IN BRIEF

- There have been concerns expressed about the decline in restorative care of primary teeth.
- This study describes the care and resultant outcomes of the carious primary teeth of children who were regular patients of 50 GDPs in the North West of England.
- Although extractions were common GDPs restored over 80 % of carious deciduous molars.
- The bulk of carious teeth exfoliated naturally irrespective of whether they were restored or not.
- The design of this study was limited but the results raise many important questions which require further investigation.

# The fate of the carious primary teeth of children who regularly attend the general dental service

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**Objective** To describe the care and resultant outcomes of the carious primary teeth of children who regularly attend the General Dental Service (GDS).

**Setting** Four districts in the North West of England

**Subjects and Materials** A retrospective study of the case notes of 677 children who received their dental care from 50 general dental practitioners (GDPs). Each dentist must have had a minimum of 10 patients and a maximum of 20 patients whose care had been provided by the same dentist from or before the age of five to the age of 14. All of the children included in the study had a history of approximal caries. The outcomes of interest were extraction due to pain or sepsis, or exfoliation and whether or not a tooth had given rise to the prescription of a course of antibiotics. Teeth that did not have a history of extraction were assumed to have exfoliated naturally. Logistic regression models, taking into account the clustering of the teeth within patients, were fitted to compare the outcomes for restored and unrestored teeth according to size of lesion (one or two surface), age caries was first recorded and by tooth type.

**Results** A total of 4,056 teeth had been either recorded as carious or had received an intervention of some kind. Some 44.1% (N=1,789) of these teeth were extracted, however only 475 (11.7%) were extracted due to pain or sepsis. Of the teeth with a documented history of caries or restoration and for which an outcome was recorded (N=3,145), most first (81.1%) and second (84.3%) carious primary molars were filled during their lifetime, but only 40.5% of primary carious anterior teeth were filled. The majority of carious primary teeth exfoliated naturally. There was no difference in the proportions of teeth extracted due to pain or sepsis whether a carious tooth was restored or left unrestored, either by cavity type or by tooth type, after controlling for age when caries was first recorded. There was also no difference in the number of filled or unfilled carious teeth that caused a course of antibiotics to be prescribed.

**Conclusions** Treatment by extraction was common, but GDPs restored the majority of carious primary molar teeth of their regularly attending child patients. The bulk of carious teeth exfoliated naturally irrespective of whether they were filled or not. The reasons for these findings require further investigation.

The care index, which measures the proportion of carious teeth treated by restoration, has fallen markedly in the 5-year-old child population over the last 15 years. In 1987 24% of carious teeth in 5-year-old children in England were filled, this had dropped to 13% in 1996.[1] Many commentators put this down to the effects of capitation,[2] although examination of the trend in the care index shows that the decline started prior to the introduction of capitation.[1,3] Nevertheless, this fall in the care index was possibly one of the reasons why the Department of Health reintroduced fee-for-item payments for restoring primary teeth back into the General Dental Service (GDS). A recent publication by a working party of the British Society of Paediatric Dentistry advised general dental practitioners (GDPs) that they have a responsibility to treat children with carious primary teeth, and that failure to provide restorative care for the primary dentition was unacceptable.[4] In 2001 the British Society of Paediatric Dentistry published a policy document[5] which echoed these sentiments.

Whilst this guidance has been provided for GDPs, and the GDS fee scale has been changed to encourage restoration of primary teeth, there is some evidence that a different approach is being taken in the GDS. At the population level the reintroduction of fee-for-item seems to have had little effect on the care index, which rose slightly to 15% in 1997/8.[6] Other studies have shed light on the attitudes of GDPs to the care of children with carious primary teeth. A recent study to establish a consensus view from GDS and Community Dental Service dentists for a list of conditions which should trigger a referral from school screening did not include caries in the primary dentition as a referral criterion.[7] These results imply that the majority of primary care dentists practising in the study locality did not feel that untreated caries in the primary dentition was of sufficient concern to warrant referral. A second primary dental care study in a group of practices in the North West of England demonstrated that even for regularly attending 5-year-

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**Refereed paper**
**Received 14.06.00; Accepted 07.09.01**

old children only 29% of carious teeth were restored, compared with 3% of those of irregularly attending children.[8] These studies suggest that the views and practices of paediatric dentists are not reflected in the GDS, where the majority of dental care for children is provided.

