toothpaste: (7% vs 2% for TF≥2; 2% vs 0.2% for TF≥3).[167] **2+**

Amount of toothpaste

There is limited evidence from observational studies that the amount of toothpaste used is a contributing factor to fluorosis risk from the use of toothpaste. A small observational study with 10 children found that salivary fluoride levels were significantly lower in children when they used 0.25 g of fluoride toothpaste than when they used 1 g of the same toothpaste. The researchers concluded that reducing the amount of toothpaste, rather than the concentration of fluoride in the toothpaste, might be the most efficient way to increase efficacy while decreasing the risk of fluorosis.[168] **3**

A “pea size” amount of fluoride toothpaste is widely accepted as the recommended amount of toothpaste to be used by young children to reduce excessive fluoride ingestion, although a “smear” of toothpaste has also been recommended for children under 2 or 3 years of age when brushing with toothpaste containing at least 1,000 ppm F.[169,170] The amount of toothpaste that constitutes a “pea size” amount varies between authors, and ranges from 0.25 g[171,172] to < 0.5 g[163]. **3**

Supervision

It is accepted that young children (under the age of 7) should be supervised by an adult when brushing to ensure that the correct amount of toothpaste is dispensed, to discourage the child from swallowing the toothpaste and also to ensure that the teeth are cleaned correctly. We found no studies that tested the effect of parental supervision of home brushing. Two systematic reviews found that supervised toothbrushing in a school setting is more effective than unsupervised toothbrushing at preventing caries[94,96], which suggests that the element of supervision ensures greater compliance. **1+**

It is reasonable to assume that supervising toothbrushing at home should have a similar effect.

Figure 5.1: Pea size amount of toothpaste (0.25 g) on a child-size toothbrush and on a standard-size toothbrush

Timing of toothbrushing

Brushing before bedtime is a standard recommendation as salivary flow levels are reduced during sleep and brushing before sleep helps to maintain intra-oral fluoride levels.[173] A small observational study involving 12 subjects who brushed with 1.75 g toothpaste immediately before bedtime found that salivary fluoride levels were significantly higher than baseline 8 and 12 hours after brushing, and were comparable to concentrations found 1–4 hours after brushing during the day.[174] 3

5.3.1.2. Fluoride toothpaste and the risk/benefit balance

Assessment of the fluorosis/caries balance for a population must be based on that population's fluoride exposure profile, oral health status and socio-economic status. Most Irish children are exposed to two sources of fluoride: fluoridated water, which reaches 71% of the population[43], and fluoride toothpaste. Between 1984 and 2002, the prevalence of fluorosis in the permanent teeth of Irish children and adolescents increased in both fluoridated and non-fluoridated areas, while levels of caries declined. The prevalence of fluorosis was significantly higher in fluoridated areas, which is not unexpected as a certain degree of fluorosis is an inevitable consequence of water fluoridation. Most of the fluorosis experienced was categorised as 'Questionable' or 'Very Mild'.[3]

In 2002, the Forum on Fluoridation recommended lowering of the fluoride level in water in Ireland from 0.8–1.0 ppm to 0.6–0.8 ppm as part of a strategy to bring about *"meaningful reductions in dental decay while reducing the risk of developing fluorosis"*.[43] Levels of fluoride in the water were reduced in 2007.[175]

Recommendations on the use of fluoride toothpaste were also issued, as an additional measure to minimise the risk of fluorosis. These recommendations were updated by the Expert Body on Fluorides

and Health in 2008,[176] and were considered by the Guideline Development Group. After discussion of the risk/benefit balance of early use of fluoride toothpaste and of the conflicting evidence on the effectiveness of low fluoride toothpaste at preventing caries in preschool children, the Guideline Development Group concluded that there is insufficient evidence to support the use of low fluoride toothpaste for caries prevention in young children, and supported the recommendation of the Expert Body on Fluorides and Health that professional advice on the use of fluoride toothpaste should be considered when a child below 2 years of age is assessed as being at high caries risk. The Guideline Development Group made slight modifications to the recommendations of the Expert Body, specifically with regard to the timing of toothbrushing, and to spitting out and not rinsing after brushing.

Recommendation

Under 2 years of age: At Risk children	
➢ ***Parents/carers should be encouraged to brush their child's teeth as soon as the first tooth appears, using a soft toothbrush and water only***	**D**
Under 2 years of age: High Caries Risk children	
➢ ***Parents/carers of children who are assessed as being at high caries risk should be encouraged to brush their child's teeth:***	
➢ ***with fluoride toothpaste containing at least 1,000 ppm F***	**A**
➢ ***twice a day***	**B**
➢ ***at bedtime and one other time during the day***	**GPP**
➢ ***using a small pea size amount of toothpaste***	**D**
Age 2 years and over	
➢ ***All children should be encouraged to brush their teeth:***	
➢ ***with fluoride toothpaste containing at least 1,000 ppm F***	**A**
➢ ***twice a day***	**B**
➢ ***at bedtime and one other time during the day***	**GPP**
➢ ***using a small pea size amount of toothpaste (up to age 7)****	**D**
➢ ***Children under the age of 7 should be supervised by an adult when brushing their teeth***	**B**
➢ ***Children should spit out toothpaste and not rinse after brushing***	**B**

***** *Over the age of 7, the risk of ingesting toothpaste is greatly reduced, and a pea size amount or more of toothpaste can be used.*

5.3.2. Professionally applied topical fluorides

A guideline on the use of topical fluorides for caries prevention in Irish children and adolescents has been developed for the public dental service and contains recommendations on the use of

professionally applied topical fluorides (varnish, gel, foam, slow-release fluoride devices).[177] A summary of the evidence and recommendations on the use of fluoride varnish and gel are presented here. The full list of recommendations on the use of professionally applied topical fluorides is reproduced in Appendix 1.

5.3.2.1. Fluoride varnish and gel

A Cochrane systematic review of seven trials of the effect of fluoride varnish at preventing caries reported an average reduction in caries increment of 46% (95% CI, 30–63%; p<0.0001) in permanent teeth and 33% (95% CI, 19–48%; p<0.0001) in primary teeth. This was based on a comparison of the use of varnish two or four times a year, compared to placebo or no treatment.[91] A subsequent systematic review[107] and a randomised trial[178], both of which looked at the effectiveness of fluoride varnish at preventing caries in preschool children, supported the efficacy of fluoride varnish at preventing caries in the primary dentition. **1++**

A Cochrane systematic review involving 14 placebo-controlled trials reported an average reduction in caries of 21% (95% CI, 14–28%; p<0.0001) with the use of fluoride gel.[92] **1++**

Although the evidence of the comparative effectiveness of fluoride varnish and gel was inconclusive[153], two observational studies have reported that fluoride varnish is easier to apply, and has greater patient acceptability.[179 180] **3**

Recommendation

- ***Fluoride varnish should be used in preference to fluoride gel for caries prevention in children who are assessed as being at high caries risk*** **D**

Age 1–7 years

- ***Resin-based fluoride varnish application (22,600 ppm F) should be offered to children who are assessed as being at high caries risk, at intervals of 6 months or 3 months*** **A**
- ***Fluoride gel should not be used in children under the age of 7*** **GPP**

Age 7–15 years

- ***Fluoride varnish application (at least 22,600 ppm F) should be offered to children who are assessed as being at high caries risk, at intervals of 6 months or 3 months*** **A**
- ***Where operator or patient preference dictates the use of fluoride gel rather than fluoride varnish, gel application should be offered at 6 month intervals*** **A**

5.3.3. Use of topical fluorides in community-based programmes

The use of topical fluorides in community-based programmes is an example of a targeted population preventive strategy which brings the caries-preventive benefits of fluoride to high caries risk groups or

populations, such as those described in section 3. The topical fluoride guideline[177] covers community-based programmes involving the use of fluoride varnish, toothpaste and mouthrinse. A summary of recommendations can be found in Appendix 1. The full topical fluoride guideline can be accessed at http://ohsrc.ucc.ie.

5.4. Oral health education

Oral health education can operate at a community level or as part of individual patient care. The focus of oral health education is primarily to encourage a reduction in the consumption of sugars (fermentable carbohydrate) and to promote the effective use of fluoride toothpaste. Several systematic reviews have concluded that oral health education (OHE) is effective at increasing knowledge levels[51-54]. However increases in knowledge are short lived[53] and likely to fade over time.[54] There is disagreement as to whether changes in knowledge can result in changes in behaviour. One systematic review[54] concluded that more innovative approaches to OHE have potential to lead to behaviour change, whereas another review[51] concluded that *"the balance of evidence is that the case for a causal relationship between knowledge and behaviour is 'not proven'".* However, the reviewers added that there was an ethical responsibility to disseminate scientific knowledge to the public. **2+**

5.4.1. Preschool children

Early intervention is crucial for caries prevention in young children and in Ireland, Dietary and oral hygiene habits are established early in life, and once established, can be difficult to change.[103] It is essential that all parents receive accurate, consistent and age-appropriate oral health advice from all members of the primary care team, to promote good oral health for their child during these crucial early years.

Evidence for the effectiveness of oral health education at a young age is generally of low quality, often due to weaknesses in the design of the studies, and the results are inconsistent. However, there was a tendency for early and repeated contact with mothers, particularly in a non-clinic setting and commencing before children were 2 years of age, to be an important element in educational programmes to prevent early childhood caries.[137,181-184] Many of the studies used trained non-dental personnel to effectively deliver these programmes.

