PIT AND FISSURE SEALANTS

Evidence-based guidance on the use of sealants for the prevention and management of pit and fissure caries

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Beauchamp J, Page W, Caulfield JJ et al. Evidence-based clinical recommendations for the use of pit-and-fissure sealants: A Report of the American Dental Association on Scientific Affairs. *J Am Dent Assoc* 2008; 139: 257–268

Gooch BF, Griffin SO, Kolavic Gray S et al. Preventing Dental Caries through School-based sealant programs: Updated Recommendations and Reviews of Evidence. *J Am Dent Assoc* 2009; 140: 1356–1365

Haute Autorité de Santé (HAS). Assessment of caries risk and indications for pit and fissure sealants (first and second molars) in children and in adolescents under 18. (Short version in English, full version in French) 2005. Available at: http://www.has-sante.fr/.

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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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About this guideline

What the guideline covers

This guideline covers the use of pit and fissure sealants for the prevention and management of caries in the pits and fissures of primary and permanent teeth. The use of sealants in children, adolescents and adults is considered. The key items covered are:

- Methods for detecting occlusal caries
- Indications for use of fissure sealant (type of patient, type of dentition, type of tooth)
- Use of sealant for the management of pit and fissure caries
- Effectiveness of resin-based compared to glass ionomer sealant
- Application technique
- Follow-up and review of fissure sealants
- Side-effects or adverse reactions associated with fissure sealant use
- Cost-effectiveness of different sealant strategies, e.g. 'risk-based' compared to 'seal all'
- Cost-effectiveness of sealants applied by different dental health care professionals.

What the guideline does not cover:

- Other caries-preventive measures
- Preventive resin restorations (PRRs)/sealant restorations (restorations using an adhesive restorative material which involves the use of sealant as part of the restoration).

The aim of this guideline is to:

- Reduce levels of decay in pit and fissure surfaces in children, adolescents and adults in Ireland through effective use of fissure sealants
- Reduce variation in practice in the provision and application of fissure sealants.

Who is this guideline for?

This guideline has been developed to assist dental clinicians working in public and private practice and those responsible for the planning and management of public dental services, in making decisions about the use of pit and fissure sealants. It is also relevant to all members of the dental team, members of the primary health care team (public health nurses, general medical practitioners, practice nurses etc.), parents and children, teachers and those working in other social, health and education services that deal with children.

How was this guideline developed?

This guideline was developed by a guideline group and research team, using the ADAPTE process. Further details of the methodology can be found on page 9 and in the supplementary document available at http://ohsrc.ucc.ie/html/guidelines.html. This guideline will be updated in 2013.

Summary of Recommendations

Pit and fissure sealants are a safe and effective way to prevent dental caries and should be considered as part of an overall caries-preventive strategy that includes promotion of healthy eating and twice daily use of fluoride toothpaste containing at least 1,000 ppm fluoride. Formal caries risk assessment can assist the clinician in deciding whether an individual will benefit from sealant application, and the Caries Risk Assessment Checklist (Appendix 1) has been specifically developed for use with children and adolescents in Ireland. Just as the caries process is dynamic, so too is an individual's caries risk status. Therefore, caries risk assessment is an ongoing process. For the purposes of this guideline, the term 'high caries risk' refers to individuals or groups who are at risk of developing high levels of 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.

	RECOMMENDATION	Grade of Recommendation
PATIENT SELECTION	Children and adolescents who are assessed as being at high caries risk should have resin-based fissure sealant applied and maintained in pits and fissures of permanent teeth[34,35]	**A**
	Adults who are assessed as being at high caries risk should have resin-based fissure sealant applied and maintained in pits and fissures of permanent teeth[34,35]	**B**
	In the public dental service, a targeted population sealant programme should be considered for all individuals in specific high-caries risk groups, such as children attending special schools or designated disadvantaged schools	**D**
TOOTH SELECTION	When indicated, sealant should be applied to pit and fissure surfaces that are sound or that have demineralisation that appears confined to enamel*[73]	**B**
	In children and adolescents, priority should be given to sealing first and second permanent molar teeth[9]	**D**
	Routine application of sealants on primary molar teeth is not recommended, but may be considered for selected^ high caries risk children[33,72]	**D**
TIMING OF APPLICATION	When indicated, sealants should be applied as soon as the permanent molars are sufficiently erupted to be isolated† [100,101]	**D**

* Pits and fissures in fully erupted teeth that may display discoloration not due to extrinsic staining, developmental opacities or fluorosis. The discoloration may be confined to the size of a pit or fissure or may extend to the cusp inclines surrounding a pit or fissure. The tooth surface should have no evidence of a shadow indicating dentinal caries. If radiographs are available, they should be evaluated to determine that neither the occlusal nor proximal surfaces have signs of dentinal caries.[30] There should be no localised enamel breakdown due to caries.

^ Fissure sealing of primary molar teeth may be considered as part of a comprehensive caries-preventive programme for children with medical or other conditions where the development of caries, or its treatment, could put the child's general health at risk.

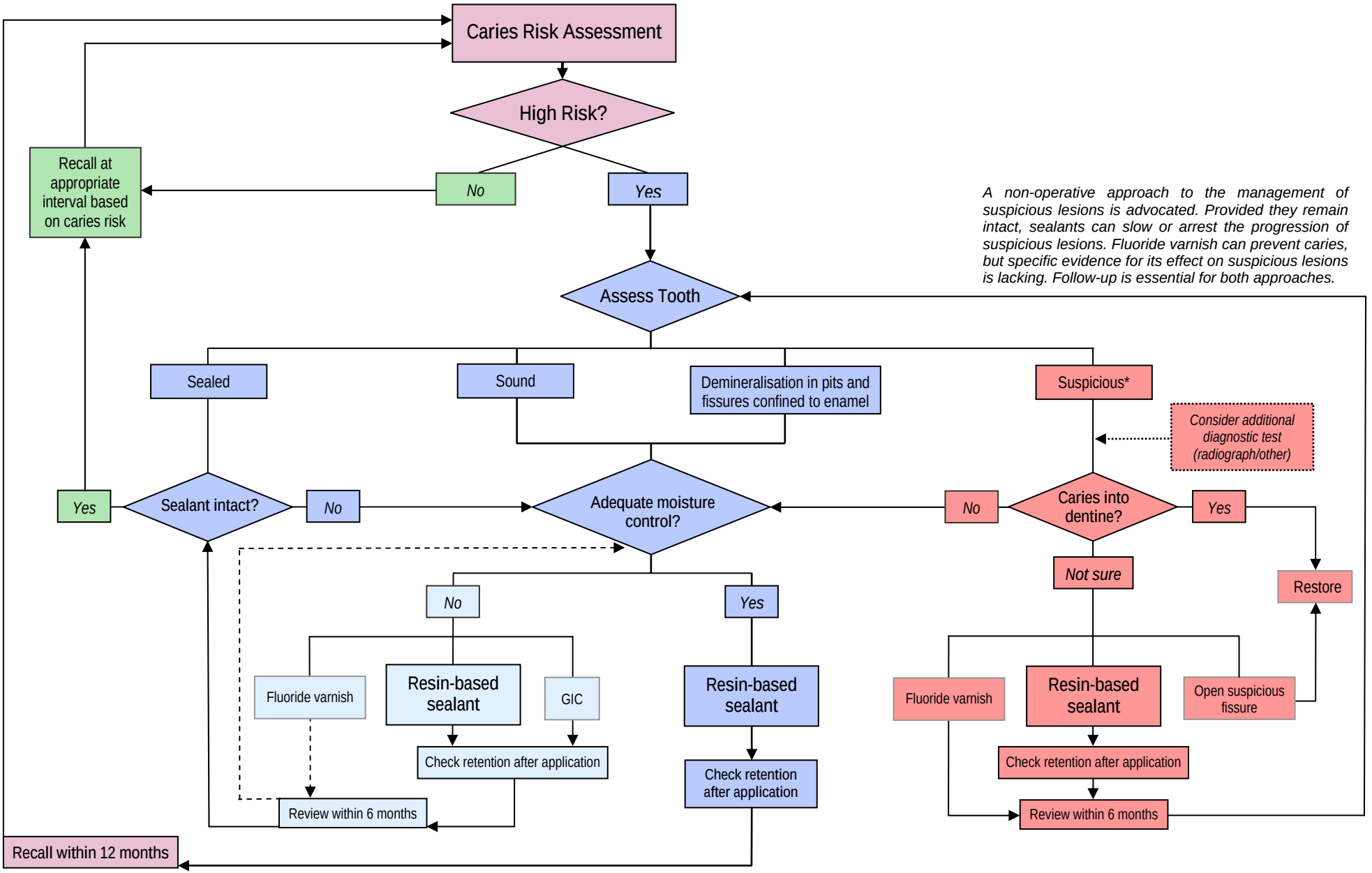
† See text for discussion on variation in age and duration for molar eruption.

	RECOMMENDATION	Grade of Recommendation
VISUAL ASSESSMENT	Teeth should be clean, dry and well illuminated for visual assessment[76,77]	**D**
	A probe should not be used to explore pits or fissures *Forceful use of a probe can damage tooth surfaces*[79-81]	**D**
	Radiographs should not be taken for the sole purpose of placing sealants[30]	**D**
	Other diagnostic technologies are not necessary for the sole purpose of placing sealants[31]	**D**
APPLICATION TECHNIQUE		
PERSONNEL	When possible, a four-handed technique should be used for the placement of pit and fissure sealants[115]	**D**
CLEANING	Clean the tooth with a dry bristle brush in a slow handpiece or with a dry toothbrush[32,117,118] Use of prophylaxis paste or pumice is not required[32]	**D**
	Mechanical preparation of enamel before placing a fissure sealant is not recommended	**D**
ISOLATION	Isolate the tooth to be sealed with either a dental dam or cotton wool rolls/isolation shields combined with effective aspiration[121-123]	**C**
ETCHING	Condition the enamel by etching with 35–37% phosphoric acid then wash and dry carefully to obtain a chalky white enamel surface Manufacturer's instructions should be consulted for recommended etch and rinse times	**GPP**
	Use of no-rinse, self-etching bonding agents instead of acid etching prior to sealant application is not recommended *No-rinse, self-etching bonding agents may provide less retention than the acid-etching technique* [69,127-130]	**B**
APPLICATION	Apply the minimum amount of sealant required to adequately cover the pit and fissure network Remove any air bubbles or voids before curing	**GPP**
	Clinical evidence on the use of bonding agent following acid-etching to enhance sealant retention is inconclusive and no recommendation on its use can be made at this time.	

