

Dental Student Management of Non-invasive Intervention for Dental Caries

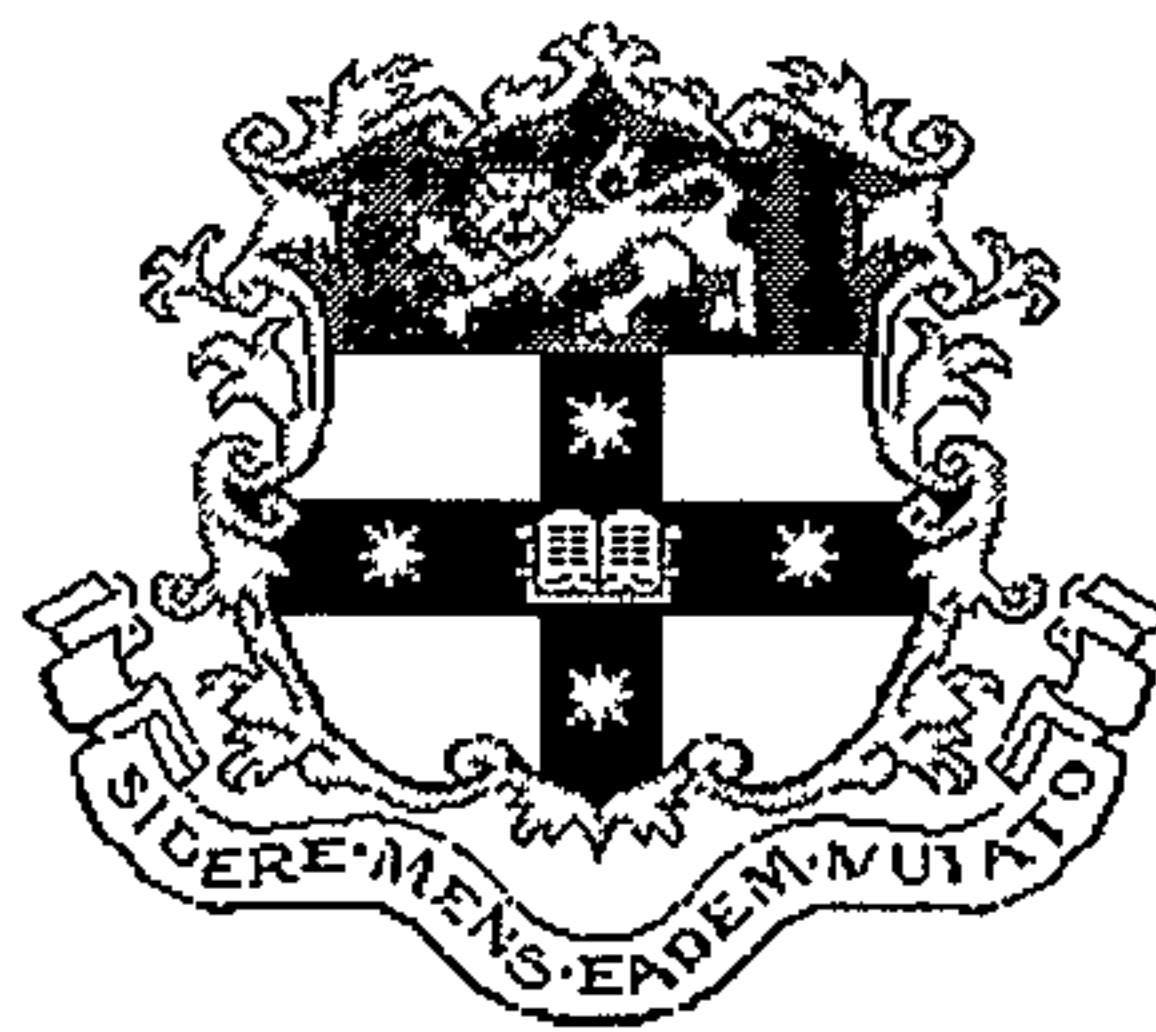
Afsaneh Pakdaman, DDS, MPH

(Tehran University of Medical Sciences)

A thesis submitted in fulfilment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Community Oral Health and Epidemiology



Faculty of Dentistry

The University of Sydney

Australia

2006

Summary

This thesis is concerned with the development of, and its implementation in the clinical practice of dental students, a new strategy known as the Caries Management System for managing non-invasively non-cavitated carious lesions. The main findings were:

Literature review: Inner rather than outer enamel lesions are more likely to progress; in children and adolescents, lesion progression is less rapid in subjects who receive other forms of topical fluorides in addition to fluoridated toothpaste; and lesion progression generally occurs slowly, though faster in primary teeth and in low-fluoride areas.

Radiographic diagnosis and treatment planning: Students are more likely to under- than to over- diagnose caries from bitewings; treatment decisions were generally correct; many students were not following the system; and that some tutors did not check compliance.

Process and clinical outcomes: Oral hygiene instruction was not always reported as being given; 22% of students had coached their patients on three or more occasions; 32% of the patients with proximal lesion (s) had not been given topical fluoride applications but others had received applications on multiple occasions; 92% of the sound surfaces remained sound; the extent of lesion progression was directly related to baseline lesion depth; only 20% of outer enamel lesions had progressed versus 90% of inner dentine lesions; 30 lesions had regressed.

Student perceptions: Students believed that the Caries Management System had been well taught; they understood risk assessment and the effectiveness of remineralisation; they experienced inconsistency between teaching and clinical policies; effective implementation of the system was compromised by their need to meet course requirements in technical proficiency; secondary preventive efforts were not rewarded.

Staff feed back: Implementation issues were time constraints and the need to ensure students achieved technical proficiency in restorative techniques. Problems were also experienced with patient acceptance and adherence to recommended preventive strategies.

Dedication

This thesis is dedicated to my son and my husband,

Amir and Fazel,

who have been tolerant

and encouraging in my pursuit of higher education,

*and also to my parents for their efforts and support
through out my life.*

Acknowledgments

I acknowledge the great support of Associate Professor Wendell Evans, throughout my study. I heartily appreciate his guidance that will undoubtedly have tremendous value in my career.

Also I acknowledge the following people for their contribution and help towards my research and the preparation of my thesis:

- My associate supervisor, Dr Evelyn Howe, University of Sydney for her effort in the preparation and management of this research.
- Associate Professor Peter Dennison, Director of Bachelor of Oral Health program for his encouragement.
- Associate Professor Chris Peck, Dean of Postgraduate studies, Faculty of Dentistry, University of Sydney for his support and encouragement throughout my research.
- Dr Karen Byth, Westmead Millennium Institute, Westmead Hospital for her help with the statistical analysis throughout the project.
- Associate Professor Peter Barnard, Community Oral Health and Epidemiology
- Dr Bradley Curtis for helping in the process of data collection.
- Ms Ramona Grimm, Administrative assistant, Community Oral Health and Epidemiology.
- Dr Raul Taliano, Ms Jacqueline Kemp, Ms Beverley Skinner, Ms Saidie Melhem in Undergraduate clinic, Westmead Centre for Oral Health for facilitating the process of data collection.
- Ministry of Health and Medical Education, Tehran University of Medical Sciences, Iran for granting me the scholarship to do this research.
- Westmead Hospital staff and students
- Dr Garythe Samuda-Evans for her encouragement.
- Australian Dental Research Foundation, for funding this research.

Table of Contents

Summary	ii
Dedication.....	iv
Acknowledgments.....	v
Table of Contents.....	vi
List of Tables.....	xi
List of Figures	xiv
Statement.....	xvi
PART I: Literature Review	1
CHAPTER 1 - A systematic review of the literature on the progression/regression of approximal carious lesions	2
Abstract	2
Background	3
Methods	4
Results	6
Primary teeth	6
Permanent teeth - rate of approximal lesion progression	9
Permanent teeth - mean progression score	20
Permanent teeth - survival analysis	20
Discussion	24
Primary teeth	25
Permanent teeth	25
Recommendations for further research	28
Conclusions	29
The utility of this review	29
Acknowledgements	30
References	31
PART II: Non-invasive Intervention for Dental Caries.....	37
CHAPTER 2 - Introduction	38
Background	38
Need for new directions in caries management.....	39
Caries diagnosis and intervention.....	40
Reform of dental caries management.....	41

Study purpose	44
CHAPTER 3 - Material and Methods 1: The Caries Management System	46
The patient at risk of caries	46
The status of each lesion	49
Patient management	53
Clinical management.....	55
Monitoring.....	61
Implementation.....	62
CHAPTER 4 - Material and Methods 2: Implementation of the Caries Management System in the clinical curriculum of the Bachelor of Dentistry program	64
Dental education at the University of Sydney	64
Evidence based management of caries	64
Student learning about dental caries.....	65
Implementing the Caries Management System in the students clinics	65
Student learning about the Caries Management System.....	65
Involvement of the clinical tutors.....	66
The sample of patients.....	66
Total patient care clinical practice.....	66
Data collection.....	67
Ethics approval	67
Clinical follow up after 24 months.....	68
Purpose of the evaluation	68
Data collection.....	68
Data analysis.....	68
CHAPTER 5 - Results.....	69
The patients	69
Researcher diagnostic reliability	69
The distribution of bitewing radiolucencies-researcher's assessment	69
Summary of the distribution of bitewing radiolucencies	70
Student application of the Caries Management System.....	76
Caries diagnosis based on bitewing radiograph assessment	76
Management of carious lesions	76

Clinical outcomes after 24 months following the implementation of the Caries Management System	82
Frequency of preventive care interventions	82
Radiographic changes observed after two years	82
CHAPTER 6 – Discussion	90
Dental student application of the Caries Management System protocols:	
Diagnosis and lesion management	90
Dental student application of the Caries Management System protocols: Clinical outcomes after 24 months.....	91
The Caries Management System.....	93
References	94
Part III: Student and staff comments on the Caries Management System	100
CHAPTER 7 - Students' Perceptions of Non-invasive Management of Dental Caries in a Student Clinic.....	101
Abstract	101
Background	102
The Caries Management System.....	103
Purpose of the study	106
Material and Method	106
The Questionnaire	106
Results	108
Demographic characteristics of the sample.....	108
Student learning and clinical experience.....	108
Time spent in oral hygiene assessment and topical fluoride treatment.....	112
Risk assessment.....	113
Reported risk-based caries management strategy	113
Association between choice of treatment and attitudes to the Caries Management System	118
Discussion	121
Acknowledgement.....	123
References	124
CHAPTER 8 - Thematic analysis of perceived problems and barriers in implementation of the Caries Management System.....	126

Background	126
Teachers and teaching practice.....	126
Student approaches to clinic-based learning	127
Researcher information and insights	128
Purpose of the study	128
Material and Method	128
Students	129
Teachers.....	129
Researcher	129
Results	130
Analysis of student feedback.....	130
Analysis of staff feedback	134
Analysis of researcher feedback.....	138
Discussion	140
References	142
CHAPTER 9 - Summary of findings and recommendations	143
Systematic review of the literature on the progression/regression of approximal carious lesions	144
Study findings.....	144
Lesion regression.....	145
Recommendations	145
The utility of this review	145
Conclusions	146
Dental student application of the Caries Management System protocols: diagnosis and lesion management	146
Student application of the Caries Management System.....	146
Summary of findings	147
Recommendations	147
Clinical outcomes after 24 months following the implementation of the Caries Management System	147
Study findings.....	147
Conclusions	148
Future directions.....	149

Student perceptions 149

 Study findings.....149

 Recommendations 150

Staff feedback.....150

 Study findings.....150

 Recommendations 151

Bibliography.....152

Appendices 171

List of Tables

Table 1.1. Summary of studies reporting on outer and inner enamel (OE & IE) and outer and inner dentine (OD & ID) approximal carious lesion progression in primary teeth.	8
Table 1.2. Summary of studies reporting on the rate of approximal carious lesion progression/regression on outer and inner enamel (OE & IE) and outer and inner dentine (OD & ID) in permanent teeth.....	10
Table 1.3. Summary of the studies reporting mean progression/regression scores of approximal carious lesions in permanent teeth.	21
Table 1.4. Summary of the studies reporting on survival analysis of approximal carious lesions in permanent teeth.....	22
Table 5.1. Distribution of patients with bitewing radiolucencies by age and caries risk status.....	71
Table 5.2. Inter-examiner reliability. Agreement between two examiners on scoring bitewing radiolucencies	72
Table 5.3. Intra-examiner reliability of the researcher. Agreement between first and second readings of the bitewing radiolucencies	73
Table 5.4. Distribution in 2004 of tooth- and surface-specific bitewing radiolucencies scored by the researcher in the deciduous teeth of 15 child patients.....	74
Table 5.5. Distribution in 2004 of tooth- and surface-specific bitewing radiolucencies scored by the researcher in the permanent teeth of 15 child and 51 adult patients.....	75

Table 5.6. Summary of bitewing radiolucency scores in 66 patients, and correspondence between researcher and students on scoring bitewing radiolucencies in 27 patients	77
Table 5.7. Number and percentage distribution of management decisions by students for 332 lesions, stratified by radioluceny score and caries risk as determined by the researcher.....	78
Table 5.8. Distribution of 66 patients followed from 2004 to 2006 by background and preventive care received	83
Table 5.9. Occasions of preventive care received by 66 patients and follow-up during 2004 and 2006.....	84
Table 5.10. Inter-examiner reliability. Agreement between two examiners in August 2006 on scoring bitewing radiolucencies.....	85
Table 5.11. Intra-examiner reliability of the researcher. Agreement between first and second readings in August 2006 of the bitewing radiolucencies	86
Table 5.12. Distribution of radiographic scores on proximal surfaces of 28 patients related to scores at baseline compared with scores after mean follow up time of 25 (3.06) months	87
Table 5.13. Summary of changes observed in bitewing radiographic appearance after two years (28 patients).....	89
Table 7.1. Demographic characteristic of responding students.....	109
Table 7.2. Student learning, clincial experience, and perceptions regarding non-invasive management of dental caries (percentage distributions).....	110

Table 7.3. Percentage distribution of students by number of minutes spent at each visit assessing oral hygiene and delivering topical fluoride 114

Table 7.4. Percentage agreement between researcher and students regarding patient risk diagnosis 115

Table 7.5. Odds that student selection of restorative management options for lesions of varying depth in low, medium, and high risk patients was associated with student attitudes and beliefs about the CMS 120

Table 8.1. Barriers reported by 52 students concerning the implementation of the Caries Management System 131

Table 8.2. Inter-rater reliability on thematic analysis of students comments about barriers to implementing the Caries Management System 132

Table 8.3. Barriers reported by staff members concerning the implementation of the Caries Management System 136

Table 8.4. Inter-rater reliability on thematic analysis of staff comments about barriers to implementing the Caries Management System 137

List of Figures

Figure 1.1 Progression rate estimates, with 95% CI, of approximal carious lesions from individual studies of subjects aged 8 to 18 years, stratified by mode of intervention and follow-up interval.....	15
Figure 1.2 Box plot distributions illustrating the effect difference at 36 months between progression estimates for lesions treated with (a) fluoride toothpaste alone and (b) the combination of topical fluoride products in individuals aged 8 to 18 years.	18
Figure 1.3. Mean average progression per month of approximal lesions in association with (a) use of fluoride toothpaste alone or (b) with the topical fluoride combination of fluoride toothpaste, fluoride varnish, rinse, or gel, stratified by duration of study.	19
Figure 3.1. Ten step summary of the Caries Management System.	47
Figure 3.2. Diet information obtained using the Usual 24-hour <i>Snacking Questionnaire</i>	48
Figure 3.3. Criteria and instructions for reporting the Plaque Index scores, and one panel of recording boxes for the scores.	51
Figure 3.4. Criteria for scoring bitewing radiolucencies on occlusal and approximal surfaces (after Mejare, 1999).	51
Figure 3.5. One panel of boxes on the <i>Bitewing radiographic assessment</i> form for recording bitewing findings.....	52
Figure 3.6. Criteria for assigning caries risk status.	52
Figure 3.7. Tooth decay information leaflet (front side only).....	54

Figure 3.8. The *Where do I brush ?* leaflet (front side only). 56

Figure 3.9. Protocol for the management of lesions following caries diagnosis based on the bitewing radiographic survey. 57

Figure 3.10. Professional care topical fluoride protocol for adults aged 18 years and over. 58

Figure 3.11. Home care topical fluoride protocol for adults aged 18 years and over... 59

Figure 3.12. Recall protocol - schedule for monitoring caries activity and bitewing surveys..... 63

Figure 5.1. Management by BDent3 students of enamel lesions in low, medium and high caries risk patients attending the Westmead Center for Oral Health in 2004. 80

Figure 5.2. Management by BDent3 students of dentine lesions in low, medium, and high caries risk patients attending the Westmead Center for Oral Health in 2004. 81

Figure 7.1.Schematic overview of the lesions management strategy recommended in the Caries Management System. 105

Figure 7.2. Selected management strategy for lesions of varying depth in low risk patients..... 116

Figure 7.3. Selected management strategy for lesions of varying depth in medium risk patients. 117

Figure 7.4. Selected management strategy for lesions of varying depth in high risk patients..... 119

Statement

Approval to conduct this study was sought from and approved by the Human Research Ethics Committees of the Sydney West Area Health Service and the University of Sydney.

I confirm that the material presented in this thesis is original and developed by me with the assistance of my supervisors except for (a) that material that I have referenced and (b) the contribution of co-workers in Chapters 1 and 3.

Chapter 1 has been submitted for publication in *Community Dentistry and Oral Epidemiology* and is now subject to revision. The authors and their respective contributions are: Pakdaman A (85%), Evans RW (10%), and Byth K (5%).

Chapter 3, which concerns the Caries Management System, has been submitted for publication in the *Australian Dental Journal* and is currently under review. The respective contributions by the authors to the development of the Caries Management System are: Evans RW (45%), Pakdaman A (40%), Dennison PJ (10%), and Howe E (5%). In particular, my contribution in development of Caries Management System is: 1) Development of the initial plan to implement risk-based protocols in an educational environment prior to its implementation in private practice, 2) Background literature review on: fluoride protocols (Professional and home use), risk based recall protocol, oral hygiene instruction and monitoring, and diet advice, 3) Development of "Where do I brush" leaflet, 4) Development of the fluoride protocol for professional application of fluoride, 5) Development of the fluoride protocol for home care application, 6) Development of the recall protocol for monitoring lesions, 7) Development of the usual 24 hour snacking questionnaire, 8) Development of the protocols for oral hygiene instruction and monitoring.

The original material in this thesis has not been submitted elsewhere in whole or in part for the award of another degree.

Afsaneh Pakdaman

August 2006

PART I: Literature Review

Chapter 1 has been submitted for publication in *Community Dentistry and Oral Epidemiology*. Currently under revision.

Authors: Pakdaman A, Evans RW, Byth K

CHAPTER 1 - A systematic review of the literature on the progression/regression of approximal carious lesions

Abstract

Objective - The purpose of this systematic review was to investigate the reported occurrence and magnitude of approximal carious lesion progression.

Methods: Articles referring to studies of 24 months duration or more on approximal carious lesions were sought. 42 articles relating to studies that spanned a period of about 40 years were reviewed independently.

Results - The studies were heterogeneous in terms of sample age and size, number of subjects, duration, background fluoride, and mode of and intensity of preventive intervention. It appears that the rate of progression of carious lesions has decreased during the last 40 years. Lesion progression is retarded more by the use of a combination of topical fluoride products than by use of fluoride toothpaste alone, and the data suggest that pattern of rate of lesion progression over time differed according to the intensity of the fluoride treatment.

Conclusions - The main conclusions were that: (i) IE (inner enamel) lesions are more likely to progress during a given period than OE (outer enamel) lesions, (ii) in children and adolescents, lesion progression is less

rapid in subjects who receive professional applications of topical fluoride in addition to home use of fluoridated toothpaste, than in subjects whose topical fluoride source is limited to fluoride toothpaste alone, and (iii) lesion progression generally occurs slowly, though faster in primary teeth and in low-fluoride areas.

Background

The diagnosis and monitoring of initial carious lesions on smooth buccal and lingual surfaces of posterior teeth, and on their occlusal surfaces, is possible without the need to rely on x-ray technology. However, for diagnostic and monitoring purposes of lesions on approximal surfaces, it is necessary to depend on the aid of an imaging system. The standard approach is to examine bitewing radiographs and assess the extent of any radiolucencies that are characteristic signs of dental caries (1).

In relation to whether any sign is indicative of a need for some intervention, the degree to which radiolucency extends into the enamel and beyond the dentino-enamel junction must be determined. Radiolucencies that extend deeply into dentine indicate, most likely, a progressive lesion and an associated need for urgent operative intervention, whereas the interpretation of radiolucencies that are confined to enamel or which extend not far into dentine is more complex (2, 3). The progression status of such a lesion cannot be determined from a single radiograph taken at any one time because the existence of any radiolucency could be associated with any one of three possible diagnoses: that of a progressive, remineralising, or already arrested lesion. A dated series of radiographs is required to determine the progression status of both enamel and shallow dentine lesions. A radiolucency of interest that increases, diminishes, or remains unchanged indicates that the lesion it represents has progressed, remineralised, or has (or already was) arrested, respectively (4).

The management of dental caries is moving away from a predominantly restorative approach to a more conservative one, which has an emphasis on non-

surgical intervention. In responding to this development, The National Institute of Health Consensus Development Conference Statement identified that research into caries diagnostic methods is one of six priority research directions (5). Dentists need evidence-based guidelines to follow and for reference when seeking informed consent from patients to embark on new treatment methods.

Approximal lesion progression has been the subject of few previous systematic literature reviews. The review by Pitts was to determine whether there was already sufficient data and analysis on caries progression that could have implications for clinical decision-making (6). Vanderas and Skamnakis were focussed on the efficacy of caries preventive strategies in which approximal lesion progression was used as a marker for the purpose of drawing comparisons between caries preventive agents (7). The reviews of Bader et al. and Treasure were broader, in that they considered approximal lesion progression in addition to lesion activity on other tooth surfaces (8, 9). Their interest in lesion progression was similar to that of Vanderas and Skamnakis.

The systematic review intended to explore the following research question: Considering the reported occurrence and magnitude of approximal carious lesion progression, arrest, and regression in relation to different preventive strategies, is there a potential for improving protocols fostering the non-invasive management of dental caries?

Methods

The search strategy was developed with the support of the Dental Librarian at the University of Sydney. The following data bases were searched for material from dates as indicated below until August 2004 and the search was updated in July 2005: ACP Journal Club (from 1991), AMI (the Australasian Medical Index, from 1968), Biological Abstract (from 1980), BIOSIS Preview (from 2002), CINAHL (Nursing and Allied Health, from 1982), the Cochrane central register of controlled trials (from 1996), CDSR (the Cochrane database of systematic reviews, from 1996), DARE (database of abstracts of reviews of effects, from 1996), EMBASE (from 1974), ISI Current Content (from 1998), MEDLINE (from 1966), PREMEDLINE (most recently published articles), and

PUBMED (from 1951). The following key words were used: dental caries, carious, decay, proximal, approximal, progression, regression, reversal, remineralisation, arrest, and survival. In addition, hand searches of *Community Dentistry and Oral Epidemiology*, and *Community Dental Health*, published since 1970, were conducted.

Results were limited to human studies reported in English. The title and abstract of 424 articles were read independently by AP and RWE and irrelevant articles were discarded. Of these, the full texts of an agreed set of 70 articles were read by both authors, and their respective reference lists were also searched for additional material. Except for the study reported by Pitts and Renson in which the follow-up period was 18 months, only papers which referred to cohort studies of 24 months duration or more, and in addition, reported on baseline and follow-up bitewing radiographic data, were considered further. A total of 42 articles, selected according to these criteria, were reviewed independently and then, in consultation, to extract the data. Studies were scored, yes or no, in relation to whether or not the following conditions were met:

1. Trial duration was 3 or more years.
2. Attrition rate of 10% or less.
3. Reported a standard method of radiography.
4. Reported a described and validated method of radiolucency diagnosis.

Studies that scored yes for 1+2+3, (1 or 2) +3, and 1 or 2 or 3 were rated as A, B, and C, respectively, otherwise were rated D to indicate the strength of the progression/regression estimates. It is stressed that these scores do not refer to the scientific quality of the papers, rather they are measures of how strongly we may rely on the progression/regression estimates contained therein.

Several systems were used to report on the principal outcome of approximal carious lesion progression/regression in deciduous and permanent teeth. In this review, progression/regression of existing lesions was calculated with reference to lesion status at baseline (excluding sound and filled surfaces). Lesion progression, expressed as progression incidence, or alternatively, rate of lesion progression, was determined from reported data as the percent of baseline lesion images

(radiolucencies) that advanced to a deeper zone or were censored due to restoration or extraction (for regression, images had retracted from a former front line). In some studies, mean progression scores were reported, in which a progression score of 1 measured progression from (a) outer enamel (OE) to inner enamel (IE), or (b) from IE to outer dentine (OD), or (c) from OD to inner dentine (ID). A progression score of 2 would indicate progression over two boundaries, for example, from OE to OD, or from IE to ID, and similarly for progression scores 3 and 4. In addition to these two methods, the progression of caries was also reported according to survival times, as derived from survival analysis. The results reported in relation to survival analysis were taken directly from original data as reported in the respective papers.

Results

In the following tables, the progression estimates reported define outcomes observed at the end of the duration interval of the respective studies; they are not annualised.

Primary teeth

Table 1.1 (10-16) summarises results of seven studies. All studies relating to primary teeth were conducted in low-fluoride areas and showed that prior to the availability and use of topical fluoride, approximal lesion progression was rapid. In the Netherlands, van Erp observed over 24 months that for children receiving regular dental care, the mean time for an enamel radiolucency to develop on an initially sound surface and then progress into dentine was 11.5 months, whereas the mean time for such an initial lesion to become a dentine lesion was only 7 months (16). However, even with the use of combinations of topical fluoride application, chlorhexidine gel, and fluoride toothpaste, around 70% of lesions progressed during 24 months; slightly less than in the associated control groups (11, 12, 15). On the other hand, 24 months following treatment with 40% AgF solution and SnF₂ paste, Craig found that about 75% of enamel lesions and nearly 50% of OD lesions were observed to have arrested (14). It was not reported in the joint Swedish and USA study (13) whether fluoride toothpaste was used by the participants but it probably was available. However, lesion progression observed in this study was comparable to that observed by van Erp (although expressed as mean survival time), except that the rate

of progression from IE to OD was 50% less in the Swedish sample (survival time of 21 months compared with 10 months).

More recently, lesion progression of 60% (survival of 40%) at 48 months was observed in both OE and OD lesions in a prospective non-controlled study of yearly tray applications of APF gel together with daily use of fluoride toothpaste (10). The associated median survival time of both lesion types was about 30 months as reported in this study. Regarding lesion progression in primary teeth, no studies were rated higher than C.

Permanent teeth - rate of approximal lesion progression

Table 1.2 (17- 41) summarises 25 studies dealing with the *rate of approximal lesion progression* in permanent teeth, and is categorised according to four modes of preventive intervention: (a) fluoride toothpaste alone, (b) fluoride toothpaste in combination with fluoride varnish, or (c) in combination with fluoride rinse or gel, and (d) “other” treatment mode not related to any particular intervention involving use of fluoride. The studies of the effects of fluoride varnish, rinse, and gels, on lesion progression were for the most part conducted on samples whose members were already using fluoride toothpaste. Subject age varied considerably across studies. Data for mixed age groups were pooled, and hence any age-related effect could not be elucidated. The results show that compared with enamel lesions, dentine lesions were more likely to progress, and progression rates were lower in studies in which the measurement system did not divide the enamel into outer and inner zones.

Summary of findings - A summary of the progression rate of lesions in subjects aged 8 to 18 years, taken from the studies of 36 months duration only, as listed in Table 1.2, show that the median progression rate estimates of OE lesions that were treated with (a) fluoride toothpaste alone, (b) fluoride toothpaste in combination with fluoride varnish, or (c) in combination with fluoride rinse or gel, and (d) “other” treatment mode were: 56%, 49%, 53%, and 63%, respectively. For IE lesions, the respective values were: 80%, 59%, 77% and 82%. Data from three studies relating to age groups above 18 years pertained to dental students and showed that, in this particular population, progression rates were very low.

Toothpaste - The studies in which fluoride toothpaste was the intervention mode were conducted in low fluoride areas. Progression incidence in relation to OE and IE lesions was in the order of 70-90% (18, 19, 21), however, it was reported that lesion regression of 7% was reported in one of these studies (18, 20). With regard to enamel, as a whole, lesion progression was reported as 52% in historical radiographs (the UK data analysed by Pitts and Renson) whereas in a study of Hong Kong dental students, only 18% of lesions were observed to progress and, moreover, 6% of lesions regressed (20). The outcome of the RCT comparing the effect of toothpastes containing 250

Table 1.2. Summary of studies reporting on the rate of approximal carious lesion progression/regression on outer and inner enamel (OE & IE) and outer and inner dentine (OD & ID) in permanent teeth

Reference	Country F status	N	(Age)	Design	Treatment, frequency	(No. of Control, lesions) frequency	(No. of Months lesions) duration	Progression estimate (%)										Strength of estimate	
								Treatment					Control						
								OE	IE	OD	ID	ALL	OE	IE	OD	ID	ALL		
Foster, 1998 (17)	UK nr	65	(17-79)	Prospective non-contd.	Individual preventive advice on use of F toothpaste, 2/day + Flossing, daily + Snacking <5 times/day	(54) na	(na)	36	nr	nr	50	92	69	na	na	na	na	B	
Brabner et al., 1995 (18)	UK <0.3 ppm	165	(12)	Historical cohort	1000 ppm F toothpaste, nr	(90) na	(na)	36	81 [-7] ⁵	89 [-8] ⁵	92	nr	83	na	na	na	na	B	
Bjarnason & Finnbogason, 1991 (19)	Iceland Non-F	315	(11)	RCT	1000 ppm NaF toothpaste, nr	(852)	(638)	36	72	80	nr	nr	nr	68 ¹	85 ¹	nr	nr	C	
Pitts & Renson, 1987 (20)	1) Hong Kong 0.8 ppm	nr	(20)	Prospective non-contd.	Dental students used F tooth paste, nr	(50) na	(na)	18	18 ⁴ [-6] ^{4,5}	nr	nr	nr	nr	na	na	na	na	B	
Fluoride toothpaste	2) UK Non-F	nr	(11)	Prospective non-contd.	Sn-F-Ca pyrophosphate toothpaste, nr	(50) na	(na)	24	52 ⁴ [-2] ^{4,5}	nr	nr	nr	nr	na	na	na	na	na	
	UK	1162	(11)	RCT	0.8% MFP toothpaste (low abrasive), nr	(152)	(202)	36	nr	80	95	na	nr	nr	81 ¹	87 ¹	na	nr	B
	Murray, 1986 (21)	nr			0.8% MFP toothpaste, (conventional abrasive), nr														
Fluoride varnish	Bruun et al., 1985 (22)	Denmark	251	(9)	RCT	(207)	(202)		nr	79	86	na	nr	nr	81 ¹	87 ¹	na	nr	na
	Modeer et al., 1984 (23)	nr Sweden 0.2 ppm	194	(14)	RCT	(86)	(63)	36	50	100	100	na	60	44 ³	75 ³	100 ³	na	49	B
	Grondahl et al., 1984 (24)	Sweden 0.1 ppm	135	(13)	Prospective non-contd.	(264)	(388)	36	60 [-7] ³	62 [-2] ³	na	na	61	61 ³	77 ³	na	na	42# 64	B
					0.2% NaF varnish (Duraphat), 4/yr + 0.2% NaF rinse, fortnightly	(310) na	(na)	36	49	55	100	100	40	na	na	na	na	na	B
					F varnish (Duraphat), 2/yr + F rinse, fortnightly + OHI & diet advice based on individual needs + F tablet, nr														
	Seppa et al., 1983 (25)	Finland 1.2 ppm	60	(11)	Prospective contd.	(131)	(152)	36	14	nr	nr	nr	nr	nr	28 ^{2,4}	nr	nr	nr	B

¹ Non significant, ² Significant, ³ p-value not reported, ⁴ (OE + IE) lesions, ⁵ Regression, # Individuals, na = not applicable, nr = not reported

(Cont.) Table 1.2. Summary of studies reporting on the rate of approximal carious lesion progression/regression on outer and inner enamel (OE & IE) and outer and inner dentine (OD & ID) in permanent teeth

Reference	Country F status	N	(Age)	Design	Treatment, frequency	(No. of Control, lesions) frequency	(No. of Months lesions) duration	Progression estimate (%)										Strength of estimate
								Treatment					Control					
								OE	IE	OD	ID	ALL	OE	IE	OD	ID	ALL	
Bille & Carstens, 1989 (26)	Denmark 0.5 ppm	278	(13)	Prospective contd.	Up to 4 applications of 2% NaF gel + OHI, 2/yr	(52) 2% NaF gel, several times for two months + Professional plaque removal, fortnightly + F products; nr	(96) 24	38	11	nr	nr	nr	36 ¹	15 ¹	nr	nr	C	
Axelsson et al., 1987 (27)	Sweden Non-F	252	(13)	RCT	0.2 % NaF toothpaste, 2/day + placebo rinse, weekly 0.2 % NaF toothpaste, 2/day + 0.7 % Fluor Protec, 4/yr Placebo toothpaste, 2/day + 0.05 % NaF rinse, weekly F varnish (Fluor Protector), 2/yr + Placebo rinse, fortnightly	(86)# 0.2% NaF toothpaste, 2/day + 0.05% NaF rinse, weekly (78)# 0.2% NaF toothpaste, 2/day + 0.05% NaF rinse, weekly (74)# 0.2% NaF toothpaste, 2/day + 0.05% NaF rinse, weekly (86) 0.2% NaF rinse, fortnightly + Placebo varnish, 2/yr	(82)# 36	42	nr	nr	nr	nr	45 ¹	nr	nr	nr	C	
Bruun et al., 1985 (22)	Denmark nr	251	(9)	RCT	Placebo paste, nr + 10% SnF ₂ rinse, 2/yr + placebo toothpaste, nr	(81) Placebo	(198) 48	85	nr	nr	nr	nr	88 ¹	nr	nr	nr	C	
Powell et al., 1981 (28)	Australia <0.1 ppm	307	(12)	RCT	Placebo paste, nr + placebo rinse, 2/yr + 0.4% SnF ₂ toothpaste, nr Placebo paste + 10% SnF ₂ rinse, 2/yr + 0.4% SnF ₂ toothpaste, nr	(129) Placebo (147) Placebo	(198) 48	77	nr	nr	nr	nr	88 ²	nr	nr	nr	B	
Kolehmainen & Rytomaa, 1977 (29)	Finland nr	59	(24)	Prospective non-contd.	Dental students received professional fluoride application, 2/yr + F toothpaste, 2/day + diet advice, nr	(318) na	(na) 24	3	(OE to OD)	nr	na	na	na	na	na	na	C	
Forsman, 1974 (30)	Sweden 0.2 ppm	253	(12)	RCT	0.025% NaF rinse, weekly + OHI, nr	(91) 0.2% NaF rinse, weekly + OHI, nr	(109) 24	30	nr	nr	nr	nr	20 ^{3,4}	[9] ⁵	nr	nr	C	
Hyde, 1973 (31)	Canada Non-F	122	(6)	RCT	APF, 4 min. at baseline 8% SnF ₂ solution, at baseline Silver nitrate solution, at baseline	(45)# Placebo (29)# Placebo (30)# Placebo	(18)# 24	51	nr	nr	nr	nr	82 ^{2,4}	82 ^{2,4}	nr	nr	C	
Hollender, 1969 (32)	Sweden Non-F	400	(10)	Prospective contd.	0.22% NaF toothpaste, daily 10 ml 0.5% NaF rinse, fortnightly	(122)# Placebo dentifrice (87)# Placebo rinse	(18)# 36	69	nr	nr	nr	nr	82 ^{2,4}	51 ²	nr	nr	B	
Muhler et al., 1967 (33)	USA 1 ppm	86	(adults)	Prospective contd.	Dental students received SnF ₂ paste, nr + Topical SnF ₂ , 2/yr + SnF ₂ - Ca ₂ P ₂ O ₇ toothpaste, 2/yr	(nr) Placebo paste + Placebo rinse + Placebo toothpaste	(nr) 30	84	nr	nr	nr	nr	425*	50 ²	nr	nr	C	
progression in lesion size																		

¹ Non significant, ² Significant, ³ p-value not reported, ⁴ (OE + IE) lesions, ⁵ Regression, # Individuals, na = not applicable, nr = not reported, * % increase in lesion size

(Cont.) Table 1.2. Summary of studies reporting on the rate of approximal carious lesion progression/regression on outer and inner enamel (OE & IE) and outer and inner dentine (OD & ID) in permanent teeth

Reference	Country F status	N	(Age)	Design	Treatment, frequency	(No. of Control, lesions) frequency	(No. of Months lesions) duration	Progression estimate (%)										Strength of estimate
								Treatment					Control					
								OE	IE	OD	ID	ALL	OE	IE	OD	ID	ALL	
Tweetman & Peterson, 1999 (34)	Sweden 0.1 ppm	107	(8)	Prospective contd.	1% CHX-thymol varnish (Cervitec), 3 times/2 wk + Regular preventive care, 1/yr	(119) Regular preventive care, 1/yr	(nr)	24	31	32	67	nr	34	nr	nr	nr	B	
Hintze, 1997 (35)	Denmark nr	197	(15)	Prospective non-contd.	Community care since age 3, 1/yr	(613) na	(na)	36	31 ⁴ [-5] ^{4,5}	71	100	37	na	na	na	na	A	
Hugoson et al., 1985 (36)	Sweden nr	80	(15)	Prospective non-contd.	No exposure to systematic prophylactic measure during the study	(297) na	(na)	60	63	75	94	67	nr	na	na	na	B	
Cook, 1984 (37)	Australia nr	95	(adults)	Prospective non-contd.	Dental students received routine preventive care, nr	(88) na	(na)	32	32	42	86	na	39	na	na	na	C	
Granath et al., 1980 (38)	Sweden Non-F	126	(12)	Prospective non-contd.	School dental care + Regular check up, 1/yr	(396) na	(na)	24	71	65	nr	nr	nr	na	na	na	D	
Grondahl et al., 1977 (39)	Sweden nr	158	(16)	Prospective non-contd.	Follow up after leaving school dental services	(1554) na	(na)	36	62	82	89	nr	74	na	na	na	B	
Zamir et al., 1976 (40)	Israel nr	51	(14-24)	Prospective non-contd.	nr	(96) nr	(na)	36	88	85	nr	nr	nr	na	na	na	B	
Backer-Dirks, 1966 (41)	Nether-lands nr	100	(11)	Prospective non-contd.	nr	(92) na	(na)	48	52 ⁴	nr	nr	nr	nr	na	na	na	A	

¹Non significant, ² Significant, ³ p-value not reported, ⁴(OE + IE) lesions, ⁵ Regression, # Individuals, na = not applicable, nr = not reported

versus 1000 ppm fluoride on progression incidence was that they were nearly identical (19). In one study that compared the incidence of progression of OD lesions, the result was similar to the incidence of the enamel lesions (21). The evidence from most toothpaste studies was rated B.

Fluoride varnish - Among studies published in the mid-80s, conducted in low fluoride areas, in which fluoride varnish was the mode of intervention, the incidence of both OE and IE lesions was in the order of 40-60%; the inner lesions tended to progress at a greater rate. An exception was an incidence of 14 and 28% in relation to the use of Duraphat and a placebo varnish respectively observed in Finland in an area where the drinking water fluoride concentration was 1.2 ppm (25). Lesion regression of 7% in OE was reported at 36 months in both treatment and control arms in one study (23). The 100% progression reported for outer dentine lesions most likely indicates a restorative decision rather than lesion progression (24). Evidence from all fluoride varnish studies was rated B.

Fluoride rinses and gels - Several applications of 2% NaF gel per year, whether or not accompanied by twice monthly professional plaque removal, was associated with an OE progression incidence of around 37%. In this study, the progression incidence of IE lesions was substantially lower; in the order of 10-20% (26). However, studies published from 1969 to 1989 on the effect of fluoride rinses, of both different concentrations and application frequency, were associated with two different incident rates, both of which were higher than that associated with the use of fluoride gel. The incident rates observed were either around 40-50% or around 70-90% in relation to both OE and IE lesions (22, 27, 28, 31, 32). The lower progression outcomes were associated with studies conducted in Scandinavia, whereas the higher progression rates were associated with an Australian and Canadian study. The Australian study showed that the progression incidences of OE lesions associated with the combinations of (a) a SnF₂ fluoride rinse and non-fluoride toothpaste and (b) a SnF₂ fluoride rinse and a SnF₂ fluoride toothpaste were 85% and 65%, respectively, whereas the progression incidences of OE lesions in all of the control samples were 88% (28). The Canadian results were similar except that for those in one sub-group, who used an APF rinse, the progression incidence for the combined OE and IE lesions

was 51% (31). In the Swedish study, two groups of children were given weekly rinses; for one group, the concentration was 0.025% fluoride and for the other, 0.2% fluoride. Progression rates were 30% and 20%, respectively (30). The study of Finnish dental students demonstrated a progression rate of as little as 3% (29). Evidence from studies in this group was rated B or C.

Other intervention modes - The Backer Dirks study is included in this group; the oldest and longest running study of its kind (41). It was observed that at the height of the caries pandemic in industrialised countries, and prior to the introduction of water fluoridation and the advent of fluoridated toothpaste, caries progression was not inevitable and that approximal lesions progressed slowly; on average, only 52% of lesions progressed from enamel to dentine in four years. Progression was slower in the study involving dental students (37) and the important observation that IE lesion regression was 30%, is noted. OE lesion regression of 14% and 5% was also reported (35, 36) and OD lesion regression of 3% was reported in another study in this section (35). Evidence from studies in this group was rated A or B.

Overall trends in the rate of approximal lesion progression - In order to visualise (a) differences in mode of intervention, (b) any secular trends, and (c) trends relating to exposure duration (follow-up interval), progression estimates derived from both arms of each study in relation to OE and IE lesions, and lesions within enamel as a whole, are presented in Figure 1.1. The estimates shown refer only to study subjects aged 8 to 18 years. Since the progression estimates for OD lesions were uniformly high across all intervention modes, they are not included in this figure.

Broadly, lesion progression in OE and IE lesions at 36 months, in association with the combined use of fluoride toothpaste and either fluoride varnish or fluoride rinse/gel, occurs at a lower rate than in the case of the use of fluoride toothpaste alone (see Figure 1.2 for further summary). Regarding the effect of fluoridated toothpaste alone on lesion progression in OE, the secular trend indicates that progression rates at 36 months have increased since 1987. While the earliest estimate was 42% (27), the most recent is 81%. The one study reporting a 48-month result estimated that 77% of lesions had progressed beyond OE.

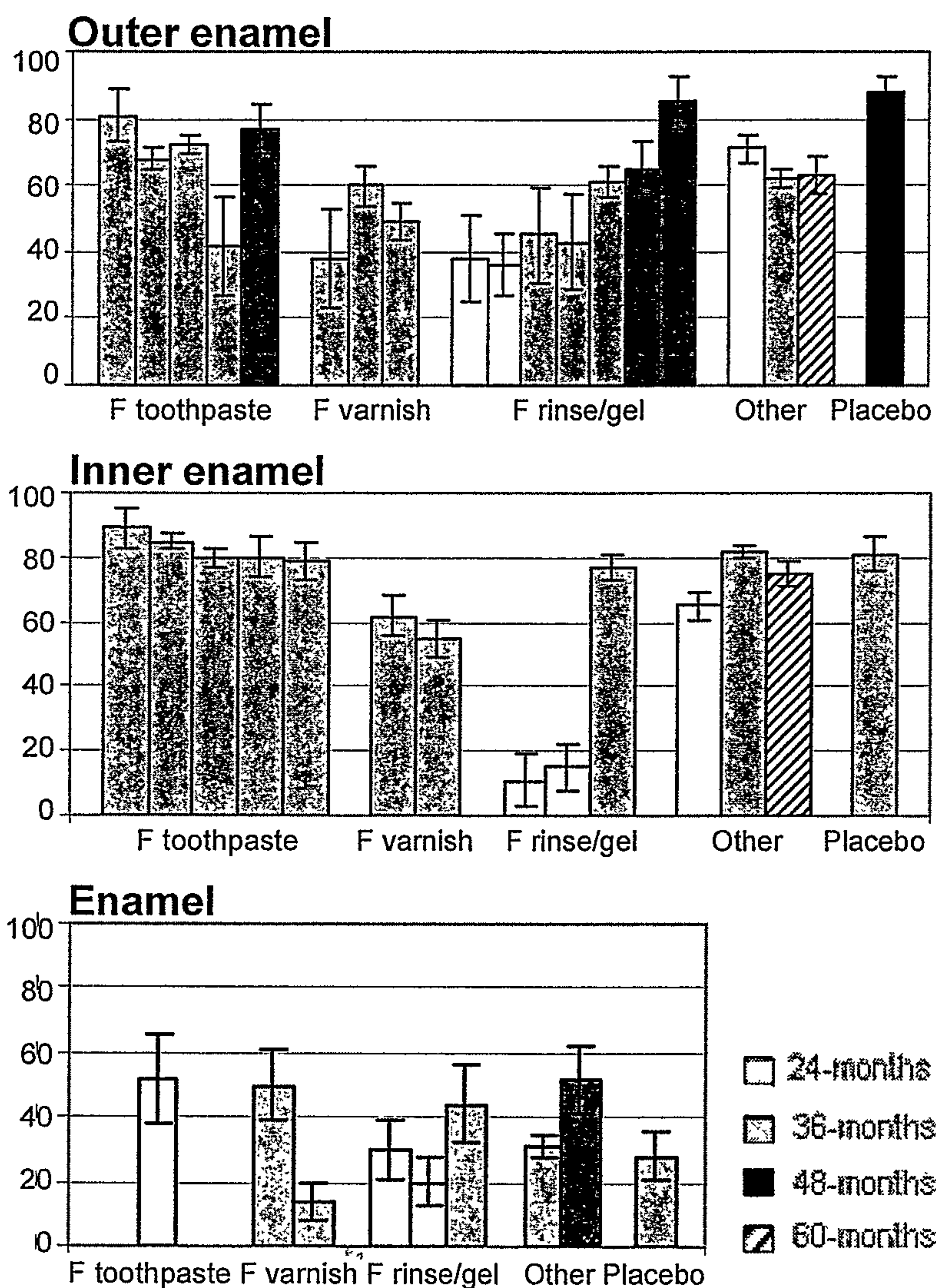


Figure 1.1. Progression rate estimates, with 95%CI, of approximal carious lesions from individual studies of subjects aged 8 to 18 years, stratified by mode of intervention and follow-up interval. The estimates relating to the same follow-up intervals are arranged in chronological order in which the left-most bar refers to the most recent study.

Progression estimates at 36 months for outer enamel lesions for both varnish and rinses/gels ranged from about 40% to 60%, and with regard to the secular trend seen in relation to the rinses/gels, the more recent estimates indicate reduced progression. In relation to the use of fluoride rinse/gel, there is a clear trend that progression appears to increase as a function of time, in which the 24 and 48-month studies were associated with progression rates of around 40 and above 60%, respectively. The earlier 48-month progression estimate of 85% was in association with the use of a non-fluoridated toothpaste.

Three estimates from “other” studies, not related to any particular intervention involving use of fluoride, but related to follow-up intervals ranging from 24 to 60 months, indicated that 60 to 70% of lesions had progressed. Progression of almost 90% was reported in association with a placebo intervention.

Progression estimates for IE lesions show that except for those treated with fluoride varnish, all estimates at 36 months were around 80%. No secular trend was evident with regard to any particular intervention. The two 36-month estimates associated with fluoride varnish were around 60%, however, two rinse/gel progression estimates at 24 months were below 20%.

When lesion progression from within enamel as a whole (that is, not delineated as OE or IE lesions) to dentine is considered, the rate estimates appear to be slower than those from either OE to IE or IE to OD. The 36-month progression estimates, across the fluoride varnish and fluoride rinse/gel intervention modes, range from 15 to 50%. For the fluoride rinse/gel and “other” intervention mode groups, which include studies of different duration, it appears that progression increases with time. While it is observed that the placebo intervention was associated with lesions that were associated with low progression rates, it is noted that this study occurred in a fluoridated area.

Assuming a linear model of progression, estimates of annualised lesion progression rates were calculated in a meta-analysis with respect to both OE and IE lesions and were based on the outcomes of the individual studies of 36 months

duration only. In this general linear model analysis, the estimates were weighted by the number of lesions that were followed. The annualized progression estimates for OE lesions in relation to the use of (a) fluoride toothpaste alone, and (b) fluoride toothpaste in combination with fluoride varnish, rinse, or gel were 22% (95%CI = 20%, 24%) and 19% (95%CI = 15% to 22%), respectively. For IE lesions, the equivalent estimates were 27% (95%CI = 26% to 29%) and 22% (95%CI = 19% to 25%), respectively. The effect difference at 36 months between the mean progression estimates for lesions treated with (a) fluoride toothpaste alone and (b) the combination of topical fluoride products was 11% ($p=0.063$) in relation to OE lesions and 16%, ($p=0.008$) in the case of IE lesions (Figure 1.2).