A pilot study[9] which looked at the outcomes of filling and not filling carious primary teeth could find no difference in the proportions of teeth extracted as a result of caries or sepsis. This study could also find no evidence that children with unrestored carious teeth were being given excessive amounts of antibiotics to control pain or infection, a scenario that has been hypothesised by some commentators. This pilot study was on a small-scale and although the results were not definitive, they posed fundamental questions, necessitating a larger investigation to establish whether or not the results of the pilot study could be reproduced.

The aim of this study was to describe the approach, to and the outcomes of the care of primary teeth in the GDS. The objectives were to measure the proportion of restored and unrestored carious primary teeth that exfoliated naturally, or were extracted due to pain or sepsis, according to whether lesions affected one or two surfaces,and controlling for tooth type and the age that caries was first recorded in each tooth. The study also measured the proportions of restored and unrestored carious primary teeth by tooth type that gave rise to the prescription of a course of antibiotics, again after controlling for one or two surface lesions and the age when caries was first recorded in each tooth.

## METHOD

Fifty GDPs practising in four health authorities in the North West Region (Bury and Rochdale, Salford and Trafford, North Cheshire and South Cheshire) were recruited to the study. All dentists in each district were given the opportunity to participate in the study. However various factors limited the number of dentists involved, some chose not to participate, whilst others were excluded due to the strict criteria set for patient inclusion. A dentist could only be included in the study if he or she had a minimum of ten patients and a maximum of 20 patients who could meet the following criteria:

- Date of birth January 1, 1984 to December 31, 1985
- Care overseen by the same dentist from or before December 31, 1990
- Must have a history of approximal caries experience in primary molars
- Must be regular attenders, defined as a child who has attended at least once every 18 months.

Dentists with more than 20 patients meeting these criteria had 20 cases selected at random for inclusion.

Retrospective data were collected from each patient's case notes. This was undertaken by photocopying the case notes within the practice using a portable photocopier. Data on treatments and outcomes were transferred to a standardised data abstraction form by two trained and calibrated data abstractors. The data abstraction form recorded treatment associated with each tooth from or before December 31, 1990 to September 1999 when the data collection was undertaken, enabling the total dental history of each child to be recorded. So although the subject inclusion criteria defined a regular attender as a child who had attended at least once every 18 months, each child must have visited the same dentist on a regular basis from or before the age of five up to 14 years of age.

The first outcome of interest was whether a tooth was extracted due to pain or sepsis or exfoliated naturally. Teeth that were extracted for other reasons such as for balancing purposes, prophylactically, or because they were loose and about to exfoliate were excluded from the analyses. Teeth that did not have a history of extraction were assumed to have exfoliated naturally. Only carious teeth were included in the analyses and were separated into those which had been filled at least once, and those that had never been filled. These two sets of carious teeth, categorised according to tooth type and whether they had cavities affecting one or two surfaces, were compared according to whether they exfoliated naturally or were extracted due to pain or sepsis.

A logistic regression model was fitted with exfoliation or extraction due to pain or sepsis as the dependent variable. This model included: the size of the lesion (one surface versus two surfaces), tooth type as a categorical variable (anterior teeth [all primary incisors and canines], first and second primary molars), whether it was restored or not, and the age caries was first recorded for each tooth as independent variables in the model. The model also took the clustering of the teeth within patients into account. Stata software was used to calculate the logistic regression models using robust standard errors (Stata Corporation, Texas, USA).

The second outcome investigated was whether or not a tooth had provoked a course of antibiotics to be prescribed. This was used as a proxy measure of symptoms arising from individual teeth that had not necessarily resulted in an extraction. Again a logistic regression model was fitted, taking the clustering of the teeth within patients into account, to compare restored and unrestored molar teeth according to whether or not the tooth provoked a course of antibiotics to be prescribed. Whether the teeth were first or second molars was also included as an independent, categorical variable in the model, as was the size of the lesion (one surface versus two surfaces), and the age caries was first recorded for each tooth.