	RECOMMENDATION	Grade of Recommendation
POLYMERISATION	Position the light-curing tip as close as possible to the surface being sealed and cure for at least the recommended curing time	**GPP**
	If more than one surface on a tooth is being sealed, e.g. occlusal and buccal/palatal, cure each surface separately	**GPP**
	Protocols for testing the light output and curing performance of light curing units should be implemented in accordance with the manufacturer's instructions[135,136]	**D**
	Manufacturer's instructions for sealant materials and for curing lights should be available in all dental surgeries	**GPP**
RETENTION	Sealant retention should be checked with a probe after application, and the sealant re-applied, if necessary, repeating each step of the application procedure	**GPP**
RECALL	Sealants should be checked when the patient is recalled, and repaired or replaced if necessary. The recall interval for high caries risk children should not exceed 12 months[60]	**D**
	If there is particular concern about sealant retention, recall within 6 months is appropriate[121]	**D**
INADEQUATE MOISTURE CONTROL	*Achieving good moisture control is one of the greatest challenges to successful sealant application. The circumstances influencing moisture control will vary from patient to patient, and a number of options for dealing with situations where moisture control is inadequate are presented.*	
	Where resin-based sealant is indicated and moisture control is difficult to achieve but patient co-operation allows, resin-based sealant should be attempted and reviewed within 6 months[101,121]	**D**
	Where resin-based sealant is indicated but adequate moisture control cannot be achieved, fluoride varnish containing at least 22,600 ppm F should be applied to pits and fissures at intervals of 3–6 months until isolation can be achieved[92,138]	**B**
	Glass ionomer cement may be considered on a case by case basis as an interim preventive measure when there are indications for placement of a resin-based sealant but concerns about moisture control may compromise such placement[30,33]	**D**

Fissure Sealant Cycle

The use of pit and fissure sealants for high caries risk individuals or groups should form part of an overall caries preventive programme, which includes advice on home care, with a focus on twice-daily tooth brushing with fluoride toothpaste containing at least 1,000 ppm fluoride and appropriate dietary advice. Maintenance of fissure sealants is important to ensure their continued effectiveness, and sealant integrity can be assessed at recall. It is recommended that the recall interval for high caries risk children should not exceed 12 months.[60]



* Concerned that demineralisation may extend into dentine

1. Introduction

While levels of tooth decay (dental caries) in children and adolescents have declined in many parts of the world in recent decades, caries remains a public health problem in many countries.[2] Oral health data for Irish children show that 22% of 8-year-olds, over 50% of 12-year-olds and approximately 75% of 15-year-olds have experienced decay in their permanent teeth.[3]

The back (molar) teeth account for most of the decay experience in the primary[4-6] and permanent teeth[7,8] of children and adolescents. Among Irish children, almost all (97%) of the decay in permanent teeth of 8-year-olds occurs in the first permanent molars, while the first and second molars together account for 85% and 79% of the decay experienced by 12- and 15-year-olds respectively.[9]

The molar teeth have many grooves (fissures) and pits on the chewing (occlusal) surface and on the buccal and palatal surfaces, which can be very difficult to keep clean. These are the sites most susceptible to developing decay[6,7] (Figure 1.1).

Figure 1.1: Diagram of pits and fissures on a molar tooth

Pit and fissure sealants are materials that are applied to the pits and fissure surfaces of teeth to create a thin barrier which protects the sealed surface from decay. Fissure sealant materials fall into two broad categories: resin-based sealants and glass ionomer sealants. Resin-based sealants are based on acrylic (methacrylate), may or may not contain filler particles or fluoride, and the setting reaction can be automatic (auto-polymerised) or light activated (light-polymerised). Low-viscosity resin-based restorative materials (flowable composites) have also been used as fissure sealants.[10-14] Glass ionomer sealants have evolved from glass ionomer cements, which can adhere directly to tooth substance.[15] Glass ionomer materials release fluoride over time and have the advantage of being less sensitive to moisture contamination than resin-based materials, making them a potential alternative to resin-based sealants when moisture control is an issue.[16] Hybrid materials which incorporate features of both resin and glass ionomer, e.g. polyacid-modified resins (compomers) and resin-modified glass ionomers, have also been developed and used as pit and fissure sealants.

1.1 Pit and fissure sealants and the Irish public dental service

One of the core functions of the Irish public dental service is to provide state-funded dental services to children and adolescents under the age of 16. The provision of fissure sealants by the public dental service has been strongly advocated in a number of reports.[17-20] Fissure sealants have subsequently become the key caries-preventive strategy of the public dental service, and are an important element

in services for children with special care needs. The strong focus placed on fissure sealants by the public dental service is reflected in the high prevalence of fissure sealants among 8-, 12- and 15-year-olds in the Republic of Ireland[3] which is substantially higher than in the UK[7] (47%, 70% and 69% compared to 13%, 25% and 30% in each age group respectively).

However, in spite of the widespread use of fissure sealants by the public dental service, sealants may not be targeted effectively at those who need them most. A social gradient in the prevalence of sealants exists, with fewer children who are disadvantaged having at least one sealed tooth compared to children who are not disadvantaged.[3,21] The prevalence of sealants is also lower among children attending special schools compared to their counterparts in mainstream schools.[22,23]

There is also considerable geographic variation in the prevalence of sealants across Ireland (range 45–71% for 12-year-olds),[3] but it is unclear if this difference is due to variation in caries levels, staff levels or skill mix in different parts of the country, or differences in sealant programme policies, which have been found to vary between dental areas.[24]

Evaluation of the effectiveness of fissure sealants applied by the public dental service is limited. One survey conducted in Meath found that, approximately two years after application, sealant retention rates compared favourably to international studies, with 56% completely retained, 27% partly retained and 12% missing. In the same study, caries experience on previously sealed teeth was low (2.9%). Children who had all four first permanent molars sealed had significantly less caries compared to children who had no first molars sealed (mean DMFT 0.33 vs. 0.7, $p<0.0001$).[25]

Historically, the public dental service has focused on providing dental services to children in selected primary school classes – usually 1st or 2nd class (age 7–8) and 6th class (age 12) – to maximise the potential for sealing the first and second permanent molar teeth.[18] However, a survey of 3,310 children in Junior Infants class (age 5) found that 19% of children already had at least one first permanent molar present.[26] National data show that in 2nd class (age 8), which is commonly selected because most of the first permanent molars will be sufficiently erupted to be sealed, 96% of children had all four of their first permanent molars but 22% had already experienced decay in at least one of these teeth.[27] A report from 2005 on fissure sealants and the targeting of dental services in the Irish public dental service, which was commissioned by the Department of Health and Children, demonstrated the wide age range for permanent molar emergence among Irish children – from age 4.5 to 8 years for the first permanent molar and from age 9.4 to 13.5 years for the second permanent molar. The authors of the report concluded that the current system of targeting specific classes was not in line with evidence and, for an efficient sealant strategy, 2 or 3 classes would need to be targeted around the time of eruption of both the 1st and 2nd molar teeth.[28]

The development of an evidence-based clinical practice guideline on the use of fissure sealants should improve the effectiveness and efficiency of the use of fissure sealants, as part of public dental service programmes and for individual patient care.

2. Methodology

The development of this guideline was based on the ADAPTE process, which provides a systematic framework for adapting high-quality guidelines produced in one cultural and organisational setting, for use in a different setting. The ADAPTE process respects the evidence-based principles of guideline development, which includes reliable and consistent methodology and involvement of key stakeholders. Explicit consideration is given to the context for the adapted guideline, to ensure relevance to local practices and policies. Further information about ADAPTE is available at http://www.adapte.org/.

For this guideline, a multi-disciplinary Guideline Group was established, representing key stakeholders in the guideline (Appendix 2). Stakeholders who were not represented on the Guideline Group were invited to contribute comments on the draft scope and key questions (Appendix 3) for the guideline and on the draft guideline.

A search for relevant guidelines published in the last ten years was conducted by the research team in websites of various guideline development organisations, guideline repository websites and in PubMed and Google. Full details of the sites searched are available in a supplementary document available at http://ohsrc.ucc.ie/html/guidelines.html.

Seven potentially suitable guidelines were identified and appraised using the AGREE instrument.[29] The Guideline Group considered the currency, rigour of development and extent to which the key questions for this guideline were addressed by each of the potential source guidelines, before selecting three guidelines as the source guidelines. Each of the three source guidelines provided different perspectives on sealant use, and together addressed most of the key questions for this guideline. The source guidelines were:

- *Evidence-based clinical recommendations for the use of pit-and-fissure sealant*[30] (American Dental Association Council on Scientific Affairs)
- *Preventing dental caries through school-based sealant programs: updated recommendations and reviews of evidence*[31] (Centers for Disease Control and Prevention).
- *Assessment of caries risk and indications for pit and fissure sealants (first and second molars) in children and in adolescents under 18*[32] (Haute Autorité de Santé) [Short version in English and full version in French]

The Group agreed to keep a fourth guideline from the European Academy of Paediatric Dentistry – *EAPD guidelines for the use of fissure sealants*[33] – as a 'satellite' guideline, due to the clarity of presentation of the recommendations.

The research team also searched for systematic reviews, clinical trials and economic evaluations, published between 2004 and February 2010, that might be used to update the source guidelines. A separate search of the literature was conducted for systematic and narrative reviews of caries detection methods and for reports of adverse effects associated with the use of pit and fissure

sealants. At least one reviewer critically appraised the evidence supporting the recommendations in the source guidelines and the new systematic reviews and trials retrieved in our update search. Summaries of the source guideline recommendations, evidence statements and new evidence were presented to the Guideline Group at two meetings, with further discussions held by conference call. After consideration of the evidence and recommendations in light of the Irish context, the Guideline Group adapted or adopted the recommendations from the source guidelines, through discussion and informal consensus. Where a specific key question was not addressed by any of the source guidelines, the Group used informal consensus to formulate a new recommendation based on the evidence presented at the Guideline Group meetings. Grading of recommendations was based on the criteria of the Scottish Intercollegiate Guideline Network (SIGN). A full description of the guideline development process, including the search strategies for each database and the dates covered by the searches can be found as a supplementary document at http://ohsrc.ucc.ie/html/guidelines.html.

The consultation draft of the guideline was reviewed by key stakeholders and by six international reviewers (Appendix 2). The Group held their final meeting in August 2010 to agree the final content of the guideline.

3. How effective are fissure sealants at preventing caries?

Resin-based fissure sealants are effective at preventing caries on pit and fissure surfaces in children and adolescents. A Cochrane systematic review of 16 trials found that first permanent molar teeth sealed with resin-based sealant had 78% less caries on occlusal surfaces after 2 years and 60% less after 4–4.5 years compared to unsealed molars.[34] **1++**

Sealant retention is critical to the effectiveness of resin-based sealants and retention has become an important 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.[34] There was a clear trend for decreasing sealant retention with time.