The progression model was pursued further by adjusting for study duration. In this analysis, the progression estimate from each study was divided by the study duration to give a monthly estimate. Using least squares regression, the mean average progression estimate per month for OE lesions treated with fluoride toothpaste alone at two years was nearly 3%, decreasing to 1.8%, 1.6%, and 1% in relation to lesions that were followed for three, four, and five years, respectively, or annualised as 36%, 22%, 19% and 12%, respectively. This decrease in observed average monthly progression is consistent with a model in which the incidence of progression is higher in the first two years and then attenuates over time. This behaviour is not present in the group of studies in which the lesions were treated more intensively using the combination of topical fluoride products. The average monthly progression estimates in these studies of two, three, and four years duration were roughly 1.5%, 1.4%, and 1.3%, or annualized as 18%, 17%, and 16%, respectively (Figure 1.3).

Regarding the IE lesions, a similar monthly progression trend was observed in relation to the fluoride toothpaste alone studies; that is, the rate of progression appeared to peak at 24 months and then attenuate, whereas for the combination of topical fluoride products, the pattern for IE lesions was not the same as for OE lesions. Monthly progression rates for IE lesions treated with a combination of topical fluoride products were low at two years and then appeared to increase. The respective annualised values for two, three, and five years in relation to (a) fluoride toothpaste alone and (b) a combination of topical fluoride products were, respectively, 32%,

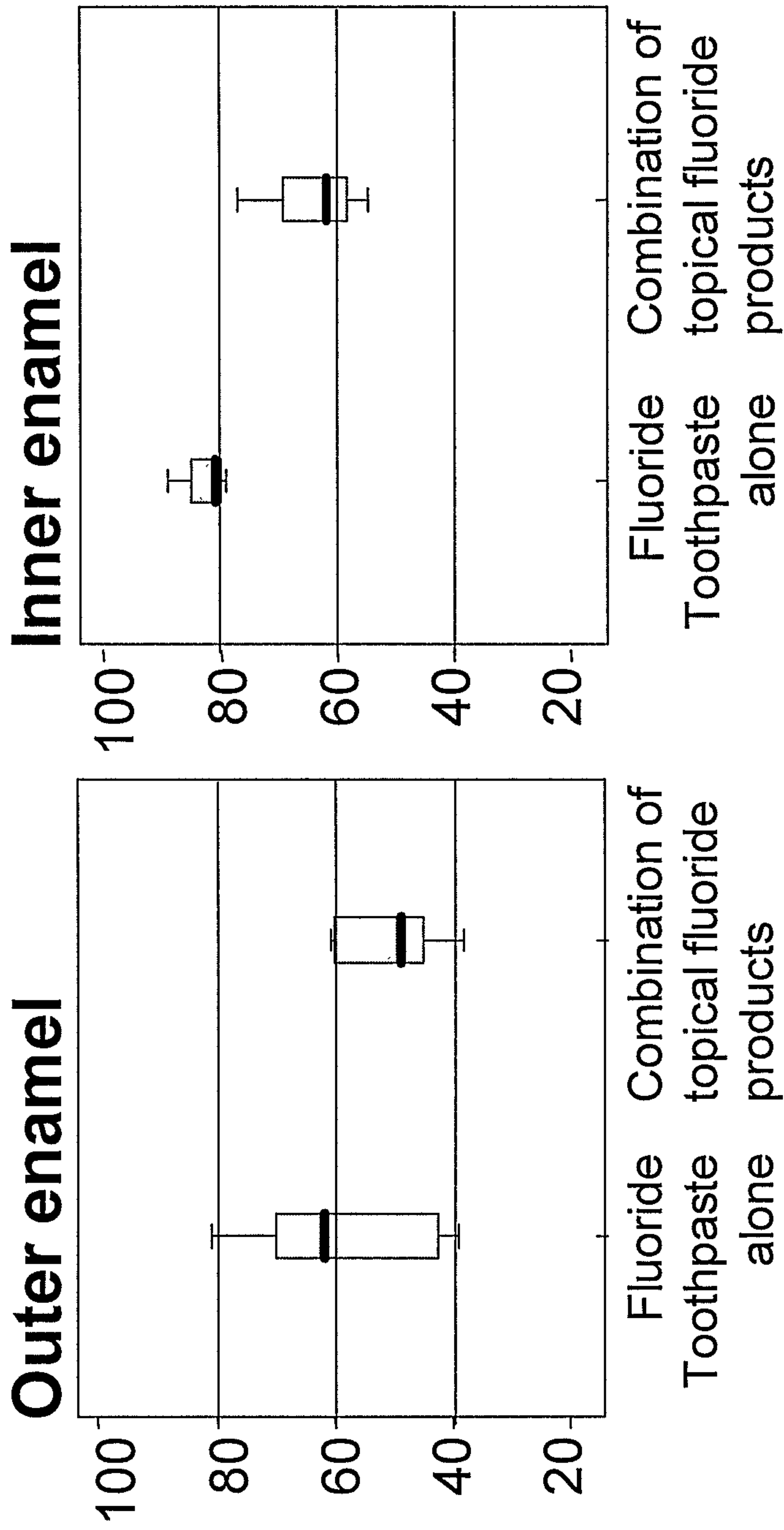


Figure 1.2 Box plot distributions illustrating the effect difference at 36 months between progression estimates for lesions treated with (a) fluoride toothpaste alone and (b) a combination of topical fluoride products in individuals aged 8 to 18 years.

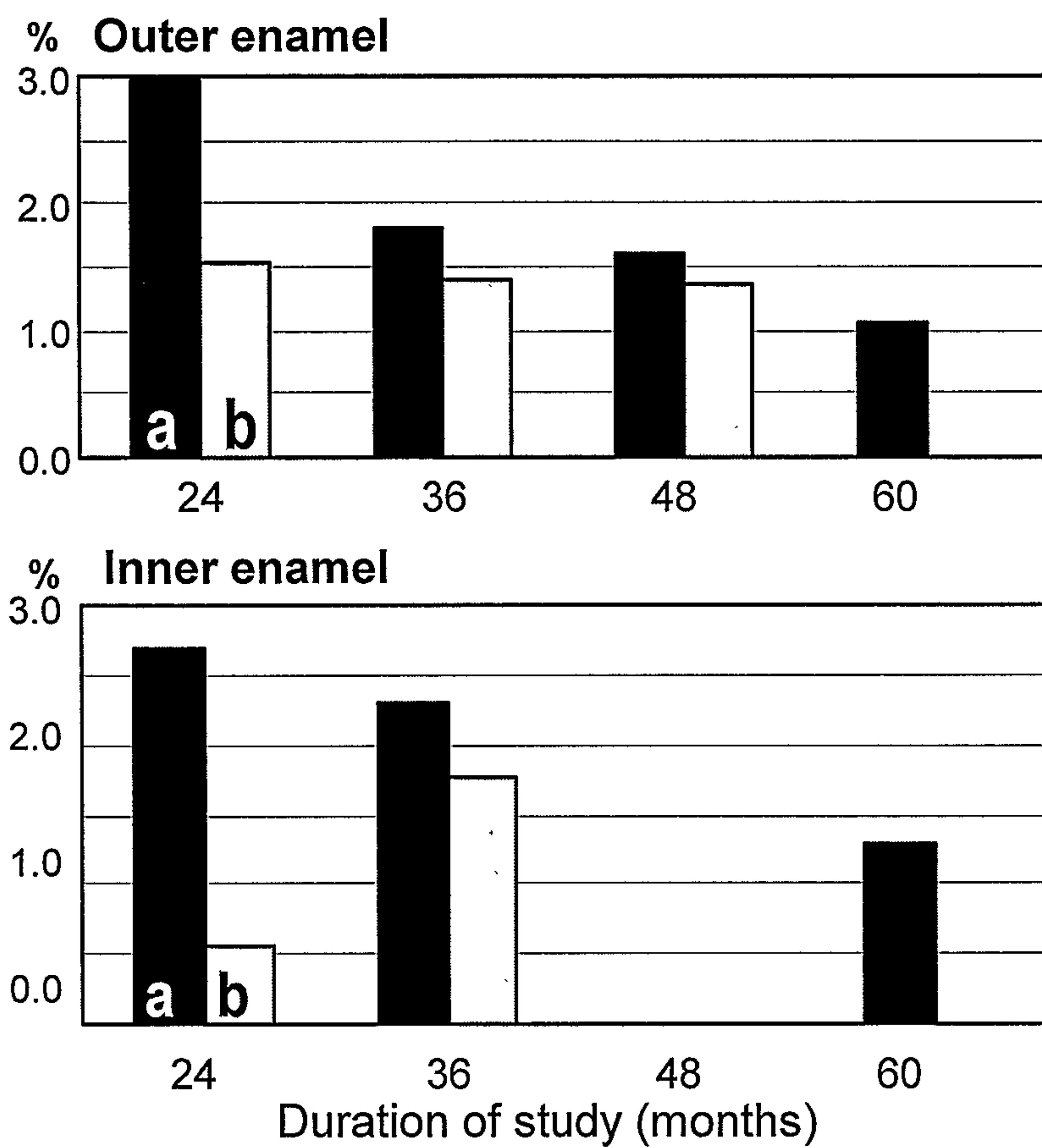


Figure 1.3. Mean average progression per month of approximal lesions in association with (a) use of fluoride toothpaste alone or (b) with the combination of fluoride toothpaste, fluoride varnish, rinse, or gel, stratified by duration of study.

28%, 16%, and 7%, 21%, (no data available at four years). There were insufficient data from the few studies available to demonstrate any statistical significance in relation to the modelling in which study duration was taken into account.

Permanent teeth - mean progression score

Table 1.3 (34, 42, 43) summaries three studies reporting *mean progression scores* in permanent teeth. Results have been reported in relation to three controlled studies on the effect of chlorhexidine varnish, and variations in frequency of application of fluoride varnish on the caries progression. The studies were conducted over periods of 24, and 36 months. The most recent study (42) used this scoring system slightly differently, and treated both OE and IE lesions as combined in the analysis, and hence the scores probably indicate conservative estimates. In this study, the progression score in the treatment group was only one quarter that of the control group (0.1 vs 0.4). The other studies (34, 43) reported mean progression scores in relation to OE lesions in the experimental groups of 0.41, and -1.63, respectively (negative sign indicates lesion regression). Use of chlorhexidine varnish was more effective than "regular dental care", and both fluoride varnish protocols resulted in lesion regression. The studies in this group were rated A to C.

Permanent teeth - survival analysis

Table 1.4 (10, 13, 28, 31, 38, 40, 41, 44-49) summarises 11 studies reporting survival analysis in terms of (a) median incidence rate, per 100 surface-years, of progression of approximal lesion, and (b) median or mean survival time of approximal lesions. The median survival time of OE lesions ranged from 9.7 months, associated with a study conducted in a low fluoride area and with no reported preventive intervention (40), to 45 months (10) (Table 1.4). The longer survival times were associated with preventive strategies that included use of fluoride toothpaste and topical fluoride applications. IE lesions survived for median periods ranging from 12.5 to 57.6 months, where again, the longer periods were associated with preventive strategies. In two studies (28, 44, 45), where OE and IE lesions were aggregated as enamel lesions, the median survival times ranged from 38 to 125 months, respectively. In two studies that reported on the status of OD lesions over periods ranging from 120 to 156 months, the median survival times were around 38 months (44, 45, 47, 48).

Table 1.3. Summary of the studies reporting mean progression/regression scores of approximal carious lesions in permanent teeth

Table 1.3: Summary of the studies reporting mean progression (SD) of approximal carious lesions in F																
Reference	Country F status	N	(Age)	Design	Experimental group, frequency	(No. of lesions)	Control group, frequency	(No. of lesions)	Months duration	Mean progression estimate (SD)						Strength of estimate
										Experimental			Controls			
										OE	IE	OD	OE	IE	OD	
Skold et al., 2005 (42)	Sweden	758	13	RCT	F varnish (Duraphat), 2/yr	(nr)	No intervention	(nr)	36	0.1 ⁴ (0.35)	nr	nr	0.4 ^{2,4} (0.92)	nr	nr	A
Twetman & Petersson, 1999 (34)	Sweden	167	(8)	Prospective contd.	1% CHX-thymol varnish (Cervitec), 3 times in 2 wk + F toothpaste, daily + Regular preventive care, nr	(424)	Regular preventive care, 1/yr	(nr)	24	0.41 (0.64)	nr	nr	0.62 ³ (0.9)	nr	nr	B
Petersson et al., 1991 (43)	Sweden	160	(11)	RCT	Duraphat, 3 times/week once a year + OHI & diet advice, nr	(nr)	Duraphat, 2/yr + OHI & diet advice, nr	(nr)	36	[-1.63] ⁵ (nr)	nr	nr	[-1.04] ^{3,5} (nr)	nr	nr	C

¹ Non significant, ² Significant, ³ p-value not reported, ⁴ (OE + IE) lesions, ⁵ Regression, # Individuals, na = not applicable, nr = not reported

Table 1.4. Summary of the studies reporting on survival analysis of approximal carious lesions in permanent teeth

Reference	Country F status	N	(Age)	Design	Treatment, frequency	(No. of lesions)	Duration (months)	Outcome estimate						Strength of estimate
								Median incidence rate per 100 surface-years			Median/Mean survival time (months)			
								Sound to E	E to OD	OD to ID	OE	IE	OD	
Vanderas et al., 2003 (10)	Greece < 0.03 ppm	196	(6)	Prospective non-contd.	APF gel 4min in tray, 1/yr + OHI, 1/yr + F toothpaste, nr	(33)	48	nr	nr	nr	45	nr	nr	C
Lith et al., I & II, 2002 (44, 45)	Sweden, 1.2 ppm	285	(6)	Historical cohort	Topical fluoride, 1/yr + OHI & diet advice, 1/yr	(nr)	156	nr	nr	nr	22.8	43.2	38.4	A
Hintze, 2001 (46)	Denmark, nr	640	(16)	Historical Army cohort	Community dental care, since age 3 + Postpone filling until obvious cavity or radiolucency in inner dentin	(12797)	87	2.4	9.2	2.3	nr	nr	nr	A
Mejare et al., 1998, 99 (47, 48)	Sweden, 0.3 ppm	536	(11)	Prospective non-contd.	Duraphat, 1/yr + (high risk patients 4/yr) OHI & diet advice, 1/yr (for high risk patients 4/yr)	(3421, 13640)	120	3.9	5.4	20.3	nr	57.6	37.2	A
Shwartz et al., 1984 (13)	1) Sweden, <0.1 ppm 2) USA, Non-F 3) Sweden, <0.1 ppm	100 117 99	(10) (11) (17)	Prospective non-contd. Prospective non-contd.	NaF solution, fortnightly + Regular dental check up, 1/yr No intervention, low SES	(223) (192) (561)	48-120	nr	nr	nr	20.9	27.9	nr	C
	4) USA, Non-F Low SES	342	(17)	Prospective contd.	NaF solution, fortnightly + F varnish, 2/yr + Regular dental check up, 1/yr	(765)		nr	nr	nr	22.6	18.6	nr	
					NaF solution, fortnightly + F varnish, 2/yr + Regular dental check up, 1/yr			nr	nr	nr	37.6	47.4	nr	
					APF gel, on 10 consecutive school days + NaF rinse, daily (for 2yrs)			nr	nr	nr	20.1	26.5	nr	
					Placebo gel, on 10 consecutive school days + NaF rinse, daily (for 2yrs)			nr	nr	nr	13.8	26.5	nr	
					APF gel, on 10 consecutive school days + Placebo rinse, daily (for 2yrs)			nr	nr	nr	18.8	26.5	nr	
					Placebo gel, in 10 consecutive school days + Placebo rinse, daily (for 2yrs)			nr	nr	nr	9.7	26.5	nr	
	5) Sweden, <0.1 ppm	100	(21-22)	Prospective non-contd.	NaF solution, fortnightly + Regular dental check up, 1/yr	(642)		nr	nr	nr	41.2	56.4	nr	

¹Non significant, ²Significant, ³p-value not reported, ⁴(OE + IE) lesions, # Individuals, na = not applicable, nr = not reported

(Cont.) Table 1.4. Summary of the studies reporting on survival analysis of approximal carious lesions in permanent teeth

Reference	Country F status	N	(Age)	Design	Treatment, frequency	(No. of lesions)	Duration (months)	Outcome estimate					Strength of estimate		
								Median incidence rate per 100 surface-years			Median/Mean survival time (months)				
								Sound to E	E to OD	OD to ID	OE	IE		OD	
Powell et al., 1981(28)	Australia <0.1 ppm	307	(12)	RCT	10% SnF ₂ solution, 2/yr in 1st & 2nd year (not 3rd & 4rd year)+ Placebo dentifrice + Placebo paste Placebo solution + 0.4% SnF ₂ dentifrice + Placebo paste 10% SnF ₂ solution , 2/yr in 1st & 2nd year only + 0.4%SnF ₂ dentifrice + Placebo paste Placebo rinse + Placebo dentifrice + Placebo paste	(81) (129) (147) (198)	48	nr	nr	nr	16	nr	nr	C	
												38			
												19	nr	nr	
												49			
												34	nr	nr	
												72			
												16	nr	nr	
												38			
Granath et al., 1980 (38)	Sweden Non-F	126	(12)	Prospective non-contd.	School dental care & check up, 1/yr	(396)	24	nr	nr	nr	19.4	22.9	nr	D	
Zamir et al., 1976 (40)	Jerusalem, nr	51	(14, 21)	Prospective	nr	(96)	36	nr	nr	nr	9.7	12.5	nr	B	
Hyde, 1973 (31)	Canada Non-F	122	(6)	RCT	APF, 4 min at baseline 8% SnF ₂ solution, 4 min at baseline Silver nitrate solution, 4 min at baseline Placebo	(45)# (29)# (30)# (18)#	24	nr	nr	nr	33.5 ⁴	21.4 ⁴	nr	C	
												20.6 ⁴	nr		
												14 ⁴	nr		
Marthaler & Wiesner, 1973 (49)	Switzerland nr	133	(7)	Prospective non-contd.	F toothpaste, nr	(518)	84	nr	nr	nr	20.5	nr	nr	C	
Backer-Dirks, 1966 (41)	Netherlands, nr	100	(11)	Prospective non-contd.	nr		48	nr	nr	nr	70.5		nr	A	

¹Non significant, ² Significant, ³ p-value not reported, ⁴(OE + IE) lesions, # Individuals, na = not applicable, nr = not reported, *as reported in ref 13

Survival is also reported in terms of mean survival time. In one study (13), the outcome, in relation to OE lesions, for children belonging (in Sweden) or not belonging (in USA) to preventive programs, was similar; 21-22 months

However, for adolescents, those exposed or not exposed to preventive strategies, had mean survival times for OE lesions of 38 and 10-20 months, respectively. The results for IE lesions were similar, though slightly better (13). In another Swedish study (38) conducted at the same time, mean survival times in children for OE and IE lesions were 19 and 23 months, respectively. Three studies, including the landmark study of Backer Dirks, reported on mean survival times for combined OE and IE enamel lesions that ranged from 14 to 71 months (31, 38, 41).

More recently, survival has been reported in terms of median incidence rate of progression. In two studies, in which enamel lesions were followed for 87 and 120 months, the median incidence rates of progression from enamel to dentine were 9.2 and 5.4 per 100 surface-years respectively, or equivalently, 9.2% and 5.4% of enamel lesions progressed into dentine per year respectively (46-48). For progression from OD to ID, the median incidence rates were 2.3 and 20.3 per 100 surface-years respectively. In relation to the survival of sound surfaces reported in these two studies, the median incidence rates of enamel lesions were 2.4 and 3.9 per 100 surface-years, respectively. Most studies in this group were rated A or C.

Discussion

This systematic review of reported progression/regression of approximal carious lesions found that lesion progression outcomes might be expressed in several meaningful ways. In more recent times, lesion progression has been assessed in relation to a variety of preventive interventions in controlled studies, whereas the focus of the early studies, such as that by Backer Dirks, was in measuring progression *per se* in the absence of any preventive mode. Hence, the studies that were reviewed according to our selection criteria were heterogeneous in terms of sample size, age, study duration, background fluoride, and mode of and intensity of preventive intervention. In these circumstances it is possible to reach a conclusion that may be

phrased in general terms only, in contrast to the outcome of a meta-analysis which is defined in terms of a best estimate bound by a confidence interval. Most papers that we reviewed did not address our research question directly as they were written for other purposes. Their significance was in relation to the evidence that each contributed indirectly to our research question.

Primary teeth

A substantial majority of lesions in primary teeth appear to progress over 24-month observation periods, even in situations where the children had participated in preventive programs. The most recent study (10) indicates median survival times for lesions of two to three years, raising expectations that under favourable conditions, the need for operative intervention in primary teeth, prior to their exfoliation, can be averted.

Permanent teeth

Lesion progression in permanent teeth is less than in primary teeth, and more likely to occur in non-fluoridated areas. The secular trend of an increasing lesion progression associated with fluoride toothpaste use may not be real, and could be due an "outlier" result of the Axelsson study (27). The use of fluoride varnish and rinses/gels, in combination with fluoride toothpaste use, appears to be associated with lower progression rates and longer survival rates than use of fluoride toothpaste alone. However, appearances can be deceiving; in most cases, varnish use was in addition to current use of fluoride toothpaste, and the apparent greater effect of varnish is, in fact, the added effect of the varnish over and above that due to fluoride toothpaste alone. Generally, the more comprehensive preventive strategies, employing a package of preventive measures, were associated with lower progression rates. In particular, strategies that were followed by highly motivated patients, such as dental students, were seen to be most effective in retarding progression.

The studies included in this review span a period of about 40 years. During this period, lesion survival rates appear to have increased. This most likely reflects the additive effects of increasing exposure to water fluoridation, fluoride toothpaste, additional topical fluoride agents as prescribed in preventive programs, or taken up as

a result of media advertising and added to the range of personal oral hygiene habits. In addition, a general improvement in standards of personal hygiene has occurred over this period, including increased frequency of daily tooth brushing (50).

A meta-analysis of studies in Table 2, restricted to those in which subjects were aged up to 18 years, showed that lesion progression behaves differently, depending on mode of topical fluoride treatment. Lesions in subjects whose fluoride exposure was mainly from fluoride toothpaste, progressed at a greater monthly rate, at least up to two years, compared with lesions treated with a combination of topical fluoride products that included fluoride toothpaste. However, the lower rate of progression associated with the combined fluoride therapy, rather than attenuating (within the limits of the data range), was, never-the-less, almost constant, indicating the challenge that faces efforts toward non-invasive caries management. Although in some studies, notably recent ones in which success, in terms of survival analysis, appeared to be very promising and demonstrating, therefore, that some clinicians can deliver efficacious treatment, the effectiveness of such programs in the real world will depend on constant vigilance on the part of both patient and clinician to sustain the favourable conditions under which such arrest did occur.

The possibility of lesion arrest, even in a population at high risk of caries, was first demonstrated by Backer Dirks (41) and then more comprehensively so by Grondahl (24). It is difficult to understand how this fact was not exploited more fully at that time. The fact that a lesion arrests is indicative of a situation reflecting a reduced exposure to cariogenic factors, or to an increased exposure to anti-cariogenic factors, or both. However, there is no guarantee that this situation will be sustained on a permanent basis with the consequence that the lesion in question will remain arrested.

This review has highlighted the phenomenon of lesion regression, first studied in detail by Pitts on a sample of dental students, but in fact, has been reported on since 1975 (20, 51). Pitts observed that regression was evident in 6% of lesions that were confined to enamel only. In another study of lesion progression in dental students, the regression incidence of enamel-only lesions was 30% (37). However, in one study of

OE lesions (36), the incidence of regression was reported at 14%, but only modest levels of regression at 5 to 7% were reported in other studies (18, 23). In relation to IE lesions, regression incidence of 2% was reported in two studies, but such results could be related to measurement error (23, 35). In one other study, OD lesion regression of 8% was reported (18). At this time, due to the scarcity of studies on lesion regression, it is not possible to predict the probability of lesion regression in relation to any particular preventive application, other than to note that this event does occur and that it should be pursued as the best possible treatment outcome.

Since non-invasive approaches have, in the main, not been attempted despite evidence from one study that 50% of radiolucencies, confined to the outer half of dentine, were not associated with enamel cavitation (52), the potential for gathering follow-up data on lesion behaviour has been mostly forfeited and hence data on the dentine lesion progression and regression is most scarce. Most recent authors refer to half-way mark between the enamel surface and the dentine enamel junction to measure the extent of lesion progression in enamel. However, for dentine, there is no accepted standard. Authors have expressed dentine progression variously as: 0.5 mm into dentine, or into the outer and inner halves of dentine, or into the outer, middle, and inner thirds of dentine. It would be desirable if a standard system existed for the assessment of lesion progression into dentine.

The progression/regression estimates derived from studies rated as A, may be used to inform the development of protocols to be used in circumstances where patients attend for dental care on a regular basis at intervals determined according to their risk status. The preventive strategies in studies rated B can also be used to inform the development of preventive protocols but more caution would be needed in the application of such protocols; recall appointments for follow-up would need to be strictly monitored. Rating C indicates that evidence is available to indicate that caries progression is not inevitable, but that progression rates observed across these studies are highly variable. In these circumstances, study results indicate only that monitoring is possible and that any protocols that are designed according to strategies followed in these papers should be regarded as tentative. Studies that are not standardized in terms of radiographic technique have limited potential for informing protocol development.

Recommendations for further research

As more emphasis is placed on non-invasive caries management methods, the analysis of lesion status will become an important consideration and there will be strong demands for the use of standardised methods of diagnosis.

Recommendation 1 - A simple method for standardising the positioning of the bitewing film and x-ray beam is needed for use, especially by researchers (and by practitioners who wish to standardise their within-practitioner reliability regarding bitewing diagnosis), to ensure that a series of images are reliable and non-distorted, and hence will allow for unbiased readings.

It appears that the assessment of the status of enamel lesions has been successfully refined through scoring OE and IE lesions separately.

Recommendation 2 - For monitoring dentine lesions, it is suggested that consideration be given to a scoring system that divides the distance between the dentino-enamel junction and the pulp chamber into three equal zones.

It is necessary to consider the division of the dentine thickness into thirds because lesions that extend fully through the outer half of dentine are regarded by practitioners as deep lesions, and they are not convinced that it is safe to postpone operative intervention (even for 6 months) in order to pursue an alternative non-invasive remineralising strategy. The division of the dentine into three zones is manageable, thus it should be possible to gather data on the extensions of radiographic lesions into these zones (including the outer and inner halves) for analysis. The result of this would lead to better information becoming available to practitioners who may then be persuaded to take a less radical intervention approach.

Recommendation 3 - Further research is needed to clarify the likelihood that radiolucences, which extend into the outer third and middle third of dentine, are subject to arrest and remineralisation, or are cavitated and in need of restorative care.

Until it is demonstrated otherwise, the guiding principle should be that non-cavitated surfaces associated with symptomless teeth should not be subjected to restorative intervention.

Recommendation 4 - More studies in adults, and more long-term studies need to be conducted with regular follow-ups to allow for better modelling of the behaviour of lesions over time.

Conclusions

It is concluded from the results of this systematic review that: (a) progression of dental caries, which leads to cavitation on approximal surfaces is not inevitable, (b) IE lesions are more likely to progress during a given period than OE lesions, (c) in children and adolescents, lesion progression is less rapid in subjects who receive professional applications of topical fluoride in addition to home use of fluoridated toothpaste, than in subjects whose topical fluoride source is limited to fluoride toothpaste alone, (d) some lesions do arrest, (e) lesion arrest is more likely to occur in individuals who are exposed to a caries preventive strategy that includes attention to: (i) home-care plaque control, topical fluoride application via fluoridated toothpaste, and fluoride rinses, (ii) professional application of high concentration fluoride products, and (iii) patient motivation through coaching and monitoring activities, (f) lesion regression occurs via remineralisation of both enamel and dentine, though there is insufficient data currently to indicate how extensive this phenomenon is, (g) lesion progression generally occurs slowly, though faster in primary teeth and in low-fluoride areas, although (h) in some individuals, the progression of caries from enamel to dentine occurs in a matter of months.

The utility of this review

This review and analysis demonstrates that: (a) time is on the side of efforts to arrest caries progression safely via non-invasive strategies, (b) once arrested, an arrested status may be sustained. It is noted that the non-invasive strategies aimed to arrest caries progression also prevent new primary lesions.

In this context, "safely" means that within the timeframe of a recall period, the patient will be unlikely to experience a level of deterioration that would be more compromising than being exposed to an early operative intervention.

This analysis of lesion progression may be used to inform the development of better protocols for non-invasive caries management. For example, an indication that the incidence of caries progression over a period of 36 months is, say 22%, means that it is 78% likely that a similar lesion, similarly treated, would not progress in 36 months and, therefore, that it is safe to pursue a non-invasive management strategy for an initial 6-month review period, and during other such intervals thereafter. The practitioner may advocate this approach by noting the advantages for the patient, such as: (a) the health benefit of caries risk reduction, (b) the benefit that a non-cavitated proximal surface will likely be preserved, (c) the potential for cost saving due to deferring (hopefully indefinitely) a probably unnecessary restoration, and (d) the elimination of the stress associated with the same.

No protocols may be regarded as fail-safe and, therefore, prognosis guarantees cannot be given. Nevertheless, it is now entirely possible for non-invasive lesion management to be promoted confidently. So as long as patients are (a) informed about the status of lesions that are being monitored, (b) understand the nature of the risks, (lesion progression leading to pulp infection/pain and subsequent need for emergency care and associated costly follow up or tooth extraction) and benefits of non-invasive management, and (c) understand that they should seek attention if symptoms are experienced, dentists should not be fearful that a perceived delay in adopting an invasive strategy will be considered as negligent. Should such a challenge arise, a substantial evidence base is available to support a defence of the use of non-invasive measures.

Acknowledgements

We are grateful to Dr Diana Kingston, Dental Librarian, for her expert assistance with the literature search.

References

1. Pitts NB. Diagnostic tools and measurements - impact on appropriate care. *Community Dent Oral Epidemiol* 1997;25:24-35.
2. White BA, Maupome G. Clinical decision-making for dental caries management. *J Dent Educ* 2001;65:1121-1125.
3. Anusavice K. The maze of treatment decisions. In: Fejerskov O, Kidd E, editors. *Dental Caries-The disease and its clinical management*: Oxford: Blackwell Munksgaard; 2003. p. 251-265.
4. Anusavice KJ. Clinical decision-making for coronal caries management in the permanent dentition. *J Dent Educ* 2001;65:1143-1146.
5. NIHC. National Institute of Health Consensus Development Conference, March 26-28; Diagnosis and management of dental caries throughout life. *J Dent Educ* 2001;65:1162-1168.
6. Pitts NB. Monitoring of caries progression in permanent and primary posterior approximal enamel by bitewing radiography - A review. *Community Dent Oral Epidemiol* 1983;11:228-35.
7. Vanders AP, Skamnakis J. Effectiveness of preventive treatment on approximal caries progression in posterior primary and permanent teeth: A review. *Eur J Paediatr Dentistry*. 2003;4:9-15.
8. Bader JD, Shugars DA, Bonito AJ. A systematic review of selected caries prevention and management methods. *Community Dent Oral Epidemiol* 2001;29:399-411.
9. Treasure ET. Methods of stopping or reversing early carious lesions fluoride: A European perspective. *J Dent Educ* 2001;65:1073-1077.

10. Vandas AP, Manetas C, Koulatzidou M, Papagiannoulis L. Progression of proximal caries in the mixed dentition: A 4-year prospective study. *Pediatr Dent* 2003;25(3):229-34.
11. Gisselsson H, Birkhed D, Bjorn A-L. Effect of a 3-year professional flossing program with chlorhexidine gel on approximal caries and cost of treatment in preschool children. *Caries Res* 1994;28:394-399.
12. Peyron M, Matsson L, Birkhed D. Progression of approximal caries in primary molars and the effect of Duraphat treatment. *Scand J Dent Res* 1992;100:314-8.
13. Schwartz M, Grondahl H-G, Pliskin J S, Boffa J. A longitudinal analysis from bite-wing radiographs of the rate of progression of approximal carious lesions through human dental enamel. *Archs Oral Biol*. 1984;29:529-536.
14. Craig GG, Powell KR, Cooper MH. Caries progression in primary molars: 24-months results from a minimal treatment programme. *Community Dent Oral Epidemiol* 1981;9:260-265.
15. Murray JJ, Majid ZA. The prevalence and progression of approximal caries in the deciduous dentition in British children. *Br Dent J* 1978;145:161-164.
16. Erp NAKM van, Meyer-Jansen AC. A caries study of the temporary molars and its significance for their regular conservative care. *Neth Dent J* 1970;77(suppl 5):51-74.
17. Foster LV. Three year *in vivo* investigation to determine the progression of approximal primary carious lesions extending into dentine. *Br Dent J* 1998;185:353-357.
18. Brabner D, Downer MC, Moles DR, Naylor MN. Initial caries attack and average progression rates in 12-year-old Isle of Wright children. *Community Dent Oral Epidemiol* 1995;12:190-193.

19. Bjarnason S, Finnbogason SY. Effect of different fluoride levels in dentifrice on the development of approximal caries. *Caries Res* 1991;25:207-212.
20. Pitts NB, Renson CE. Monitoring the behaviour of posterior approximal carious lesions by image analysis of serial standardised bitewing radiographs. *Br Dent J* 1987;162:15-21.
21. Shaw L, Murray JJ. The progression of approximal caries in the permanent dentition of British children. *Community Dent Health* 1986;3:199-205.
22. Brunn C, Bille J, Hansen KT, Kann J, Qvist V, Thystrup A. Three-year caries increments after fluoride rinses or topical applications with a fluoride varnish. *Community Dent Oral Epidemiol* 1985;13:299-303.
23. Modeer T, Twetman S, Bergstrand F. Three-year study of the effect of fluoride varnish (Duraphat) on proximal caries progression in teenagers. *Scand J Dent Res* 1984;92:400-7.
24. Grondahl H-G, Andersson B, Torstensson T. Caries increment and progression in teenagers when using a prevention-rather than restoration - oriented treatment strategy. *Swed Dent J* 1984;8:237-242.
25. Seppa L, Hausen H, Tuutti H, Luoma H. Effect of a sodium fluoride varnish on the progress of initial caries lesions. *Scand J Dent Res* 1983;91:96-8.
26. Bille J, Carstens K. Approximal caries progression in 13- to 15-year-old Danish children. *Acta Odontol Scand* 1989;47:347-354.
27. Axelsson P, Paulander J, Nordkvist K, Karlsson R. Effect of fluoride containing dentifrice, mouthrinsing, and varnish on approximal dental caries in a 3-year clinical trial. *Community Dent Oral Epidemiol* 1987;15:177-80.

28. Powell KR, Barnard PD, Craig GG. Effect of stannous fluoride treatments on the pregression of initial lesions in approximal surfaces of permanent posterior teeth. *J Dent Res* 1981;60(9):1648-1654.
29. Kolehmainen L, Rytomaa I. Increment of dental caries among Finnish dental students during a period of 2 years. *Community Dent Oral Epidemiol* 1977;5:140-144.
30. Forsman B. The caries preventing effect of mouthrinsing with 0.025% sodium fluoride solution in Swedish children. *Community Dent Oral Epidemiol* 1974;2:58-65.
31. Hyde EJ. Caries-inhibiting action of three different topically-applied agents on incipient lesions in newly erupted teeth: Results after 24 months. *J Can Dent Assoc* 1973;3:189-193.
32. Hollender L, Koch G. Influence of topical application of fluoride on rate of progress of carious lesions in children. *Odontologisk Revy* 1969;20:37-41.
33. Muhler JC, Spear LB, Bixler D, Stookey GK. The arrestment of incipient dental caries in adults after the use of three different forms of SnF₂ therapy: results after 30 months. *JADA* 1967;75:1402-1406.
34. Twetman S, Petersson LG. Interdental caries incidence and progression in relation to mutans streptococci suppression after chlorhexidine-thymol varnish treatments in schoolchildren. *Acta Odontol Scand* 1999;57:144-148.
35. Hintze H. Caries behaviour in Danish teenagers: a longitudinal radiographic study. *Int J Paediatr Dentistry*. 1997;7:227-234.
36. Hugoson A, Rylander H, Koch G. Longitudinal study of dental caries in individuals in Jonkoping, Sweden, aged 15 years in 1973 and 20 years in 1978. *Community Dent Oral Epidemiol* 1985;13:100-3.

37. Cook SR. A longitudinal radiographic study of caries progression in dental students. *Aust Dent J* 1984;29:315-320.
38. Granath L, Kahlmeter A, Matsson L, Schroder U. Progression of proximal enamel caries in early teens related to caries activity. *Acta Odontol Scand* 1980;38:247-251.
39. Grondahl H-G, Hollender L. Dental caries and restorations in teenagers II. A longitudinal radiographic study of the caries increment of proximal surfaces among urban teenagers in Sweden. *Swed Dent J* 1977;1:51-57.
40. Zamir T, Fisher D, Fishel D, Sharav Y. A longitudinal radiographic study of the rate of spread of human approximal dental caries. *Archs Oral Biol* 1976;21:523-526.
41. Baker Dirks O. Post-eruptive changes in dental enamel. *J Dent Res* 1966;45:503-510.
42. Skold UM, Peteresson LG, Lith A, Birkhed D. Effect of school-based fluoride varnish programmes on approximal caries in adolescents from different caries risk areas. *Caries Res* 2005;39:273-279.
43. Petersson LG, Arthursson L, Ostberg C, Jonsson G, Gleeup A. Caries inhibiting effects of different modes of Duraphat varnish reapplication: A 3-year radiographic study. *Caries Res* 1991;25:70-73.
44. Lith A, Lindstrand C, Grondahl H-G. Caries development in a young population managed by a restrictive attitude to radiography and operative intervention: II. A study at the surface level. *Dentomaxillofacial Radiology* 2002;31:232-239.
45. Lith A, Lindstrand C, Grondahl H-G. Caries development in a young population managed by a restrictive attitude to radiography and operative intervention: I. A study at the patient level. *Dentomaxillofacial Radiology* 2002;31:224-231.

46. Hintze H. Approximal caries prevalence in Danish recruits and progression of caries in the late teens: A retrospective radiographic study. *Caries Res* 2001;35:27-35.
47. Mejare I, Kallestal C, Stenlund H, Johansson H. Caries development from 11 to 22 years of age: A prospective radiographic study. *Caries Res* 1998;32:10-16.
48. Mejare I, Kallestal C, Stenlund H. Incidence and progression of approximal caries from 11 to 22 years of age in Sweden: A prospective radiographic study. *Caries Res* 1999;33:93-100.
49. Marthaler TM, Wiesner V. Rapidity of penetration of radiolucent areas through mesial enamel of first permanent molar. *Helv Odont Acta* 1973;17:19-26.
50. Thylstrup A, Fejerskov O. Text book of clinical cariology; 1994.
51. Pitts NB. Regression of approximal carious lesions diagnosed from serial standardized bitewing radiographs. *Caries Res* 1986;20:85-90.
52. Bille J, Thylstrup A. Radiographic diagnosis and clinical tissue changes in relation to treatment of approximal carious lesions. *Caries Res* 1982;16:1-6.

PART II: Non-invasive Intervention for Dental Caries

Material from Chapters 2 and 3 have been submitted for publication in the *Australian Dental Journal*. Currently under review.

Authors: Evans RW, Pakdaman A, Dennison PJ, Howe E.

CHAPTER 2 - Introduction

Background

The principles of modern restorative dental care were established by GV Black one century ago, long before it became evident that dental caries could be arrested or prevented. In the absence of effective preventive strategies and with an increasing incidence of caries in industrialized countries, the restorative model of care became firmly established as the means of dental practice.

The concept of preventive dentistry was, however, well developed by the 1970s when protocols for use of individual preventive agents were already available (1). However, despite these developments, restorative care has remained the central management strategy for caries control in general practice.

Restorative care has limitations. The success of several conservative operative caries management strategies: the proximal *tunnel* restoration; the proximal *box-only* restoration; and the preventive resin restoration; was investigated by McComb in a systematic review. It was reported that

" In the permanent dentition, the evidence reveals low effectiveness for "tunnel" restorations, limited but supportive results for proximal-only restorations, and generally favourable outcomes for the occlusal composite resin-sealant restoration. The weak link in the latter is the overlying fissure sealant, which requires adequate ongoing maintenance. Conservative operative strategies in the primary dentition have not been uniformly successful, and deleterious material effects dominate restoration performance. This systematic review concludes that operative conservatism per se does not guarantee increased restoration longevity and that all restorations are vulnerable to caries recurrence, material failure, and technical deficiencies. The more

successful conservative strategies are expected to enhance tooth longevity, provided concomitant caries control is effective"(2).

Need for new directions in caries management

The introduction of water fluoridation resulted in a declining caries incidence, which decreased further following the advent of fluoridated toothpaste. The dentate population now, in many countries including Australia, is a mix of those who did not benefit from water fluoridation during their early years and as a result have many restored teeth in need of lifelong maintenance, and those who did benefit and are either clinically caries-free or have few restored teeth. In addition, there are in both groups, those who are more at risk of caries than others. The challenge today in relation to these caries risk groups is to develop a model of practice that will (a) sustain a low level of primary caries experience in the younger generation and (b) prevent primary and secondary caries experience in the older generations.

The possibility of moving towards an alternative non-invasive clinical approach to caries control became apparent fifty years ago following the publication by Backer Dirks (3) of his landmark eight-year prospective study of caries progression. He demonstrated, even during the caries pandemic sweeping Europe and before fluoridation was introduced in Holland, that caries on approximal surfaces was slowly progressive (in terms of years rather than months) and was susceptible to arrest.

It also became apparent that the dynamics of caries progression was extremely variable. Von der Fehr (4) had demonstrated on young healthy adults, that caries on smooth surfaces could be initiated and progress rapidly in a matter of weeks, but could be arrested and reversed in two months by a combination of meticulous plaque control and topical fluoride applications.

The chemistry of the caries process – demineralisation and remineralisation – including the role of fluoride is now well understood and provides the rationale for non-invasive methods of caries control (5).

The systematic review of the literature on the progression/regression of approximal carious lesions (Chapter 1) extend and confirm these findings and provide

further evidence on the nature of caries dynamics. This review has highlighted the fact that there is decreasing pattern in the rate of progression of proximal carious lesion during the last 40 years. More recent studies have demonstrated that it takes about 5 years for enamel lesions to pass through DEJ (dentine enamel junction) and establish in the outer half of dentine (6, 7). This pattern is obviously different from what was reported in late 70s (8).

Moreover, this review profoundly demonstrated the effect of fluoride products in retarding the rate of progression of proximal lesions (9) (10) (11) (12) (13) (14) (Chapter 1, Figure 1.2). Importantly, less progression over time was observed in studies that employed an intensive fluoride therapy (10, 11).

Considering the pattern of outcomes observed in this review associated with proven preventive agents, the data from these studies have been used as the basis for clear guidelines to a risk-based and conservative non-invasive approach to the management of carious lesions, as seen in bitewing radiographs (see below).

Caries diagnosis and intervention

The diagnosis of dental caries on proximal surfaces, and to some extent on occlusal surfaces, relies on the assessment of bitewing radiographs since many more lesions are detected though the use of bitewings than are detected by clinical inspection alone (42-44). However, not all lesions detected are in need of restorative care. The diagnostic threshold for restorative intervention is the D3 clinical lesion (a cavity extending into dentine). However, due to the declining prevalence of dental caries, the use of bitewing radiographs to identify this threshold has become problematic because of the consequent increase in frequency of false positive diagnoses, and hence poor positive predictive value. It was concluded that the sensitivity and specificity of bitewings to detect this threshold is moderate to high only when a lesion has an associated radiolucency that clearly extends into dentine (45, 46). Given that false positive diagnoses are inevitable, whatever threshold is selected, there is a risk of over-treatment. But, since carious lesions progress slowly, time is on the side of caution and it is possible to arrest progression and allow lesions to remineralise, or to

defer the instigation of invasive treatment until there is further evidence of non-arrestable progression (Chapter 1, this thesis).

Critical to the restorative model of caries management, is the diagnostic determination of signs that warrant a decision to treat. There is no universal agreement upon this point. With regard to proximal lesions, treatment decisions are reached following analysis of the depth of associated bitewing radiolucencies and in this respect the practice of dentists varies widely (15, 16). Rugg-Gunn showed little correspondence between the depth of a radiolucency and the clinical status of the tooth surface (whether or not it was sound, had an extensive white spot, or was cavitated) (17). In this study of English children, about 50% of the bitewing radiolucencies that extended to the DEJ, but not beyond, occurred in teeth that were cavitated. More recently in Denmark, which has a fluoride environment similar to Sweden (use of fluoride tablets, fluoride toothpaste, and fluoride rinses), Bille and Thylstrup found that only around 20% and 50% of radiolucences in adolescents that extended to the DEJ or were confined to the outer half of dentine, respectively, corresponded to tooth surfaces that were cavitated (18).

Clearly, there is a diagnostic dilemma. What sign indicates whether a proximal surface is cavitated and in need of a restoration, or has a progressive lesion that cannot be arrested, or could be arrested, or in fact, is already arrested? In a prospective study, Pitts (19) demonstrated that approximal carious lesions could not only be arrested, they could be reversed, as shown by the regression of bitewing radiolucencies.

Reform of dental caries management

The challenge to reform dental caries management has been taken up. Anusavice (20) published a protocol on "how modern preservative dentistry can be implemented" and new management principles, involving both preventive and restorative strategies have been described (21).

The American Dental Association has discussed the principles and rationale for treating caries as an infectious disease along with detailed options for preventive strategies (22). The focus of this review was on the primary prevention of caries.

Regarding the management of existing disease, and taking into account the new understanding of caries dynamics, the concept of Minimal Intervention Dentistry was developed, as reviewed by Tyas et al. (23).

The background to this review acknowledged that caries progression is, on average, slow, that it is reversible, and that restorative care should be delayed until cavitation has occurred. It was noted that if caries infection was managed better, up to a 50 percent reduction in the need for restorative care could be achieved.

Minimal intervention refers to the conservation of sound tooth structure during the process of surgical intervention. It is concerned with limiting damage to sound dental tissue during the surgical process to remove decayed dental tissue. This is achieved through new engineering principles designed to reduce the damaging effects from excessive tissue removal that, in previous times, was considered to be good practice (extension for prevention) but which, in fact, weakened the remaining tooth structure. This new approach was facilitated by the development of new adhesive restorative materials.

In their introduction to the techniques of minimal intervention, Mount and Ngo (24) refer to the need to diagnose and control active caries. There is an emphasis on patient education and motivation, but the objective of the motivation is not made clear. They suggest that positive steps can be taken to encourage the patient to bring about the control of disease. These include the identity of the microflora, presumably so that it may be controlled and that new kits to test pathogenic levels of infection can be used to provide proof that favourable outcomes can be achieved, and hence assist motivation. Other positive steps are to test for salivary flow, perform a thorough prophylaxis, use chlorhexidine mouthwash and topical fluoride, and place transitional restorations in all cavitated lesions. The use of the transitional restorations is an interim measure, which are not to be replaced with final restorations until active disease is eliminated.

Regarding the management of approximal lesions, these authors note that lesions that involve dentine, as seen in bitewings, are not necessarily cavitated and therefore in need of restorative care. They suggest that these surfaces be inspected

after separation with rubber spacing rings as used in orthodontics. Any non-cavitated surfaces should be treated intensively with fluoride varnish or gel "several times daily over a reasonable period".

On pit and fissure surfaces, it is recommended that sealants be used to protect defective areas, presumably (but not stated) due to initial caries. They stress, importantly, that this does not require the removal of any tooth structure and, drawing on the work of Mertz-Fairhurst *et al.* that "progress of the caries will be arrested for as long as the seal remains"(25, 26). The remainder of this paper deals with minimally invasive procedures for managing cavitated lesions.

Kidd and Fejerskov (27) highlighted that caries is a "ubiquitous natural process". It is associated with dental plaque that is always present and that within the plaque, metabolic fluctuations cannot be prevented. In situations regarded as favourable, the enamel matures, and in unfavourable situations, the enamel is subject to mineral loss. It is possible, however, to influence these situations and while caries, since it is a natural process, cannot be prevented, it is possible to arrest an advanced level of mineral loss leading to cavity development, and to remineralise the demineralised enamel, both partially and completely. These authors focus on the separate effects on caries of plaque control, fluoride exposure, dietary composition, and saliva factors.

