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## **Paediatric dentists' views on the use of silver diammine fluoride: a UK perspective**

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Caries is a persistent problem in the UK with around a quarter of five-year-olds affected.<sup>1,2</sup> If left to progress, caries can cause pain and infection, negatively affecting a child's oral health related quality of life.<sup>3,4</sup> Different approaches to the management of caries include prevention-only care, biological and operative techniques, sometimes necessitating general anaesthesia (GA).<sup>5,6</sup>

An example of an alternative biological management technique is silver diammine fluoride (SDF). SDF is a liquid solution with a concentration of 44,800ppm fluoride that is applied topically for caries arrest.<sup>7,8</sup> SDF works through a combination of the synergistic action of silver being bactericidal to plaque bacteria, and fluoride promoting remineralisation and the formation of fluorohydroxyapatite.<sup>7,8</sup> One drop of SDF is suggested to treat up to five teeth; this would contain 9.5mg of SDF.<sup>9</sup> SDF has been shown to outperform fluoride varnish and the atraumatic restorative technique for achieving caries arrest in the primary dentition but it has the side effect of staining caries black.<sup>7,8</sup>

SDF is used commonly in the developing world, and is included in World Health Organization and International Academy of Paediatric Dentistry policy statements as an option for caries arrest in the primary dentition.<sup>10,11</sup> Despite its potential, the use of SDF is limited in the UK. Surveys undertaken in the US and Brazil indicate that paediatric dentists felt there was a place for SDF in caries management; however, concern was raised regarding aesthetics.<sup>12-14</sup> Paediatric dentists are key decision makers involved in research, guideline development and clinical practice. They are therefore well placed to discuss the use of SDF for children in the UK. The aim of this project was to explore the views of paediatric dentists on SDF as well as its current use.

## **Methods**

This study involved multisite qualitative research utilising semi-structured interviews to elicit paediatric dentists' opinions on the use of SDF in the UK. It was approved by the University of Sheffield research ethics committee prior to commencing (application 033200).

As our research related to behaviours and influences on decision making, a qualitative approach was appropriate.<sup>15-17</sup> Purposive heterogeneous sampling was employed to include participants with different employment and experience levels.

Participants were provided with a written information leaflet and a verbal summary of the study, following which written consent was given. Interviews were conducted by members of the research team either in their workplace or using video communication due to COVID-19 social distancing

guidelines. After 14 interviews, data saturation was reached (ie no new themes were emerging) and no further participants were recruited.

A topic guide was developed based on clinical experience, discussion with colleagues and a literature review. It was produced using the stages described by Kallio et al, piloted in Sheffield and modified in response to feedback.<sup>18</sup> Interviews were audio-recorded and transcribed verbatim by the researcher.

Analysis of transcripts was undertaken using a data driven inductive approach following the six stages of thematic analysis described by Braun and Clarke.<sup>19</sup> This was completed by one author (LT). The interviews were conducted, coded and analysed concurrently. Themes were revised while reviewing the data and all authors confirmed the analysis. Respondent validation was sought from all participants, with all agreeing that their views were represented. One participant gave feedback that was incorporated into the findings.

## **Results**

Fourteen semi-structured qualitative interviews were carried out with paediatric dentists across seven sites in England and Scotland. These were conducted between March and May 2020. Of these participants, ten were female. The sample included eight consultants and six specialists. Ten were primarily employed by the NHS and four in academia. The NHS component of the participants' work included the community dental service, dental hospitals, a district general hospital and a children's hospital. Two of the participants had experience of using SDF across three of the dental units involved.

The indication most commonly discussed was the role of SDF in caries management, particularly caries arrest for young children in the primary dentition with limited cooperation. SDF was viewed as a definitive management strategy or for temporisation prior to GA. Participants felt that SDF was useful as it is an active treatment stopping caries progression while buying time for improving cooperation and could be used to avoid GA. However, concern was also raised that a high cariogenic diet may override the effect of SDF. Many participants believed appropriate case selection was important. All participants were unanimous on SDF being employed as a treatment for asymptomatic teeth only where signs and symptoms of infection was a universal contraindication.

Five main themes influenced clinicians' views on the use of SDF. The themes were factors related to: 1) the child; 2) parental influence; 3) external influences; 4) clinician's knowledge, experience and beliefs; and 5) properties of SDF. Within each theme, there was variation in the views expressed.

### *Child factors*

The extent of caries was influential, especially the number of teeth affected, the progression of caries and importantly, whether this had progressed to the pulp and whether the child was suffering symptoms. Participants felt that symptomatic disease and caries to the pulp excluded the use of SDF for caries management.

