An oral health promotion intervention for high-caries-risk children referred for tooth extraction under General Anaesthesia

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Awarding institution:
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An oral health promotion intervention for high-caries-risk children referred for tooth extraction under General Anaesthesia

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King’s College London, August 2015
Abstract

**Background:** Many high-caries-risk children in England receive dental extractions under General Anaesthesia (GA), this has become the leading cause for child hospital admissions in the country. King’s College Hospital (KCH) in South London is one of the largest GA service providers in England. Despite the radical approach to treatment under GA, many families re-attend the service for more treatment either for the same child or for a sibling, indicating failure to improve caries prevention. Parents of children referred to KCH for dental extractions under GA previously revealed to the author that they face challenges in preventing dental caries, one of which was having gaps in their oral health knowledge. They requested more support from the hospital, and suggested audio-visual media as an acceptable method for delivering oral health education to their families. Oral health education is a small, yet important, part of oral health promotion.

**Aim:** To develop and test an oral health education video-game, and assess the children’s compliance and views on fluoride varnish application within the pathway of care of children receiving dental extractions under GA at KCH. This will be achieved by: (i) exploring the challenges local General Dental Practitioners’ (GDPs) face in promoting oral health in those children; (ii) modifying a previous oral health education video-game to make it appropriate for use as part of the GA care pathway; (iii) assessing the game’s acceptability to the children and their parents, and its impact on the children’s oral health knowledge and practices in comparison to one-on-one verbal advice given by a Dental Nurse with Additional Skills (DNAS); finally, (iv) assessing the children’s compliance and their views about having Duraphat® fluoride varnish applied to their teeth in a medical clinic within the hospital’s GA pathway.

**Methods:** A series of research steps was performed. First, a qualitative study that involved semi-structured interviews with a purposive sample of local GDPs who have referred children to KCH for dental extractions under GA was performed. Second, a prototype oral health education video-game, designed to fit with the primary-two Scottish curriculum, was modified using more recent technology to address the oral health education needs of children referred to KCH for dental
extractions under GA, as informed by contemporary evidence for caries prevention, the findings of previous research involving their parents, and the views of the GDPs in this thesis.

Finally, a blind Randomised Controlled Trial (RCT) recruited a sample of children attending at KCH for dental extractions under GA, and compared the new video-game to one-on-one verbal oral health education delivered by a DNAS in terms of: (i) child and parent acceptability using a 100 mm Visual Analogue Scale (VAS); (ii) effect on child’s dietary knowledge using a 70-item Pictorial Dietary Quiz (PDQ); (iii) effect on child’s snack selections and toothbrushing frequency as reported by child-completed diaries; (iv) effect on dietary practices as reported by a parent-completed Children’s Dietary Questionnaire (CDQ); and finally, (v) effect on attendance for follow-up after GA. Children from both groups also received an application of Duraphat® fluoride varnish and were asked to indicate what they thought of it using a VAS and a short structured interview. Outcome measures were collected at: baseline; immediately following the intervention; on the day of the GA; and three months after the GA.

**Results:** In the qualitative study, eighteen GDPs (56% male) were interviewed. They perceived challenges to the promotion of oral health in high-caries-risk children that were related to: (i) the child; (ii) parents; (iii) social and cultural environment; (iv) primary dental care training and remuneration; (v) hospital communication and engagement upon referral; and finally, (vi) national health promotion policies. In parallel, they perceived that the referral to the hospital for extractions under GA was a chance to capture and educate the families that they thought lacked knowledge on dental attendance and hidden sugars.

The Scottish oral health education video-game was made available on a touch-tablet and modified by introducing new graphics and voice-over, and adding advice on: the cariogenicity of fruit juices and fruit drinks, brushing with 1450 ppm fluoride toothpaste, as well as the importance of regular application of fluoride varnish and regular dental attendance.

In the RCT, 109 children were recruited. The majority (84%) came from deprived neighbourhoods. Their average age was 6.5 years [SD=1.6], and they were
scheduled to have a mean of 6.7 primary teeth extracted under GA [SD=4.1]. The children had an unhealthy diet at baseline, including low consumption of fruits and vegetables [Mean=9.6; CDQ recommended: ≥14], and high consumption of sweetened drinks [Mean=2.4; CDQ recommended: ≤1], non-core foods [Mean=2.3; CDQ recommended: ≤2], and fat from dairy [Mean=4.0; CDQ recommended: 0].

The children and their parents found both methods of education highly acceptable [Video-game child median VAS=97; SD=25]; [Video-game parent median VAS=91; SD=20]. [Verbal education child median VAS=99; SD=27]; [Verbal education parent median VAS=98; SD=10], although the parents seemed to slightly favour one-on-one education [Mann-Whitney-U test P=0.003].

Children from both groups were better at identifying unhealthy foods immediately following the education [Video-game PDQ score improvement=4.8;  t-Test P<0.001; 95%CI=3.0-6.6] [Verbal education PDQ score improvement=7.6;  t-Test P<0.001; 95%CI=5.1-10.1], with no differences between the groups [t-Test P=0.7]. However, those in the one-on-one education group were better at identifying fruit juice [Chi-Square P=0.014] and fruit drinks [Chi-square P=0.037] as unhealthy.

Seventy six children (70%) returned completed snack diaries and toothbrushing diaries on the day of the GA. There were no significant differences between the groups in reported snack selection [Mann-Whitney-U test P=0.59] or toothbrushing frequency [Mann-Whitney-U test P=0.44].

Only 59 parents (55%) completed phone follow-up three months after the child’s GA, and reported small changes in dietary practices, including less sweetened drinks [CDQ score improvement=0.5;  t-Test P=0.019; 95%CI=0.1-0.8], non-core foods [CDQ score improvement=0.3;  t-Test P=0.046; 95%CI=0.0-0.6], and fat from dairy consumption [CDQ score improvement=0.6;  t-Test P=0.037; 95%CI=0-1.3], with no differences between the groups. The improvements did not make the children’s scores reach the questionnaire’s thresholds for a healthy diet except in the non-core foods parameter. Non-respondents (45%) reported higher consumption of sweetened drinks at baseline [CDQ score difference=0.8;  t-Test P=0.02; 95%CI=0-1.7].
education methods failed to achieve good attendance for a three month follow-up visit, as only 11 families in total (11%) attended.

Only 39% of the parents were familiar with fluoride varnish at baseline. One hundred and five out of the 109 children taking part in the RCT were offered the treatment. Application was unsuccessful in only four children (4%). The children found the application acceptable [VAS mean=62; median=82; SD=40], and described the process as "easy". However, some said that they found the varnish “disgusting” or “sticky” and suggested different flavours.

**Conclusion:** The introduction of an educational oral health intervention, which also included applying fluoride varnish, within the hospital’s care pathway for children needing dental extractions under GA, was acceptable to the children and their parents. The oral health education delivered, whether verbally or using a video-game, improved the children’s dietary knowledge in the short-term, but long-term retention could not be confirmed due to poor follow-up attendance. Verbal education was found slightly more acceptable by the parents, and led to better recognition of some cariogenic items by the children. As such, it might be more suitable for this setting. Neither method of education delivery seems to have led to substantial dietary changes or better dental attendance in this cohort.

The overall findings of this thesis highlight the challenges in providing support to high-caries-risk children referred for dental extractions under GA and their families; referring dentists felt that they could not provide the preventive care and oral health education that those children need in their primary dental practices and requested more efforts at the hospital, but delivering an oral health intervention at the hospital was not sufficient to achieve substantial changes in those children’s oral health practices. Future efforts are needed to address the barriers discussed by the GDPs in this thesis, and explore possible approaches and collaborations to provide more support with caries prevention to those children and their families.
Acknowledgments

First, I would like to express my deepest gratitude to my supervisor Prof. Marie Therese Hosey. Not only has she provided me with unwavering support, encouragement and countless hours of guidance throughout my PhD, but she has also been the best mentor a young researcher can have all through my five years of studying and researching at King’s College London (KCL). She made sure that this experience helped me grow as a researcher, a clinician and a person.

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Third, I would like to thank Mrs. Amie Wickens and Mrs. Susan Jones, the two Dental Nurses with Additional Skills (DNASs) that voluntarily agreed to take part in this research project. This truly showed their enthusiasm and dedication to the improvement of preventive dental care provided for children at King’s College Hospital.

Forth, I want to express my sincere thanks to Mr. Manoharan Andiappan for meeting me on multiple occasions, providing the randomisation grid used in chapter 6, and giving me the guidance needed for the statistical analysis performed in that chapter.

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Author’s declaration

Mr Manoharan Andiappan, a statistician at KCL’s Dental institute, provided the randomisation grid used in chapter 6 and provided guidance for statistical analysis in that chapter.

Mrs. Amie Wickens and Mrs. Susan Jones, the two dental nurses taking part in this project, were responsible for the allocation of the participants to the research groups in the Randomised Controlled Trial (RCT) in chapter 6 under the guidance and supervision of Prof. Marie Therese Hosey to ensure the author remained blinded to the group allocation.

All other contents of this project, including protocol writing, seeking ethical approval, data collection, data analysis and write up are the author’s own work. This work has not been previously submitted in part or in full for a degree of this or any other university or examination board.