They emphasise that the treatment of the caries lesion is concerned with the control of these factors and that the term "treatment" should not be restricted to operative management alone, since that only some lesions may need additional operative treatment. They emphasise, further, that the control of disease determinants is partly dependent on the behaviour of individuals who vary greatly. The authors believe that reserving the use of "treatment" for operative management has resulted in an attitude that operative treatment is complex and is the more important aspect of care while the control of the disease determinants is not complex and of secondary importance, and further, that it can be delegated to those of who are less fully trained. They challenge this attitude and identify that dental schools need to accept responsibility for changing this attitude to reflect that the more important and complex aspect of care is to arrest lesion progression and prevent cavity development.

The recent publication by Mount and Hume (28) of the second edition of *Preservation and restoration of tooth structure* continues the emphasis on operative intervention, even though the use of the word "preservation" in the title might indicate otherwise. Of the 20 chapters, only two are devoted to aspects of preservation. There is, of course, promotion of the minimal intervention approach, and an appropriate stress on the need to protect the pulp during and after tooth restoration.

In summary, these recent developments in caries management have continued the trend, commenced in the early 1970s, towards increasingly more conservative cavity designs for restorative care. In addition, the promotion of non-invasive approaches in caries management has occurred. This promotion has centred on establishing principles that should guide non-invasive management of caries by general dental practitioners. However, if this approach is to be successful, there needs to be a standardised system for diagnosis and intervention so that outcomes can be objectively monitored. The evidence, so obtained, can then be used as time goes by to modify any protocols in a controlled manner.

Advocacy for the need to decrease reliance on operative intervention and to foster non-invasive strategies for caries was given new impetus by the National Institutes of Health Consensus Development Conference on the Diagnosis and Management of Dental Caries throughout Life (29).

Study purpose

The purpose of this study was two fold: first, to develop a formal non-invasive intervention strategy for dental caries. The principles developed by Anusavice (20) and Fejerskov and Kidd (30) have been followed. The approach was to identify the sequence of steps along the path of caries clinical management, similarly to Anusavice (31), and to create a set of clinical protocols to be followed, depending on patient risk status. The second purpose was to implement this system in the Bachelor of Dentistry (BDent) curriculum, University of Sydney; to monitor the ability of the dental students to follow the Caries Management System protocols; to evaluate the

effectiveness of the Caries Management System in student clinical practice; and to evaluate the process of its implementation.

CHAPTER 3 - Material and Methods 1:

The Caries Management System

A formal non-invasive intervention strategy for dental caries was developed and referred to as the Caries Management System. The Caries Management System is a ten step non-invasive strategy to arrest and remineralise early lesions (Figure 3.1). This system was developed to implement a new Caries Management Policy that had been adopted by the Faculty of Dentistry, University of Sydney (Appendix 2).

The governing principle of this system is that caries management must include consideration of: (a) the patient at risk, (b) the status of each lesion, (c) patient management, (d) clinical management, and (e) monitoring.

Both dental caries *risk* and dental caries *treatment* are managed according to a set of protocols (see Figures 3.9-3.11 below) that are applied at various steps throughout patient consultation and treatment and have a twin focus on the primary prevention of caries and its secondary prevention (arrest and reversal of early lesions) through non-invasive measures. It is not concerned directly with the management of cavitated or symptomatic lesions other than recognizing their need for operative care and providing for this.

The patient at risk of caries

The case history and clinical examination provides an overview of unfavourable exposures to potential caries causative or risk factors (sucrose, fluoride, dental plaque, tooth morphology, and salivary characteristics).

Ten Steps of the Caries Management System	
1	Diet assessment
2	Plaque assessment
3	Bitewing radiographic survey
4	Caries risk assessment
5	Preparation of treatment plan
6	Case presentation at which patient is informed about: • Dental caries: □ Arrest □ Reversal/natural repair (remineralisation) □ Prevention □ Number and status of current lesions □ Role of dental practitioner in caries management □ Role of home care in caries prevention □ Current caries risk status of patient • Result of diet assessment and recommendations
7	Oral hygiene coaching
8	Topical fluoride application (both professional and home care)
9	Monitoring of plaque control and treatment outcomes at each visit
10	Recall program tailored to caries risk status

Figure 3.1. Ten step summary of the Caries Management System.

Content of the <i>Usual 24 hour Snacking Questionnaire</i>	
Five questions are asked.	
Do you usually have anything to eat or drink:	
1	as soon as you get up in the morning before breakfast ?
2	between breakfast and lunch ?
3	between lunch and dinner ?
4	after dinner ?
5	just before you go to bed or during the night ?
In relation to yes answers, the type and frequency of each sugar-containing food and beverage (shown on the lists below) that is consumed on that occasion is recorded. The number of spoons of sugar added to hot beverages is also recorded.	
Biscuit Cake Pastry Chocolates, lollies Other sweet food	Fruit juice Cordial Fizzy drinks (coke, lemonade, etc) Tea Coffee Other hot drink

Figure 3.2. Diet information obtained using the *Usual 24 hour Snacking Questionnaire*

Assessment of between-meal snacking: One of the main risk factors for caries is the frequent exposure to refined dietary sugar. As part of the dental history, a *Usual 24-hour Diet Questionnaire* is completed (Figure 3.2). Through analysis of the frequency of consumption of (a) between-meal sugar-containing snacks and (b) between-meal sugar-containing beverages, insight into the burden of diet related caries risk is achieved.

Assessment of dental plaque control: At the initial clinical examination and at every appointment thereafter, dental plaque distribution is recorded according to the Plaque Index on a form which has space for multiple dated entries (Figure 3.3) (32). It is equally acceptable to record, instead, scores that relate to gingivitis or bleeding on gentle probing.

Twelve sites are assessed: the buccal and lingual surfaces of the first permanent molars (8 sites) and the buccal and lingual surfaces of the upper and lower right permanent incisors (4 sites). The site on the buccal and lingual surfaces of each tooth to be assessed is the area adjacent to the gingival margin, extending from papilla to papilla. Individual surface scores are summed to give the patient score, which has a maximum value of 36.

Final assessment of the patient at risk follows completion of the bitewing radiographic survey described below.

The status of each lesion

Bitewing radiographic survey: The clinical examination for dental caries includes a radiographic bitewing survey to identify and score any radiolucencies according to the five category system proposed by Mejare (6) (Figure 3.4). These results are entered on a form (developed by PD) (33) that also allows for multiple dated entries so that radiographic changes can be followed serially (Figure 3.5). The purpose of this form is to aid monitoring of non-invasive management of early non-restored occlusal and approximal lesions. There is provision for recording the radiographic status of distal, occlusal, and mesial surfaces of posterior teeth. For each surface, there is a column of boxes numbered 1 to 5 corresponding to a lesion score. No entry is recorded for sound

surfaces. For each surface that presents with a radiolucency, *only one box* is filled in; that which corresponds to the radiolucency score. Radiolucencies associated with already restored occlusal and approximal surfaces (that is, secondary caries) are not recorded on this form.

Completion of the assessment of the patient at risk: Following the clinical examination and bitewing survey, the caries risk status of the patient is determined pragmatically, but not according to an assessment of exposures to various epidemiologic risk factors. Whereas the caries risk of the population can be predicted on the basis of these factors, the risk of the individual patient cannot. Nevertheless, knowledge of patient exposures to the various caries risk factors may help to explain the current clinical situation of each patient and define a starting point for individual counselling. Risk of caries, according to the Caries Management System, is determined at the first visit solely according to the clinical presentation of the dentition (Figure 3.6). At later follow-up appointments, risk is determined according to the incidence of new lesions.

Criteria for Plaque Index (Silness & Loe, 1964)

3 = **thick** plaque is visible along gingival margin (no need to probe)

2 = plaque is **visible** along gingival margin, with or without air drying (no need to probe)

1 = following air drying, plaque is **not visible**, but **can be picked up** with an explorer

0 = following air drying, plaque is **not visible** and **cannot** be picked up with an explorer

Notes:

1. If an index tooth is missing, score the nearest tooth in that sextant. If there are no teeth in the sextant, enter X.
2. If the plaque thickness varies along the gingival margin, score according to the worst situation.
3. The overall score is the sum of the 12 surface scores (maximum of 36).

Date: _____

Buccal

16	11	26
46	41	36

Lingual

16	11	26
46	41	36

Score _____

Figure 3.3. Criteria and instructions for reporting the Plaque Index scores, and one panel of recording boxes for the scores. (Note: There are 13 panels of boxes on one A4 page.)

Criteria for Bitewing Radiolucency Scores	
C0	No radiolucency evident (not recorded)
C1	Radiolucency is evident within the <i>outer half</i> of enamel
C2	Radiolucency extends to the <i>inner half</i> of enamel and may reach the DEJ
C3	Radiolucency extends <i>just beyond</i> the DEJ
C4	Radiolucency is evident within the <i>outer third</i> of dentine
C5	Radiolucency extends to the <i>inner two thirds</i> of dentine and may reach the pulp

Figure 3.4. Criteria for scoring bitewing radiolucencies on occlusal and approximal surfaces (after Mejare, 1999).

Key to Rating Caries			18	17	16	15	14	13	23	24	25	26	27	28
	Outer 1/2 of Enamel	1				55	54	53	63	64	65			
	Inner 1/2 of Enamel	2	DOM	DOM	DOM	DOM	DOM	DOM	MOD	MOD	MOD	MOD	MOD	MOD
	Just into Dentine	3	DOM	DOM	DOM	DOM	DOM	DOM	MOD	MOD	MOD	MOD	MOD	MOD
	Outer 1/3 of Dentine	4	DOM	DOM	DOM	DOM	DOM	DOM	MOD	MOD	MOD	MOD	MOD	MOD
	Inner 2/3's of Dentine	5	DOM	DOM	DOM	DOM	DOM	DOM	MOD	MOD	MOD	MOD	MOD	MOD
Date of radiograph: / /			48	47	46	45	44	43	33	34	35	36	37	38
Read by: (Print name).....			Other findings:- e.g. bone loss, unerupted teeth, resorption, cysts, etc.											
Date of reading: / /														
Signature:.....														

Figure 3.5. One panel of boxes on the *Bitewing radiographic assessment* form for recording bitewing findings. In this example, tooth 16 has a grade 4 radiolucency on the mesial surface and a grade 3 radiolucency on the occlusal surface. (Note: There are 3 such panels on an A4 sized form.)

Criteria for Caries Risk Status		
Caries Risk	New patient	Recall patient
Low	1 No clinical signs of caries 2 May have bitewing radiolucencies not greater than C3	< 1 new lesion per year
Medium	1 No frank cavitation 2 May have sticky pits or fissures 3 And/or bitewing radiolucencies not greater than C4	1 new lesion per year
High	1 Untreated frank cavities 2 And/or extensive white spot lesions 3 And/or C5 bitewing radiolucencies	> 1 new lesion per year

Figure 3.6. Criteria for assigning caries risk status.

Patient management

The management of the patient at risk entails obtaining co-operation to implement protocols that will deliver a package of non-invasive measures designed to arrest active non-cavitated lesions and, once arrested, to maintain arrest.

Case presentation and treatment planning: The caries findings are presented to the patient in a case presentation and this is aided by reference to a Tooth Decay information leaflet (Figure 3.7). The front side of this leaflet contains essential information regarding caries (that the decay process involves demineralisation and remineralisation, or natural repair, and that home care is the key to oral health) while other important information is contained on the reverse side. The leaflet avoids dental terminology, instead utilizing words and phrases familiar to the Sydney population. This pamphlet serves as the principle patient educational material for dental caries and provides a basis for obtaining informed consent from patients regarding the treatment plan. On this pamphlet, the number of tooth surfaces showing bitewing radiolucencies of varying depth is entered as appropriate. Alongside is an explanation of the diagnosis and consequent treatment need. The prime responsibility of the dental practitioner is to ensure that patients *understand* the diagnosis and management plan.

Diet advice: It is recognised that the process of changing an individual's diet is extremely difficult. However, because of the complexity of the diet-caries relationship, the probability that caries risk will be reduced by reducing refined sugar is strong only in the case where there is close to complete absence of sugar in the diet. It is almost impossible to achieve this goal in the world of today. While there is a sound theoretical basis for recommending that dietary sugar should be reduced, both

Tooth Decay

Tooth decay, can be stopped, reversed, and prevented.

Hidden decay can be seen on your x-rays.

Holes in teeth need to be cleaned out and then filled by your dental practitioner.

What can your dental practitioner do to stop decay ?

- give you the latest information on diet management and decay prevention
- show you a tooth brushing method tailor-made for you
- clean out and fill any teeth that have holes
- seal any deep groves on your chewing surfaces
- put concentrated fluoride on your teeth
- see you for regular checks

What can you do at home to prevent and stop decay ?

- use fluoridated water for drinking and preparing food
- eat and drink less sugary things *between meals* to stop the acid attack and aid the process of natural repair
- brush *twice daily* with a fluoride toothpaste - before bed and in the morning
- take care to do a good job with your brushing
- use fluoride gel, paste, or rinse if recommended
- use an antibacterial gel or rinse if recommended

Your situation is shown on the chart below:

	X-ray shadow	Number of surfaces affected	The most likely situation is	Treatment need
C1		☐	The surface has <i>minimal</i> decay which is most likely non-active or arrested.	Normal home care.
C2		☐	The surface has <i>slightly more</i> decay which may be non-active or arrested.	Normal home care.
C3		☐	Decay on this surface is <i>just under</i> the enamel layer, but is <i>probably not</i> a hidden cavity.	Special home care for at risk (high).
C4		☐	Decay extends under the enamel layer, and <i>it may or may not be</i> a hidden cavity.	Special home care and, <i>depending on risk</i> , filling.
C5		☐	This deep decay needs <i>urgent attention</i> .	Filling plus special home care.

Your current risk of decay is ☐ Low ☐ Medium ☐ High

You are strongly recommended to attend your next appointment on

Figure 3.7. Tooth decay information leaflet (front side only).

in relation to caries and other health problems, it should be clearly understood that effective diet counseling protocols aimed at reducing dietary sugar are scant, possibly non-existent (34). Nevertheless, dental practitioners accept responsibility for (a) assessing this dietary risk, (b) bringing this risk to the attention of patients, and (c) providing appropriate advice.

Oral hygiene instruction and coaching: The attainment of effective tooth brushing skills takes time and effort. Oral hygiene instruction and coaching, which has as its objective, the reduction in Plaque Index score, should be conducted in a bathroom type environment where there is access to a mirror and basin. Patients are trained to recognize plaque and gingivitis and to observe how quickly gingivitis will resolve following the institution of regular and careful tooth brushing. The development of oral hygiene skills is facilitated with reference to the *Where do I brush* leaflet shown in miniature in Figure 3.8. The main purposes of this pamphlet are (a) to illustrate toothbrush positions for oral hygiene practice, (b) for reference at future visits to demonstrate where plaque has not been removed, and (c), on the reverse side, to record the diet goals. This pamphlet complements the use of models during oral hygiene coaching. Note that the order of the boxes is: left - front - right, that is, the patient's mirror image. Clinical experience shows that more than two intensive sessions is necessary for patients to reach a level of proficiency and self-motivation that will sustain a life-long commitment to a habit of twice daily and careful tooth brushing.

Clinical management

The risk-based caries management options are: preventive, preservative (non-invasive), and restorative (invasive).

Cavitated lesions are managed using restorative procedures. Other lesions, discovered as a result of the bitewing survey, are managed with non-invasive methods (Figure 3.9). The application of topical fluorides for preventing, arresting, and remineralising lesions follows protocols relating to professional and home care use (Figures 3.10 and 3.11) (35).

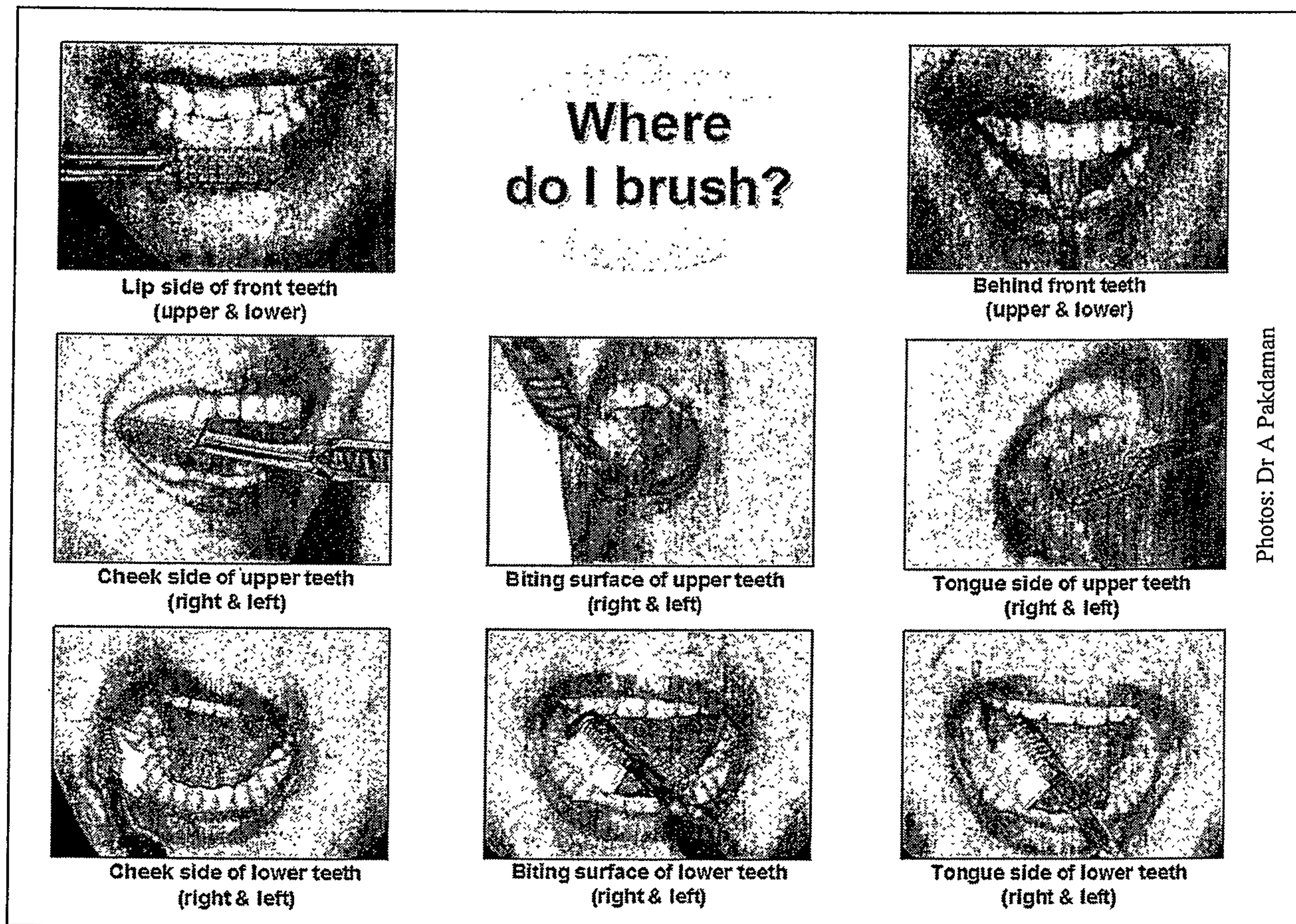


Figure 3.8. The *Where do I brush ?* leaflet (front side only).

Lesion Management Protocol	
Lesion score	Treatment
C1	Do not restore - apply topical fluoride and monitor
C2	Do not restore - apply topical fluoride and monitor
C3	Do not restore - apply topical fluoride and monitor
C4	Do not restore <i>without further consideration</i>
C5	Restore now - it is almost certain that the cavity has breached the DEJ
Caries Risk	Further consideration for surfaces scored C4
Low and Medium	• Restore <i>only if</i> the radiolucency extends <i>fully</i> 1/3 into dentine, or following tooth separation when cavitation is confirmed • Otherwise <i>do not</i> restore because it is most likely: ◦ that the approximal surface is not cavitated, and ◦ that the lesion has arrested • Apply topical fluoride and monitor: ◦ to arrest and remineralise active lesions, or ◦ to maintain arrested lesions
High	• Restore now • Apply topical fluoride and monitor: ◦ to arrest and remineralise lesions not yet showing radiographically, and ◦ to prevent recurrent caries

Figure 3.9. Protocol for the management of lesions following caries diagnosis based on the bitewing radiographic survey.

Topical Fluoride Protocol for Professional Care		
Caries Risk	Fluoride Varnish (Duraphat) 5% NaF (22,600 ppm) or GIC (Fuji 7)	Fluoride Gel 1.23% NaF (12,300 ppm)
Low	1 Apply varnish or GIC to newly erupted wisdom teeth. 2 Yearly applications on lesions until arrested	At recall appointments to maintain lesion arrest.
Medium	1 Apply varnish or GIC to newly erupted wisdom teeth. 2 Apply varnish to all lesions at each treatment session, then 3 6-monthly varnish applications on lesions until patient becomes low risk.	NOT APPLICABLE
High	1 Apply varnish or GIC to newly erupted wisdom teeth. 2 Apply varnish to all lesions at each treatment session, then 3 3-monthly varnish applications on lesions until patient becomes medium risk.	NOT APPLICABLE

Figure 3.10. Professional care topical fluoride protocol for adults aged 18 years and over.

Topical Fluoride Protocol for Home Care			
Caries Risk	Toothbrushing with fluoride toothpaste (pea size)	Fluoride rinse 0.05% (220 ppm) NaF (neutral) ONE MINUTE	Chlorhexidine rinse or gel 0.2% CHX
Low	Twice daily using 1000 ppm	Not applicable	Not applicable
Medium	Twice daily using 1000 ppm	Once daily at a separate time from toothbrushing	Not applicable
High	Twice daily using 5000 ppm	Not applicable	Not applicable
Very high*	Twice daily using 5000 ppm	Not applicable	Once daily before bed
* For example, patients with hyposalivation, or who have active lesions on anterior teeth, or who have active lesions on buccal surfaces of posterior teeth.			

Figure 3.11. Home care topical fluoride protocol for adults aged 18 years and over.

Other than for lesions scored C4, management decisions about individual lesions are relatively uncomplicated. C5 lesions are almost certainly associated with cavitation into dentine and in need of urgent restorative treatment if pulp complications are to be avoided. Most C1, C2, and C3 lesions are unlikely to exhibit enamel cavitation and, therefore, do not warrant restorative intervention, whereas C4 lesions may or may not be so affected.

According to the CMS protocol, C4 lesions are scheduled for restorative care only where patients are rated at high risk, or, for medium and low risk patients, only when the lesion depth extends through fully one third of the dentine thickness, or when, following tooth separation, cavitation is confirmed.

Provided any cavities remain within enamel, the underlying dentine, although affected, remains uninfected and risk of rapid lesion progression is minimal. Radiographic analysis reveals that progression of lesions through enamel is usually very slow. In Holland in 1966, at the height of the caries pandemic, it was estimated that the mean time for lesion progression from enamel to dentine was four years (3). In Australia today, where the use of fluoridated toothpaste is almost universal and where most people have access to fluoridated water, caries experience in children and adolescents is substantially less than formerly and it may be assumed that lesion progression rates have also declined (36). Hence, there is no urgency for restorative intervention on discovery of lesions scored C4. Time is on the side of success in boosting the natural repair mechanism of remineralisation. For low and medium risk patients, it is beneficial and safe to defer the restoration of most C4 surfaces, either indefinitely or until cavitation is proved, because the negative consequences of acting on false positive diagnoses are minimized. That is, if arrested C4 lesions are not restored, then there are no harmful consequences for surfaces that are actually sound although showing white-spot lesions without cavitation. The C4 lesions are potentially arrestable. With referral to the *Tooth Decay* leaflet, the patient is informed of the potential problem, the probability of arrest, and the potential for arresting the lesion in this case. If, on follow-up, a C4 lesion has not progressed then it is reasonable to conclude that it has arrested, or had already been arrested, and that the surface is probably sound. If, on the contrary, it turns out that the C4 lesions are enamel cavities,

they may progress (without detriment in patients on regular recall) and when, at a later regular check up, the increased depth of the radiolucencies reveals that the lesions have not arrested, they may then be restored.

Monitoring

Patients are recalled for monitoring caries activity and toothbrushing competency according to a schedule based on caries risk (Figure 3.12). Monitoring of caries activity and patient health behaviour comprises assessment of bitewing radiolucency progression, diet control, plaque control, fluoride exposure and, in extreme cases of hyposalivation, saliva control.

Caries activity: The monitoring of lesions through the review of bitewing radiolucencies is the means to assessing caries activity. At recall appointments, the radiolucency status of new bitewings is compared with those of earlier series. Radiolucency regression or stability indicates lesion arrest and the need to maintain preventive care. On the other hand, radiolucency progression and/or the appearance of new lesions, either approximally or elsewhere, indicates caries activity. Accordingly, the patient risk determination is confirmed or amended and this, in turn, indicates which management protocols are to be followed. Consequently, some invasive intervention may be warranted, or the non-invasive measures may need to be applied with greater urgency.

Diet control: A review of diet history from time to time enables trends to be identified and discussed.

Plaque control: At each appointment, the Plaque Index distribution and overall score is recorded. Ongoing oral hygiene coaching and encouragement is necessary. The active demonstration of recording plaque/BOP and reviewing serial findings at each visit motivates patients to improve and maintain a high standard of oral hygiene. For very high risk patients, the use of chlorhexidine is indicated.

Fluoride exposure: More than any other factor, the management of an appropriate fluoride exposure is the key to caries control. In the absence of a positive response to

caries arrest, fluoride exposure is increased since it is the intervention that the patient is most likely to manage well. Both professional and home care schedules are adjusted, as necessary, according to patient risk.

Implementation

In cohort studies, it has been demonstrated that implementation of intensive preventive strategies results in substantial reduction in caries incidence (37) (38) and arrest and remineralisation of existing lesions (38, 39). In general dental practice, similar results have also been reported (38, 40).

Such results imply that patients understand the benefits of a non-invasive approach and since they do not enjoy having to endure restorative care, are motivated to maintain effective plaque control and topical fluoride use.

The anticipated outcome of implementing the Caries Management System in general dental practice is reduction in caries incidence and increased patient satisfaction. Since the attainment and maintenance of oral health is determined mainly by controlling both caries and periodontal disease, the implementation of the Caries Management System in general practice will promote both outcomes.

Recall Protocol		
Caries risk	Caries activity	Bitewing survey
Low	• 12 months following completion of treatment plan developed at first visit • then consider 18-24 month recalls	• at first visit • then 12 months later • then every 18-24 months
Medium	• 6 months following completion of treatment plan developed at first visit • then 6-monthly until patient is classified as low risk	• at first visit • then 6 monthly until patient becomes low risk
High	• 3 months following completion of treatment plan developed at first visit • then 3-monthly until ◦ home care goals have been achieved for: — oral hygiene — fluoride therapy ◦ lesion progression has arrested/reversed and patient is reclassified as medium/low risk	• at first visit • then 6 monthly until patient is reclassified as low risk

Figure 3.12. Recall protocol - schedule for monitoring caries activity and bitewing surveys.

CHAPTER 4 - Material and Methods 2:

Implementation of the Caries Management System in the clinical curriculum of the Bachelor of Dentistry program

Dental education at the University of Sydney

In 2001, the Faculty of Dentistry introduced a new curriculum that centred on problem-based learning. Entry to this new program is restricted to graduates only, in a move that aimed to broaden the educational base of dental graduates. The curriculum is built around four themes: life sciences, total patient care, personal and professional development, and dentist and the community. An important component of the personal and professional development theme was the inclusion of the principles of evidence-based practice. Experience in applying the concepts of evidence based practice is developed during the four-year BDent program (41).

Evidence based management of caries

The prospect to develop the course in cariology using evidence based material was realised as an opportunity to reform cariology teaching and learning, and more importantly, to steer the practice of caries management away from the dominant restorative approach and towards non-invasive care.

The Faculty of Dentistry, University of Sydney, adopted a new Caries Management Policy in 2003 (Appendix 2), which has as its focus, the non-invasive management of non-cavitated carious lesions. In order to make this policy operational, the Caries Management System was developed (Chapter 3, this thesis).

Student learning about dental caries

The underlying science relating to the dynamics of dental caries pathogenesis and the role of bitewing radiography in caries diagnosis and management is covered in the Foundations of Total Patient Care Theme during the first two years of the Bachelor of Dentistry curriculum. During this time, students also learn the principles and practice of conservative operative dentistry.

Implementing the Caries Management System in the students clinics

Student learning about the Caries Management System

Following the development of the Caries Management System, an instruction manual was compiled to introduce the system and to illustrate how to apply the protocols (Appendix 2).

At the beginning of Year 3, when students commence clinical general dental practice at the Westmead Centre for Oral Health, the students were informed by the principal investigator about the Caries Management System at a lecture and invited to give their consent for the monitoring data to be used for research purposes. At the same time, Year 4 students were similarly informed and invited to give their consent.

A folder containing Caries Management System manual was provided to each student together with a copy of the Caries Management Policy of the Faculty of Dentistry and sets of forms to be completed for each patient. Since these forms had not been approved by the Westmead Hospital Forms Committee, they could not be retained in the patient folders and they were retained in the student folders and brought to the clinical sessions. Subsequently, the *Bitewing radiographic assessment* form was approved by the Forms Committee and it is now retained in the patient folders.

Involvement of the clinical tutors

The clinical tutors were informed in small groups or individually about the Caries Management System and were given copies of the manual. They were asked to ensure that students followed the protocols and completed the forms. Informed consent was also sought and obtained from the clinical tutors so that the data relating to the clinical activities that they supervised could be used for research purposes.

The sample of patients

Two hundred and three patients were allocated for treatment in the General Practice Clinic by 51 Year 3 Bachelor of Dentistry students at the commencement of the first semester in 2004. Further allocations of patients were made during the year, but only those in the first round were followed in this review.

Total patient care clinical practice

During their clinical experience under the Total Patient Care Theme, students learned to take social, medical, and dental histories, and the details of how to conduct clinical oral examinations. The findings were entered on charts in patient folders (Appendix 3). Special tests, such as bitewing radiographs, were ordered as necessary. The radiographs were taken at the X-ray Department at the Westmead Centre for Oral Health by a radiographer. Two x-ray machines are used: Gendex 765, Des Plaines, Ill, USA, 65 kV DC, 7.0 mA; and Sirona, Heliodont DS, Germany, 60 kV DC, 7.0 mA. The RINN XCP film holder is used for F-speed or D-speed Kodak films. The exposed films are developed in a Velopex automatic processor (Medivance Co. England) using AGFA G 1381 developer and AGFA G 334 fixing solutions.

Following the development of the radiographic films and their mounting, the bitewing radiographs were assessed.

In the clinics, students placed the radiographs on light boxes (Medilite, Sydney, Australia), which deliver 10,000 lux (screen size 6 x 9 inches) of full spectrum light with fixed light intensity. The bitewing radiographs were read without magnification and the findings were entered on the form shown in Figure 3.5 (Chapter 3).

The scores associated with any radiolucencies associated with non-restored tooth surfaces were entered on the *Bitewing radiograph assessment forms*. With reference to the radiographic findings, draft treatment plans for individual lesions were recorded on the *Treatment plan report* forms and also on the hospital treatment plan charts in the patient folders. Any surfaces that were associated with recurrent caries or broken restorations were recorded on the hospital charts only. Approval for the draft treatment plans were obtained from the supervising clinicians prior to their implementation.

Data collection

During clinical sessions, the researcher, who was not involved in the clinical instruction of the students, collected the student folders containing the completed forms (bitewing assessment, plaque record, and draft treatment plans) and entered related data electronically. The patient folders were collected again at a later time by the researcher who read the bitewings independently without magnification, and blind to the student findings, using a light box with a fixed light intensity similar to the light boxes available in the student clinics. The researcher's scores of the bitewing images were recorded and entered electronically in order to make comparisons with the student scores. Tooth surfaces that were unerupted, extracted, overlapped, outside of the field of view of the bitewing, or unreadable due to poor contrast were recorded separately. Approximately 10% of the radiographs were selected randomly for duplicate scoring to assess examiner reliability. Data regarding the actual treatment delivered, as approved by the clinical tutors, that had been recorded in the patient folders in relation to each lesion identified radiographically, was retrieved and entered for computer processing and analysis. Data relating to occasions of oral hygiene instruction and topical fluoride delivery was retrieved from the electronic records maintained by the Westmead Centre for Oral Health.

Ethics approval

Ethics approval was sought and obtained from both the Human Research Ethics Committee of the Sydney West Area Health Service and the University of Sydney.

Clinical follow up after 24 months

Purpose of the evaluation

The purpose of this evaluation of clinical outcomes was to determine the:

1. Frequency of oral hygiene coaching sessions given to patients by students
2. Type and frequency of application of clinical preventive agents
3. Rate of arrest or reversal of carious lesions
4. Rate of progression of carious lesions

Data collection

The records of these patients who had approximal lesions at baseline were retrieved in 2006 and recent bitewing radiographs were reviewed. For cases that did not have recent bitewings, the patients were invited to attend for a follow-up examination and bitewing radiographs. These were read by the researcher (AP) under the same conditions as at baseline. Due to the likelihood that the diagnostic standards of the researcher had changed from baseline, the baseline radiographs were also re-read. Hence, the 2006 scores of the baseline and follow-up radiographs comprised the dataset for the clinical outcomes analysis. The follow-up readings were carried out blind to the baseline data recorded earlier and to the re-readings of the baseline radiographs in 2006. The data were entered on an Excel spreadsheet and exported for analysis using SPSS software (SPSS Version 12.00, 2006).

Data analysis

The data was processed using SPSS computer software (SPSS Version 12.00, 2006) to obtain distributions of the variables of interest. The intra-examiner reliability of the researcher and inter-examiner reliability of the researcher and principal investigator were tested by means of Cohen's κ statistic. Similarly, the assessment of student ability to follow the bitewing scoring system entailed comparisons of individual student scores with those of the researcher (whose diagnoses were assumed to be correct) and their correspondence was assessed through an inspection of the matrix that is generated by the κ test. Other analytic methods will be described subsequent sections.

CHAPTER 5 - Results

The results presented in this chapter relate to material derived from the clinical activities of Year 3 Bachelor of Dentistry students in 2004.

The patients

Of the 203 patients, only 66 (33%) including 15 children and 51 adults had evidence of caries shown as radiolucencies on the occlusal and approximal surfaces of their bitewing radiographic images (Table 5.1). The mean ages at x-ray for the children aged 7-11, adults aged 18-34 and 35-67 years were 8.7, 26.4, and 45.7, respectively. Of these, 52% were assessed as being at low risk of caries and 18% and 30%, respectively, were assessed as being at medium and high risk.

Researcher diagnostic reliability

Duplicate readings of the bitewing radiographs were conducted to assess both inter-examiner and intra-examiner reliability (Tables 5.2 and 5.3). The related Cohen's κ statistics were 0.73 and 0.96, respectively.

The distribution of bitewing radiolucencies- researcher's assessment

Details of the tooth- and surface-specific radiolucency scores are shown in Table 5.4 for deciduous teeth and in Table 5.5 for permanent teeth.

The potential number of surfaces available for assessment in each quadrant totaled 16 (three each for the molars and premolars and the distal surface of the canine). The 66 patients had, therefore, $16 \times 4 \times 66 = 4224$ potential surfaces. The actual number of surfaces scored were 4224, less those that had been restored or outside of the field of view of the bitewing and those that were associated with teeth that were unerupted or had been extracted. In total, 2320 surfaces were available for scoring.

Most primary tooth surfaces were scored as sound but there was a distribution of lesions across the grades, C1 to C5. Similarly, for permanent teeth, most surfaces were scored as sound (the default score), however, many surfaces, mainly at the distal end of the film, were classed as unreadable, being either blurred or associated with insufficient contrast, or because the surfaces were outside of the field of view altogether. As with the primary teeth, there were radiolucencies of all grades in permanent teeth.

Summary of the distribution of bitewing radiolucencies

The researcher scored the bitewing images of 2320 tooth surfaces and identified 332 radiolucencies, the majority being in enamel (Table 5.6, bottom row).

Table 5.1. Distribution of patients with bitewing radiolucencies by age and caries risk status

Patients with bitewing radiolucencies												
Total with bitewing radiolucencies			Caries risk status*									
Age (yrs)	Total N	Mean age at x-ray	Gender	Low		Medium		High		Total		
				N	%	N	%	N	%	N	%	
7—11	—	8.7	Male	5	45	1	9	5	45	11	100	
			Female	1	25	2	50	1	25	4	100	
18—34	—	26.4	Male	4	67	1	17	1	17	6	100	
			Female	7	47	0	0	8	53	15	100	
35—67	—	45.7	Male	2	57	4	27	1	17	7	100	
			Female	15	65	4	17	4	17	23	100	
Total	203			34	52	12	18	20	30	66	100	

* According to the Caries Management System criteria

Table 5.2. Inter-examiner reliability. Agreement between two examiners on scoring bitewing radiolucencies.

Researcher	Supervisor											
	C0		C1		C2		C3		C4		C5	
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Sound (C0)	88 (81)	4	1	2								
Outer enamel (C1)	2	5 (45)	1						2		1	108 (100)
Inner enamel (C2)	1	4	4 (27)	3							1	11 (100)
Just into dentine (C3)	1			2 (50)	1							15 (100)
Outer dentine (C4)					1 (100)							4 (100)
Inner dentine (C5)						0 (0)						1 (100)
Uninterrupted						0 (0)						0 (100)
Unreadable	1											0 (100)
Overlapped	6											50 (100)
Extracted												20 (100)
Filled	2											0 (100)
Supervisor Total	101	13	6	7	4	0	0	0	54	24	0	256 (100)

Number and % agreement by both examiners, Cohen's kappa = 0.73

Table 5.3. Intra-examiner reliability of the researcher. Agreement between first and second readings of the bitewing radiolucencies.

First reading	Second reading											
	C0		C1		C2		C3		C4		C5	
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	Total
Sound (C0)	216 (96.9)	4	2									223 (100)
Outer enamel (C1)	2	22 (8.8)	1									25 (100)
Inner enamel (C2)		1	8 (3.2)	2								11 (100)
Just into dentine (C3)				10 (100)								10 (100)
Outer dentine (C4)					1 (100)							1 (100)
Inner dentine (C5)						2 (100)						2 (100)
Uninterrupted								37 (100)				37 (100)
Unreadable									37 (100)			37 (100)
Overlapped										36 (100)		36 (100)
Extracted											39 (100)	39 (100)
Filled											27 (100)	27 (100)
Second Reading Total	218	27	11	12	1	2		37	38	36	39	448 (100)

Number and % agreement on both occasions.
Cohen's kappa = 0.96

Table 5.4. Distribution in 2004 of tooth- and surface-specific bitewing radiolucencies scored by the researcher in the deciduous teeth of 15 child patients.

		55			54			53			63			64			65		
		D	O	M	D	O	M	D			D			M	O	D	M	O	D
Maxilla	Sound (C0)	11	12	9	10	13	10	9			8	10	12	8	9	14	11		
	Outer enamel (C1)	1	0	0	0	0	0	0			0	0	0	0	1	0	1		
	Inner enamel (C2)	1	0	0	1	0	0	0			0	0	0	1	1	0	0		
	Just into dentine (C3)	0	0	1	0	0	1	0			0	0	0	2	1	0	1		
	Outer dentine (C4)	0	0	1	0	0	0	0			0	0	0	0	1	0	0		
	Inner dentine (C5)	0	1	1	1	0	0	0			0	0	0	1	0	0	0		
	Unreadable	0	0	0	0	0	0	0			1	1	1	1	1	1	1		
	Unerupted	0	0	1	0	0	1	5			5	3	2	1	0	0	0		
	Overlapped	1	0	1	0	0	1	1			1	1	0	1	1	0	1		
	Extracted	0	0	0	2	2	2	0			0	0	0	0	0	0	0		
	Filled	1	2	1	1	0	0	0			0	0	0	0	0	0	0		
	Total	15	15	15	15	15	15	15			15	15	15	15	15	15	15		
Mandible	Sound (C0)	7	12	11	4	9	9	9			7	7	8	5	9	10	12		
	Outer enamel (C1)	2	0	0	0	0	0	0			0	0	0	0	0	0	1		
	Inner enamel (C2)	1	0	0	0	0	0	0			0	0	0	0	0	0	1		
	Just into dentine (C3)	0	1	0	2	0	0	0			0	0	0	0	1	0	0		
	Outer dentine (C4)	1	2	2	1	0	0	0			0	0	0	1	0	0	0		
	Inner dentine (C5)	0	0	1	1	0	0	0			0	0	0	1	0	0	0		
	Unreadable	0	0	0	0	0	0	0			1	1	1	1	1	1	1		
	Unerupted	0	0	0	0	0	1	5			6	3	2	1	1	1	0		
	Overlapped	4	0	1	1	0	0	0			1	1	1	2	2	0	0		
	Extracted	0	0	0	2	2	2	0			0	3	3	3	0	0	0		
	Filled	0	0	0	4	4	4	3			0	0	0	1	1	3	0		
	Total	15	15	15	15	15	15	15			15	15	15	15	15	15	15		
		D	O	M	D	O	M	D			D	M	O	D	M	O	D		
		85			84			83			73	74			75				

Table 5.5. Distribution in 2004 of tooth- and surface-specific bitewing radiolucencies scored by the researcher in the *permanent teeth* of 15 child and 51 adult patients.

		18		17		16		15		14		13		23		24		25		26		27		28	
		D O M		D O M		D O M		D O M		D O M		D		D		M O D		M O D		M O D		M O D		M O D	
Maxilla		8 8 10		26 19 31		35 29 35		21 35 25		17 29 22		22		24		27 32 18		22 33 20		31 28 35		27 24 31		8 7 10	
	Sound (C0)	0 0 1		0 1 0		2 2 2		3 0 6		6 0 0		0		0		2 0 3		5 0 4		5 4 0		2 0 0		0 1 0	
	Outer enamel (C1)	0 0 0		1 1 0		2 2 1		3 0 3		2 0 0		1		1		0 0 6		3 0 3		0 0 2		0 2 0		0 0 0	
	Inner enamel (C2)	0 0 0		0 2 1		2 2 1		1 0 0		4 0 1		1		0		1 0 0		1 0 2		0 1 2		2 0 0		0 0 0	
	Just into dentine (C3)	0 0 1		0 0 0		0 0 0		2 0 0		1 0 0		0		2		0 0 1		0 0 1		0 0 0		0 0 0		0 0 0	
	Outer dentine (C4)	0 0 0		1 1 2		3 2 1		1 0 1		1 1 1		0		2		0 0 2		0 0 0		1 2 0		0 0 1		0 0 0	
	Inner dentine (C5)	18 18 18		14 14 14		1 1 1		0 0 0		0 0 0		0		0		0 0 0		0 0 0		3 3 3		14 14 14		17 17 17	
	Unreadable	14 7 2		7 3 1		1 0 0		1 0 0		2 6 14		20		18		10 6 4		2 2 2		2 1 2		3 2 4		1 2 3	
	Unerupted	0 0 6		8 0 7		8 0 4		4 0 1		1 0 2		2		0		1 0 4		4 0 7		8 0 6		6 0 4		4 0 0	
	Overlapped	26 26 26		4 4 4		6 6 6		4 4 4		3 3 3		0		4		4 4 4		4 4 4		10 10 10		7 7 7		36 36 36	
	Extracted	0 7 2		5 21 6		6 22 15		11 12 11		14 12 8		5		2		5 9 9		10 12 8		7 18 4		5 17 5		0 3 0	
	Filled	66 66 66		66 66 66		66 66 66		51 51 51		51 51 51		51		51		51 51 51		51 51 51		66 66 66		66 66 66		66 66 66	
	Total	13 14 15		23 18 24		27 24 19		19 35 29		32 39 29		21		18		23 38 26		27 37 24		28 24 31		20 16 30		14 10 14	
	Sound (C0)	0 0 1		2 0 3		1 3 11		4 1 1		2 1 2		0		0		0 1 6		4 0 5		8 2 2		1 0 0		0 0 0	
	Outer enamel (C1)	0 0 1		1 0 4		3 0 0		7 0 6		4 0 1		0		0		0 0 4		3 0 5		1 1 3		5 1 0		1 0 0	
	Inner enamel (C2)	0 0 0		1 2 0		2 2 1		0 0 0		0 0 0		1		0		2 0 1		0 0 2		0 5 2		2 2 1		0 0 0	
	Just into dentine (C3)	0 0 0		0 0 0		0 0 0		0 0 0		0 0 0		0		0		0 0 0		0 0 1		0 0 0		1 0 0		0 0 0	
	Outer dentine (C4)	0 0 0		0 0 1		1 0 1		1 1 1		0 0 0		1		1		0 0 0		0 0 0		0 0 2		0 0 0		0 1 0	
	Inner dentine (C5)	17 17 17		14 14 14		1 1 1		0 0 0		0 0 0		0		0		0 0 0		0 0 0		2 2 2		14 14 14		16 16 16	
	Unreadable	16 11 3		5 0 0		1 0 0		0 0 0		3 9 17		28		26		18 8 3		3 1 1		1 1 1		2 2 2		2 7 9	
	Unerupted	0 0 9		10 0 8		8 0 9		6 0 5		6 0 0		0		4		5 0 6		7 0 4		4 0 3		3 0 4		5 0 0	
	Overlapped	20 20 20		6 6 6		15 15 15		4 4 4		1 1 1		0		1		2 2 2		5 5 5		14 14 14		11 11 11		27 27 27	
	Extracted	0 4 0		3 26 6		6 19 8		10 10 5		3 1 1		0		1		1 2 3		2 8 4		8 17 6		7 20 4		1 5 0	
	Filled	66 66 66		66 66 66		66 66 66		51 51 51		51 51 51		51		51		51 51 51		51 51 51		66 66 66		66 66 66		66 66 66	
	Total	D O M		D O M		D O M		D O M		D O M		D		D		M O D		M O D		M O D		M O D		M O D	
		48		47		46		45		44		43		33		34		35		36		37		38	
Mandible																									

Student application of the Caries Management System

Caries diagnosis based on bitewing radiograph assessment

Students assessed 1971 surfaces of which 1926 (98%) were scored sound and 45 were scored as C1 or greater (Table 5.6). These scores relate to only 27 of the 66 patients.

Of the 1971 surfaces assessed and scored by students according to the Caries Management System protocols, 45 (2%) were scored as carious but of these the researcher scored 12 (27%) as sound. Of the 1926 that were scored by students as sound, 91% were deemed correct by the researcher. The researcher agreed with the students diagnosis of outer and inner enamel lesions on only 36% and 38% of surfaces, respectively, and, on 70% and 33% of just into dentine and outer dentine surfaces, respectively. There was complete agreement regarding the two inner dentine lesions. The discrepancies were mostly only one grade different from that of the researcher.

Radiographs of the other 39 patients were read by the students and 139 surfaces were recorded as carious on the hospital charts in the patient folders but they were not scored according to the Caries Management System. The researcher, however, scored these 139 surfaces, nine of which were classified as sound. The researcher identified 169 $[332 - (139 - 9) - (45 - 12) = 169]$ other lesions not noted by the students, and of these 144 were in enamel.

Management of carious lesions

The lesion-specific management decisions by students referred to in Table 5.7, relate to lesion depths as scored by the researcher. The 206 outer and inner enamel lesions were mostly managed non-invasively or neglected (or were determined to have no need for intervention). Just over half of the 60 lesions that had just penetrated the DEJ were, correctly, not treated invasively. The seven outer dentine lesions (those confined

Table 5.6. Summary of bitewing radiolucency scores in 66 patients, and correspondence between researcher and students on scoring bitewing radiolucencies in 27 patients.

Student diagnosis scores	Researcher diagnosis scores						Student totals for 27 patients	
	Sound	Outer enamel C1	Inner enamel C2	Just into dentine C3	Outer dentine C4	Inner dentine C5	All surfaces	Surfaces with lesions
Sound	1757 (91%)	80	64	23	2	0	1926	
Outer enamel, C1	10	8 (36%)	1	3	0	0	22	22
Inner enamel, C2	2	0	3 (38%)	3	0	0	8	8
Just into dentine, C3	0	1	1	7 (70%)	1	0	10	10
Outer dentine, C4	0	0	1	1	1 (33%)	0	3	3
Inner dentine, C5	0	0	0	0	0	2 (100%)	2	2
Researcher totals								
All surfaces [lesions are boxed]	1769	89	70	37	4	2	1971	
Correspondence with student lesion numbers	12	9	6	14	2	2		45
Additional 139 lesions in 39 patients scored by researcher only								
Lesions [boxed] in 39 patients diagnosed and charted by students but not scored	9	27	20	23	19	41		
Total confirmed lesions								
Total lesions [in 39 + 27 = 66 patients]		116	90	60	23	43		332

[boxed] Number and % of student scores deemed correct by researcher (student total is denominator).
 Note: Frequencies above and below the shaded cells indicate under- and over-diagnosis, respectively, on the part of the student.

Table 5.7. Number and percentage distribution of management decisions by students for 332 lesions, stratified by radioluceny score and caries risk as as determined by the reseacher.