*'I think: pre-cooperative, multiple early childhood caries patients who are asymptomatic. I think that it would be a perfect tool for acclimatisation.'* [P11]

The long-term prognosis of the tooth was discussed, and this was linked to the extent of the caries, the child's age and time until exfoliation. The pattern of the caries in terms of anterior versus posterior or primary versus permanent dentition affected the decision to use SDF. It was mainly used in the primary dentition, particularly to avoid invasive treatment or extraction for anterior teeth.

*'Probably on children who are asymptomatic who have extensive caries in the primary dentition who perhaps are uncooperative for any other forms of treatment and whose parents don't wish them to have a general anaesthetic for dental extractions.'* [P9]

Some participants felt that SDF had a role in the permanent dentition, particularly in anxious teenagers or those with a high caries rate where stabilisation was required. However, others reported that they would not use it in the permanent dentition.

The child's level of cooperation also played a key role, specifically in relation to the treatment modalities of local anaesthesia, sedation and GA. Lack of cooperation was seen as a motivator to use SDF as it was felt to be easy for children to manage. Conversely, if the child's cooperative potential meant GA was required, the use of SDF was not deemed appropriate.

*'It is another tool and gives us more treatment options. It will be useful especially for caries management in more challenging patients: the very young, the ones who have cooperation difficulties maybe due to behavioural or medical reasons.'* [P14]

The long-term burden of treatment for the child was an important factor. Generally, SDF was seen in a positive light in this regard as limited cooperation is required compared with other treatments. It was suggested as a possible tool for acclimatisation and a procedure that was unlikely to induce dental anxiety in a child patient.

Finally, participants expressed a need to ensure sufficient information was available to share with children. There was concern about the potential for discolouration from SDF to have a psychosocial impact on the child.

*'The discolouration side effects. So I think that's what parents would be most concerned about, is how the discolouration might affect the child from a psychosocial perspective, especially where front teeth are involved rather than back teeth.'* [P9]

#### *Parents' views*

The parents' attitude towards GA (ie whether this was positive or negative) determined whether SDF was seen favourably.

*'I definitely think that it has a use and it has a scope for practice as there are some parents who do not want their children to have a general anaesthetic so you need a method to arrest the caries and manage the more symptomatic teeth.'* [P12]

Furthermore, the attitude of parents towards the discolouration seen with SDF was also a guiding factor. Some participants felt that SDF would be acceptable as many parents tolerate the appearance of caries and some thought that parents who did not like preformed metal crowns may accept SDF. Conversely, others believed that parents who did not like preformed metal crowns would also not like SDF and they would not be happy with the appearance of SDF even if they accepted the appearance of caries. Similarly, if the parents wished to maintain anterior teeth and avoid extraction, SDF was seen more favourably although it was acknowledged that some parents preferred the option of GA and extractions.

The need to inform parents about the options available for the child was raised. Specific to SDF, this included explanation of the evidence base, and suitable patient information on the risks and benefits. The parents were seen as decision makers having the ultimate decision after the clinician had discussed all the available options.

*'It just needs to be carefully communicated and consented, probably with visual images.'* [P6]

#### *External influences on SDF use*

SDF was not available in the majority of units and approval of the material was needed via various systems across different units. This was affected by the regulatory status of the use of SDF being off

label for caries management in the UK. It was noted that this may be more of an issue in primary care. Nevertheless, for some, it had posed a barrier in secondary care. On reviewing the findings of the interviews, one participant raised that this could be related to a litigious environment.

Cost was also linked to availability as there is only a single supplier in the UK. Opinion was split on this issue: some participants felt SDF to be a cheap option whereas some thought it was expensive. This discrepancy was perhaps a result of the lack of an economic evaluation, a gap in the evidence base that was highlighted by participants. Furthermore, when discussing value, SDF was compared with GA and fluoride varnish, both of which have distinctly different costs.

*'In terms of cost, everyone is quite mindful that SDF can make savings within the service. If you can use a relatively cheap material, a few pounds per application compared with £1,000 for GA, there is a strong argument to make savings there.'* [P14]

The persistent problem of dental caries in children as well as long GA waiting lists and the need for non-aerosol generating procedures were also seen to facilitate the use of SDF.

In terms of commissioning, some participants felt that primary dental care was the most appropriate setting for dental services to use SDF while others were of the opinion that it should be 'tested' first in secondary care. However, given the high severity of caries in patients referred to secondary care, these children may not be an appropriate group for treatment with SDF.

*'Actually, it could be used in primary care before we ever even see the patient. I think it will be... it will be a lot of benefit.'* [P7]

There was wide variation in participants' knowledge of the evidence base for SDF and the strength of the evidence. Some participants believed that there was strong evidence for the efficacy of SDF (particularly for caries arrest) but others were of the opinion that more research was needed in the UK, specifically with children.