The findings of the first study and the methodology of the second study in this thesis have been published in the following peer-reviewed papers (full manuscripts in Appendix 3):


- Qualitative study King’s College London ethics reference number: BDM/12/13-34
- RCT National Research Ethics Service reference number: 11/LO/0220
- RCT KCH Research and Development reference number: KCH12-013
- RCT International Standard Randomised Controlled Trial database reference number: ISRCTN94617251
## Abbreviations

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<thead>
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<th>Abbreviation</th>
<th>Definition</th>
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<tbody>
<tr>
<td><strong>AAPD</strong>: American Academy of Pediatric Dentistry</td>
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<tr>
<td><strong>ADA</strong>: American Dental Association</td>
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<tr>
<td><strong>BDM REC</strong>: Biomedical Sciences, Dentistry, Medicine and Natural and Mathematical Sciences Research Ethics Committee.</td>
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<tr>
<td><strong>CAMBRA</strong>: Caries Management by Risk Assessment</td>
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<tr>
<td><strong>CCG</strong>: Clinical Commissioning Group</td>
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<tr>
<td><strong>CDHS</strong>: Child Dental Health Survey</td>
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<tr>
<td><strong>CDQ</strong>: Children’s Dietary Questionnaire</td>
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<tr>
<td><strong>CDS</strong>: Community Dental Services</td>
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<tr>
<td><strong>CONSORT</strong>: Consolidated Standards of Reporting Trials</td>
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<tr>
<td><strong>COREQ</strong>: Consolidated Criteria for Reporting Qualitative Research</td>
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<tr>
<td><strong>DBOH</strong>: Delivering Better Oral Health</td>
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<tr>
<td><strong>DMFT/dmft</strong>: decayed, missing, filled teeth</td>
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<tr>
<td><strong>DNAS</strong>: Dental Nurse with Additional Skills</td>
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<tr>
<td><strong>DSU</strong>: Day Surgery Unit</td>
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<tr>
<td><strong>EAPD</strong>: European Academy of Paediatric Dentistry</td>
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<tr>
<td><strong>ECC</strong>: Early Childhood Caries</td>
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<tr>
<td><strong>EDDN</strong>: Extended duty dental nurse</td>
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<tr>
<td><strong>GA</strong>: General Anaesthesia</td>
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<td><strong>GDC</strong>: General Dental Council</td>
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<tr>
<td><strong>GDP</strong>: General Dental Practitioner</td>
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<tr>
<td><strong>IMD</strong>: Index of Multiple Deprivation</td>
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<tr>
<td><strong>KCL</strong>: King’s College London</td>
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<tr>
<td><strong>KCH</strong>: King’s College Hospital</td>
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<tr>
<td><strong>NHS</strong>: National Health Service</td>
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<td><strong>NHS CB</strong>: National Health Service Commissioning Board</td>
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<tr>
<td><strong>NICE</strong>: National Institute for Clinical Excellence</td>
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<tr>
<td><strong>NMES</strong>: Non-Milk Extrinsic Sugars</td>
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<tr>
<td><strong>OFCOM</strong>: Office of Communications</td>
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<tr>
<td><strong>PC</strong>: Personal Computer</td>
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<tr>
<td><strong>PCT</strong>: Primary Care Trust</td>
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<tr>
<td><strong>PDQ</strong>: Pictorial Dietary Quiz</td>
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<tr>
<td><strong>PHE</strong>: Public Health England</td>
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<tr>
<td><strong>ppm</strong>: Parts Per Million</td>
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<tr>
<td><strong>RCT</strong>: Randomised Controlled Trial</td>
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<tr>
<td><strong>REC</strong>: Research Ethics Committee</td>
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<tr>
<td><strong>R&amp;D</strong>: Research and Development</td>
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<tr>
<td><strong>SAE</strong>: Serious Adverse Event</td>
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<tr>
<td><strong>SIGN</strong>: Scottish Intercollegiate Guidelines Network</td>
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<tr>
<td><strong>UDA</strong>: Unit of Dental Activity</td>
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<tr>
<td><strong>UK</strong>: United Kingdom</td>
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<tr>
<td><strong>USA</strong>: United States of America</td>
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<tr>
<td><strong>VAS</strong>: Visual Analogue Scale</td>
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<tr>
<td><strong>WHO</strong>: World Health Organisation</td>
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Chapter 1:

Introduction
1.1 Introduction

Dental caries is an entirely preventable disease, and yet it is the most prevalent childhood disease in the world. In the United Kingdom (UK), this leads to many children needing to have teeth removed. In fact, the need for dental extractions, often under General Anaesthesia (GA), is the commonest reason for paediatric hospital admissions (Health and Social Care Information Centre 2013a). The issue has become such a concern that it’s no longer being discussed solely by those involved in oral health care, but by national media outlets as well (BBC 2012; The Times 2014; Channel 4 2014).

In England, Delivering Better Oral Health (DBOH) is an evidence-based toolkit for prevention (Public Health England et al., 2014) that gives clear guidance regarding the dental health messages that need to be delivered to families of children at risk of developing dental caries. These include a healthy diet with reduced sugar intake volume and frequency, toothbrushing twice a day with 1450 ppm fluoride toothpaste and regular application of fluoride varnish. Yet exposure of high-caries-risk children referred for GA and their families to these evidence-based messages remains poor (Olley et al., 2011).

In fact, parents of such children have previously requested more support with preventing dental caries. Specifically, they asked for more support during their child’s referral. In addition, they suggested audio-visual media as one of the possible platforms for oral health education delivery (Karki et al., 2011; Olley et al., 2011). Furthermore, earlier work by the author, during his MSc, explored the barriers to promoting better caries prevention as perceived by the parents of those children and revealed that they perceive multiple barriers, amongst which is the lack of oral health knowledge in some areas such as understanding the potential cariogenicity of fruit juice and the use of fluoride varnish (Aljafari et al., 2014).

In light of this, the focus of this thesis is to develop and evaluate a child-centred oral health education video-game that can be used as an educational oral health intervention for high-caries-risk children scheduled to have extractions of decayed teeth under GA at King’s College Hospital (KCH), London. KCH is one of the biggest providers of this service in England, and serves some of the most

As it stands, the “GA pathway” for children referred for dental extractions under GA does not include significant efforts to support prevention (Adewale et al., 2011). This focus on the surgical treatment of the disease, without looking at how the root causes can be addressed, has left those children and their families entering a cycle of disease and surgical treatment. Indeed, a recent study has confirmed that almost half of the families attending this service at KCH eventually come back again for repeat extractions either for the same child or a sibling (Olley et al., 2011).

The author acknowledges that providing those children and their families with oral health education alone will not necessarily lead to sustained changes in their oral health practices. However, the referral for multiple extractions under GA might present what could be thought of as a “teachable moment” (Flocke et al., 2014). Furthermore, delivering oral health education that addresses deficits in knowledge remains an important part of oral health promotion policies and strategies as outlined in the Ottawa Charter (World Health Organization 1986). Moreover, knowledge remains a component that is needed to achieve behaviour change (Michie and West 2013). As such, it is important that acceptable, effective, accessible and cost-effective oral health education methods continue to be developed and assessed in a research-informed manner.

Rice (2009) developed an oral health education game that fits with the Scottish curriculum and is based on sound educational principles as part of his MSc project, and targeted five- to six-year-old Scottish school children. In this thesis, the author will first explore the barriers and challenges that General Dental Practitioners (GDPs) in Lambeth, Southwark, and Lewisham, perceive in providing preventive care and promoting oral health in high-caries-risk children referred for GA, and how these barriers can be addressed. In the second part, the game developed by Rice (2009) will be modified to provide oral health education that addresses the needs of those children as informed by interviewing the GDPs, previous interviews with the parents at KCH during the author’s MSc (Aljafari et al., 2014), and England’s caries prevention guidelines (Public Health England et al., 2014). Finally, the new oral
health education video-game will be compared to one-on-one verbal oral health education delivered by a Dental Nurse with Additional Skills (DNAS) in a blind Randomised Controlled Trial (RCT). The RCT will take place at a medical pre-assessment clinic that all children attend prior to their treatment under GA at KCH. This stage of care is provided due to the fact that KCH serves an area of London that has a large Afro-Caribbean and Mediterranean population. It is currently not attended by any oral health professionals, and no efforts to support good oral health are being provided.

Fluoride varnish, applied a few times a year by a dental professional, has been shown to reduce risk of developing dental caries in children (Marinho et al., 2009), and is an important part of the evidence-based toolkit for caries prevention (Public Health England et al., 2014). Despite this, the provision of fluoride varnish in high-caries-risk children referred for GA at KCH seems to be poor (Olley et al., 2011, Aljafari et al., 2014). As a paediatric dentist, the author knows that some children don’t seem to like the taste of the varnish, and others can be nervous, making the application sometimes difficult. Therefore, as part of this thesis the GDPs will be asked to report on their views on using fluoride varnish, while the children taking part in the RCT will be asked to report their views on the acceptability of Duraphat® fluoride varnish applied to them at the medical pre-assessment clinic.

The qualitative study involving the local GDPs and the protocol of the RCT have been published in two peer-reviewed journals. Some other parts of this thesis have been disseminated in two conference presentations. All publications can be found in Appendix 3.
1.2 Outline

Chapter two is a review of the relevant literature. Chapter three presents the aims of this thesis. Chapter four presents a qualitative study that explored the local GDP-perceived barriers to oral health promotion and preventive care in families of high-caries-risk children referred for extractions under GA. Chapter five outlines the preparation of an oral health education video-game for those children, and the planning and piloting of a phase II RCT to evaluate it. Chapter six will present the RCT, and includes an evaluation of children’s compliance and acceptability of Duraphat® fluoride varnish application at the medical pre-assessment clinic. Chapter seven will provide a general discussion and finally, Chapter eight will present the conclusions of this thesis. Appendix one presents the relevant Ethical approval documents and correspondence, Appendix two displays the various measuring tools that were used and finally, Appendix three includes all published work.
Chapter 2:

Literature review
2.1 Introduction

The research conducted in this thesis will aim to develop and assess an educational oral health intervention for high-caries-risk children referred for dental extractions under General Anaesthesia (GA) that can become a part of their GA pathway at KCH. As such, this literature review will examine the current evidence in a range of relevant topics, this will include: providing a brief overview of childhood caries and its risk factors, exploring the general social and behavioural factors that are associated with high caries risk in children, examining childhood dental caries in England and the current approach to its management and prevention, examining the current GA care pathway for high-caries-risk children in England and the specific oral health education and preventive care needs of those children, and finally, exploring how oral health education and preventive care can be better delivered to those children and their families, all while developing an understanding of the need for wider multidimensional, multilevel, and multiagency oral health promotion in society.

2.2 Search strategy

The author utilised electronic searches to gather relevant articles. The Medline (OVID) database was used to gather articles from the year 2000 onwards on the main topics of interest using the terms: oral health promotion, oral health intervention, oral health education, fluoride varnish, video-game, high-caries-risk children, general dental practitioners UK, and dental general anaesthesia. Abstracts of articles determined to be of interest by their title were read, and if deemed to be of interest, the full article was obtained using King's College London's (KCL) Shibboleth. Reference lists in key articles were examined when necessary to identify any other important resources. In addition, PubMed and Google Scholar were sometimes used to look for relevant literature outside the specified terms. Other grey literature such as health service and government reports was located and obtained electronically using Google.co.uk and Gov.uk.
2.3 Childhood caries – a global issue

Childhood caries is a global issue. This part of the literature review will provide an overview of the extent of this worldwide problem and how social, economic and behavioural factors influence caries-risk in young children.