Lesion management											
Lesion depth		Caries risk	No intervention		Non-invasive management		Invasive management		Total		
			N	(%)	N	(%)	N	(%)	N	(%)	
Outer enamel (C1) (n=116)	Low		37	(57)	24 (37)		4	(6)	65	(100)	
	Medium		9	(41)	12 (55)		1	(5)	22	(100)	
	High		21	(72)	4 (14)	(40, 34%)*	4	(14)	29	(100)	
Inner enamel (C2) (n=90)	Low		22	(48)	20 (43)		4	(9)	46	(100)	
	Medium		5	(42)	6 (50)		1	(8)	12	(100)	
	High		28	(88)	3 (9)	(29, 32%)*	1	(3)	32	(100)	
Just into dentine (C3) (n=60)	Low		12	(31)	23 (59)		4	(10)	39	(100)	
	Medium		2	(33)	4 (67)		0	(0)	6	(100)	
	High		7	(47)	5 (33)	(32, 53%)*	3	(20)	15	(100)	
Outer dentine (C4) (n=23)	Low		—		—		—		—		
	Medium		3	(21)	1 (7)	(1, 4%)*	10	(71)	14	(100)	
	High		—		—		9 (100)	(9, 100%)*	9	(100)	
Inner dentine (C5) (n=43)	Low		—		—		—		—		
	Medium		—		—		—		—		
	High		—		—		43 (100)	(43, 100%)*	43	(100)	

Correct management according to the Caries Management System.
 * Total and % of surfaces managed correctly.

to the outer third) and the 43 inner dentine lesions in high risk patients were all managed by tooth restoration which is the accepted treatment mode for lesions of this depth and the correct management according to the Caries Management System. These results are illustrated in Figures 5.1 and 5.2. The striking observation in Figure 5.1 is that both outer and inner enamel lesions were either mainly not noticed or neglected, whereas the lesions in low and medium risk patients did receive some remineralising therapy. In Figure 5.2, it is seen that lesions just into dentine were mainly treated correctly and few were incorrectly restored. However, for outer dentine lesions, it is dramatically clear that only one lesion was managed properly in the medium risk patients, and equally clear that lesions in high risk patients were managed appropriately.

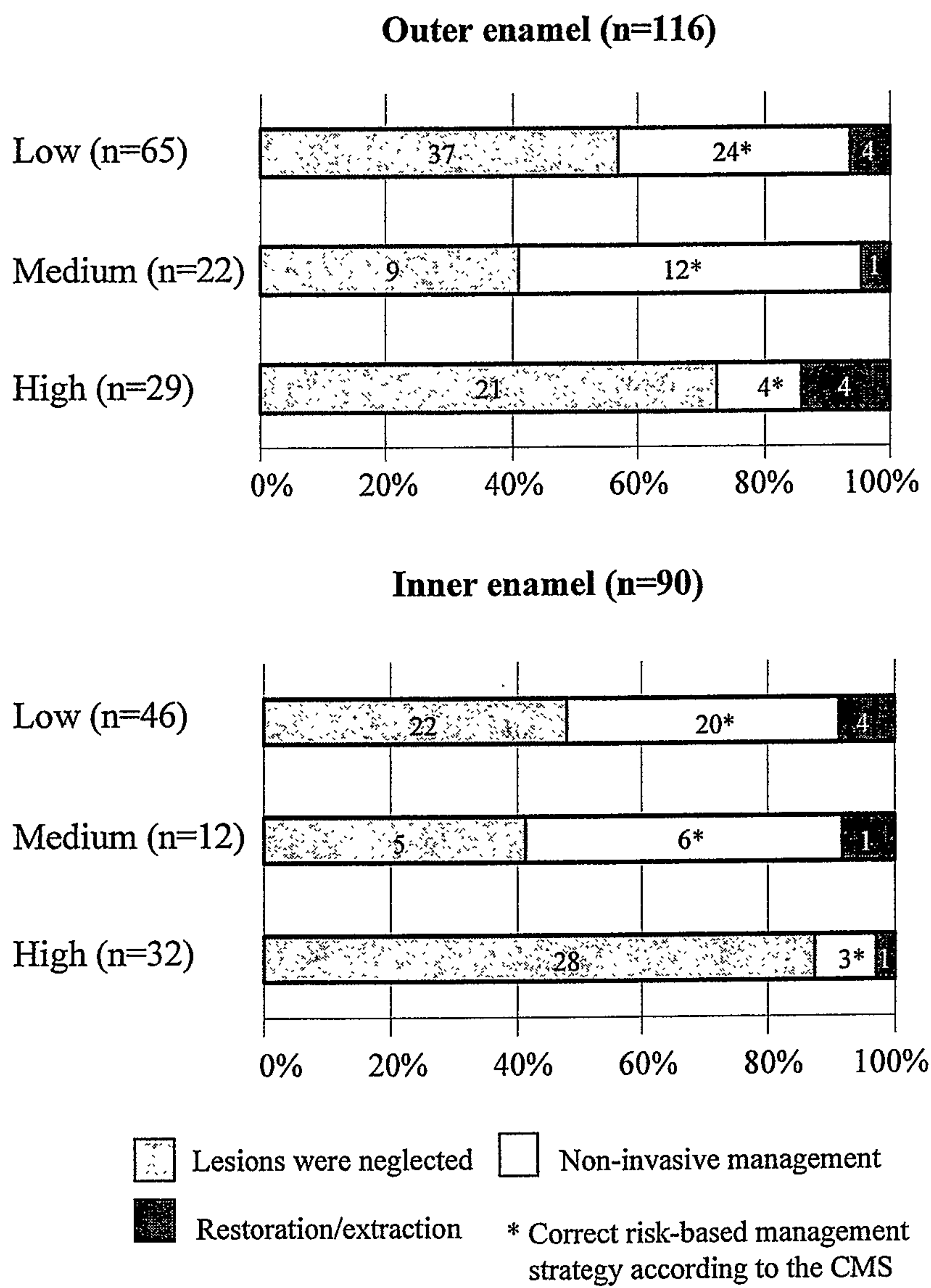
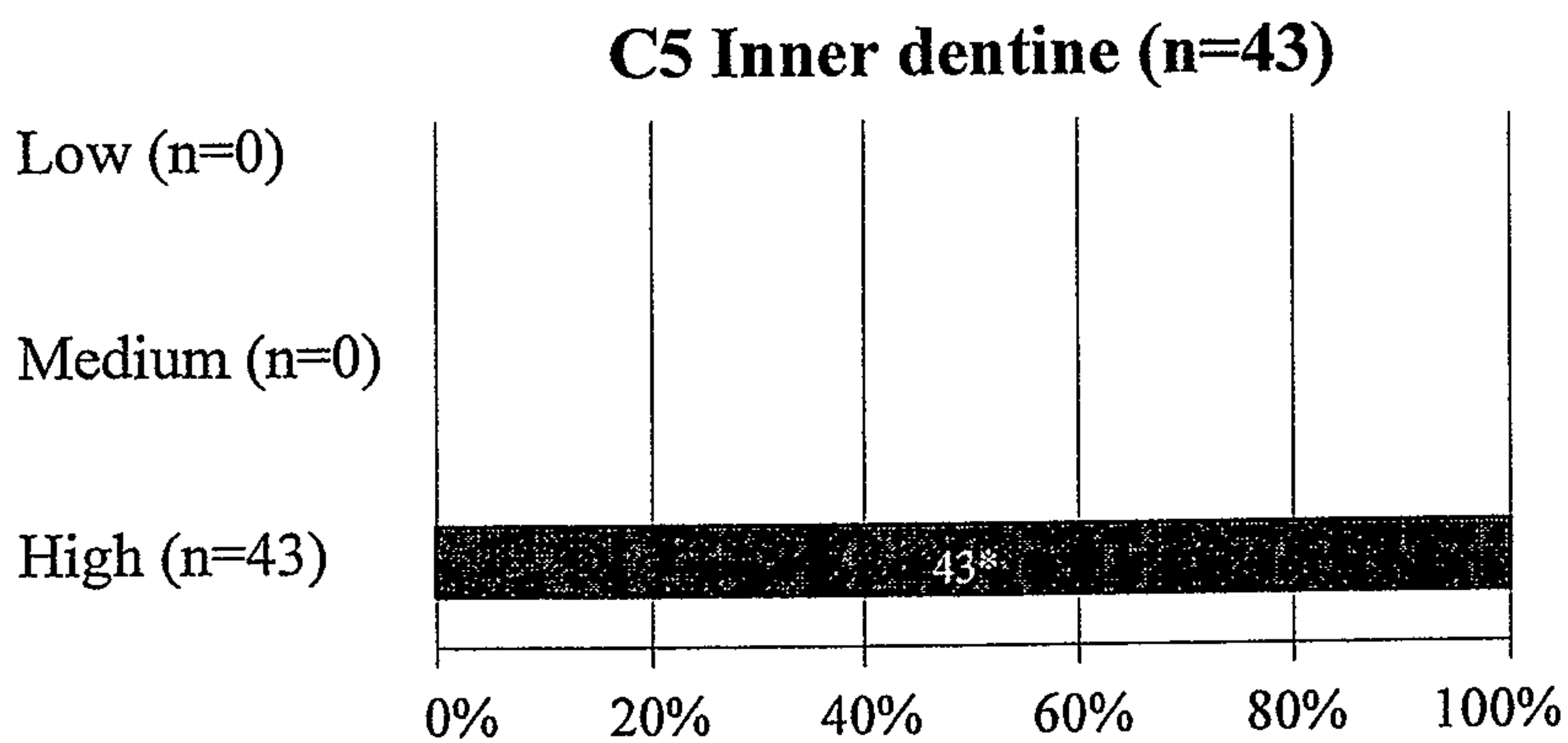
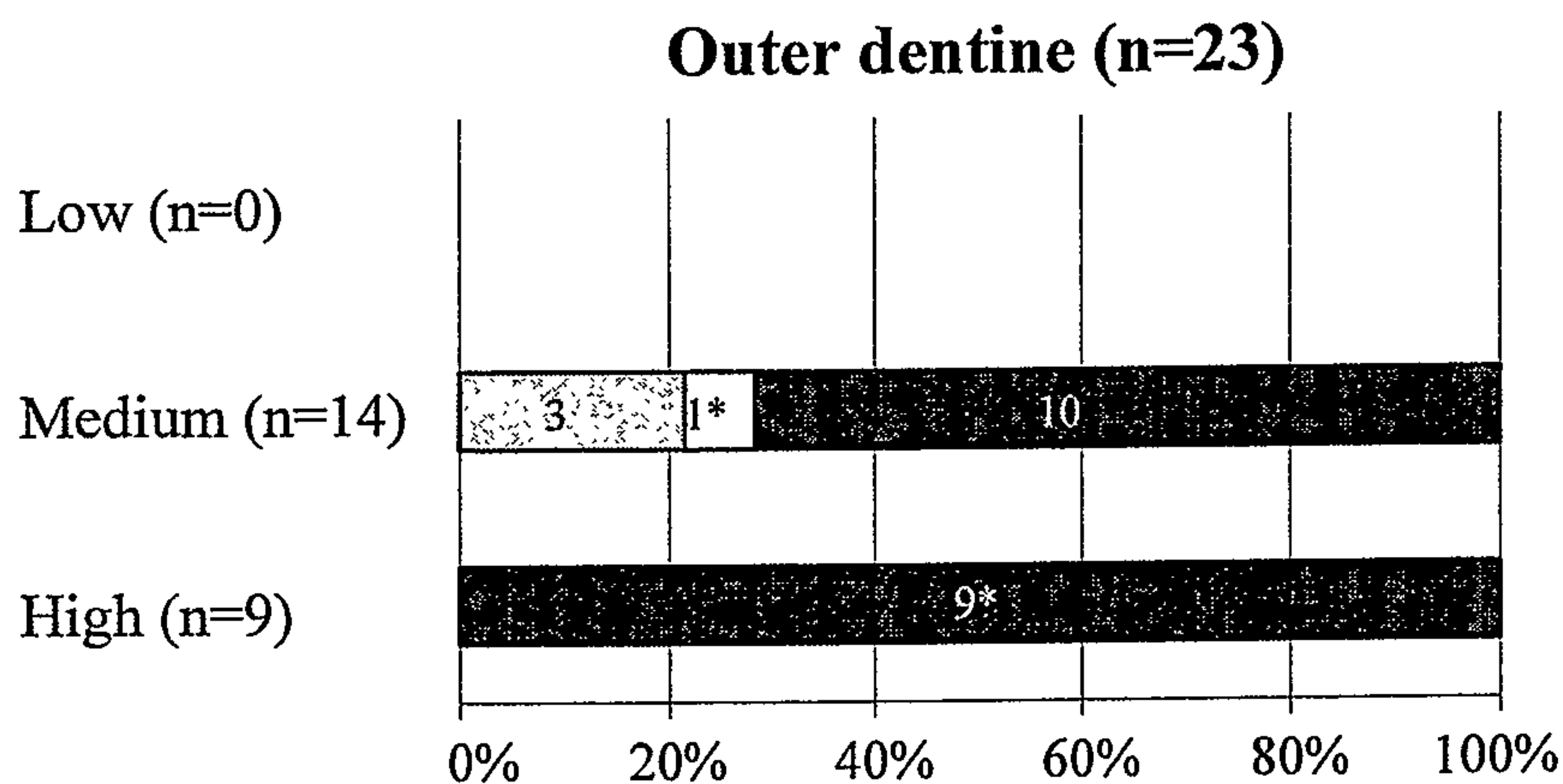
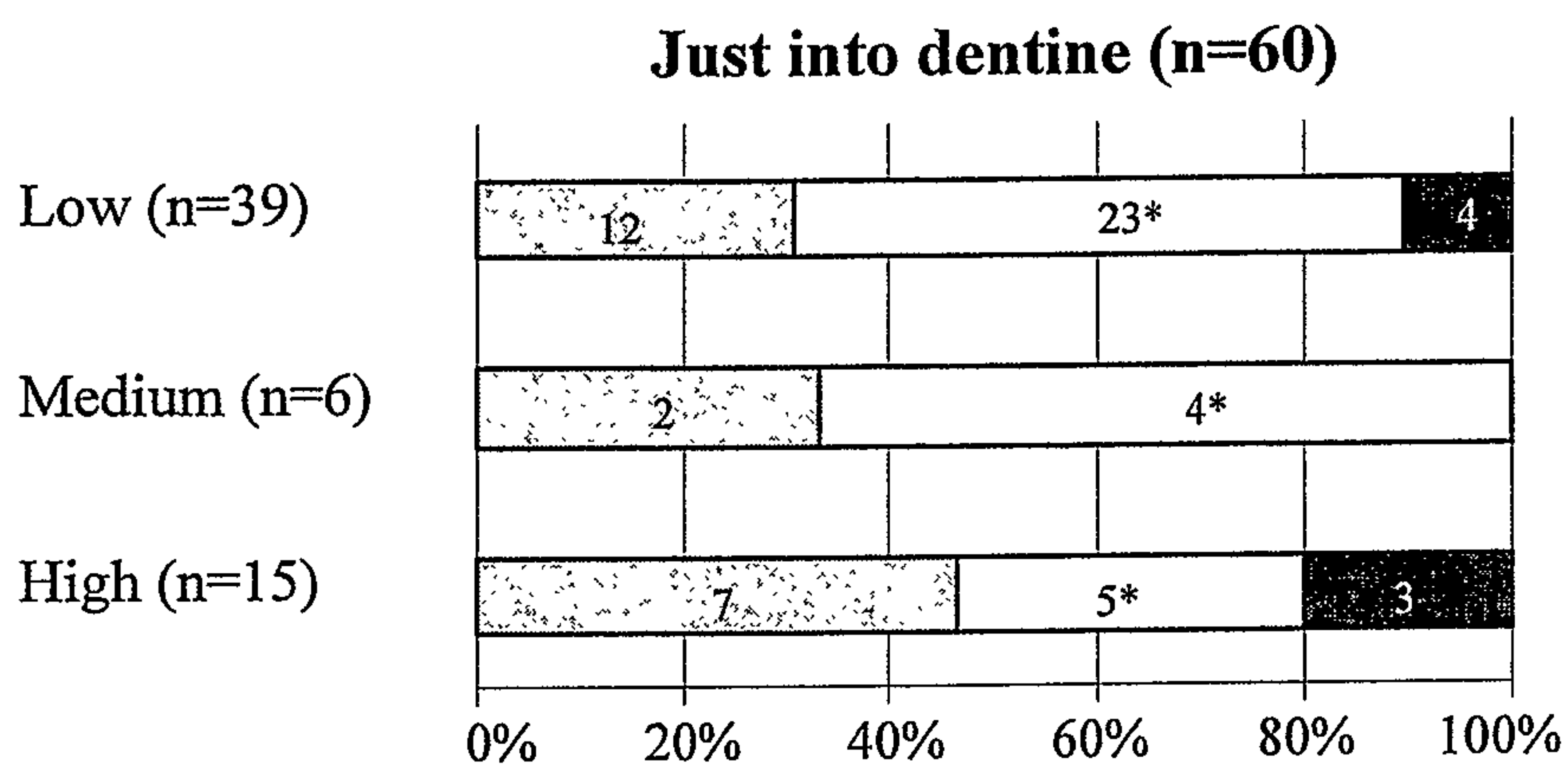


Figure 5.1. Management by BDent 3 students of enamel lesions in low, medium, and high caries risk patients attending the Westmead Centre for Oral Health in 2004.



Lesions were neglected
 Non-invasive management

Restoration/extraction
 * Correct risk-based management strategy according to the CMS

Figure 5.2. Management by BDent 3 students of dentine lesions in low, medium, and high caries risk patients attending the Westmead Centre for Oral Health in 2004

Clinical outcomes after 24 months following the implementation of the Caries Management System

The baseline evaluation of bitewing radiographs revealed that 66 of 203 patients who attended in student clinics in 2004 (Table 5.8) were diagnosed to have approximal radiolucencies in enamel and dentine. The majority were Australian born and English speaking

Frequency of preventive care interventions

The mean time between baseline and follow-up bitewing radiographs was 25.4 months (Table 5.9). Oral hygiene instruction was not reported as being given to 24% of the patients. On the other hand, 22% of students had coached their patients on three or more occasions. According to the hospital electronic records, 32% of the 66 patients under review had not been given topical fluoride applications, however, 13 of them had received topical fluoride applications on two occasions and five patients were given applications on three or more occasions.

Radiographic changes observed after two years

In 2006, the files of the 66 patients were reviewed. Three patients had follow up bitewings already in their folders. An attempt was made to contact the other 63 patient by phone. Contact was made with 29 and they were invited to attend for follow up bitewings, but only 13 did so. For those not contacted by phone, messages were left on their answer machines and, in addition, invitation letters were posted out. Also, invitation letters were posted to patients whose telephones had been disconnected. As a result, a further 12 patients attended for follow up bitewings.

In summary, the bitewings 28 of the original 66 patients were reviewed. The inter- and intra-examiner reliability findings are shown in Tables 5.10 and 5.11; the respective κ statistics were 0.87 and 0.96 indicating almost perfect agreement beyond chance.

Table 5.8 Distribution of 66 patients followed from 2004 to 2006 by background and preventive care received.

		N	%
Background	Australian born English speaking	39	60
	Non-Australian born non-English speaking	14	20
	Non-Australian born English speaking	12	18
	Australian born non-English speaking	1	2
		66	100
Status	Married	23	35
	Single	16	24
	Divorced/defacto	8	12
	Children	15	23
	Missing value	4	6
		66	100
Preventive care received	Fluoride varnish	29	44
	Fluoride gel	6	9
	Fluoride varnish and gel	10	15
	No fluoride delivered	21	32
		66	100

Table 5.9. Occasions of preventive care received by 66 patients and follow-up during 2004 and 2006.

Occasions	Topical fluoride		Oral Hygiene instruction		Follow-up (months)		
	N	%	N	%	Mean (SD)	Min	Max
0	21	32	16	24	25.4 (3.1)	17	30
1	27	41	22	33			
2	13	20	14	21			
3	1	2	7	11			
4	2	3	4	6			
>4	2	3	3	5			
Total	66	100	66	100			

Table 5.10. Inter-examiner reliability. Agreement between two examiners in August 2006 on scoring bitewing radiolucencies.

Researcher	Supervisor									
	C0	C1	C2	C3	C4	C5	Unerrupted	Overlapped	Filled	Total
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Sound (C0)	176 (91)	2					10	4	1	193 (100)
Outer enamel (C1)	8	16 (57)	4						28	28 (100)
Inner enamel (C2)	1	3	3 (38)		1					8 (100)
Just into dentine (C3)				0 (100)						0 (100)
Outer dentine (C4)					3 (100)					3 (100)
Inner dentine (C5)			1		6 (0)					7 (100)
Unerrupted/unreadable	11						297 (95)	2	1	311 (100)
Overlapped								16 (100)		16 (100)
Filled	4						3		67 (91)	74 (100)
Supervisor Total	200	21	8	0	4	6	310	22	69	640 (100)

Number and % agreement by both examiners.
Cohen's kappa = 0.87

Table 5.11. Intra-examiner reliability of the researcher. Agreement between first and second readings in August 2006 of the bitewing radiolucencies.

Second reading														
	C0	C1	C2	C3	C4	C5	Uninterrupted	Unreadable	Overlapped	Extracted	Filled	Exfoliated	Total	
First reading	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Sound (C0)	266 (97)	3		1				1					275 (100)	
Outer enamel (C1)	2	11 (85)											13 (100)	
Inner enamel (C2)		3	6 (60)	1									10 (100)	
Just into dentine (C3)	1		2	2 (40)									5 (100)	
Outer dentine (C4)					6 (86)								7 (100)	
Inner dentine (C5)						3 (100)							3 (100)	
Uninterrupted							81 (100)						81 (100)	
Unreadable		1						74 (97)	1				76 (100)	
Overlapped	1								20 (95)				21 (100)	
Extracted										165 (100)			165 (100)	
Filled	2										95 (98)		97 (100)	
Exfoliated												15 (100)	15 (100)	
Second reading Total	272	18	8	12	1	2	37	38	36	39	27	15	768 (100)	

Number and % agreement on both occasions.
Cohen's kappa = 0.96

The distribution of the bitewing scores relating to the approximal surfaces of the 28 patients are shown in Table 5.12. Of the 704 sound surfaces in these patients at baseline, 75% remained unchanged. If the exfoliated, overlapped, unreadable surfaces are excluded, then it may be interpreted that 92% of the sound surfaces remained sound. The frequencies shown above the shaded boxes indicate deteriorated status whereas those below indicate improvement. These changes are summarised in Table 5.13 and relate to baseline totals that have been adjusted to reflect the exfoliation of primary teeth and readability of the follow-up bitewings. The extent of lesion progression or status change following an invasive procedure observed at follow-up was directly related to baseline lesion depth; only 20% of outer enamel lesions had progressed versus 90% of inner dentine lesions. Altogether, 30 lesions were observed to have regressed.

Table 5.13. Summary of changes observed in bitewing radiographic appearance after two years (28 patients).

Lesion depth	Number of approximal surfaces		Change from valid baseline comparator					
	At baseline	Readable and valid comparators at follow-up*	No change			Regression		
			N	%	N	%	N	%
Sound (C0)	704	574	527	92	—	—	47	8
Outer enamel (C1)	54	41	16	39	17	41	8	20
Inner enamel (C2)	44	31	18	58	10	32	3	10
Just into dentine (C3)	24	19	8	42	2	10	9	47
Outer third (C4)	19	15	5	33	1	7	9	60
Inner two thirds (C5)	13	10	1	10	0	—	9	90
Total	858	690	575	83	30	4	85	12

* Baseline number less number (exfoliated + extracted*** + overlapped + unreadable)

** Increase in lesion depth or status change following invasive procedure

*** Sound surface belonging to an extracted carious tooth

CHAPTER 6 – Discussion

Dental student application of the Caries Management System protocols: Diagnosis and lesion management

The patients allocated to Year 3 students are selected as being suitable for management by junior clinicians. Many dentate patients did not have any bitewing radiolucencies, and other allocated patients who were edentulous were attending for new dentures.

The results concerning the scoring of the bitewings reflect the early experience of students in the clinic and their first encounter with patients. They show that the majority of students did not score the bitewing radiolucencies according to the Caries Management System protocol, although they were charted independently in a non-graded manner. Those who followed the protocol identified 45 radiolucent surfaces of which one quarter were recorded as sound by the researcher. On the other hand, students failed to notice 169 radiolucencies identified by the researcher.

The treatment decision results shown in Table 5.7 and in Figures 5.1 and 5.1 relate to the 332 lesions as confirmed by the researcher. From this perspective, they indicate that the majority of the enamel lesions were neglected. However, some students may have determined that the respective surfaces were sound or missed seeing the early radiographic signs. It is possible that the high risk patients also had dentine lesions and that students placed a higher priority in managing them at the expense of the enamel lesions, and that in the absence of dentine lesions the medium and low risk patients, the students paid more attention to enamel lesions.

All of the enamel lesions, according to the Caries Management System, should have been managed non-invasively but a minority was treated operatively. Lesions that were just beyond the DEJ should also have been managed non-invasively but

more than half were scheduled for restorative care. Most of the deeper dentine lesions were treated by restoration but the outer dentine lesions in low risk patients should not have been assumed to be already cavitated. They should have been managed non-invasively and monitored. In the case that a lesion was arrested and not associated with a cavity, the radiolucency showing on a future bitewing should not have progressed. If the radiolucency is shown to have progressed at follow-up, the diagnosis is reviewed and the lesion may be restored then

In summary, results indicate that (a) students, at this stage in their careers, are more likely to under- than to over- diagnose caries from bitewings and are, therefore, in need of more coaching in the art of reading and scoring bitewing radiolucencies, (b) many students were not following the system, and (c) that some supervising dentists were not checking this omission.

Dental student application of the Caries Management System protocols: Clinical outcomes after 24 months

The results show that some members of this small cohort experienced positive benefits from the non-invasive caries management that they received. Most lesions did not change which may indicate that they were already arrested at the commencement of treatment, or that they responded favourably to the treatment. Among the lesions that deteriorated or appear now as downgraded, a higher percentage of them were already deeper rather than shallower at baseline. However, many lesions were and not given the opportunity to respond to arresting and remineralising therapy and, therefore, the downgrade of their status may not necessarily be a consequence of a deteriorating situation.

The insights gained from the results of this short term follow-up are not sufficient to forecast the future stability of the arrested lesions. It is claimed that the lesions that underwent regression are true positive results and not due to measurement reversals; the researcher demonstrated excellent diagnostic reliability. Further, this was not an epidemiological study, and although the follow-up radiographs were read

blind the baseline ones initially, there was opportunity to confirm the changed status. It should be noted, however, that the readings were conducted without magnification because students in the clinic are not required to follow this practice. Since this study was designed to monitor student competence in applying the protocols of the Caries Management System, it seemed reasonable to match their performance against that of the researcher without introducing magnification bias.

The generally positive response observed, occurred despite the fact that some students may not have helped their patients to improve their oral hygiene or to deliver professional applications of topical fluoride. It is not certain whether some students failed to act in this respect but, in fact, if they did provide this care, they failed to record the activity in the patients' notes.

It was anticipated that a larger sample of patients would be followed over the two-year period. Coping with the task of meeting with all patients of both Year 3 and Year 4 students and of collecting data from their clinical records proved overwhelming and it was decided to concentrate on monitoring the patients of the Year 3 cohort. The number of study subjects was eroded further with loss to follow-up, partly because the patient pool at Westmead is not stable. Among the adults, only social security card-holders and unemployed people are eligible for publicly funded dental care and this entitlement ceases when employment is gained. Additionally, recall appointments are not available on completion of treatment and patients, if they remain eligible, may not attend the clinic for further treatment in the medium term unless they experience an emergency. This situation is not conducive to the proper management of dental caries, especially for patients at high risk.

The important finding from this study is that many of the patients presenting for general dental care at the Westmead Centre for Oral Health have a caries risk that is not out of control and is amenable to risk reduction intervention. It was evident that some dentine lesions among patients of this cohort had not progressed during the two year period of observation, confirming that not all lesions are subject to rapid progression. It should not be presumed, therefore, that patients with lesions showing as dentine radiolucencies are placed at risk if dentine lesions are not restored.

Provided that the lesions are managed, in the first instance, as if they are active and treated intensively with appropriate topical fluorides and patients in this situation are recalled regularly to monitor progress, there is no reason to suppose that a dental emergency would likely develop within the timeframe of a reasonable recall period. It is concluded that within the patient pool of the Westmead Centre for Oral Health, there are, among all caries risk categories, many who have the potential to derive real benefits from non-invasive strategies to control, not only their caries risk, but their risk of developing a dentition that will become weakened through cycles of restorative intervention and in need of costly lifetime maintenance care. It is important to note also that a non-invasive approach to prevent and manage dental caries applies equally to prevent and manage periodontal disease.

The Caries Management System

The interventions detailed in the protocols do not refer to saliva management. Apart from extreme reductions in saliva flow, other salivary characteristics, though easily measured, are very poorly associated with caries incidence (47). There seems little point in profiling these characteristics, as part of the Caries Management System, at great expense, when no meaningful action can be taken to alter them. On the other hand, extreme reduction in salivary flow is very rare (48). Caries management in these patients needs an intensive approach and is rather specialized. This aspect is not covered in the Caries Management System, which is designed to apply to the general population.

Although the use of sealants are effective, both for caries prevention and therapeutically to arrest initial pit and fissure lesions, these uses have not been referred to in the Caries Management System for adults where the focus has been on the approximal surface. The system will be developed for children and adolescents and will include the management of the occlusal surface.

References

1. Dunning JM. Preventive dentistry. In: Principles of Dental Public Health. 2nd ed. Cambridge MA: Harvard University Press; 1970. p. 215-249.
2. Mc Comb D. Systematic review of conservative operative caries management strategies. J Dent Educ 2001;65(10):1154-1161.
3. Baker Dirks O. Posteruptive changes in dental enamel. J Dent Res 1966;45:503-510.
4. von der Fehr FR, Loe H, Theilade E. Experimental caries in man. Caries Res 1970;4:131-48.
5. Featherstone JDB. Prevention and reversal of dental caries: role of low level fluoride. Community Dent Oral Epidemiol 1999;27:31-40.
6. Mejare I, Kallestal C, Stenlund H, Johansson H. Caries development from 11 to 22 years of age: A prospective radiographic study. Caries Res 1998;32:10-16.
7. Mejare I, Kallestal C, Stenlund H. Incidence and progression of approximal caries from 11 to 22 years of age in Sweden: A prospective radiographic study. Caries Res 1999;33:93-100.
8. Zamir T, Fisher D, Fishel D, Sharav Y. A longitudinal radiographic study of the rate of spread of human approximal dental caries. Archs Oral Biol 1976;21:523-526.
9. Seppa L, Hausen H, Tuutti H, Luoma H. Effect of a sodium fluoride varnish on the progress of initial caries lesions. Scand J Dent Res 1983;91:96-8.

10. Axelsson P, Paulander J, Nordkvist K, Karlsson R. Effect of fluoride containing dentifrice, mouthrinsing, and varnish on approximal dental caries in a 3-year clinical trial. *Community Dent Oral Epidemiol* 1987;15:177-80.
11. Powell KR, Barnard PD, Craig GG. Effect of stannous fluoride treatments on the pregression of initial lesions in approximal surfaces of permanent posterior teeth. *J Dent Res* 1981;60(9):1648-1654.
12. Hyde EJ. Caries-inhibiting action of three different topically-applied agents on incipient lesions in newly erupted teeth: Results after 24 months. *J Can Dent Assoc* 1973;3:189-193.
13. Hollender L, Koch G. Influence of topical application of fluoride on rate of progress of carious lesions in children. *Odontologisk Revy* 1969;20:37-41.
14. Skold UM, Peteresson LG, Lith A, Birkhed D. Effect of school-based fluoride varnish programmes on approximal caries in adolescents from different caries risk areas. *Caries Res* 2005;39:273-279.
15. Tan PLB, Evans RW, Morgan MV. Caries, bitewings, and treatment decisions. *Aust Dent J* 2002;47(2):138-141.
16. Riordan PJ, Espelid I, Tveit AB. Radiographic interpretation and treatment decisions among dental therapists and dentists in western Australia. *Community Dent Oral Epidemiol* 1991;19:268-71.
17. Rugg-Gunn AJ. Approximal carious lesions, A comparison of the radiological and clinical appearances. *Br Dent J* 1972;133:481-484.
18. Bille J, Thylstrup A. Radiographic diagnosis and clinical tissue changes in relation to treatment of approximal carious lesions. *Caries Res* 1982;16:1-6.

19. Pitts NB. Regression of approximal carious lesions diagnosed from serial standardized bitewing radiographs. *Caries Res* 1986;20:85-90.
20. Anusavice KJ. Protocol for conservative treatment decisions. *JADA* 1995;126:740-743.
21. NIHC. National Institute of Health Consensus Development Conference, March 26-28; Diagnosis and management of dental caries throughout life. *J Dent Educ* 2001;65:1162-1168.
22. American Dental Association: Council on access prevention and interprofessional relations. Caries diagnosis and risk assessment: a review of preventive strategies and management. *JADA* 1995;126(Special supplement):2S-24S.
23. Tyas MJ, Anusavice KJ, Frencken JE, Mount GJ. Minimal intervention dentistry-a review (FDI Commission Project 1-97). *Int Dent J* 2000;50:1-12.
24. Mount GJ, Ngo H. Minimal intervention: early lesions. *Quintessence Int* 2000;31:535-546.
25. Mertz-Fairhurst EJ, Schuster GS, Fairhurst CW. Arresting caries by sealants: Results of a clinical study. *JADA* 1986;112:194-7.
26. Mertz-Fairhurst EJ, Curtis JW, Ergle JW, Rueggeberg FA, Adair SM. Ultraconservative and cariostatic sealed restorations: results after 10 years. *JADA* 1998;129:55-66.
27. Kidd EAM, Fejerskov O. Prevention of dental caries and the control of disease progression: concepts of preventive non-operative treatment. In: Fejerskov O, Kidd EAM, editors. *Dental caries - The disease and its clinical management*. Oxford: Blackwell Munksgaard; 2003. p. 167-169.

28. Mount GJ, Hume WR. Preservation and restoration of tooth structure. Sandgate, Queensland: Knowledge books and software; 2005.
29. Thompson VP, Kaim JM. Nonsurgical treatment of incipient and hidden caries. *Dent Clin N Am* 2005;49:905-921.
30. Fejerskov O, Kidd EAM. Dental Caries: the disease and its clinical management. Oxford: Blackwell Munksgaard; 2003.
31. Anusavice KJ. The maze of treatment decisions. In: Fejerskov O, Kidd E, editors. Dental Caries: the disease and its clinical management. Oxford: Blackwell Munksgaard; 2003. p. 251-265.
32. Silness J, Loe H. Periodontal disease in pregnancy. II. Correlation between oral hygiene and periodontal condition. *Acta Odontol Scand* . 1964;22:121-135.
33. Dennison PD. Bite-wing radiographic assessment (Form WSDR-007): Western Sydney Area Health Service; 2004.
34. van Loveren C. The role of diet in caries prevention. *Int Dent J* 2001;51:399-406.
35. Australian Research Centre for Population Oral Health. The use of fluorides in Australia: guidelines. *Aust Dent J* 2006;51:in press.
36. Australian Health Ministers' Advisory Council. Oral health of Australians: National planning for oral health improvement. Final Report. Adelaide: South Australian Department of Human Services; 2001.

37. Axelsson P, Lindhe J, Nystrom B. On the prevention of caries and periodontal disease: results after a 15-year longitudinal study in adults. *J Clin Periodontol* 1991;18:182-189.
38. Johansen E, Papas A, Fong W, Olsen TO. Remineralization of carious lesions in elderly patients. *Gerodontology* 1987;3:47-50.
39. De Paola PF. Caries in our aging population: What are we learning? In: Bowen WH, Tabak LA, editors, editors. *Cariology for the nineties*. Rochester: Rochester University Press; 1993. p. 25-36.
40. Barnard PD, Gillings BRD, Gillings KJR. Assessment of a preventive dentistry programme in private practice. *N Z Dent J* 1974;70:15-24.
41. Klineberg I, Massey W, Thomas M, Cockrell D. A new era of dental education at the University of Sydney Australia. *Aus Dent J* 2002;47:194-201.
42. Hintze H, Wenzel A. Clinically undetected dental caries assessed by bitewing screening in children with little caries experience. *Dentomaxillofac Radiol* 1994;23:19-23.
43. Hopcraft MS, Morgan MV. Comparison of radiographic and clinical diagnosis of approximal and occlusal dental caries in a young adult population. *Community Dent Oral Epidemiol* 2005;33:212-8.
44. Bloemendal E, de Vet HCW, Bouter LM. The value of bitewing radiographs in epidemiological research: a systematic review of the literature. *J Dent* 2004;32:255-264.
45. Pitts NB. Diagnostic tools and measurements - impact on appropriate care. *Community Dent Oral Epidemiol* 1997;25:24-35.

46. Kidd EAM, Mejare I, Nyvad B. Clinical and radiographic diagnosis. In: Fejeroskov O, Kidd E, editors. Dental caries: The disease and its clinical management: Oxford: Blackwell Munksgaard; 2003. p. 111-128.
47. Johnson NW. Risk markers for oral diseases. Volume 1: Dental caries. Cambridge: Cambridge University Press; 1991.
48. Billings RJ. Saliva flow and dental caries in aging adults. In: Bowen WH, Tabak LA, editors. Cariology for the nineties. Rochester, NY: University of Rochester Press; 1993. p. 235-260.

Part III: Student and staff comments on the Caries Management System

CHAPTER 7 - Students' Perceptions of Non-invasive Management of Dental Caries in a Student Clinic

Abstract

Introduction - A system for non-invasive caries management was introduced to dental students at the Westmead Centre for Oral Health, The University of Sydney. The purpose of this study was to evaluate the senior dental students' understanding of risk-based lesion management, their clinical experience of implementation of the Caries Management System and, their perception of applicability of the program in their future careers.

Methods - A sample of 109 students was invited to complete a questionnaire survey to obtain data relating to the study objectives.

Result - Ninety-three percent of third year and 46% of fourth year students responded. In treating low and medium risk patients, more than 85% of students selected a remineralisation strategy for outer and inner enamel lesions and 65% chose remineralisation for lesions that had penetrated just beyond the dentin-enamel junction (DEJ). However, the majority (76%) selected the restorative option for outer dentine lesions in medium risk patients. For high-risk patients, most students chose remineralisation to manage enamel-only lesions (80%) and lesions that had progressed just beyond the DEJ (62%). More than 70% of students reported that it took 10 minutes or less to deliver oral hygiene instruction and any necessary fluoride therapy at each visit while 84% reported that most of their patients showed interest and 79% felt confident to use non-invasive measures in their future careers.

Conclusion - Students demonstrated a clear understanding of caries risk and appropriately applied the caries management protocols for enamel lesions but were less confident in correct application of protocols for lesions of greater depth. Overall, the program was successful in clarifying the concept of risk and students obtained valuable experience in managing caries non-invasively. *With acknowledgement to ADRF for grant No. 5/2005.*

Background

Guidelines describing the threshold for restorative care have become more conservative over the years. Lith discussed the National Swedish Social Welfare Board proposal of 1984 that radiographic lesions up to and including, or just exceeding, the enamel-dentin junction should be treated with preventive measures when slow progression is expected (1). The International Symposium on Criteria for Placement and Replacement of Dental Restorations, Florida 1987, recommended that preventive advice should be given to patients who were judged clinically or by tests to be at high risk of caries in order to shift their risk status to a lower category. Along with these recommendations, Anusavice argued that restorative procedures are indicated only if: (a) coronal caries is judged to extend well into the dentin, (b) pulpal symptoms are present, and (c) caries is the cause of aesthetic, functional or periodontal problems for the patient (2).

The shift towards a more conservative approach can be seen in Scandinavian studies. In Sweden, Hugoson and colleagues described a shift in treatment strategy towards a more preventive approach over a 10-year period (3). Moreover when the restorative treatment thresholds used by dentists in Scotland were compared in 1987 and 1990, 17% of dentists reported choosing a later stage for intervention in 1990 than they had in 1987 (4, 5). In Denmark a similar change toward later intervention was noted for outer and inner enamel lesions as well as superficial dentine lesions. Later intervention was more apparent for enamel lesions, reducing from 16% in 1974 to 9% in 1984 while operative treatment was chosen for only 28% of outer dentine lesions in 1984 compared with 40% reported in 1976 (6).

The results have not been consistent across all epidemiological studies. Espelid found that, in a sample of 243 Norwegian dentists, restoration was the strategy of choice for 76% of lesions in the inner half of enamel and approximately 50% of dentists chose to fill sound surfaces and surfaces with discoloured lesions (7). A collaborative study of Norwegian and Dutch dentists found 50 to 60% decided to restore lesions when approximal radiolucencies were confined to enamel (8).

Results for Australian dentists working in fluoridated areas were surprisingly similar. Riordan et al. in his study of 252 dentists and dental therapists in Western Australia showed that 60% of the respondents believed a cavity to be present when the radiographic lesion was confined to enamel and 53% of dental therapists and 40% of dentists intervened operatively with such lesions (9). In this study, 57% of dentists thought that it took 12 months on average for outer enamel lesions to progress to dentine but the majority of dental therapists believed it would take even less than 12 months. The practitioner's view of cavity formation was found to be the most important predictor of choice of treatment in this study. The findings were unexpected because both caries prevalence and caries experience are very low in children in Western Australia, and almost all of the study participants worked in areas with water fluoridation. More recently, Tan et al. (2002), in a survey of 550 Victorian dentists, reported similar findings, where 50% of responding dentists selected an operative intervention for radiographic lesions confined to enamel (10).

The Caries Management System

Together, these findings suggest that dental practitioners require continuing education in cariology that addresses current misconceptions together with a clear, user-friendly management protocol. There is a clear need for a standard approach to lesion management. The Caries Management System, developed in 2004 (see chapter 2 for detail) and adopted by the University of Sydney, addresses this need. This system comprises risk assessment, management options for non-cavitated (asymptomatic) lesions, oral hygiene instruction, dietary advice, and fluoride therapy. It is designed as a package of materials that can be used in private and public health practice.

Risk Assessment: Risk assessment, an important constituent of modern caries management, is necessary to achieve the following objectives: (1) focus on preventive strategies for high- risk patients and (2) delay of surgical intervention in low risk patients (11). Since past and current dental caries experience is considered the best predictor for risk of future caries (12) (13) this was chosen as the basis for risk assessment in this program.

Grading approximal lesions: Approximal lesions demonstrated in bitewing radiographs are first classified according to the following system (14) (15) :

C1: lesions in the outer half of enamel

C2: lesions in the inner half of enamel

C3: lesions just beyond the dentine-enamel junction (DEJ)

C4: lesions in the outer third of dentine

C5: lesions in the inner two third of dentine

Determination of risk status: Risk status is determined in relation to known risk factors according to the following protocol.

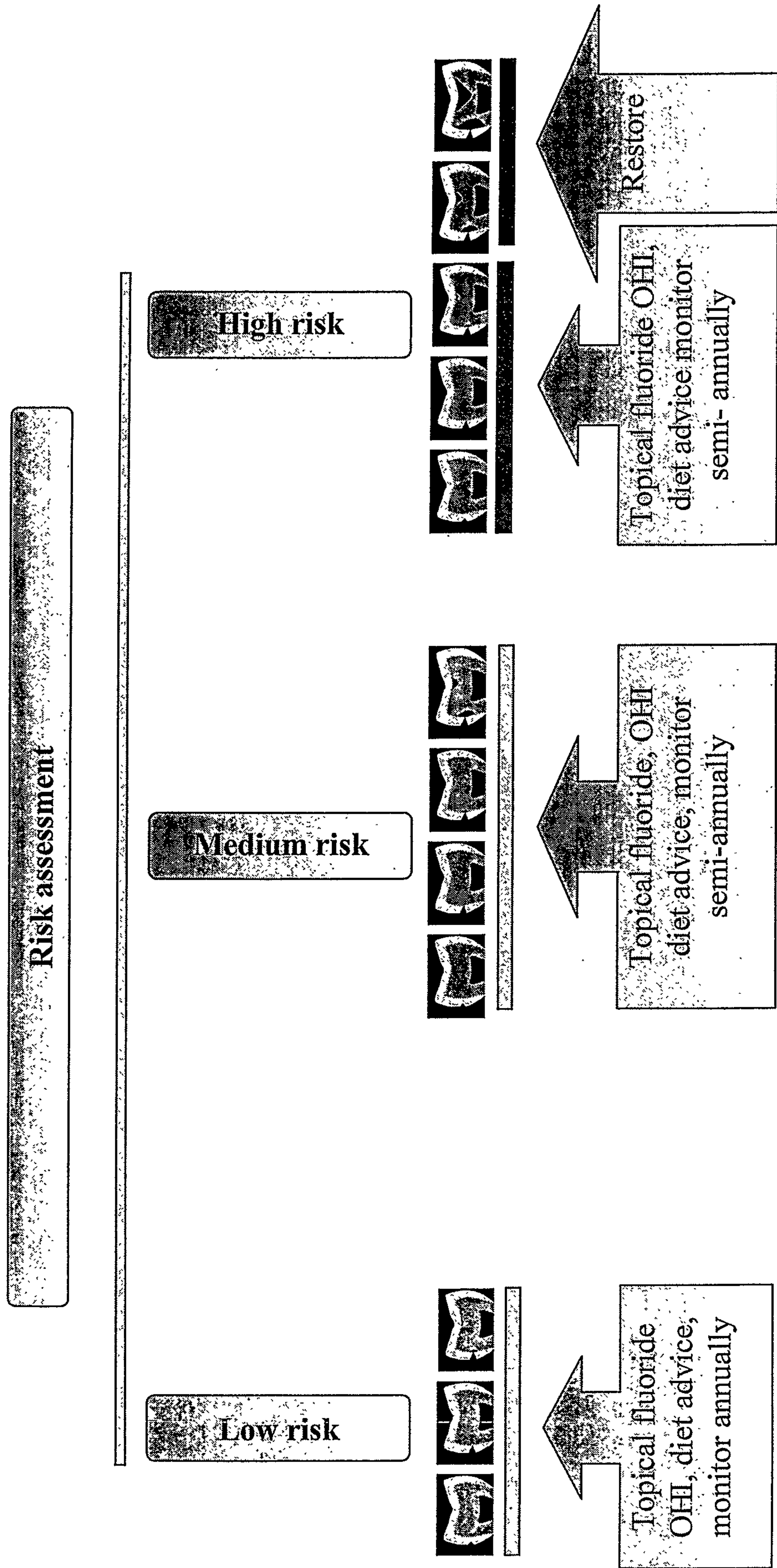
High risk - Untreated frank cavities and/or bitewing radiolucency of grade C5.

Medium risk - No frank cavities and/or bitewing radiolucency of grade C4 or less

Low risk - Absence of clinical signs of caries and bitewing radiolucency of grade C3 or less.

Recommended lesion management for different levels of risk: The recommended management of each lesion according to the risk status of patients is described in Figure 7.1. In the absence of symptoms, the recommended management option for surfaces with bitewing radiolucencies of C1, C2, and C3 in all risk groups is to delay restoration, monitor with bitewing radiographs and provide fluoride therapy, dietary advice and oral hygiene instruction. A six-month interval for bitewing radiographs is recommended in high or medium risk patients and an annual interval for low risk patients. For grade C4 lesions in low and medium risk patients, restoration is recommended only if a radiolucency extends fully one third through the dentine wall. If less extensive, restorative treatment is not recommended for two reasons: (1) it is more likely that the proximal surface is not cavitated (16) (17) (18) , and (2) it is likely that the lesion has already been arrested (14, 15). However, in high-risk adults, restorative treatment is recommended for grade 4 lesions, together with implementation of preventive strategies, in order to prevent recurrent caries and arrest and remineralise those lesions not yet showing radiographically.

Figure 7.1. Schematic overview of the lesions management strategy recommended in the Caries Management System



Purpose of the study

The purpose of this study was to evaluate implementation of the Caries Management System in a dental student clinic in relation to: (1) student understanding of risk-based lesion management (2) clinical experience of students applying the Caries Management System in a public health patient context, and (3) student perceptions of the applicability of the program in their future careers.

Material and Method

The study population comprised 109 senior dental students in the Bachelor of Dentistry degree at the University of Sydney. All students in Year 3 and 4 were introduced to the Caries Management System as part of their academic instruction in 2004 and had completed approximately 6 or 18 months respectively working with dental patients in the Tooth Conservation clinics at Westmead Centre for Oral Health. Students were invited to complete a questionnaire survey (Appendix 4) by an independent researcher who was not involved either in the introduction of the Caries Management System to the student clinics or the academic evaluation of the students. Questionnaires were distributed in the clinical session and students were asked to fill in the questionnaire anonymously and return it to a collection box.

