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Dentists' perspectives on caries-related treatment decisions

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Objective: To assess the impact of patient risk status on Colombian dentists' caries related treatment decisions for early to intermediate caries lesions (ICDAS code 2 to 4)**.** ***Methods****:* A web-based questionnaire assessed dentists' views on the management of early/intermediate lesions. The questionnaire included questions on demographic characteristics, five clinical scenarios with randomised levels of caries risk, and two questions on different clinical and radiographic sets of images with different thresholds of caries. ***Results:*** Questionnaires were completed by 439 dentists. For the two scenarios describing occlusal lesions ICDAS code 2, dentists chose to provide a preventive option in 63% and 60% of the cases. For the approximal lesion ICDAS code 2, 81% of the dentists chose to restore. The main findings of the binary logistic regression analysis for the clinical scenarios suggest that for the ICDAS code 2 occlusal lesions, the odds of a high caries risk patient having restorations is higher than for a low caries risk patient. For the questions describing different clinical thresholds of caries, most dentists would restore at ICDAS code 2 (55%) and for the question showing different radiographic thresholds images, 65% of dentists would intervene operatively at the inner half of enamel. No significant differences with respect to risk were found for these questions with the logistic regression. ***Conclusion:*** The results of this study indicate that Colombian dentists have not yet fully adopted non-invasive treatment for early caries lesions.

Key words: *caries detection, clinical decision-making, treatment thresholds, caries management, Colombia, general dental practitioners*

Introduction

Current evidenced-based caries management strategies are based on a biological understanding of the disease process, new approaches in caries detection, assessment and therapeutic interventions targeted at early non-cavitated lesions. This paradigm requires changes in caries-related treatment decision-making within the dental workforce if the advantageous outcome of prevention is to be realised (Baelum, 2010).

Previous systematic reviews have highlighted inabilities to accurately identify early caries lesions and a need for changes with respect to the non-surgical management of non-cavitated lesions (Bader *et al.*, 2002; Ismail, 2004; Gomez *et al.*, 2012). Unfortunately, this approach has not been universally adopted, often due to remuneration and incentive systems based on rewards for restorative treatments and the inability for dentists to detect lesions at an early stage (Ismail *et al.*, 2013).

One of the most important activities in dental clinical practice is making decisions. However, a wide variation in management decisions among dentists has been reported. The decision-making process of how dentists choose the most appropriate therapeutic strategy is not well understood and it is influenced by several factors, including learned concepts, years of experience and public and private practice settings amongst others (Bader and Shugars, 1995).

The diagnosis process is based on how a clinician can unify diverse information into clinical pictures (Maupome *et al.*, 2010) using a specified memory structure leading to clinical elucidation (Gale and Marsden, 1982). It has been suggested that during an examination, dentists use caries scripts as a process of pattern recognition (Bader and Shugars, 1997). In dentistry the decision-making process can be divided in three separate stages. The first is the detection phase where a disease is identified. The second stage involves a decision about intervention based on a previous diagnosis. The third phase is the selection of the treatment from among different options but mainly the choice between two types of treatment: operative and non-operative (Ekstrand *et al.*, 2001).

Based on the diagnosis and risk assessment together with patient and practitioner preferences, the clinician then considers various treatment alternatives (White and Maupome, 2001). Often alternatives are not evidence-based but rather based on economic constraints (Chiappelli and Cajulis, 2009). Clinicians want to provide effective treatments; patients want to be involved in the treatment decisions and health or insurance systems need to know what are they paying for and if these measures are effective to reduce the costs of treatment (Bader and Ismail, 1999). Clinical decision-making is a "social process", where the dentist, the patient and in some countries the insurers are all involved in the process (Weinstein *et al*., 1979).

The aim of this study was to describe the management decisions for early caries lesions among Colombian general dental practitioners (GDPs) in terms of: considering individual patient caries risk for the treatment decision; threshold and types of lesions dentists decide to treat (both preventive and operative) and monitoring of the

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treatment (recall interval). The influence of dentists' characteristics such as gender and date of graduation in the practitioners' treatment decisions was also explored.