Another systematic review on sealant effectiveness found that the caries-preventive effect of sealants was influenced by sealant replacement, with relatively high reductions in caries risk found in those studies in which a sealant replacement strategy had been used.[35] **1+**

The effectiveness of school-based and school-linked fissure sealant delivery programmes at reducing caries in pits and fissures of children's teeth was reported in a systematic review of 10 studies of various designs, including 3 randomised trials.[36] The pooled median reduction in caries experience was 60% (range 5% to 93%) for children receiving sealants as part of a school sealant programme compared to children who did not receive sealants. All of the included studies used resin-based sealant. **2+**

While there is strong evidence for the caries-preventive effect of resin-based sealant, the evidence for the effectiveness of glass ionomer as a sealant material is less clear. Only one study which compared glass ionomer sealant with no treatment was included in the Cochrane review. The results of this

study showed a significant reduction in occlusal caries increment after 24 months for children aged 7–8 years who had their first permanent molars sealed with glass ionomer compared to children who had not received sealant. However, for children aged 12–13, no significant difference in caries increment was found between the sealed and non-sealed groups.[37] **2+**

The evidence for the relative caries-preventive effect of resin-based and glass-ionomer sealants is conflicting. Of the eight trials included in the Cochrane systematic review[34] which compared the two materials, three trials found that resin-based sealants were superior,[37-39] two trials found that glass ionomer was better,[40,41] and three trials did not find any difference between the two materials.[42-44] Comparison of retention rates of the two materials yielded similarly divergent results. The Cochrane review also included two trials that compared resin-based sealant with compomer (poly-acid modified composite resin), which found no difference in effect for caries prevention but conflicting findings for retention.[45,46] The review authors concluded that more research is needed to clarify the relative effectiveness of different sealant materials.

Three subsequent systematic reviews which compared the caries-preventive effect of glass ionomer or resin-modified glass ionomer sealants with resin-based sealant also found inconsistent results among the included studies.[16,47,48] **1-**

Clinical trials comparing the two sealant materials published since these reviews are of varying quality and also provide conflicting results for the relative effectiveness of glass ionomer and resin-based sealants.[11,49,50] **1+, 1+, 1-**

Few studies have looked at the effectiveness of pit and fissure sealants at preventing caries in the young primary dentition. One randomised split-mouth trial involving children aged 3–4 years reported complete retention of resin-based sealant in over 70% of primary molars after two years.[51] Another split mouth trial involving children aged 4–7 years reported complete sealant retention in primary molars of 77.5% with resin-based sealant and 95% with flowable composite after one year.[10] **1+**

Retention of glass ionomer sealant on primary teeth in young children tends to be poorer than that reported for resin-based sealant.[52,53] **1+**

Recommendation

➢ ***Resin-based sealants are the first choice of material for dental sealants***	**A**

4. Who should get sealants?

The Cochrane systematic review concluded that the effectiveness of sealants was obvious for children at high caries risk, but that information was lacking on the benefits of sealing for different levels of caries risk.[34] **1++**

In Ireland, the factors associated with higher caries levels in children and adolescents include disadvantaged status (as measured by parental medical card ownership), lifetime exposure to non-fluoridated water, toothbrushing less than twice a day and snacking on sugary foods or drinks more than twice a day.[3] For the purpose of this guideline, the term 'high caries risk' refers to individuals or groups who are at risk of developing high levels of 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. Formal risk assessment to guide treatment planning decisions and recall intervals for individual patients is advocated by numerous international experts or organisations.[54-59] **4**

A Caries Risk Assessment Checklist (CRAC) has been developed by the Irish Oral Health Services Guideline Initiative[60] to encourage a formal, risk-based approach to the management of caries in Irish children. The Checklist takes into account the factors that might put the patient at high caries risk (i.e. previous caries experience, dietary habits, tooth morphology, deprivation (measured by medical card status) and medical and other conditions), together with the factors that might reduce a patient's caries risk (e.g. adequate exposure to fluorides, presence of fissure sealants). However, caries risk assessment remains an imprecise measure and an individual's caries risk status can change over time, which is why caries risk assessment must be repeated on an ongoing basis. Further details on the development of the Caries Risk Assessment Checklist can be found in the full version of the guideline *Strategies to prevent dental caries in children and adolescents*[60] available at http://ohsrc.ucc.ie/html/guidelines.html. The Caries Risk Assessment Checklist and accompanying notes can be found in Appendix 1.

It is important to note that individual caries risk assessment is considered practical only where the proportion of high caries risk individuals in a given population is 30–40% of that population. If the proportion of high-risk individuals is closer to 50% or more, preventive efforts should be directed to the whole of that particular population.[61,62] This directed population approach,[63] also known as geographic targeting,[64] is proposed as a more efficient way of providing preventive services to high caries risk communities and should supplement preventive approaches that are aimed at the entire population.[65] The targeted population approach uses socio-demographic or epidemiological data to identify high-risk subgroups or geographic areas that would benefit from preventive interventions. **4**

The Guideline Group agreed that there are specific subgroups, including, but not limited to, special schools or designated disadvantaged (DEIS) schools, where most of the children could be considered high caries risk. In this situation, a targeted population approach was advocated, whereby fissure sealants would be offered to all children in a given population subgroup as part of a comprehensive caries prevention programme (See Appendix 4).

The decline in caries levels among children and adolescents has meant that more children reach adulthood with fewer decayed and restored teeth. Several studies have suggested that the occlusal surface of posterior teeth remains susceptible to caries into adulthood and that sealants could play a role in caries prevention in adults.[66,67] **2+**

Currently, the evidence for the effectiveness of fissure sealants at preventing caries in adults is limited and of variable quality.[68-70] However, it is not unreasonable to extrapolate the results for children and adolescents to adults.

Recommendation

➢ ***Children and adolescents who are assessed as being at high caries risk should have resin-based fissure sealant applied and maintained in pits and fissures of permanent teeth***	**A**
➢ ***Adults who are assessed as being at high caries risk should have resin-based fissure sealant applied and maintained in pits and fissures of permanent teeth***	**B**
➢ ***In the public dental service, a targeted population sealant programme should be considered for all individuals in specific high-caries risk groups such as children attending special schools or designated disadvantaged schools***	**D**

5. Which teeth should be sealed?

The first and second permanent molar teeth account for 80% or more of the total caries experience in permanent teeth of Irish children, making these teeth the most important for sealant application.[9] **3**

Other teeth, such as premolars, third molars or the palatal surfaces of incisor teeth, may be considered for sealant application, based on the dentist's overall assessment of the individual's caries risk status and a thorough assessment of the tooth surface.

Although primary molars account for most of the decay in primary teeth of young Irish children[71] and resin-based sealants are retained well on primary molars,[10,51] pit and fissure surfaces contribute only 40% of the total caries experience in primary teeth.[3] Therefore, the impact of fissure sealants alone on reducing caries is likely to be less for primary teeth than for permanent teeth. **3**

However, for some children, such as those with medical or other conditions where the development of caries or its treatment could put the child's general health at risk, sealing primary molar teeth should be considered as part of a comprehensive caries-preventive programme.[33,72] **4**

Recommendation

➢ ***In children and adolescents, priority should be given to sealing first and second permanent molar teeth***	**D**
➢ ***Routine application of sealants on primary molar teeth is not recommended, but may be considered for selected high caries risk children***	**D**

5.1. Pit and fissure sealants for managing caries

There is limited but consistent evidence that sealants applied to pit and fissure surfaces with non-cavitated caries lesions can prevent lesion progression provided the sealant remains intact. A systematic review by Griffin et al.[73] of the effectiveness of dental sealants at preventing the progression of caries in the pits and fissures of permanent teeth found that sealing non-cavitated carious lesions reduced the percentage of lesions that progressed by 71% up to five years after placement. The effect was consistent in size and direction across the six included studies. **1++**

A review by Bader and Shugars[74] identified seven studies (two of which were included in the Griffin review) where sealants were placed over early non-cavitated enamel surfaces. The findings of these studies also indicated low rates of caries progression over periods of one to five years. **3**

Oong et al.[75] systematically reviewed the evidence for the effectiveness of fissure sealant in stabilising or reducing bacteria levels in caries lesions and found no significant increase in total bacteria under sealed cavitated caries lesions. Placement of fissure sealants over caries reduced the mean number of viable bacteria at the last follow-up by 100 to 1,000 fold. On average, 47% of sealed lesions had viable bacteria compared with 89% of unsealed lesions, two weeks to five years after placement. **1+**

The Guideline Group agreed to use the term 'demineralisation that appears confined to enamel' to indicate when sealant can be used for the management of caries. This avoids confusion over the term 'non-cavitated lesion', which refers to the integrity of the enamel surface and not to lesion depth. The Group agreed however, that the definition for non-cavitated carious lesions used in the American Dental Association guideline on fissure sealants clearly described the circumstances in which sealants could be used for managing caries: *"Pits and fissures in fully erupted teeth that may display discolouration not due to extrinsic staining, developmental opacities or fluorosis. The discoloration may be confined to the size of a pit or fissure or extend to the cusp inclines surrounding a pit or fissure. The tooth surface should have no evidence of a shadow indicating dentinal caries, and if radiographs are available, they should be evaluated to determine that neither the occlusal nor proximal surfaces have signs of dentinal caries*."[30] Because the Guideline Group opted not to use the term 'non-cavitated', it is important to note that there should be no localised enamel breakdown on surfaces with 'demineralisation that appears confined to enamel'.

Recommendation

➢ ***When indicated, sealant should be applied to pit and fissure surfaces that are sound or that have demineralisation that appears confined to enamel***	**B**

6. How should teeth be assessed for sealant?

Visual dental examination is the starting point for dental assessment and treatment planning. The assessment of occlusal surfaces is particularly challenging, due to their complex morphology. The basic prerequisites for visual caries detection are clean, dry teeth and good illumination.[76,77] **4**

A systematic review of the accuracy of various caries-detection methods found that visual methods for detecting enamel or dentine lesions on occlusal surfaces tend to be more accurate at detecting surfaces *without* caries (specificity) rather than surfaces *with* caries (sensitivity).[78] Visual assessment using a probe also had high specificity and low sensitivity, which suggests that the use of a probe does not improve the accuracy of detection of occlusal dentine lesions. Additionally, the use of a sharp probe has been shown to cause irreversible traumatic defects in demineralised areas in occlusal fissures, favouring conditions for isolated lesion progression.[79-81] **3**

The difficulty in detecting and correctly assessing occlusal caries by visual examination alone has led to the development of various caries detection methods to refine the diagnostic process, and to enhance the identification of early lesions. These methods include dental radiography, light-based technologies e.g. fibre-optic transillumination, quantitative laser fluorescence (DIAGNOdent) or light-induced fluorescence (QLF) and methods based on electrical current.