2.3.1 The global impact of childhood caries

Dental caries in children is a worldwide issue and a major public health concern. Despite overall improvements in oral health during the recent few decades, dental caries remains a disease that affects a large number of children worldwide (Bagramian et al., 2009, Vadiakas 2008). Moreover, untreated caries in primary teeth is the tenth most prevalent health condition in the world, affecting 9% of children worldwide (Marcenes et al., 2013a). The distribution of the disease is strongly associated with socio-economic deprivation as well as poor parental oral health practices (Congiu et al., 2014), two issues that are often intertwined. This association has led to the disease being clustered within a specific portion of society, which is under higher risk. As such, researchers have reported that children in developing countries, or socially deprived populations within developed countries, are under a significantly higher risk of developing caries (Marthaler 2004). In fact, some reports have suggested that up to 70% of those children can be affected (Milnes 1996).

The presence of dental caries can affect the life of children and their parents. In fact, the 2013 Child Dental Health Survey (CDHS) in England has revealed that about one fifth of families in England have reported being impacted by the disease in the previous six months, whether the impact was the child needing more attention, the parent feeling anxious or guilty, or the parent needing to take time off work and causing financial difficulties (Health and Social Care Information Centre 2015a). Other authors around the world have reported similar findings (Abanto et al., 2014; Ramos-jorge et al., 2014). Casamassimo et al. (2009) reported that untreated caries in children leaves an impact on the child, their family and society. They noted that children with caries can suffer from pain, eating and sleeping dysfunctions, loss of attentiveness at school, reduced academic performance, as well as morbidity.
associated with treatment upon late presentation. Meanwhile, the parents lose sleep, need to take time off work and in some countries have to pay towards treatment, placing a financial burden on those often deprived families. Indeed the family as a unit could be put under a lot of stress. Finally, society as a whole is affected, as significant expenditures are required for managing a disease that is ideally completely preventable (Casamassimo et al., 2009).

2.3.2 Early Childhood Caries

The term Early Childhood Caries (ECC) refers to caries affecting the primary teeth of young children. Different organisations concerned with children’s oral health adopted different definitions to determine what disease pattern constitutes ECC. Perhaps the most accepted definition of ECC is “the presence of one or more decayed (non-cavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth in a child younger than six years old” (Ismail 1998). This definition has been adopted by the European Association of Paediatric Dentistry (EAPD). The American Academy of Paediatric Dentistry (AAPD), has adopted a similar definition, but also suggested an additional category that they named severe ECC: ‘any sign of smooth-surface caries in children younger than three years of age, or one or more cavitated, missing (due to caries), or filled smooth surfaces in primary maxillary anterior teeth in children aged three to five, or a decayed, missing, or filled score of ≥4 (age 3), ≥5 (age 4), or ≥6 (age 5)’ (American Academy of Paediatric Dentistry 2008).

2.3.3 Overview of childhood caries risk factors

As we know, dental caries occurs when four objects interact: teeth, cariogenic bacteria, fermentable carbohydrates and time. Caries is, however, a multi-factorial process that is influenced by a multitude of factors that Fejerskov (1997) classified as: biochemical (cariogenic bacteria, availability of fluoride, salivary composition, enamel quality, etc.), behavioural (oral hygiene habits, dietary habits, dental attendance, etc.) or social (social class, education, income, etc.).

Seow (1998) stated that young children are especially at risk of developing the disease, due to their developing immunity and newly erupted teeth. More importantly, Seow (1998) noted that behavioural patterns, such as the presence of
parental difficulties in establishing healthy diets and good oral health care habits, play a major role in increasing caries risk in children.

Harris et al. (2004) again noted the importance of oral health practices, such as oral hygiene habits, and dietary habits including bottle feeding and sugar consumption, when assessing caries risk in children. These behavioural factors interact together to achieve a balance of “good” and “bad’ habits that affect the progress of the disease. In their review, Arora et al. (2011) reiterated those suggestions. Furthermore, they stressed the importance of understanding wider socioeconomic factors that play a role in determining the risk of developing the disease, such as dental visit patterns, socioeconomic status, ethnicity, and parental health literacy.

### 2.3.4 The presence of caries is one of the strongest predictors of future caries

The presence of caries at baseline remains the single strongest predictor for caries development in children (Litt et al., 1995; Mejare et al., 2014). Different approaches for assessing and subsequently categorizing a child’s caries risk have been developed and recommended by various organisations concerned with oral health. Examples include tools developed by the American Dental Association (ADA) (American Dental Association 2011a; 2011b) and the AAPD (American Academy of Paediatric Dentistry 2014), the Caries Management by Risk Assessment ‘CAMBRA’ tool (Bratthall and Hansel Petersson 2005), and the Cariogram, a computer based software (Featherstone et al., 2003). Evidence for those tools remains limited, especially when it comes to risk assessment in children, or for populations other than the ones they were developed within (Tellez et al., 2013; Mejare et al., 2014). Those risk assessment tools are very structured in nature, and do not leave much room for clinical intuition. Some include laboratory tests such as Streptococcus Mutans counts or salivary tests, which have been suggested to be of questionable value in young children (Mejare et al., 2014), not to mention that in many populations they may not be readily available at clinicians’ disposal.

In a systematic review of caries risk assessment, Mejare et al. (2014) concluded that assessing baseline caries levels, socioeconomic factors, and aetiological factors,
might be the best approach to assessing caries risk in children. The authors questioned the cost effectiveness of complex methods mentioned earlier in comparison to a clinician’s gut feeling. In the UK, the Scottish Intercollegiate Guideline Network (SIGN) provided guidance on caries risk assessment that fits well with such recommendations. Their guidelines suggest that oral health professionals use their clinical intuition, after taking into account the biological, behavioural, and social risk factors, to assess caries risk in children (Scottish Intercollegiate Guideline Network 2014).

The biological risk factors for caries, such as fluoride availability or cariogenic bacteria counts, are influenced by behavioural elements, such as toothbrushing with fluoride toothpaste twice a day, reducing sugar intake, and receiving fluoride varnish. Caries risk is further impacted by wider socioeconomic and cultural elements. Hence, tackling the disease risk necessarily means tackling those behavioural and socioeconomic issues. In the next section of the literature review we will take a closer look at socioeconomic and behavioural challenges in the families of high-risk children.
2.4 Challenges to caries prevention in high-risk children

To gain a better understanding of how dental caries in high-risk children can be prevented, it will be necessary to take a better look at their reported oral health practices and the factors impacting them, as well as develop an understanding of the socioeconomic challenges those children and their families face and that impact their oral health.

2.4.1 Poor oral health practices

Some studies have suggested that parents’ oral health practices can reflect on their children’s oral health practices and subsequently predict caries risk (Sasahara et al., 1998; Okada et al., 2002). More importantly, parents are responsible for establishing positive oral health behaviours in their children. A systematic review has revealed that there is evidence that suggests that parental feeding practices, behaviours, attributes, attitudes, knowledge, and beliefs all have a strong association with child caries experience (Hooley et al., 2012).

A recent study by Weatherwax et al. (2014) held a different opinion. In that cross-sectional study of 181 low-income families in the USA, the authors suggested that there was no correlation between a child’s number of decayed, missing and filled teeth (dmft), and their parents’ oral health knowledge, perceived value of oral health, and sense of control of their child’s oral health after adjusting for socioeconomic factors. However, their failure to find such correlations might have been due to the fact they recruited deprived families already taking part in an oral health promotion programme that reduced the differences in oral health knowledge between families.

Clearly, developing a complete understanding of how social and behavioural elements interact and correlate with clinical oral health outcomes is a complex issue that continues to be explored. Nonetheless, there is substantial evidence on the practices of families of high-risk children that is important to discuss and take into account when planning to promote their oral health.
2.4.1.1 Dietary habits

Families of children with caries might have dietary practices associated with an increased risk of dental caries. A case-control trial in the USA that involved children with severe ECC (ECC involving anterior teeth) reported that they were consuming a larger amount of sugary drinks and having more frequent food intakes daily than a control caries-free group (Evans et al., 2013a). In the UK, 16% of 12-year-old children taking part in the Child Dental Health Survey (CDHS) in 2013 reported consuming sweetened drinks more than four times a day, while 8% reported consumption of fruit juice with the same frequency (Health and Social Care Information Centre 2015c). Children that were from more deprived backgrounds, as determined by their eligibility for free school meals, were twice as likely to consume those drinks more than four times a day (Health and Social Care Information Centre 2015c). This high consumption of free-sugars is very alarming, as not only does it put children under the risk of developing caries, but it also increases the risk for developing of other chronic conditions associated with excessive consumption of free-sugars such as obesity. Moreover, the acidity of those drinks is known to cause tooth erosion.

2.4.1.2 Tooth brushing with fluoride toothpaste

The majority of children in the UK brush their teeth twice a day (Health and Social Care Information Centre 2015c). This applies to children across the socioeconomic gradient, although those from lower social classes have been reported to brush slightly less frequently (White et al., 2006; Health and Social Care Information Centre 2015c). In Wales, a study by Trubey et al. (2013) provided a closer look at the barriers to regular toothbrushing perceived by parents from a poor socioeconomic background and revealed that they might be struggling with ‘organisation’, as they found it difficult to establish a toothbrushing regimen for their children.

The fact that most children in the UK seem to brush their teeth frequently is encouraging. However, it is important to note that we know very little regarding other important aspects of toothbrushing that were suggested by Delivering Better Oral Health (DBOH) (Public Health England et al., 2014), including: concentration
of fluoride used, the presence of parental supervision, and not rinsing following brushing.

### 2.4.1.3 Regular dental attendance

Families of children with higher caries risk are reported to be less likely to attend for regular dental care. A retrospective study of five-year-old children attending a clinic in Norway, where child health care is free, revealed that those that missed appointments were four times more likely to have experienced caries (Wigen et al., 2009). Another Norwegian study had similar conclusions (Wang and Aspelund, 2009). Meanwhile in North-West England, children from more deprived backgrounds in a high-caries-risk area were reported to be more likely to be ‘symptomatic’ attenders (Eckersley and Blinkhorn, 2001). This poor attendance can partly be explained by the presence of barriers to accessing dental care. These barriers might vary from one country to another, depending on the system for dental care provision, but some core barriers, such as: families with high-caries-risk children feeling overwhelmed with more pressing matters, limited transportation, and forgetting appointments that had been scheduled months in advance, seem to persist across the globe (Hallberg et al., 2008; Lewis et al., 2010).