The Questionnaire

The questionnaire was designed in two sections:

Section 1: Ten questions assessed students' clinical experience and perceptions of the program using a 5-point Likert scale with a range from "strongly disagree" to "strongly agree". The questions enabled evaluation of the students' clinical experience in relation to their perception of quality of teaching, consistency of caries management approach throughout the curriculum, protocol complexity, usefulness of the treatment modality, patient response to oral hygiene instruction, time spent in oral hygiene assessment and instruction and applicability of the program in future dental practice.

Section 2: Students understanding of risk-based lesion management was assessed by three case scenarios, each one representing a different level of risk based on past

caries experience, oral hygiene status, diet and saliva factors. In each case students were asked to choose the preferred management strategy for proximal radiolucencies of grade 1 to grade 4 on schematic bitewing radiographs. The SPSS package was used to analyse the data (SPSS version 12.00, 2006)

Because graduate students entering the Faculty of Dentistry have varied background knowledge of medical sciences, Pearson's chi-square was used to assess the homogeneity of the student sample in relation to previous experience, which might affect understanding of the theoretical background of the Caries Management System. Pearson chi-square was also used to assess possible gender differences in response to test items.

It was possible that the 12-month difference in clinical experience between the year 3 and year 4 senior students may have produced differences in choice of preferred risk-management strategy in the three case-scenarios. For this reason, Pearson's chi-square was used to assess differences between the responses of the two groups and choice of the correct strategy. Because the data for years of experience and perceptions of the Caries Management System were in rank order, Spearman's rank correlation was applied to evaluate associations between the variables.

Whether or not the attitudes or beliefs of the students towards the CMS were associated with how they responded to the clinical scenarios, was investigated by cross-tabulating the attitude/belief responses with the selected management options. This was done for responses to each of the 10 attitude/belief questions in relation to the three risk scenarios. Then odds ratios were calculated to quantify the likelihood of selecting the restorative option for each of the 120 possible management combinations (10 questions x 3 risk groups x 4 management options = 120).

Results

Demographic characteristics of the sample

A response rate of 93% (sample $n = 53$) of third year students and 46% (sample $n = 24$) of the fourth year students was obtained. The majority of students in both groups had a previous degree in science or medical science and the distribution of background degrees was similar for the two groups (Table 7.1). No association was found between the students' background degree and their responses to the questionnaire including their choice of lesion management for each defined risk category. The gender distribution was similar for both student groups and no association was found between gender and responses to the questionnaire.

Student learning and clinical experience

Table 7.2 describes the responses of the third and fourth year dental students to questions about their learning, clinical experience and perceptions of non-invasive management.

Quality of teaching: A significantly higher number of third year students (74%) than fourth year students (54%) agreed that sound background knowledge of the Caries Management System had been achieved from Faculty lectures and tutorials ($r = -0.275$, $n = 77$, $p < 0.05$). This finding has implications for the timing of these lectures and tutorials within the degree program.

Table 7.1. Demographic characteristic of responding students.

		BDent3 (N=57)	BDent4 (N=52)
Response rate		53 (93)	24 (46)
Gender*	Male	28 (53)	11 (46)
	Female	25 (47)	11 (46)
	Not reported	0 (0)	2 (8)
	Total	53 (100)	24 (100)
Background degree*	Science	20 (35)	15 (63)
	Medical Science	21 (37)	6 (25)
	Other	7 (13)	0 (0)
	Not reported	5 (9)	3 (13)
	Total	53 (100)	24 (100)

* p > 0.05, Pearson chi-square

Table 7.2. Student learning , clincial experience, and perceptions regarding non-invasive management of dental caries (percentage distributions).

	BDent 3 (N=53)						BDent 4 (N=24)						p value	
	Strongly disagree			Strongly agree			Strongly disagree			Strongly agree				
	Disagree	Not sure	Agree	Strongly agree	(Total)	Disagree	Not sure	Agree	Strongly agree	(Total)	r*			
Student learning														
Q1. I feel the background science and rationale for non-invasive management of tooth decay is clearly taught within this faculty	0	7	15	74	4	(100)	0	29	17	54	0	(100)	-0.275	0.015
Q2. The knowledge provided in other courses is compatible to what you have been taught in in the non-invasive management handout	0	15	50	35	0	(100)	0	39	22	39	0	(100)	0.393	0.39
Clinical experience														
Q3. I feel that the non-invasive management of tooth decay is a useful treatment modality in the student clinics	0	25	15	53	7	(100)	0	17	12	71	0	(100)	0.658	0.65
Q6. Patients responded to my oral health education efforts	2	6	2	85	6	(100)	0	4	8	83	4	(100)	-0.046	0.69
Q7. I noticed an improvement in my patient's oral care as a result of my education efforts	0	4	17	77	2	(100)	0	0	13	74	13	(100)	0.184	0.10
Q8. I feel the treatment and home-care protocols are complicated	2	43	11	44	0	(100)	17	58	4	21	0	(100)	-0.309	0.006

*Spearman-rank correlation

Continued over

Table 7.2 (contuned). Student understanding , clincial experience, and perceptions regarding non-invasive management of dental caries (percentage distributions).

	BDent 3 (N=53)					BDent 4 (N=24)					r*	p-value		
	Strongly disagree					Strongly disagree								
	Disagree	Disagree	Not sure	Agree	Strongly agree	Total	Disagree	Disagree	Not sure	Agree			Strongly agree	Total
Perceptions of non-invasive management														
Q9. I will feel confident using non-invasive management of dental caries in my future career:	0	4	19	60	17	100	0	3	13	67	17	100	0.041	0.72
Q10. I feel this treatment approach will be easily integrated into private practice	0	19	30	38	13	100	4	0	29	46	21	100	0.177	0.12
*Spearman-rank correlation														

Curriculum consistency: More than half of the students in both groups responded that they were uncertain whether the caries management instruction provided by all teachers within the degree program was compatible with the Caries Management System as described on the handout they were using in the clinic. This finding indicates that staff professional development may need to address this issue.

Usefulness of the Caries Management System as a treatment modality: The majority of third year students (60%) and fourth year students (71%) considered the system to be a useful modality in the student clinics.

Patient response: More than 80% of students in both groups reported that patients responded positively to their health education efforts and demonstrated an improvement in oral care.

Protocol complexity: Forty-four percent of third year students considered the treatment and home-care protocols to be complicated whereas the majority of fourth year students (75%) considered the protocols uncomplicated ($r = -0.309$, $n = 77$, $p < 0.05$). This finding may reflect the fourth year students' greater level of experience in delivery of home-care information.

Applicability of the Caries Management System in future practice: More than 70% in both groups felt confident to use non-invasive management methods in their future career and largely agreed that this approach could be easily integrated into private practice.

Time spent in oral hygiene assessment and topical fluoride treatment

Table 7.3 presents data on time taken to assess oral hygiene of patients and deliver topical fluoride as required. The majority in both groups reported that they spent on average of ten minutes or less at each visit assessing the oral hygiene status of patient and providing fluoride therapy. There was no significant difference between third and fourth year students in the time spent on these tasks. An average time of less than 5 minutes delivering fluoride was reported by 56% of third year and 33% of fourth year students.

Risk assessment

Table 7.4 reports student risk assessment results for the three case scenarios presented in section two of the questionnaire. All students were successful in recognising high-risk patients. With medium risk patients, 54% of third year students considered the risk status to be higher than medium compared with 16.7% of fourth year students ($\chi^2 = 9.28$, $df = 1$, $p = 0.002$). For low risk patients the difference between third year and fourth year results was non-significant; most students correctly assigning the risk.

Reported risk-based caries management strategy

Low risk case scenario: The preferred management strategy chosen by the students for proximal lesions with different depths as seen in the schematic bitewing radiographs is demonstrated in Figure 7.2. The majority selected remineralisation strategies for lesions in the outer and inner half of the enamel (93.5% and 92.2%, respectively). However, choice of the remineralisation strategy for lesions with radiolucency of just into DEJ was only reported by 65% of the students. For outer dentine lesions almost half the students decided to intervene by restoration. The tendency towards invasive management of these lesions was significantly higher among those students who assigned medium risk in a situation where the actual risk was low ($\chi^2 = 13.9$, $df = 2$, $p = 0.001$)

Medium risk case scenario: A similar pattern to the one for low risk patients was observed in management options reported by students for the medium risk patients (Figure 7.3). More than 85% of students selected a non-invasive management strategy for outer and inner enamel lesions and 64% for radiolucencies which had progressed to the dentin-enamel junction. However, restoration was the preferred option reported by 76% of the students for lesions in the outer half of dentin. Those students who assigned a higher risk were more likely to choose to restore lesions with radiolucency of just into DEJ ($p < 0.000$, Fisher's Exact Test) and when there was dentine involvement in the schematic radiograph ($p < 0.000$, Fisher's Exact Test).

Table 7.3. Percentage distribution of students by number of minutes spent at each visit assessing oral hygiene and delivering topical fluoride.

	BDent 3 (N=53)					BDent 4 (N=24)					r*	p value		
	<5	5-10	10-15	15-20	>20	(Total)	<5	5-10	10-15	15-20			>20	(Total)
Time spent in the clinic														
Q4. Time spent on average at each visit assessing the oral hygiene of the patient	23	66	9	2	0	(100)	38	46	13	4	0	(100)	-0.081	0.48
Q5. Time spent on average at each visit delivering fluoride to the patient	56	33	2	2	0	(100)	33	54	13	0	0	(100)	0.17	0.12

*Spearman-rank correlation

Table 7.4. Percentage agreement between researcher and students regarding patient risk diagnosis.

Researcher diagnosis	Student diagnosis					
	BDent 3 (N=53)			BDent 4 (N=24)		
	High	Medium	Low	High	Medium	Low
High	100.0	0.0	0.0	100.0	0.0	0.0
Medium*	54.0	46.0	0.0	16.7	83.3	0.0
Low	0.0	30.2	69.8	0.0	12.5	87.5

* p<0.05, Pearson Chi-Square

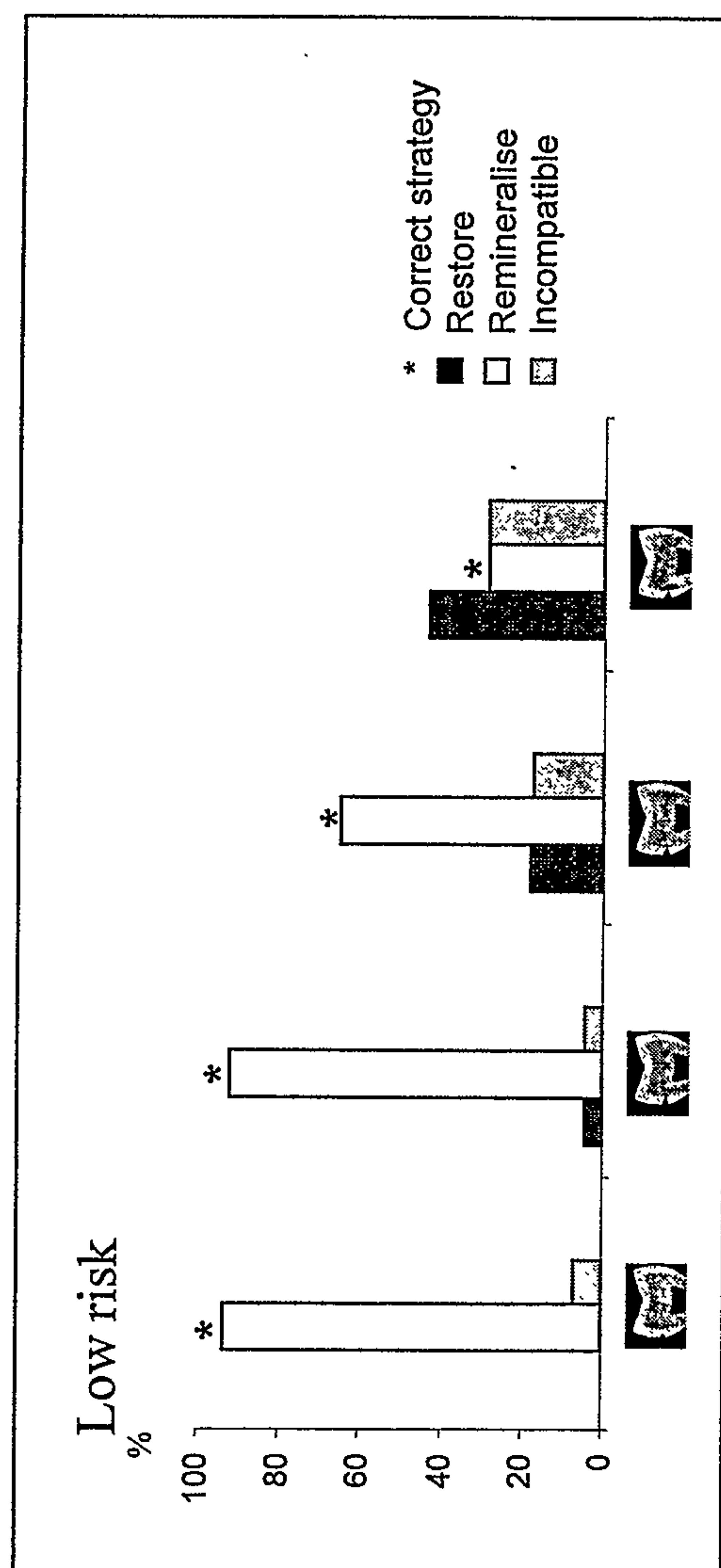


Figure 7.2. Selected management strategy for lesions of varying depth in low risk patients. (Incompatible means that a lesion of this depth is incompatible with a low risk patient.) (N=77)

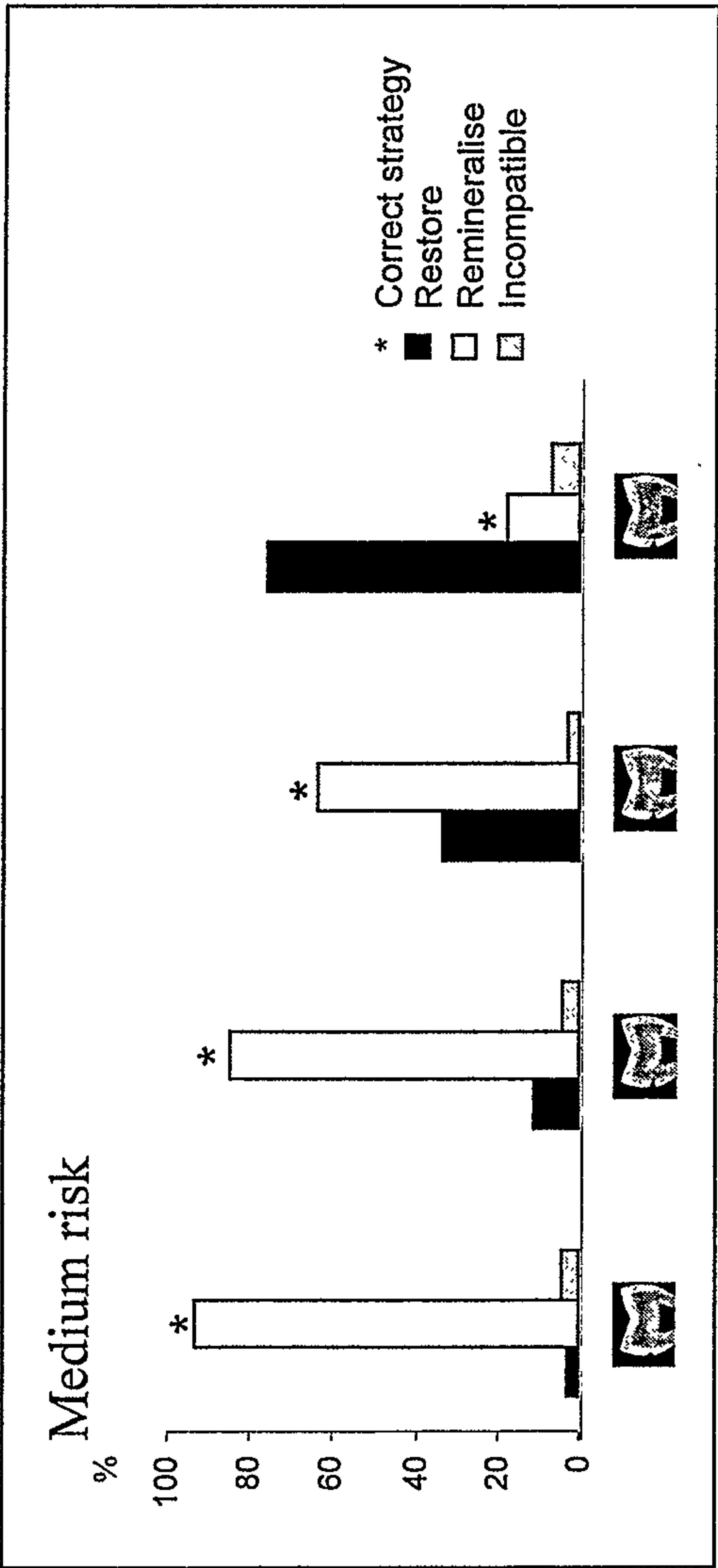


Figure 7.3. Selected management strategy for lesions of varying depth in medium risk patients. (Incompatible means that a lesion of this depth is incompatible with a medium risk patient.) (N = 77)

High risk case scenario: For the high risk patient, 90% of students selected the remineralising strategy for outer enamel lesions and 79% for inner enamel lesions as diagnosed in bitewing radiographs but there was a strong trend towards choice of restoration for radiolucency just beyond DEJ (62%). As this was the recommended strategy for lesions with radiographs demonstrating dentine involvement in a high risk patient their preferred management strategy was correct (Figure 7.4).

Association between choice of treatment and attitudes to the Caries Management System

Association between students' choice of treatment for all types of lesion in low, medium and high-risk patients and their attitudes and beliefs about the Caries Management System was further investigated by calculating odds ratios, of which ten of the 120 possible combinations were significant. Students who believed that non-invasive management was useful were 69% (OR=0.31, 95%CI=0.09, 0.99) less likely to use restoration as the treatment of choice for inner enamel lesions in high-risk patients. Compared with those students who spent less than five minutes in assessing oral health status, those who spent sufficient time were nearly 80% (OR=0.19, 95%CI=0.05, 0.69) less likely to choose remineralisation for lesions just beyond the DEJ for their low and high risk patients. Similarly, compared with those who believed that their patients did not respond to oral health education, those with a more positive view were 78% (OR= 1.78, 95%CI= 1.40, 2.28) more likely to restore outer dentine lesions in low risk patients. Compared with students who disagreed that the background science was clearly taught, those who agreed were more than four times (OR=4.55, 95% CI=1.19, 17.42) more likely to restore lesions just beyond DEJ in medium risk patients (Table 7.5).

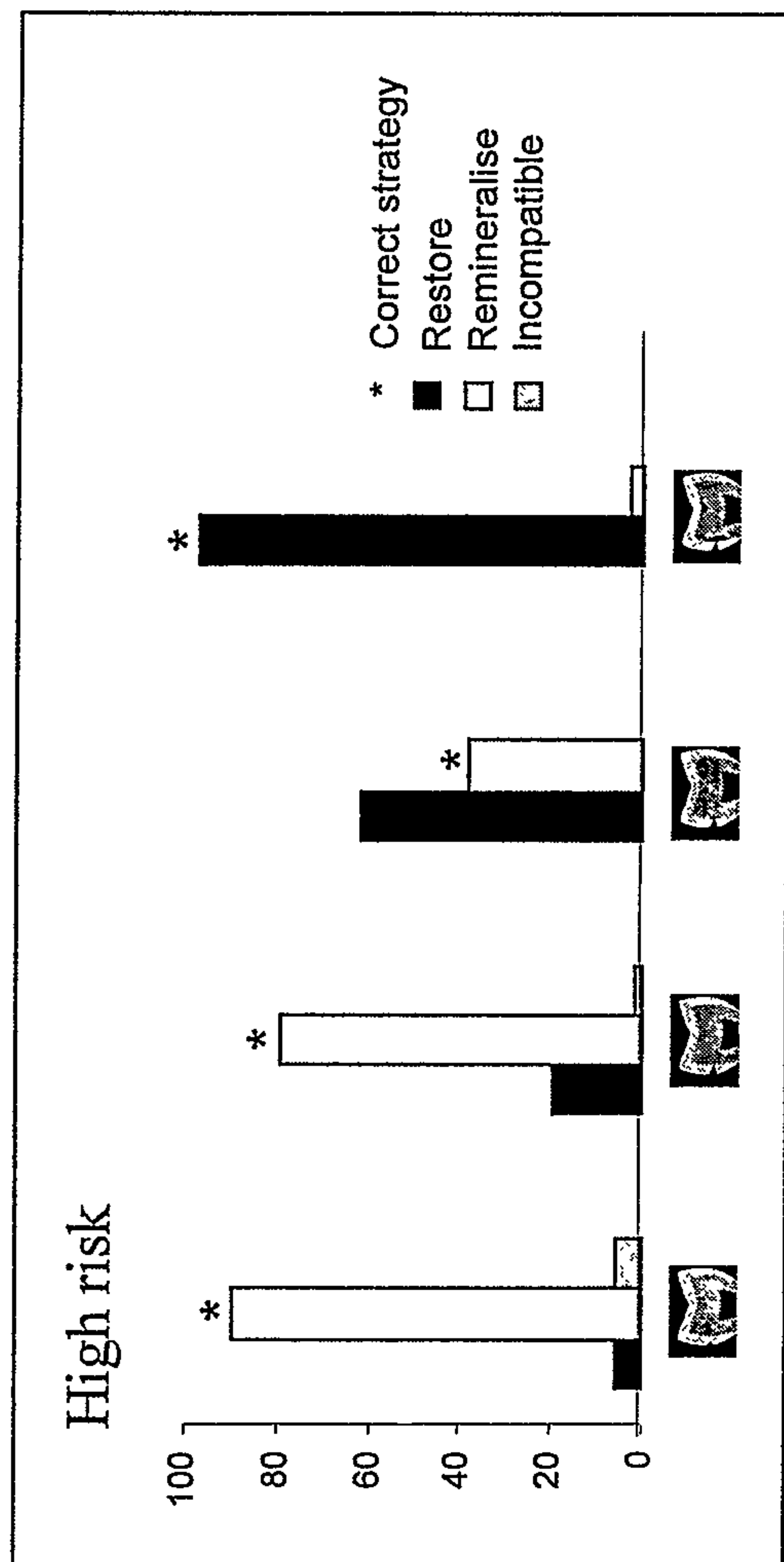


Figure 7.4. Selected management strategy for lesions of varying depth in high risk patients. (Incompatible means that a lesion of this depth is Incompatible with a high risk patient.) (N = 77)

Table 7.5. Odds that student selection of restorative management options for lesions of varying depth in low, medium, and high risk patients was associated with student attitudes and beliefs about the CMS.

Question topic	N	Lesion depth	Patient risk	OR	95%CI
1 Background cariology science is clearly taught*	72	Just beyond DEJ	Medium	4.55	1.19, 17.42
3 Non-invasive management is a useful modality in student clinics*	75	Inner enamel	High	0.31	0.09, 0.99
	72	Just beyond DEJ	Medium	0.35	0.13, 0.97
	76	Just beyond DEJ	High	0.29	0.10, 0.86
4 Time spent in assessing/coaching oral hygiene performance**	64	Just beyond DEJ	Low	0.19	0.05, 0.69
	76	Just beyond DEJ	High	0.19	0.05, 0.70
6 Patients responded positively to oral health education	64	Just beyond DEJ	Low	0.16	0.03, 0.83
	55	Outer dentine	Low	1.78	1.40, 2.28
	69	Outer dentine	Medium	1.27	1.11, 1.44
8 The CMS protocols are complicated*	68	Outer enamel	Medium	0.91	0.83, 0.99

* Attitudes or beliefs were dichotomised as strongly disagree/disagree/not sure and agree/strongly agree

** Time spent assessing/coaching was dichotomised as < 5 minutes and 5 minutes or more.

Discussion

This study shows that senior dental students who completed the questionnaire generally considered the Caries Management System to be a useful modality in the student clinic, largely demonstrating an understanding of how to undertake caries risk assessment and selecting remineralisation for management of enamel lesions. It was disappointing that less than half of the class completed the questionnaire. It was administered towards the end of the academic year when students were preparing for the final examinations. It was appreciated that the students were busy and, therefore, to encourage a good response, the questionnaires were distributed to the students by their clinical mentors (independently of the researcher) at a group meeting. They were encouraged by the mentors to complete it, and it was stressed that it was to be completed anonymously. In addition, a box was put in a convenient location for the returns. Despite these measures, the response was low.

Those who took part in the survey reported an intention to apply the strategy in their future careers. It is possible that those Year 4 students who did not take part in the study may have responded less positively but, given the strong affirmative intention of the year 3 students (93%), it is reasonable to assume that students will take non-invasive concepts into practice; however this has to be tested in future. Also it is recommended to test the applicability of this system in private practice. Because the survey was anonymous it was not possible to test the veridicality of the students' perceptions of the oral hygiene improvement of their patients and thus the possibility of attribution bias cannot be discounted.

The finding that students chose to restore lesions just beyond DEJ in medium risk patients and outer dentine lesions in low risk patients, when the correct management according to the Caries Management System is to treat them non-invasively, is a matter of concern. This finding probably highlights the belief held by some clinic staff that it was an unacceptable risk to treat such lesions non-invasively when these patients were presumed to be insufficiently motivated to attend for continuing non-invasive intervention. Since non-invasive management of these lesions is the prime focus of the Caries Management System, further investigation of staff

beliefs concerning the efficacy of the System and its implementation in student clinics was undertaken (see Chapter 8).

More than half of the students reported uncertainty about compatibility between the information provided for caries management by different disciplines in the Faculty. Although the Faculty had endorsed implementation of the program within the curriculum, individual teachers may hold differing views of its application in specific contexts and this may contribute to student confusion. This issue was evaluated in the study presented in Chapter 8.

The difference between third and fourth year students in terms of their perception of the degree of complexity of the program has implications for the way the program is taught and administered within the curriculum. It is possible that the greater experience of fourth year students in delivery of home-care instruction may result in their holding a more confident view. However, although the intention of the question was to evaluate their understanding of the program in relation to academic teaching, it is possible that they may have been referring to administrative issues when answering it. These issues are also addressed in the thematic analysis presented in Chapter 8.

This study shows clearly that those students who spend more time on average at each visit assessing the oral hygiene of their patients and providing oral hygiene instruction tend to adopt less invasive strategies such as remineralisation. The reasons for the variability of student estimates of time spent in these activities is unclear. It is possible that the pressures of meeting other treatment requirements as part of their academic assessment may have been contributing to perceived time pressure. Student and staff feedback was investigated for elucidation of these concerns and is reported in the study in Chapter 8.

The clear trend that students choose to restore lesions with radiolucencies just into DEJ and the outer third of dentine even in low risk patients, neither concurs with the principles of the Caries Management System nor with the international guidelines (2) upon which it is based. The tendency to make this choice was observed to be

stronger when the caries risk status was medium or high. It is possible that this may have occurred because of the students' need to obtain experience in restorative dentistry and this is investigated in a later study. However there is a second implication of this finding that is of concern. The studies of Australian dentists reporting a similar bias towards over-treatment when radiolucency is confined to enamel (10) or up to DEJ in low-risk patients (9) suggests that there may be a risk that new graduates moving into private practice may be influenced by experienced dentists practicing in this way. Although the results of this study show that the Caries Management System holds promise as a way of standardising practice according to international guidelines, the sustainability of the program in private practice by graduates cannot be guaranteed. Studies to evaluate the long-term effect of implementation of the program in practice are required.

Acknowledgement

With acknowledgement to Australian Dental Research Foundation for grant no. 5/2005.

References

1. Lith A, Pettersson LG, Grondahl H-G. Radiographic study of approximal restorative treatment in children and adolescents in two Swedish communities differing in caries prevalence. *Community Dent Oral Epidemiol* 1995;23:211-6.
2. Anusavice KJ. Symposium Summary Statements, Criteria, and Recommendations. In: Anusavice KJ, editor. *Quality evaluation of dental restorations, criteria for placement and replacement*. Chicago, Illinois: Quintessence Publishing Co., Inc; 1989. p. 411-415.
3. Hugoson A, Koch G, Hallonsten A-L. Caries prevalence and distribution in individuals aged 3-20 years in Jonkoping, Sweden, 1973, 1978, and 1983. *Swed Dent J* 1988;12:125-32.
4. Nuttall NM, Pitts NB. Restorative treatment thresholds reported to be used by dentists in Scotland. *Br Dent J* 1990;169:119-125.
5. Nuttall NM, Pitts NB, Fyffe HE. Assessment of reports by dentists of their restorative treatment thresholds. *Community Dent Oral Epidemiol* 1993;21:273-8.
6. Heidmann J, Hollund U, Poulsen S. Changes in criteria for restorative treatment of approximal caries over a 10-year period. *Caries Res* 1987;21:460-3.
7. Espelid I. Radiographic diagnosis and treatment decisions on approximal caries. *Community Dent Oral Epidemiol* 1986;14:265-70.
8. Mileman PA, Espelid I. Decision on restorative treatment and recall intervals based on bitewing radiographs: a comparison between national surveys of Dutch and Norwegian practitioners. *Community Dent Health* 1988;5:273-284.
9. Riordan PJ, Espelid I, Tveit AB. Radiographic interpretation and treatment decisions among dental therapists and dentists in Western Australia. *Community Dent Oral Epidemiol* 1991;19:268-71.

10. Tan PLB, Evans RW, Morgan MV. Caries, bitewings, and treatment decisions. *Aust Dent J* 2002;47(2):138-141.
11. Anusavice K. The maze of treatment decisions. In: Fejerskov O, Kidd E, editors. *Dental Caries-The disease and its clinical management*: Oxford: Blackwell Munksgaard; 2003. p. 251-265.
12. Haugejorden O, Birkeland JM. Evidence for reversal of the caries decline among Norwegian children. *Int J Paediatr Dent* 2002;12(5):306-15.
13. Burt BA, Eklund SA. *Dentistry, dental practice, and community*, 5th edition. Philadelphia: WB Saunders Company; 1999.
14. Mejare I, Kallestal C, Stenlund H, Johansson H. Caries development from 11 to 22 years of age: a prospective radiographic study. *Caries Res* 1998;32:10-16.
15. Mejare I, Kallestal C, Stenlund H. Incidence and progression of approximal caries from 11 to 22 years of age in Sweden: a prospective radiographic study. *Caries Res* 1999;33:93-100.
16. Rugg-Gunn AJ. Approximal carious lesions, A comparison of the radiological and clinical appearances. *Br Dent J* 1972;133:481-484.
17. Bille J, Thylstrup A. Radiographic diagnosis and clinical tissue changes in relation to treatment of approximal carious lesions. *Caries Res* 1982;16:1-6.
18. Pitts NB, Rimmer PA. An in vivo comparison of radiographic and directly assessed clinical caries status of posterior approximal surfaces in primary and permanent teeth. *Caries Res* 1992;26:146-152.

CHAPTER 8 - Thematic analysis of perceived problems and barriers in implementation of the Caries Management System

Background

Implementation of a new clinical teaching program within an existing curriculum is heavily dependent on the effective teaching of the academic and clinical staff who supervise and mentor the clinical program, student learning of new clinical strategies and patient receptivity to a different approach to disease management. In a situation where for many years staff have been teaching a different curriculum, effective implementation may depend on the degree to which these staff are familiar with or convinced by the evidence-base for the new program. The ease of acceptance of new strategies may also depend upon how well they are integrated into the existing curriculum and how well the students understand how to apply them. In any research situation, the process of carrying out research may yield information concerning implementation of new elements of the curriculum and for this reason, data supplied by the researcher may add valuable insights.

Teachers and teaching practice

Research studies of effective clinical teaching have identified several factors of critical importance in clinical teaching (1, 2). Irby found that excellent clinical instructors were positive role models of compassionate and competent patient care, provided effective supervision, used diverse teaching strategies and were generally supportive of student learning (1). Important attributes of teachers identified in the review by Heidenreich et al. included providing students with clear feedback on

performance, having a demonstrable interest in teaching, motivating students to learn, assisting students to apply didactic information to patient care, explaining clearly and embodying a compassionate and proactive approach to learning. The extensive review by Heidenreich et al. also examined the evidence base for effective clinical teaching strategies. They found that, despite existence of a body of evidence describing characteristics of effective teachers, there was little empirical evidence for the effectiveness or time-efficiency of the specific teaching methods that both students and staff believed to be most valuable (2). A broader issue of potential relevance to change in teaching practice is described by Benn. He argued that the most important barriers to changing dental practice to incorporate evidence-based strategies were: (a) the requirement to collect a more comprehensive history and data concerning clinical caries, (b) the greater complexity of evidence-based decision-making, and (c) the dentists' difficulty in standardising such decision-making processes (3).

Student approaches to clinic-based learning

Senior students in dental clinics are required to learn under supervision to provide invasive treatment such as restorations for the patients in their care so that by graduation they are safe to work as sole dental practitioners. This requirement means that acquisition of the technical skills of dentistry is a prime focus in the curriculum. Henzi et al, in their study of student perspectives on clinical education, report that students are thus strongly focused on evaluation and judge effectiveness of clinical teaching in relation to how well feedback and evaluation of clinical performance is conducted (4). In a study of student perceptions of effective dental learning experiences, Victoroff and Hogan found that the most effective approaches to learning that were identified by students provided opportunities that were focused and specific, involved modeling and demonstrations, offered the option to apply new knowledge, ensured availability of quality feedback and enabled peer learning interactions within a supportive learning environment (5). The Bachelor of Dentistry degree at the University of Sydney is a postgraduate entry degree designed around problem-based learning and thus embodies many of the principles of adult learning cited by Victoroff and Hogan (5). The opportunity to evaluate the Caries Management System as part of the existing structure for evaluation of student performance for academic progression

was not possible at the time of its introduction and evaluation was conducted separately in this study and the study reported in Chapter 7.

Researcher information and insights

The involvement of a researcher who was not involved in academic teaching or student evaluation and who used anonymous questionnaire survey methodology to evaluate implementation of the Caries Management System reduced the necessity for the researcher to intrude into the research context. However, insights into the process of introduction of new variables into a clinical teaching context are available to the researcher as much as they are to any other person involved in the project. For this reason, the progress notes of the researcher were seen as a valuable data resource. In the present study, the views of the researcher are presented as an additional source of information in evaluation of implementation barriers to the Caries Management System.

Purpose of the study

The purpose of the study was to identify problems and barriers to implementation of the Caries Management System in a University teaching clinic conducted in a public health setting from the points of view of the researcher and the students and staff involved in its use.

Material and Method

The Caries Management System was introduced to integrated clinics following endorsement by the Faculty. Students were introduced to the rationale, evidence base and clinical methodology of the program in lectures and followed up in smaller groups or individually later in the clinical situation. Many of the teachers involved in clinical mentoring were dentists in private practice who taught on a part-time basis and academics responsible for curriculum areas other than cariology. The students applying the Caries Management System in the clinics were at two different stages in the completion of the senior years of their degree.

Students

Fifty-two of the 109 senior students who took part in the study (see chapter 7), provided responses to an open-ended question appended to the Questionnaire Survey, also described in detail in chapter 7. This question invited students to describe the problems they had experienced in using the Caries Management System, an important source of information of potential relevance for modification of the System to facilitate its use in the teaching environment. Analysis of the written comments was undertaken in two stages.

1. In stage 1 the lead author and a senior academic staff member developed open coding categories for the students' comments according to the protocol, based on grounded theory, described by Liamputtong (6). They then coded the responses according to these categories. The coding categories of the two raters were compared to ensure that similar meanings were being extracted and the coding categories refined using axial coding to ensure that any ambiguities could be more reliably resolved.
2. In stage 2 the data were re-coded by each author using the refined coding categories. The results of categorisation according to specific axial themes were then compared using crosstabs to evaluate the inter-rater consistency of categorisation.

Teachers

An independent interviewer (not involved with implementation or evaluation of the Caries Management System) carried out focussed interviews with the senior clinical tutors and hospital staff responsible for management of the clinic where the Caries Management System was introduced. The feedback was recorded and reported anonymously for data analysis. The scripts of these interviews were analysed using a similar procedure to that described above and the inter-rater consistency evaluated using Cohen's kappa.

Researcher

In order to have systematic overview of progress of implementation of the Caries Management System the researcher made a weekly visit to each clinic in which the

program was trialled during 2004 and 2005. The field notes and observations of the researcher were treated categorised according to specific themes.

Results

Analysis of student feedback

In coding the student responses, the two raters agreed that there were two main themes of responses to be distilled from 83 comments about implementation barriers provided by the respondents. Some positive comments were also provided spontaneously by the respondents.

The two themes were: (a) patient-related factors and (b) clinic-related factors. Axial coding within these themes identified five sub-themes. Among patient-related factors were motivation/adherence and comprehension/skill. Clinic-related factors comprised incompatibility of Caries Management System teaching and clinical requirements, staff inconsistency/lack of support, perceived complexity of the system and time/paperwork considerations. A miscellaneous category was used for comments that were difficult to code on the selected themes.

Some ambiguity in assignment of comments to the sub-themes was noted. The raters then collaborated to refine the meanings of the identified themes. Since categorization within the patient-related sub-themes was difficult, the sub-themes were discarded and only the main theme category retained. In the clinic-related theme groups, some overlap was found between the categories staff inconsistency or lack of support and incompatibility of teaching and clinical requirements. This category was collapsed and identified as problems with clinic policy or staff support. The comments were then re-coded independently by each rater using the agreed theme categories.

The results of the thematic analysis are presented in Table 8.1. Inter-rater reliability in assignment of comments to these new theme categories was very high (Kappa = 0.86, $p < 0.001$) and results are presented in Table 8.2.

Table 8.1. Barriers reported by *52 students* concerning the implementation of the Caries Management System.

Main themes	N	%
Issues concerning patients		
Motivation/adherence/understanding	26	31
Issues relating to the clinic and the CMS		
Time and paperwork	12	14
Clinic policy/staff support	25	30
Complexity	12	14
Miscellaneous	8	10
Total comments	83	100

Table 8.2. Inter-rater reliability on thematic analysis of *students comments* about barriers to implementing the Caries Management System.

Researcher	Supervisor									
	1		2		3		4		5	
	N	%	N	%	N	%	N	%	N	%
1	12	100								
2			20	80	4				1	
3	1				10	83			1	
4			1		1		6	75		
5									26	100
Total	13		21		15		6		28	

Number and % agreement by researcher and supervisor.
Cohen's kappa=0.86

Patient motivation, adherence and comprehension: The most frequent theme (31% of responses) to emerge was that patient adherence to recommended oral hygiene practice was a barrier to successful implementation of the Caries Management System. The comments reflected perceived lack of patient motivation for prevention. Patients in the public health system were seen to believe that invasive dental treatment was the prime or sole reason for dental attendance and were disinterested in attending for non-invasive management. Some patients were perceived as lacking the required dexterity to remove plaque successfully while others appeared to lack comprehension. All of these factors disposed towards a poor attendance for non-invasive management, thus reducing efficacy of the Caries Management System for this patient population. The following quotes illustrate this theme.

- “Lack of patient's motivation and compliance due to lack of understanding despite the continuous education given”
- “Problem with regular return for check up of patients, they do not return after acute treatment of their presenting problem”
- “Some patients cannot or refuse to lower their risk by changing their dietary habits or oral hygiene despite my advice at every session”
- “Difficulty in persuading patients to accept minimum intervention. Most patients prefer to have something done to their teeth when coming to dental appointment. However younger the patient the more willingness to accept non-invasive management”

Problems with clinic policy and staff support: A second frequently endorsed theme was the difficulty experienced by the students in implementing the Caries Management System in a context where other clinical requirements competed for their time. The students (14%) complained about the paperwork requirements, which they believed cut into their time to complete required restorative procedures on which they were being assessed. There was also perceived diversity of opinion amongst the clinical tutoring staff (30%). Some were perceived as being uncertain about how the system should be implemented. Others placed a lower priority on implementation of the Caries Management System, encouraging students to gain experience in restorative procedures. This problem appeared related to the current clinic policy of

marking restorative work but not oral hygiene, health education or remineralisation procedures. In some cases (14%) the Caries Management System was perceived as complex or difficult to apply to an individual case where other factors required consideration. Examples of comments in this theme are provided below:

- “Differences of opinions between current teaching policy and clinical opinion of some senior staff members!”
- “Varied information from staff about the importance of this method”
- “Discrepancies between clinicians opinion and guidelines”
- “There was no uniformity between individual tutors. Some were not even aware of different grades of lesions. Its not to indicate there should be a 'black and white' of dentistry but the variance was quite extensive. Difficult to implement due to constant changing of tutors”
- “Not considered a high priority to implement” “Based on definitions for previous and new lesions it is difficult to assign risk”
- “Interferes with tutor’s course aim for students to practice restorations”
- “Useful modality in the clinic except we don't get requirement/points out of fluoride therapy”
- “Difficult to apply in hospital waiting period, can't watch lesion closely, ends up more likely in intervention, management system should be only for private in reliable patients, It is hard to apply this system in the NSW hospital system due to the waiting lists, cannot monitor lesions appropriately in this system”

Analysis of staff feedback

In coding the staff feedback, the raters agreed that there were three main themes. These were identified as clinic-related factors, student-related factors and constructive suggestions. A miscellaneous category was used for comments that did not fall into a theme category. Axial coding within these themes identified four sub-themes within the clinic-related theme. These were identical to those derived from the student feedback data, namely time/paperwork, perceived complexity of the system, and clinic policy/staff support. A fourth sub-theme, administration, was added when a body of comments was found to report this barrier to implementation of the system. The comments were then coded by the two raters according to these revised theme categories.

The results of the thematic analysis are presented in Table 8.3. Inter-rater reliability in assignment of comments to theme categories was very high (Kappa = 0.92, $p < 0.001$) and results are presented in Table 8.4.

Clinic-related factors: The most frequently endorsed theme (32%) was the difficulty in management of time issues in the clinic. In teaching clinics, where students are required to develop expertise in restorative treatment, difficulty was experienced in integrating the protocol of non-invasive management. Staff experienced problems with the competing demands on clinical time posed by having to develop treatment plans and check additional patient forms. The system was also reported to be more complex than expected in its application (16%). Staff members felt that, because many clinical factors (for example, patient motivation and past history of failure to attend) were not easily represented on the CMS forms, it was sometimes necessary to make the choice to restore rather than manage non-invasively. Staff support was also compromised by lack of ease with the new system and a perceived need for further education in its use. A further issue, of which the students were unaware, was the barrier to implementation posed by difficulty in administration of the system (16%). Administrative staff experienced difficulty with the changed requirement of patient bookings and the inability of the existing computer recording systems to cope with a different management protocol. Comments illustrative of this theme are presented below:

- “In many ways it was too black and white. It was like “how to do dentistry from X-rays” . It didn’t allow for weighing up of clinical factors. For example – a patient may need to have restorative treatment because if they don’t, and then they don’t come back for 3 years, it will necessarily be an extraction”
- “It is another layer of paperwork and a different procedure in a very hectic routine of assessment”
- “The main problem was the chaos of ordering the patient files and getting records.”

Table 8.3. Barriers reported by *staff members* concerning the implementation of the Caries Management System.

Main themes	N	%
Clinic related factors		
Time and paperwork	10	32.3
Clinic policy/staff support	5	16.1
Complexity	5	16.1
Administrative issues	5	16.1
Student related factors		
Perceived patient motivation	2	6.5
Student motivation	1	3.2
Constructive suggestions		
Co-ordination of teaching and clinical practice	1	3.2
Caries management should occur in a special clinic	1	3.2
Miscellaneous	1	3.2
Total comments	31	100.0

Table 8.4. Inter-rater reliability on thematic analysis of *staff comments* about barriers to implementing the Caries Management System.

		Supervisor																			
		1		2		3		3		4		5		6		7		M		Total	
Researcher		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
1	Administrative issues	5	100																	5	100
2	Time and paperwork			10	100															10	100
3	Clinic policy/staff support					4	80	1												5	100
4	Complexity							4	80											5	100
5	Teaching change									1	100									1	100
6	New clinic											1	100							1	100
7	Motivation and adherence													1	100					1	100
8	Students motivation															1	100			1	100
M	Miscellaneous.															1	100	2	100	2	100
Total		5		10		4		5		1		1		1		2		2		31	100

Number and % agreement by researcher and supervisor.
Cohen's kappa = 0.96

- “There was no system in place for sorting out what had to be done with the patients”
- “It was not clear to staff when restoration could take place and when fluoride should be applied. It was hard to review”

Student-related factors: A second theme related to student acceptance and ease with the Caries Management System. Students were perceived as focused on the academic requirements to achieve technical excellence in restorative procedures. Because they were often slow, they were frustrated by the time required to manage caries non-invasively. Patients were also perceived as lacking motivation, thus making the process of non-invasive management more difficult for students. Some examples of this theme include:

- “Students were confused. If the tutor said “restore” for clinical reasons and the CMS said “no don’t” then it all was very inflammatory”
- "Students see things are assessable. There are things that are absolute requirements and the CMS had nuisance value"

Constructive suggestions for the future: Staff members were helpful in making constructive suggestions to improve the system. Two useful ideas put forward were:

- Improving the teaching of the program to ensure familiarity and acceptance by staff and dovetailing the lectures and clinics more tightly in treatment planning pedagogical instruction.
- Developing a separate caries control clinic from which patients could be referred for restorative treatment.

Analysis of researcher feedback

The field notes provided by the researcher were categorised according to the following themes:

Hospital treatment priorities: The main endeavour of the teaching hospital was to provide treatment for patients, especially in emergency situations. The process

involved placing patients on a waiting list and recalling them for treatment on the basis of level of severity of oral health problems (ranging from infection/abscess to regular check ups). Patients were allocated to students according to the requirements of the course. A priority in teaching was provision of educational opportunities for mastering diagnosis and treatment planning (tertiary prevention), which is a very time consuming process. In this context, less time was available to be allocated to primary and secondary prevention, which are the prime focus of the Caries Management System.

Hospital administration: Hospital staff members were very concerned about increasing the average chair time. The time taken by students to score lesions on bitewings increased chair time markedly and created challenges for the usual administrative procedures. Follow up of patients led to the necessity to keep hospital records at the reception desks and was an additional burden when patients did not reply to messages. The long waiting list of patients made addition of any component to the above-mentioned system more difficult.

Clinical tutors: The university employs general dentists and specialists for supervision of clinical sessions. Turnover of tutors makes it difficult to standardise provision of services including treatment plans. Encouraging tutors to participate in research was often difficult as it was perceived as secondary to teaching needs.

Forms and paperwork: The paperwork involved in treatment planning for patients with different dental problems was already perceived to be challenging. There was resistance to any additional paperwork, especially where some tutors held the view that the additional information was unnecessary.

Lack of research incentives: Without incentives to take part in a clinical research program it was difficult to keep students motivated to participate in the program. Students were focused on assessment requirements for academic progression and, since none were available for this program, student involvement relied upon good will and belief in its value.

Patient expectations: Patient expectations were also problematic. They expected to receive a tangible treatment and often found delivery of primary prevention such as of oral hygiene instruction and dietary advice unsatisfactory.

Discussion

Evaluation of feedback from teaching, clinical and administrative staff, students and the researcher indicated that there were five main problem areas associated with implementation of the Caries Management System in a University teaching hospital clinic: time constraints, administrative problems, teaching and learning issues, problems in perceived patient motivation and issues associated with mastery of the system itself.

Most prominent throughout the feedback was the problem of time management. Although the time involved to assess patients and deliver treatment at any one session was relatively short, the impact on overall time management in the clinic posed problems for students and staff. The suggestion to create a caries control clinic from which patients could be referred for restorative treatment is a suggestion worthy of further consideration. This would reduce the perceived conflict for time between restorative and non-invasive management programs and would assist students in focussing on skill development in both areas.

Such a change would require attention to administrative needs of the different hospital programs. The problems for staff administration of student teaching clinics is already complicated by providing patients suitable for student learning at the same time as prioritising treatment for patients with the greatest need in the context of long waiting lists. Establishment of a caries control clinic would separate invasive and non-invasive treatment programs and thus reduce complexity of administration.

Continuing education of staff and formal agreement to implementation of the Caries Management System in the teaching clinic is necessary to prevent staff resistance to continuing patient evaluation which occurred ostensibly because of competing demands for clinical time (although the study by Benn suggests that other

factors may be involved in staff resistance)(3). It may be that different teaching strategies are needed to implement the new system of caries management and the exhortation by Heidenreich et al. for evidence-based research in clinical teaching should be heeded here (2).

The student suggestion that regular use of the Caries Management System be formally assessed as part of their overall clinical competency would ensure that non-invasive procedures were applied appropriately as well as encouraging their regular use. Such a view is supported by the research of Henzi et al. and would also represent a commitment by the Faculty of Dentistry to best practice in caries management(4).