5.4.1.1. Individual educational interventions commencing before 2 years of age

A randomised trial from a fluoridated, low income area of Brazil used trained fieldworkers to give advice about healthy breastfeeding and weaning to new mothers at ten home visits within the first year of the child's life. The mean number of decayed surfaces was significantly lower in the test group (0.37 vs 0.63, p=0.03) and the prevalence of caries was also lower in the test group (10% vs 18%). Self reported dietary practices such as duration of exclusive breastfeeding, later introduction of sugar or sweet foods or soft drinks were also more favourable in the intervention group.[137] **1+**

Two studies from the UK which evaluated the effect of dental health education delivered in the home to new mothers found conflicting results. The first study, a 3-year controlled trial, which was conducted

in low income/high caries areas of Leeds, involved 228 mother/child pairs randomly assigned to one of four groups: mothers in groups A, B and C received dental health education (DHE) at 3-month intervals for the first two years, and twice a year in the third year of the study. The emphasis of the DHE message differed between the three groups (Group A: diet focus, Group B: oral hygiene focus, Group C: equal focus on diet and oral hygiene). The fourth group (Group D) received DHE with equal focus on diet and hygiene once a year for each of the 3 years. The interventions commenced when the children were aged 8 months. Two trained oral health educators (one dental and one non-dental) delivered the DHE to mothers in their own homes. The control/comparison group comprised children who met the entry requirements at the start of the study, but had not been randomly selected to be in the test groups. These children were not contacted until towards the end of the intervention period. At the end of the trial, fewer children who had received the intervention had caries compared to the comparison group (1% vs 33%) and caries levels were significantly lower in the test group (mean dmfs: 0.29 vs 1.75, p<0.001). A weakness of this trial was that outcome assessment was not fully blinded, as the control group was examined in nursery school whereas the children in the test group were examined at home, which could have introduced examiner bias. However, the examiner was blind to the model of DHE received by the mothers (3 monthly or annual), and no difference in effect was found between the groups who received 3-monthly visits and the group that received annual visits.[181] **2+**

The second UK study was a randomised trial. It found no significant difference in caries levels at age 3 in children whose mothers had received structured oral health education from a specially trained health visitor during the child's 8 month and 20 month developmental checks, compared to children whose mothers had received the usual level of advice from health visitors in the area (mean dmfs: 2.03 (95% CI, 1.39–2.67) in the test group vs 2.19 (95% CI, 1.41–2.97) in the control group). It was suggested that cross-contamination between the two groups might have obscured any true difference between the two strategies.[182] **1+**

At age 5 years, an opportunistic comparison of the children in this trial found that the difference in caries levels between the two groups had widened, but remained non-significant (mean dmfs: 3.99 (95% CI, 2.94–5.04) in the test group compared to 4.84 (95% CI, 3.39–6.29) in the control group). However, caries levels were lower in both groups compared to the mean dmfs of over 2,000 5-year-old children in the area who were examined as part of a separate epidemiological survey (mean dmfs 5.94 (95% CI, 5.55–6.33). The difference in mean dmfs between the test and the "census" groups was statistically significant.[182] **1+**

A controlled trial from Canada found that motivational interviewing delivered by trained South Asian women, with regular follow-up contact to encourage maintenance of good health practice, resulted in an average reduction in caries of 54% among children of South Asian mothers who had received the intervention compared to those who received oral health education in the form of a pamphlet and video (mean dmfs 3.52 vs 7.59, p=0.001). Motivational interviewing is a patient-centred, personalised form of counselling and children in this group had, on average, more fluoride applications during the 2 years of the trial than the control group (mean no. of varnish applications: 3.8 vs 0.25, p=0.001), which suggested that the intervention was effective at promoting dental attendance for varnish application.[183] **1+**

A trial from Australia took an early approach to delivering oral health messages to women expecting their first child. In this controlled trial, potential participants were allocated to test and control groups prior to consent, using Zelen's design with double consent and a random number table. With this method, participants who consent are informed of their group allocation and can change it, if they wish. In this trial, 5 women changed from the group to which they were randomised: All moved to the test group from the control group. Women in the test group received printed oral health information during the 5th to 7th month of pregnancy, and again when their infant was aged 6 months and 12 months (by post). The control group received no oral health information. The outcome measure was Severe Early Childhood Caries (S-ECC) – defined as cavitated or non-cavitated caries in at least one maxillary incisor. When the children were 20 months old, the incidence of S-ECC was significantly lower among children in the intervention group compared to the control group (1.7% vs 9.6%, $p<0.01$). The inclusion of a structured telephone consultation with a randomised sub-set of mothers in the test group (n=165) when the children were aged 6–12 months had no effect on S-ECC incidence compared to the rest of the test group. Weaknesses in the design of the study included no measurement of examiner reliability, and lack of blind outcome assessment.[184] **2+**

5.4.1.2. Group education

A study from Thailand tested the effect of participatory group dental health education sessions with mothers/caregivers of children attending "test" health centres. The sessions were facilitated by trained health centre personnel, at 3 month intervals during one year, and mothers/caregivers were encouraged to contribute to the discussions. The average age of the children was 12 months (range 6–18 months) at the start of the trial. Toothbrushes and toothpaste containing 500 ppm F were provided at each session. Mothers/caregivers attending "control" health centres received didactic DHE at the same time as the vaccination programme when their babies were 9 and 18 months old. At the end of the trial, there was no significant difference in caries increment or prevalence of caries between the test and control groups. The self-reported toothbrushing practices by the mothers were significantly better in the test group, but there were no significant differences for dietary habits such as falling asleep with a bottle, night feeds or sweet food between meals.[185] **1+**

5.4.1.3. Surgery-based oral health education

A cluster randomised controlled trial, in which 30 dental practices in high caries areas in north west England were the units of randomisation, tested the effect of a surgery-based oral health education programme on plaque and caries levels in preschool children. Each participating dental practice had to provide at least 10 patients aged between 1–6 years, who had some caries experience, attended regularly and were considered by the dentist to be at risk of caries over the next 2 years. Following stratification by age and caries levels of the children involved, participating practices were randomly allocated to test and control groups using computer generated random numbers. In the "test" practices, an oral health educator provided detailed oral health education and toothbrushing instruction to the mothers of the participating children over the course of two visits, and then recalled the children every 4 months during the 2 year trial. Children attending the "control" practices received

their usual treatment. At the end of the trial, no statistically significant differences in caries levels or in plaque levels between the test and control group were found (mean dmft 2.65 vs 3.22).[186] 1+

5.4.1.4. Population-based interventions

A cluster randomised trial conducted in two matched Primary Care Trusts in Manchester[187] combined DHE delivered by health visitors or practice nurses, at the child's 8 month developmental check and their MMR vaccination at 12–15 months, with provision of a feeder cup (at 8 months) and a toothbrush and fluoride toothpaste (1,450 ppm F) at age 12–15 months, and every 6 months thereafter up to age 32 months. When the children were 5 years old, the prevalence and severity of caries in children who had participated in the intervention in the test area was significantly less than "participants" in the control area (i.e. children that would have been eligible to participate, if the intervention had been available) (prevalence: 54% v 64%, p=0.03; mean dmft: 2.23 v 3.72, p=0.0001; percentage with nursing caries: 20% v 32%, p=0.002). However, a high level of population mobility in the test area meant that after 5 years, only 53% of the 5-year-olds in the test area had participated in the programme. The impact of non-participation in a deprived urban area with high levels of population mobility was sufficient to dilute the impact of the intervention such that few benefits were discernable at a population level.[187] 1-

A programme of community development to promote dental health in preschool children in a socially deprived district of Glasgow applied a multifaceted and multidisciplinary approach to promoting healthy eating, toothbrushing with fluoride toothpaste and early dental attendance. Although the evaluation of the programme was ecological in nature (i.e. a series of cross sectional assessments), the proportion of 3-year-olds who were caries-free increased from 38% at the start of the programme to 51% in year 4 of the programme in the pilot area, and reductions of 46% in caries experience of 3-year-olds over the 4-year period were also seen.[188] Further evaluation of the programme's impact at population level, using epidemiological data from secondary sources (BASCD surveys) suggested that the improvements in caries levels seen at age 5 in the targeted, high deprivation areas were not seen in most other less deprived areas that had not been exposed to the programme, but the improvements in the deprived areas were of sufficient magnitude to impact on caries levels for the whole of Glasgow.[189] 4

The Guideline Development Group considered that an intervention similar to that used in the Manchester trial, which timed DHE interactions to coincide with the 8 month developmental check and 15 month MMR vaccination, could potentially have a greater effect in an Irish setting, where population mobility is likely to be less than in the UK.[187]

Recommendation

- ***Oral health education and diet advice should be incorporated into each child's developmental visits from age 8 months and at any appropriate opportunity that arises*** **D**

5.4.2. Maternal Interventions to prevent early childhood caries

Some oral health promotion interventions have combined oral health education with interventions to improve the oral health of the mother. Two longitudinal studies in which pregnant women received dental treatment prenatally, with follow-up regular DHE and preventive care for mother and child found a significant difference in caries levels in the primary[190,191] and permanent teeth[192] of children in the intervention group compared to the untreated control group. A third study of similar design found no significant difference in the children's oral health at age 24 months.[193] The poor quality of the studies, including their large losses to follow-up, limits any conclusions that can be drawn from them. **1-**

Several clinical trials have used antibacterial agents to reduce early colonisation of infants with maternal mutans streptococci (MS) with the aim of reducing the incidence of caries in these children, with varying results. Kohler et al.[194] and Tenovuo et al.[195] showed that chlorhexidine gel treatments of highly infected mothers could reduce MS colonisation and caries development in their children. A placebo controlled trial by Dasanayake[196] showed a significant reduction in MS levels in both mothers and children but no effect on caries in the children when mothers received chlorhexidine varnish treatments during eruption of the children's first teeth and during the second year of life. A systematic review of antimicrobials for caries control concluded that although topical applications of antibacterial agents may reduce the transmissions of oral MS from host to host, this does not necessarily result in less caries.[197] **1+**

