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Vital pulpotomy in the primary dentition: attitudes and practices of community dental staff in Wales

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Objective. The International Agency for Research on Cancer (IARC) has classified formaldehyde as carcinogenic to humans, leaving the dental profession to look for viable substitutes to formocresol in the vital pulpotomy technique. This study was designed to examine the attitudes and practices of Community Dental Service (CDS) staff in Wales in relation to vital pulpotomy for primary molars 18 months following the IARC's press release.

Methods. The study employed a postal questionnaire.

Results. Questionnaires were returned by 79 (78.2%) of the CDS staff surveyed, yielding a sample of 65 dentists practising the technique. The most commonly used pulpotomy agents were formocresol, paraformaldehyde and ferric sulphate. Twenty-seven (41.5%) dentists expressed concern regarding their preferred pulpotomy agent and 17 (26.2%) were considering changing their technique. Only one respondent (1.5% of the sample) routinely took preoperative radiographs; follow-up radiographs were routinely taken by only three dentists (4.6%). Only 44 respondents (67.7%) always used local anaesthesia for this form of treatment. Amalgam was the most commonly used restorative material. Twenty-two respondents (33.8%) stated that they would pulp treat a primary molar on more than one occasion.

Conclusions. The results of this study suggest that there is need for relevant continuing professional development courses for CDS staff in Wales.

Introduction

In a study published in 2003, Hunter and Hunter[1] reported that more than half (54.2%) of UK specialists in paediatric dentistry practising the vital pulpotomy technique for primary molars expressed concern regarding the potentially adverse effects of formocresol and formaldehyde. At this time, 75 respondents (41.9% of the sample) were considering changing their technique. Since the publication of the above paper, an International Agency for Research on Cancer (IARC) expert working group has evaluated the available evidence on the carcinogenicity of formaldehyde, an ingredient of Buckley's formocresol[2]. Based on their findings, the group concluded that there is now sufficient evidence to link formaldehyde with nasopharyngeal cancer in humans; in addition, they considered that there is limited evidence to link formaldehyde with cancer of the nasal cavity and paranasal sinuses, and 'strong but not sufficient' evidence to link this substance with leukaemia. In light of these conclusions, dentists, particularly those predominantly treating children, have been left to look for viable alternatives to agents containing formaldehyde.

This study, carried out 18 months following the IARC report, sought to examine the current attitudes and practices of Community Dental Service (CDS) staff in Wales in relation to vital pulpotomy for primary molars.

Subjects and methods

The names and addresses of 116 dentists working within the CDS in Wales were obtained from the relevant clinical directors. Specialists in paediatric dentistry, specialists in orthodontics, and those dental officers working solely with adults or providing only exodontia under general anaesthesia were subsequently identified and excluded, leaving a potential sample of 101 dentists. A postal questionnaire previously employed in a study conducted among UK specialists in paediatric dentistry[1] was modified

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for the purposes of this study: specifically, additional questions relating to the use of local anaesthesia, the choice of restorative materials and the management of failures were included. The modified questionnaire was piloted among the staff of a CDS outside Wales, when it was considered that it was unnecessary to make any modifications to the instrument.

The questionnaire included both 'open' and 'closed' questions. Closed questions were used to examine the following topics shown in Box 1.

Box 1. Closed questions used.

- use of the vital pulpotomy technique for primary molars;
- use of preoperative and follow-up assessment radiographs;
- use of local anaesthesia;
- choice of pulpotomy agent;
- choice of restorative material for definitive restoration of molars treated by vital pulpotomy; and
- management of failures.

Subsidiary 'open' questions were used to examine:

- respondents' concerns regarding possible undesirable side-effects related to pulpotomy agents; and
- respondents' reasons for having changed pulpotomy agent.

Each eligible dentist was sent a copy of the questionnaire and a stamped addressed envelope for its return. An explanatory letter was also included. In order to allow the identification of non-respondents, each questionnaire was coded, a code-break being kept by a third party not directly involved in the study. Non-respondents were sent a second postal questionnaire.

Results

A total of 79 dentists returned wholly or partially completed questionnaires, a response rate of 78.2%. Of these, 65 (82.3%) reported that they used the vital pulpotomy technique in the treatment of primary molars. The 14 respondents who stated that they did not carry out this technique were, in the main, treating specific client groups (e.g. adults and patients with 'special needs') or providing services (e.g. general anaesthesia) in which the technique was inapplicable. One respondent, however, commented that she/he lacked confidence in her/his ability to perform the technique adequately, with a resultant low success rate. One respondent who also experienced a high failure rate commented that 'they are only temporary teeth so it is much better to extract'.