Dental radiography is the most widely used adjunct to visual caries detection, but has poor sensitivity when it comes to assessing early occlusal enamel or dentine lesions.[78] This means that it is more likely to incorrectly assess an occlusal surface as sound when there is an early carious lesion present. Its use solely for the purpose of placing sealants is not recommended.[30,31] **4**

The systematic review of the performance of the various caries detection methods mentioned above was unable to draw any conclusions about the relative accuracy of any of these methods, due to the poor quality of the studies available.[78] A subsequent systematic review of the performance of laser fluorescence (DIAGNOdent)[82] found that it was more sensitive than visual assessment at detecting occlusal dentinal caries, but it was less specific. This meant that it was more likely to incorrectly assess a surface as being carious when it was sound. In populations with a generally low level of caries, high specificity is preferred, as it reduces the probability that sound teeth will be restored unnecessarily.[83] There is some evidence from an observational study that the use of multiple caries detection tools can increase the frequency of inappropriate operative intervention.[84] Therefore it is generally accepted that caries detection technologies should be used judiciously as adjuncts to visual examination.[82,85-87] **3**

Given the importance of the visual examination, a system for detailed visual examination of teeth – the International Caries Detection and Assessment System (ICDAS) – has been developed, which promotes the recording of the earliest changes in enamel as well as dentinal caries.[88] ICDAS has shown good association between the scores for caries in enamel and dentine and histological measurement.[77,88] ICDAS also includes a method for measuring lesion activity, since this is an important factor in deciding the type of treatment a carious lesion requires. A description of ICDAS scores for pit and fissure surfaces can be found in Appendix 5. **4**

The Guideline Group agreed that careful visual assessment of the tooth was appropriate for assessing the need for sealants, and also that existing radiographs, if recent, should be consulted before sealant application. Additional caries detection tools should only be considered when there is concern that caries might extend into dentine.

Recommendation

➢ ***Teeth should be clean, dry and well-illuminated for visual assessment***	**D**
➢ ***A probe should not be used to explore pits or fissures*** *Forceful use of a probe can damage tooth surfaces*	**D**
➢ ***Radiographs should not be taken for the sole purpose of placing sealants***	**D**
➢ ***Other diagnostic technologies are not necessary for the sole purpose of placing sealants***	**D**

6.1. The suspicious lesion

The extension of caries into dentine is generally considered to be the threshold for operative intervention. However, accurate determination of the depth of a lesion, particularly on occlusal surfaces can be difficult. When the dentist is faced with a 'suspicious' lesion, i.e. the lesion may or may not extend into dentine, the assessment of the tooth status, and therefore the treatment options, is particularly challenging. The review by Bader and Shugars[74] identified only three papers in which the accuracy of clinicians at correctly assessing 'suspicious' lesions was measured. Although the studies differed in their criteria of what constituted a suspicious area and in their method of validation, their findings pointed in the same direction: the proportion of suspicious areas that actually involved dentine was 41%, 44% and 51%. This suggests that when dentists consider an area suspicious, the likelihood of caries extending into dentine is about 50/50. **3**

The evidence for the effectiveness of different management strategies for suspicious lesions is weak. Bader and Shugars[74] considered four treatment strategies for dealing with the suspicious lesion: (a) do nothing and monitor; (b) apply fissure sealant; (c) apply fluorides or antimicrobials; (d) operative treatment. Of the three non-operative options considered, only the use of pit and fissure sealants showed evidence of slowing or halting lesion progression, provided the sealant remained intact. No conclusion could be reached from the evidence on monitoring suspicious lesions, due to the small number of studies, most of which were old, and the wide variation in estimates of lesion progression which ranged from 16% to 77%. No studies on the effectiveness of fluorides or antimicrobials specifically for treating suspicious lesions were identified. **3**

Some evidence has subsequently emerged on the potential of silver diamine fluoride solution to prevent or arrest caries lesions in primary[89-91] and permanent teeth,[91] but further studies are required to determine if this fluoride modality has a role in caries prevention in Europe. The use of chlorhexidine is not recommended for caries prevention.[60]

The Guideline Group strongly advocated a non-operative approach to the management of suspicious lesions, particularly when the status of the tooth remains uncertain after additional diagnostic tests have been performed. In these circumstances, the Guideline Group favoured the use of pit and fissure sealant, and emphasised the importance of follow-up as outlined in the Fissure Sealant Cycle (page 6). Although evidence was lacking for the effectiveness of fluoride varnish at managing suspicious lesions, given the evidence for its effectiveness at preventing caries,[92] the Guideline Group considered that no harm would come from the application of fluoride varnish to a suspicious lesion. Therefore, provided there is follow-up, fluoride varnish was suggested as an alternative non-operative option for managing the suspicious lesion.

7. Are teeth that have lost sealant or have partially retained sealant at higher risk of caries than teeth that were never sealed?

One of the perceived concerns about the use of pit and fissure sealants is that partial loss of sealant may leave the tooth at increased risk of developing caries. This issue was of particular concern for school-based sealant programmes in the United States, which are targeted at children from low-income families who are unlikely to have access to regular dental care. Best practice for school-based sealant programmes in the US includes re-examination of children within one year of sealant placement to check and repair sealant.[93] However, because of the high mobility of the target population, follow-up for sealant maintenance is not always possible. A meta-analysis of seven split-mouth randomised controlled trials published between 1976 and 1984 was undertaken to compare the caries risk of teeth with partial or complete loss of sealant (formerly sealed teeth) with that of teeth that were never sealed. The results indicated that teeth with fully or partially lost sealant are not at higher risk of developing caries than teeth that were never sealed.[94] **1+**

The implications of this meta-analysis are two-fold: firstly, in the context of a school-based sealant programme, the findings suggest a child should not be deprived of the benefits of a sealant even when follow-up care cannot be ensured. Secondly, given that formerly sealed teeth are not at higher risk of developing caries than teeth that were never sealed, in order to reduce the possibility of formerly sealed teeth returning to their original risk status, sealants need to be maintained. This is particularly true for children who have sealants applied to teeth with demineralised enamel or suspicious lesions.

8. When should sealants be applied?

Prospective European studies of tooth emergence have shown consistent mean/median ages of emergence for first permanent molars (6.0–6.3 years for girls and 6.3–6.5 years for boys) and second permanent molars (11.5–12.3 years for girls and 11.8–12.4 for boys).[95-99] The age range for permanent molar emergence is wide: from age 5 to 8 for first permanent molars and from age 9 to 15 for second permanent molars,[95-99] which highlights the considerable individual variation in the timing of permanent molar emergence. It is important to note that most tooth emergence studies do not record the stage of eruption of the tooth, but only whether any part of the tooth is visible in the mouth.

Only one study[97] measured the duration of eruption, i.e. time from first appearance of some part of the tooth to functional occlusion (firm contact). The average duration of eruption was approximately 15 months (range 5–32 months) for first permanent molars and 27 months (range 9–45 months) for second permanent molars. This enormous variation in duration of eruption is important when it comes to the timing of sealant application: molar teeth are vulnerable to developing caries during the eruption phase due to favourable conditions for plaque accumulation,[100] but the stage of eruption can adversely affect sealant retention.[101] A prospective study in which sealant was applied to first or second molar teeth at varying stages of eruption found that after three years, more than half (54%) of the teeth that were sealed when an operculum covered the marginal ridge required retreatment, compared to one quarter (26%) of teeth sealed when the gingival tissue was level with the distal marginal ridge. None of the sealants placed on teeth where the distal marginal ridge was above gingival level required retreatment.[101] **3**

Recommendation

➢ ***When indicated, sealants should be applied as soon as the tooth is sufficiently erupted to be isolated.***	**D**

The public dental service has historically prioritised the treatment of permanent molar teeth. In line with the recommendations of several reports, [17-19] the public dental service has focused on offering dental assessments to children in selected classes in primary school, when most children are likely to have newly erupted first or second permanent molar teeth. The most frequently selected classes are 1st or 2nd class (age 7–8) for first permanent molars and 6th class (age 12) for second permanent molars. In 2nd class, nearly all children (96%) have their four first permanent molars present, but one child in five (22%) will already have experienced decay in at least one of these teeth.[27] This suggests that selecting 2nd class for sealant application may be too late. Selecting 6th class for sealant application to second permanent molars is also problematic, due to the wide age range for eruption of these teeth. Although two thirds (65%) of children in 6th class have at least one second permanent molar, only around one third (38%) have all four of their second permanent molars present. Worryingly, almost one out of ten children in 6th class have experienced caries in a second permanent molar.[27]

The selection of specific classes for providing fissure sealants is easy to administer. However, the variable emergence times for molar teeth, coupled with the age range of children within individual classes (most children in Ireland start primary school between age 4 and 5 years, but legally do not have to start school until age 6), means that selecting a single class for a once-off dental assessment is unlikely to identify all children who could benefit from the timely application of fissure sealant. An earlier guideline for the public dental service recommended a dental assessment for children during their first year in primary school to allow early identification and follow-up of high caries risk individuals.[60] Implementation of this recommendation could facilitate timely application of sealant for high caries risk children.

Where early identification of high caries risk individuals is not feasible, consideration should be given to assessing children at approximately 7 years of age (1st class), with follow-up at age 8 (2nd class). This would ensure that all children have their first permanent molars assessed and sealed if indicated, and would allow the checking of sealant integrity for those who had molars sealed the previous year. For second permanent molars, children in 6th class should be assessed and high caries risk individuals followed-up up to age 13 and possibly 14 to ensure that all second permanent molars are assessed for sealant. As noted in section 7, inability to provide follow-up to check sealant retention should not exclude a child who would benefit from pit and fissure sealants from receiving them.

Due to the slower progression of dental caries, the occlusal surface remains at risk throughout childhood and adolescence and even into early adulthood.[66,67] Thus, there is no post-eruptive time limit on the placement of sealants, if indicated.

9. Cost-effectiveness of fissure sealants

In the context of the Irish public dental service, where the interval between dental assessment often exceeds two years, one of the key questions for this guideline concerned the cost-effectiveness of providing pit and fissure sealants to all children ('seal all' approach) or only to those at high caries risk ('risk-based' approach).

A systematic review of the cost-effectiveness of fissure sealants undertaken for the Haute Autorité de Santé guideline on fissure sealants[32] analysed 13 economic studies from the United States, Canada and Australia. Taking into account differences in study design and analysis, the limitations of the evidence and of transposing findings from different health systems, the overall conclusions were:

- Sealing the first permanent molars was cost-effective for children with high caries risk
- Data were contradictory when the population was not selected on any risk basis
- For children with low caries risk, cost-effectiveness was not shown in the medium term, and long-term data were lacking
- Follow up after several years was needed to see an effect
- The available evidence did not allow the cost-effectiveness of fissure sealants to be assessed for France.