Several trials have investigated the potential of xylitol to reduce maternal transmission of mutans streptococci (MS) to their infants. Isokangas et al.[198] randomly allocated pregnant women with high levels of MS in their saliva to either a xylitol group or to one of two comparison groups receiving chlorhexidine or fluoride varnish treatments. The xylitol group was instructed to chew xylitol chewing gum (65%) four times a day, commencing three months after the birth of their babies until 24 months. The comparison groups received chlorhexidine or fluoride varnish treatments 6, 12 and 18 months after the birth of their babies. In addition to a statistically significant reduction in the mother-child transmission of MS in the xylitol group at age 2,[199] the authors reported a statistically significant lower caries prevalence in the xylitol group compared to the chlorhexidine and fluoride groups at age 5 (mean dmf 0.83, 3.22, 2.87 respectively; $p<0.001$). However, methodological weaknesses in the conduct of this study (including lack of examiner blinding, failure to measure intra- and inter- examiner reliability, and no indication of whether the dmf index measured teeth or surfaces) reduce the strength of the evidence. **1-**

A subsequent randomized trial[200] compared caries levels in 4-year-old children whose mothers chewed gums containing principally xylitol (650 mg xylitol), chlorhexidine (5 mg chlorhexidine, 533 mg xylitol, 141.9 mg sorbitol), or fluoride (0.55 mg sodium fluoride, 289 mg xylitol, 188.8 mg sorbitol) for 5 minutes three times a day for one year, commencing when the infants were 6 months old. Children of mothers who chewed gum with xylitol as the single sweetener during the eruption of the first primary teeth had significantly less caries than children of mothers who chewed gum containing principally fluoride (mean defs 0.38 vs 1.38, $p<0.05$). The mean defs of children whose mothers chewed gum

containing principally chlorhexidine was 0.66. This was not statistically significantly different from the xylitol and fluoride groups. 1-

5.4.3. School-aged children

Most oral health promotion interventions for children in Ireland tend to be school-based and educational and aim to improve knowledge.[33] These interventions may be targeted at certain disadvantaged or special needs groups, but most activity takes place in mainstream schools. Our situation analysis for this Guideline found that over half of all dental areas provided school-based dental health education (DHE) involving over 40,000 children in 614 primary schools.

We identified only two studies that assessed the effectiveness of school-based oral health education in terms of reductions in caries. Petersen et al.[201] assessed the effectiveness of a school-based oral health education programme at preventing caries in grade 1 children (age not reported) attending primary schools in Wuhan City, China. Although the schools were randomly selected, it is unclear whether they were randomly assigned to receive the intervention. The programme was based on the concept of the WHO Health Promoting Schools Project. Teachers were trained to conduct monthly oral health education sessions and daily instruction on toothbrushing method, and children were advised to brush twice a day with fluoride toothpaste. The report of the trial is unclear about whether the daily oral hygiene instructions included toothbrushing. Children in the control schools received no intervention. The caries increment was very low in both the test and the control groups (0.2 of a permanent tooth surface over 3 years) and there were no significant differences in DMFS or DMFT increments between the two groups after 3 years. There were, however, positive effects on oral health knowledge and attitudes of mothers and teachers, and on the oral health behaviour of the children reported by the mothers. 2+

A cohort study compared the oral health of 12-year-old Flemish children who received one hour of oral health education at school annually for 6 years to a control group who did not receive the intervention.[202] After 6 years, there was no significant difference in mean DMFT (p=0.49), DMFS (p=0.31) or prevalence of caries (p=0.76) between the two groups. However, the programme was found to be successful in improving reported dietary habits and reported use of fluoridated toothpaste. 2+

The programme of oral health education in schools used in Flanders is similar to that used in Ireland. The Guideline Development Group considered that the public dental service had an ethical responsibility to provide oral health education to children, but that this could be effectively delivered by teachers as part of the Social and Personal Health Education (SPHE) programme of the school curriculum. This approach would allow oral health promotion personnel to work in partnership with other disciplines and in other settings to develop interventions with potentially greater impact on oral health than purely educational oral health programmes.

Recommendation

- ***Oral health education should be incorporated into the Social and Personal Health Education (SPHE) programme of the school curriculum*** **D**

5.5. Fissure sealants

Fissure sealants are applied to the grooves and pits of teeth, usually molars, to create an impervious barrier between the tooth surface and the oral environment, thereby preventing dental caries. A Cochrane systematic review of 16 trials found that first permanent molar teeth sealed with resin-based sealant had a 78% reduction in caries on occlusal surfaces after 2 years and 60% reduction after 4–4.5 years compared to unsealed molars. Evidence of the caries-preventive effect of resin-based sealants versus other types of sealant (mainly glass ionomer) was inconclusive.[203] The authors of the review concluded that the effectiveness of sealants was obvious for children at high caries risk, but that information was lacking on the effectiveness of sealants at different levels of caries risk. **1++**

A systematic review on sealant effectiveness by Mejare et al.[204] which had different inclusion criteria, graded the evidence of a caries-preventive effect of fissure sealants as “limited”, due to the poor quality of the studies included in the review. The authors of that review suggested that research into the effectiveness of sealants in both low and high caries risk children was needed. They also found that the effect of sealants was affected by sealant replacement, with relatively high reductions in caries risk seen in studies in which a sealant replacement strategy had been used. **1+**

Sealant retention is critical to its effectiveness and sealant retention rather than caries has become the principal outcome measure of sealant effectiveness. The Cochrane systematic review reported widely varying complete sealant retention rates for the studies it included. These ranged from 79% to 92% at 12 months, 71% to 85% at 24 months, 61% to 80% at 36 months, 52% at 48 months, 72% at 54 months and 39% at 9 years.[203]

Recommendation

- ***Children who are assessed as being at high caries risk should have resin-based fissure sealant applied and maintained in vulnerable pits and fissures of permanent teeth*** **A**

5.6. Chlorhexidine

5.6.1. Introduction

Dental caries is an infectious disease of bacterial origin. Therefore, it seems rational to use an antimicrobial approach to prevent and control dental caries. Chlorhexidine is an antimicrobial agent that has been studied extensively over the last 30 years for its ability to suppress the levels of mutans

streptococci in the mouth and for its potential to prevent and control dental caries. It is used in a variety of formulations and vehicles, such as mouthrinses, gels and toothpastes. Chlorhexidine varnishes were developed to prolong the contact of the chlorhexidine with the dentition to provide sustained release of the antimicrobial agent.[205]

Table 5.1: Product name and chlorhexidine (CHX) concentration of a selection of chlorhexidine vehicles

CHX Vehicle	Product name	CHX concentration
Varnish	EC40 (Biodent)	40%
	BioC (Biodent)	20%
	Chlorzoin (Oralife)	10%
	Cervitec Plus (Ivoclar-Vivadent)	1%
Gel	Cervitec	0.2%*
	Corsodyl (GSK)	1%w/w
Mouthrinse	Corsodyl (GSK)	0.2%w/v

**900 ppm F*

5.6.2. Effectiveness of chlorhexidine varnish for caries prevention in preschool children

Evidence for the effectiveness of chlorhexidine for caries prevention in preschool children is limited to four trials involving the application of a chlorhexidine varnish[206,207] or gel.[208,209] With the exception of the double blind, randomised placebo-controlled trial conducted by Du et al. in China, the trials are of poor quality, involve small sample sizes, and have produced conflicting results. Du et al.[207]reported a 37.3% reduction in caries increment (p=0.036) in primary molars over 2 years, with biannual application of chlorhexidine varnish. Unfortunately, although the trial was well conducted, the children in the trial had very low exposure to fluoride, which raises questions about the applicability of these findings to Irish children. **1+**

5.6.3. Effectiveness of chlorhexidine varnish for caries prevention in school-aged children

We identified 5 systematic reviews on the effectiveness of chlorhexidine for caries prevention in permanent teeth. An early meta-analysis[210] of the caries-preventive effect of chlorhexidine rinse, gel and toothpaste reported a prevented fraction of 46% (95% CI, 35–57%). Rozier et al.[211] updated this meta-analysis with three additional trials involving chlorhexidine varnish.[212-214] These three trials provided mixed evidence and were judged by the author of the review to provide insufficient evidence for the caries-preventive effectiveness of chlorhexidine varnish.[211] A subsequent systematic review of selected caries prevention and management methods for high risk individuals found the evidence to be insufficient but suggestive of efficacy for all forms of chlorhexidine.[215] The authors of this review highlighted how the variations in the vehicles used to deliver the chlorhexidine, the concentration of the chlorhexidine and the administration patterns employed meant that there was limited evidence for any particular chlorhexidine intervention. A systematic review by Twetman of trials published between 1995 and 2003 rated the evidence for the effectiveness of varnish as inconclusive for caries active schoolchildren and adolescents with daily exposure to fluoride.[197] The authors of the most recent review on the subject tentatively concluded that chlorhexidine varnish has a moderate caries-inhibiting

effect when applied at intervals of 3 to 4 months, but noted that the effect seemed to diminish by around 2 years after the last application.[216] 1+

Therefore, although several systematic reviews have assessed the effectiveness of chlorhexidine for caries prevention in permanent teeth, the conclusions drawn by these reviews are not consistent, reflecting the varying quality and conflicting results of the included trials. Several trials have been published since the reviews, but their results do not change the conclusions of the reviews.