The majority of parents of five-year-olds surveyed recently in the UK (88%) reported that the child has visited a dentist for a regular check-up (Health and Social Care Information Centre, 2015c), although the frequency was not investigated. Such findings are encouraging, but also mean that more than one of every ten five-year-old children (12%) has either not seen a dentist at all or only for an emergency management. In addition, the genuineness of the parent-reported attendance must be questioned, as the same survey has reported that parental and child reports of attendance often did not match in older children who stated they did not attend for a check-up. Such discrepancy might be accidental; more likely, they reflect that parents tended to provide the surveyors with what they deem an acceptable answer. Moreover, the reported number of children that do attend for dental check-ups might be further questioned by looking at the NHS dental statistics for the same year (NHS Prescribing and Primary Care Team, 2013). The statistics show that in June 2013, 70% of children in England were reported to have visited their GDPs at least once in
the last two years, indicating that 30% most probably do not attend their GDPs regularly.

The 2013 CDHS (Health and Social Care Information Centre 2015c) showed that those more deprived, evident by their eligibility for free school meals, and those from urban areas were less likely to have attended for a check-up. It comes as no surprise, then, that regular attendance of children is an issue in the inner city areas that are the Boroughs of Lambeth, Southwark, and Lewisham, served by KCH. In June 2013, around 60% of children in the three boroughs were reported to have had visited a GDP in the last two years (NHS Prescribing and Primary Care Team 2013). Furthermore, Gallagher et al. (2009) reported that only 21% of children five years or younger and 51% of those 6-17 years old were registered for dental care in Lambeth, and the rates for registration for Southwark and Lewisham were not any better.

The poor dental attendance in a subset of children in England can be partially explained by issues in access, as 12% of parents surveyed in the 2013 CDHS reported that they have found it difficult to find a dentist to see their child, namely because their local GDP was not taking patients under the NHS contract or conditioned that the parent has to register as a private patient if the child is to receive care (Health and Social Care Information Centre 2015c). Such conditions meant that those from socially deprived backgrounds were more likely to have faced difficulties. Nonetheless, it is important to understand that the dental attendance of high-risk populations is further impeded indirectly by the impact of their socioeconomic circumstances on knowledge, beliefs, and practices.

2.4.2 Factors impacting the establishment of good oral health practices

2.4.2.1 Poor oral health knowledge

Knowledge is an important pre-requisite for establishing behaviour (Michie and West 201). Blinkhorn et al. (2001) surveyed the mothers of one- to six-year-old children in Manchester deemed to be under high caries risk. The results were interesting. An initial reading of their results might hint that most of those mothers do have good oral health knowledge, as almost three quarters knew that teeth should
be brushed twice daily and that sugary food cause decay. However, only 3% knew the required concentration of fluoride for high-risk children and a mere 7% knew the four most cariogenic foods and drinks out of a list of foods and drinks. In fact, much of the UK public seems to be oblivious to the potential cariogenicity of fruit juices and drinks, as suggested by the findings of an online survey by the University of Glasgow (Gill and Sattar 2014).

2.4.2.2 Poor oral health literacy

Health literacy can be defined as ‘an individual’s capacity to obtain, process and understand basic health information and services needed to make appropriate health decisions’ (Nielsen-Bohlman et al., 2004). From this definition it can be concluded that health literacy and health knowledge are related but not quite the same. Health education can improve health knowledge, but only if the recipient possesses sufficient capacity to obtain and understand the information delivered, i.e. health literacy.

A comprehensive review of literature on health literacy has concluded that parents with low health literacy are 1.2-4.0 times more likely to exhibit negative health behaviours that affect child health, even after adjusting for socioeconomic status (Sanders et al., 2009). Another comprehensive review by DeWalt and Hink (2009) has reported similar findings. In that review, it was interesting to note that poor health literacy in either parents or children led to poor health behaviours, suggesting that attempts to promote healthy behaviours in children should always include efforts to improve health literacy in both parents and the children themselves.

In addition, the findings of a study by Vann et al. (2010) involving caregivers of preschool children suggested that oral health literacy correlates very well to oral health knowledge. The study also reported that it correlates well with the child’s oral health status. However, the findings of this study might not be reliable, as oral health in this study was not measured but rather reported by caregivers. Another study in the same year did involve clinical evaluation of oral health on a simple three rank scale (No caries, posterior teeth caries, anterior teeth caries) and suggested that parental health literacy does indeed correlate with oral health status (Miller et al., 2010).
The clear importance of health literacy suggests that any attempts to promote oral health in such families should always be considerate of their ability to understand the information delivered. Education should be tailored to the population targeted, include parents and children, and provided in a form that they both find easy and acceptable.

2.4.2.3 Poor oral health attitudes and beliefs

Attitudes and beliefs are other important components influencing behaviour. Those attributes have for a long time maintained a place in most theories explaining how health behaviour is initiated and sustained (Vermaire et al., 2010). The same applies to oral health behaviours; for example, a previous study has suggested that attitude towards oral health, perceived control over oral health and perceived social norms for toothbrushing can partially explain the variance in oral hygiene practices of an adult (Buunk-Werkhoven et al., 2011). Parental beliefs and attitudes about oral health are of particular importance when their children’s oral health habits are in question.

Positive attitudes were found to be correlated with positive oral health practices. For example, a study in Iran reported that mothers with positive attitudes towards the importance of oral health also reported more favourable oral hygiene habits in their children (Saied-Moallemi et al., 2008). Meanwhile, a study by Chhabra and Chhabra (2012) suggested that parents of children with ECC might have negative attitudes about oral health. In their study in India, they reported that almost 40% of parents of preschool children referred for dental treatment did not believe regular dental visits were important, and more than half (55%) reported anxiety as a factor preventing them from attending the dentist regularly. In the same study, almost two-thirds (65%) indicated that they do not think primary teeth are as important as permanent teeth.

Beliefs and emotions also come into play. In depth interviews with parents of children referred for extraction of carious teeth under GA in Scotland suggested that parental experience with dental care strongly affects their approach to dental care in their children (Smith and Freeman 2010). The parents in that study had a sense of ‘uneasiness’ and ‘anxiety’ when recalling their childhood dental experiences and that might have reflected on their child’s dental attendance. This trend can be seen in
other countries, for example, in another study that involved low-income families in the USA, parents that perceived that the development of dental caries in their children to be out of their control were more likely to perceive their children as having poor oral health (Sohn et al., 2008).

2.4.2.4 Poor parenting skills and practices

Parenting practices might play an important role in mediating oral health practices of children. In fact, a 2012 study suggested that parenting style is a stronger predictor of a child’s dietary habits than general nutritional knowledge (Peters et al., 2012). Another study reached similar conclusions, as parenting style and child’s temperament interactions were found to influence the child’s dietary practices (Gubbels et al., 2009).

Some studies looked specifically into parenting practices in families of high-caries-risk children. For example, a study with a blind observer compared the interaction between parents and children with caries with a control group of parents and children reported that parents of those with caries displayed less positive parenting practices, including positive involvement of the child, encouragement, problem solving and pleasant interaction (De Jong-Lenters et al., 2014). In addition, a cross-sectional study of a sample of five- and six-year-old children from various socioeconomic backgrounds suggested that family functioning, including parental responsiveness to the child’s needs, family communication, organisation, and perceived social support influence the child’s toothbrushing practices and subsequently caries experience (Duijester et al., 2014).

2.4.2.5 Negative Child influence on parents’ practices

While recognising the influence of parenting style on children’s behaviour, it is also important to acknowledge the influence of child behaviour on parenting style. The behavioural traits of children themselves were suggested to mediate caries risk. For example, children with ‘difficult’ temperaments are reported to be under higher caries risk, as their parents soothe, reward, and motivate them with food (Spitz et al., 2006). In addition, a recent cross-sectional study of pre-school children has suggested that those that display certain traits such as: shyness, sadness, fear, frustration, and attention shifting, were more likely to suffer from caries (Aminabadi
et al., 2013). It then comes as no surprise that children attending for dental extractions under GA have been found to display signs of difficult behaviour, according to their parents (Hosey et al., 2009).

Furthermore, parents of children from the same cohort interviewed by the author for his MSc research expressed frustration with their children’s compliance with healthy oral hygiene and dietary practices (Aljafari et al., 2014). In that study, some suggested they need help with conveying healthy messages to their children, who might be more receptive to sources of advice other than their parents, whom they see as ‘nagging’. Children indeed have the ability to influence their parents spending behaviour (Beder 1998), a fact that advertisers have been utilising for a long time. Children as young as four have been suggested to have a role in their families shopping (Kenway 2001).

2.4.3 Understanding the role of social inequality

As Arora et al. (2011) suggested in their review, socioeconomic challenges have a very strong role in childhood caries risk. As such, it is important to discuss how living in social inequality can further put vulnerable children at risk.

2.4.3.1 Definition of inequality and its influence on health

The term social inequality refers to ‘differences in income, resources, power and status within and between societies’ (Warwick-Booth 2013). This inequality in turn can lead to health inequity or inequality, which is defined by the World Health Organisation (WHO) as ‘differences in health status or in the distribution of health determinants between different population groups’ (WHO 2008).

The WHO (2008) stated that social inequality translates into poor health outcomes through many social determinants that play a role in an individual’s health. It defines these determinants as ‘the conditions in which people are born, grow, live, work and age’. It has been suggested that these determinants can be classified into five main categories: Economic stability, education, sense of social and community cohesion, accessibility to health and health literacy, and finally, healthy and safe neighbourhood and environment (Department for Environment, Food and Rural Affairs 2014).
The influence of those social and economic determinants on peoples’ health has been deeply researched and well established, as has been discussed in the UK’s Black report (Department of Health and Social Security 1980). The oral health of young children is no exception. In fact, discrepancies in oral health exist between those considered most and least affluent in our society and those discrepancies are most prominent in children of young age (Watt and Sheiham 1999; Locker 2000).