Another systematic review which included only economic studies of school-based or school-linked sealant programmes estimated that a programme sealing first permanent molars would be cost saving if these molars were decaying at an average rate greater than 0.47 surfaces per year.[36] The authors suggested that decision makers could compare this threshold to caries levels in their area, whilst admitting that *"almost no data exist on annual caries increment by type of surface"*.

Two economic analyses compared the cost of three different sealant delivery strategies: 'seal all', 'risk-based' and 'seal none'.[102,103] Both studies found that, under baseline assumptions, the 'risk-based' approach was the most cost-effective strategy over a simulated 9 or 10 year period. The 'seal all' approach was the most effective, but also the most costly strategy. Although both studies used

published literature to inform their baseline assumptions, their methodologies differed considerably, which may have contributed to the very different costs reported for moving from a 'risk-based' to a 'seal all' strategy: $73.96 per saved tooth surface in the study by Griffin et al.[102] and $0.96 for every year a cavity was delayed in the study by Quinonez.[103] However, the sensitivity of the results of both studies to changes in the baseline and other assumptions reflects the uncertainty of these estimates.

A third study from Finland compared treatment costs over approximately six years for children who received dental treatment in two communities – one with a 'seal all' policy and the other with a 'risk-based' sealant policy.[104] The treatment provided was obtained from patient documents and the costs per child (including sealant) were calculated using the private dental health care fee schedule used in Finland. Costs per child were 21% higher in the 'seal all' area (€234.30) compared to the 'risk-based' area (€184.20), due mainly to the higher costs for restorative treatment required by children who had not attended for sealant in the 'seal all' area. However, there may have been fundamental differences in the caries profile and risk status of the 'non-sealed' children in the two areas: in the 'seal all' area, children without sealant were non-attenders, which would suggest that they were likely to have greater treatment needs when they did attend; in the 'risk-based' areas, children without sealant were assessed as low risk. Differences in background preventive programmes and caries levels between the two communities could also have biased the results of this study.

Only one cost-utility analysis of fissure sealants has been published. This retrospective cohort study of 2,132 children continuously enrolled in the Iowa Medicaid programme over a 4-year period found that while the cost of treatment associated with sealed first permanent molars was higher than that for unsealed teeth, the utility was also slightly higher. Sealing first permanent molars in low utilisers of dental services (i.e. children with one preventive visit or less per year) was found to be the most cost-effective approach for prioritising resources.[105]

The applicability of economic analyses from other countries, which are based on assumptions that may not pertain to the Irish context, is limited. The only Irish cost data on providing fissure sealants in the public dental service comes from a thesis by O'Connor, which found that the labour cost per sealant was lower when the sealant was applied by a dental hygienist rather than a dentist.[106] When updated to January 2010 salary scales, the cost per sealant was €3.66 for a dentist/dental nurse team and €2.58 for a dental hygienist/dental nurse team, a cost difference of 30%. In a public dental service, increased deployment of dental hygienists would be an efficient way to ensure provision of fissure sealants to children who need them, both in terms of direct labour cost, and the opportunity gain in 'freeing up' the more expensive clinical time of dentists.

Lack of data on other factors influencing the cost-effectiveness of providing pit and fissure sealants within the public dental service, such as caries increment on first permanent molars, rate of sealant loss and replacement, cost of assessing children for a risk-based programme, cost of restoration (tooth coloured and amalgam), and the value of a sound tooth versus a restored tooth, indicate that primary economic evaluation of sealant delivery in the public dental service is required. Such evaluation should take into account the cost of early identification of high caries risk children and subsequent recall until their permanent molars are sufficiently erupted to be sealed, and should also

consider the cost-effectiveness of outreach programmes, such as the use of mobile units, to facilitate the provision of sealants to low utilisers of dental services.

10. Are pit and fissure sealants safe?

Concerns have been expressed about potential exposure to Bisphenol A (BPA) from resin-based restorative materials, including fissure sealants. BPA has been described as being 'weakly oestrogenic', and while there is no direct evidence that exposure of humans to BPA adversely affects reproduction or development, studies with laboratory rodents have shown such effects.[107]

BPA is not an active ingredient in any dental sealant or composite, but derivatives of BPA used in dentistry include bis-glycidyl dimethacrylate (bis-GMA) and BPA-dimethyl acrylate (bis-DMA). BPA may be present as an impurity in these substances, or may be formed as a result of degradation of bis-DMA. Most sealants contain only bis-GMA.[107]

Research on human subjects which measured the level of BPA in saliva following the application of fissure sealant or composite have found increases in salivary BPA within one hour of placement.[108-112] No BPA was found in 24 hour saliva or serum samples in one study,[110] but a more recent study by Joskow et al.[112] detected an increase in BPA levels in urine at 24 hours. The BPA levels in urine were significantly different for the two fissure sealant products tested – 2.06 ng/mL for Helioseal F compared to 7.34 ng/mL for Delton LC. **3**

A systematic review which included 11 studies on possible harm or toxic effects of sealant concluded that patients are not at risk of exposure to BPA from the use of dental sealants, but recommended precautionary measures to reduce potential exposure to BPA from dental sealants which include: rinsing the surface of the cured material for 30 seconds with water while using effective suction; getting the patient to rinse for 30 seconds and spit out after the procedure; removing the surface residual monomer layer with pumice on a cotton pellet or a prophy cup.[113] A comprehensive review of the potential human reproductive and developmental effects of BPA estimated that approximately 99% of BPA exposure comes from diet and considered that exposure from dental sealants was an acute and infrequent event with little relevance to estimating general population exposures.[107] **3**

The Guideline Group concluded that pit and fissure sealants are a safe and effective method of preventing dental caries.

11. Application Technique

The application of pit and fissure sealant, while inherently simple, is very technique-sensitive, requiring attention to detail at all stages. There is very limited evidence on the best technique for each stage of the process.

11.1 Operator

Few studies have assessed the effectiveness of sealants placed by auxiliary dental operators or have directly compared the effectiveness of sealants placed by dentists with those placed by auxiliary

dental operators. A literature review for an economic evaluation of the use of dental hygienists in the fissure sealant programmes of the former Mid-Western Health Board public dental service identified 10 studies which allowed indirect comparison of the retention rates of sealants provided by different dental operators. There was little evidence that the effectiveness of sealants placed by auxiliaries was any different from those placed by dentists.[106] The cost analysis, however, showed that operator type impacted on costs: the cost per sealant was lower when a dental hygienist rather than a dentist was deployed. **3**

A subsequently published 10-year retrospective cohort study comparing the effectiveness of sealants placed by dentists, registered dental hygienists and registered dental assistants in a private dental practice in Minnesota found that the risk of sealant failure was significantly lower for sealants placed by registered dental hygienists compared to those placed by dentists or registered dental assistants. However, variation in sealant success rates within operator groups suggested that differences in sealant success may have been due to the individual operator rather than to the provider type.[114] **3**

11.1.1 Four-handed versus two-handed application technique

There are no studies that directly compare the effect of four-handed versus two-handed sealant delivery on sealant effectiveness or retention. Griffin et al.[115] conducted an indirect comparison of the effect of four- and two-handed delivery on sealant retention using data extracted from 11 studies where autopolymerised resin-based sealants were applied to the occlusal surfaces of first permanent molars using either a four-handed (8 studies) or two-handed (3 studies) technique. After controlling for years since placement, tooth-surface cleaning method prior to etching (handpiece or toothbrush), type of primary operator (dentist or non-dentist) and income level of the country, four-handed delivery increased sealant retention by a statistically significant nine percentage points. **3**

Recommendation

➢ ***When possible, a four-handed technique should be used for the placement of pit and fissure sealants***	**D**

11.2 Cleaning

The removal of plaque and debris is a critical step in the sealant application process, but few clinical studies have directly compared different cleaning methods.

A double-blind, split-mouth randomised trial showed no difference in sealant retention after 12 months when teeth were cleaned with pumice prophylaxis compared to when teeth were cleaned with a sharp probe and forceful washing from a three-in-one syringe prior to sealant application.[116] **1+**

A split mouth quasi-randomised trial which compared handpiece prophylaxis using fluoridated prophylaxis paste with dry toothbrushing (performed by the dentist on the selected side), also found no difference in sealant retention after 12 months.[117] In both studies, complete retention rates for each cleaning method were over 95%. **1+**

Indirect comparison of the effect of toothbrush or handpiece cleaning on sealant retention based on selected studies from four systematic reviews indicated that retention of sealants after a supervised toothbrush cleaning by the patient (with or without paste) was at least as high as those associated with traditional handpiece prophylaxis.[118] **3**

Air abrasion is a method for cleaning the tooth that uses a stream of aluminium oxide particles directed through a handpiece and powered by compressed air or nitrogen gas. There is limited evidence that cleaning teeth with pumice prophylaxis followed by air abrasion prior to acid etching improves sealant retention. A split-mouth randomised trial involving 16 participants aged 16–17 found that 91% of teeth cleaned with air abrasion had completely retained sealant after two years compared to 76.5% of teeth cleaned without air abrasion. Most of the teeth sealed in the trial (72%) were premolars.[119] **1+**

Given the limited evidence, the Guideline Group agreed that cleaning the tooth with a dry toothbrush or bristle brush in a slow handpiece was appropriate.

Recommendation

➢ ***Clean the tooth with a dry bristle brush in a slow handpiece or with a dry toothbrush Use of prophylaxis paste or pumice is not required***	**D**

11.3 Isolation

A systematic review of sealant retention[120] identified three split-mouth trials and one prospective observational study that evaluated the effect of tooth isolation using rubber dam or cotton wool rolls on sealant retention.[121-124] No difference in retention was found between the two methods of isolation for auto-polymerised sealants after 24 months.[121,123,124] **1+**

The one trial that evaluated retention of two light-polymerised, fluoride-containing sealants found that the retention rate after 12 months was significantly better for both materials with rubber dam isolation.[122] **1+**

Recommendation

➢ ***Isolate the tooth to be sealed with either a dental dam or cotton wool rolls/isolation shields combined with effective aspiration***	**B**

11.4 Enamel preparation

Acid etching with 35–37% phosphoric acid followed by rinsing and drying the tooth is the accepted method of preparing enamel prior to sealant application. However, several alternative methods of enamel preparation have been tested in an effort to improve retention, reduce the procedure time or both.

