IN BRIEF

- The paper presents a retrospective analysis of the outcome of the non-restoration of carious deciduous teeth.
- Multi-surface cavities presenting early in lower molar teeth were most likely to produce pain or infection.
- A pain-predictive model is generated from the data analysis.
- The model may provide a basis for further development.

Pain prediction for preventive non-operative management of dentinal caries in primary teeth in general dental practice

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Objective To provide a pain-predictive model for the non-operative management of carious deciduous teeth from the analysis of data from a retrospective analysis of clinical case notes of children regularly attending two general dental practices and receiving preventive care.

Design A clearly defined protocol was used to determine the fate of deciduous teeth diagnosed as carious into dentine but symptomless and left unrestored from the sequential examination of the clinical records of 480 children attending at least annually.

Results The age of the children at the first visit when carious teeth were diagnosed ranged from 0.8 to 12.3 years, with the majority of children (243/480) presenting by 6 years of age. In all, 250 teeth from 162 children were extracted because of pain or became painful and were treated. The remaining 318 children did not report pain on subsequent visits. The strongest predictor of pain was age on diagnosis, the other factors being tooth type and extent of the cavity when first seen. Data from the present study provides a model that enables a child with deciduous caries to be placed into one of six pain–predictive groups associated with a risk of pain or infection if the teeth are not restored but provided with preventive care only.

Conclusion In these patients, the majority of unrestored carious deciduous teeth remain symptomless until shed. A higher risk of subsequent pain or infection was associated with the development of caries in younger patients, disease extending beyond single surfaces, and disease in lower deciduous molars. The results provide evidence to aid the treatment planning of carious deciduous teeth in children receiving regular preventive dental care.

Treatment planning for the management of caries in the deciduous dentition can be one of the most difficult areas in clinical dentistry. In addition to the practical aspect of the physical treatment of the teeth, consideration of the maturity and emotional state of the child and the effect of previous dental treatment, together with medical and socio-economic factors and the dental history of siblings and parents are all relevant to treatment planning. While the view that all cavities must be restored by conventional means and carious lesions totally eradicated from all little mouths has lost support amongst many members of the profession, concern has been rightly expressed that the high level of untreated caries in some sectors of the UK child population may indicate a failure in primary dental care provision. Only 14% of decayed deciduous teeth in England and Wales and 10% in Scotland have been treated conservatively in five-year-olds.[1] This is the traditional approach to the management of carious deciduous teeth and is still strongly supported by one school of thought.[2] However, recent debate has emphasised the view that treatment for children must be appropriate to their feelings and fears with the aim of building a healthier dental future through confidence in dental care, while at the same time managing the carious process both effectively and appropriately.[3]

The principal reason put forward for the elimination of carious lesions from the deciduous dentition is to overcome the risk of the development of pain or infection.[4] Surprisingly, this concept exists despite an almost complete lack of evidence on the incidence of pain when carious teeth are left unrestored. Clearly such evidence is fraught with project design and ethical difficulties, however the results from two independent studies, both conducted in northern England have been reported recently in the pages of this journal.

A Manchester based research team conducted a retrospective study of the dental case notes of 677 children under the care of 50 general dental practitioners.[5] One of the most striking findings was that there was no difference in the proportions of teeth extracted due to pain or infection, whether the teeth were restored or left unrestored. The present authors have recently reported a retrospective study of the case notes of 481 children under the care of one dentist.[6] Of the 1,587 carious deciduous teeth followed from diagnosis to loss from the mouth, 84% remained symptomless until being exfoliated. The present paper provides additional data from this study with the aim of providing a basis for pain prediction for the management of caries in deciduous teeth, based on data available when the child is first diagnosed with dentinal decay and seeking to predict whether the child will eventually return in pain.