Feedback about issues of complexity in mastery of the Caries Management System suggests that with improved continuing education for teaching staff, better management of the conflicting demands for clinical time and attention to issues of patient motivation perceptions of complexity would diminish.

The problem in perceived motivation of patients to attend for non-invasive management suggests that, for the Caries Management System to be implemented successfully in a public hospital setting, attention must be given to adjunctive use of motivational interviewing techniques for change of oral health behaviour such as those described by (7). The elements of these programs are already taught in the junior years of the Bachelor of Dentistry and Bachelor of Oral Health degrees and this finding suggests that the transition between the pre-clinical and clinical years and integration of dental therapists into the senior teaching clinics requires further scrutiny and research. The potential for extending the Caries Management System to include evidence-based strategies for health behaviour change is promising.

References

1. Irby DM. Teaching and learning in ambulatory care settings: thematic review of the literature. *Acad Med* 1995;70:898-931.
2. Heidenreich C, Lye P, Simpson D, Lourich M. The search for effective and efficient ambulatory teaching methods through the literature. *Pediatrics* 2000;105:231-237.
3. Benn DK, Clark TD, Dankel DD, Kostewicz SH. Practical approach to evidence-based management of caries. *J Am Coll Dent* 1999;66:27-35.
4. Henzi D, Davis E, Jasinevicius R, Hendricson W. North American dental students' perspectives about their clinical education. *J Dent Educ* 2006;70:361-377.
5. Victoroff KZ, Hogan S. Student perceptions of effective learning experiences in dental school: a qualitative study using a critical incident technique. *J Dent Educ* 2006;70:124-132.
6. Liamputtong P, Ezzy D. *Qualitative Research Methods*. Melbourne: Oxford University Press; 2005.
7. Rollnick S, Butler R, Butler C. *Health Behaviour Change: A Guide for Practitioners*. Edinburgh: Churchill Livingstone; 1999.

CHAPTER 9 - Summary of findings and recommendations

The need for a robust, standardised and user-friendly system for caries management is indisputable in view of the increasing dentate population with unmet treatment needs. Over the past three decades research into remineralisation as a strategy for prevention, arrest and reversal of caries has grown has led to an evidence base that is sound and convincing, yet this message has not penetrated public awareness.

The Caries Management System (CMS) was developed in response to this need. Implementation in a public health facility which is part of a teaching hospital had the potential to achieve two goals. It provided the opportunity to trial acceptance of the program and ease of integration into a public health environment and at the same time enabled introduction of the system to undergraduate students in a clinical teaching environment.

Evaluation of the CMS was undertaken from three points of view. Patient knowledge was surveyed to identify levels of existing knowledge and beliefs about dental caries. Student understanding, clinical experience and perceived problems with the system were investigated. Experience of the system from the point of view of teaching and administrative staff was then undertaken.

Systematic review of the literature on the progression/regression of approximal carious lesions

Study findings

The studies were heterogeneous in terms of sample age and size, number of subjects, duration, background fluoride, and mode of and intensity of preventive intervention. It appears that the rate of progression of carious lesions has decreased during the last 40 years. Lesion progression is retarded more by the use of a combination of topical fluoride products than by use of fluoride toothpaste alone, and the data suggest that pattern of rate of lesion progression over time differed according to the intensity of the fluoride treatment.

Primary teeth: All studies relating to primary teeth were conducted in low-fluoride areas and showed that prior to the availability and use of topical fluoride, approximal lesion progression was rapid. However, even with the use of combinations of topical fluoride application, chlorhexidine gel, and fluoride toothpaste, around 70% of lesions progressed during 24 months; slightly less than in the associated control groups. More recently, lesion progression of 60% (survival of 40%) at 48 months was observed in both OE and OD lesions in a prospective non-controlled study of yearly tray applications of APF gel together with daily use of fluoride toothpaste. The associated median survival time of both lesion types was about 30 months as reported in this study.

Permanent teeth: Estimates for subjects aged 8 to 18 years were determined. Assuming a linear model of progression, estimates of annualised lesion progression rates were calculated in a meta-analysis with respect to both outer and inner enamel lesions and were based on the outcomes of the individual studies of 36 months duration only. In this general linear model analysis, the estimates were weighted by the number of lesions that were followed. The annualized progression estimates for outer enamel lesions in relation to the use of (a) fluoride toothpaste alone, and (b) fluoride toothpaste in combination with fluoride varnish, rinse, or gel were 22% (95%CI = 20%, 24%) and 19% (95%CI = 15% to 22%), respectively.

For inner enamel lesions, the equivalent estimates were 27% (95%CI = 26% to 29%) and 22% (95%CI = 19% to 25%), respectively. The effect difference at 36 months between the mean progression estimates for lesions treated with (a) fluoride toothpaste alone and (b) the combination of topical fluoride products was 11% ($p = 0.063$) in relation to outer enamel lesions and 16%, ($p = 0.008$) in the case of inner enamel lesions.

Lesion regression

This review has highlighted the phenomenon of lesion regression. Since non-invasive approaches have, in the main, not been attempted despite evidence from one study that 50% of radiolucencies, confined to the outer half of dentine, were not associated with enamel cavitation the potential for gathering follow-up data on lesion behaviour has been mostly forfeited and hence data on the dentine lesion progression and regression is most scarce.

Recommendations

Recommendation 1 - A simple method for standardising the positioning of the bitewing film and x-ray beam is needed.

Recommendation 2 - For monitoring dentine lesions, it is suggested that consideration be given to a scoring system that divides the distance between the dentino-enamel junction and the pulp chamber into three equal zones.

Recommendation 3 - Further research is needed to clarify the likelihood that radiolucences, which extend into the outer third and middle third of dentine, are subject to arrest and remineralisation, or are cavitated and in need of restorative care.

Recommendation 4 - More studies in adults, and more long-term studies need to be conducted with regular follow-ups to allow for better modelling of the behaviour of lesions over time.

The utility of this review

This review and analysis demonstrates that: (1) time is on the side of efforts to arrest caries progression safely via non-invasive strategies, (2) once arrested, an arrested status may be sustained. It is noted that the non-invasive strategies aimed to arrest

caries progression also prevent new primary lesions. This analysis of lesion progression may be used to inform the development of better protocols for non-invasive caries management.

Conclusions

The main conclusions were that: (1) inner enamel lesions are more likely to progress during a given period than outer enamel lesions, (2) in children and adolescents, lesion progression is less rapid in subjects who receive professional applications of topical fluoride in addition to home use of fluoridated toothpaste, than in subjects whose topical fluoride source is limited to fluoride toothpaste alone, and (3) lesion progression generally occurs slowly, though faster in primary teeth and in low-fluoride areas.

Dental student application of the Caries Management System protocols: diagnosis and lesion management

Student application of the Caries Management System

Diagnosis: Of the 1926 lesions that were scored by students as sound, 91% were deemed correct by the researcher. The researcher agreed with the student's diagnosis of outer and inner enamel lesions on only 36% and 38% of surfaces, respectively, and, on 70% and 33% of just into DEJ and outer dentine surfaces, respectively. There was complete agreement regarding the two inner dentine lesions. The discrepancies were mostly only one grade different from that of the researcher. The researcher identified 169 $[332 - (139 - 9) - (45 - 12) = 169]$ other lesions not noted by the students, and of these 144 were in enamel.

Management of carious lesions: The 206 outer and inner enamel lesions were mostly managed non-invasively or were determined to have no need for intervention. Just over half of the 60 lesions that had just penetrated the DEJ were, correctly, not treated invasively. The seven outer dentine lesions (those confined to the outer third) and the 43 inner dentine lesions in high risk patients were all managed by tooth restoration

which is the accepted treatment mode for lesions of this depth and the correct management according to the Caries Management System.

Summary of findings

The results indicate that (1) students, at this stage in their careers, are more likely to under- than to over- diagnose caries from bitewings and are, therefore, in need of more coaching in the art of reading and scoring bitewing radiolucencies, (2) treatment decision making was generally correct, (3) many students were not following the system, and (4) that some supervising dentists were not checking this omission.

Recommendations

Clinical tutorials should be arranged for students to review the radiographs, diagnostic decision, and treatment plans of each others patients. Continuing education should also be arranged for clinical demonstrators to review the evidence base regarding dental caries natural history, caries management, the prognosis of non-invasively managed lesions, and caries prevention.

Clinical outcomes after 24 months following the implementation of the Caries Management System

Study findings

Frequency of preventive care interventions: The mean time between baseline and follow-up bitewing radiographs was 25.4 months. Oral hygiene instruction was not reported as being given to 24% of the patients. On the other hand, 22% of students had coached their patients on three or more occasions. 32% of the 66 patients under review had not been given topical fluoride applications, however, 13 of them had received topical fluoride applications on two occasions and five patients were given applications on three or more occasions.

Radiographic changes observed after two years: Follow-up radiographs were obtainable from 28 of the 66 patients being reviewed. Of the 704 sound surfaces in

these patients at baseline, it may be interpreted that 92% of the sound surfaces remained sound. The extent of lesion progression or status change following an invasive procedure observed at follow-up was directly related to baseline lesion depth; only 20% of outer enamel lesions had progressed versus 90% of inner dentine lesions. Altogether, 30 lesions were observed to have regressed.

Conclusions

The results show that some members of this small cohort experienced positive benefits from the non-invasive caries management that they received. Most lesions did not change which may indicate that they were already arrested at the commencement of treatment, or that they responded favourably to the treatment. Among the lesions that deteriorated or appear now as downgraded, a higher percentage of them were already deeper rather than shallower at baseline.

The insights gained from the results of this short term follow-up are not sufficient to forecast the future stability of the arrested lesions. The generally positive response observed, occurred despite the fact that some students may not have helped their patients to improve their oral hygiene or to deliver professional applications of topical fluoride

The important finding from this study is that many of the patients presenting for general dental care at the Westmead Centre for Oral Health have a caries risk that is not out of control and is amenable to risk reduction intervention. It was evident that some dentine lesions among patients of this cohort had not progressed during the two year period of observation, confirming that not all lesions are subject to rapid progression.

Within the patient pool of the Westmead Centre for Oral Health, there are, among all caries risk categories, many who have the potential to derive real benefits from non-invasive strategies to control, not only their caries risk, but their risk of developing a dentition that will become weakened through cycles of restorative intervention.

Future directions

New models for clinical learning and teaching need to be developed that will enable students to gain an appropriate experience in managing caries non-invasively in an environment that is free from pressure to gain operative experience.

A review of hospital policies regarding recall will be needed to ensure that the benefits of hospital care are not lost due to unfavourable schedules for follow-up and monitoring.

Student perceptions

Study findings

Dental students perceived the Caries Management System as a valuable treatment modality and were interested to continue using it in practice after graduation. They believed that it had been well taught and largely demonstrated an understanding of risk assessment and the effectiveness of remineralisation in treatment of enamel lesions.

Students reported experiencing inconsistency between teaching and clinical policies. In their view effective implementation of the System was compromised by their need to meet course requirements in technical proficiency in restorations and by perceived lack of staff support and acceptance of the System despite Faculty endorsement. Students tended to choose restoration as the treatment for lesions with radiolucencies just in DEJ and the outer third of dentine, especially for patients whose caries risk status medium to high. Because a similar bias towards over-treatment has also been observed in Australian graduate dentists in practice, there is a strong possibility that new graduates will continue to practice in this way.

Completion of an appropriate number of restorations is one of the clinical requirements of the course, whereas chair-side education and topical fluoride application are not currently assessed in the same way. This is likely to promote the concept of drilling and filling indirectly. The clinical requirements of the course together with different messages from the Faculty disciplines make the process of decision-making more complicated for the students. While focus of the health system

is to reduce acute infection, emergency treatment and reconstruction of the dentition, the failure to make prevention of new lesions and retarded progression of existing lesions a priority in clinical treatment works against achievement of these goals. The problem of long waiting lists for hospital treatment compounds the problem and makes implementation of the Caries Management System more difficult. In this context there is a need to promote secondary preventive efforts by rewarding such efforts.

This study shows clearly that those students who spend more time on average at each visit assessing the oral hygiene of their patients tend to adopt less invasive strategies such as remineralisation. Time and effort has to be spent by clinician who wishes to reduce the risk of new lesions and retard progress of already established lesions.

Recommendations

Undergraduate teaching needs to focus on the evidence base for use of remineralisation strategies as an effective treatment for lesions just in DEJ and the outer third of dentine and this message repeated and rigorously assessed. Staff professional development programs also need to emphasise these findings to ensure that the same message is presented in all faculty disciplines and that teaching clinic staff are convinced of its efficacy.

In order to increase the sustainability of the services provided and to improve the quality of care, non-invasive and preventive strategies such as oral hygiene instruction and remineralisation need to be made a clinical requirement of the course in all University teaching clinics.

Staff feedback

Study findings

The most difficult issues in implementation of the System in a teaching clinic were time constraints and the need to ensure students achieved technical proficiency in

restorative techniques. Difficulties also arose in administration of the System within integrated clinics because of the different requirements for chair time for restorative and preventive or caries arrest techniques.

Problems were also experienced with patient acceptance and adherence to recommended preventive strategies. The Caries Management System incorporates oral health education and dietary advice but development of specific strategies such as motivational interviewing to achieve behaviour change may be a useful adjunct.

Recommendations

Coordination between disciplines and training of all clinical teaching staff in the Caries Management System must be achieved. Administrative and time management problems would be diminished by establishment of a special site in the teaching hospitals to manage follow-up visits and provide more intensive surveillance of patients with higher risk of caries. Improved opportunities for application of knowledge of health behaviour change techniques currently taught in junior years, if incorporated within the Caries Management System would improve patient acceptance of and adherence to preventive and remineralisation methods.

Bibliography

1. Ainamo J (1980). Relative roles of toothbrushing, sucrose consumption and fluorides in the maintenance of oral health in children. *Int Dent J* 30: 54-66.
2. Ainamo J, and Parviainen K (1979). Occurrence of plaque, gingivitis and caries as related to self reported frequency of toothbrushing in fluoride areas in Finland. *Community Dent Oral Epidemiol* 7: 142-6.
3. Akpata ES, Farid MR, Al-Saif K, and Roberts EA (1996). Cavitation at radiolucent areas on proximal surfaces of posterior teeth. *Caries Res* 30: 313-316.
4. American Dental Association: Council on access prevention and interprofessional relations (1995). Caries diagnosis and risk assessment: a review of preventive strategies and management. *JADA* 126 (Special supplement): 2S-24S. [p.41]
5. Anusavice KJ (1989). Symposium summary statements: criteria, and recommendations. In: *Quality evaluation of dental restorations: criteria for placement and replacement*. Anusavice KJ. Chicago, Illinois, Quintessence: 411-415. [p. 102]
6. Anusavice KJ (1995). Treatment regimens in preventive and restorative dentistry. *JADA* 126: 727-743.
7. Anusavice KJ (1995). Protocol for conservative treatment decisions. *J Am Dent Assoc* 126: 740-743. [p.41, 44]
8. Anusavice KJ (2001). Clinical decision-making for coronal caries management in the permanent dentition. *J Dent Educ* 65: 1143-1146. [p. 3]
9. Anusavice KJ (2003). The maze of treatment decisions. *Dental Caries: the disease and its clinical management*. Fejerskov O and Kidd E. Oxford, Blackwell Munksgaard: 251-265. [p. 3, 44, 103]

10. Australian Health Ministers' Advisory Council (2001). Oral health of Australians: National planning for oral health improvement. Final Report. Adelaide, South Australian Department of Human Services: 17-47. [p. 60]
11. Australian Research Centre for Population Oral Health (2006). The use of fluorides in Australia: guidelines. Aust Dent J 51: in press. [p. 55]
12. Axelsson P, Paulander J, Nordkvist K, and Karlsson R (1987). Effect of fluoride containing dentifrice, mouthrinsing, and varnish on approximal dental caries in a 3-year clinical trial. Community Dent Oral Epidemiol 15: 177-80 [p. 9, 11, 13, 14, 25, 40]
13. Axelsson P, and Lindhe J (1977). The effect of a plaque control program on gingivitis and dental caries in schoolchildren. J Dent Res (Special Issue): C142-C148.
14. Axelsson P, Lindhe J, and Nystrom B (1991). On the prevention of caries and periodontal disease: results after a 15-year longitudinal study in adults. J Clin Periodontol 18: 182-189. [p. 62]
15. Bader JD, Shugars DA, and Bonito AJ (2001). A systematic review of selected caries prevention and management methods. Community Dent Oral Epidemiol 29: 399-411. [p.4]
16. Baker Dirks O (1966). Post-eruptive changes in dental enamel. J Dent Res 45: 503-510. [p. 9, 14, 20, 23, 24, 26, 39, 60]
17. Barnard PD, Gillings BRD, and Gillings KJR (1974). Assessment of a preventive dentistry programme in private practice. N Z Dent J 70: 15-24. [p.62]
18. Bellini HT, Arneberg P, and von der Fehr FR (1981). Oral hygiene and caries: a review. Acta Odontol Scand 39: 257-65.

19. Benigeri M, Brodeur J M, Olivier M, and Bedos C (2002). Knowledge and perceptions of adolescents regarding oral health. *Canad J Public Health*. 93(1): 54-8.
20. Benn DK, Clark TD, Dankel DD, and Kostewicz SH (1999). Practical approach to evidence-based management of caries. *J Am Coll Dent* 66(1): 27-35. [p. 141]
21. Berenie J, Ripa LW, and Leske G (1973). The relationship of frequency of toothbrushing, oral hygiene, gingival health and caries-experience in school children. *J Public Health Dent* 33: 160-71.
22. Bibby BG (1975). The cariogenicity of snack foods and confections. *JADA* 90: 121-132.
23. Bille J, and Carstens K (1989). Approximal caries pregression in 13- to 15-year-old Danish children. *Acta Odontol Scand* 47: 347-354. [p. 9, 11, 13]
24. Bille J, and Thylstrup A (1982). Radiographic diagnosis and clinical tissue changes in relation to treatment of approximal carious lesions. *Caries Res* 16: 1-6. [p. 27, 41, 104]
25. Billings RJ (1993). Saliva flow and dental caries in aging adults. In: *Cariology for the nineties*. Bowen WH and Tabak LA. Rochester, NY, University of Rochester Press: 235-260. [p. 93]
26. Bjarnason S, and Finnbogason SY (1991). Effect of different fluoride levels in dentifrice on the development of approximal caries. *Caries Res* 25: 207-212. [p. 9, 10, 13]
27. Bloemendal E, de Vet HCW, and Bouter LM (2004). The value of bitewing radiographs in epidemiological research: a systematic review of the literature. *J Dent* 32: 255-264. [p. 40]

28. Brabner D, Downer MC, Moles DR, and Naylor MN (1995). Initial caries attack and average progression rates in 12-year-old Isle of Wright children. *Community Dent Oral Epidemiol* 12: 190-193. [p. 9, 10, 27]
29. Brunn C, Bille J, Hansen KT, Kann J et al. (1985). Three-year caries increments after fluoride rinses or topical applications with a fluoride varnish. *Community Dent Oral Epidemiol* 13: 299-303. [p. 9, 10, 13]
30. Burt BA, and Eklund SA (1999). *Dentistry, dental practice, and community*, WB Saunders Company. [p. 103]
31. Burt BA, and Ismail AI (1986). Diet, nutrition, and food cariogenicity. *J Dent Res* 65 (Special Issue): 1475-84.
32. Burt BA, and Pai S (2001). Sugar consumption and caries risk: a systematic review. *J Dent Educ* 65(10): 1017-23.
33. Clark DC (1982). A review on fluoride varnishes: an alternative topical fluoride treatment. *Community Dent Oral Epidemiol* 10: 117-123.
34. Cook SR (1984). A longitudinal radiographic study of caries progression in dental students. *Aust Dent J* 29: 315-320. [p. 9, 12, 14, 26]
35. Craig GG, Powell KR, and Cooper MH (1981). Caries progression in primary molars: 24-months results from a minimal treatment programme. *Community Dent Oral Epidemiol* 9: 260-265. [p. 6, 8]
36. Dale JW (1969). Toothbrushing frequency and its relationship to dental caries and periodontal disease. *Aust Dent J* April: 120-123.
37. De Paola PF (1993). Caries in our aging population: What are we learning? In: *Cariology for the nineties*. Bowen WH, Tabak LA and editors. Rochester, Rochester University Press: 25-36. [p. 62]

38. de Vries HCB, Juiken HMHM, Konig KG ,and van Hof MA (1990). Radiographic versus clinical diagnosis of approximal carious lesions. *Caries Res* 24: 364-70.
39. Dennison PD (2004). Bite-wing radiographic assessment (Form WSDR-007), Western Sydney Area Health Service. [p. 49]
40. Dove SB (2001). Radiographic diagnosis of dental caries. *J Dent Educ* 65(10): 985-990.
41. Dunning JM (1970) . Preventive dentistry. Principles of Dental Public Health. Cambridge MA, Harvard University Press: 215-249. [p. 38]
42. Edblad E, Gustafsson A, Svenson B, and Jansson L (1998). Number and frequency of bitewing radiographs and assessment of approximal caries in 14-to-19-year- old Swedish adolescents. *Swed Dent J* 22: 157-164.
43. Erp NAKM van, and Meyer-Jansen AC (1970). A caries study of the temporary molars and its significance for their regular conservative care. *Neth Dent J* 77 (suppl 5): 51-74. [p. 6, 8]
44. Espelid I (1986). Radiographic diagnosis and treatment decisions on approximal caries. *Community Dent Oral Epidemiol* 14: 265-70. [p.102]
45. Featherstone JDB (1999). Prevention and reversal of dental caries: role of low level fluoride. *Community Dent Oral Epidemiol* 27: 31-40. [p. 39]
46. Featherstone JDB (2000). The science and practice of caries prevention. *JADA* 131(7): 887-99.
47. Featherstone JDB (2004). The continuum of dental caries-evidence for a dynamic disease process. *J Dent Res* 83 (Spec Iss C): C39-C42.

48. Fejerskov O, and Kidd EAM (2003). Dental Caries: the disease and its clinical management. Oxford, Blackwell Munksgaard. [p. 44]
49. Fejerskov O (1997). Concepts of dental caries and their consequences for understanding the disease. Community Dent Oral Epidemiol 25: 5-12.
50. Forsman B (1974). The caries preventing effect of mouthrinsing with 0.025% sodium fluoride solution in Swedish children. Community Dent Oral Epidemiol 2: 58-65. [p. 9, 11, 14]
51. Foster LV (1998). Three year *in vivo* investigation to determine the progression of approximal primary carious lesions extending into dentine. Br Dent J 185: 353-357. [p. 9, 10]
52. Gisselsson H, Birkhed D, and Bjorn A-L (1994). Effect of a 3-year professional flossing program with chlorhexidine gel on approximal caries and cost of treatment in preschool children. Caries Res 28: 394-399. [p. 6, 8]
53. Gluck M, and Morganstein WM (1998). Jong's Community Dental Health, Mosby-Year Book, Inc.
54. Granath L, Kahlmeter A, Matsson L, and Schroder U (1980). Progression of proximal enamel caries in early teens related to caries activity. Acta Odontol Scand 38: 247-251. [p. 9, 12, 20, 23, 24]
55. Grondahl H-G, Andersson B, and Torstensson T (1984). Caries increment and progression in teenagers when using a prevention-rather than restoration - oriented treatment strategy. Swed Dent J 8: 237-242.[p. 9, 10, 13, 26]
56. Grondahl H-G, and Hollender L (1977). Dental caries and restorations in teenagers II. A longitudinal radiographic study of the caries increment of proximal surfaces among urban teenagers in Sweden. Swed Dent J 1: 51-57. [p. 9, 12]

57. Hamp SE, Lindhe J, Fornell J, Johansson L-A et al. (1978). Effect of a field program based on systematic plaque control on caries and gingivitis in schoolchildren after 3 years. *Community Dent Oral Epidemiol* 6: 17-23.
58. Harrison JJ, Turner RJ, Marques Lyriam LR, and Ceri H (2005). Biofilms. *Am Sci* 93(6): 508-515.
59. Haugejorden O, and Birkeland JM (2002). Evidence for reversal of the caries decline among Norwegian children. *Int J Paediatr Dent* 12(5): 306-15. [p. 103]
60. Heidenreich C, Lye P, Simpson D, and Lourich M (2000). The search for effective and efficient ambulatory teaching methods through the literature. *Pediatrics* 105(1): 231-237. [p. 126, 127, 141]
61. Heidmann J, Hollund U, and Poulsen S (1987). Changes criteria for restorative treatment of approximal caries over a 10-year period. *Caries Res* 21: 460-3. [p.102]
62. Helfenstein U, and Steiner M (1994). Fluoride varnishes (Duraphat): a meta-analysis. *Community Dent Oral Epidemiol* 22: 1-5.
63. Henzi D, Davis E, Jasinevicius R, and Hendricson W (2006). North American dental students' perspectives about their clinical education. *J Dent Educ* 70(4): 361-377. [p. 127, 141]
64. Hintze H (1997). Caries behaviour in Danish teenagers: a longitudinal radiographic study. *Int J Paediatr Dentistry*. 7: 227-234. [p. 9, 12, 14, 27]
65. Hintze H (2001). Approximal caries prevalence in Danish recruits and progression of caries in the late teens: A retrospective radiographic study. *Caries Res* 35: 27-35. [p. 20, 22, 24]

66. Hintze H, and Wenzel A (1994). Clinically undetected dental caries assessed by bitewing screening in children with little caries experience. *Dento Maxillo Fac Radiol* 23: 19-23. [p. 40]
67. Hollender L, and Koch G (1969). Influence of topical application of fluoride on rate of progress of carious lesions in children. *Odontologisk Revy* 20: 37-41. [p. 9, 11, 13, 103]
68. Holm AK (1979). Effect of a fluoride varnish (Duraphat) in preschool children. *Community Dent Oral Epidemiol* 7: 241-245.
69. Hopcraft MS, and Morgan MV (2005). Comparison of radiographic and clinical diagnosis of approximal and occlusal dental caries in a young adult population. *Commnity Dent Oral Epidemiol* 33: 212-8. [p. 40]
70. Hugoson A, Koch G, and Hallonsten A-L (1988). Caries prevalence and distribution in individuals aged 3-20 years in Jonkoping, Sweden, 1973, 1978, and 1983. *Swed Dent J* 12: 125-32. [p. 102]
71. Hugoson A, Rylander H, and Koch G (1985). Longitudinal study of dental caries in individuals in Jonkoping, Sweden, aged 15 years in 1973 and 20 years in 1978. *Community Dent Oral Epidemiol* 13: 100-3. [p. 9, 14, 12, 27]
72. Hyde EJ (1973). Caries-inhibiting action of three different topically-applied agents on incipient lesions in newly erupted teeth: Results after 24 months. *J Can Dent Assoc* 3: 189-193. [p. 9, 11, 13, 14, 20, 23, 24, 40]
73. Irby DM (1995). Teaching and learning in ambulatory care settings: thematic review of the literature. *Academic Medicine* 70(10): 898-931. [p. 126]
74. Ismail AI (1997). Clinical diagnosis of precavitated carios lesions. *Community Dent Oral Epidemiol* 25: 13-23.

75. Johansen E, Papas A, Fong W, and Olsen TO (1987). Remineralization of carious lesions in elderly patients. *Gerodontology* 3: 47-50. [p. 62]
76. Johnson NW (1991). Risk markers for oral diseases. Volume 1: Dental caries. Cambridge, Cambridge University Press. [p. 93]
77. Kay EJ, and Locker D (1998). A systematic review of the effectiveness of health promotion aimed at improving oral health. *Community Dent Health* 15: 132-144.
78. Kidd EAM (1998). Assessment of caries risk. *Dent Update* 25: 385-390.
79. Kidd EAM (1999). Caries management. *Dent Clin N Am* 43: 743-764.
80. Kidd EAM, Mejare I, and Nyvad B (2003). Clinical and radiographic diagnosis. Dental caries: The disease and its clinical management. Fejerskov O and Kidd E, Oxford: Blackwell Munksgaard: 111-128. [p. 40]
81. Kidd EAM, and Fejerskov O (2003). Prevention of dental caries and the control of disease progression: concepts of preventive non-operative treatment. In: Dental caries - The disease and its clinical management. Fejerskov O and Kidd EAM. Oxford, Blackwell Munksgaard: 167-169. [p. 43]
82. Klineberg I, Massey W, Thomas M, and Cockrell D (2002). A new era of dental education at the University of Sydney Australia. *Aus Dent J* 47: 194-201. [p. 64]
83. Kolehmainen L, and Rytomaa I (1977). Increment of dental caries among Finnish dental students during a period of 2 years. *Community Dent Oral Epidemiol* 5: 140-144. [p. 9, 11, 14]
84. Liamputtong P, and Ezzy D (2005). Qualitative Research Methods. Melbourne, Oxford University Press. [p. 129]

85. Lith A, Lindstrand C, and Grondahl H-G (2002). Caries development in a young population managed by a restrictive attitude to radiography and operative intervention: I. A study at the patient level. *Dento Maxillo Facial Radiol* 31: 224-231.[p. 20, 22]
86. Lith A, Lindstrand C, and Grondahl H-G (2002). Caries development in a young population managed by a restrictive attitude to radiography and operative intervention: II. A study at the surface level. *Dento Maxillo Facial Radiol* 31: 232-239. [p. 20, 22]
87. Lith A, Pettersson LG, and Grondahl H-G (1995). Radiographic study of approximal restorative treatment in children and adolescents in two Swedish communities differing in caries prevalence. *Community Dent Oral Epidemiol* 23: 211-6. [p. 102]
88. Lunder N, and von der Fehr FR (1996). Approximal cavitation related to bite-wing image and caries activity in adolescents. *Caries Res* 30: 143-147.
89. Marinho VC, Higgins JP, Logan S, and Sheiham A (2002). Fluoride gels for preventing dental caries in children and adolescents. CD002280.
90. Marinho VC, Higgins JP, Logan S, and Sheiham A (2002). Fluoride varnishes for preventing dental caries in children and adolescents. CD002279.
91. Marinho VC, Higgins JP, Logan S, and Sheiham A (2003). Fluoride mouthrinses for preventing dental caries in children and adolescents. CD002284.
92. Marinho VC, Higgins JP, Logan S, and Sheiham A (2003). Systematic review of controlled trials on the effectiveness of fluoride gels for the prevention of dental caries in children. 448-58.

93. Marinho VC, Higgins JP, Logan S, and Sheiham A (2003). Topical fluoride (toothpastes, mouthrinses, gels or varnishes) for preventing dental caries in children and adolescents.[see comment]. CD002782.
94. Marinho VC, Higgins JP, Sheiham A, and Logan S (2003). Fluoride toothpastes for preventing dental caries in children and adolescents. CD002278.
95. Marinho VC, Higgins JP, Sheiham A, and Logan S (2004). Combinations of topical fluoride (toothpastes, mouthrinses, gels, varnishes) versus single topical fluoride for preventing dental caries in children and adolescents.[see comment]. CD002781.
96. Marinho VC, Higgins JP, Sheiham A, and Logan S (2004). One topical fluoride (toothpastes, or mouthrinses, or gels, or varnishes) versus another for preventing dental caries in children and adolescents. CD002780.
97. Marsh PD (1999). Microbiologic aspects of dental plaque and dental caries. *Dent Clin North Am* 43(4): 599-614.
98. Marthaler TM, and Wiesner V (1973). Rapidity of penetration of radiolucent areas through mesial enamel of first permanent molar. *Helv Odont Acta* 17: 19-26. [p. 20, 23]
99. Mc Comb D (2001). Systematic review of conservative operative caries management strategies. *J Dent Educ* 65(10): 1154-1161. [p. 39]
100. Mertz-Fairhurst EJ, Curtis JW, Ergle JW, Rueggeberg FA et al. (1998). Ultraconservative and cariostatic sealed restorations: results after 10 years. *JADA* 129: 55-66. [p. 43]
101. Mertz-Fairhurst EJ, Schuster GS, and Fairhurst CW (1986). Arresting caries by sealants: Results of a clinical study. *JADA* 112: 194-7. [p. 43]

102. Mejare I, Kallestal C, and Stenlund H (1999). Incidence and progression of approximal caries from 11 to 22 years of age in Sweden: A prospective radiographic study. *Caries Res* 33: 93-100. [p. 20, 22, 24, 40, 104]
103. Mejare I, Kallestal C, Stenlund H, and Johansson H (1998). Caries development from 11 to 22 years of age: A prospective radiographic study. *Caries Res* 32: 10-16. [p. 20, 22, 40, 49, 104]
104. Mileman PA, and Espelid I (1988). Decision on restorative treatment and recall intervals based on bitewing radiographs: a comparison between national surveys of Dutch and Norwegian practitioners. *Community Dental Health* 5: 273-284. [p. 103]
105. Modeer T, Twetman S, and Bergstrand F (1984). Three-year study of the effect of fluoride varnish (Duraphat) on proximal caries progression in teenagers. *Scand J Dent Res* 92: 400-7. [p. 9, 10, 13, 27]
106. Moles DR, and Downer MC (2000). Optimum bitewing examinations recall intervals assessed by computer simulation. *Community Dent Oral Epidemiol* 17: 14-19.
107. Morgan MV, Campain AC, Adams GG, Crowley SJ et al. (1998). The efficacy and effectiveness of a primary preventive dental programme in non-fluoridated areas of Victoria, Australia. *Community Dental Health* 15: 263-271.
108. Mount GJ, and Ngo H (2000). Minimal intervention: early lesions. *Quintessence Int* 31: 535-546. [p. 42]
109. Mount GJ, and Hume WR (2005). Preservation and restoration of tooth structure. Sandgate, Queensland, Knowledge books and software. [p. 44]
110. Moynihan PJ (2002). Dietary advice in dental practice. *Br Dent J* 193(10): 563-568.

111. Muhler JC, Spear LB, Bixler D, and Stookey GK (1967). The arrestment of incipient dental caries in adults after the use of three different forms of SnF₂ therapy: results after 30 months. *JADA* 75: 1402-1406. [p. 9, 11]
112. Murray JJ, and Majid ZA (1978). The prevalence and progression of approximal caries in the deciduous dentition in British children. *Br Dent J* 145: 161-164. [p. 6, 8]
113. Murray JJ, Nunn JH, and Steele JG (2003). *Prevention of Oral Disease*. New York, Oxford University Press.
114. Newbrun E (2001). Topical fluorides in caries prevention and management: a north American prospective. *J Dent Educ* 65(10): 1078-1083.
115. NIHC (2001). National Institute of Health Consensus Development Conference, March 26-28; Diagnosis and management of dental caries throughout life. *J Dent Educ* 65: 1162-1168. [p. 4, 41]
116. Nuttal NM, Pitts NB, and Fyffe HE (1993). Assessment of reports by dentists of their restorative treatment thresholds. *Community Dent Oral Epidemiol* 21: 273-8. [p. 102]
117. Nuttall NM, and Pitts NB (1990). Restorative treatment thresholds reported to be used by dentists in Scotland. *Br Dent J* 169: 119-125. [p. 102]
118. Ogaard B, Seppa L, and Rolla G (1994). Relationship between oral hygiene and approximal caries in 15-year-old Norwegians. *Caries Res* 28: 297-300.
119. Petersson LG, Arthursson L, Ostberg C, Jonsson G et al. (1991). Caries inhibiting effects of different modes of Duraphat varnish reapplication: A 3-year radiographic study. *Caries Res* 25: 70-73. [p. 20, 21]

120. Peyron M, Matsson L, and Birkhed D (1992). Progression of approximal caries in primary molars and the effect of Duraphat treatment. *Scand J Dent Res* 100: 314-8. [p. 6, 8]
121. Pitts NB (2004). Modern concepts of caries measurement. *J Dent Res* 83 (Spec Iss C): C43-C47.
122. Pitts NB (1983). Monitoring of caries progression in permanent and primary posterior approximal enamel by bitewing radiography - a review. *Community Dent Oral Epidemiol* 11: 228-35. [p. 4]
123. Pitts NB (1986). Regression of approximal carious lesions diagnosed from serial standardized bitewing radiographs. *Caries Res* 20: 85-90. [p. 26, 41]
124. Pitts NB (1996). The use of bitewing radiographs in the management of dental caries: scientific and practical considerations. *Dento Maxillo Facial Radiol* 25: 5-16.
125. Pitts NB (1997). Diagnostic tools and measurements - impact on appropriate care. *Community Dent Oral Epidemiol* 25: 24-35. [p. 3, 40]
126. Pitts NB, and Renson CE (1987). Monitoring the behaviour of posterior approximal carious lesions by image analysis of serial standardised bitewing radiographs. *Br Dent J* 162: 15-21.[p. 9, 10, 26]
127. Pitts NB, and Rimmer PA (1992). An in vivo comparison of radiographic and directly assessed clinical caries status of posterior approximal surfaces in primary and permanent teeth. *Caries Res* 26: 146-152. [p. 104]
128. Powell KR, Barnard PD, and Craig GG (1981). Effect of stannous fluoride treatments on the progression of initial lesions in approximal surfaces of permanent posterior teeth. *J Dent Res* 60(9): 1648-1654. [p. 9, 11, 13, 20, 23, 40]

129. Riordan PJ, Espelid I, and Tveit AB (1991). Radiographic interpretation and treatment decisions among dental therapists and dentists in Western Australia. *Community Dent Oral Epidemiol* 19: 268-71. [p. 41, 103]
130. Ripa LW (1989). Review of the anti-caries effectiveness of professionally applied and self-applied topical fluoride gels. *J Public Health Dent* 49(5): 297-309.
131. Rollnick S, Butler R, and Butler C (1999). *Health Behaviour Change: A Guide for Practitioners*. Edinburgh, Churchill Livingstone. [p. 141]
132. Rugg-Gunn AJ (1972). Approximal carious lesions, A comparison of the radiological and clinical appearances. *Br Dent J* 133: 481-484. [p. 41, 104]
133. Rugg-Gunn AJ, and Edgar WM (1984). Sugar and dental caries: a review of the evidence. *Community Dent Health* 1: 85-92.
134. Rugg-Gunn AJ, and Nunn JH (1999). *Nutrition, diet and oral health*. Oxford, Oxford University Press.
135. Schwarz E (1998). Is caries prevention cost-effective? Does anybody care? *Acta Odontol Scand* 56: 187-192.
136. Seppa L, Hausen H, Pollanen L, Karkkainen S et al. (1991). Effect of intensified caries prevention on approximal caries in adolescents with high caries risk. *Caries Res* 25: 392-395.
137. Seppa L, Hausen H, Tuutti H, and Luoma H (1983). Effect of a sodium fluoride varnish on the progress of initial caries lesions. *Scand J Dent Res* 91: 96-8. [p. 9, 10, 13, 40]

138. Seppa L, Tuutti H, and H L (1982). Three-year report on caries prevention using fluoride varnishes for caries risk children in a community with fluoridated water. *Scand J Dent Res* 90: 89-94.
139. Shaw L, and Murray JJ (1986). The progression of approximal caries in the permanent dentition of British children. *Community Dent Health* 3: 199-205. [p. 9, 10, 13]
140. Shwartz M, Grondahl H-G, Pliskin J S, and Boffa J (1984). A longitudinal analysis from bite-wing radiographs of the rate of progression of approximal carious lesions through human dental enamel. *Archs Oral Biol.* 29: 529-536. [p. 6, 8, 20, 22, 24]
141. Shwartz M, Pliskin JS, grondahl H-G, and Boffa J (1986). The frequency of bitewing radiographs. *Oral Surg Oral Med Oral Pathol* 61: 300-305.
142. Silness J, and Loe H (1964). Periodontal disease in pregnancy. II. Correlation between oral hygiene and periodontal condition. *Acta Odontol Scand.* 22: 121-135. [p. 49]
143. Skold UM, Peteresson LG, Lith A, and Birkhed D (2005). Effect of school-based fluoride varnish programmes on approximal caries in adolescents from different caries risk areas. *Caries Res* 39: 273-279. [p. 20, 21, 40]
144. Strohmenger L, and Brambilla E (2001). The use of fluoride varnishes in the prevention of dental caries: a short review. *Oral Diseases* (7): 71-80.
145. Swango PA (1983). The use of topical fluorides to prevent dental caries in adults: a review of the literature. *JADA* 107(september): 447-50.
146. Tan PLB, Evans RW, and Morgan MV (2002). Caries, bitewings, and treatment decisions. *Aust Dent J* 47(2): 138-141. [p. 41, 103, 123]

147. Thompson VP, and Kaim JM (2005). Nonsurgical treatment of incipient and hidden caries. *Dent Clin N Am* 49: 905-921. [p. 44]
148. Thylstrup A, and Fejerskov O (1994). Textbook of clinical cariology. Copenhagen, Munksgaard. [p. 26]
149. Thylstrup A, Bille J, and Qvist V (1986). Radiographic and observed tissue changes in approximal carious lesions at the time of operative treatment. *Caries Res* 20: 75-84.
150. Treasure ET (2001). Methods of stopping or reversing early carious lesions fluoride: A European perspective. *J Dent Educ* 65: 1073-1077. [p. 4]
151. Twetman S, Axelsson P, Dahlgren H, Holm AK et al. (2003). Caries-preventive effect of fluoride toothpaste: a systematic review. *Acta Odontol Scand* 61: 347-355.
152. Twetman S, and Petersson LG (1999). Interdental caries incidence and progression in relation to mutans streptococci suppression after chlorhexidine-thymol varnish treatments in schoolchildren. *Acta Odontol Scand* 57: 144-148. [p. 9, 12, 20, 21]
153. Tyas MJ, Anusavice KJ, Frencken JE, and Mount GJ (2000). Minimal intervention dentistry-a review (FDI Commission Project 1-97). *Int Dent J* 50: 1-12. [p. 42]
154. van Loveren C (2001). The role of diet in caries prevention. *Int Dent J* 51: 399-406. [p. 55]
155. van Rijkom HM, Truin GJ, and van 't Hof MA (1998). A meta-analysis of clinical studies on the caries-inhibiting effect of fluoride gel treatment. *Caries Res* 32: 83-92.

156. van Rijkom HM ,and Verdonschot EH (1995). Factors involved in validity measurements of diagnostic tests for approximal caries: a meta - analysis. *Caries Res* 29: 364-370.
157. Vanderas AP, Manetas C, Koulatzidou M, and Papagiannoulis L (2003). Progression of proximal caries in the mixed dentition: a 4-year prospective study. *Pediatr Dent* 25(3): 229-34. [p. 6, 7, 8, 20, 22, 25]
158. Vanderas AP, and Skamnakis J (2003). Effectiveness of preventive treatment on approximal caries progression in posterior primary and permanent teeth: a review. *Eur J Paediatr Dentist*. 4: 9-15. [p. 4]
159. Victoroff KZ, and Hogan S (2006). Student perceptions of effective learning experiences in dental school: a qualitative study using a critical incident technique. *J Dent Educ* 70(2): 124-132. [p. 127]
160. von der Fehr FR, Loe H ,and Theilade E (1970). Experimental caries in man. *Caries Res* 4: 131-48. [p.39]
161. Whelton H, and O'Mullane D (2001). The use of combinations of caries preventive procedures. *J Dent Educ* 65(10): 1110-1113.
162. White BA, and Maupome G (2001). Clinical decision-making for dental caries management. *J Dent Educ* 65: 1121-1125. [p. 3]
163. Zamir T, Fisher D, Fishel D, and Sharav Y (1976). A longitudinal radiographic study of the rate of spread of human approximal dental caries. *Archs Oral Biol* 21: 523-526.[p. 9, 12, 20, 23, 40]
164. Zero DT (1999). Dental caries process. *Dent Clin North Am* 43(4): 635-64

Appendices

Appendix 1

1. Conference abstracts

Pakdaman A, Evans RW. Systematic Review of proximal caries progression.
 Oral Presentation at International Association for Dental Research – ANZ
 Division 44th Annual Conference, Denarau Island, Nadi, Fiji, 2004

	Systematic review of non-invasive management of proximal carious lesions. PAKDAMAN A, EVANS RW Community Oral Health & Epidemiology, The University of Sydney, Australia
The main <i>objective</i> of this systematic review was to examine the extent to which caries may be managed by non-invasive methods. <i>Material and methods</i> - The main electronic databases were searched for English-language papers published between 1966 and 2004. Inclusion criteria: randomised controlled trials or cohort studies of more than 12 months duration, criteria for assessing lesions at baseline and end points, posterior teeth, lesions assessed by bitewing radiographs. The papers were grouped according primary and permanent teeth and to mode of results presentation. <i>Results -Primary teeth:</i> more than 50% of lesions progressed but progression rates were significantly higher for control groups in some studies. Median survival times were 2 years or more except for deep dentinal lesions. <i>Permanent teeth:</i> (a) <i>Progression rates</i> - In more recent studies, arrest rates ranged from 15 to 86% and were greater in treatment than control groups. Combinations of preventive agents gave higher arrest rates than single agents. (b) <i>Progression score</i> - Fluoride toothpaste and both fluoride and chlorhexidine varnishes were effective in retarding or reversing mean progression scores. (c) <i>Survival analysis</i> - Under varying conditions, median survival rates (MSR) for lesions in the outer and inner halves of enamel ranged from 23 to 76 and from 34 to 58 months respectively. MSR for early dentinal lesions was about 3 years. <i>Discussion</i> - Rates of progression of lesions is higher in primary than in permanent teeth. In primary teeth, it appears that many lesions may not need restorative care prior to exfoliation. For permanent teeth, prospects are better for arresting caries and for retarding the progress of lesions. <i>Conclusion</i> - <u>The overall slow progress rates observed allow for safe monitoring and further intensive fluoride therapy to increase arrest rates.</u>	

Pakdaman A, Evans RW, Howe E. Monitoring the implementation by dental students of Caries Management System-Result after 12 months. Oral Presentation at International Association for Dental Research – ANZ division 45th Annual Conference. Queenstown, New Zealand, 2005.

	Implementing the Caries Management System in the student clinic - Results after 12 months. A PAKDAMAN*, RW EVANS, E HOWE. Faculty of Dentistry, The University of Sydney.
The main <i>objective</i> of this study was to audit the implementation in the student clinic of a new caries management system aimed to maximise opportunities for arresting and remineralizing lesions and to minimise the need for restorative care. <i>Material and methods</i> - Qualitative methods including observation (researcher field notes describing students' activity) and interview (semi-structured interview with BDent3 and BDent4 students) were used as unobtrusive tools to assess the process of implementing the program. A quantitative analysis of documents (review of patient files and additional forms completed by students in relation to diagnosis and treatment planning) was used to assess the outcomes. <i>Results</i> - Less than one quarter of BDent3 students in 2004 followed the protocols correctly with some improvement in 2005. Problems cited by students were lack of time and too much paper work. In 2004, BDent3 students experienced difficulty in detecting both inner and outer enamel lesions, and were inclined to restore some of them instead of attempting to arrest them. Their treatment planning decisions were better in relation to the dentinal lesions. <i>Discussion</i> - The improvement observed this year is due to better integration of the program in the curriculum, and due to increased support from the clinical demonstrators. <i>Conclusion</i> - Although the rate of adoption of the program in its standard format needs improvement, the basic concepts applied to clinical management seems to be improved. Success in implementing major changes to the curriculum depends on teamwork and keeping in close contact with clinical supervisors of the students. An ongoing monitoring of the system is also suggested to improve the quality of the services provided.	

Pakdaman A, Howe E, Evans RW, Curtis B. Student perceptions on the non-invasive management of dental caries. Poster Presentation at International Association for Dental Research-84th General session & exhibition of the IADR, Brisbane, Australia, 2006, *Abstract* #80683

Student perceptions on the non-invasive management of dental caries

A. PAKDAMAN, E. HOWE, W. EVANS, and B. CURTIS,
The University of Sydney, Westmead Centre for Oral Health, Westmead, Australia

A system for non-invasive caries management was introduced to dental students at The University of Sydney. *Objectives:* The purpose of this study was to evaluate dental students' understanding, clinical experience, perceptions regarding applicability of the program in their future careers, and perceptions regarding implementation barriers in relation to non-invasive caries management. *Material and methods:* Senior dental students were invited to complete a questionnaire survey to obtain data relating to the study objectives. *Results:* 93% (n=57) of third year and 40% (n= 52) of fourth year students responded. For situations relating to low and medium risk patients, more than 85% of students selected a remineralization strategy regarding outer and inner enamel lesions; 65% selected a remineralization strategy for lesions that had just penetrated beyond the DEJ. However, the majority (76%) selected the restorative option for outer dentine lesions in the situation relating to medium risk patients. For high-risk patients, remineralizing strategies were mostly preferred for managing the enamel only lesions and lesions that had progressed to just beyond the DEJ (80% and 62%, respectively). More than 70% of students reported that it took 10 minutes or less to deliver oral hygiene instruction and any necessary fluoride therapy at each visit. 84% reported that most of their patients showed interest and 79% felt confident to use non-invasive measures in their future careers. The main perceived problems were poor patient interest in home care and lack of support in the clinic. *Discussion:* Students demonstrated a clear understanding of caries risk and mainly applied the caries management protocols correctly regarding enamel lesions. *Conclusions:* Overall, the program was successful in clarifying the concept of risk and it appeared that students obtained valuable experience in managing caries non-invasively. *With acknowledgement to ADRF for grant No. 5/2005.*

Appendix 2

1. Faculty of Dentistry Caries Management Policy
2. The Caries management System Manual
3. ADRF Grant Award



The University of Sydney

Faculty of Dentistry CARIES MANAGEMENT POLICY

Caries management centres on (1) the patient at risk, (2) the status of each lesion, (3) clinical management, (4) patient management, and (5) monitoring.