## RESULTS

The 50 dentists involved in the study had 677 patients that met the inclusion criteria, the mean number of children per dentist was 13.5 (SD 3.3). The 677 children in the study had 13,540 primary teeth in

**Table 1. Summary of the number and percentage of teeth with extracted and exfoliation outcome data and hence the teeth which were included in and excluded from the analyses**

| | Teeth present in the data set with no history of caries or restoration but for which an intervention or outcome was recorded | Teeth present in the dataset with a documented history of caries or restoration and for which an outcome was recorded | Total |
|---|---|---|---|
| Outcomes | N (row percent) | N (row percent) | N (column percent) |
| Exfoliation | 44 (1.9) | 2,223 (98.1) | 2,267 (55.9) |
| Extracted due to pain or sepsis | 50 (10.5) | 425 (89.5) | 475 (11.7) |
| Extracted for other reasons | 817 (62.2) | 497 (37.8) | 1,314 (32.4) |
| Total | 911 (22.5) | 3,145 (77.5) | 4,056 |

**Table 2. Denominators: Number and percentage of teeth with a history of caries and restorative intervention and a history of exfoliation or extraction due to sepsis by tooth type**

| | Total number of teeth that had a documented caries/restorative history | Total number of teeth which either exfoliated or were extracted due to pain or sepsis |
|---|---|---|
| | N (percent) | N (percent) |
| Anterior teeth (incisors and canines) | 285 (9.1) | 247 (9.3) |
| First molars | 1,416 (45.0) | 1,194 (45.1) |
| Second molars | 1,444 (45.9) | 1,207 (45.6) |
| Total | 3,145 (100.0) | 2,648 (100.0) |

**Table 3. Primary molar teeth only: Number and percentage of carious teeth that were extracted due to pain or sepsis or exfoliated according to whether they were restored or never restored and according to whether they had one and two surface lesions (column percentages in parentheses). Teeth extracted for other reasons were excluded from analyses (N = 2401)**

| *one surface lesions* | decayed never restored | decayed restored | Total |
|---|---|---|---|
| exfoliated | 113 (87.6) | 413 (88.2) | 526 (88.1) |
| extracted due to pain or sepsis | 16 (12.4) | 55 (11.8) | 71 (11.9) |
| Total (row percentages) | 129 (21.6) | 468 (78.4) | 597 |
| | | | |
| *two surface lesions* | decayed never restored | decayed restored | Total |
| exfoliated | 225 (78.4) | 1,235 (81.4) | 1,460 (80.9) |
| extracted due to pain or sepsis | 62 (21.6) | 282 (18.6) | 344 (19.1) |
| Total (row percentages) | 287 (15.9) | 1517 (84.1) | 1804 |

**Table 4. Number and percentage of carious teeth that were extracted due to pain or sepsis or exfoliated according to whether they were restored or never restored and according to tooth type (column percentages in parentheses). Teeth extracted for other reasons were excluded N =2648**

| anterior (incisors and canines) teeth | decayed never restored | decayed restored | Total |
|---|---|---|---|
| exfoliated | 144 (98.0) | 93 (93.0) | 237 (96.0) |
| extracted due to pain or sepsis | 3 (2.0) | 7 (7.0) | 10 (4.0) |
| Total (row percent) | 147 (59.5) | 100 (40.5) | 247 |
| | | | |
| first molars | decayed never restored | decayed restored | Total |
| exfoliated | 174 (77.0) | 778 (80.4) | 952 (79.7) |
| extracted due to pain or sepsis | 52 (23.0) | 190 (19.6) | 242 (20.3) |
| Total (row percent) | 226 (19.9) | 968 (81.1) | 1194 |
| | | | |
| second molars | decayed never restored | decayed restored | Total |
| exfoliated | 164 (86.3) | 870 (85.5) | 1,034 (85.7) |
| extracted due to pain or sepsis | 26 (13.7) | 147 (14.5) | 173 (14.3) |
| Total (row percent) | 190 (15.7) | 1017 (84.3) | 1207 |

total. Some 4,056 of these teeth were recorded as carious or had some form of intervention and were included in the data set for analysis. The outcomes for these teeth are displayed in Table 1. Out of the total, 911 (22.5%) had no record of being filled or decayed, yet an intervention or outcome of some kind was recorded. The majority of these teeth (N=817, 89.7%) were extracted for reasons other than pain or sepsis, principally it would seem for orthodontic reasons as the largest number (N=336, 41.1%) were primary canine teeth.