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METHOD

The setting for this retrospective longitudinal study was two general dental practices in West Yorkshire, England, one in Leeds and the other in Halifax, both being non-fluoridated areas. Both practices are located in health authority health centres together with other primary care services. The Leeds practice serves a multi-ethnic, inner city community with high levels of social deprivation and oral disease. The Halifax practice serves a largely white caucasian community with a rather more mixed socio-economic profile. The established policy for the management of symptomless carious deciduous teeth was the same in both practices and had remained unchanged since the practices were established in 1976 and 1982 respectively. Symptomless carious deciduous teeth were not restored unless there were medical or specific practical reasons or if the parent/career requested restoration. Examples included children with cardiac or bleeding disorders where early intervention was indicated or children in temporary foster homes or who were leaving for countries where continuity of dental care could not be assured. Records for such children were not included, but would have amounted to less than 20% of the number of cases used for the project. No data relating to medical history, socio-economic or emotional status was recorded. All cavities were recorded using standard notation on dental charts indicating the surfaces involved and any changes in extent or symptoms were noted. The system of recording and notation was standardized between the two practices and remained unchanged. Management for all children consisted of the provision of simple dietary and tooth brushing advice following the guidelines of the Health Education Authority.[7] The key recommendations were reinforced at every visit for children with carious teeth.

The detailed clinical records of children from these practices provide the source of the longitudinal data used in this study. Two experienced dental nurses using a defined protocol extracted data from the case records. They examined the clinical records cards held at the practices in alphabetical order. In order to help ensure consistency of record keeping, only the records of patients under the care on one dentist (RSL) were examined. Full details of the nature of the data source and means of collection have been described.[6] Record cards for children who were first seen by 12 years of age and subsequently attended at least annually for routine examination were selected and the clinical notes were sequentially reviewed to identify deciduous teeth recorded as carious but not initially restored. The initial diagnosis was recorded and classified as:

- Code 1 – One surface cavity
- Code 2 – Two surface cavity
- Code 3 – carious pulpal exposure

The initial diagnosis date was recorded and the history of each untreated carious tooth was then followed through the clinical notes to determine the outcome, which was placed in one of four outcome categories. These were:

- Outcome 1 – extracted because of pain
- Outcome 2 – treated because of pain, including temporary or permanent restorations or the prescription of antibiotics
- Outcome 3 – remained symptomless but extracted together with other painful teeth under general anaesthesia
- Outcome 4 – remaining symptomless until exfoliation

Finally, the outcome date was recorded. For the purposes of the study the category of 'pain' included the recording in the clinical notes of a complaint of pain or the presence of symptomless chronic infection and such teeth were not identified separately during data collection. However, pain not resulting from caries, such as mucosal lesions, pericoronitis or discomfort from exfoliating teeth, were excluded. Teeth were also excluded if there was any doubt about the source of the pain, outcome, if restorative treatment appeared to have been provided for symptomless teeth, or if there was a break in the continuity of the record of more than one year. Since the data analysis is tooth–based and not patient-based, a child presenting with symptoms on more than one occasion would have that event related to the tooth. The data set also included date of birth for each subject and the notation of each carious tooth.

Data was available for 480 children from the 481 used in the original analysis. The age at first appointment was missing in one case. The data was submitted to *SPSS®* software.

RESULTS

The case notes of 480 children were identified as suitable and 1,584 carious deciduous teeth were identified and were followed through the records until loss from the mouth. The mean age when caries was first diagnosed was 6.19 years (range 0.8 – 12.3). When first presented, these children had 1,225 decayed teeth, 197 of which eventually were reported with pain. They subsequently presented 359 further decayed teeth, 53 of which eventually were reported with pain. Full details of these data, together with an analysis and discussion have been previously reported.

Further calculation using Chaid analysis at $P = 0.05$ for χ^2 and an equivalent level of impurities for Classification and Regression Trees resulted in the division of the data into six distinct pain-predictive groups. Chaid analysis compares predictors with chi-square and selects the highest chi-square value per degree of freedom. This predictor is used to split the sample and the process is repeated on each separate arm until no significant predictors remain. Significance levels are corrected for multiple comparisons. The informative variables were drawn from data collected at the time when the first carious tooth or teeth were recorded and included:

- Age at diagnosis of caries
- Number of decayed upper molars
- Number of decayed lower molars
- Number of decayed incisors and canines
- Extent of decay in the most decayed tooth (codes 1-3)

The outcome that the model was attempting to predict was whether the patient reported experiencing pain resulting in either treatment or extraction, regardless of whether the tooth treated or extracted was recorded as decayed at this first diagnostic visit. As in any long-term follow-up of deciduous teeth, the eventual outcome without intervention was exfoliation, and age determined the time available for decay to progress and cause symptoms, so the age at which each subject first presented with decay is the overarching factor in predicting the outcome for an individual. Beyond the age of two, both the severity of decay and its distribution can inform decision making about future risk. The six pain-predictive groups can be described using a flow diagram (Fig. 1) beginning with the age of the child when caries was diagnosed. Group 1 represents the lowest risk for the development of pain or infection and Group 6 the highest risk. This flow diagram provides a simple graphical illustration of the relative risk of the development of symptoms from carious teeth based on age of presentation, tooth type and cavity extent. All branches in the dichotomous key appear to be logical, ie increased disease severity and disease in younger subjects increases risk.