THE PATIENT AT RISK

Dental caries is an infectious disease. A patient *at risk* is one who maintains a reservoir of the infecting bacteria (plaque) and whose caries susceptibility is increased due to a combination of one of more other *primary* factors:

- inadequate saliva (amount, composition)
- inadequate fluoride exposure
- excessive dietary sucrose or other fermentable carbohydrate
- unfavourable tooth morphology/tooth site

and *secondary confounding* factors:

- social class
- education level
- knowledge
- attitudes
- behaviour

Patient caries risk categories

In relation to risk categorisation of a *new* patient:

High risk = patient presenting with:

- untreated frank cavities
- and/or extensive and friable white spot lesions
- and/or bitewing radiolucencies of *Grades 4 or 5*

Very high risk = patient presenting with rampant caries as seen in many people taking methadone.

Medium risk = patient presenting with:

- no frank cavitation
- but may have sticky pit/fissures
- and/or bitewing radiolucency(s) not greater than *Grade 4*

Low risk = patient presenting with:

- no clinical signs of caries
- but may have bitewing radiolucency(s) not greater than *Grade 3*

and in relation to risk categorisation of a *recall* patient:

High risk = new lesion incidence of >1 per year

Medium risk = new lesion incidence of 1 per year

Low risk = new lesion incidence of <1 per year

The outcome of dental treatment is highly dependent on home-care personal efforts. Hence, patient risk is also subject to secondary confounding factors. You may judge (sometimes referred to as the social diagnosis) that success in reducing patient risk is likely to be:

- favourable
- uncertain
- unfavourable

Hence, a high risk patient with an unfavourable rating is likely not to respond well to the benefit of dental care.

STATUS OF THE CARIES LESION

The status of the caries lesion may be:

- active (progressive, quiescent, regressive)
- arrested

and the affected surface may be:

- cavitated
- demineralised to varying degrees
- at the point of cavitation

CLINICAL MANAGEMENT

The management options are:

- preventive
- preservative (non-invasive)
- conservative operative procedures (invasive)

The approach taken, as noted above, centres on patient and lesion management.

Lesion management

- *arrested* lesions should be managed preventively to maintain this desired status (see elsewhere)
- *cavitated* lesions should be managed via conservative operative procedures

- *active non-cavitated* lesions should be arrested via a protocol of *non-invasive* measures that address the causative factors noted above

PATIENT MANAGEMENT

The management of the *at-risk patient* entails the development (by the dentist) of a firm understanding of the situation of the at-risk patient (via the patient history and clinical examination) and then obtaining *patient co-operation* to implement a suitable protocol that will deliver a package of *non-invasive* measures designed to *arrest active non-cavitated lesions*, and once arrested, to *maintain arrest*. This process is facilitated through use of the **TOOTH DECAY** pamphlet which gives details of the causes and prevention of caries, and on which is recorded the clinical status of the patient and risk status. This pamphlet is presented to the patient at the *case presentation*.

Patient history and clinical examination

Via the history and clinical examination, the status of the following potential causative factors may be diagnosed:

- sucrose intake
- fluoride exposure
- plaque and plaque control habits
- tooth morphology
- salivary characteristics (principally flow rate and microbiology)

Treatment planning with reference to evidence based protocols

Then a protocol is developed that will address each causative factor diagnosed as contributing to the problem:

- diet monitoring
- an appropriate fluoride exposure via professional and home application
- plaque control via professional and personal inputs - intensive coaching
- fissure sealant application, elimination of restoration overhangs and undercuts, elimination of prosthetic plaque traps
- saliva substitutes or other appropriate management including monitoring of salivary bacteria
- recall schedule appropriate to patient risk status

Case presentation and the responsibilities of clinician and patient

The administration of the protocols entails patient counseling where the clinician plays a pivotal role - the clinician must assume a *prime responsibility* to ensure that patients understand that home care is the key to caries prevention and that patients themselves are largely responsible for their oral health. Other than coaching and facilitating a monitoring program, the clinician can do little more for oral health in any environment, some of which are exposed to more risk factors than others.

MONITORING CARIES ACTIVITY

Monitoring has a dual focus on patient response and caries activity

Patient response

How is the patient responding to coaching? The following need to be monitored for life:

- diet control
- plaque control
- fluoride exposure
- saliva control

Diet monitoring

See notes given elsewhere. A diet diary and associated analysis from time to time enables trends to be identified and discussed.

Plaque control monitoring

At each appointment, record surfaces that demonstrate visible plaque and give a copy to the patient with related advice. Or, later, relate these sites to bleeding on probing. If sites do not bleed on probing, periodontists consider that these have been sufficiently cleaned. Such level of cleaning is probably sufficient for caries control too.

The active demonstration of recording plaque/BOP and reviewing serial findings at each visit motivates patients to improve and maintain high levels of oral hygiene.

Saliva monitoring

See notes given elsewhere.

Fluoride exposure monitoring

More than any other factor, fluoride exposure is the key to caries management. In the absence of a positive response to caries arrest, fluoride exposure

can be increased, since it is the least bothersome factor for the patient to manage well.

Lesion activity - clinical and radiographic monitoring

- bitewing radiolucency activity
- carious white spots
- exposed roots
- surfaces along restoration margins and prosthesis abutments

are in need of careful scrutiny at recall appointments.

Bitewing radiographs should be taken at intervals appropriate to the risk status of the patient. Suitable guidelines may be:

- *low risk* at 2-yearly intervals
- *medium* at yearly intervals
- *high risk* at 6-monthly intervals

The purpose of radiographic monitoring is to evaluate the status of proximal lesions and pit/fissure lesions. Note that one set of bitewings *cannot* indicate progression/regression - a dated series is necessary.

Radiolucency status grades

For proximal lesions, the bitewing radiolucency grades are:

- 0 no radiolucency evident
- 1 a radiolucency is evident in the *outer half* of enamel
- 2 a radiolucency extends into the *inner half* of enamel and may reach the DEJ
- 3 a radiolucency extends *just* beyond the DEJ
- 4 a radiolucency is evident in the *outer third* of dentine
- 5 a radiolucency extends into the *inner two thirds* of dentine and may reach the pulp

Recording bitewing findings

Bitewings are special tests and it is the responsibility of the dentist who ordered them to (1) read them and (2) to date and record the findings, either on the dental chart (odontogram) or somewhere readily accessible in the patient notes. Both the tooth site and radiolucency grade should be entered.

Interpretation of bitewing findings

For new patients for whom you do not have serial bitewing records, treat as follows.

In the *absence of symptoms*, the best option for surfaces associated with bitewing radiolucency grades:

- 1 do not restore*
- 2 do not restore*

- 3 do not restore*
- 4 do not restore without further consideration
- 5 restore now

* Follow topical fluoride protocols for professional and home care application as per patient caries risk category.

Further consideration for surfaces associated with a Radiolucency Grade of 4

Low and medium risk children and adolescents

- restore *only if* the radiolucency extends *fully 1/3* into dentine
- *otherwise do not restore* because it is more likely than not that the *proximal surface is not yet cavitated*
- implement *preventive strategy* (1) to arrest and remineralise active lesions or (2) to maintain arrested lesions

Low and medium risk adults (Age > 18 years)

- restore *only if* the radiolucency extends *fully 1/3* into dentine
- *otherwise do not restore* because (1) it is more likely than not that the proximal surface *is not cavitated* and (2) that the lesion *has arrested*
- implement *preventive strategy* (1) to arrest and remineralise active lesions or (2) to maintain arrested lesions

High risk children, adolescents, and adults

- restore now
- implement strategy (1) to arrest and remineralise lesions not yet showing radiographically and (2) to prevent recurrent caries

At recall appointments, compare the radiolucency status on new bitewings with that of earlier series, and note any changes:

- radiolucency regression or no change indicates caries arrest - maintain preventive protocol.
- radiolucency extension and or the appearance of new lesions indicates caries active status and lesion progression - reapply and maintain the non-invasive strategy with greater urgency

- some invasive intervention may be warranted - lesions should be treated according to their new radiolucency grade

THE EVIDENCE

See notes on *Caries dynamics* for evidence underpinning the principles of the non-invasive approach to caries management, and see other notes on caries prevention via:

- diet modification
- toothbrushing
- topical fluoride
- water fluoridation
- fissure sealants

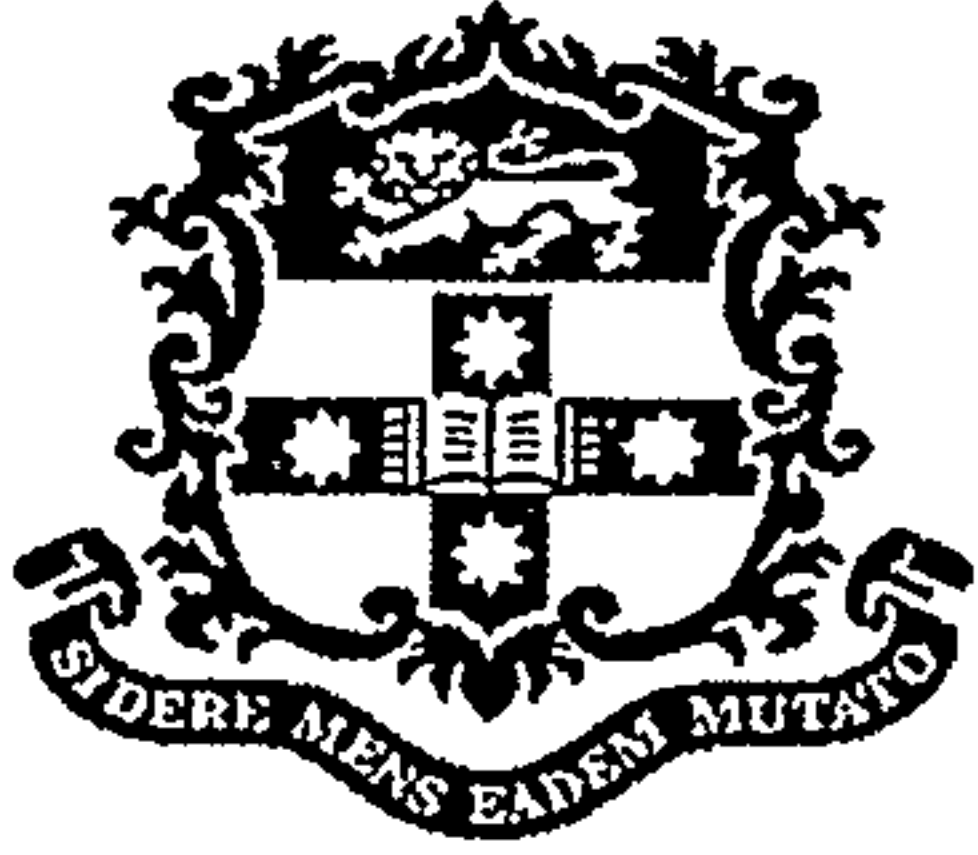
And see notes on the *Capacity for prevention* for the evidence base concerning the success of the non-invasive approach to caries management.

Related Documents

- Bitewing caries report form
- Dental caries information pamphlet
- Non-invasive management of dental caries
- The patient at risk

Faculty of Dentistry, University of Sydney
Prepared by Wendell Evans, MDS DDSc

and edited in accordance with the consensus reached at the
Curriculum Content Committee Meeting, 10 April 2003



The University of Sydney

The Caries Management System

**Wendell Evans
Afsaneh Pakdaman
Peter Dennison
Evelyn Howe**

Introducing The Caries Management System

The purpose of this lecture

1. To introduce The Caries Management System
2. To explain the administrative arrangements regarding the implementation of The Caries Management System.
3. To inform students that (1) the implementation of the system, (2) patient response to it, and (3) clinical outcomes will be monitored by means of an ongoing audit.
4. To explain the audit process.
5. To inform students that informed consent will be obtained from patients regarding the administration of the questionnaires.
6. To inform students that their consent is not required for audit purposes, but that for publication of the audit results, informed consent by students is required. The ethical issue is that students should be informed that the data they generate will be subject to publication. Dental students are, therefore, participants in a research project and hence informed consent is required (according to the Human Research Ethics Committees of Westmead Hospital and the University of Sydney).
7. To inform students of the consent process in studies involving humans.
8. To request that all students give consent for the use of, for research purposes, the clinical data that they have generated.

What does the Caries Management System involve ?

The Caries Management System involves:

1. diet assessment
2. plaque assessment
3. bitewing radiograph assessment
4. caries risk assessment
5. preparation of treatment plan
6. case presentation where patient is informed about:
 - dental caries
 - ☐ arrest
 - ☐ reversal/natural repair (remineralisation)
 - ☐ prevention
 - ☐ number and status of current lesions
 - ☐ current risk status
 - ☐ role of dentist in caries prevention and management
 - ☐ role of home care in caries prevention and management
 - result of diet assessment and recommendations
7. oral hygiene instruction
8. topical fluoride application (professional and home care)
9. monitoring plaque control at each visit
10. monitoring treatment outcomes via recall system tailored to risk status

The Caries Management System

The Caries Management System is a strategy that was designed for implementing the Caries Management Policy. This policy was developed by the Curriculum Content Committee (10 April 2003) and adopted by the Faculty of Dentistry, University of Sydney.

Both dental caries *risk* and dental caries *treatment* is managed according to The Caries Management System during various stages throughout patient consultation and treatment. At some of these stages, the details of what will occur are defined in a set of eleven documents of which the *Caries Management Policy (1)* is the first.

Stages and details of The Caries Management System

HISTORY

Student will:

- administer *Usual 24 hour diet questionnaire (2)*

CLINICAL EXAMINATION

Student will:

- complete *Student plaque report form (3)*
- conduct a caries examination according to *existing policy**
- take bitewings and interpret them according to *Caries management policy (1)*
- complete *Bitewing radiographic assessment form (WSDR-007) (4)*
- determine patient caries risk according to *Caries management policy (1)*

TREATMENT PLAN

Student will:

- Interpret bitewing findings according to:
 - ☐ patient risk (as above)
 - ☐ other considerations according to *Caries management policy (1)*
- complete *Treatment plan report form (5)* according to *Caries management policy (1)*

TREATMENT

Student will:

- explain the *Tooth decay report form (6)* (the dental caries information sheet for patients)
- discuss the results of the *Usual 24 hour diet questionnaire (2)*
- give oral hygiene instruction according to *Oral hygiene instruction protocol (7)*
- and issue the pamphlet *Good oral care (8)* (includes *Toothbrushing goals* and *Diet goals*)
- address fluoride exposure according to:
 - ☐ *Topical fluoride protocol for professional care (9)*
 - ☐ *Topical fluoride protocol for home care (10)*
- address other operative management (see elsewhere where not related to this new material)

MONITORING

Student will:

- recall patients according to *Recall and bitewing interval protocol (11)*

The audit process

This audit will involve (1) patient questionnaires, (2) review of patient notes, and (2) review of student notes (special forms that will be completed by students in addition to patient notes - eventually, these forms will become a standard part of the patient notes, subject to hospital reviews).

The patient questionnaire will not be administered by students. Informed consent (according to the Human Research Ethics Committees of Westmead Hospital (WSAHS) and the University of Sydney) will be obtained.

Student consent is not required for an internal audit of teaching and learning within the faculty, but in relation to the publication of the results (that hopefully will bring fame and fortune), informed consent by students is required. The ethical issue is that students should be informed that the data they generate will be subject to publication. Dental students are, therefore, participants in a research project and hence informed consent is required (according to the Human Research Ethics Committees of Westmead Hospital and the University of Sydney).

The consent process in studies involving humans

By law, in Australia, studies involving humans must be approved by a Human Research Ethics Committee that is constituted according to NMHRC guidelines.

Each committee must contain a scientist, a lay person, a minister of religion, and a lawyer, and other members appropriate to the study area.

There are Human Research Ethics Committees within the University of Sydney and within the Western Sydney Area Health Service.

All studies that involve researchers who are staff members of the University of Sydney must receive ethics clearance from the University Human Research Ethics Committee, and all studies involving patients at Westmead Hospital must receive ethics clearance from the Western Sydney Area Health Service (WSAHS) Human Research Ethics Committee.

The application form is 24 pages, and the WSAHS Committee requires 17 copies to be submitted. The University requires only one copy. The application forms for both institutions are almost identical.

Our study, therefore, had to be submitted to both committees.

It is a very long process.

A study must satisfy the committee that it is worthy of pursuit:

- it will not be a waste of time for the participants
- it will generate valid data
- the analysis of the data will generate important new knowledge
- etc

The committee must approve *an information statement*, written in lay language, to be given to potential participants.

The committee must also approve the content of the *consent form*, which must be prepared in a format according to the NHMRC guidelines.

Our study has now been approved and we may proceed.

Request for consent

As Principal Investigator of the project entitled:

Monitoring dental student management of non-invasive intervention for dental caries

I would be grateful if you would all consent to participate.

In accordance with the requirements of the Human Research Ethics Committees of the University of Sydney and the Western Sydney Area Health Service, you will be issued with:

- an *information statement*
- two copies of the *consent form*
 - ☐ one for you to sign and retain
 - ☐ the other for you to sign and return to the researcher

the consent form provides for the signature of a witness

Special attention

Your attention is drawn to the *information statement* where it is noted that the data you generate in both the patient notes and your own notes (that will be collected for analysis) will not be used by the researchers (or given by them to others) for the purpose of either assessment of any individual student's academic progress, or clinical management, or clinical progress.

Any analysis we conduct and report on will relate to the group as a whole, and no one individual will be identified, nor will it be possible to infer that any particular individual is identifiable through any published report of the study.

Wendell Evans, MDS DDSc
Associate Professor
Community Oral Health and Epidemiology
Faculty of Dentistry
University of Sydney

NOTES RE THE CARIES MANAGEMENT SYSTEM

Notes re *Usual 24 hour diet questionnaire*

The purpose of the questionnaire

The purpose of this questionnaire is to determine diet-related caries risk.

It is recognised that the process of changing an individual's diet is extremely complex and difficult. One of the main risk factors for caries is the *frequent consumption* of refined sugar. However, because of the complexity of the diet-caries relationship, the probability that caries risk will be reduced by reducing refined sugar is certain only in the case where there is close to a complete absence of sugar in the diet. This goal is not really possible to achieve in the world of today. While there is a sound theoretical basis for recommending that dietary sugar should be reduced, both in relation to caries and other health problems, it should be clearly understood that effective diet counseling protocols aimed at reducing dietary sugar do not exist (if they did, we would not experience this extremely complex and difficult problem).

Nevertheless, we do accept responsibility for (1) assessing risk, (2) bringing this risk to our patient's attention, and (3) advising accordingly.

Completion of the questionnaire:

There are three columns for entering data; columns A and B, and the column on the right side of the questionnaire where the number of spoonfuls of sugar in tea/coffee is entered.

1. In column A, a box is ticked only if that item is consumed.
2. Column B is completed only if the corresponding box in column A is ticked.
3. Where applicable, in column B, enter the number of cups of tea/coffee drunk on that occasion.
4. Then on the right, enter the number of spoonfuls of sugar added — do not leave these boxes blank — enter a zero in cases where sugar is not added.

On the basis of this risk assessment, you will determine the frequency of consumption of (1) between-meal sugar-containing snacks and (2) between-meal sugar-containing drinks.

If appropriate, advise your patient accordingly to reduce this intake, and in addition, enter *Diet Goals* in the boxes in the *Good Oral Care* pamphlet (see below) that you will issue to each patient. You will monitor these recommendations.

The questionnaire data, in addition to other history and clinical data, will be entered for computer analysis. You will be informed of the results.

Notes re *Plaque report form*

Purpose of the plaque report form

It is a record of *unstained* plaque deposits according to the *Plaque Index* of Silness and Loe (1965) for *monitoring* oral hygiene performance. The goal of monitoring oral hygiene performance is to *reduce* and *maintain* plaque scores at near zero values (see the *Oral Hygiene Instruction Protocol* below).

Use of the plaque report form

1. This form is to be completed at the *commencement of each visit*.
2. In relation to a new patient, the scoring is to be done *before* you give oral hygiene instruction.
3. Twelve sites are assessed - that is, the buccal and lingual surfaces of the first permanent molars (8 sites) and the buccal and lingual surfaces of the upper and lower right permanent incisors (4 sites).
4. The area on the buccal and lingual surfaces each tooth to be assessed, is the area adjacent to the gingival margin, from papilla to papilla.
5. The patient score is the sum of the individual surface scores, and has a maximum value of 36.



Usual 24 hour diet questionnaire
of between meal drinks and snacks

Date:
(dd / mm / yyyy)

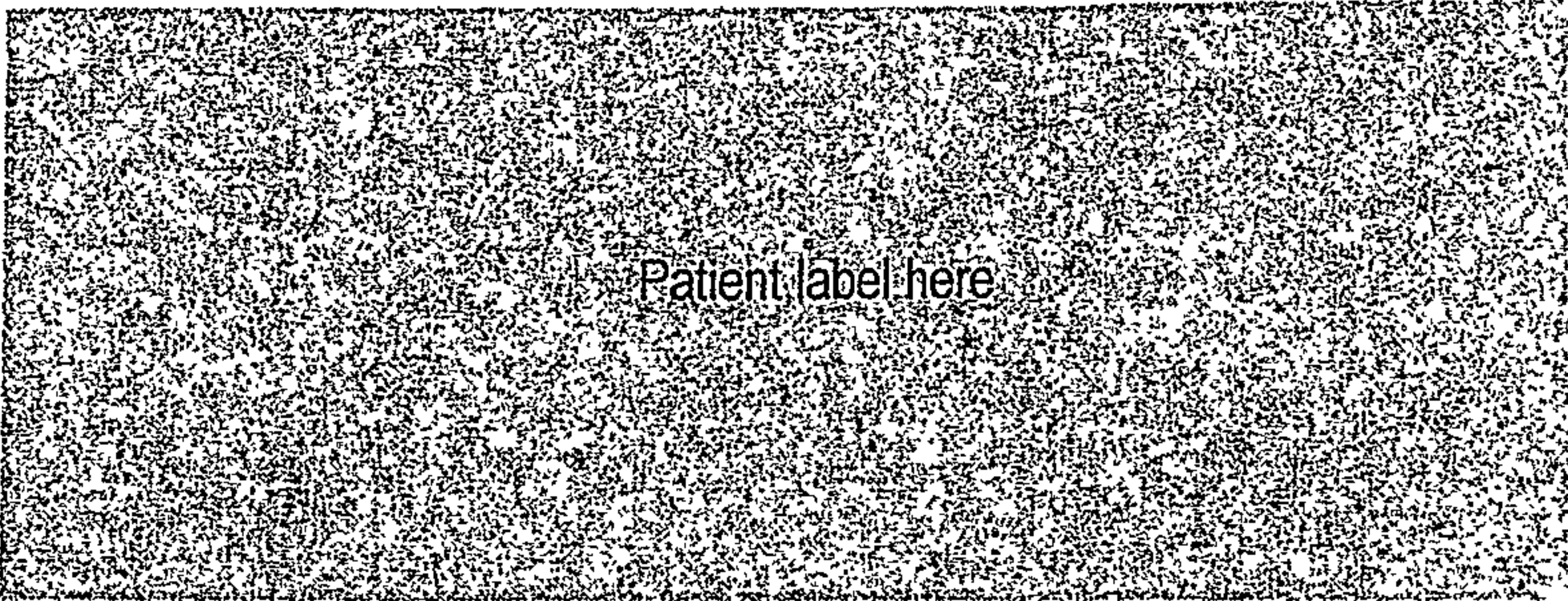
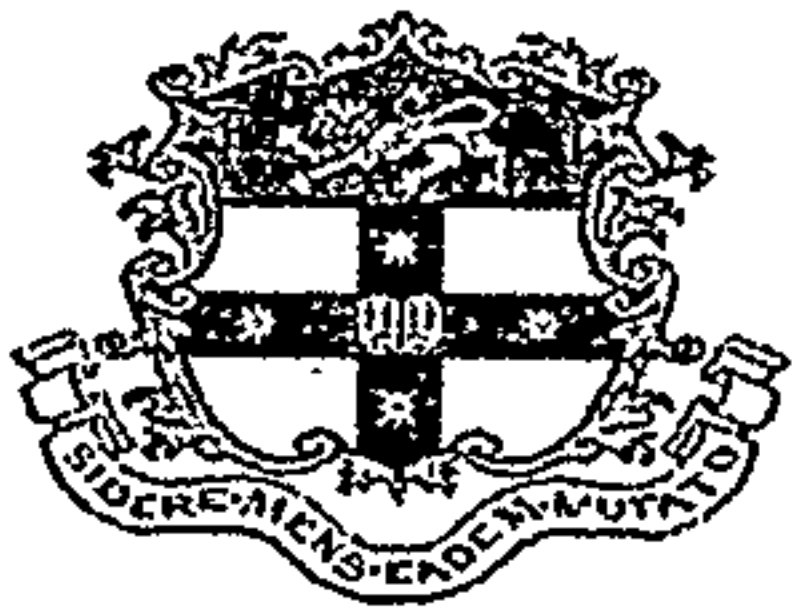
NO	YES	FREQ*	Do you usually have anything as soon as you get up in the morning <i>before breakfast</i> ?
☐	☐	☐	Fruit juice
☐	☐	☐	Cordial
☐	☐	☐	Fizzy drinks (coke, lemonade, etc)
☐	☐	☐	Tea
☐	☐	☐	How many spoons of sugar do you add ? ☐
☐	☐	☐	Coffee
☐	☐	☐	How many spoons of sugar do you add ? ☐
☐	☐	☐	Other hot drink
☐	☐	☐	How many spoons of sugar do you add ? ☐
☐	☐	☐	Other sugary food

NO	YES	FREQ*	Do you usually have anything to eat or drink <i>between breakfast and lunch</i> ?
☐	☐	☐	Fruit juice
☐	☐	☐	Cordial
☐	☐	☐	Fizzy drinks (coke, lemonade, etc)
☐	☐	☐	Tea
☐	☐	☐	How many spoons of sugar do you add ? ☐
☐	☐	☐	Coffee
☐	☐	☐	How many spoons of sugar do you add ? ☐
☐	☐	☐	Other hot drink
☐	☐	☐	How many spoons of sugar do you add ? ☐
☐	☐	☐	Biscuit
☐	☐	☐	Cake
☐	☐	☐	Pastry
☐	☐	☐	Chocolate, sweets
☐	☐	☐	Other sugary food

NO	YES	FREQ*	Do you usually have anything to eat or drink <i>between lunch and dinner</i> ?
☐	☐	☐	Fruit juice
☐	☐	☐	Cordial
☐	☐	☐	Fizzy drinks (coke, lemonade, etc)
☐	☐	☐	Soft drinks (coke, lemonade, etc)
☐	☐	☐	Tea
☐	☐	☐	How many spoons of sugar do you add ? ☐
☐	☐	☐	Coffee
☐	☐	☐	How many spoons of sugar do you add ? ☐
☐	☐	☐	Other hot drink
☐	☐	☐	How many spoons of sugar do you add ? ☐
☐	☐	☐	Biscuit
☐	☐	☐	Cake
☐	☐	☐	Pastry
☐	☐	☐	Chocolate, sweets
☐	☐	☐	Other sugary food

NO	YES	FREQ*	Do you usually have anything to eat or drink <i>after dinner</i> ?
☐	☐	☐	Fruit juice
☐	☐	☐	Cordial
☐	☐	☐	Fizzy drinks (coke, lemonade, etc)
☐	☐	☐	Tea
☐	☐	☐	How many spoons of sugar do you add ? ☐
☐	☐	☐	Coffee
☐	☐	☐	How many spoons of sugar do you add ? ☐
☐	☐	☐	Other hot drink
☐	☐	☐	How many spoons of sugar do you add ? ☐
☐	☐	☐	Biscuit
☐	☐	☐	Cake
☐	☐	☐	Pastry
☐	☐	☐	Chocolate, sweets
☐	☐	☐	Other sugary food

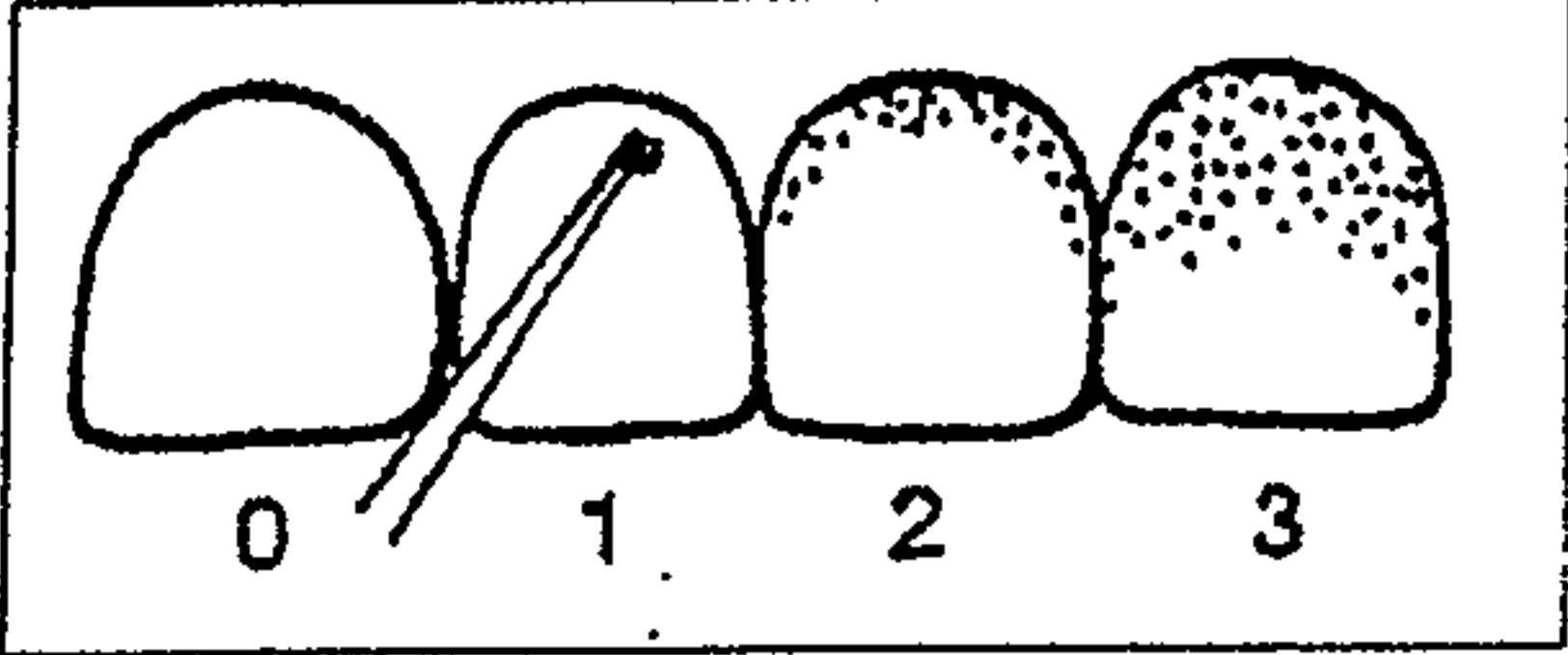
NO	YES	FREQ*	Do you usually have anything to eat or drink <i>just before you go to bed or during the night</i> ?
☐	☐	☐	Fruit juice
☐	☐	☐	Cordial
☐	☐	☐	Fizzy drinks (coke, lemonade, etc)
☐	☐	☐	Tea
☐	☐	☐	How many spoons of sugar do you add ? ☐
☐	☐	☐	Coffee
☐	☐	☐	How many spoons of sugar do you add ? ☐
☐	☐	☐	Other hot drink
☐	☐	☐	How many spoons of sugar do you add ? ☐
☐	☐	☐	Biscuit
☐	☐	☐	Cake
☐	☐	☐	Pastry
☐	☐	☐	Chocolate, sweets
☐	☐	☐	Other sugary food



PLAQUE REPORT FORM

Plaque Index (Silness & Loe)

- 3 = **thick** plaque is visible along gingival margin (no need to probe)
- 2 = plaque is **visible** along gingival margin, with or without air drying (no need to probe)
- 1 = following air drying, plaque is **not visible**, but **can be picked up** with an explorer
- 0 = following air drying, plaque is **not visible** and **cannot** be picked up with an explorer



Notes: (1) If an index tooth is missing, score the nearest tooth in that sextant. If there are no teeth in the sextant, enter X.
(2) If the plaque thickness varies along the gingival margin of a surface, score according to the worst situation.
(3) The overall score is the sum of the 12 surface scores (minimum of 0 and maximum of 36)

Date

Buccal Surfaces

161126

464136

Lingual Surfaces

161126

464136

Score

Date

Buccal Surfaces

161126

464136

Lingual Surfaces

161126

464136

Score

Date

Buccal Surfaces

161126

464136

Lingual Surfaces

161126

464136

Score

Date

Buccal Surfaces

161126

464136

Lingual Surfaces

161126

464136

Score

Date

Buccal Surfaces

161126

464136

Lingual Surfaces

161126

464136

Score

Date

Buccal Surfaces

161126

464136

Lingual Surfaces

161126

464136

Score

Date

Buccal Surfaces

161126

464136

Lingual Surfaces

161126

464136

Score

Date

Buccal Surfaces

161126

464136

Lingual Surfaces

161126

464136

Score

Date

Buccal Surfaces

161126

464136

Lingual Surfaces

161126

464136

Score

Treatment plan report form

Patient name

Student proposal

Date

Risk category

	Low
	Medium
	High

18	17	16	15	14	13	13	24	25	26	27	28
D O M	D O M	D O M	D O M	D O M	D	D	M O D	M O D	M O D	M O D	M O D
Bitewing score											
Treatment code											

48	47	46	45	44	43	33	34	35	36	37	38
D O M	D O M	D O M	D O M	D O M	D	D	M O D	M O D	M O D	M O D	M O D
Bitewing score											
Treatment code											

Treatment codes

A = arrest/monitor (see protocol elsewhere)
R = restore/endo
E = extract

OFFICE USE	18	17	16	15	14	13	13	24	25	26	27	28
	D O M	D O M	D O M	D O M	D O M	D	D	M O D	M O D	M O D	M O D	M O D
Bitewing score												
Treatment code												

48	47	46	45	44	43	33	34	35	36	37	38
D O M	D O M	D O M	D O M	D O M	D	D	M O D	M O D	M O D	M O D	M O D
Bitewing score											
Treatment code											

Patient label here

BITE-WING RADIOGRAPHIC ASSESSMENT

Binding Margin - No Writing

190

Notes re *Bitewing radiographic assessment*

Purpose of the bitewing radiographic assessment form

The purpose of this form is to monitor and facilitate the non-invasive management of the early *non-restored* occlusal and interproximal lesions. Radiolucencies associated with already filled occlusal and interproximal surfaces (that is, secondary caries) are not recorded on this form. Record details of radiolucencies associated with secondary caries elsewhere in the patient notes.

Recordings of future bitewing examinations (see *Recall and bitewing interval protocol* below) will also be entered on this form and will allow an assessment of the lesion dynamics. The lesions may regress, remain the same, or progress.

When this form is completed, it goes into the patient's folder.

Use of the bitewing radiographic assessment form

1. There is provision for recording radiographic status of the distal, occlusal, and mesial surfaces of each tooth excluding incisors.
2. For each surface, there are five boxes, numbered 1 to 5 corresponding to lesion depth.
3. For each surface that presents with a radiolucency, *only one box* is filled in; that being the one associated with your estimate of the deepest extent of the radiolucency.

Following the taking of readable bitewing radiographs and *before* you discuss them with your clinical supervisor, complete the bitewing radiographic assessment form (for monitoring lesion dynamics), and transfer these findings to the *Treatment plan report form (5)* - (see below).

Notes re *Treatment plan report form*

The purpose of this form

This form is for the purposes of auditing student understanding of caries management policy and it is to be completed *before* you discuss the findings with your demonstrator.

When this form has been completed it will be collected. However, if it is not collected (or handed in) prior to your discussion of the findings and your treatment decisions with your demonstrator, the form *must not be amended* as a result of such discussion.

If your demonstrator disagrees with your findings and decisions, that outcome will be reflected in the notes and charts in the patient's folder.

The completion of this form

1. The caries risk category is entered on this form as per the *Caries management policy (1)*.
2. The bitewing scores are transferred to this form. The scores relate only to non-restored surfaces that have radiolucencies. Leave the boxes blank for surfaces that are sound or associated with restorations (sound or otherwise).
3. In relation to the teeth that have bitewing scores, enter the appropriate treatment code.
4. If the sites have overlaps and cannot be read, enter X in the corresponding two boxes.

Notes re *Tooth decay report form*

The purpose of this form

This form contains essential information regarding caries on the front side, and other important information on the reverse side. This form is the main patient educational material for dental caries and provides a basis for obtaining informed consent from patients regarding the treatment plan.

Use of this form

1. Give this form to patients during the case presentation and go through it step by step.
2. Show the bitewing radiographs to your patient and draw attention to the teeth that show radiolucencies.
3. The number of radiolucencies, according to bitewing scores, will be entered as appropriate.
4. Explain to your patient how the bitewing finding is related to the *treatment need*.
5. The caries risk is also indicated in the appropriate box as per the *Caries management policy (1)*.
6. Go through the material on the reverse side of the form: *More information on tooth decay*.
7. At some point in the discussion after this, the patient will be asked if the treatment plan proposal is acceptable and may or may not give consent to proceed according to the treatment plan, or may agree to consent to some other treatment plan that is mutually acceptable.
8. Enter the date of the next appointment.

Notes re *Good oral care pamphlet*

The purpose of the pamphlet

There are three purposes for this pamphlet. The main purpose is to provide a set of illustrations showing toothbrush positions (1) for oral hygiene instruction purposes, and (2) for demonstration at future visits of tooth sites where plaque has not been removed.

The second and third purposes are: (2) to record the diet goals, and (3) to record sites where toothbrushing emphasis is required. This pamphlet complements the use of models during oral hygiene instruction.

Use of pamphlet

On the toothbrushing goals panel:

1. Enter the plaque score reduction goals that you have set for your patient.
2. Inform your patient that you will be checking oral hygiene instruction progress at the next visit.
3. Note that the order of the boxes is left - front - right, that is, the patient's mirror image.

On the diet goals panel:

1. Enter the snacking reduction and added sugar reduction goals that you have set for your patient on the basis of your analysis of the Usual 24 hour diet questionnaire (2). Be practical !! Suggestion: one less than usual ??

On the Where do I brush ? panel:

1. Draw, or highlight, or write instructions as appropriate.

Notes re *Topical fluoride protocols*

Purpose of the protocols

These protocols, based on the most recent guidelines and meta-analyses, define the topical fluoride regimen to follow for (1) professional care and (2) home care.

Use of protocols

1. Enter table according risk category
2. Go for it !!

Tooth Decay

Tooth decay, can be stopped, reversed, and prevented.

Hidden decay can be seen on your x-rays.

Holes in teeth need to be cleaned out and then filled by your dental practitioner.

What can your dental practitioner do to stop decay ?

- give you the latest information on diet management and decay prevention
- show you a tooth brushing method tailor-made for you
- clean out and fill any teeth that have holes
- seal any deep groves on your chewing surfaces
- put concentrated fluoride on your teeth
- see you for regular checks

What can you do at home to prevent and stop decay ?

- use fluoridated water for drinking and preparing food
- eat and drink less sugary things *between meals* to stop the acid attack and aid the process of natural repair
- brush *twice daily* with a fluoride toothpaste - before bed and in the morning
- take care to do a good job with your brushing
- use fluoride gel, paste, or rinse if recommended
- use an antibacterial gel or rinse if recommended

Your situation is shown on the chart below:

		Number of surfaces affected		The most likely situation is	Treatment need
X-ray shadow					
C1		Outer 1/2 of enamel	☐	The surface has <i>minimal</i> decay which is most likely non-active or arrested.	Normal home care.
C2		Inner 1/2 of enamel	☐	The surface has <i>slightly more</i> decay which may be non-active or arrested.	Normal home care.
C3		Just into dentine	☐	Decay on this surface is <i>just under</i> the enamel layer, but is <i>probably not</i> a hidden cavity.	Special home care for at risk (high).
C4		Outer 1/3 of dentine	☐	Decay extends under the enamel layer, and <i>it may or may not be</i> a hidden cavity.	Special home care and, <i>depending on risk</i> , filling.
C5		Inner 2/3 of dentine	☐	This deep decay needs <i>urgent attention</i> .	Filling plus special home care.

Your current risk of decay is ☐ Low ☐ Medium ☐ High

You are strongly recommended to attend your next appointment on

More Information on Tooth Decay

What is tooth decay ?

Tooth decay (dental caries) is caused by **bacteria** in the **dental plaque** (a soft creamy coloured film) that builds up daily and sticks to teeth. These bacteria **ferment sugar** and produce acids which dissolve the hard tooth enamel and may cause a hole.

How is tooth decay prevented ?

Three ways to prevent decay:

- reduce **sugar** intake between meals
- remove **plaque** with your toothbrush
- drink **fluoridated water** and use a **fluoride** toothpaste.

How is tooth decay managed ?

The management of decay involves....

- (1) **home care** which is the **more important**
- (2) **professional care** by a dental practitioner

Why should I avoid having holes and fillings ?

- when decay is cut out of a tooth, the tooth is usually weakened
- fillings have a limited life and need replacing from time to time
- replacement fillings are larger and weaken the tooth further
- fillings do not prevent decay from coming back

What are the benefits of dental care ?

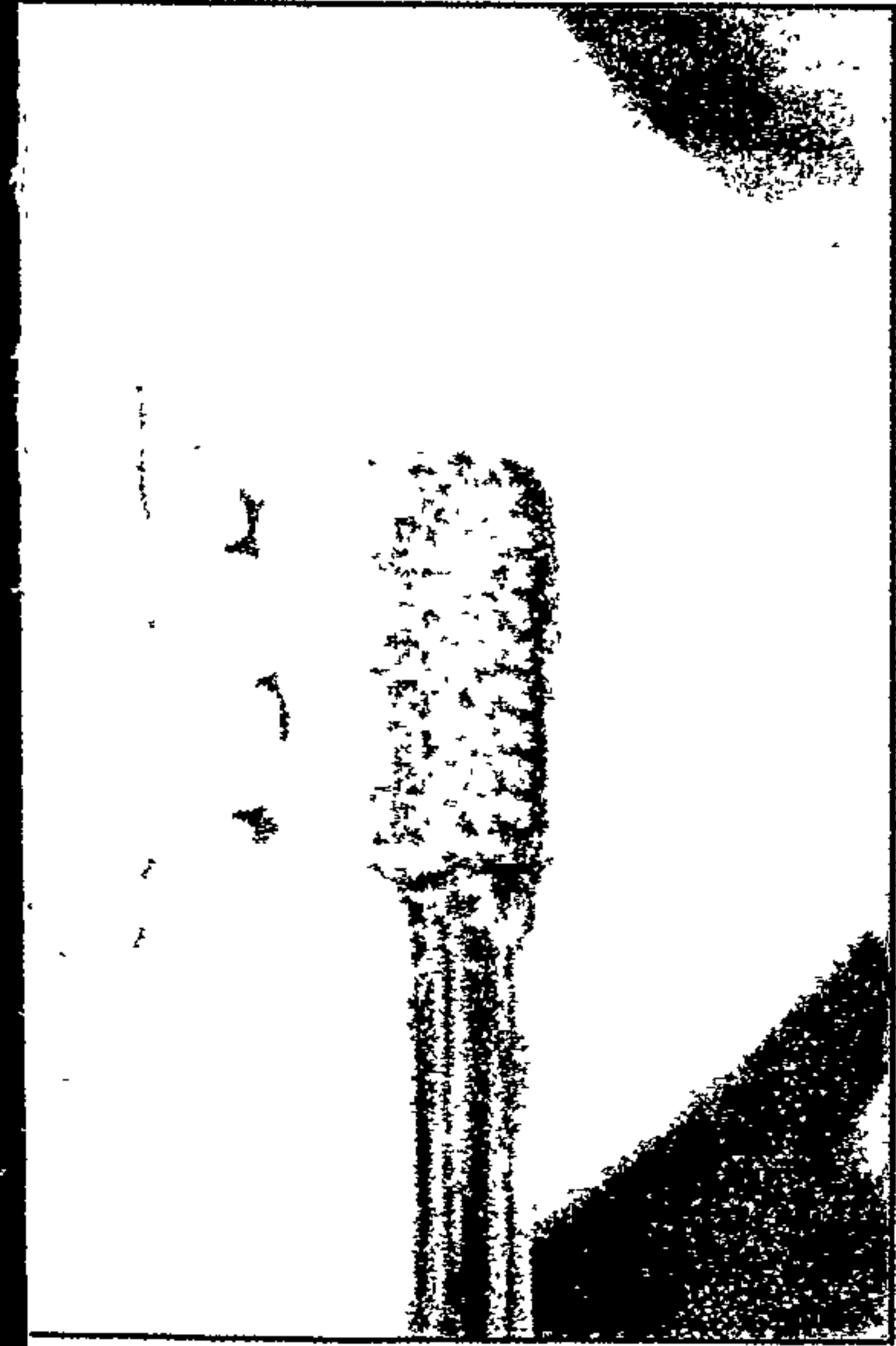
- decay is stopped without weakening the tooth
- your situation is monitored with follow-up x-rays
- your risk of new decay will be greatly reduced

Your child needs an urgent dental appointment

- if any teeth become sensitive to cold foods or drinks
- if a tooth gets a hole
- if a part of a tooth breaks off

Where

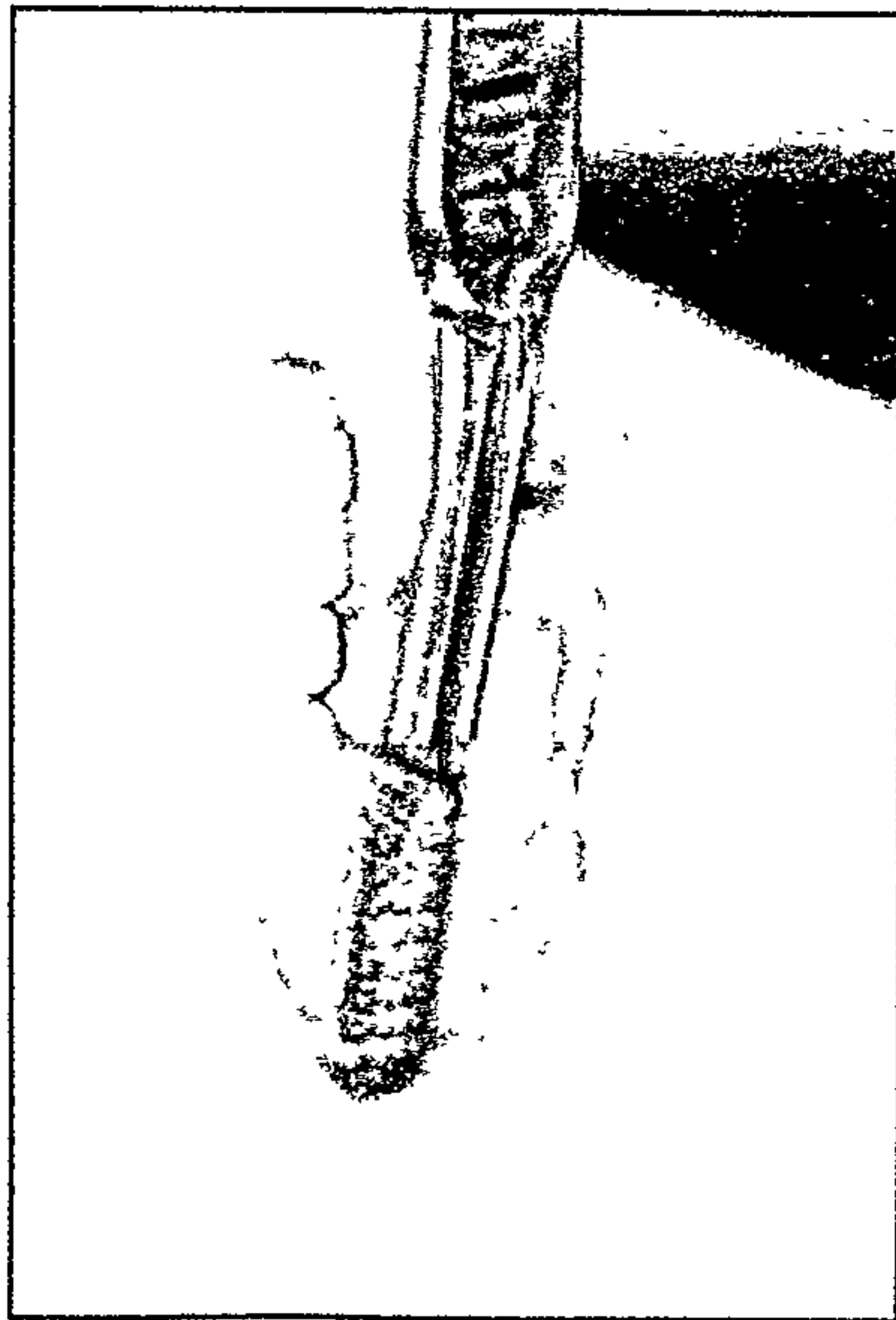
do I brush?