2.4.3.2 Inequalities in oral health – a global phenomenon
Inequality in oral health is a global issue with a wealth of evidence that associates socio-economic deprivation with poorer oral health (Watt 2007). In fact, a recent study has demonstrated how income inequality is strongly correlated to dental caries in five- to six-year-old children in 48 developed and developing countries (Bernabe and Hobdell 2010). Moreover, poor oral health has been reported in children from various deprived populations, ethnic groups and immigrant populations across the developed world. For example, children of first nation families in Canada (natives which are usually from a deprived socio-economic background) reported higher ECC than their counterparts (Schroth and Smith 2007). Meanwhile in the United States of America (USA), children from low-income families were more likely to suffer from ECC than those from more affluent families (Finlayson et al., 2007), and in another study, those from ethnic minority backgrounds or with parents with shorter education were also more likely to suffer from ECC (Weatherwax et al., 2014). Children from an immigrant background in European countries such as Austria (Cvikl et al., 2014), Denmark (Christensen et al., 2010), Italy (Ferro et al., 2010), Norway (Skeie et al., 2006), and Sweden (Stecksén-Blicks et al., 2008) were reported to be more likely to have dental caries than the rest of the population. The UK, as a developed country, has similar issues as will be demonstrated.

2.4.3.3 Inequalities in oral health in the UK
Watt and Sheiham (1999) and Locker (2000) reviewed oral health inequalities in the UK and reported that wide inequalities exist between different regions, socio-economic classes, and ethnic groups. Steele et al. (2015) recently confirmed that those inequalities continue to exist. In their study, they reported a significant correlation between income and caries prevalence, as well as between income and the number of teeth in adults. They noted that those with higher income had less
caries and more teeth; however, income was not the only factor playing a role. Other social determinants such as education and area of residence also contributed to the variance, depending on the individual’s age group and the oral health outcome measured (Steele et al., 2015).

Socio-economic indicators related to local area, rather than to the household or the individual, are frequently used nowadays to assess inequalities as recommended by Locker (2000). This approach is said to be reliable and also very helpful when it comes to planning and delivering oral health promotion. The findings of a recent study in Sheffield suggested that the English 2010 Index of Multiple Deprivation score (IMD) (Department for Communities and Local Government 2011), contributed for almost 60% of variance in the distribution of dental caries in five-year-old children at neighbourhood level (Broomhead et al., 2014).

2.4.3.4 Inequalities in children’s oral health in the UK

When it comes to children, inequalities can be even more pronounced (Watt and Sheiham 1999; Locker 2000). In fact, a study that involved pre-school children across the UK demonstrated that socio-economic class of the family was a stronger predictor of caries experience than reported dietary habits or toothbrushing frequency (Gibson and Williams 1999). Moreover, recent research in Scotland by (Levin et al., 2009) has suggested that children from the most deprived areas are four times as likely to have dental caries as those from the most affluent areas. More worryingly, the same study by Levin et al. reported that although inequalities in the prevalence of dental caries have been reduced, the inequalities in the amount of caries for those that have the disease haven’t, making the disease clustered in a small high-risk proportion of children.

In the 2003 CDHS in England, 60% of five-year-old children from deprived schools, based on free meals entitlement, were reported to have caries experience compared to 40% of those from non-deprived schools (Office of National Statistics 2005). This trend was also noted in the 2013 CDHS. In fact, dental caries was again more prevalent in five- and eight-year-old children eligible for free meals than those that were not eligible (Health and Social Care Information Centre 2015a). However, direct comparisons between the 2003 and 2013 surveys in terms of deprivation cannot be made, as the first recorded eligibility for free meals on a school level,
while the later recorded them on an individual level. More locally in London, the prevalence of dental caries in five-year-old children is reported to vary between boroughs, reflecting local socioeconomic inequalities (Davies et al., 2013).

Inequality between different ethnicities also persists. A comparison of caries experience of five-year-old children in North-West England has reported that Asian children were more likely to have experienced caries, even when adjusting for socioeconomic status (Pine et al., 2003). Moreover, a study has reported that the prevalence of dental caries in three- to four-year-old children in three deprived London boroughs varies depending on ethnicities, as white British children were reported to have less dental caries than their White European, Pakistani or Bangladeshi peers (Marcenes et al., 2013b). In a large cross sectional study in South London, Zoitopoulos et al. (1996) reported that young children from Afro-Caribbean ethnicity had lower levels of cariogenic bacteria and caries experience than their Caucasian counterparts, even when other socioeconomic factors were accounted for. As such, inequalities in children’s caries experience between ethnicities exist and might be related to biological, social or cultural factors.

2.4.3.5 Impact of socioeconomic deprivation on oral health practices

Being on the deprived end of the socio-economic scale creates external barriers to achieving good oral health, such as limiting access to health care and education, and can also create internal barriers in terms of individuals’ health beliefs, attitudes and behaviours (Sabbah et al., 2009). A UK study that involved parents of seven- to eleven-month-old infants has suggested that lack of higher education together with living in a socially deprived area can lead to having poorer oral health knowledge and oral health attitudes (Williams et al., 2002). Another study in Belgium reported similar findings, as mothers with less education had poorer attitudes about oral health (Van Den Branden et al., 2012).

The impact of deprivation can be noted in reported dietary habits. The national food surveys in the 1990s and 2000s reported higher consumption of foods and drinks containing Non Milk Extrinsic Sugars (NMES) amongst low-income groups (Gregory et al., 1995; Ntouva et al., 2013). This trend seems to continue in our present day (Department for Environment, Food and Rural Affairs 2014). Economic
necessity might in part explain this trend in behaviour, as a qualitative study in the USA suggested that low-income families can struggle to maintain food supply throughout the month, and in turn are less likely to consume a varied, nutrient-rich diet (Darko et al., 2013).

Furthermore, an impact on toothbrushing has been reported. Children from schools deemed more deprived were reported to brush their teeth less frequently and consume sweet drinks more often (Jerkovic et al., 2009). Another study reported that low socioeconomic status adolescents brushed their teeth less frequently than their more affluent peers (Polk et al., 2010). However, neither of the two studies was able to demonstrate a correlation of these results with clinical caries experience, which in both cases was more strongly linked to deprivation than to oral hygiene habits, meaning that although socioeconomic deprivation is associated with reported poorer oral hygiene, this does not directly cause poorer oral health, and other determinants must be coming into play.

Finally, dental attendance is impacted. Families of children from deprived backgrounds all around the world have been reported to perceive barriers to regular dental care (Harford et al., 2004; Tapias-Ledesma et al., 2005; Werneck et al., 2008). More specifically in the UK, lower social classes reported perceiving barriers to attending for routine dental care, whether in adults (Donaldson et al., 2008), or children (Maunder et al., 2006; Morris et al., 2006). In London, a negative correlation between social deprivation and registration of children with General Dental Practitioners (GDPs) was reported (Gallagher et al., 2009). This suggests an inverse care law (Hart 1971) as those that are under higher caries risk are receiving less care.
2.5 Overview of childhood caries in England

Now that the behavioural and social factors underlying childhood caries have been outlined, it is necessary to take a closer look at the issue of childhood caries in England and more locally to the setting of this research in South London. This part of the literature review will discuss the prevalence, current approach to management and prevention of childhood caries in England, as well as try to explore why many of those from the highest risk families eventually end up requiring dental extractions under GA.

2.5.1 Prevalence of childhood caries in England

A survey of preschool children in 2012 reported that 12% of three-year-old children in England suffer from dental caries, with the average dmft score for those children being 3.1 (Public Health England 2014c). Moreover, the same survey reported that one-third of those children (4% of the total population) suffer from a more aggressive form of the disease, affecting their anterior teeth. The 2013 CDHS has reported that by the age of five, the proportion of those that have obvious caries experience rises to 31%, with the average dmft score of those affected being 2.9 (Health and Social Care Information Centre 2015b).

The findings of the 2013 CDHS (Health and Social Care Information Centre 2015b) suggest that very limited improvement in oral health of five-year-old children has occurred since the earliest comparable survey in 2008, where 31% of five-year-old children were reported to have dental caries with a mean dmft of 3.5 (NHS Dental Epidemiology Programme for England 2009). At quick glance, the results of those two recent surveys might suggest that children’s oral health has improved in comparison to the findings of earlier surveys, such as the one in 2003 (Pitts et al., 2006). However, such comparisons are not valid, as the introduction of positive consent as a requirement for recruitment in 2008 has most probably significantly altered the sample of participants.

In fact, in the 2013 survey, almost one-third of the total number of potential participants did not take part due to the lack of parental consent (Health and Social Care Information Centre 2015b). Those are possibly from higher risk families less
motivated to take part. This fact, in addition to the fact that caries prevalence in five-year-old children saw little change between 1983, 1993 and 2003 (Pitts et al., 2006), makes it likely that the true prevalence of the disease did not actually change drastically. Indeed, Monaghan et al. (2011) showed that evidence for this trend can be drawn from comparing the findings of the first survey following the introduction of positive consent in Wales with the findings of the last negative consent survey just one year earlier. They concluded that performing such comparison, the significant reduction in the number of children with obvious caries experience within such a small time frame can only be explained by fewer children with caries taking part in the survey following the introduction of positive consent.

2.5.1.1 Prevalence of severe childhood caries in England

The burden of dental caries in England remains unequally distributed. Not only do 31% of five-year-old children have caries while the rest (69%) do not (Health and Social Care Information Centre 2015b), but further inequalities in distribution within those that have dental caries exist, and a small subset of children has a severe form of the disease.

In the 2013 CDHS (Health and Social Care Information Centre 2015a), 13% of five-year-old children in England had at least one sign of what was deemed a severe form of dental caries. This included: five or more teeth with obvious decay experience (6%), three or more teeth with decay into dentine (10%), one or more unrestorable tooth (5%), or any signs of sepsis (4%). As expected, children from more socioeconomically deprived backgrounds were more likely to develop such severe form of the disease. Children from the most deprived quintile, according to the 2010 English IMD scores, were almost five folds more likely to have developed one or more of the signs of severe caries than those in the least deprived quintile. In another display of the impact of social inequality, those who were eligible to receive free school meals were almost twice as likely to have a severe form of the disease as those that did not.

2.5.1.2 Prevalence of childhood caries in London

As expected by understanding the socioeconomic caries risk factors, the distribution of dental caries varies amongst different regions and areas of the country. A 2012
survey of five-year-old children in England has revealed that caries experiences was closely associated with social deprivation, and correlated well with the 2010 English IMD (Davies et al., 2013).