Methods

A cross-sectional, observational study was conducted among GDPs in Colombia where there were 28,310 dentists in 2000 (0.69 dentists for each 1,000 inhabitants, Ministerio de Protección Social, CENDEX, 2007). There is no public database of Colombian dentists on account of data protection legislation so a convenience sample based on the first available dentists was selected from the Colgate database of 8,725 dentists Colombian GDPs distributed across six cities. The obtained sample was compared to the Colgate GDP database to test if the sample was representative of the Colgate database (30.7% male, 60.9% graduating pre-2001, 89.8% in private practice). The GDPs were approached by the Colgate Oral Care Consultants (OCCs) who explained the objectives and the voluntary and anonymous nature of the study. GDPs who were willing to participate, were asked to record on an iPad, preventive and/or restorative treatment options for different clinical scenarios and recall intervals. This descriptive study was limited to a single visit that lasted no more than 10 minutes.

The questionnaire had three sections. The first section gathered information on demographic characteristics of the dentists, including city, graduation year, university, gender and type of practice. The second section contained five clinical scenarios (Figure 1A) represented by photographs indicating either:'Low risk' defined as no new caries lesions or a recent history (within 3 years) of restorations without any risk factor associated; or 'High risk' described as one or more new caries lesions at any severity and two or more risk factors associated: i.e. white spots on smooth surfaces, visible heavy plaque, frequent snacks (>3 times daily between meals), inadequate saliva flow. Scenario 1, 2 and 3 (ICDAS code 2), involved demineralization in the inner half of enamel. Scenario 4 (ICDAS code 3) and Scenario 5 (ICDAS code 4) involved demineralization in the outer third of dentine. The first clinical scenarios question listed treatment options: watch and wait until the next visit; enhanced oral health instructions; fluoride varnish; seal and follow-up; open fissure and place a sealant restoration (not for Scenario 3); provide resin-based composite; provide amalgam. The second question focused on recall intervals where practitioners were asked when they would like to see the patient again (less than 3 months, 3 months, 9 months or 12 months). The third section consisted of photographs (Figure 1B) and radiographs (Figure 1C) at different caries thresholds. The clinical thresholds were: C1-Sound; C2-ICDAS code 2: C3-ICDAS code 2; C4-ICDAS code 3, and C5-ICDAS code 4. The radiographic thresholds (Espelid *et al*., 1997), were radiolucency at: R1, outer half of enamel; R2, inner half of enamel through to the enamel-dentine junction; R3, external third of dentine; R4, middle third of dentine. The treatment options for this section were divided into preventive (topical fluoride or sealant) and operative (resin-based composite or amalgam) and an open space for 'other options' where the participants were able to express other preferences. For the clinical scenarios and for the radiographic and clinic thresholds, respondents were asked to choose from preventive and/or restorative options.

The photographs chosen for the questionnaire were scored using the International Caries Detection and Assessment System (Ismail *et al.*, 2007) by two trained ICDAS examiners (SM, JG). The questionnaire was validated in 2012 in terms of understanding, content, and language, first by the Preventive Dentistry Faculty from University of Manchester and subsequently by GDPs in Manchester. Then, the questionnaire was forward translated from English into Spanish by two bilingual individuals, who worked independently of each other. Second, the two initial Spanish versions were compared and revised through a consultation process involving a review committee. After this process, the questionnaire was reviewed by the Caries Research Unit from Universidad El Bosque and tested in a target population using a convenience sample of 59 GDPs to ensure that it was comprehensible and acceptable. As a result of the piloting process, details on the questionnaire were adjusted to improve the interpretation of the questions, better summarise treatment options, offer fewer options and remove two clinical scenarios.

There were 8,725 dentists in the Colgate GDPs database. A sample size of 368 would be needed assuming a 50% response rate to achieve a 95% confidence level.

The data extracted from the completed questionnaires were exported into an Excel file and analysed using SPSS v19. Binary logistic regression modelling calculated odds ratios (ORs) and confidence intervals (95%CIs) of the associations between the dependent variable (dichotomised into preventive or operative options) and the independent variables: risk, gender and date of graduation. Date of graduation was dichotomised using the median date of graduation as the point of dichotomisation. Chi-square tests identified any significant differences between the recall intervals and the individual caries risk (threshold set at $p<0.05$).

Results

Approached to participate in the study were 493 dentists across six Colombian cities and 439 (89%) participated. Respondents were mostly female (69%) and mainly in private practice (68%), followed by mixed practice (24%) and public practice (8%). Most were located in middle-ranking socio-economic areas (73%) followed by high- (21%) and low-socio-economic areas (6%). Some 52% of the dentists in the sample graduated in 2001 or later and 48% before 2001.