11.4.1 Mechanical preparation

Mechanical preparation of the fissure system using a bur at low speed has been shown to significantly increase retention of auto-polymerised sealants up to six years after placement.[125,126] A significant improvement in retention was seen in the maxillary molars (87% compared to 47% complete retention for test and control teeth respectively at 6 years, p<0.016). It was postulated that the mechanical preparation counteracted the tendency for the sealant material to flow distally on maxillary teeth. The difference in sealant retention between the test and control mandibular molars was not statistically significant (89% compared to 79%, p>0.33). **1+**

Given the limited evidence, the fact that the flow of sealant distally is not as much of a concern with light-polymerised materials, and the preference of the Guideline Group to avoid unnecessary operative intervention particularly in young molar teeth, the Guideline Group did not recommend mechanical preparation of enamel prior to sealant application.

Recommendation

➢ ***Mechanical preparation of enamel before placing a fissure sealant is not recommended***	**D**

11.4.2 Self-etch vs. acid etch

Self-etch adhesive systems which require no rinsing have been tested as an alternative to acid etching prior to sealant application, with conflicting results. One split-mouth randomised trial involving children aged 7–13 (18 pairs of permanent molars) found no difference in retention after two years between teeth prepared using acid etch and those prepared using a self-etch adhesive system.[127] In both groups, the complete sealant retention rate was 61%. **1+**

A retrospective cohort study found that children who had sealants placed in a school-based sealant programme using a self-etch adhesive system were six times more likely to have experienced a sealant failure compared to those who had their teeth sealed using the acid etch technique (OR 5.97, 95% CI: 2.39–14.86, p<0.0001).[128] **3**

A split mouth randomised trial which compared two different methods for curing resin-based sealant applied with a no-rinse, self-etch adhesive in children aged 5–8 reported complete retention of just 45% twelve months after placement for both methods of curing.[129] **1+**

Two additional trials were identified that compared sealant retention using a self-etch adhesive system with retention using an acid-etch technique plus adhesive. Both of these studies found that sealant retention was better in the acid-etch plus adhesive group.[69,130]

1+

➢ ***Use of no-rinse, self-etching bonding agents instead of acid etching prior to sealant application is not recommended*** *No-rinse, self etching bonding agents may provide less retention than the acid-etching technique*	**B**

11.4.3 Acid etch vs. acid etch plus adhesive

The use of an adhesive following phosphoric acid etching has been suggested as a method to improve sealant retention, particularly where isolation may be difficult.[30] However, the evidence from clinical trials is inconsistent. One randomised split-mouth trial showed significantly better sealant survival when a one-bottle adhesive system was used following acid etching of newly erupted permanent molars.[131] Two split-mouth randomised trials found no statistically significant difference in retention after 24 months, with or without adhesive.[132,133] Differences in outcome measure (time to survival compared to sealant retention) prevented combination of the results of these three trials in a meta-analysis. The authors of one of the trials suggested that the adhesive system they used might not have been compatible with the resin-based sealant and may have led to no difference being found but concluded that, when a proper technique is used in sealant placement, use of an adhesive system does not enhance sealant retention.[132] **1+**

The use of an adhesive system following acid etching may improve long-term sealant retention in mildly hypomineralised first permanent molars i.e. molars with occlusal demarcations but no disintegration. One split mouth randomised trial found that after 4 years, 70.2% of hypomineralised molars that had been acid etched, and had adhesive applied were completely sealed compared to just 25.5% of the teeth that were acid etched and had sealant applied without adhesive ($p<0.001$). In both groups, the fissures had been mechanically cleaned using a bur.[134] **1+**

➢ ***Clinical evidence on the use of bonding agent following acid-etching to enhance sealant retention is inconclusive, and no recommendation on its use can be made at this time***	

11.5 Sealant application

The Guideline Group agreed that best practice was to apply the minimum amount of sealant to adequately cover the pit and fissure network, and to ensure that any air bubbles or voids were removed before curing the material.

Recommendation

➢ ***Apply the minimum amount of sealant required to adequately cover the pit and fissure network; Remove any air bubbles or voids before curing***	**GPP**

11.6 Polymerisation

One of the key factors affecting polymerisation is the light intensity of the dental light curing unit. A Canadian study[135] reported that 12.1% of light curing units tested in a sample of dental practices had intensities that would be considered inadequate (< 300 mW/cm^2). The corresponding figure was 28% in a similar study from England.[136] These results suggest that regular testing of light-curing units should be conducted to monitor their light intensity and curing performance (i.e. depth of cure on a sample of composite material).

All the units tested in the Canadian and English studies were Quartz Tungsten Halogen lights, which are probably the most widely used by dentists worldwide.[135] However, Light Emitting Diode (LED) lights are also available and are becoming increasingly popular. As the maintenance requirements of different types of units may differ, protocols for testing and maintenance of light-curing units should be developed in line with the manufacturer's instructions. **3**

Other factors that may influence polymerisation include curing time, distance of the light guide from the material being cured, and thickness, shade and composition of the material being cured.[137] **3**

Recommendation

➢ ***Position the light-curing tip as close as possible to the surface being sealed and cure for at least the recommended curing time***	**GPP**
➢ ***If more than one surface on the same tooth is being sealed, e.g. occlusal and buccal/palatal, cure each surface separately***	**GPP**
➢ ***Protocols for testing the light output and curing performance of light curing units should be implemented in accordance with the manufacturer's instructions***	**D**
➢ ***Manufacturer's instructions for sealant materials and for curing lights should be available in all dental surgeries***	**GPP**

11.7 Testing retention

Sealant retention should be checked with a probe after polymerisation to ensure that all fissures are completely sealed. If any material is dislodged, the sealant should be reapplied after re-cleaning (if necessary) and re-etching the exposed fissure.

Recommendation

➢ ***Sealant retention should be checked with a probe after application, and the sealant re-applied, if necessary, repeating each step of the sealant application procedure***	**GPP**

11.8 Inadequate moisture control

Achieving good moisture control is one of the greatest challenges to successful sealant application. The circumstances influencing moisture control will vary from patient to patient, and may relate to the state of eruption of the tooth, the patient's ability to co-operate, the materials and equipment available for isolation, or a combination of these factors. The options considered by the Guideline Group for 'interim' treatment of teeth for which a sealant was indicated but for which adequate isolation could not be achieved were: resin-based sealant, fluoride varnish and glass ionomer sealant.

Resin-based sealant application is particularly sensitive to moisture contamination, and the clinician can expect between one half to one quarter of sealants to require re-treatment if they are placed on teeth that are not completely above the gingival level.[101] **3**

A Cochrane review that compared the caries-preventive effect of pit and fissure sealants versus fluoride varnish concluded there was some evidence of the superiority of sealants over fluoride varnish in the prevention of occlusal decay. However, although the reviewers were unable to make any recommendations for clinical practice, they did suggest that the benefits of pit and fissure sealants and fluoride varnishes should be considered locally and individually.[138] **1++**

Although fissure sealants may be better than fluoride varnish at preventing occlusal caries, fluoride varnish is still an effective caries-preventive agent when compared to placebo or no treatment. A Cochrane review of the effectiveness of fluoride varnish at preventing caries reported caries reductions of 46% (95% CI: 30–63%) in permanent teeth with the use of fluoride varnish.[92] **1++**

The use of glass ionomer sealant has been advocated for situations in which moisture control may be difficult.[30] The evidence of a caries-preventive effect for glass ionomer sealants compared to resin-based materials is conflicting[34] and evidence from randomised controlled trials of a caries-preventive effect for glass ionomer compared to a no-treatment control group is limited.[37,139]

The Guideline Group considered the evidence for the alternative interim measures, and favoured the application of resin-based sealant when possible, or the application of fluoride varnish, as the evidence for a caries-preventive effect for both these interventions was established. The Guideline Group considered the possible need for re-application of resin-based sealants as an acceptable trade-off for protecting molar teeth in high caries risk children.

The Guideline Group was hesitant to recommend the use of glass ionomer sealant as an interim measure, given the limited evidence of its effect, but recognised that there may be circumstances where, in the clinical judgement of the operator, use of glass ionomer sealant may be appropriate. **4**

In all cases where an interim sealant was indicated, the Guideline Group recommended that advice on toothbrushing with fluoride toothpaste, with particular emphasis on brushing the molar teeth, and appropriate dietary advice should be provided.

Recommendation

➢ ***Where resin-based sealant is indicated and moisture control is difficult to achieve but patient co-operation allows, resin-based sealant should be attempted and reviewed within 6 months***	**D**
➢ ***Where resin-based sealant is indicated but adequate moisture control cannot be achieved, fluoride varnish containing at least 22,600 ppm F should be applied to pits and fissures at intervals of 3-6 months until isolation can be achieved.***	**B**
➢ ***Glass ionomer cement may be considered on a case by case basis, as an interim preventive measure when there are indications for placement of a resin-based sealant but concerns about moisture control may compromise such placement***	**D**

12. Is there an optimum time for reviewing sealants?

Once applied, sealants need to be maintained. When sealants are applied in high caries risk children, review of sealant retention should be part of the recall visit. An earlier guideline in this series has recommended that the recall interval for high caries risk children should not exceed 12 months.[60] **4**

If there is particular concern about sealant retention, e.g. if isolation has been difficult to achieve or the sealant has been applied over a suspicious lesion, recall within 6 months is appropriate. A 3-year sealant study involving children aged 5–14 years with partially or newly erupted first or second permanent molars, found that the re-treatment rate was higher at the first 6-month recall than at any other recall during the study, irrespective of the method of tooth isolation used (rubber dam or cotton rolls).[121] **2+**

Recommendation

➢ ***Sealants should be checked when the patient is recalled, and repaired or replaced if necessary. The recall interval for high caries risk children should not exceed 12 months***	**D**
➢ ***If there is particular concern about sealant retention, recall within 6 months is appropriate***	**D**

13. Implementation, Audit and Future Research

This guideline provides an evidence-based approach to the use of pit and fissure sealants and should lead to more efficient and effective use of sealants to improve the oral health of children in Ireland. From a public health perspective, and in line with national health strategies,[140,141] the recommendations in this guideline aim to make the best use of available resources by focusing attention on children and specific sub-groups (targeted populations) that have the greatest need. The release of a new national oral health strategy, commissioned by the Minister for Health and Children, is anticipated. This guideline provides a robust yet flexible resource that can be used irrespective of any organisational or policy changes that the new strategy may bring.

The commitment to the guideline from the Department of Health and Children, coupled with the support of the newly appointed Clinical Lead for Oral Health within the HSE, will facilitate implementation of the guideline in the public dental service, and will help to address the barriers to implementation at an organisational level.

13.1 Barriers to implementation

Barriers to implementation include:

- Organisational restructuring and lack of clear and effective reporting relationships
- Acceptability of change to some staff and service users
- Current moratorium on recruitment in the public service, against a background of dental personnel shortages, which is affecting the capacity of the public dental service to identify children who are at high caries risk and to recall and check sealants that have been applied
- Lack of dental hygienist posts
- Lack of timely access to oral health care
- Use of key performance indicators for the public dental service that focus on activity rather than outcome
- Lack of local data on high caries risk communities within a dental area* to allow a targeted population approach.