The situation in London particularly seems to be worse than the rest of the country. In fact, according the findings of Davies et al. (2013), London was the only part of England where the prevalence of caries in five-year-old children was not reduced between 2008 and 2012. Their findings also showed that almost 33% of five-year-olds had dental caries in 2012 (3rd highest in the UK), with a mean dmft of 3.7 (highest in the UK). Meanwhile, the Care Index was very poor (13%), with wide variations between different local authorities (6-30%) most likely due to variations in social deprivation and access to care (Davies et al., 2013).

2.5.1.3 Prevalence of childhood caries South London

Of special interest in this thesis is the caries experience of children in the London Boroughs of Lambeth, Southwark, and Lewisham, as those three boroughs are where most of the children seen at KCH are from. These London Boroughs are some of the most highly deprived in England, ranking 15th, 17th and 24th respectively in total deprivation according to the 2010 English IMD (Department for Communities and Local Government 2011). As such, it is logical to assume that caries experience in those areas will be high.

Surprisingly though, Davies et al. (2013) reported that only 22% of five-year-old children in both Lewisham and Southwark, and 24% of them in Lambeth, were reported to have obvious caries experience in 2012, which is less than the national average. However, their study also found that the dmft score of those that have caries hovered around the national average, ranging from 2.7 to 3.6 across those three boroughs. This suggests clustering of the disease in a minority of children and indicates possible inequalities even on a local borough level. Davies et al. (2013) also reported that the Care Index in those areas remains less than ideal. However, they showed it was significantly higher than the national average in Lewisham (26%) and close to the national average in Lambeth and Southwark (16% and 13% respectively).
2.5.2 Organisation of child dental care in England

Different countries around the world run their dental care systems differently, which in turn naturally means that the way the issue of dental caries in children is handled can also be different. As such, prior to exploring the approach to childhood caries management in the UK, it is helpful to provide a short overview of how oral health care is provided and funded in England.

2.5.2.1 Commissioning of child dental care

National Health Service (NHS) England is the highest health authority in England. It receives its funds through the United Kingdom’s Department of Health. In 2013, it received almost 95 billion pounds (NHS England 2014a). A proportion of those funds is retained by NHS England to cover its running costs and the services it commissions directly, including: primary care (including primary dental care), specialised services, and prisoner and military healthcare (NHS England 2014a). Since 2013, the NHS Commissioning Board (NHS CM) became responsible for commissioning all NHS dental services including primary, community and secondary care (NHS Commissioning Board 2013). Specialist and community dental services, are led by a task group that incorporates the expertise from NHS commissioners, clinicians, and consultants in dental public health, with support from the Department of Health (NHS Commissioning Board 2013).

The remainder of the NHS yearly budget, approximately 60%, is passed on to 211 Clinical Commissioning Groups (CCGs) that will commission services for their local populations (NHS England 2014a). The CCGs commission most services at a local level including: planned hospital care, rehabilitative care, urgent and emergency care (including out-of-hours), most community health services, and mental health and learning disability services (NHS England 2014a). These groups were created under the health and social care act of 2012 to replace Primary Care Trusts (PCTs) as the units responsible for local commissioning (NHS England 2014a). The members of each group include General Medical Practitioners and other clinicians such as nurses and consultants (NHS England 2014a). The CCGs have an interest in the delivery of dental services, mostly oral and maxillofacial surgery, but they do not have a direct role in their commissioning (NHS England 2014a).
Public Health England (PHE) is another health authority that is involved in commissioning health promotion efforts in England, including oral health promotion. This government body provides NHS England and local authorities with evidence-based advice on how to address the needs of the population as well as provides support for public health initiatives (Public Health England 2014a). In the year 2013-2014, PHE gave local authorities 2.7 billion pounds in grants (Public Health England 2014b).

2.5.2.2 Providers of child dental care

All children under 18 years of age in England are entitled to free dental care under the NHS (NHS Choices 2014). Forty thousand GDPs across the country provide children with primary dental care, including preventive care (General Dental Council 2014). There are no certain obligations to register children for regular dental care. However, parents are encouraged to take their child to a primary dental care practice to see a GDP on a regular basis for routine dental check-ups and treatment (NHS Choices 2013). The GDPs have the discretion to refer children to secondary care providers to receive specialist Paediatric dentistry care when needed. A relatively limited number of Community Dental Services (CDS) centres also play a role in high-risk children’s dental care. They provide some of them with regular dental care, and in some cases, treatment under sedation or GA (Community Dental Services 2015). In addition, those services sometimes provide local oral health promotion initiatives (Community Dental Services 2015).

2.5.2.3 Remuneration of child primary dental care

The GDPs are currently remunerated for the dental care they provide for children according to a Unit of Dental Activity (UDA) scheme (Sihra and D’Cruz 2014). In this system, the GDPs are paid per course of treatment, meaning that whether a patient had one or multiple fillings, crowns or extractions, they will receive the same remuneration, equal to the value for that band (Sihra and D’Cruz 2014). Most treatments provided by the GDPs are categorised into three UDA remuneration bands (NHS Choices 2015). The first (lowest) band is for providing dental examination, taking radiographs, scaling and polishing and any form of preventive treatment. The second band includes providing simple treatments such as fillings,
root canal treatments and extractions. Finally, the third band includes complex treatments such as crown, bridges and surgical extractions (NHS Choices 2015).

It can be noted that the provision of preventive care and advice to children and their families falls under the same band as providing a dental examination, garnering no additional remuneration for the GDP. The UDA system was introduced in 2006 as part of NHS reform in hopes that it will improve access, care quality and prevention (Sihra and D’Cruz 2014). However, by now it is quite clear that it failed. In fact, a report by the health select committee in 2008 suggested that the system failed to improve access for deprived families, with many dentists preferring to move away from NHS dentistry (House of Commons Health Committee 2008). It also failed to improve quality, as it might have encouraged some GDPs to maximise the UDAs per course of treatment by splitting courses of treatment rather than providing the entire planned treatment as one course (Sihra and D’Cruz 2014). Finally, it provided no incentive for preventive care, evident by the Steele report in 2009 recommending reform of the way preventive care is provided under the NHS (Steele et al., 2009).

2.5.3 Provision of preventive care

2.5.3.1 Development of “Delivering Better Oral Health”

In 2007, The Department of Health issued the first edition of DBOH. In 2009, the second edition was issued (Department of Health 2009a) and in 2014, PHE issued the third edition (Public Health England et al., 2014), which now provides the latest guidance for prevention of oral health conditions in England. The advice includes prevention of dental caries, tooth erosion and periodontal disease, and advice on general healthy eating, and smoking and alcohol cessation. As such, this document should be the source for any preventive advice given to families of children under high caries risk.

In terms of prevention of dental caries in children, DBOH classifies children into two categories: low-risk and high-risk population (Public Health England et al., 2014). The guidelines recommend that all children attending primary dental care receive a baseline level of preventive care that includes: (1) delivering advice on good toothbrushing practice with fluoride toothpaste with the right concentration, (2) maintaining a balanced diet with low sugar intake, as well as (3) receiving
regular applications of fluoride varnish every six months. Children that are at high risk, such as those that already have developed caries or are expected to develop caries, require more intensive measures on top of those population baseline measures.

2.5.3.2 Have the GDPs been applying the recommendations?
Failure to fully implement DBOH into care is clear when it comes to the delivery of oral health education messages and fluoride varnish to children in primary dental care settings. The well-documented poor dental attendance of those under the highest risk coupled with minimal oral health promotion outside the dental setting, further minimises the exposure of high-risk families to those important components in caries prevention.

2.5.3.2.1 Delivery of oral health education messages
GDPs in England have been previously reported to struggle in delivering oral health education messages. Threlfall *et al.* (2007b) reported that the oral health education they provide seems to be generic rather than tailored, with focus seeming to revolve only around sugary foods avoidance and frequency of toothbrushing. Tickle *et al.* (2007) noted that the approach they take in provision of care for children is inconsistent, and varies from dentist to dentist as well as from child to child. Furthermore, Tickle *et al.* (2003) noted the advice given seems to be reactionary, as more advice is given to children with more caries.

The introduction of the DBOH in 2007 might have done little to change those patterns of oral health education delivery. Taking a look at the findings of the CDHS in 2013, it can be noted that only 36% of five-year-old children were reported to have ever received oral health advice, despite the same survey reporting a much higher percentage of children having had attended for dental care before (Health and Social Care Information Centre 2015c). Indeed, Pearce and Catleugh (2013) reported that GDPs still seem to be neither consistent nor thorough in delivering preventive care in accordance with the guidance. In their study, most GDPs presented with a case scenario that involves a high-caries-risk child stated that they give generic dietary advice and suggest toothbrushing, but almost none seemed to provide more detailed advice that includes identifying and reducing sugar intake,
supervised toothbrushing with an appropriate concentration of fluoride, followed by spitting instead of rinsing.

2.5.3.2.2 Application of fluoride varnish

NHS statistics suggest that the use of fluoride varnish in children in primary dental practice in England has indeed been increasing over the last few years (NHS Prescribing and Primary Care Team 2013; 2014). In 2014, about a quarter of courses of treatment provided for children at primary dental practice included fluoride varnish application (NHS Prescribing and Primary Care Team 2014). However, it is noteworthy that the same statistics also showed that there were significant variations in reported application on local authority level. In fact, the application of fluoride varnish constituted only 8% of courses of treatment provided to children in some local authorities and 59% in others. In the Boroughs of Lambeth, Southwark, and Lewisham, where KCH is located, poor rates of varnish application were reported in 2014, as it constituted 22% of courses of treatment provided to children in Lambeth, 15% to children in Lewisham and 16% to children in Southwark. Meanwhile, more affluent areas of London, such as Kensington and Chelsea (Department for Communities and Local Government 2011), reported that 53% of courses of treatment provided to children included varnish application.

These findings raise the question of whether all children are receiving fluoride varnish as recommended by DBOH. In fact, only half of the GDPs surveyed by Pearce and Catleugh (2013) noted that they would use fluoride varnish when the researchers presented them with a high-caries-risk child scenario. As such, the reported surge in fluoride varnish application in the recent years might be due to fluoride varnish being applied more to those who need it the least: regular attenders with low caries risk.

2.5.3.3 Why are GDPs not applying preventive recommendations?

Suga et al. (2014) performed a systematic review of studies investigating reasons why dentists around the world might fail to provide preventive care. Their analysis of the 48 studies that met criteria, several of which were in England or the UK, provided some insight into what issues GDPs in England might be facing. The review reported that dentists were less likely to provide preventive care if they had less training, had negative personal beliefs towards the treatment provided, were not
remunerated properly for their efforts, or were delivering the advice to whom they perceive as an unmotivated parent or a young anxious child.