Lip side of front teeth
(upper & lower)



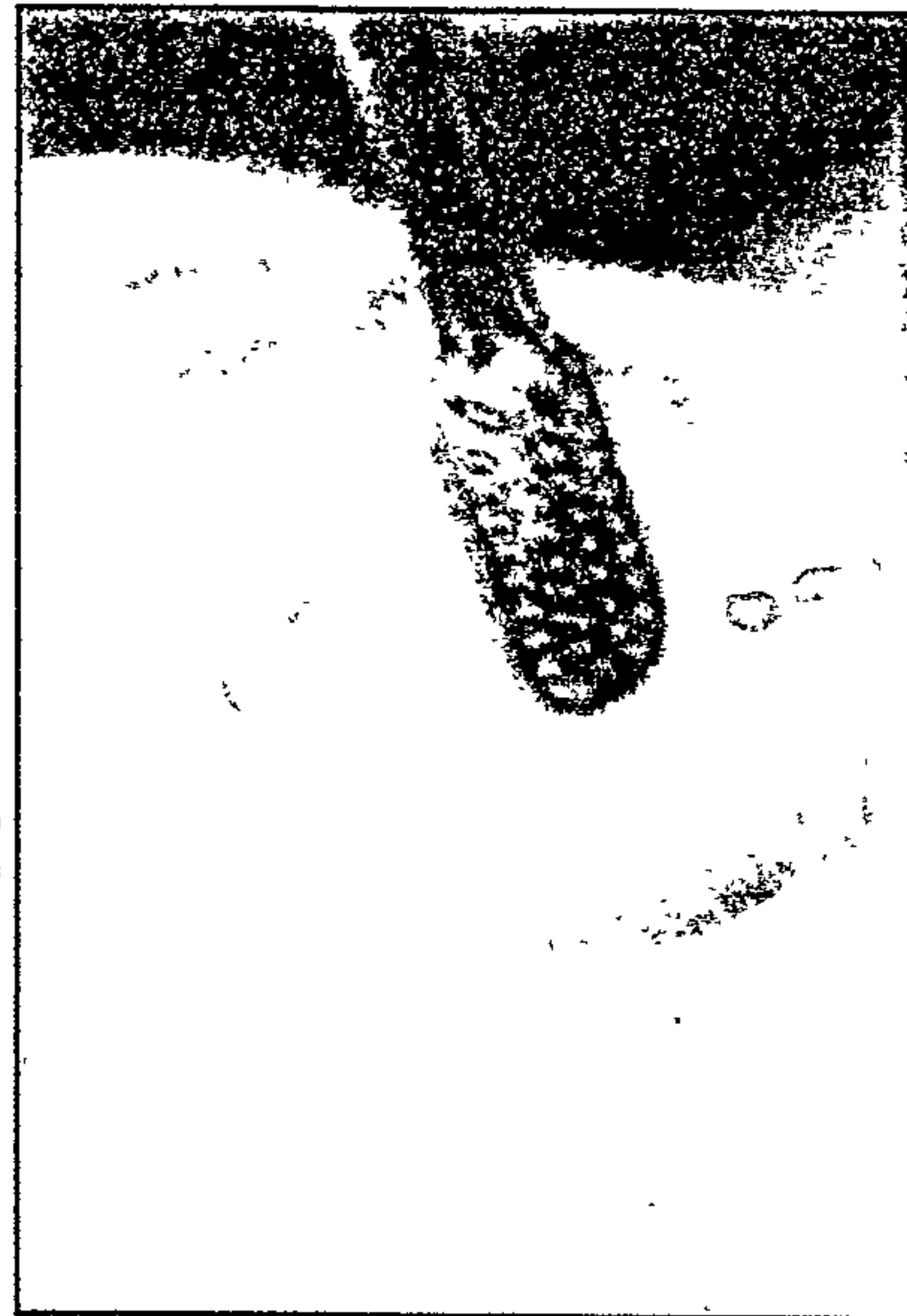
Behind front teeth
(upper & lower)



Cheek side of upper teeth
(right & left)



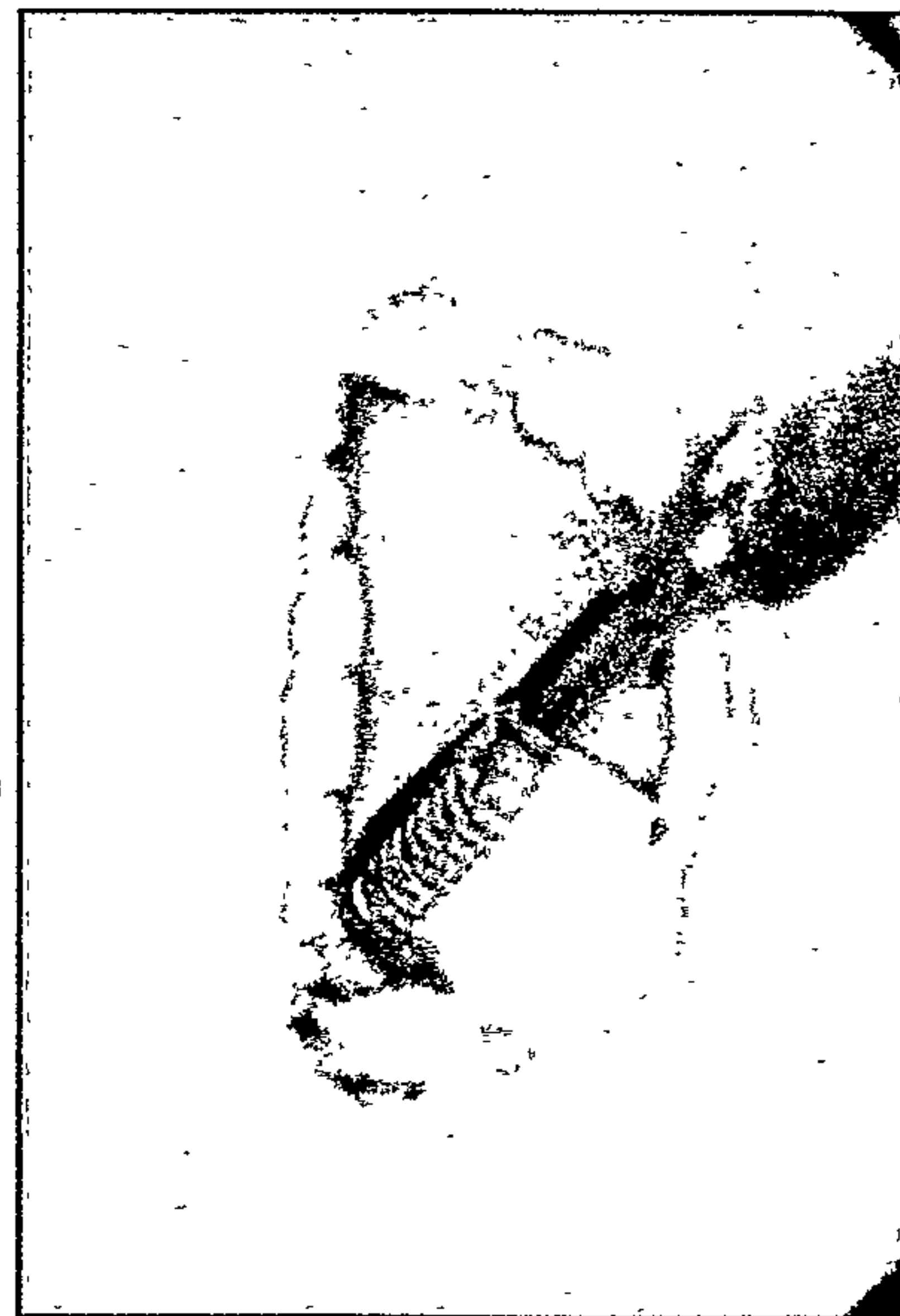
Biting surface of upper teeth
(right & left)



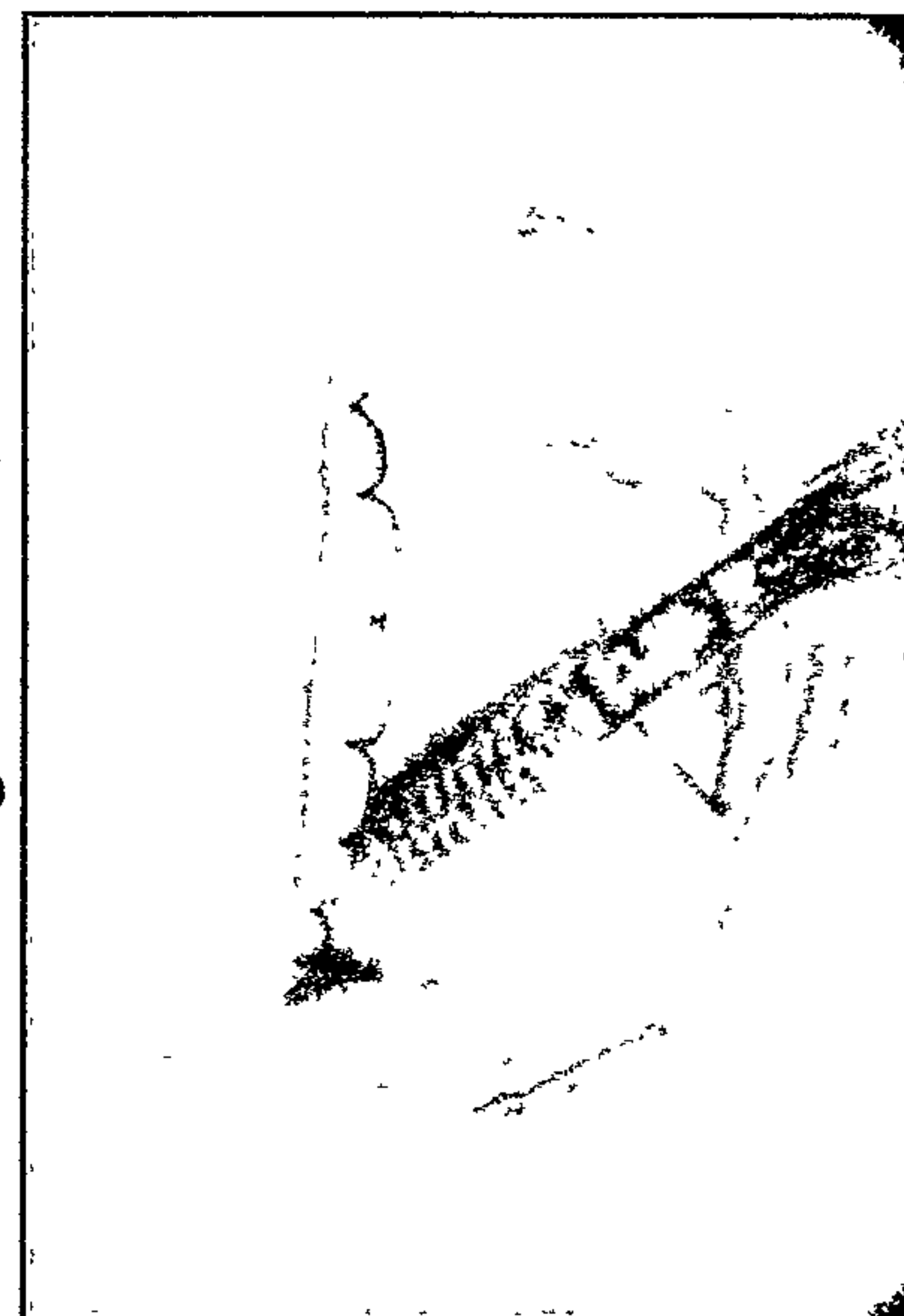
Tongue side of upper teeth
(right & left)



Cheek side of lower teeth
(right & left)



Biting surface of lower teeth
(right & left)



Tongue side of lower teeth
(right & left)

My toothbrushing goals

Upper teeth

Outsides (cheek & lip sides)		Insides (facing tongue)	
Left	Front	Right	
	Left	Front	Right

Lower teeth

Outsides (cheek & lip sides)		Insides (facing tongue)	
Left	Front	Right	
	Left	Front	Right

When you have become expert at using your toothbrush, you may consider using dental floss.

My diet goals

Reduce

1. Between meal snacking to

occasions.

2. Sugar added to tea/coffee/etc to

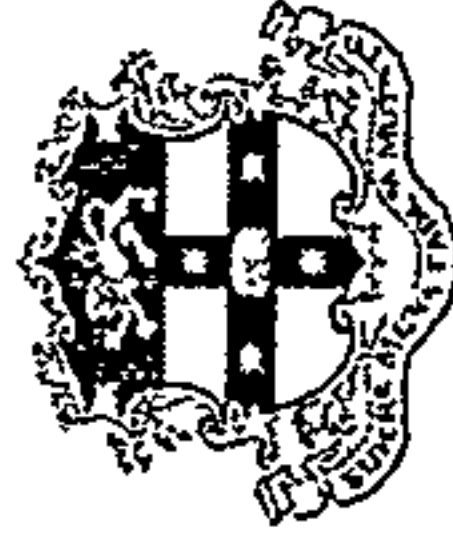
spoonfuls.

FOR FURTHER INFORMATION

Contact:

Community Oral Health & Epidemiology

Facsimile: (02) 9845 8306



University of Sydney

Good oral care

In order to remove bacterial plaque and prevent tooth decay, brush your teeth twice daily with fluoride toothpaste before bed and in the morning.

Take care to do a good job with your brushing, especially along the gum margins.

The five toothbrushing steps

1. Put teeth together— Brush outsides of the front teeth starting at gum margins.
2. Then outsides of back teeth Top and Bottom – Left and Right.
3. Don't miss the corners when you turn from one side to the other.
4. Next brush the chewing surfaces Top and Bottom – Left and Right.
5. Finally brush insides of teeth – Top and Bottom – Left and Right.

TOPICAL FLUORIDE PROTOCOL FOR PROFESSIONAL CARE				
RISK CATEGORY	AGE GROUP IN YEARS	FLUORIDE VARNISH (DURAPHAT) 5% NaF (22,600 ppm)	FLUORIDE GEL 1.23% NaF (12,300 ppm)	
LOW RISK	2-6 7-12 13-18 19 plus	<i>For all age groups:</i> 1. Apply GIC (eg Fuji 7) or varnish to newly erupted permanent molars. 2. Yearly application on lesions until arrested.	<i>For age-groups above 6 years:</i> 1. At recall appointments to maintain lesion arrest.	
MEDIUM RISK	2-6 7-12 13-18 19 plus	<i>For all age groups:</i> 1. Apply GIC (eg Fuji 7) or varnish to newly erupted permanent molars. 2. Apply to all lesions <i>at each treatment session</i> , then 3. 6-monthly application on lesions until patient becomes low risk.	NOT APPLICABLE	
HIGH RISK	2-6 7-12 13-18 19 plus	<i>For all age groups:</i> 1. Apply GIC (eg Fuji 7) or varnish to newly erupted permanent molars. 2. Apply to all lesions <i>at each treatment session</i> , then 3. 3-monthly application on lesions until patient becomes medium risk.	NOT APPLICABLE	

TOPICAL FLUORIDE PROTOCOL FOR HOME CARE				
RISK CATEGORY	AGE GROUP IN YEARS	TOOTHBRUSHING WITH FLUORIDE TOOTHPASTE	RINSE 0.05% NaF (neutral) (220 ppm) ONE MINUTE	GEL Chlorhexidine 0.2% CHX
LOW RISK	2-6	Daily using 400 ppm (smear only)	NOT APPLICABLE	NOT APPLICABLE
	7-12 13-18 19 plus	Twice daily using 1000 ppm (pea size)		
MEDIUM RISK	2-6	Daily using 400 ppm (smear only)	NOT APPLICABLE Once daily before bed	NOT APPLICABLE
	7-12 13-18 19 plus	Twice daily using 1000 ppm (pea size)		
HIGH RISK	2-6	Daily using 400 ppm (smear only)	NOT APPLICABLE	NOT APPLICABLE
	7-12 13-18 19 plus	Twice daily using 1000 ppm (pea size) Twice daily using 5000 ppm (pea size)		
VERY* HIGH RISK	Age groups above 12 years	Twice daily using 5000 ppm (pea size).	NOT APPLICABLE	Once daily before bed

* For example, patients with hyposalivation, or who have active lesions on anterior teeth, or who have active lesions on buccal surfaces of posterior teeth.

ORAL HYGIENE INSTRUCTION PROTOCOL

Objective of oral hygiene instruction (OHI)

The objective of OHI is to:

- custom-make an oral hygiene program for the individual patient
- ensure that patients understand that plaque should be removed effectively, especially along gingival margins and the dental papilla
- ensure that patients given are given practical toothbrushing demonstration
 - ☐ on a model
 - ☐ and on themselves (visual and tactile)
- and to ensure that patients know that their oral hygiene status will be monitored at *every appointment to coach them in becoming effective*

Oral hygiene instruction

at first visit for each new patient the student shall:

1. introduce plaque (students should memorise the following)

The two main dental diseases, *tooth decay* and *gum disease*, are caused by bacteria in the mouth. These bacteria settle on teeth and cover the tooth surface. This covering of bacteria is called *dental plaque*.

Dental plaque is soft and is easily removed with a toothbrush. However, plaque builds up again following toothbrushing. It is invisible at first, but after one day it can be easily seen. Plaque is thickest along the gum margin. In order to see plaque more clearly, it can be stained with a dye.

Plaque bacteria that cause gum disease produce *toxins* (poisons) which irritate the gums causing *inflammation* (redness).

The bacteria that cause tooth decay feed on sugar in our diet and produce acids which dissolve the hard tooth enamel and may cause a hole.

When we brush our teeth most of us now do it automatically. But even though we do it without having to think about, it may not be effective. So, I am going to custom make a program just for you to help you relearn how to do it well enough to help prevent dental disease.

2. ask the patient where the teeth are brushed. "Is this in front of a mirror?"
3. ask the patient, "When did you last brush your teeth?"
4. have patient observe own teeth in a hand mirror
5. if no visible plaque, demonstrate Plaque Index score of 1 (where on an apparently clean surface, plaque can be picked up with a probe)

however, most patients will have some visible plaque, especially along the linguals of the lower 6s

You may omit steps 6 to 14.

6. apply disclosing solution and show patient the distribution of stained plaque
7. chart stained plaque distribution (patient folder or student workbook)
8. demonstrate the stained plaque - use the mouth mirror to aid reflection in the hand mirror
9. complete patient the *Good tooth care pamphlet* - for patient to take home
10. show patient how to read the *Good tooth care pamphlet*
11. provide a toothbrush and ask patient to remove the (stained) plaque - and observe their toothbrushing method, and sequence of going around the sextants
12. check result and demonstrate and in the mouth and on the models where they have missed, what movements to use to brush the teeth effectively
13. patient to remove the remaining (stained) plaque

14. check patients efforts and give further advice, and repeat once more if necessary
15. give the patient a prophy - as a baseline and because it feels good and makes patients happy, and will assist motivating them
16. demonstrate that plaque cannot be disclosed on the prophed teeth
17. set goals for patient (for example, if today, thick plaque is visible in all sextants - score 36 - then at next visit aim for score 24)
18. then, explain to patient that their oral hygiene will be checked first thing at next appointment as a coaching aid to relearning how to brush effectively
19. now, talk about fluoridated toothpaste
20. ask patient to bring his/her toothbrush at next visit
21. **DO NOT DISCUSS FLOSSING AT THIS FIRST VISIT UNLESS PATIENT ASKS** - it is far more important for patients to become expert at toothbrushing. When patients demonstrate expertise in brushing, you may consider flossing.

at second visit

1. ask how they think their brushing is going and explain process
2. complete the *Plaque report form* (it is not necessary to stain plaque, but you may do so)
3. compare result with first visit - did patient improve
4. if yes, praise patient and give encouragement
5. redemonstrate Plaque Index score 1 because this illustrates that we give priority to oral hygiene and that toothbrushing needs detailed care and attention - the aim is for as many surfaces as possible to have score 0
6. ask patient a brush and ask them to remove the (stained) plaque (if patient did not bring back toothbrush, issue another)
7. discuss results
8. redemonstrate brushing technique
9. set new goals
10. complete the *Good oral care* - for patient to take home
11. remind patient how to read the Good oral care pamphlet
12. advise patient that results will be checked again first thing next visit as a coaching aid for them
13. ask patient to bring his/her toothbrush at next visit

third and subsequent visits

1. do not stain plaque this time
2. complete the *Plaque report form* (it is not necessary to stain plaque, but you may do so)
3. complete the *Good oral care* - for patient to take home
4. we expect a real improvement - there should *definitely be no PII scores of 3* and few PII scores of 2
5. if not, investigate the barriers
 - is it that patient *cannot*, or *will not* brush effectively
 - *if cannot*, then identify the problem and demonstrate an effective new technique or apparatus, eg special brush, special handle
 - *if will not*, then this is serious, *why is the patient coming here* - it is our responsibility to ensure that the patient understands that oral health is almost entirely dependent upon home care - the preventive treatment will fail and oral health will deteriorate if home care is not followed
6. as times goes on, introduce the concept of bleeding on probing, that is Gingival Index score 2 (an inflamed margin that bleeds on probing, or better still, 6 site bleeding on probing (BOP))
7. when PII scores are mostly 0 and corresponding GI scores are mostly 0, the oral hygiene status is good and indicates a low caries risk
8. if patients wish to improve beyond this point, consider dental floss, *but do not introduce dental floss until it is certain that patient has demonstrated a high level of motivation - the evidence is maintenance of low plaque scores over many visits*
9. if gingivitis is controlled, that is, Gingival Index scores are 0 or 1, but BOP occurs with 6-point probing, then the diagnosis is likely to be a localised periodontal problem and that this problem should now be investigated

RECALL AND BITEWING INTERVAL PROTOCOL

Recall at the following times:

Low risk

- 12 months following completion of treatment plan developed at first visit
- then consider 18-24 month recalls

Medium risk

- 6 months following completion of treatment plan developed at first visit
- then 6-monthly until patient is classified as low risk

High risk

- 3 months following completion of treatment plan developed at first visit
- then 3-monthly until:

0. home care goals have been met

- ☐ diet modification
- ☐ oral hygiene
- ☐ fluoride therapy

0. lesion progression has arrested/reversed (that is, patient is reclassified as medium/low risk)

Bitewing radiographs should be taken following times:

Low risk

- at first visit
- then 12 months later
- then every 18-24 months

Medium risk

- at first visit
- then 6 monthly until patient becomes low risk

High risk

- at first visit
- then 6 monthly until patient becomes low risk



Australian Dental Research Foundation Inc.

75 Lithgow Street, St Leonards, NSW 2065 Telephone: (02) 9906 4412 Facsimile: (02) 9906 4676

Address all correspondence to: Honorary Secretary, PO Box 520, St Leonards, NSW 1590

Email: adrf@ada.org.au Website: www.ada.org.au

30 November 2005

Dr A Pakdaman
Faculty of Dentistry
Westmead Centre for Oral Health
WESTMEAD NSW 2145

Dear Dr Pakdaman,

ADRF GRANT APPLICATION 5/2005

Pakdaman Dr A

Evans A/Prof W

At their Annual Meeting held on 22 November 2005, the Directors of the Australian Dental Research Foundation considered your application for a grant to support the project entitled:

"Monitoring dental students management of non-invasive intervention for dental caries"

It was agreed that your application be supported to the extent of \$4000.00 for one year. Subject to your agreement to the Conditions, the Directors have specified your research grant will take effect from January 2006. Australian Dental Research Foundation grants are normally paid in arrears. However, the Directors recognise that applicants may incur some unavoidable expenses in commencing their projects, particularly where equipment is to be purchased, and we would be willing to make an initial payment available to you on receipt of a detailed statement of the requirements.

I enclose a document setting out the Conditions of your research grant and I would be grateful if you would sign the attached acknowledgment form (page 3 of Conditions) and return it to this office. This exchange will represent the contract between you, your co-workers and the Foundation.

At the conclusion of the project a final report shall be submitted to the Foundation, together with ~~either~~ an article ~~or~~ an extended abstract in a form suitable for publication in the *Australian Dental Journal*. The article or abstract will be forwarded by the Foundation to the *Australian Dental Journal* for consideration for publication at the Editor's discretion. A copy of "Guidelines for Authors" is enclosed. Publication in the *Australian Dental Journal* shall not prevent the author(s) from submitting more detailed or specialised papers to other scientific journals. It is permissible also to submit the primary article to another scientific journal provided that an extended abstract is supplied to the Foundation.

It was the recommendation of the Research Advisory Committee that comments from your referees be made available to you and a copy/copies are enclosed.

May I take this opportunity to wish you every success with your undertaking.

Yours sincerely

A handwritten signature in dark ink, appearing to read 'R N Boyd-Boland', with a stylized, flowing script.

R N Boyd-Boland
Honorary Secretary

Encls:

Please tick ☒

Eastern

- ☐ Auburn
- ☐ Cumberland
- ☐ Westmead

Central

- ☐ Blacktown
- ☐ Mt Druitt

Western

- ☐ Blue Mountains
- ☐ Lithgow
- ☐ Nepean
- ☐ Portland
- ☐ Springwood

Integrated Health

- ☐ Community Health Facility

Ward

Hospital/Facility/Community Health Centre		M.R.N.	
Title		Family name	
Given names		Sex	DOB
Address		Ward/Unit	

Condition on examination

18

17

16

15

14

13

12

11

01

21

22

23

24

25

26

27

28

10

55

54

53

52

51

61

62

63

64

65

20

R

40

85

84

83

82

81

71

72

73

74

75

30

48

47

46

45

44

43

42

41

02

31

32

33

34

35

36

37

38

03

04

05

08

07

06

Perio

Exam

Treatment required

18

17

16

15

14

13

12

11

01

21

22

23

24

25

26

27

28

10

55

54

53

52

51

61

62

63

64

65

20

R

40

85

84

83

82

81

71

72

73

74

75

30

48

47

46

45

44

43

42

41

02

31

32

33

34

35

36

37

38

Fluoride Tx

Fissure Tx

GI

Composite

Amalgam

Endo

Inlay/onlay

Crown/bridge/veneer

Extraction

Removable Pros

Tx Sequence

1.

2.

3.

4.

5.

6.

7.

8.

(Name of clinician) and I have discussed my/my child's (Name of child) present condition, the various ways in which it might be treated and the risks and complications which may occur. I have had the opportunity to ask questions. I request and consent to the treatment plan described above for me/my child.

Name of parent/guardian (print)

Signature of patient/parent/guardian

Signature of interpreter (if required)

Date / /

Clinician/student (print)

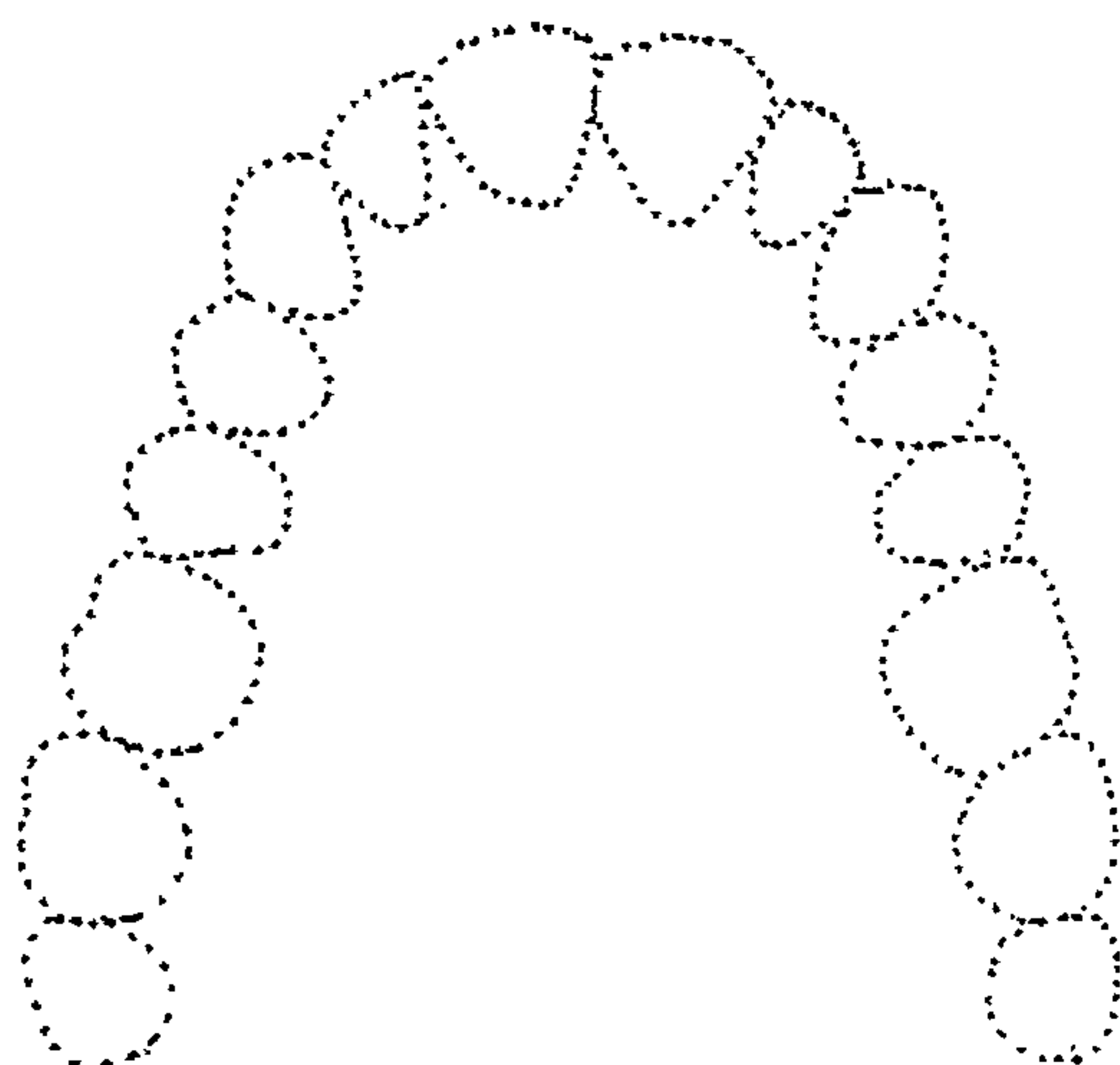
Staff signature

11/05 21035794

204

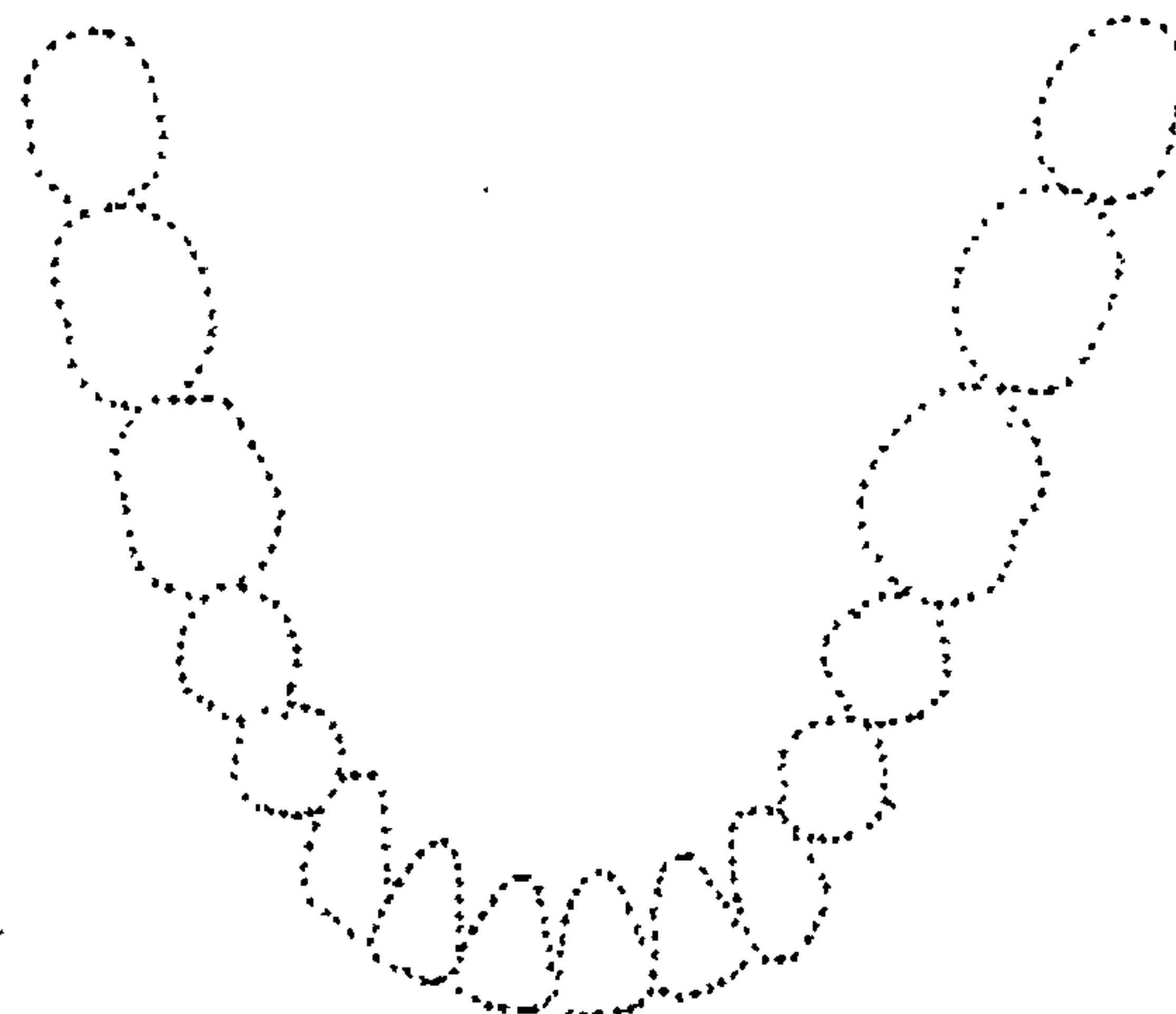
Treatment sequence (*continued*)

Appliance/denture/bridge design



R

L



R

L

Rests: _____

Retainers: _____

Retention areas: _____

Reciprocation: _____

Guide planes: _____

Connectors: _____

Artificial teeth: _____

Saddles: _____

Mouth preparations: _____

Shades/moulds: _____

Other instructions: _____

Date / / _____

Clinician/student (*print*)

Staff signature

Appendix 4

1. Ethics approval
2. Ethics approval - protocol amendments
3. Questionnaire

WESTERN SYDNEY AREA HEALTH SERVICE
HUMAN RESEARCH ETHICS COMMITTEE

Research Office, Clinical Sciences,
Westmead Hospital
Westmead NSW 2145

Telephone: 02 9845 8183
Facsimile: 02 9845 8352
Email: researchoffice@westgate.wh.usyd.edu.au

In reply please quote:

HS/TG HREC2003/12/4.10(1781)

Committee Secretariat:

A/Prof Graeme Stewart AM
Chairman
Medical Graduate -
Immunologist

Dr Howard Smith
Secretary
Medical Graduate -
Endocrinologist

Committee Members:

Mr Leonard Burney
Layman

Dr Michael Cole
Neonatal Paediatrician

Mrs Patricia Fa
Clinical Trials Pharmacist

Mr John Fisher
Lawyer

Ms Jillian Gwynne Lewis
Patient Representative

Dr Anthony Harris
Medical Graduate -
Psychiatrist

A/Prof Ian Kerridge
Haematologist and Bioethicist

A/Prof Vivien Lane RN
Nursing Professional
Development Unit - Research

Dr Geoff Shead
Medical Graduate - Surgeon

Rev Janine Steele
Minister of Religion

Miss Freda Whitlam AM
Lawyer

Mrs Gillian Wyatt
Lawyer

11 February, 2004

A/Prof R.Wendell Evans
Community Oral Health & Epidemiology
Westmead Centre for Oral Health

Dear Professor Evans

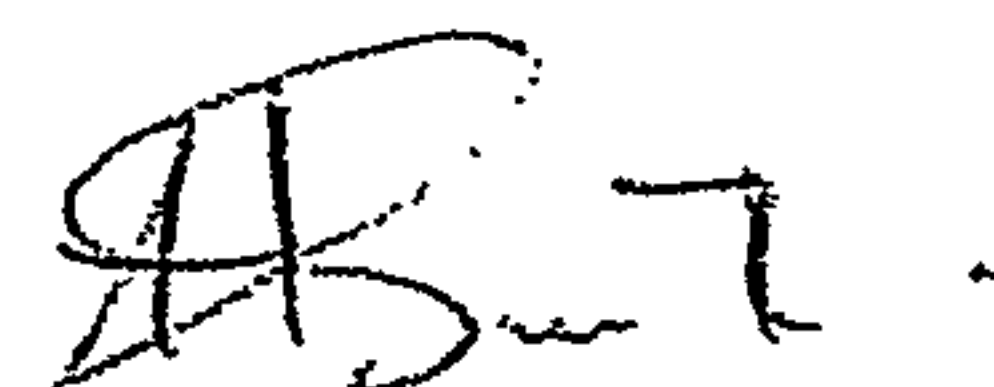
Research Proposal: 'Monitoring dental student management of non-invasive intervention for dental caries'

Thank you for submitting revised Participant Information and Consent Forms (Version 2 dated 10 February 2004), in accordance with the requests of the Human Research Ethics Committee in its letter dated 5 February 2004. These forms are approved.

As the Committee's ethical concerns have now been satisfied, approval of the study is confirmed and it may now begin.

The Committee wishes you well with the study and looks forward to receiving progress reports in due course.

Yours sincerely



Dr Howard Smith
Secretary
Western Sydney Area Health Service
Human Research Ethics Committee

SYDNEY WEST AREA HEALTH SERVICE (Westmead Campus)

HUMAN RESEARCH ETHICS COMMITTEE

Research Office, Clinical Sciences
Westmead Hospital Campus
Westmead NSW 2145

Telephone: 02 9845 8183
Facsimile: 02 9845 8352
Email: researchoffice@westgate.wh.usyd.edu.au

In reply please quote:

HS/pme HREC2003/12/4.10(1781)

8 July, 2005

A/Prof R.Wendell Evans
Community Oral Health & Epidemiology
Westmead Centre for Oral Health

Dear Professor Evans

Research Proposal: Monitoring dental student management of non-invasive intervention for dental caries

Thank you for your letter dated 26 May 2005 addressing the Committee's letter dated 17 May 2005.

As the Committee's ethical concerns have now been satisfied, approval of the protocol amendment is confirmed.

The Committee's initial assessments is that the amendments are a minor departure from the original protocol, with no additional ethical implications, and they are approved. They will be held on file in the Research Office with your original proposal. A copy of the approved questionnaire is attached for your records.

Would you please ensure that any further amendments to this study are brought to the attention of the Human Research Ethics Committee.

Yours sincerely



Dr Howard Smith
Secretary
Sydney West Area Health Service
Human Research Ethics Committee

Committee Secretariat:

Professor Stephen Leeder AM
Chairman
Professor of Public Health &
Community Medicine

Dr Howard Smith
Secretary
Medical Graduate -
Endocrinologist

Committee Members:

Dr Leonard Burney
Chairman

Dr Michael Cole
Medical Graduate - Neonatal
Paediatrician

Dr Patricia Fa
Clinical Trials Pharmacist

Prof Lorraine Ferguson AM
Nursing Research Unit

John Fisher
Lawyer

Janet Fox
Medical Graduate

Jillian Gwynne Lewis
Patient Representative

Anthony Harris
Medical Graduate -
Psychiatrist

Prof Ian Kerridge
Geriatrician and Bioethicist

Rada Kusic
Clinical Trials Manager

John Shaw
Nurse

Geoff Shead
Medical Graduate - Surgeon

Bruce Stanley
Minister of Religion

Shane Waterton
Nurse



Questionnaire

Non-invasive management of tooth decay:
A student perspective

Part I: Student Details

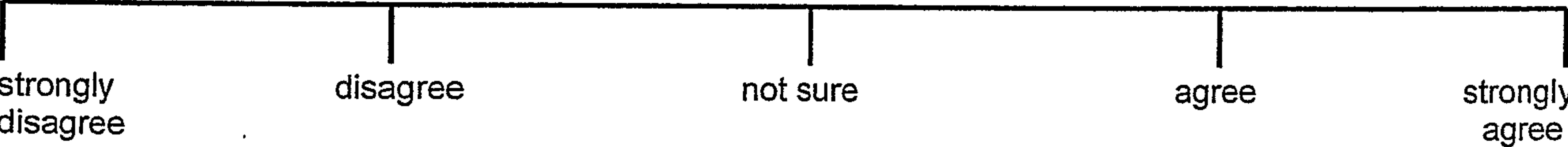
BDent 3 / BDent 4 (please circle as appropriate)

Gender..... Degree(s) previously obtained.....

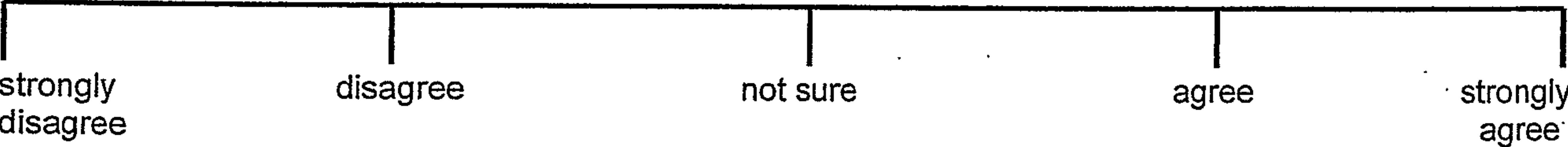
(Please indicate your response to each question by placing a (x) at the appropriate point on the scale)

Teaching

I feel the background science and rationale for non-invasive management of tooth decay is clearly taught within this faculty

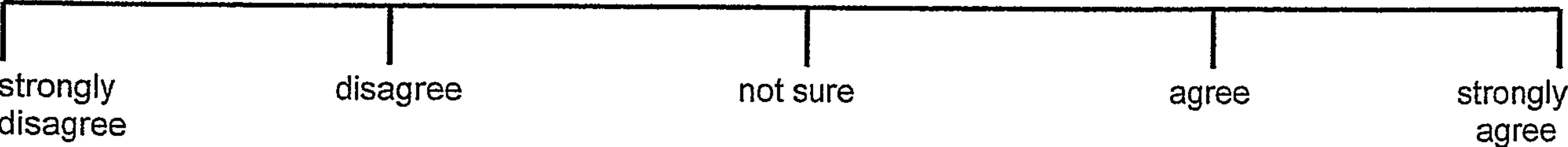


The knowledge provided in other courses is compatible to what you have been taught in non-invasive management handout?



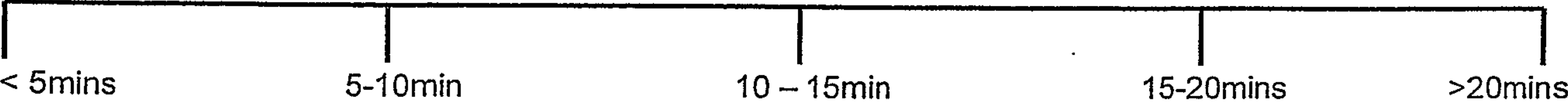
In the clinics

I feel that the non-invasive management of tooth decay is a useful treatment modality in the **student clinics**



a) Time spent

How much time did you spend on average at each visit assessing the oral hygiene of the patient?



How much time did you spend on average at each visit delivering fluoride to the patient?

< 5mins	5-10min	10 – 15min	15-20mins	>20mins
---------	---------	------------	-----------	---------

b) Patient Response

My patients responded to my oral health education efforts as follows.....

none of my patients showed any interest at all	most of my patients showed no interest	not sure	most of my patients showed some interest	all of my patients were very interested
--	--	----------	--	---

I noticed an improvement in my patient's oral care as a result of my education efforts

strongly disagree	disagree	not sure	agree	strongly agree
-------------------	----------	----------	-------	----------------

c) Complexity

I feel the treatment and home-care protocols are complicated

strongly disagree	disagree	not sure	agree	strongly agree
-------------------	----------	----------	-------	----------------

Implications for my career in dentistry

I will feel confident using non-invasive management of dental caries in my future career:

strongly disagree	disagree	not sure	agree	strongly agree
-------------------	----------	----------	-------	----------------

I feel this treatment approach will be easily integrated into private practice

strongly disagree	disagree	not sure	agree	strongly agree
-------------------	----------	----------	-------	----------------

Part II. Hypothetical clinical scenarios of three patients

These tables show the clinical presentations of three patients.

Read the case 1

Circle risk category as High, Medium or Low as appropriate

Consider the bitewings, which reveal radiolucencies graded 1 to 4. Taking into account their caries risk status, please indicate your preferred treatment option either to restore or remineralise. If, on the basis of the patient risk, you would not expect to see a lesion of this depth, then indicate accordingly (you need to make four decisions for each patient)

Scenario 1			
35 yr old male Lives in fluoridated area No medical complications Regular attender Brushes evening only with fluoridated toothpaste Snacks between lunch and dinner Saliva: hydration <30 sec, pH=7, watery-clear 3 missing teeth 6 filled teeth No obvious decay Plaque score: 10/36*			
Risk=	High	Medium	Low
			☐ Restore ☐ Remineralize ☐ Unlikely to have lesions of this depth
			☐ Restore ☐ Remineralize ☐ Unlikely to have lesions of this depth
			☐ Restore ☐ Remineralize ☐ Unlikely to have lesions of this depth
			☐ Restore ☐ Remineralize ☐ Unlikely to have lesions of this depth

*Silness and Loe Plaque index (max=36)

☐ Read the case 2

- ☐ Circle risk category as High, Medium or Low as appropriate
- ☐ Consider the bitewings, which reveal radiolucencies graded 1 to 4. Taking into account their caries risk status, please indicate your preferred treatment option either to restore or remineralise. If, on the basis of the patient risk, you would not expect to see a lesion of this depth, then indicate accordingly (you need to make four decisions for each patient)

Scenario 2	
25 yr old female Migrated recently from overseas Uses antidepressant medication Last visit>2 yrs Brushes once a day Snacks frequently Saliva: hydration 30-60secs, pH: 6.0, sticky 10 missing teeth 6 filled teeth 2 teeth with frank cavity 3 teeth with white spot lesion 3 new interproximal lesions Plaque score: 24/36*	
Risk= High Medium Low	
	☐ Restore ☐ Remineralize ☐ Unlikely to have lesions of this depth
	☐ Restore ☐ Remineralize ☐ Unlikely to have lesions of this depth
	☐ Restore ☐ Remineralize ☐ Unlikely to have lesions of this depth
	☐ Restore ☐ Remineralize ☐ Unlikely to have lesions of this depth

*Silness and Loe Plaque index (max=36)

Read the case 3

- Circle risk category as High, Medium or Low as appropriate
- Consider the bitewings, which reveal radiolucencies graded 1 to 4. Taking into account their caries risk status, please indicate your preferred treatment option either to restore or remineralise. If, on the basis of the patient risk, you would not expect to see a lesion of this depth, then indicate accordingly (you need to make four decisions for each patient)

Scenario 3	
18-yr old female Lives in fluoridated area No medical complications Last visit > 1 yrs Brushes once a day with fluoridated toothpaste 3-5 cups of coffee every day with 3 tsp of sugar in each cup Saliva: hydration 30-60; pH: 6.5; watery-clear 4 missing teeth 3 filled teeth, 2 new interproximal lesions & 3 sticky fissures, Plaque score: 12/36	
Risk= High	Medium Low
	☐ Restore ☐ Remineralize ☐ Unlikely to have lesions of this depth
	☐ Restore ☐ Remineralize ☐ Unlikely to have lesions of this depth
	☐ Restore ☐ Remineralize ☐ Unlikely to have lesions of this depth
	☐ Restore ☐ Remineralize ☐ Unlikely to have lesions of this depth

*Silness and Loe Plaque index (max=36)

What problems did you experience in the delivery of the non-invasive management of dental caries (caries management system)?

Thank you for completing this questionnaire!!