A recent split-mouth trial involved 6 applications of chlorhexidine varnish (Cervitec: 1% chlorhexidine and 1% thymol) or placebo varnish, at intervals of 15 days for a 75 day period to pairs of sound, newly erupted first permanent molars in children aged 6 to 8 years attending a public school in Sao Paulo, Brazil.[217] This intensive application of chlorhexidine varnish was not found to have a protective effect against caries development when the children were assessed after one year. 1-

Ersin et al. reported 2-year caries increments in three groups of high caries risk children aged 11–13 years (n=149), who were randomly assigned to receive chlorhexidine varnish applications (Cervitec: 1% chlorhexidine and 1% thymol) every three months, sodium fluoride gel applications every 6 months, or individual dental health education sessions every three months.[218] Although the children had no caries in their permanent teeth at baseline, they were classified as being high caries risk because they had previous caries experience in their primary dentition and strep mutans levels higher than 10^5 at baseline. The 2-year mean DMFS increments were 0.95, 0.88 and 1.05 for the chlorhexidine, fluoride gel and dental health education groups, respectively. The differences between the groups were not statistically significant (p>0.05). 1+

A cluster randomised controlled trial involving 181 Spanish children aged 6–7 years evaluated the effectiveness of 3-monthly chlorhexidine-thymol varnish applications for preventing caries in primary molars.[219] There was no significant difference in 2-year caries increments between the chlorhexidine varnish group and the no-treatment control group (mean dfs 2.21 vs 2.54, p=0.36). However, of the children who were caries free at baseline (dft=0), those in the test group (n=34) had significantly lower caries increments than the control group after 2 years, in both primary molar teeth (mean dft 0.61 vs 1.10, p=0.049) and primary molar surfaces (mean dfs 0.94 vs 1.73, p=0.041). 1-

➢ ***The use of chlorhexidine for caries prevention is not recommended*** **D**

5.7. Remineralising products

With the increasing focus on early detection and non-invasive management of caries, researchers have been testing new methods to enhance the remineralisation of enamel. Recent developments in the area of remineralisation include casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) nanocomplexes, which are derived from bovine milk protein, casein, and calcium and phosphate. The suggested mechanism of action for CPP-ACP is the localisation of calcium and phosphate ions in plaque, which provides a reservoir of soluble calcium phosphate ions to promote remineralisation.[220] An alkaline, stable and highly soluble CPP-ACP has been trademarked as

Recaldent™ and has been commercialised in sugar-free gum and mints and in dental products (e.g. Tooth Mousse™).

Much of the research on the remineralising effect of CPP-ACP has been carried out using animal or laboratory-based studies or "in situ" trials using human volunteers, who wear removable appliances containing blocks of artificially demineralised enamel. These appliances are worn while the product under investigation is being used and are usually removed and stored until the next exposure to the product. Thus, the testing method does not replicate real life conditions. The enamel blocks are removed from the appliance at the end of the trial period and analysed for mineral content and percent remineralisation.

A systematic review of the clinical efficacy of casein derivatives identified 12 studies that involved human subjects.[221] Ten trials, eight of which were "in situ", were concerned with remineralisation /caries prevention. The eight "in situ" trials tested the remineralising effect of CPP-ACP and other calcium-containing products when added to chewing gum[220,222-226], mouthrinses[220], lozenges[227] and milk.[228] None of the trials involved more than 30 participants, and with the exception of one study from Hong Kong[226], all participants were recruited from the staff and students of dental schools, and thus could not be considered representative of the general population. Six of the "in situ" trials found that CPP-ACP produced greater remineralisation than the control products.[220,222,223,225,227,228] In one of these, it was shown that lesions remineralised by gum containing CPP-ACP had greater resistance to subsequent acid challenge compared to the control gum.[223] All six of these trials came from the same research team in Australia. Of the two other "in situ" trials, one found no difference in lesion depth or maximum mineral content between gum containing dicalcium phosphate dehydrate and gum containing CPP-ACP.[226] The other trial found no significant difference in the average percent remineralisation produced with three test gums containing different calcium compounds, including CPP-ACP.[224] The design of both these studies differed from the Australian "in situ" trials in that they used mandibular removable appliances to house the demineralised enamel test slabs, rather than maxillary appliances. This may have influenced the results.

The two remaining trials included in the Azarpazhooh and Limeback systematic review[221] that had caries/remineralisation as an outcome, were conducted in specific high caries risk patients. Hay and Thomson tested a mouthrinse containing casein derivatives complexed with calcium phosphate (CD-CP) against a 0.05% sodium fluoride mouthrinse in a 12 month trial involving 124 patients with salivary gland dysfunction (Sjögren's syndrome or head and neck radiation therapy patients).[229] At the end of the trial, no significant difference for coronal caries incidence or increment was found between the two groups: 27% developed caries in the CD-CP group compared to 21% in the fluoride group, (p>0.0.5). The mean coronal caries increment was 0.32 and 0.39 DFS in the CD-CP and fluoride groups respectively, (p>0.05). **1+**

The second randomised trial measured the regression of 132 white spot lesions on 60 teeth in 26 adolescents who had completed orthodontic treatment.[230] The test group used a dental paste containing CPP-ACP (Topacal C-5) for 3 months followed by a standard fluoride toothpaste (1,000–1,100 ppm F) for 3 months, while the control group used standard fluoride toothpaste and daily 0.05%

sodium fluoride mouthrinse for 6 months. A higher proportion of white spot lesions disappeared in the test group compared to the control group at 3 months (55% vs 18%, p value not reported) and at 12 months (64% v 23%, p<0.01), when remineralisation was measured visually. When remineralisation was assessed objectively by laser fluorescence (DIAGNOdent), both groups showed significant reductions in the laser fluorescence scores at 6 months and 12 months compared to baseline, indicating a change in the severity of the lesions, but the difference between the two groups was not significant (mean laser fluorescence values 6.4 ± 7.5 vs 4.4 ± 5.2, p>0.05, in the test and control groups.

Based on the 12 trials in their systematic review, Azarpazhooh and Limeback concluded that there is insufficient good quality clinical evidence to make a recommendation regarding the longterm effectiveness of casein derivatives for preventing caries in vivo.[221]

One “in situ” trial and one randomised trial have been published since the Azarpazhooh and Limeback systematic review. The Australian “in situ” trial found that a mouthrinse containing 2% w/v CPP-ACP plus 450 ppm F produced significantly higher plaque fluoride levels compared to a 450 ppm F mouthrinse. Superior remineralisation was achieved by a dentifrice containing 2% CPP-ACP plus 1,100 ppm F compared to dentifrices containing only CPP-ACP or only fluoride (1,100 ppm F and 2,800 ppm F).[231]

The randomised trial published since the review tested the effect of two sugar-free gums – one containing CPP-ACP and the other containing sorbitol – on approximal caries progression in 1,820 low caries Australian adolescents aged 11.5 to 13.5 years.[232] Caries progression was measured radiographically. At the end of the trial, 5.4% of approximal surfaces had experienced caries progression in the CPP-ACP group compared to 6.5% in the sorbitol group. The absolute difference in the proportion of approximal surfaces experiencing caries progression was 1.1% and the prevented fraction was 17%. However, given the small absolute difference in approximal caries progression between the two groups, and the absence of data on caries progression in other tooth surfaces, the clinical significance of the results of this trial are uncertain. **1+**

- ***There is insufficient evidence on which to base a recommendation on the use of remineralising products (CPP-ACP) for caries prevention***

5.8. Combinations of caries preventive interventions for high risk children

Thus far we have mainly considered interventions that involved a single preventive modality. In this section, we consider if combinations of effective interventions provide any additional benefit for high caries risk children.

A Cochrane systematic review that compared the effectiveness of combinations of topical fluorides (i.e. toothpaste, mouthrinse, varnish and gel) to a single topical fluoride for the prevention of dental

caries reported an increase in effect of 10% (95% CI, 2–17%; p=0.01) with the combined use of toothpaste plus mouthrinse, varnish or gel compared to toothpaste alone.[152] **1++**

A systematic review of selected caries prevention and management methods for high caries risk individuals identified six relevant trials involving combinations of preventive agents.[215] Four trials reported on the effectiveness of chlorhexidine combined with some form of topical fluoride compared to a no treatment control group, one trial reported on the effectiveness of chlorhexidine combined with fissure sealants compared to a no treatment control group and one trial compared a combination of chlorhexidine varnish plus fluoride varnish to fluoride varnish alone. The evidence for combined treatment approaches was judged to be insufficient, due to the variability in outcomes and the limited evaluation of any one intervention, but the evidence was suggestive of efficacy. **1+**

Axelsson et al. reviewed the effect of two or more interventions, each expected to prevent caries, compared to standard care, no treatment or placebo.[233] Twenty-four controlled trials involving combined preventive methods for children, adolescents, individuals at high risk of caries and the elderly were identified. Almost all the included trials involved some form of topical fluoride (toothpaste, varnish, gel or rinse). The authors of the review concluded that there was moderate evidence that combinations of treatments involving fluoride had a caries preventive effect on children and adolescents. However, they were unable to draw any conclusions about the effectiveness of combined preventive measures in high caries risk children because the evidence was conflicting. **1+**

A subsequent randomised trial from Finland assessed the effectiveness of an intensive clinic-based caries preventive programme for children aged 11–12 years with at least one initial active caries lesion.[234] The intensive preventive programme involved interactive counselling by hygienists trained in patient- and empowerment-centred counselling, intensive oral hygiene instruction, fluoride lozenges, xylitol lozenges, fluoride varnish, chlorhexidine varnish and distribution of toothpaste containing 1,500 ppm fluoride and 10% xylitol. The comparison group received preventive treatment normally given in the local public dental clinics (fluoride varnish and dental health education), which was limited in comparison to the intervention group. After 3.4 years, the DMFS increments for the test and comparison groups were 2.56 (95% CI, 2.07–3.05) and 4.60 (95% CI, 3.99–5.21) respectively ($p<0.0001$), and the prevented fraction was 44.3%. **1+**