These 911 teeth were excluded from subsequent analyses, leaving 3,145 teeth that had a documented history of unrestored disease or of restoration. Some 497 (15.8%) of these teeth were also extracted for reasons other than pain or sepsis, for example prophylactically, or for balancing purposes during multiple extractions under general anaesthetic, or for orthodontic reasons, or because a tooth was loose and about to exfoliate. These teeth were also excluded from the analyses when extraction due to pain or sepsis/exfoliation was examined as an outcome indicator leaving a denominator of 2,648. Table 2 summarises the number of teeth by tooth type for which the caries and restoration status, and the outcomes could be ascertained. Some 151 teeth had both restored and unrestored lesions present; these teeth were coded as restored teeth, as they had had a restorative intervention. Only 120 teeth had pulp therapy of some description. These were counted as restored teeth, as a restorative intervention had been made. The majority of these 120 teeth exfoliated (N= 66, 55.1%), 35.0% (N=42) were extracted due to pain or sepsis, leaving 12 (10.0%) that were extracted for other reasons.

There was no significant difference between anterior, restored and never restored carious teeth according to the mean age when caries was first recorded (5.3 (SD 1.5) years vs 5.1 (SD 2.1) years respectively). However, in both first and second molar teeth, on average caries was recorded earlier in restored teeth than unrestored teeth (first molars 6.6 years (SD 2.0) vs 7.2 years (SD 2.4) respectively [p<0.01]; second molars 6.5 years (SD 2.2) vs 7.1 years (SD 2.5) respectively [p<0.01]).

Tables 3 summarises the outcomes (exfoliated naturally or extracted due to pain or sepsis) of restored and never restored molar teeth with either 1 and 2 surface lesions. The majority of carious molar teeth exfoliated naturally; 88.1% of those with one surface lesions and a smaller percentage (80.9%) of teeth with 2-surface lesions. The majority of molar teeth with both one (78.4%) and two (84.1%) surface lesions were filled at some time or other during their lifetime.

Table 4 examines the same relationship as Table 3 but this time by tooth type. Similar results were found; the majority of carious primary teeth exfoliated naturally; 96% of anterior teeth, 79.7% of first primary molars and 85.7% of second primary molars. The majority of first primary molars (81.1%) and second primary molars (84.3%) were filled, however, only 40.5% of primary anterior teeth were filled. The logistic regression model summarised in Table 6 demonstrated that teeth with two surface lesions were significantly more likely to be extracted due to pain or sepsis than one surface lesions with odds ratio = 1.72 (95% confidence interval 1.28, 2.31) (p<0.001). First primary molars were over 7 times more likely to be extracted due to pain or sepsis than other tooth types (odds ratio = 7.04, 95% confidence interval 3.70, 15.98 [p<0.001]). Second primary molars were also more likely to be extracted due to pain or sepsis than other tooth types (odds ratio=5.18, 95% confidence interval 2.26, 11.88 [p<0.001]). The later caries was first recorded in a tooth the less likely it was to be extracted (odds ratio=0.89, 95% confidence interval 0.84, 0.94 [p<0.001]). There was no difference in the exfoliation/extraction outcomes of carious restored teeth or unrestored teeth, irrespective of tooth type, whether they had one surface or two surface lesions, or the age when caries was first recorded (odds ratio=0.93, 95% confidence interval 0.78, 1.10 [p=0.41]).

Table 5 summarises the results for the number of courses of antibiotics prescribed in response to symptoms generated in first and second molar teeth, for teeth that had been restored or never restored. The results of the logistic regression analysis looking at whether or not a tooth was associated with antibiotic prescription as the dependent variable are also summarised in Table 6. Significantly more first molars (10.7%) caused symptoms prompting a course of antibiotics to be prescribed compared with second

**Table 5. Deciduous molar teeth only: Number and percentage of carious teeth that were or were not associated with the prescription of antibiotics according to whether they were restored or never restored (column percentages in parentheses) (all teeth included N = 2860)**

| first molars | decayed never restored | decayed restored | Total |
|---|---|---|---|
| had antibiotics | 24 (8.4) | 128 (11.3) | 152 (10.7) |
| never had antibiotics | 262 (91.6) | 1,002 (88.7) | 1,264 (89.3) |
| Total (row percent) | 286 (20.2) | 1,130 (79.8) | 1,416 |
| | | | |
| second molars | decayed never restored | decayed restored | Total |
| had antibiotics | 16 (6.5) | 96 (8.0) | 112 (7.8) |
| never had antibiotics | 229 (93.5) | 1,103 (92.0) | 1,332 (92.2) |
| Total (row percent) | 245 (17.0) | 1,124 (82.1) | 1,444 |