For the scenarios describing occlusal lesions ICDAS code 2 (Scenarios 1 and 2), the dentists chose to provide a preventive treatment in 63% of the cases for Scenario 1 and in 60% for Scenario 2. For Scenario 3, they chose to restore the approximal lesions ICDAS code 2 in 81% of cases. The results for the Scenarios 1 to 5 by risk are described in Table 1. For the question describing different caries clinical thresholds, the majority of dentists would restore at ICDAS code 2 (C3) (55%), and for the question on radiographic thresholds, 65% of dentists would intervene operatively at the inner half of enamel (R2) (Figure 2).

A. Clinical Scenarios

Scenario 1: This image is from a 20 year old woman who is a regular attender at your practice. Her caries risk based on caries experience, tooth brushing, attendance and plaque control is indicated by the traffic light. Assume that a radiograph of the tooth shows evidence of caries extending into the inner half of enamel.

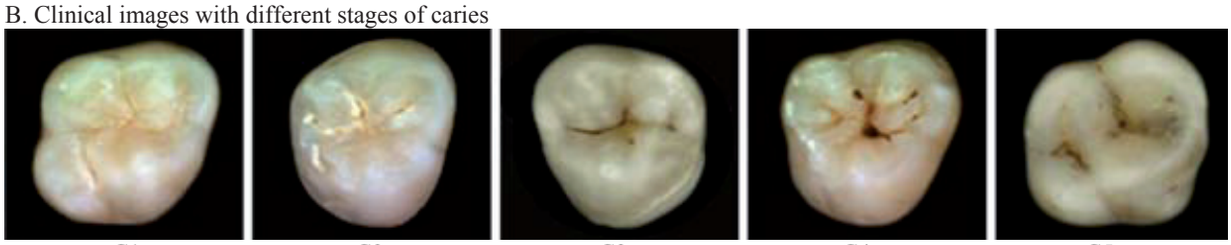
Scenario 2: This image is from a 14 year old boy who is a regular attendant at your practice. During your routine examination you notice this spot on an upper premolar. His caries risk based on caries experience, tooth brushing, attendance and plaque control is indicated by the traffic light. Assume that a radiograph of the tooth shows evidence of caries extending into the inner half of enamel.

Scenario 3: This image is from a 30 year old woman who presents at your practice for the first time today. Her caries risk based on caries experience, tooth brushing, attendance and plaque control is indicated by the traffic light. Assume that a radiograph shows evidence of caries extending into the inner half of enamel.

Scenario 4: This 16 year old girl presents to your practice for the first time today. Her caries risk based on caries experience, tooth brushing, attendance and plaque control is indicated by the traffic light. The radiograph of the tooth shows evidence of caries extending to the outer third of dentine. The clinical examination shows enamel breakdown.

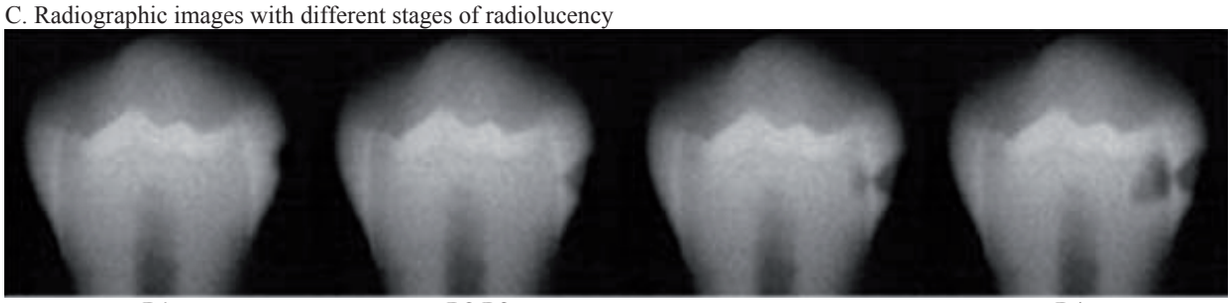
Scenario 5: This image is from a 16 year old girl who is a regular attender at your practice. Her caries risk based on caries experience, tooth brushing, attendance and plaque control is indicated by the traffic light. Assume that a radiograph of the tooth shows evidence of caries extending into the outer third of dentine.