A controlled clinical trial, also from Finland, found that a risk-based preventive approach was effective at reducing caries in preschool children. In the test area, children received treatment based on a risk assessment conducted at baseline when the children were 2 years of age. The low risk group (MS negative, caries free) received an annual examination with oral health education to parents. The intermediate risk group (caries free, MS positive) received preventive measures including oral health education and fluoride varnish application twice a year. The high risk group (caries present) received a combination of fluoride varnish 4 times a year, plus chlorhexidine varnish if the child was MS positive and glass ionomer sealant if signs of discolouration were seen. Children in the comparison area received routine prevention, which included fluoride varnish and oral health education. They also had their baseline MS and caries levels recorded, to allow risk status to be assigned at the end of the study, for comparison with the test group. After 3 years, children with intermediate caries risk status

who received routine prevention were almost 3 times more likely to have caries or fillings at age 5 compared to children with intermediate risk who had received risk-based prevention (OR: 2.8; 95% CI, 1.2–6.6). For high caries risk children, the odds of having caries or fillings in the comparison group was ten times greater in the routine prevention group compared to the risk-based prevention group. (OR 10.3; 95% CI, 2.5–43.1). However, the numbers in this group were small. **2+**

A cluster randomised trial by Morgan et al., which was not included in the Axelsson et al. systematic review, assessed the effectiveness of a comprehensive school-based preventive dental programme in high caries risk children aged 12–13 years attending disadvantaged schools in non-fluoridated areas of Victoria, Australia.[235] The intervention group rinsed weekly with 0.2% sodium fluoride and had annual application or maintenance of fissure sealants on all appropriate first and second molar teeth in addition to annual dental examinations and an annual oral hygiene education programme. The control group received annual dental examinations and an annual oral hygiene education programme only. Children in the intervention group who completed the programme developed, on average, 1.49 fewer decayed, missing or filled tooth surfaces compared to the control group during the three year study ($p<0.001$). When the results were analysed by intention-to-treat, the difference remained highly statistically significant. **1+**

Tapias et al. conducted a non-randomised controlled trial to evaluate the effectiveness of a preventive programme in 6-year-old children attending schools in Mostoles, Madrid.[236] The preventive programme involved health education and weekly mouthrinsing with 0.2% sodium fluoride. Children who were considered 'at risk' according to specific criteria received fissure sealants on their first permanent molars and fluoride gel applications. The children in the comparison group attended schools outside the basic zone of the healthcare centre and did not have access to these preventive measures. After 7.5 years, the mean DMFS of the children receiving the preventive programme was significantly lower than that of the control group (2.09 v 4.33, $P<0.001$). **2-**

Studies involving combinations of preventive interventions differ in the precise combinations of interventions used and also in the extent to which the control group is exposed to preventive measures, which makes interpretation of the results of these studies difficult. There is a tendency for combination interventions involving either fluoride or fissure sealants or both, to show a benefit, particularly when the comparison group receives limited preventive services.

Recommendation

- ***Preventive programmes comprising combinations of interventions that include fluoride or fissure sealants should be considered for high caries risk children*** **A**

6. Implementation and Audit

A new national oral health policy has been commissioned by the Minister for Health, and its publication is awaited. Many of the recommendations in this guideline address issues that the oral health policy planned to examine, such as the integration of oral health in the wider health care and education systems, and developing working partnerships within primary care to enhance oral health care for children. The guideline takes both a population and an individual approach to caries prevention, which is consistent with the Health Service Executive's (HSE) population health strategy.[237] Therefore, the implementation of the Guideline should be supported at strategic and operational level.

The focus of the guideline is on the early identification of high caries risk children. This represents a major shift in focus for the public dental service, which up to now has concentrated on providing dental care for school-aged children. This reorientation towards younger target groups requires greater collaboration with members of the primary care team as well as development of oral health education resources that are concise, consistent and can be confidently delivered by non-dental primary health care professionals. Examples of such collaboration already exist in the HSE: The Child Health Information Service Project (CHISP) has incorporated age-appropriate oral health messages into its 3-part information pack for parents, and Shared Learning is a pilot project evaluating the effect of early assessment and referral of children with special care needs. The resources developed for these programmes could be adapted or updated for wider use.

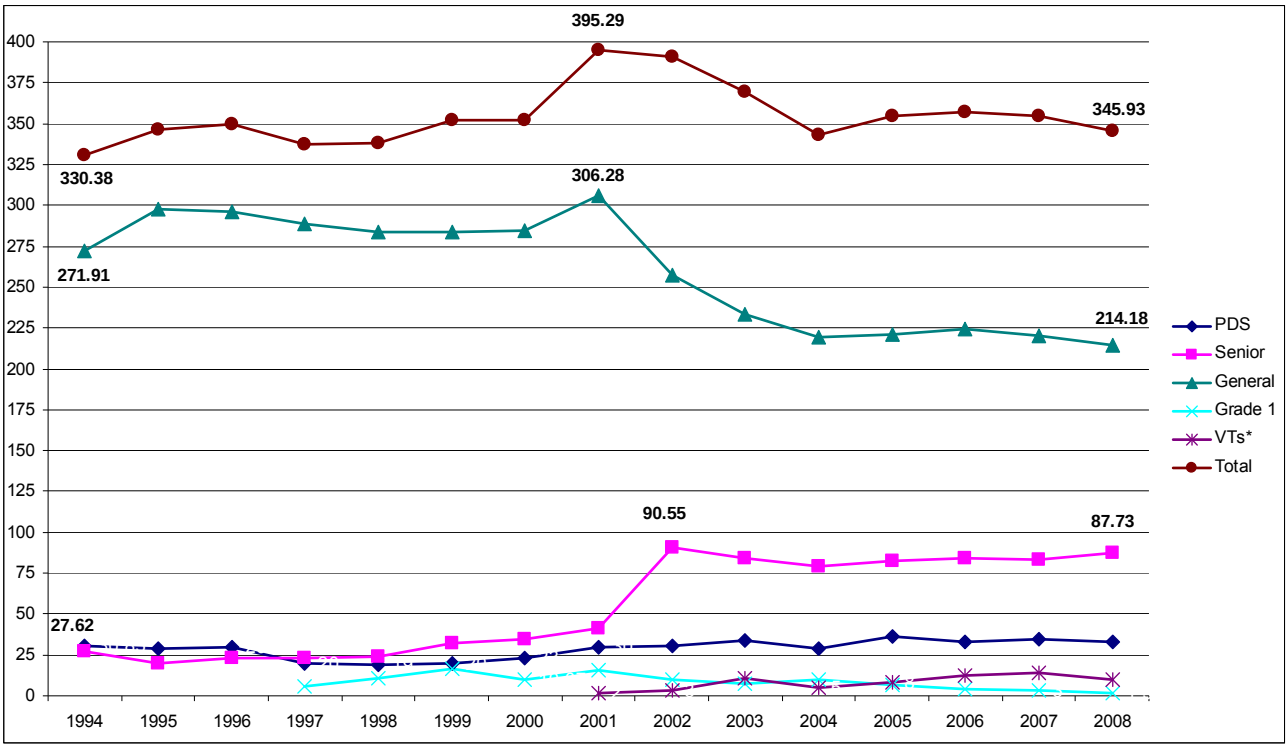
6.1. Resource implications and barriers to implementation

The introduction of employment ceilings to all service units within the HSE from 2006 onwards, and further restrictions on recruitment in 2009 presents the greatest organisational barrier to implementation of the guideline recommendations, as it affects not just dental services, but almost all primary care services that could be involved in the early identification of high caries risk children.

Employment statistics from the Department of Health and Children (1994–2004)[238,239] and from the National Employment Monitoring Unit of the HSE (2005–2008) (personal communication) show that the number of whole time equivalent (WTE) dentists working in the public dental service has fallen from a peak of just over 395 WTEs in 2001 to 345.9 at the end of 2008, a decrease of 49.1 WTEs (Figure 6.1). Hygienist numbers have remained stable at between 50 and 60 WTEs since 2001. Resource limitations within the public dental service will specifically affect the capacity of the service to:

- Accept referrals of high caries risk preschool children
- Provide treatment services for high caries risk preschool children
- Maintain the SDS and the emergency service while directing resources to the development of preventive strategies for high caries risk children.

Figure 6.1: Number of whole time equivalent (WTE) dentists in the public dental service, by grade, 1994–2008



Additional barriers that could delay the implementation of recommendations include:

- Willingness and capacity of non-dental health professionals to engage in oral health education
- Funding to develop oral health promotion module for public health nurse graduate and post-graduate training
- The need to reorientate the public dental service away from the current culture of identifying children's oral health needs late rather than early, and to instill a focus on primary prevention rather than restoration.

6.2 Key points for Audit

The following data should be collected as part of the audit of the implementation of the guideline:

- Awareness of the guideline among dental and primary care team personnel
- Training of in-post Public Health Nurses (PHNs) in oral health assessment of preschool children
- Development of national oral health training programme as part of PHN postgraduate training
- Number of dental areas who have developed referral pathways for high caries risk children from primary care services to dental services

- Number of dental areas providing dental assessment for high caries risk preschool children identified by primary care services
- Number of areas offering a dental assessment to children during their first year in primary school
- Proportion of public dental service dentists using the Caries Risk Assessment Checklist
- Average recall interval for children identified as being high caries risk using the Caries Risk Assessment Checklist
- Proportion of children assessed as high risk who receive:
    - Fissure sealants
    - Topical fluoride application
    - Oral Health Education
- Proportion of parents using toothpaste containing at least 1,000 ppm F for children > 2 years
- Change in dmft/DMFT in children aged 5, 8 and 12 in areas that have implemented the guideline.