**Table 6. Results from two logistic regression analyses for the dependent variables extracted due to pain or sepsis or exfoliated naturally and whether or not a tooth was associated with a course of antibiotics, and the independent variables, restored or unrestored carious teeth, one or two surface lesions, tooth type and the age when caries was first recorded. The models also take into account clustering of teeth within patients.**

| Dependent variable: extracted due to pain or sepsis or exfoliated naturally (all teeth included) | | | |
|---|---|---|---|
| Independent variables | odds ratio | 95% confidence interval | p |
| Restored versus unrestored | 0.93 | 0.78, 1.10 | 0.41 |
| Two surface versus one surface lesions | 1.72 | 1.28, 2.31 | <0.001 |
| First molar versus other types of teeth | 7.04 | 3.70, 15.98 | <0.001 |
| Second molars versus other types of teeth | 5.18 | 2.26, 11.88 | <0.001 |
| Age caries first recorded | 0.89 | 0.84, 0.94 | <0.001 |

| Dependent variable: teeth that either were or were not associated with the prescription of antibiotics (molar teeth only included in the analysis) | | | |
|---|---|---|---|
| Independent variables | odds ratio interval | 95% confidence | p |
| Restored versus unrestored | 1.11 | 0.93, 1.33 | 0.26 |
| Two surface versus one surface | 1.21 | 1.002, 1.45 | <0.05 |
| First molar versus second molars | 1.29 | 1.01, 1.66 | <0.05 |
| Age caries first recorded | 0.92 | 0.86, 0.99 | <0.05 |

molars (7.8%) (odds ratio=1.29, 95% confidence interval 1.01, 1.66 [p<0.05]). The later caries was first recorded in a tooth the less likely it was to precipitate the prescription of a course of antibiotics (odds ratio=0.92, 95% confidence interval 0.86, 0.99 [p<0.05]). Two surface cavities were more likely to prompt a course of antibiotics than one surface lesions (odds ratio=1.21, 95% confidence interval 1.002, 1.45 [p<.05]). There was no difference in the proportions of filled and unfilled teeth which prompted a course of antibiotics to be prescribed, when tooth type, and age when caries was first recorded were included in the logistic regression model prescribed (odds ratio=1.11, 95% confidence interval 0.93, 1.33 [p=0.26]).

## DISCUSSION

This study used actual data from GDS case notes; this methodology has certain advantages and disadvantages. It avoids the pitfalls of self-reported or dentist-reported data[10] and the problems of non-response bias encountered with study designs using questionnaires. However, case notes are an *aide-mémoire* for clinicians treating their patients; they are not purpose-specific data collection forms. Therefore retrospective case notes studies are limited by the information contained within them. This issue was highlighted by the 911 teeth that had been extracted or had prompted the prescription of antibiotics but for which no information was available concerning their caries/restoration status. Out of these teeth only 50 were extracted due to pain or sepsis and had no record of caries or restoration, but 5 of these had a history of trauma, which had precipitated the extraction. This left 45 teeth which had been extracted but had no history of caries or restoration. To put this in context, if these teeth were added to the 3,145 teeth which had a documented history of untreated caries or restoration, this would make up 1.4% of the teeth under study. Alternatively, if all of the posterior teeth (assuming the majority of incisors and canines were extracted for orthodontic purposes or because they were loose) in the 911 teeth that could not be accounted for (N=365) were added to the 2,905 posterior teeth included in the study they would make up 11.2% of the teeth under study. These percentages compare favourably with data from many cross-sectional questionnaire studies in which response rates of 70% are considered adequate.