Table 1 indicates the percentage of children within each pain-predictive group reporting pain in any tooth or remaining symptomless until exfoliation. Children in Group 1 never reported pain from any tooth while in Group 6, 67% reported pain, 21% with one year of presentation. Overall, two-thirds of the 480 chil-

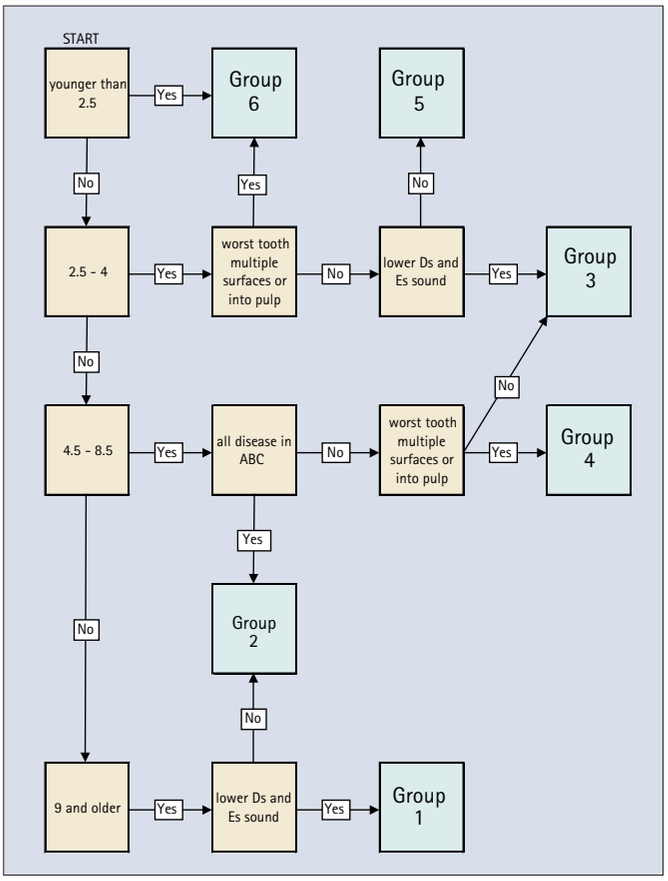

Fig. 1 Flowchart defining allocation to pain predictive groups

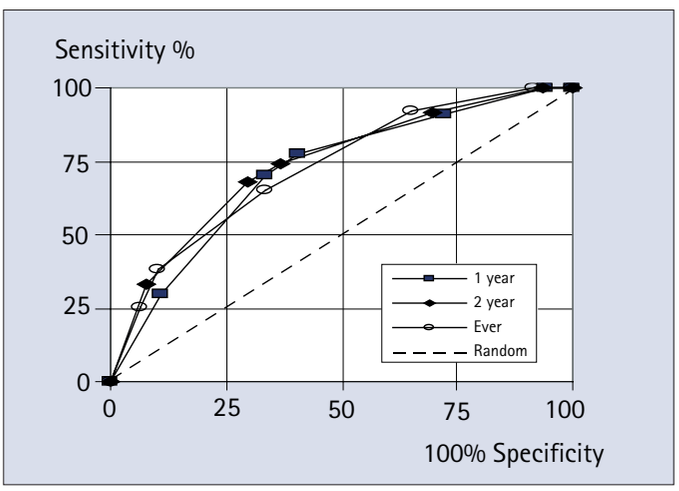

Fig. 2 Receiver–Operator–Characteristic curve

dren with unrestored carious deciduous teeth never reported pain from any carious tooth. Of those who did, less than 10% did so within the year following presentation. An indication of the ranked relative risk of pain for the groups is given in Table 2 where Group 3, the numerically largest group, has been taken as the reference point. It should be made clear that the children recorded with pain were those who returned to the practice with a complaint of pain.