Only one respondent (1.5%) stated that they routinely assessed the tooth radiographically (with an intraoral periapical radiograph) prior to carrying out a vital pulpotomy. Thirty-eight respondents (58.5%) stated that they sometimes carried out this form of preoperative radiographic assessment; the remainder ($n = 26$, 40.0%) were in the habit of proceeding without the benefit of a preoperative radiograph. Only three respondents (4.6%) routinely took a follow-up intraoral periapical radiograph; 37 respondents (56.9%) stated that they never carried out this form of postoperative evaluation, while 25 (38.5%) sometimes did so.

Of the 65 respondents practising the technique, 20 (30.8%) stated that they sometimes used local anaesthesia, while one dentist never provided the child with pain relief.

Table 1 illustrates the respondents' preferred pulpotomy agents. It should be noted that answers were not mutually exclusive; some dentists reported the use of more than one agent, but did not explain the reasons underlying this.

Thirty-three respondents (50.8%) reported that they were no longer using the agent that they had been taught to use as undergraduates. Table 2 illustrates how and why their practices had changed. It should be noted that one respondent (1.5%) could not remember which agent she/he had been taught to use, while two respondents (3.1%) had not been taught the vital pulpoptomy technique as undergraduates.

Table 1. Agents employed in the vital pulpotomy technique (total number of respondents = 65).

Agent	Number (%) of respondents
Formocresol:	
full-strength	13 (20.0%)
1:5 dilution	8 (12.3%)
Calcium hydroxide	3 (4.6%)
Paraformaldehyde	21 (32.3%)
Ferric sulphate	19 (29.2%)
Ledermix	2 (3.1%)
Cresophene	2 (3.1%)

Table 2. Changes in practice with respect to techniques taught in undergraduate education (total number of respondents = 33).

Agent taught as undergraduate	Agent currently used	Number (%) of respondents	Reasons for change*
Full-strength formocresol	Ferric sulphate	8 (24.2%)	'evidence of carcinogenicity of fomocresol and both efficacies are similar', 'clinical availability', 'Trust policy/CDS recommendation'
Full-strength formocresol	Paraformaldehyde	6 (18.2%)	'better results with paraformaldehyde', 'easier management of paraformaldehyde', 'availability', 'toxicity of formocresol'
Full-strength formocresol	1:5 dilution of formocresol	1 (3.0%)	'efficacy is not significantly reduced by dilution'
Full-strength formocresol	Ledermix	1 (3.0%)	'toxicity of formocresol'
Full-strength formocresol	Cresophene	1 (3.0%)	'advice'
Paraformaldehyde	Ferric sulphate	9 (27.3%)	'unavailability of paraformaldehyde', 'post-op pain associated with paraformaldehyde', 'literature/CDS recommendations', 'carcinogenic possibility of paraformaldehyde'
Paraformaldehyde	Full-strength formocresol	2 (6.1%)	'paraformaldehyde causes post-op pain'
Paraformaldehyde	1:5 dilution of formocresol	1 (3.0%)	'paraformaldehyde causes post-op pain and expires quickly'
1:5 dilution of formocresol	Ferric sulphate	1 (3.0%)	'research'

*CDS: Community Dental Service.

Table 3. Concerns raised by respondents in relation to specific pulpotomy agents.

Agent	Number of respondents	Reason for concern
Ferric sulphate	7	carcinogenicity (n = 2) mutagenicity (n = 1) long-term success rate (n = 1) technique sensitivity (n = 1) nonsedative (n = 1) efficacy (n = 1)
Paraformaldehyde	8	carcinogenicity (n = 5) mutagenicity (n = 1) efficacy ('it doesn't work') (n = 1) 'general feeling' (n = 1)
Full-strength formocresol	4	carcinogenicity (n = 1) 'if introduced today would not pass Committee on Safety of Medicines' (n = 1)
1:5 dilution of formocresol	3	carcinogenicity (n = 1) mutagenicity (n = 1) carcinogenicity and mutagenicity (n = 1)

Twenty-seven of the 63 respondents for whom data were available (41.5% of those using the vital pulpotomy technique) stated that they had concerns about their preferred pulpotomy agent. Twenty-two of these gave their reasons for concern (Table 3). Seventeen respondents (26.2% of those using the vital pulpotomy technique) were considering changing their technique; 13 of these stated that they were considering ferric sulphate as a possible alternative to the agent that they were currently using (in all cases, this was either paraformaldehyde or formocresol).

Table 4 shows the materials usually used by respondents to restore a primary molar on which a vital pulpotomy had been performed. It should be noted that answers were not mutually exclusive.