6.3 Recommendations for future research

During the development of this Guideline, a number of gaps in the evidence base were identified. These need to be filled. Some of the necessary research is described below, using the EPICO structure to outline the design of specific studies.[240]

Research is needed to identify:

- Prevalence and severity of dental caries in Irish children aged between 2 and 3 years in the Republic of Ireland
- The accuracy of dental screening and referral carried out by trained Public Health Nurses in Ireland

Evidence	2 studies comparing the sensitivity and specificity of non-dental professionals (after appropriate training) at identifying caries in preschool children with that of a dentist (gold standard)[104,106]
Population	Children aged 12–24 months at high risk of caries
Intervention	Knee to knee dental examination using a flashlight and a tongue blade, following appropriate training
Comparison	Similar examination by a calibrated dentist
Outcomes	Identification of children with one or more cavitated carious lesions or dental sepsis (sensitivity and specificity) Acceptability of the process to Public Health Nurses and parents

- Compliance by Irish parents with current recommendations on toothpaste use
- Geographic distribution of dental caries using software that allows spatial presentation of oral health data e.g. Health Atlas Ireland
- Effects of chlorhexidine varnish for the prevention of caries in preschool children

Evidence	Randomised trials of chlorhexidine varnish[206,207]
Population	Children aged 12–24 months attending community preschools, early start programmes or crèches in high caries risk areas
Intervention	3 monthly application of 40% chlorhexidine varnish
Comparison	No chlorhexidine varnish application
Outcomes	dmfs (increment) at age 3–4 years (i.e. 2 years after the intervention) Acceptability Adverse effects

- Routine collection of relevant oral health data on Irish children to assist with planning and targeting of services.

Glossary of Terms

Approximal caries	Decay occurring on the surface of a tooth where it contacts the tooth beside it.
Caries	Tooth decay.
Caries increment	The amount of caries developing during a specific period of time, usually from the start of a study (baseline) to the end of the study.
Cohort study	An observational study in which a defined group of people (the cohort) is followed over time. The outcomes of people in subsets of this cohort are compared, to examine people who were exposed or not exposed (or exposed at different levels) to a particular intervention or other factor of interest.
Cross sectional study	A study measuring the distribution of some characteristic(s) in a population at a particular point in time. This type of study design is also known as a survey.
Demineralisation	Loss of minerals (usually calcium and phosphate) from the tooth surface caused by exposure to acid, from either bacteria or dietary sources.
def	Variation on the DMF index (see below) where “e” stands for teeth extracted due to caries
dmf/DMF	An index which is used to describe the level of dental caries in individuals or groups. It represents the number of teeth (DMFT) or tooth surfaces (DMFS) which are decayed, missing or filled. By convention, dmf in lower case letters refers to primary teeth and DMF in capital letters denotes permanent teeth.
d_{3vc}mft/ D_{3vc}MFT	Caries recorded at the dentine level, with or without cavitation.
$d_3$mft/ D_3MFT	Caries recorded at cavitation level.
Fissure Sealant	A thin plastic coating that is applied to the grooves (pits and fissures) on the chewing surfaces of back teeth to prevent decay by creating a physical barrier against bacteria and food.
Fluorosis	Fluorosis is a specific disturbance in tooth formation that is caused when excess fluoride is ingested during tooth development and results in an altered appearance of the tooth, which ranges from almost imperceptible fine white lines to pitting or staining of the enamel.
Hypomineralised	Literally means “less mineralised”. It is a defect of enamel that occurs during tooth formation and results in a tooth surface that is more porous and therefore more prone to decay and wear than normal.
Meta-analysis	The use of statistical techniques in a systematic review to integrate the results of included studies.
ppm F	Parts per million fluoride. A commonly used measure of the concentration of fluoride in a product.
Prevented fraction	The difference in caries increment at the end of the study between the control and treatment group, divided by the caries increment in the control group. (Also called the percent caries reduction.)
Randomised controlled trial (RCT)	An experiment in which two or more interventions, possibly including a control intervention or no intervention, are compared by being randomly allocated to participants.
Remineralisation	The replacement of minerals lost from enamel due to the action of acids
Systematic review	A review of a clearly formulated question that uses systematic and explicit methods to identify, select, and critically appraise relevant research, and to collect and analyse data from the studies that are included in the review. Statistical methods (meta-analysis) may or may not be used to analyse and summarise the results of the included studies.
95% confidence interval (CI)	A measure of the uncertainty around the main finding of a statistical analysis. Estimates of unknown quantities, such as the odds ratio comparing an experimental intervention with a control, are usually presented as a point estimate and a 95% confidence interval. This means that if someone were to keep repeating a study in other samples from the same population, 95% of the confidence intervals from those studies would contain the true value of the unknown quantity. Alternatives to 95%, such as 90% and 99% confidence intervals, are sometimes used. Wider intervals indicate lower precision; narrow intervals, greater precision.

Appendix 1: Summary of Recommendations on the use of topical fluorides

Professionally Applied Topical Fluorides

The use of professionally applied topical fluorides for the prevention and control of dental caries in individual patients should be considered as part of an overall preventive programme for the patient, based on an assessment of the individual patient's risk for caries and their exposure to other sources of fluoride. A Caries Risk Assessment Checklist for Irish children has been developed for this purpose (Appendix 3).

FLUORIDATED AND NON-FLUORIDATED AREAS				
	Age 1– 7 years	**Grade of recommendation**	**Age 7–16 years**	**Grade of recommendation**
FLUORIDE VARNISH	Resin-based fluoride varnish application (22,600 ppm F) should be offered to children who are assessed as being at high caries risk	**A**	Fluoride varnish application (at least 22,600 ppm F) should be offered to children who are assessed as being at high caries risk	**A**
	Varnish should be applied at intervals of 6 months or 3 months	**A**	Varnish should be applied at intervals of 6 months or 3 months	**A**
	Because of its ease of application, the small amount used, and the precise application of the material to individual tooth surfaces, resin-based varnish (22,600 ppm F) can be used in very young children who are assessed as being at high caries risk	**GPP**		
	The introduction of a school-based fluoride varnish programme should be considered for children attending special schools			**GPP**
FLUORIDE GEL	Fluoride gel should not be used in children under the age of 7	**GPP**	Because of its ease of application and greater patient acceptability, fluoride varnish should be used in preference to fluoride gel for caries prevention in children who are assessed as being at high caries risk	**D**
			In situations where operator or patient preference dictates the use of fluoride gel rather than fluoride varnish, gel application should be offered at 6 month intervals	**A**
FLUORIDE VARNISH & GEL	Manufacturer's instructions regarding use of fluoride varnish and gel should be carefully followed, as these products have high concentrations of fluoride			**GPP**
	Every fluoride varnish or gel application should be recorded as a treatment item in the patient record and also in the day book, if used			**GPP**
FLUORIDE FOAM	There is insufficient evidence at this time on which to base a recommendation on the use of fluoride foam			
SLOW-RELEASE FLUORIDE DEVICES	There is insufficient evidence at this time on which to base a recommendation on the use of slow-release fluoride devices			

Community-Based Use of Fluoride Toothpaste

The use of topical fluorides for caries prevention should form part of an overall community-based preventive strategy, which should be population-specific and tailored to meet the needs and preferences of the population under consideration. The identification of high caries risk groups or populations in Ireland is currently based on local knowledge of disadvantaged schools or districts, special needs groups, geographic location (non-fluoridated areas) or, where available, on small area data on the distribution of caries.

FLUORIDATED AND NON-FLUORIDATED AREAS				
	Age < 2 years	**Grade of recommendation**	**From age 2 years**	**Grade of recommendation**
FLUORIDE TOOTHPASTE	Community-based programmes involving the use of fluoride toothpaste are not recommended for children under the age of 2 years	**GPP**	**Daily supervised toothbrushing programmes** should:	
			• Be considered for targeted populations of children who are at high risk of developing dental caries	**A**
			• Be undertaken in community settings such as	
			o crèches, nurseries, preschools	**B**
			o primary schools	**A**
			• Involve the use of toothpaste containing at least 1,000 ppm fluoride	**A**
			• Support home use of fluoride toothpaste through provision of toothpaste, toothbrush and instructions for home use during school holidays	**D**
			Programmes involving the distribution of fluoride toothpaste should**:**	
			• Be considered in targeted populations of children at high risk of caries *Toothpaste distribution has the advantage of being cheaper, but is less effective than supervised brushing.*	**A**
			• Involve the use of toothpaste containing at least 1,000 ppm fluoride	**A**
			• Distribute toothpaste at 3-month intervals, with instructions for home use	**GPP**
			• Distribute toothpaste directly to parents/guardians of children under the age of 7 years	**GPP**
			Any community-based preventive programme should be conducted as an RCT to establish both the effectiveness and cost of the programme in Ireland	**GPP**

Community-Based Use of Fluoride Mouthrinse

NON-FLUORIDATED AREAS ONLY				
	Age < 7 years	**Grade of recommendation**	**Age 7–16 years**	**Grade of recommendation**
FLUORIDE MOUTHRINSE	Children under the age of 7 years should not participate in a school-based fluoride mouthrinsing programme because of the increased risk of the rinse being swallowed by young children	**GPP**	Weekly fluoride mouthrinsing with 0.2% sodium fluoride rinse should be offered to children living in non-fluoridated areas (sub-analysis of review by Marinho et al.)	**B**
			The target number of applications should be at least 30 per year	**GPP**
			Fortnightly mouthrinsing with 0.2% sodium fluoride rinse is effective at reducing caries, but appears to be less effective than weekly rinsing (sub-analysis of review by Marinho et al.)	**B**
			Children participating in a school-based fluoride mouthrinsing programme should rinse for two minutes with 0.2% sodium fluoride rinse	**GPP**
			Rinsing times of less than 2 minutes should be considered for new participants in a mouthrinsing programme to avoid excessive ingestion of fluoride mouthrinse	**GPP**
			Children should wait for at least 20–30 minutes after rinsing before eating or drinking	**D**
			Staff responsible for administering the fluoride mouthrinse are an important part of the dental service and should be appropriately trained in the delivery of the fluoride mouthrinsing programme	**GPP**
			A standardised protocol should be developed for fluoride mouthrinsing programmes in Ireland, which should include an individual rinse record for each child, incident reporting, monitoring and evaluation of participation, and information for participants on the maintenance of good oral health when the programme ends	**GPP**

Appendix 2: Stakeholder Organisations

- Society of Chief & Principal Dental Surgeons
- Principal Dental Surgeon Group with regional responsibility for the planning and evaluation of Children's Dental Services
- Principal Dental Surgeon Group with regional responsibility for services for patients with special needs
- Health Service Executive (HSE)
- Irish Society for Disability and Oral Health
- Irish Society of Dentistry for Children
- Oral Health Managers' Society of Ireland
- Expert Body on Fluorides & Health
- Community Action Network
- Dental Health Foundation
- Irish Dental Association
- Cork Dental School and Hospital
- Dublin Dental School and Hospital
- Oral Health Promotion Research Group - Irish Link

Appendix 3: Key questions

Background questions

1. What is the prevalence of caries in Irish

   - preschool children – with and without special needs?
   - school-aged children – with and without special needs?