Receiver – Operator – Characteristics (ROC) analysis[8] demonstrates that the flow chart (Fig. 1) has diagnostic value when predicting pain within 1 year, within 2 years or before the loss of all deciduous teeth by extraction or exfoliation (Fig. 2).

Table 3 gives the mean number of carious teeth present at the initial diagnostic visit and the number of teeth found to be carious at subsequent visits for each Pain Predictive Group. In

Table 1 Percentage of each group reporting pain within specified times

Group	Pain reported within				Sample size
	1 year or less	1-2 years	More than 2 years	Never	
1	0	0	0	100	26
2	4.1	4.1	5.1	86.7	98
3	4.2	7.6	18.1	70.1	144
4	15.4	12.8	9.4	62.4	117
5	8.8	8.8	44.1	38.2	34
6	21.3	31.1	14.8	32.8	61
All	9.2	10.8	13.8	66.3	480

Table 2 Relative risk of reporting pain in six pain-predictive groups

Group	Sample size	% with pain	Relative risk	Confidence interval
1	26	0	0	
2	98	13.3	0.44	0.25–0.78
3 – reference	144	29.9	1	
4	117	37.6	1.26	0.89–1.77
5	34	61.8	2.07	1.44–2.98
6	61	67.2	2.25	1.66–3.06

Groups 5 and 6 more than four carious teeth became carious, while for Group 1 the mean total number was 1.4 teeth. Data for the provision of treatment for pain is given in Tables 4 and 5. The mean number of treatment sessions (occasions when treatment was provided under outcome 1 or 2) was 0.4 per child and ranged from 0 for Group 1 to 0.89 for Group 6 (Table 4). The mean number of treated teeth per child was 0.52 and ranged from 0 for Group 1 to 1.23 for Group 6 (Table 5). Fig. 3 represents the percentage of children within each group receiving treatment on one or more occasions.

DISCUSSION

Any retrospective study based on the analysis of case notes is dependent on the accuracy and long-term consistency of clinical recording. One strength of the present study is that the data source is the case notes of one dentist who used a standardized system of recording and the data was extracted by two dental nurses who assisted the dentist and recorded the clinical notes on a weekly basis for over 15 years. Carious cavities extending into dentine D(3) were always recorded together with the stan-

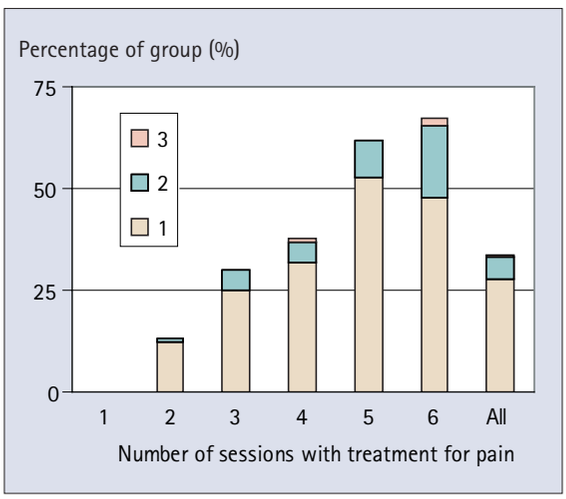

Fig. 3 Percentage of subjects in each group receiving treatment for pain in 1, 2 or 3 sessions

Table 3 Disease levels in six pain-predictive groups

Group	Teeth decayed at diagnostic visit				Teeth developing decay later	Total dt	Subjects
	Upper molars	Lower molars	Incisors and canines	Total			
1	1.2	0	0.1	1.2	0.2	1.4	26
2	0.6	1.0	1.0	2.6	0.3	2.9	98
3	0.8	0.8	0.6	2.2	0.9	3.2	144
4	1.3	1.3	0.3	2.9	0.5	3.4	117
5	0.8	1.8	0.4	3	1.4	4.4	34
6	0.8	0.9	1.1	2.9	1.3	4.1	61