In the event that a vital pulpotomy were to fail, 22 respondents (33.8%) stated that they would re-treat the tooth, while 35 respondents (53.8%) would opt for extraction. Eight respondents stated that they would base their decision on a consideration of individual circumstances.

Table 4. Respondents' usual choice of material for the definitive restoration of a tooth treated by the vital pulpotomy technique.

Material	Number (%) of respondents		
	Occlusal cavity	Two-surface cavity	Three-surface cavity or more
Amalgam	41 (63.1%)	45 (69.2%)	38 (58.5%)
Glass ionomer	29 (44.6%)	21 (32.3%)	19 (29.2%)
Compomer	13 (20.0%)	10 (15.4%)	10 (15.4%)
Composite	2 (3.1%)	3 (4.6%)	1 (1.5%)
Preformed crown	0	11 (16.9%)	21 (32.3%)

Discussion

The debate in relation to vital pulpotomy agents is one of the most controversial topics in contemporary paediatric dentistry. In the UK, national clinical guidelines for the pulp treatment of the primary dentition were first published in 2000[3]. In its preparation, this document was circulated to an 'expert panel' comprising of all consultants in paediatric dentistry in the UK, the Council of the British Society of Paediatric Dentistry and members of related specialties recognized to have expertise in the subject. The final version was produced from a combination of this input and thorough review of the published literature. As such, it represented a consensus of opinion as to what was then best clinical practice. The guideline advocated both the '5-minute formocresol' and 'devitalising' (paraformaldehyde paste) pulpotomy techniques as being applicable to vital primary teeth, the use of both being supported by Grade B evidence (well-conducted clinical studies)[4]. Although specific supporting references were not cited in the guideline, a 1:5 dilution of Buckley's formocresol was recommended as being equally effective and less toxic than the original formulation.

A revised British Society of Paediatric Dentistry pulpotomy guideline has recently been published[5]. This document supports the use of the following agents in the vital pulpotomy technique: 15.5% ferric sulphate solution; 20% (1:5 dilution) Buckley's formocresol solution; mineral trioxide aggregate paste (MTA); pure calcium hydroxide powder.

It should be noted that there remains a conflict of opinion amongst UK paediatric dentists as to the justification for the continued use of formocresol, even in a 1:5 dilution. Readers are directed to two very comprehensive narratives published during the past year[6,7].

In the absence of a consensus, it is perhaps the availability of formocresol that will finally lead to a change in clinical practice. The authors consider the routine use of the formocresol pulpotomy to be inappropriate given the availability of effective alternatives. Of these, ferric sulphate and MTA seem, at least at the present time, to be the most promising.

Although this study was designed to examine attitudes and practices of CDS staff in Wales in relation to vital pulpotomy for primary molars 18 months following the IARC press release[2], the participants were not specifically asked whether they had seen or heard of this publication. In retrospect, this was a limitation of the questionnaire design. That almost 30% of respondents stated that they were using ferric sulphate either solely or as one of a number of pulpotomy agents may reflect the fact that, on the advice of its specialists in paediatric dentistry, one National Health Service trust in Wales has recommended that the use of formocresol be abandoned and that ferric sulphate be adopted as an appropriate alternative.

Table 3 suggests that some respondents are confused as to which pulpotomy agents are associated with concerns with respect to carcinogenicity and mutagenicity. Indeed, some respondents were under the impression that ferric sulphate was associated with these undesirable side-effects; others were concerned about the product's efficacy. None of these concerns is supported by the literature.

In this study, 40.0% of respondents stated that they would carry out a vital pulpotomy without the benefit of a preoperative radiograph. Likewise, 56.9% of respondents stated that they never took follow-up radiographs. In contrast, it has been reported that 76.5% of UK specialists in paediatric dentistry routinely take preoperative radiographs while 59.8% routinely take follow-up views[1].

It should be borne in mind that the pulpotomy technique is contraindicated in the following conditions, which can only be diagnosed radiographically: a tooth with caries penetrating

the floor of the pulp chamber; a tooth close to exfoliation (i.e. with less than two-thirds of its root length remaining); a tooth with advanced pathological root resorption; a tooth with periapical or furcation osseous radiolucency.

The revised British Society of Paediatric Dentistry pulpotomy guideline[5] states that preoperative radiographs are *usually* mandatory, whereas regular clinical and radiographic review following any primary molar pulpotomy is definitely so, particularly since radicular cyst formation is a well-recognized sequel to the technique[8,9].