2. How do we define high caries risk in an Irish context? Is there an acceptable level of caries for children at different ages?

3. How can we access preschool children in order to identify those at high risk of caries?

4. Should the public dental service target groups at high risk of caries/individuals at high risk of caries/both?

Foreground questions

The key questions have been divided into those relating to the identification of high caries risk children and questions relating to caries prevention. In all cases, the questions can be applied to children with special needs.

Identification of high caries risk children

5. What are the main risk factors/risk indicators for dental caries in

   - preschool children
   - school-aged children up to the age of 16

6. How accurate, in terms of sensitivity and specificity, positive and negative predictive values, are risk assessment tools at predicting which children will be at risk of decay?

   - In the primary dentition?
   - In the permanent dentition?

7. How effective are trained non-dental personnel at identifying high caries risk preschool children compared to dental personnel?

8. How effective are geographic-based deprivation indices at identifying high caries risk children?

Prevention of caries in high caries risk children under the age of 16

Individual patient interventions

9. How effective are the following agents at preventing caries in the primary and permanent dentition in high caries risk children under the age of 16:

   - Topical fluorides (gel, varnish, mouthrinse, toothpaste)?
   - Anti microbial agents e.g. chlorhexidine gel/varnish?
   - Fissure sealants?

10. In high caries risk children, are combinations of the above caries preventive interventions more effective than one single intervention?

11. What evidence is there of the effectiveness of remineralising products e.g. casein phosphopeptides at reversing or arresting early enamel caries in children under the age of 16? (We will exclude animal and in vitro studies.)

12. What evidence is there that sugar substitutes are effective at preventing dental caries in children under the age of 16?

Population or targeted population interventions

13. What oral health promotion (including oral health education) interventions are effective at preventing caries in:

   - preschool children?
   - School-aged children under the age of 16?

14. Does dietary advice to parent/carer by dental personnel or other health care professionals at an early stage in the child's life reduce levels of caries in the deciduous or permanent dentition?

15. Is oral health education or oral health promotion conducted in schools effective in reducing caries in the deciduous or permanent dentition? (This will include preschools and consider one-off visits, specific OHP programmes and healthy schools initiatives where OHP is incorporated into school curriculum.)

Appendix 4: Search Strategy

A separate search was commissioned from the Cochrane Oral Health Group in Manchester, to identify randomised trials, quasi-randomised trials or longitudinal studies of any health promotion intervention which had caries as an outcome measure, as described in Section 2.3.2. The oral health promotion search generated 2,566 non-duplicate records, from which 60 full text articles not identified by other searches were obtained. Of these, 23 RCTs or controlled clinical trials were included in the guideline.

ORAL HEALTH PROMOTION SEARCH STRATEGY FOR MEDLINE via OVID

1. Dental Caries Susceptibility/
2. exp Tooth Demineralization/
3. Tooth Remineralization/
4. (((dental or tooth or teeth or enamel) and (decay$ or caries or carious or cavity or cavities or cavitation or demineral$ or remineral$)) or ((caries or decay$ or cavities) adj4 (reduc$ or revers$ or arrest$ or prevent$))).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
5. ((bottle or nursing or "early childhood" or early-childhood) adj (caries or decay)).mp.
6. DMF INDEX/
7. DMF$.mp. or dmf$.ti,ab. [mp=title, original title, abstract, name of substance word, subject heading word]
8. or/1-7
9. Fluorides, Topical/
10. Tin Fluorides/
11. exp Sodium Fluoride/
12. ((Fluor$ adj5 (gel$ or varnish$ or lacquer$)) or (fluorid$ and (mouthwash$ or "mouth wash$" or mouthrinse$ or mouth-rinse$ or "mouth rinse$" or rinse or rinsed or rinsing or toothpaste$ or "tooth paste$" or tooth-paste$ or dentifrice$))).mp.
13. ("SnF" or "SNF2" or "SMFP" or "stannous F" or "sodium F" or "MFP" or "NaF" or "AMF" or "APF" or "amine F" or "amine fluoride$" or monofluor or ("slow release" adj3 fluor$) or "Biofluorid 12").mp. [mp=title, original title, abstract, name of substance word, subject heading word]
14. (Duraphat$ or "Elmex fluid" or "Elmex gel").mp. [mp=title, original title, abstract, name of substance word, subject heading word]
15. ("ozone generating device" or "ozone-generating device").mp. [mp=title, original title, abstract, name of substance word, subject heading word]
16. "Fluor protector".mp. [mp=title, original title, abstract, name of substance word, subject heading word]
17. Fluorides/ad, tu [Administration & Dosage, Therapeutic Use]
18. or/8-17
19. Oral Hygiene/
20. (oral hygiene or mouth hygiene or "oral health" or "dental health" or mouth care or dental care or (care adj5 teeth)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
21. Toothbrushing/ or dentifrices/ or toothpaste/
22. (toothbrush$ or tooth-brush$ or mouthbrush$ or mouth-brush$).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
23. ((tooth adj3 clean$) or (teeth adj3 clean$) or (mouth adj3 clean$)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
24. (19 or 20 or 21 or 22 or 23) and (motivat$ or instruct$ or advise$ or advice or promot$ or educat$ or teach$ or train$ or supervis$ or demonstrat$ or oversee).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
25. Dental Plaque/
26. ((dental or tooth or teeth) adj5 plaque).mp. [mp=title, original title, abstract, name of substance word, subject heading word]

27. ((Dental Plaque/ or ((dental or tooth or teeth) adj5 plaque).mp.) adj5 remov$.mp.) or control$.mp. [mp=title, original title, abstract, name of substance word, subject heading word]

28. ((dental or tooth or teeth) adj5 plaque adj5 (remov$ or control$)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]

29. or/24-28

30. Health Fairs/ or exp Health Promotion/

31. ((health$ adj4 (fair$ or campaign$ event$ or program$)) and (dental or teeth or "oral health")).mp. [mp=title, original title, abstract, name of substance word, subject heading word]

32. 30 and (dental or teeth or "oral health").mp. [mp=title, original title, abstract, name of substance word, subject heading word]

33. Chlorhexidine/ or chlorhexidine.mp. or chlorhexidine-thymol.mp. or Cervitec.mp. or (EC40 adj6 varnish).mp. or chlorzoin.mp. [mp=title, original title, abstract, name of substance word, subject heading word]

34. exp Dental Prophylaxis/

35. ("dental prophylaxis" or "oral prophylaxis").mp. [mp=title, original title, abstract, name of substance word, subject heading word]

36. Health Education, Dental/

37. ("oral hygiene" or "mouth hygiene" or (mouth adj3 care) or "dental care" or (care adj3 teeth)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]

38. Patient Education/

39. 38 and (dental or teeth or "oral health").mp. [mp=title, original title, abstract, name of substance word, subject heading word]

40. 31 or 32 or 33 or 34 or 35 or 36 or 37 or 39

41. Diet/ or Diet, cariogenic/

42. Drinking Behavior/

43. exp Dietary Carbohydrates/

44. Feeding Behavior/

45. (diet and cariogenic).mp. [mp=title, original title, abstract, name of substance word, subject heading word]

46. (diet$ or nutrition or "food habit$" or "feeding habit$").mp. [mp=title, original title, abstract, name of substance word, subject heading word]

47. ("sugar intake" or (diet$ adj4 (sugar or sucrose)) or (sugar$ adj4 food$) or (sugar$ adj4 beverage$) or (sweeten$ adj4 food$) or (sweeten$ adj4 beverage$) or (sugar$ adj4 drink$) or (sweeten$ adj4 drink$)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]

48. ((carbonat$ adj3 (beverage$ or drink$)) or (fizzy adj3 (beverage$ or drink$))).mp. [mp=title, original title, abstract, name of substance word, subject heading word]

49. ((baby or babies) adj4 (food$ or drink$)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]

50. ("dinky feeder$" or ((baby or babies or infant$) adj3 (comforter$ or soother$))).mp. [mp=title, original title, abstract, name of substance word, subject heading word]

51. (xylitol or sorbitol or "artificial sweetener$").mp. [mp=title, original title, abstract, name of substance word, subject heading word]

52. (sugarfree or sugar-free or sugarless or "sugar free").mp. [mp=title, original title, abstract, name of substance word, subject heading word]

53. or/41-52

54. "Pit and Fissure Sealants"/

55. ((fissure$ adj6 seal$) or (dental adj3 sealant$) or (resin$ adj4 sealant$)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]

56. exp Glass Ionomer Cements/

57. Resin Cements/

58. ("glass ionomer$" or glassionomer$).mp. [mp=title, original title, abstract, name of substance word, subject heading word]

59. 54 or 55 or 58

60. Public Health Dentistry/ or Community Dentistry/

61. ("public health dentist$" or "community dentist$").mp. [mp=title, original title, abstract, name of substance word, subject heading word]

62. Nurseries/
63. exp Schools/
64. Community Health Centers/
65. Community Health Services/
66. Child Health Services/
67. Maternal-Child Health Centers/
68. Community Health Nursing/
69. School Nursing/
70. (midwife or midwives).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
71. (nursery or nurseries).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
72. school$.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
73. (kindergarten$ or play-group$ or playgroup$).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
74. (community clinic$ or community-based).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
75. ("health visitor$" or "community nurse$").mp. [mp=title, original title, abstract, name of substance word, subject heading word]
76. or/60-75
77. exp child/
78. infant/
79. Adolescent/
80. (child$ or toddler$ or infant$ or baby or babies or teenager$ or "young adult$" or "young person$" or "young people" or schoolchild$ or school-child$).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
81. or/77-80
82. 8 and (18 or 29 or 40 or 53 or 59) and (76 or 81)
83. randomized controlled trial.pt.
84. controlled clinical trial.pt.
85. randomized.ab.
86. placebo.ab.
87. drug therapy.fs.
88. randomly.ab.
89. trial.ab.
90. groups.ab.
91. or/83-90
92. humans.sh.
93. 91 and 92
94. comparative study.sh.
95. exp evaluation studies/
96. FOLLOW UP STUDIES.sh.
97. PROSPECTIVE STUDIES.sh.
98. (control$ or prospectiv$ or volunteer$).ti,ab.
99. or/94-98
100. 92 and 99
101. 93 or 100
102. exp Cohort Studies/
103. (cohort$ adj4 stud$).mp.
104. 103 or 102
105. 82 and (101 or 104)
106. letter.pt.
107. editorial.pt.
108. retrospective stud$.mp.
109. news.pt.