Table 4 Teeth receiving treatment for pain in six pain-predictive groups

Group	Average number of teeth treated/extracted for pain				
	Total	Diagnosed at first visit	Diagnosed subsequently	Extracted	Treated
1	0	0	0	0	0
2	0.18	0.15	0.03	0.13	0.05
3	0.40	0.28	0.13	0.31	0.09
4	0.56	0.48	0.08	0.38	0.17
5	1.00	0.82	0.18	0.68	0.32
6	1.23	0.95	0.28	1.05	0.18
All	0.52	0.41	0.11	0.40	0.13

dard notation for the surfaces involved. Lesions considered to be confined to enamel were not recorded. Carious but symptomless deciduous teeth were always left unrestored unless there were medical or social reasons for doing so or if the parent/carer requested restoration. Episodes of pain or infection were always recorded together with the treatment provided. For the purposes of this study the definition of pain as an outcome also included the presence of symptomless chronic infection, usually indicated by the presence of a chronic sinus adjacent to the carious tooth and such cases were not recorded separately. While the presence of chronic infection may go unnoticed by both child and parent, this is not usually the case and advice is often sought and some form of treatment indicated. Depending on circumstances these teeth together with those producing actual pain were placed into outcome categories 1 or 2. This was done because pathological changes had spread from the tooth into the periodontal and alveolar tissue. Nevertheless, it is accepted that the impact on the child and parent from symptomless chronic infection and the indicated treatment are different from that of actual pain.

The recently reported study from the Manchester-based research group, while using the case notes of 50 dentists, has produced very similar results for the outcome of the non-restoration of carious teeth. However an illuminating result from this study, which also compared the outcome of restored and non-restored carious teeth, was that restoration had no influence on the subsequent development of pain or infection. Total decay experience was found to be the significant predictor of pain.[9] A compounding factor in this study was the lack of a control over the allocation of carious teeth to restoration or non-restoration groups. This decision was presumably determined by the clinical judgement of the 50 dentists who submitted clinical cases for analysis. The explanations offered for this finding are inadequate restoration technique and factors related to case selection by the dentists. The authors of this study conclude that a more effective means of management of caries in deciduous teeth is a preventive approach.

If non-restoration is accepted as a management option, then a system for pain prediction becomes an important tool. The

Table 5 Sessions of treatment for pain in six pain-predictive groups

Group	Average number of sessions in which treatment was provided for pain			
	Total	For teeth diagnosed at first visit	For teeth diagnosed subsequently	Mixed sessions
1	0	0	0	0
2	0.14	0.12	0.02	0
3	0.35	0.24	0.10	0
4	0.44	0.38	0.05	0.02
5	0.71	0.53	0.09	0.09
6	0.89	0.67	0.16	0.05
All	0.40	0.31	0.08	0.02

Manchester-based study suggests that total caries experience is the principal predictor of pain. In the present study, the total number of teeth with dentinal caries at the initial diagnostic visit was a potential predictor in the Chaid analyses, but did not significantly improve the predictions. When examined in detail, it is clear that consideration of tooth number alone would conceal another important variable – the type of tooth in which decay occurs. The number of teeth with decay at the diagnostic visit (Table 2) is not well correlated with outcome (Linear 2 $P = 0.17$). The number of decayed teeth throughout the course of the study is correlated with outcome ($P < 0.002$) but this may be viewed as a measure of both effectiveness of the provision of simple preventive advice in retarding the carious process and the time remaining until all deciduous teeth have exfoliated.

Data from the present study provides a model that enables a child with deciduous caries to be placed into one of six pain-predictive groups associated with a risk of pain or infection if the teeth are not restored but provided with preventive care only. It is stressed that this model was developed from clinical records at two dental practices only and with a specific clinical management policy. In addition, this model takes no account of many important facets of patient care such as medical, social and emotional factors. The use of a pain predictive model using a simple

flow diagram may have some value not only for treatment planning for individual children, but also for undergraduate teaching purposes and the planning of public dental services. However, before such a model can be employed, further development and validation from prospective random controlled trials are needed. The failure of restoration to provide any benefit in terms of pain prevention as suggested by the Manchester-based study, indicates that further research in this area must also be a priority.

CONCLUSIONS

The results from this study are consistent with the other recent study in showing that the majority of unrestored carious deciduous teeth exfoliate without causing pain or infection.

The analysis of the results provides information to enable informed decisions about the appropriateness of immediate operative intervention for decay in deciduous teeth. In this study higher risk of subsequent pain or infection is associated with the development of caries in younger patients, disease extending beyond single surfaces, and disease in lower deciduous molars.

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