2.5.3.3.1 Organisational challenges

It has been reported that GDPs in England are struggling with providing adequate preventive care to their patients despite the availability of DBOH since 2007. In a study in South-West England, Witton and Moles (2013) reported that organisational barriers that GDPs perceive such as shortage of staff, facilities and time hinder the delivery of preventive care and oral health education. Furthermore, 41% of the GDPs taking part in that study suggested that inadequate training might be the cause. The results of a small survey in Bradford and Airedale by Csikar et al. (2014) suggested that the lack of staff and failure of patient attendance are some of the biggest difficulties GDPs faced in applying fluoride varnish to their patients.

However, remuneration of preventive care might be the bigger challenge to improving the delivery of prevention by the GDPs in England. This issue has indeed been raised by Steele et al. (2009) in a call for remuneration restructuring. In addition, an example from Scotland supports such proposal, as improving remuneration was effective in promoting the use of fissure sealants in primary practice, while providing education and training to dentists without improving remuneration was not (Clarkson et al., 2008).

2.5.3.3.2 GDPs’ Personal beliefs

In addition to training, level of teamwork and funding, the GDPs personal beliefs and attitudes might play a part. In fact, a Scottish study by Elouafkaoui et al. (2015) suggested that GDPs personal attitudes, self-perceived capability and motivation significantly influenced their adherence to DBOH. Humphreys et al. (2010) reported that dentists in Wales were less likely to provide advice when pressed for time, and sometimes perceived the whole process of giving advice patronising. In addition, another study in Scotland suggested that the decision of a GDP to apply varnish requires the presence of four factors: knowledge of guidelines, understanding of importance of prevention within the GDP role, parental acceptance of treatment, and finally the GDP’s personal will (Gnich et al., 2015).
Moreover, high-risk children might be under further disadvantage when it comes to receiving regular preventive care and education. Not only due to their poor access and attendance for dental care as previously discussed, but also due to the GDP’s perception of their families’ dental attitudes and motivation once they do attend. Threlfall et al. (2007c) noted that GDPs in Greater Manchester and Lancashire interviewed in their studies were less likely to spend time providing advice to families they don’t perceive as motivated. Younger generations of GDPs displayed similar lines of thinking, as foundation year dentists in Wales interviewed by Humphreys et al. (2010) reported that they feel less inclined to deliver advice to patients that lack motivation and compliance, increasing the gap between low- and high-caries-risk individuals even further.

2.5.3.3 Poor reinforcement of prevention outside the dental setting

Provision of preventive care and oral health education by GDPs is further complicated by the lack of efforts for oral health promotion outside the primary dental care setting. In fact, less than 40% of 12-year-old children surveyed in 2013 reported receiving oral health advice from an adult outside their family or dental health workers (Health and Social Care Information Centre 2015c). This means that not a lot of oral health education is taking place in schools, medical clinics or anywhere else outside the dental setting. Furthermore, 70% of 12-year-old children in the same survey reported that they have received advice through advertisements, 37% through TV or radio, 26% through newspapers and magazines and 40% through the internet (Health and Social Care Information Centre 2015c). This shows that some preventive messages might be out there on mass-media, but the content of those messages remains unknown, and often inconsistent. Ideally, children in England need better delivery of oral health messages that are consistent and continuous across dental care, medical care, schools, and mass-media.

Evidence for poor oral health promotion in the local area of KCH is also available. A study by Passalacqua et al. (2012) of an adult population attending KCH in London has reported that only one-third of them have been exposed to some form of oral health promotion. Furthermore, the study reported that those with higher education were more likely to have received promotion than those with lower
education, meaning that those who might be in more need of oral health promotion are actually receiving less.

In addition to the lack of oral health messages or programmes for caries prevention, an unhealthy environment that further complicates any efforts to promote healthy practices by families with young children persists. For example, grocery store checkouts are full of sugary snacks and almost a third of advertisement time during children’s TV programming was found to advertise cariogenic foods (Rodd and Patel 2005). Since 2007, more regulations on child programming have been put in place (OFCOM 2007), nevertheless advertisements for unhealthy foods continue to surround children in the streets and in shops.

2.5.3.3.4 Challenges to DBOH application by GDPs in South London

It is noted that a number of studies investigated challenges to provision of preventive care and oral health education in primary dental care setting across England and other parts of the UK. However, none of those studies surveyed the challenges perceived by GDPs in South London, and more specifically in the Boroughs of Lambeth, Southwark, and Lewisham. Although one can presume that challenges such as remuneration or training and organisational needs might be more or less generalisable across England, other challenges related to the local primary dental care policies and workforce, the population’s ethnic and socioeconomic profile and the local treatment needs might be variable.

The Boroughs of Lambeth, Southwark, and Lewisham, are some of the most ethnically and culturally diverse in the country. According to the 2011 national census, approximately 40% of the population in those boroughs identified as white British, 25-26% as Black British, Caribbean, or African, 12-15% as White others, and the rest as Asian or Others (Office of National Statistics 2012a). 33-37% of the population was born outside of the UK (Office of National Statistics 2012b). Furthermore, they are some of the most socioeconomically deprived, with noticeable inequalities within the boroughs themselves (Department for Communities and Local Government 2011). As such, GDPs practicing in those boroughs might perceive challenges to providing preventive care different to those reported by GDPs in other parts of the country with a different socioeconomic profile, ethnic and cultural make up, and population treatment needs.
2.5.3.4 Consequences of failure to prevent childhood caries in high-risk children

When dealing with dental caries one can assume there are three ways to manage the issue in a child: treat, leave untreated, or, ideally, prevent it before it occurs. Looking at the results of the recent surveys it can be noticed that a lot of dental caries in children is simply being left untreated, at least while they are young. In 2013, the Care Index, defined as the proportion of teeth with caries that have been filled, was very poor (11%) for three and five-year-old children (Davies et al., 2013; Public Health England 2014c). Moreover, there were significant variations between different regions and areas of the country, in a similar manner to variations in the distribution of caries experience, with children in some parts of the country having a Care Index as low as 6% and as high as 30% in others (Davies et al., 2013).

Moreover, it seems like a significant proportion of cases where dental care professionals do indeed intervene receive dental extractions. In the same surveys, 1% of three-year-olds and 3% of five-year-olds had missing teeth, most likely meaning they were extracted. Significant variations between different regions and areas of the country exist yet again (Davies et al., 2013), and are closely related to socioeconomic status. Previous studies have suggested that children from poorer socio-economic areas are more likely to have received extractions rather than fillings (Tickle et al., 2002a; Telford et al., 2012).

Due to those children’s young age, poor ability to cooperate, or complex treatment needs (Davies et al., 2008), many would have received extractions under GA. Indeed, admission for tooth extraction was the main reason for hospital admissions of five- to nine-year-old children in England in 2013 (Health and Social Care Information Centre 2013a). Worryingly, the real numbers of children receiving the treatment might even be much higher than what hospital admission statistics reveal, as many dental GA lists were reported to not be registered on such statistics databases (Robertson et al., 2012). Moreover, these numbers appear to have increased every year, causing strain on service providers, and causing referring GDPs to voice their concerns with waiting list times (Threlfall et al., 2007a). An evaluation of the service in Yorkshire and Humber revealed that some children had
to wait for up to 81 weeks for their surgery (Ni Chollai et al., 2010). Leaving those children without untreated caries for such long periods, with many of them already having developed sepsis, is unacceptable and denies them access to treatment that can greatly improve the quality of their lives (Malden et al., 2008).

The current approach to managing high-risk children in England is not ideal, as it involves either leaving the disease untreated or tackling it at a stage where radical treatment by extractions will be needed. Focus on prevention and oral health promotion remains poor and impeded by challenges in practical application in primary dental practice and the wider environment. It is important to realise that once a child develops dental caries they are more likely to develop more caries and more likely to suffer from pain and sepsis (Milsom et al., 2008; Pine et al., 2006). Hence, despite the ongoing debate on how GDPs can best manage caries in young children once it has been developed and diagnosed (Tickle et al., 2002b; Duggal 2011; Kidd 2012), one thing seems clear: prevention is of paramount importance and a change in the approach to preventive care delivery in this cohort of children is needed. In fact, the Steele Report in 2009 stressed the importance of reforming the way preventive care is provided under the NHS (Steele et al., 2009), while other authors have already pointed out the need to design intensive preventive interventions for children suffering from the disease and assess their efficiency (Milsom et al., 2008).

2.5.3.5 Future directions of dental care under the NHS in England

Since 2011, the NHS has been trying to improve focus on prevention (Department of Health 2014). New plans for oral health assessment and clinical pathways, and three new schemes for remuneration of primary dental care continue to be piloted, with the aim of supporting GDPs in delivering better quality care and more prevention. Initial evaluation has shown that new models of care were acceptable to both dental care workers and patients, have facilitated the use of a skill mix in practice, and might have helped reduce caries risk (Department of Health 2014). However, the data generated don’t provide a completely reliable prediction of full implementation, because the financial system of those practices remained in some sense protected to ensure their willingness to take part. Furthermore, clinical data were entered in different practices without a chance for assessing their reliability. For example, a
child might have been recorded to have a reduced caries risk following treatment, when in fact the treatment has only dealt with the current problem but not dealt with the root causes of risk. Moreover, the pilots also ran into some issues that are of great importance. First, increased clinical time needed to deliver quality care meant reduced access. Second, children that are high-risk need to be recalled every three months, according to the National Institute for Clinical Excellence (NICE) guidelines (National Institute for Clinical Excellence 2004), but were frequently seen at longer intervals, suggesting that GDPs still held on to their beliefs that recall intervals are six months long (Department of Health 2014). This shows the importance of updating knowledge and training in clinical practice, on top of financial remuneration. Nonetheless, the pilots still provide a positive move away from the dreaded UDA system that has failed to improve prevention.