110. technical report.pt.
111. ("case-control stud$" or "case control$ stud$").mp.
112. case reports/
113. "case report$".mp.
114. survey$.mp.
115. or/106-114
116. 105 not 115
117. 116
118. limit 117 to english language
119. limit 118 to yr="2007 - 2008"

WEBSITES SEARCHED FOR GUIDELINES

	Web address
NHS Evidence Health Information Resources (formerly National Library for Health)	http://www.library.nhs.uk/
National Institute for Health and Clinical Excellence (NICE)	http://www.nice.org.uk/
Scottish Intercollegiate Guidelines Network (SIGN)	http://www.sign.ac.uk/
NZ Guideline Group	http://www.nzgg.org.nz/
Australian National Health and Medical Research Council	http://www.nhmrc.gov.au/publications/
National Guideline Clearinghouse	http://www.guideline.gov/
Centre for Disease Control (CDC)	http://www.cdc.gov/OralHealth/guidelines.htm
Guidelines International Network (G-I-N)	http://www.g-i-n.net/
TRIP database	http://www.tripdatabase.com/
FDI World Dental Federation	http://www.fdiworldental.org/home/home.html

Appendix 5: Caries Risk Assessment Checklist and Notes

Dentist's name: _____ Date: _____

Child's name: _____ School: _____ First assessment Y / N

Risk Factors / Indicators **A "YES" in the shaded section indicates that the child is likely to be at high risk of or from caries**	Please circle the most appropriate answer	
• Age 0–3 with caries (cavitated or non-cavitated)	**Yes**	No
• Age 4–6 with dmft>2 or DMFT>0	**Yes**	No
• Age 7 and over with active smooth surface caries (cavitated or non-cavitated) on one or more permanent teeth	**Yes**	No
• New caries lesions in last 12 months	**Yes**	No
• Hypomineralised permanent molars	**Yes**	No
• Medical or other conditions where dental caries could put the patient's general health at increased risk	**Yes**	No
• Medical or other conditions that could increase the patient's risk of developing dental caries	**Yes**	No
• Medical or other conditions that may reduce the patient's ability to maintain their oral health, or that may complicate dental treatment	**Yes**	No
The following indicators should also be considered when assessing the child's risk of developing caries		
• Age 7–10 with dmft>3 or DMFT>0	**Yes**	No
• Age 11–13 with DMFT>2	**Yes**	No
• Age 14–15 with DMFT>4	**Yes**	No
• Deep pits and fissures in permanent teeth	**Yes**	No
• Full medical card	**Yes**	No
• Sweet snacks or drinks between meals more than twice a day	**Yes**	No
Protective Factors **A "NO" in this section indicates the absence of protective factors which may increase the child's risk of developing caries**		
• Fissure sealants	Yes	**No**
• Brushes twice a day or more	Yes	**No**
• Uses toothpaste containing 1000 ppm F or more	Yes	**No**
• Fluoridated water supply	Yes	**No / Don't know**

Is this child at high risk of or from caries?	**YES**	**NO**

Notes on the Caries Risk Assessment Checklist

Introduction

The approach taken during the development of this checklist was that all children are at risk of developing caries but some children area at high risk, and these are the ones we want to identify. The assessment of caries risk is something that every dentist does, usually informally or implicitly. The aim of the checklist is to encourage a formal, systematic approach to identifying individual children who may be at high risk of developing decay. Caries risk assessment should form the basis of a risk-based approach to patient treatment and recall, with repeat assessments indicating if the child's risk status is changing over time.

The checklist is divided into 2 sections: risk factors/indicators and protective factors. The shaded part contains the risk factors/indicators that the Guideline Development Group considered most important for identifying high caries risk children. A score in the shaded part indicates that a child is likely to be at high risk for caries. Other indicators that should be taken into account when assessing the child's risk status complete this section. The presence or absence of protective factors should also be considered. The checklist combines the two most consistent predictors of future caries: previous caries experience[101] and the dentist's own assessment.[97,241] The dentist makes the final decision about caries risk status, based on their overall assessment of the patient. The following notes give some pointers on filling in the checklist.

Risk Factors/Indicators

Age 0–3: Any child under the age of 4 who shows any evidence of caries – with or without cavitation – should be considered high risk, as the consequences of any caries for this age group can mean recourse to general anaesthesia for treatment.

Age 7 and over: Caries is a dynamic process that can progress or arrest. The concept of lesion activity is becoming increasingly important in assessing a patient's risk of developing future caries. There is currently no international consensus on the diagnosis of active lesions, and for the purposes of this caries risk assessment checklist, we are suggesting a modified version of the criteria defined by Nyvad et al.[242] An active lesion is one which is likely to progress if nothing is done. It is more than just a "white spot" lesion. An active, non cavitated enamel lesion is characterised by a whitish/yellow opaque surface with loss of lustre and exhibiting a "chalky" appearance. Inactive lesions tend to be shiny and smooth.

New lesions: New caries in the last 12 months, or progression of non-cavitated lesions (clinical or radiographic) is a good indicator of high caries activity. This would be a key factor to assess, particularly on repeat caries risk assessments for children deemed to be high risk.

Smooth surface caries: At least 70% of caries in permanent teeth in Irish children occurs on pit and fissure surfaces.[3] The occurrence of caries on smooth surfaces i.e. proximal, buccal or palatal (excluding the respective pits) or lingual surfaces, indicates a different pattern of disease and potentially a greater risk of developing further decay. The presence of approximal lesions on bitewing (if available) should also be considered when assessing smooth surface lesions (although it will not be possible to assess the activity of the lesion from radiographs taken at a single timepoint).

Hypomineralised molars: Molar hypomineralisation varies in severity, and some hypomineralised molars can disintegrate rapidly, making early detection and monitoring of these teeth essential. In more severe cases, hypomineralised molars present a restorative and long-term management challenge. Other developmental disorders of tooth formation, e.g. amelogenesis imperfecta, which can predispose to caries, should also be considered in this category.

Deep pits and fissures: The morphology of the occlusal surface has been shown to be a good predictor of caries risk.[97,98]

Medical history: The medical history section is meant to be a formal summary of the medical history that you normally take for your patient, expressed as a risk factor for caries. Some examples of conditions that could be included in each of the categories are shown below.

Medical or other conditions	**Examples**
Conditions where dental caries could put the patient's general health at increased risk	Cardiovascular disease Bleeding disorders Immunosuppression
Conditions that could increase the patient's risk of developing dental caries	Salivary hypofunction Medications that reduce saliva flow Long term use of sugar-containing medicine
Conditions that may reduce the patient's ability to maintain their oral health, or that may complicate dental treatment	Certain physical and intellectual disabilities, Cleft lip/palate Anxious*, nervous* or phobic conditions, Behavioural problems

**Over and above what would be considered "normal" anxiety or nervousness for children*

DMFT (Decayed/Missing/Filled Teeth): In calculating dmft/DMFT, only teeth that have been extracted due to caries should be counted as missing. Similarly, only fillings that have been placed due to caries should be counted. The DMFT cut-offs in the checklist are based on the mean DMFT of the top one third of children with the highest caries levels from the North South survey.4 In the North South survey, caries was recorded without the use of (bitewing) radiographs; therefore caries detected on (bitewing) radiographs should not be included in the dmft/DMFT calculation.

Dietary habits: Diet is one of the main risk factors for dental caries, and it can be the most difficult and sensitive area on which to get accurate information. We are suggesting that the question could be phrased along the lines of the question on diet that was included in the North South survey.

Dietary habits	**Suggested question**
Sweet snacks or drinks between meals more than twice a day	How often does your child eat sweet food or drinks e.g. biscuits, cakes, sweets, fizzy drinks/squash, fruit drinks etc between normal meals?

Medical Card: There is fairly strong evidence of an inverse relationship between socio-economic status and oral health in children under 12 years of age.[16] Medical card status has been used in Irish studies as an indicator of disadvantage. Medical card status may be a particularly useful indicator of caries risk where children are too young for their risk to be based on caries history. Since the introduction of the GP Visit card, which has higher income thresholds for eligibility, it is necessary to establish if the patient has a Full medical card. Very often this data is collected as part of the medical history or patient details, and data from these sources can be used to complete the checklist.

Protective Factors

The effectiveness of the protective factors listed in the checklist at reducing caries has been established in various systematic reviews.[89,94,96,203] The absence of protective factors could increase a child's risk for developing caries.

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