Given the apparent unpopularity of preformed molar crowns amongst primary care practitioners[10], it is encouraging that nearly one-third of respondents included a preformed crown in their choice of restorative technique for a tooth in which more than two surfaces were affected by caries. The success of the vital pulpotomy technique depends on achieving a good coronal seal, since this cuts off the nutritional supply for any remaining dentinal bacteria and prevents further bacterial microleakage. Al-Zayer and co-workers[11] have shown that failure is 7.7 times more likely in a tooth restored with an amalgam than one restored with a performed metal crown. While a recent *in vitro* study[12] has suggested that adhesive restorations might provide an excellent alternative to the latter, this advice requires clinical substantiation.

Perhaps the most astonishing finding in this study is in relation to the use of local anaesthesia, where 20 respondents (30.8%) stated that they 'sometimes' used local anaesthesia, while one dentist reported that she/he never provided the child with pain relief. One can only speculate that this finding reflects a widespread practice of restoring primary teeth without local anaesthesia. While accepting that this approach may be appropriate in the management of minimal lesions, the authors cannot condone the practice of carrying out a vital pulpotomy without adequate pain control. Indeed, one cannot conceive of any other area of paediatric surgery where such failure to provide appropriate pain relief would be considered as anything less than professional abuse. It is not surprising that a common cause of complaint from parents and their children is that the dentist 'hurt' unnecessarily, or that those children who endure such a 'bad experience' become dentally phobic in adult life. Taken as a whole, the results of this study suggest that there is need for relevant continuing professional development courses for CDS staff in Wales. It also lends support to the argument that salaried primary care services for this vulnerable group should be specialist-led.

What this paper adds

- This paper provides information regarding the current practices of community dental staff in Wales with regard to the vital pulpotomy technique for primary molars.
- The authors highlight important differences between the practices of specialists in paediatric dentistry and non-specialist primary care practitioners.
- The results lend support to the argument that salaried primary care services for this vulnerable group should be specialist-led.

Why this paper is important to paediatric dentists

- This paper highlights the need for paediatric dentists to be involved in the delivery of relevant CPD to this group of primary care practitioners.

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References

1 Hunter ML, Hunter B. Vital pulpotomy in the primary dentition: attitudes and practices of Specialists in paediatric dentistry practising in the United Kingdom. *Int J Paediatr Dent* 2003; **13**: 246–250.
2 International Agency for Research on Cancer. *IARC Classifies Formaldehyde as Carcinogenic to Humans*. Press release no. 153, June 2004. [WWW document.] URL http://www.iarc.fr/pageroot/PRELEASES/pr153a.html
3 Llewelyn DR. UK National Clinical Guidelines in Paediatric Dentistry. The pulp treatment of the primary dentition. *Int J Paediatr Dent* 2000; **10**: 248–252.
4 Gregg TA, UK. National Guidelines in Paediatric Dentistry. *Int J Paediatr Dent* 1997; **7**: 267–268.
5 Rodd HD, Waterhouse PJ, Fuks AB, Fayle SA, Moffat MA. UK National Guidelines in Paediatric Dentistry. Pulp therapy for primary molars. *Int J Paediatr Dent* 2006; **16** (Suppl. 1): 5–14.
6 Srinivasan V, Patchett CL, Waterhouse PJ. Is there life after Buckley's formocresol? Part I – A narrative review of the alternative interventions and materials. *Int J Paediatr Dent* 2006; **16**: 117–127.

7 Patchett CL, Srinivasan V, Waterhouse PJ. Is there life after Buckley's formocresol? Part II – Development of a protocol for the management of extensive caries in the primary molar. *Int J Paediatr Dent* 2006; **16**: 199–206.
8 Savage NW, Adkins KF, Weir AV, Grundy GE. An histological study of cystic lesions following pulp therapy in deciduous molars. *J Oral Pathol* 1986; **15**: 209–212.
9 Takiguchi M. Fujiwara T, Sobue S, Ooshima T. Radicular cyst associated with a primary molar following pulp therapy: a case report. *Int J Paediatr Dent* 2001; **11**: 452–455.
10 Threlfall AG, Pilkington L, Milsom KM, Blinkhorn AS, Tickle M. General dental practitioners' views on the use of stainless steel crowns to restore primary molars. *Br Dent J* 2005; **199**: 453–455.
11 Al-Zayer MA, Straffon LH, Feigal RJ, Welch KB. Indirect pulp treatment of primary posterior teeth: a retrospective study. *Pediatr Dent* 2003; **25**: 29–36.
12 Guelmann M, Bookmyer KL, Villalta P, Garcia-Godoy F. Microleakage of restorative techniques for pulpotomised primary molars. *ASDC J Dent Child* 2004; **71**: 209–211.