B. Clinical images with different stages of caries



C1 C2 C3 C4 C5

C. Radiographic images with different stages of radiolucency



R1 R2 R3 R4

Reproduced with permission from Espelid, I., Tveit, A.B., Mejáre, I. and Nyvad, B. (1997): Caries - New knowledge or old truths? *Norwegian Dental Journal* **107**, 66-74

D. Traffic light system

Red: 'High risk' described as one or more new caries lesions at any severity and 2 or more risk factors associated: i.e. white spots on smooth surfaces, visible heavy plaque, frequent snacks (>3x daily between meals), inadequate saliva flow

Green: ' Low risk' defined as no new caries lesions or a recent history (within 3 years) of restorations without any risk factor associated.

Figure 1. *Clinical and radiographic scenarios*

The main findings of the binary logistic regression analysis suggest that the odds of a high caries risk patient having restorations is higher than for a low caries risk patient with a pooled OR for ICDAS code 2 (Scenario 1) of 1.89; (95%CI 1.21-2.81; p=0.002), for ICDAS code 2 (Scenario 2) of 1.61 (95%CI 1.09-2.37; p=0.01), and for ICDAS code 3 (Scenario 4) of 1.92 (95%CI 0.43-0.96; p=0.001) (Table 2). Logistic regression analyses, regarding influences of gender on treatment decisions were not significant. Date of graduation seems to have an influence only on the ICDAS code 3 (Scenario 4). The odds of a patient having a restoration was 1.55 times higher if the dentist graduated before 2001. No significant results were found for the questions on clinical and radiographic thresholds using the regression analysis.

The results for the recall intervals by risk are described in Figure 3. Most dentists would see the patient again in 3 or 6 months. There were only statistical significant differences on the recall intervals by risk in the Scenario 5 (ICDAS code 4) (p=0.004). Further Chi-squared tests looking at differences between 3 and 6 months recall intervals revealed statistical significance for Scenario 5 showing a preference for a 6 months interval (p=0.01).

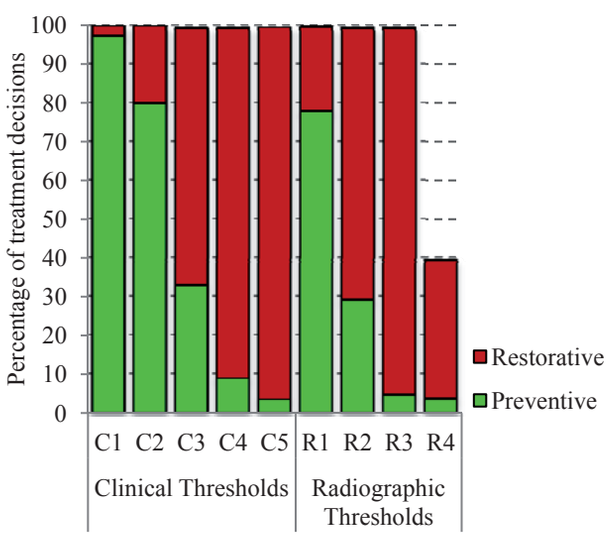


Figure 2. *Distribution of restorative and preventive treatment decisions by clinical and radiographic thresholds (n=439)*

Discussion

This study investigated caries related treatment decisions among Colombian dentists and showed that in general most dentists did not base their treatment decisions on individual caries risk. Assessing a patient's risk of developing caries is a vital component of the caries management (Fontana and Zero, 2006). In this study only scenarios representing ICDAS code 2 occlusal lesions were found to to have different treatment preferences depending on an individuals risk status. However, as might be expected high caries risk scenarios were associated with an increased tendency to restore. These results suggest that patient risk is not been taking into account when making decisions on approximal lesions (Scenario 3) where the only approach seems to be the operative intervention. Evidence suggests that assigning therapeutic regimens to individuals according to their risk levels should yield a significantly greater probability of success and better cost-effectiveness than applying identical treatments to all patients independent of risk (Anusavice, 2001).