**The term 'dental area' or 'dental service delivery area' is used to refer to the administrative organisation of dental services within the HSE, which is currently under review as part of a restructuring of the HSE.*

13.2 Key points for Audit

The following data should be collected in order to audit the implementation of this guideline:

Structure

- Awareness of the guideline among dental personnel in public and private practice.
- Number of dental service delivery areas with a targeted population sealant programme for specific high caries risk groups
- Number of dental hygienist posts per capita in the HSE

Process

- Number of dentists using formal caries risk assessment (using the Caries Risk Assessment Checklist or other formal risk assessment tools) for their patients
- Number of HSE dental personnel using no-rinse self-etching bonding agents when placing pit and fissure sealants
- Number of dental surgeries within each HSE dental area that have the manufacturer's instructions available for (a) light curing units (b) sealant materials
- Number of HSE dental areas with a protocol for testing the light intensity and the curing performance of their light curing units
- Number of dental areas providing dental assessment and sealants to high caries risk children at age 7 (1st class)
- Number of dental areas providing dental assessment and sealants to high caries risk children at age 7 (1st class) who follow-up high caries risk children with unerupted first permanent molars to 2nd class in order to provide pit and fissure sealants
- Number of dental areas that follow up high caries risk children with unerupted second permanent molars in order to provide pit and fissure sealants
- Number of dental areas providing a targeted population fissure sealant programme to groups of high caries risk children in Junior Infants, Senior Infants, 1st class, 2nd class, 5th class and 6th class.

Outcome

- Number and percentage of children in each dental area who are assessed as being high caries risk
- Number and percentage of children in each dental area who are assessed as being high caries risk who have pit and fissure sealants applied to first or second permanent molars

- Number and percentage of children attending special schools and schools designated disadvantaged in each dental area who have fissure sealant applied to first or second permanent molars
- Number and percentage of children in each dental area assessed as being high caries risk who are recalled within 12 months of sealant placement
- Number and percentage of children attending special schools and schools designated disadvantaged in each dental area who are recalled within 12 months of sealant placement
- Retention rates of pit and fissure sealants 12 and 24 months after placement
- Rate of replacement or repair of pit and fissure sealants 12 and 24 months after placement
- Change in DMFT in children aged 8, 12 and 15 years in areas that have implemented the guideline.

13.3 Recommendations for future research

During the development of this guideline, a number of gaps in the evidence base were identified. Some of the research necessary to fill these gaps is described below, using the EPICOT structure[142] (Evidence, Population, Intervention, Comparison, Outcome, Time) to outline the design of specific studies, where appropriate.

- Cost-effectiveness and cost utility of an early intervention risk-based sealant programme compared to a risk-based or 'Seal All' sealant programme at age 6–7.

Evidence	A review of economic literature on pit and fissure sealants,[32] and several economic analyses[102,103] suggest a targeted approach may be more cost-effective, but are not directly applicable to the Irish context
Population	Children in Junior infants class (age 5)
Intervention	Sealant programme commencing in Junior Infants (school entry) involving risk assessment using the Caries Risk Assessment Checklist, with follow up and sealant placement for high caries risk children as first permanent molars erupt
Comparison	1. Risk-based sealant application at age 6–7 (First class) 2. 'Seal All' at age 6–7 (First class)
Outcomes	Comparison of costs and effectiveness of the three approaches measured at age 8 Costs will include cost of assessment, recall, treatment and sealant provision Effectiveness will be measured as DMFT Cost utility should also be measured

- Effectiveness and cost-effectiveness of outreach programmes, e.g. mobile dental clinic in schools for increasing prevalence of sealant among low-utilisers in disadvantaged, high caries risk groups

- Cost-effectiveness of a fissure sealant programme targeted at a population at high caries risk.

Evidence	Two US economic models[102,103] and one Finnish study[104]
Population	Groups of children who are at high caries risk (e.g. children attending a school in an area of socioeconomic deprivation or children with special health care needs)
Intervention	Targeting all children in a particular school(s) in Junior infants, Senior infants, 1st, 2nd, 5th and 6th class for placement of pit and fissure sealants on first and second permanent molars
Comparison	Standard care in a school with a similar population of children (usually children are targeted in either 1st/2nd class and 6th class for placement of fissure sealants)
Outcomes	Differences in caries increments between the children receiving the targeted fissure sealant programme and the children receiving the standard care over time related to differences in the cost of providing the two programmes

- Effectiveness of glass ionomer cement sealant compared to resin-based sealant in preventing caries (and in improving retention) in children with fully or partly erupted first and second permanent molar teeth in a standard dental clinic setting.

Evidence	Four systematic reviews,[16,34,48] all of which have found conflicting findings for the caries-preventive effect of resin-based sealant compared to glass ionomer or resin-modified glass ionomer sealants
Population	Children at risk of caries with fully or partly erupted first or second permanent molar teeth that are sound or have caries lesions confined to enamel
Intervention	Glass ionomer cement sealant
Comparison	Resin-based light-polymerised sealant
Outcomes	Retention of sealants at 6 & 12, 24 & 36 months Incidence of caries at 12, 24 & 36 months Patient acceptance and dental personnel satisfaction with the two materials

- Retention of pit and fissure sealants placed with a bonding agent compared to those placed without a bonding agent in teeth where moisture control is difficult.

Evidence	Conflicting clinical evidence of the effectiveness of bonding agents at improving sealant retention
Population	Children with either partially erupted teeth or less than ideal co-operation, where moisture control is difficult during sealant placement
Intervention	1. Resin-based pit and fissure sealant using acid etch + bonding agent 2. Resin-based pit and fissure sealant using acid etch only
Comparison	Intensive oral health education, focusing on toothbrushing and dietary control
Outcomes	Retention at 6, 12, 24 & 36 months Parental and child acceptance of the procedure Caries (DMFT) at 24 & 36 months

- Evaluation of the usefulness of data currently collected by electronic patient records systems in the public dental service, to inform planning of dental services e.g. to facilitate the identification of high risk populations to whom a targeted population approach can be applied.

Appendix 1: Caries Risk Assessment Checklist and Notes

Dentist's name: _____ Date: _____First assessment: Y / N

Child's name: _____ School: _____ Date of birth:_____

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 are 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 main 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 of or from caries. Other indicators that should be taken into account when assessing the child's risk status complete this section. The second section contains protective factors that should also be considered. The checklist combines the two most consistent predictors of future caries: previous caries experience[143] and the dentist's own assessment.[144,145] 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 checklist, we are suggesting a modified version of the criteria defined by Nyvad et al.[76] 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. It 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. [100,145]

Medical or other conditions: This section considers factors from the medical history that you normally take for your patient that may put the person at risk of or from caries. Some examples of conditions that could be included in each of the categories are shown below.

Medical or other conditions Conditions where dental caries could put the patient's general health at increased risk	**Examples** 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.[3] 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.[146] 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. [34 ,147-150] The absence of protective factors could increase a child's risk of developing caries.

Appendix 2: Stakeholders and External Reviewers

Stakeholders

- Cork School of Dental Hygiene
- Cork University Dental School and Hospital – Department of Oral Health and Development
- Dental Health Foundation
- Dublin Dental School and Hospital – Department of Public and Child Dental Health
- Dublin School of Dental Hygiene
- Irish Dental Association – Public Dental Surgeons' Committee
- Irish Dental Hygienists Association
- Irish Society of Dentistry for Children
- Irish Society for Disability and Oral Health
- Oral Health Promotion Research Group – Irish Link
- Society of Chief and Principal Dental Surgeons

External Reviewers

- Professor Chris Deery, Professor of Paediatric Dentistry, School of Clinical Dentistry, Sheffield
- Dr Julie Frantsve-Hawley, Director, Research Institute and Center for Evidence-based Dentistry, American Dental Association, Chicago
- Dr Barbara Gooch, Dental Officer, Division of Oral Health/Surveillance, Investigations and Research Branch, Centers for Disease Control and Prevention, Atlanta
- Professor Amid Ismail, Dean and Professor, Kornberg School of Dentistry, Temple University, Philadelphia
- Dr Shellie Kolavic Gray, Public Health Division, Northrop Grumman, Atlanta
- Professor Colman Mc Grath, Professor in Dental Public Health, University of Hong Kong

Appendix 3: Key Questions

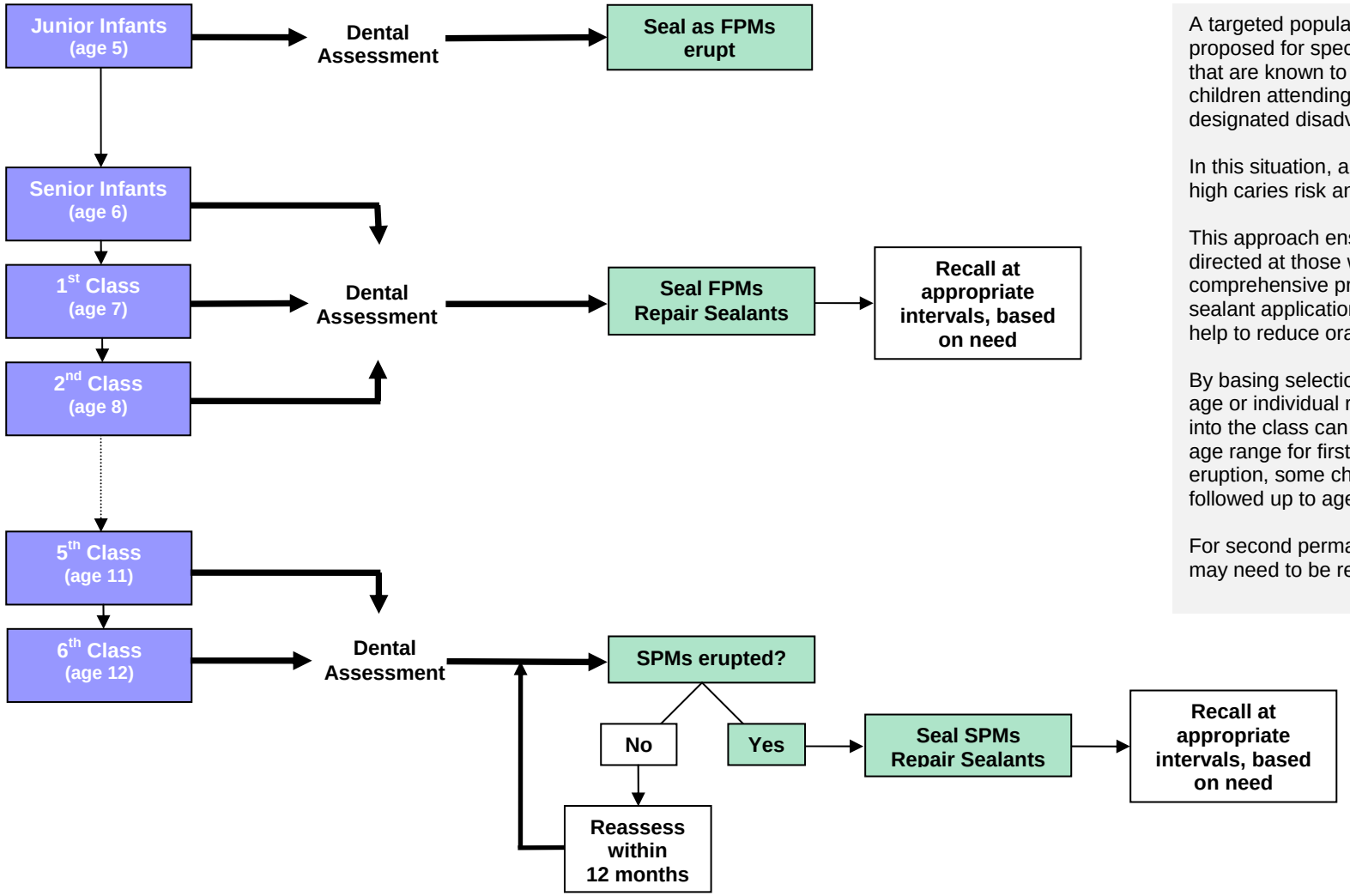
Background questions relating to caries diagnosis:

1) What is the best method for identifying occlusal caries?
2) How accurate are current caries detection methods at identifying whether caries extends into dentine?