The 1991 NHS dental survey of 5-year-old children, undertaken when the cohort of children examined in this study were approximately the same age, showed that 13% of the decayed teeth were filled in the North Western Region and 15% in Mersey Region.[1] A different picture emerges from this group of regular dental attenders. Table 4 shows that over three-quarters of carious primary molars and 40.5% of anterior teeth of regular attenders are filled at some stage during their lifetime, more than Tickle *et al.*[8] found in a study of 5-year-old children regularly attending GDS practices in the North West. There are several explanations for the discrepancy between these results and the picture painted by the NHS survey data. First the care index is a whole population statistic and includes the teeth of irregular and non-attenders, whereas this study measured the situation solely in regularly attending children. The care index is also measured in 5-year-old children, and this study examined the restorative care provided throughout the lifetime of the primary dentition. It could be that GDPs are delaying the restoration of primary teeth until children become more mature and are better able to tolerate restorative treatment. It must also be remembered that a large proportion of the teeth in the data set were treated by extraction, 44.1% (N=1789) of all teeth were extracted, but only 475 (11.7%) of teeth were extracted due to pain or sepsis. This may reflect the impact of multiple extractions of primary teeth under general anaesthetic that until recently had a major influence on the care of primary teeth in the GDS. There has been a large reduction in dental general anaesthetics following changes to GDC guidance,[11] and further reductions may be expected following the publication of *A Conscious Decision*.[12] These changes have increased the urgency for the need to develop an evidence-base for the care of children with carious primary teeth within the GDS.

The results of this study also have implications for the way that we assess children's oral health needs at the population level. This has been traditionally gauged through epidemiological surveys using normative measures of disease such as the dmft index and caries prevalence. During the last 20 years or so there has been a move towards measuring the effects of disease on the every day life of the individual rather than the disease itself.[13,14,15] The results of this study would suggest that a large proportion of carious primary teeth, restored or not, exfoliate naturally indicating that measures of disease alone will not give a true impression of the impact of the disease on the child population. Therefore assessment of the oral health needs of populations should encompass measurement of the effects of dental disease on the individual, for example the incidence/prevalence of pain, as well as continuing to measure caries experience and prevalence.

One of the most interesting findings of this study is that no difference could be found in the proportions of unrestored and restored carious primary teeth that were extracted due to pain or sepsis or that precipitated a prescription of antibiotics. As expected, the earlier caries was recorded in a tooth the more likely it was to be extracted due to pain or sepsis or to prompt a course of antibiotics to be prescribed. Although this was the case, the findings were consistent, irrespective of tooth type, age when caries was first recorded and whether or not the lesion covered one or two surfaces these was no difference in the outcomes of restored and unrestored teeth. The results also agree with the findings of the pilot study.[9]

These findings require careful interpretation and at present the reasons for the results obtained can only be speculated upon. It could be that there really is no advantage to restoring primary teeth if avoidance of pain or sepsis is the desired outcome. If this is truly the case it will have fundamental implications for the dental care of young children, but as this was an observational study this conclusion can only be tentative. Concern has been expressed about the quality of restorative care provided to primary teeth in the GDS[2,4] and not one preformed

crown was used to restore any of the teeth in this study, so perhaps this result can be explained by the hypothesis that the restorations placed by GDPs were no better than leaving a tooth unrestored. Another plausible explanation for these findings is that these experienced GDPs were using their clinical acumen to make the correct decisions on which teeth to restore and which teeth to leave unrestored to ensure that as many as possible were able to exfoliate naturally. This final hypothesis is a key concept and points to the inherent problems of researching this issue using observational study designs, as the clinical decision to fill or not to fill means that the two groups of teeth compared in this study may be fundamentally different. Scientifically, a much more elegant design would be to randomly allocate teeth to be restored or left unrestored. However, without the publication of observational studies such as this one that describe practice in primary dental care and highlight the anomalies found, it is unlikely that randomised control trials to examine this issue would be funded or given ethical approval.

The results of this study raise many issues the interpretation of which must be treated with caution. The reasons why treatments are or are not prescribed by GDPs are extremely complex[9] and multiple, interacting factors at the tooth, patient and dentist level will have an influence on the care provided and the outcomes measured in this study. What does seem likely is that GDPs are providing care to children with carious primary teeth according to a different philosophy than that advocated by specialist paediatric dentists. It could be that GDPs recognise that primary teeth are transient and that for many children restorative interventions are unpleasant, resulting in a practising philosophy of providing care which is sufficient to enable teeth to exfoliate naturally.

What is clear is that further investigations, including randomised controlled trials are necessary to obtain a firm evidence base on which to build a policy for the dental care of children with caries in the primary dentition.

*The authors would like to thank all of the general dental practitioners who took part in the study. The study was funded by the National Primary Dental Care Research and Development programme. The views and opinions expressed in this paper do not necessarily reflect those of the funding authority.*

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