For the occlusal ICDAS code 2 lesions, most practitioners felt that preventive interventions were the best options. However, regarding approximal lesions (clinical and radiographic), 79% of dentists would fill an approximal lesion whose radiolucency was confined to an ICDAS code 2 (Scenario 3) and 65% at the enamel-dentine junction in the radiographic images. This finding supports previous research showing that dentists would restore when there is evidence of radiolucency at the enamel-dentine junction (Espelid *et al*., 1985; Kay and Knill-Jones, 1992; Nuttall and Pitts, 1990) and at the enamel level in high-caries-risk scenarios (Gordan *et al*., 2009; Kakudate *et al*., 2012). However, other preventive options such as fluoride varnish, proximal sealing and proximal infiltrants may be available for non-cavitated approximal lesions (Paris *et al.*, 2010; Martignon *et al.*, 2012).

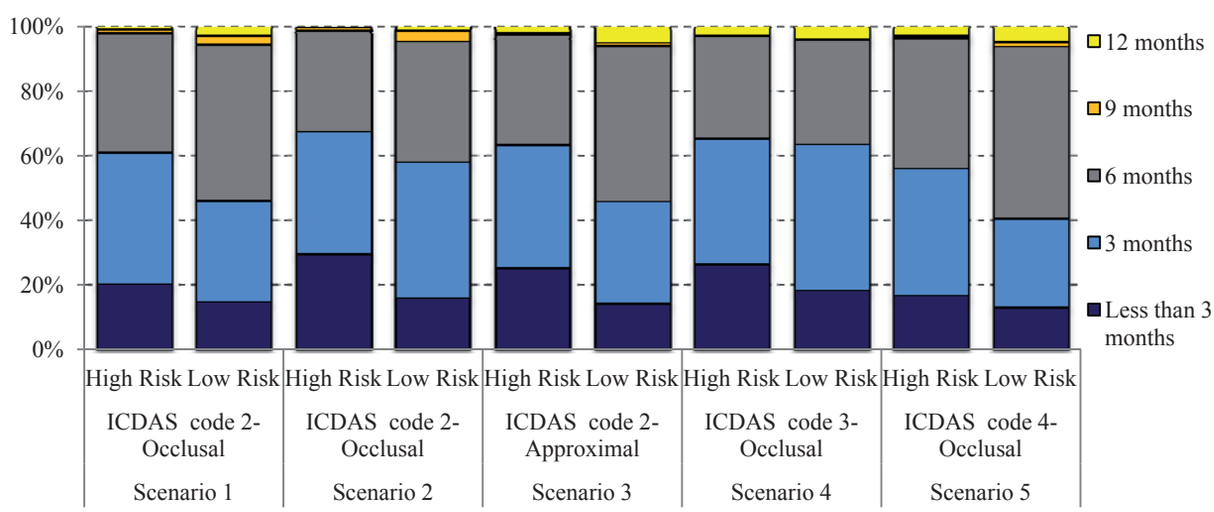


Figure 3. *Results of recall intervals by risk and ICDAS code (n=439)*

Table 1. Results for the Scenarios 1 to 5 by risk (n=439)

Treatment	*Scenario 1*				*Scenario 2*				*Scenario 3*				*Scenario 4*				*Scenario 5*			
	ICDAS code 2- Occlusal				*ICDAScode 2- Occlusal*				*ICDAS code 2- Approximal*				*ICDAS code 3- Occlusal*				*ICDAS code 4- Occlusal*			
	High Risk		*Low Risk*		*High Risk*		*Low Risk*		*High Risk*		*Low Risk*		*High Risk*		*Low Risk*		*High Risk*		*Low Risk*	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Preventive																				
Watch and wait until next control	2	0.9	4	1.9	2	0.9	9	4.2	2	0.9	5	2.3	3	1.4	6	2.7	2	0.9	1	0.4
Oral Hygiene instructions	9	3.9	9	4.3	9	4.0	5	2.4	4	1.8	4	1.9	3	1.4	4	1.8	0	0	0	0
Fluoride Varnish	38	16.7	39	18.5	31	13.7	43	20.3	26	11.7	28	13.0	17	7.9	31	13.8	1	0.5	5	2.2
Seal and follow-up	31	13.6	34	16.1	22	9.7	38	17.9	8	3.6	6	2.8	15	7.0	15	6.7	2	0.9	4	1.8
Open fissure-sealant restoration	48	21.1	63	29.9	60	26.4	45	21.2	0	0	0	0	23	10.7	41	18.3	7	3.2	11	4.9
All preventive	128	56.2	149	70.7	124	54.7	140	66.0	40	18.0	43	20.0	61	28.4	97	43.3	12	5.5	21	9.3
Operative																				
Provide resin-based composite	96	42.1	60	28.4	100	44.1	69	32.5	180	80.7	168	77.8	149	69.3	125	55.8	179	82.9	188	84.3
Provide Amalgam	4	1.8	2	0.9	3	1.3	3	1.4	3	1.3	5	2.3	5	2.3	2	0.9	25	11.6	14	6.3
All operative	100	43.9	62	29.3	103	45.4	72	33.9	183	82	173	80.1	154	71.6	127	56.7	204	94.5	202	90.6