Key clinical questions relating to fissure sealants:

1) How effective are fissure sealants at preventing dental caries in:
   a. Primary teeth?
   b. Permanent teeth?
2) Are fissure sealants effective in preventing the progression of non-cavitated enamel or dentine caries lesions in children and adults?
3) Are teeth that have lost sealants or have partially retained sealants at higher risk of caries than teeth that were never sealed?
4) Which patients should be selected for sealant application?
5) Which teeth should be fissure sealed?
6) Is there a difference in sealant retention or caries (at 6 months, 1, 2, 3, and 4 years) between resin-based sealant and glass ionomer sealant?
7) What is the best way to apply sealants to maximise retention, with regard to:
   a. Tooth cleaning prior to application?
   b. Isolation?
   c. Preparation of enamel, including the use of bonding agent?
   d. Rinsing and drying the tooth?
   e. Application of sealant?
   f. Polymerisation?
   g. Four-handed versus two-handed application technique?
8) When should teeth be fissure sealed?
9) What interim preventive measures can be used for permanent teeth that require sealant but for which adequate isolation cannot be achieved, e.g. partial eruption, poor patient co-operation?
10) Is there an optimum time for reviewing sealants after application?
11) Are there any side-effects or adverse reactions associated with the use of fissure sealants?
12) Is there a difference in the retention/effectiveness of sealants applied by a dentist compared to those applied by a dental hygienist?
13) Is there a difference in the cost per sealant applied by a dentist/dental nurse team to the cost per sealant applied by a dental hygienist/dental nurse team?
14) What is more cost-effective – to provide fissure sealants to all patients or to adopt a high risk strategy – in the context of a dental service with intervals of at least two years between dental visits and variable levels of staff?

Appendix 4: Targeted population sealant programme for specific high caries risk groups



A targeted population sealant programme is proposed for specific population subgroups that are known to be at high caries risk, e.g. children attending special schools or designated disadvantaged schools.

In this situation, all children are considered high caries risk and are offered sealants.

This approach ensures that resources are directed at those who need them most. A comprehensive programme including timely sealant application and maintenance will help to reduce oral health inequalities.

By basing selection on the class rather than age or individual risk status, new arrivals into the class can be picked up. Given the age range for first permanent molar eruption, some children may need to be followed up to age 8.

For second permanent molars, children may need to be reassessed up to age 14.

FPM First Permanent Molar
SPM Second Permanent Molar

Appendix 5: ICDAS II Codes for Pit and Fissure Caries

ICDAS II (International Caries Detection and Assessment System) is a caries detection and assessment system that has been introduced to measure the stages of the caries process, rather than just the 'decayed' stage. The system is based on detailed visual examination of clean tooth surfaces. Careful drying of the surface/lesion in question is considered important for identifying early lesions. ICDAS II measures six stages of the caries process, ranging from early clinically visible changes in enamel, to extensive cavitation. ICDAS has shown a good association between the scores for caries in enamel and dentine and histological measurement.[77 88] A measures for lesion activity has also been developed for use in conjunction with ICDAS II[77], but requires further validation.

In the ADA guideline,[30] the use of fissure sealant is recommended for "early (non-cavitated) carious lesions", the definition of which corresponds with ICDAS II codes 1 and 2.

Code	Extent	Description
0	**No evidence of caries**	There should be no evidence of caries (either no or questionable change in enamel translucency after prolonged air drying (suggested drying time 5 seconds)). Surfaces with developmental defects such as enamel hypoplasias; fluorosis; tooth wear (attrition, abrasion and erosion), and extrinsic or intrinsic stains will be recorded as **sound**. The examiner should also score as sound a surface with multiple stained fissures if such a condition is seen in other pits and fissures, a condition which is consistent with non-carious habits (e.g. frequent tea drinking).
1	**First visual change in enamel**	When seen wet there is no evidence of any change in colour attributable to carious activity, but after prolonged air drying (approximately 5 seconds is suggested to adequately dehydrate a carious lesion in enamel) a carious opacity or discoloration (white or brown lesion) is visible that is not consistent with the clinical appearance of sound enamel OR When there is a change of colour due to caries which is not consistent with the clinical appearance of sound enamel and is limited to the confines of the pit and fissure area (whether seen wet or dry). The appearance of these carious areas is not consistent with that of stained pits and fissures as defined in Code 0.
2	**Distinct change in enamel**	The tooth must be viewed wet. When wet there is a (a) carious opacity (white spot lesion) and/or (b) brown carious discoloration which is wider than the natural fissure/fossa that is not consistent with the clinical appearance of sound enamel (Note: the lesion must still be visible when dry).
3	**Localised enamel breakdown due to caries with no visible dentin or underlying shadow**	The tooth viewed wet may have a clear carious opacity (white spot lesion) and/or brown carious discoloration which is wider than the natural fissure/fossa that is not consistent with the clinical appearance of sound enamel. Once dried for approximately 5 seconds there is carious loss of tooth structure at the entrance to, or within, the pit or fissure/fossa. This will be seen visually as evidence of demineralization (opaque (white), brown or dark brown walls) at the entrance to or within the fissure or pit, and although the pit or fissure may appear substantially and unnaturally wider than normal, the dentin is NOT visible in the walls or base of the cavity/discontinuity.

4	**Underlying dark shadow from dentin with or without localized enamel breakdown:**	This lesion appears as a shadow of discoloured dentin visible through an apparently intact enamel surface which may or may not show signs of localized breakdown (loss of continuity of the surface that is not showing the dentin). The shadow appearance is often seen more easily when the tooth is wet. The darkened area is an intrinsic shadow which may appear as grey, blue or brown in colour. The shadow must clearly represent caries that started on the tooth surface being evaluated. If in the opinion of the examiner, the carious lesion started on an adjacent surface and there no evidence of any caries on the surface being scored then the surface should be coded '0'.
5	**Distinct cavity with visible dentin**	Cavitation in opaque or discoloured enamel exposing the dentin beneath. The tooth viewed wet may have darkening of the dentin visible through the enamel. Once dried for 5 seconds there is visual evidence of loss of tooth structure at the entrance to or within the pit or fissure – frank cavitation. There is visual evidence of demineralization [opaque (white), brown or dark brown walls] at the entrance to or within the pit or fissure and in the examiner judgment dentin is exposed The WHO/CPI/PSR probe can be used to confirm the presence of a cavity apparently in dentin. This is achieved by sliding the ball end along the suspect pit or fissure and a dentin cavity is detected if the ball enters the opening of the cavity and in the opinion of the examiner the base is in dentin. (In pits or fissures the thickness of the enamel is between 0.5 and 1.0 mm. Note: the deep pulpal dentin should not be probed.)
6	**Extensive distinct cavity with visible dentin:**	Obvious loss of tooth structure, the cavity is both deep and wide and dentin is clearly visible on the walls and at the base. An extensive cavity involves at least half of a tooth surface or possibly reaching the pulp

Taken from: Ismail et al., 2007. The International Caries Detection and Assessment System (ICDAS): an integrated system for measuring dental caries.[88]

Appendix 6: Glossary of Terms

AGREE	The AGREE instrument (Appraisal of Guidelines for Research and Evaluation) is a detailed checklist developed by a group of international guideline developers and researchers to assess the methodological quality of guidelines.
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.
Compomer	Also known as polyacid-modified composite resin, compomers are dental materials that contain chemical features of both composite resin and glass ionomer, but the majority of components are the same as composite. Compomers combine the fluoride-releasing properties of glass ionomer with the aesthetics of composite, and are less sensitive to moisture than composite resin.
Demineralisation	Loss of minerals (usually calcium and phosphate) from the tooth surface caused by exposure to acid, from either bacteria or dietary sources.
DEIS	The DEIS initiative (Delivering Equality of opportunity In Schools) is designed to ensure that the most disadvantaged schools benefit from a comprehensive package of supports, while ensuring that others continue to get support in line with the level of disadvantage among their pupils.
dmft/DMFT	An index which is used to describe the level of dental caries in individuals or groups. It counts the number of teeth which are decayed, missing or filled. By convention, dmft in lower case letters refers to primary teeth and DMFT in capital letters denotes permanent teeth.
Fissure Sealant	A thin 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.
Flowable composite	Tooth-coloured filling material that has a more 'runny' consistency (low viscosity) than standard tooth-coloured filling materials.
Glass ionomer cement	Glass ionomer (polyalkenoate) cements are based on an ion-leachable glass which releases fluoride in the setting process with polyacids. The set material consists of the original glass particles embedded in a polyacrylate gel. Glass ionomer materials set by an acid-base reaction in an aqueous environment.
Hypomineralised	This is a defect of enamel that occurs during tooth formation and is characterised by deficient mineral content. Hypomineralised enamel is more porous and therefore more prone to decay and wear than normal enamel.
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.
Polymerisation	The chemical process by which resin-based sealant materials set or harden.
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.
Resin-modified Glass ionomer	A restorative material that combines the chemical properties of both composite resin and glass ionomer, with the main component being glass ionomer.
Split mouth trials	An experimental trial design in which teeth in one part of the mouth receive the intervention being investigated, while teeth in another part of the mouth (usually the opposite side) act as the control.

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.

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