*'I think the evidence is very clear and I'm always supportive of using biological intervention versus more sort of surgical intervention.'* [P7]

*'Having more evidence and evidence that's within our cohort nationally here would be very useful.'* [P4]

Guidelines were felt to be important as they provided assurance from professional bodies on the use of SDF. Participants stated that further guidance was required on frequency of application and case selection.

The influence of the profession and peers was present throughout the interviews. While evidence was important, the views of peers were also influential; 'a colleague telling you it works' and 'word of mouth' inform decisions to use SDF.

#### *Clinician's knowledge, experience and beliefs*

Some participants had had a positive experience of using SDF, finding it easy to execute and simple for the child as well as having gained parental acceptance. Others were happy with their experience of other caries management techniques they had used and so did not feel SDF was necessary. Personal experience was important in 'trusting the evidence'.

Experience of patient cooperation appeared to affect clinicians' treatment planning, as did their working environment. The clinicians' beliefs (for example, feeling that it was important to save teeth and avoid GA) were more likely to lead them to feel that SDF was beneficial. However, some participants were concerned about the side effects limiting their ability to monitor disease.

#### *The properties of SDF*

The properties of SDF (such as its ease of application) were relevant. Positive attributes mentioned included its fast acting nature, that it is minimally invasive and that it is viewed as an 'active' treatment. Some participants expressed concerns that it does not seal in caries and would not maintain space in the arch in the same way as a preformed metal crown. Safety was brought up in terms of possible allergic reactions, the need for more information on toxicity and longer-term monitoring with regard to caries arrest activity, frequency of application and case selection as SDF is still a relatively new material in the UK. Other factors raised included discolouration, ease of treatment for the child and the possible prevention of pain through achieving caries arrest.

### **Discussion**

The aim of this study was to explore how a sample of UK paediatric dentists currently use SDF and their views on SDF as a procedure. This paper adds to the literature by elucidating which interconnecting factors related to the child, the child's parent, external influences (such as peer values and evidence), and the clinician's beliefs and knowledge exert influence over the clinician's overall opinion of SDF. These insights can be used to develop further research and as foundations for implementation planning to improve knowledge mobilisation specific to SDF.



These factors link to literature surrounding clinical decision making finding that guidelines, parental preferences, colleague support and clinician beliefs are influential factors.<sup>20,21</sup> Our findings also relate to research into clinical decision making for treating caries in the primary dentition, such as the extent and presentation of the disease, patient and parent preference, evidence and practitioner preference.<sup>22</sup> Likewise, issues highlighted in surveys of international dentists such as the side effect of discolouration<sup>12-14</sup> were again raised in the present study.

The strengths of this study include the heterogeneous sample, which included paediatric dentists from different units, working settings and levels of experience, both with and without access to SDF. The use of respondent validation as well as review of the analysis by the whole research team and taking a reflexive stance improves its trustworthiness.

Regarding reflexivity, one of the authors (LT) has an interest in SDF and plans to carry out further research in this area. As such, it is possible that LT's prior assumptions may have influenced the results in light of involvement in the study design and creation of the topic guide. In order to counteract this, feedback was sought on the study design from the entire research team. Similarly, these views could have affected the analysis although critical analysis of prior assumptions and a reflexive stance were employed to account for this.

All interviewers had a working, professional relationship with the participants. This could have affected the interview in that where researchers are 'insiders', they may take shared meaning from statements made by the participants.<sup>23,24</sup> This can result in misinterpretation and missing opportunities to investigate ideas further. In addition, the researchers were the junior colleagues of the participants and so they may have been unwilling to challenge their seniors where they contradicted themselves or clarification may have been required.<sup>25</sup>

Different interviewers carried out the interviews, meaning it was not possible to ensure consistency across all interviews. In order to mitigate this, the topic guide was relatively structured, which may have led to less opportunity to explore new ideas that emerged during the interviews, potentially limiting the depth of data collection.

Further research indicated from this study would include carrying out similar research with other groups of dental professionals such as general dental practitioners or dental therapists. Participants highlighted areas of further research including: qualitative exploration with children; local, clinically based research and economic evaluation; and development of subsequent guidelines indicating evidence-based case selection.

It appears that SDF is an appropriate management option for the treatment of dentinal carious lesions in the primary dentition that have not progressed to the pulp. Reflecting this, the British Society of Paediatric Dentistry has produced a standard operating procedure for the application of SDF for this purpose.<sup>26</sup>

### **Conclusions**

The paediatric dentists interviewed feel that SDF has a role in caries management and should form part of the management options for treatment of caries in the UK. Their views on the use of SDF appear to be influenced by interconnecting factors related to patients and their parents, external influences, and their own knowledge and beliefs.

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