Table 2. Association between practitioner's characteristics and choice of treatment (preventive/operative) for Scenarios 1-5 (n=439)

Variables	*Scenario 1*				*Scenario 2*				*Scenario 3*				*Scenario 4*				*Scenario 5*			
	ICDAS code 2- Occlusal				*ICDAS code 2- Occlusal*				*ICDAS code 2-Approximal*				*ICDAS code 3-Occlusal*				*ICDAS code 4-Occlusal*			
	OR	*SE*	*95%CI*	*p value*	*OR*	*SE*	*95%CI*	*p value*	*OR*	*SE*	*95%CI*	*p value*	*OR*	*SE*	*95%CI*	*p value*	*OR*	*SE*	*95%CI*	*p value*
Gender	1.10	0.22	0.71-1.69	0.67	0.90	0.21	0.6-1.37	0.63	1.29	0.26	0.78-2.15	0.32	1.21	0.22	0.79-1.86	0.38	1.22	0.39	0.57-2.6	0.61
Date of graduation	1.05	0.20	0.70-1.55	0.82	0.91	0.20	0.62-1.35	0.66	0.83	0.24	0.51-1.33	0.43	1.55	0.20	1.04-2.30	**0.03***	0.96	0.36	0.47-1.95	0.09
Caries Risk	1.89	0.20	1.27-2.81	**0.002***	1.61	0.20	1.09-2.37	**0.01***	1.13	0.24	0.70-1.83	0.60	1.92	0.20	0.43-0.96	**0.001***	1.80	0.37	0.86-3.75	0.12

Even if most dentists would choose a preventive option for the occlusal ICDAS code 2 lesions (63% and 60% for Scenarios 1 and 2), a large number of dentists would still undertake operative treatment when it could be considered inappropriate. It has been suggested that when dealing with occlusal caries clinicians should follow the 'if in doubt seal' strategy (Deery, 2013) as part as a non-invasive management approach. Over treatment by premature or provision of potentially unnecessary restoration was a major finding in this study. Such interventions eliminate the chance for remineralisation and enter the patients into a restorative cycle (Anusavice, 2001). The decision on when to intervene is crucial since any restoration requires removal of a substantial amount of sound tissue, is permanent and will likely require future replacement with further removal of tissue - a circle of treatment known as a 'death spiral of restorations' (Qvist, 2008). Therefore, to ignore non-operative treatment can be considered biologically illogical and ethically unacceptable (Kidd and Fejerskov, 2008). For many years, dentists have been oriented to a restorative approach preferring to treat rather than control caries. Trends in recent decades have been trying to discriminate between early lesions that need preventive interventions and lesions where operative care is advised. Despite a better understanding of the caries process based on a biological approach, there has been a failure to implement comprehensive caries management into the clinical practice in many countries (Pitts, 2009).

The recall interval results are complex; they seem not to be influenced by risk or by type of lesion. Routine six-monthly dental check-ups have been customary for many patients in the general dental services around the world by both patients and clinicians, however there is very little evidence to support this recall interval. Recall intervals of no longer than 12 months give the opportunity for delivering and reinforcing preventive advice and for raising awareness of the importance of good oral health (NICE, 2004). The use of longer recall intervals also enables greater capacity within dental services, especially those where access is limited or which are state-funded.

It is interesting to note that only in one clinical scenario (ICDAS code 3) did date of graduation influence the decision to treat and older dentists were more likely to restore. The results of younger dentists not following a more preventive approach for all the scenarios corroborates with a previous study using sealants in non-cavitated caries lesions (Tellez *et al.*, 2011) showing no difference between younger and older dentists, suggesting that dental curricula have not yet fully adopted an evidence-based approach, confirmed by a questionnaire conducted among Latin American dentists in 2010-2011, where Colombian dentists prefer to use ICDAS for the detection and classification of caries lesions, but tend mostly to only treat lesions in need of operative treatment, probably influenced by the reimbursement characteristics of the Colombian National Health System. More recently, the global initiative Alliance for a Caries Free Future, launched its first chapter in Colombia (2011) and a consensus on cariology curriculum for undergraduate students among Colombian dental schools has been achieved and is being adopted (Martignon *et al.*, 2013).

It is important to bear in mind the possible limitations of this study. Firstly, dentists may find it difficult to interpret what constitutes a lesion in terms of a simple visual description. Second, the low utilization of non-operative treatment in this specific population can be explained by different factors related to the health system incentives, patients demand and dentists' knowledge, among others (Domejean-Orliaguet *et al.*, 2009). Third, most of the dentists surveyed are in private or mixed practice, where the patient may pay per procedure and prevention is not well remunerated, except for sealants. Another reason that may explain the interventionist attitude of the practitioners is the belief that restorations are a rapid and safe method to return the tooth to health (Kay *et al.*, 1992).

The concept of 'caries scripts' described by Bader and Shugars (1997) is supported by the results of this study and others on treatment thresholds (Domejean-Orliaguet et al., 2009; Nuttall and Pitts, 1990; Kay and Knill-Jones, 1992). Dentists' inherent attitudes and learned concepts (caries scripts) appear to have greater influence in the treatment decisions than their biological understanding of the disease *per se* (Kay and Knill-Jones, 1992). Clinicians elaborate their scripts during their professional education and then they will modify them through their practicing careers. There are several experience-based feedbacks that can modify those scripts. Long-term outcomes of decisions of intervention and no intervention will modify subsequent intervention decisions. However, the mechanism of how feedback modifies intervention decisions is still unknown but is likely that changes in knowledge and increase in confidence may be part of this process (Bader and Shugars, 1997). There remains a wide gap between the dental schools' cariology curricula and what actually is done in practice and this is an area perhaps offering the greatest scope for improvement (Bader and Shugars, 1997). Suggestions on how to minimise variations in the diagnosis and treatment should be based on current evidence (Niederman, 1998). Questions have been also raised about how dentists can easily adopt new techniques but have difficulty with new concepts (Niederman and Leitch, 2006) and how they try to bring their own experiences and biases to particular treatment strategies (Bader and Shugars, 1997). The lack of consensus among dentists about the diagnosis and treatment for the same or similar patients (Bader and Shugars, 1995), has implications on the outcomes and costs for the patient (Shugars and Bader, 1996). Evidence-based guidelines and recommendations have been developed but difficulties on how to disseminate this knowledge may be present (Pitts, 2009). It seems that printed material has only a minor effect in changing clinicians' behaviour. Intervention techniques such as participatory workshops, audit and feedback and educational outreach have greater evidence of effectiveness (Bader and Shugars, 2008).

Clinical decision-making is a key element of clinical performance in terms of health outcomes and patient safety. Therefore, for patient safety it seems essential to think critically, analyse, reason, decide, and diagnose effectively (Croskerry, 2009). The ultimate goal will be to promote conservation of tooth structure with surgical intervention as a last resort.

The practice of evidence-based dentistry requires the combination of research knowledge and provider experience. In normal circumstances this combination would happen as a result of lifelong learning but clinicians often fail to integrate current best evidence into their treatment decisions (Bader *et al.*, 1999). The adoption of research findings into practice can take more than 20 years – a lengthy translation process that disadvantages patients. It may be explained by the fact that health care practitioners do not change if the systems of care and payment are not aligned to help them to provide the evidence-based care (Tellez *et al.*, 2011).

The results of this study support the development of an evidence-based, standardised, less invasive management system of early caries lesions for the dental curriculum, practitioners and the relevant health system. There is abundant room for further progress in determining how to standardise dentists' management concepts. Further studies will be required in other settings and populations to determine if the findings of the current study are generalisable to other countries. It would be interesting to assess if national oral care plans and strategies, such as England's *Delivering Better Oral Health*, have an impact on decision-making with regard to caries management and recall interval.

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