Policy makers in NHS England recently acknowledged that there is a growing health and wellbeing gap in English society (NHS England 2014b). They realised that billions of pounds are being spent on preventable diseases. As such, they deemed that more focus on disease prevention is needed, including the prevention of oral health conditions such as dental caries. The ‘Five year Forward view’ of the NHS advocates improving disease prevention by promoting behaviour change targeted prevention as well as supporting national and locally-tailored legislation to create a healthier environment that sustains behaviour change (NHS England 2014b). Moreover, the document advises on empowering patients by providing them with more information about their health and their treatment, and engaging better with local communities to address their needs. In addition, it advocates for a change in the model of health care provision both nationally and locally, including better multispecialty cooperation, to improve the quality of services.

However, encouraging as these recommendations might be, the reality of the future might not be as optimistic. The same document acknowledges that by 2021, the NHS might be running a 30-billion-pound deficit, unless demand, efficiency and funding are improved. It also acknowledges that such plans may not come into fruition unless political will for change exists, something that, unlike evidence-based research, is never reliable. Disappointingly, the document does not outline possible approaches to improving dental care, and reducing the numbers of children with high caries risk, outside those general preventive directions.
2.6 Management of childhood caries under GA

The fact that there seems to be failure to promote oral health in high-caries-risk children in England has meant that over the years, a large number of children have been referred for management of caries, mostly by dental extractions, as a last resort. The procedure is often performed under GA. Despite the risks involved in this, many families end up stuck in cycles of treatment and disease in their children, with a lack of focus on caries prevention, as will be discussed in this part of the literature review.

2.6.1 Paediatric dental extractions under GA in England

As pointed out earlier, a large number of young children with caries end up requiring dental extractions under GA. This issue has become a hot discussion topic. Moles et al. (2009) reported that almost 400,000 children (under 17 years old) were admitted to hospitals for dental extractions between the years 1997 and 2006 in the UK, mostly from deprived areas. Their study reported that almost 22,000 of them were admitted more than once, with some having up to seven extraction episodes.

Fast forward to the more recent data on hospital admissions in 2013, and the issue seems to persist, if not become more widespread. There were 60,000 children (under 18 years old) admitted for extractions in 2013, more than half of them (34,000) were nine years or younger (Health and Social Care Information Centre 2013b). In fact, this recent data shows that dental extraction is now the most common cause of hospital admission for children aged five to nine years in England.

At such a young age, a large number of those extractions are undertaken under GA. In fact, 3% of parents of five-year-old and 6% of parents of eight-year-old children surveyed in 2013 across England reported that their child had a tooth or more extracted under GA (Health and Social Care Information Centre 2015a). This over-reliance on Paediatric GA services as a way to manage caries in high-risk children is a source of concern.

Treatment under GA is a high-end procedure that is relatively expensive (Jameson et al., 2007). Moreover, the procedure causes distress to both the children and their
parents. Indeed, previous studies have suggested that a significant number of children show signs of distress upon inducing GA (Bridgeman et al., 1999, Hosey et al., 2006a). Meanwhile, a qualitative investigation revealed that parents often feel guilty, fearful and worried as their child’s GA appointment looms (Amin et al., 2006). Furthermore, the treatment is associated with morbidity that, in worst cases, can include death. A previous study has suggested that almost two-thirds of children undergoing dental extractions under GA suffer from some form of morbidity such as pain, bleeding, nausea and drowsiness in the first 24 hours after the procedure, while almost one quarter still reported some morbidity a week later (Hosey et al., 2006a).

The quality of referrals for GA by GDPs is questionable. In fact, Aspinall and Blinkhorn (2007) reported that almost two-thirds of GA referrals from GDPs in Salford, England were not up to the General Dental Council’s (GDC) standards as about 40% of those referrals were for children that could have been possibly managed under local anaesthesia with behavioural management or supplemented by inhalation sedation, and 60% of the parents of those children said they did not receive information on other options for treatment. Indeed, an international investigation into challenges faced by primary care dentists in providing treatment for children suggested that GDPs in England might lack confidence in treating young children as they reported that treating children is often troublesome, stressful and time consuming (Pine et al., 2004). Unfortunately, similar information regarding GA referrals in the catchment area of KCH is not available, and the reasons for increasing numbers of children referred to the hospital for dental extractions under GA require investigation.

Using GA extractions as an approach to tackle a disease that is ideally completely preventable is similar to using a sledgehammer to crack a nut. Recently, the large number of children receiving the treatment has started to not only concern the dental community but also the general public. The issue has now been discussed in multiple newspaper and television reports (BBC 2012; The Times 2014; Channel 4 2014).
2.6.2 Repeat treatment under GA

Despite the seriousness of the GA procedure, multiple studies reported on a relatively high repeat of caries treatment under GA in the UK. For example, analysis of records at Guy’s Hospital in London showed that out of 3,897 children treated, 10% had a repeat dental GA within the years 1992-1997 (Harrison and Nutting 2000). In Leeds, 9% of children that had such treatment in 1997 had it repeated within the first six years, and 72% of the teeth extracted at the repeat procedures were caries free or unerupted at the time of the initial treatment (Kakaounaki et al., 2011). Meanwhile, in Liverpool, 12% of 278 children treated in 2003 had previous treatment. The average age of those children was around five years, meaning even more treatment might be awaiting them in the future (Albadri et al., 2006). In Scotland, a large multicentre national audit reported that as many as 25% of patients referred for treatment under GA were repeat cases (Macpherson et al., 2005). In Manchester, a study of six hospitals revealed that 33-59% of the children treated come from families where the child or a sibling had the treatment before (Goodwin et al., 2015a). Finally, a study at KCH reported that 23% of the children attending for extractions under GA have had dental treatment under GA before, while a further 24% have a sibling that did. There were cases where one, two, three or four siblings had the treatment before (Olley et al., 2011).

These high repeat rates and apparent ‘familial lines’ of children needing treatment suggest that those children come from high-risk families, and that failure in post-operative prevention, not inadequate assessment, causes these high repeat rates. In fact, a couple of qualitative studies seem to solidify these findings. In one study, parents of 23 children coming for repeat treatment and 23 children that were having their treatment under GA for the first time were interviewed (Sheller et al., 2003). The authors suggested that children coming for repeat treatment were more likely to be still using a nursing bottle at the time, brush their teeth with no help from their parents, and come from a difficult socioeconomic situation.

In another study, parents of children who have developed new caries lesions after GA and of those who remained caries free were interviewed (Amin and Harrison 2007). The researchers reported that parents of children who developed more caries
did not seem to have any immediate plans to change their oral health practices, were less receptive to advice, were more permissive in their parenting and expressed lower self-efficacy for controlling their child’s oral health.

2.6.3 Lack of prevention in the GA referral pathway

Children that receive dental extractions under GA by paediatric dentistry specialists in secondary care can be referred from multiple sources, namely, they are referred by GDPs in primary dental practice, accident and emergency departments, General Medical Practitioners and community care. At KCH, three quarters of the children are referred by their GDPs, and a quarter is referred through other referral pathways (Olley et al., 2011). GDPs are asked to refer children whose age, cooperation or treatment needs make management using behavioural management, local anaesthesia and in some cases inhalation sedation not possible in accordance with the guidelines on the use of GA in Dentistry (Davies et al., 2008). As such, it is understandable that children receiving GA are often young, uncooperative and with multiple decayed teeth. Hence, treatment under GA is usually radical and a large number of teeth are usually extracted in each session. A previous study in Glasgow reported that 74% of the children undergoing the treatment had between six and sixteen teeth extracted (Hosey et al., 2006b). Another study of all GA service providers in Scotland reported that the number of teeth extracted per child was about five (Macpherson et al., 2005).

Despite cycles of treatment and disease in those high-caries-risk families, the GA referral experience is not being used to support caries prevention. In fact, the recommended pathways for GA (Adewale et al., 2011) and sedation (The Dental Faculties of The Royal Colleges of Surgeons and the Royal College of Anaesthetists 2015) in England do not exclusively include the delivery of oral health education or support for prevention at any stage of care for those children. Furthermore, the pathways fall into the pitfall of ending their recommendations at the point of treatment delivery, and do not provide secondary care providers with clear recommendations on follow-up after the procedure. As caries is a chronic disease, the delivery of treatment should not be viewed as the end point of care but rather a mere stage in disease control that needs to be followed by prevention to reduce risk.
Figure 1 displays the GA care pathway, and figure 2 the sedation pathway in England.

8. A SUGGESTED CARE PATHWAY

Figure 1: Children’s General Anaesthesia care pathway in England (Adewale et al., 2011)
The lack of appropriate oral health education

GDPs have been struggling to deliver the preventive care recommended in DBOH (Olley et al., 2011; Pearce and Catleugh 2013). As such, families of children referred for GA are reported to have received little information outside of advice on the frequency of toothbrushing and limiting the intake of obvious sources of sugar such as sweets. Furthermore, only few received fluoride varnish application.

For example, a study in Wales reported that about three quarters of families attending for GA extractions said they had received some oral health advice from their GDP. Half reported receiving advice on toothbrushing frequency but only 30% had advice on not rinsing after brushing and less than 10% received advice on fluoride or received fluoride varnish application (Karki et al., 2011). In Manchester, some of the parents of a similar population reported not receiving advice from their...
GDP regarding toothbrushing with an adult toothpaste or reduction of sugar consumption. (Goodwin et al., 2015b)

In London, similar findings were reported by Olley et al. (2011) regarding children attending for extractions under GA at KCH. In that study, three quarters (72%) of the children’s parents said they had received previous oral health advice on toothbrushing and limiting sugar intake. Little advice was reported to be given on fluoride toothpaste concentration (45%), fluoride mouth rinse (26%), fluoride varnish (8%), or fissure sealants (10%). Over half (54%) of those below seven years old brushed their teeth on their own and 40% attended a dentist only in case of emergency.

To explore the issue further, the author of this thesis performed a qualitative study for his MSc (Aljafari et al., 2014). The parents of 29 children referred for extractions under GA were interviewed to explore their dental knowledge and their opinions on promoting oral health in their families. Many parents reported that their children did not receive oral health advice or fluoride varnish application before. The parents seemed to understand the importance of toothbrushing and sugar limitation, and described it as ‘general knowledge’ and ‘common sense’. However, parenting challenges seemed to restrict their ability to control the child’s diet and establish toothbrushing. In addition, it was interesting to note that only a few seemed to understand that fruit juice was cariogenic.

2.6.3.2 The lack of follow-up arrangement and attendance

Children referred for dental extraction under GA are well known to be irregular dental attenders (Olley et al., 2011; Goodwin et al., 2015a). Amin and Harrison (2007) suggested that poor dental attendance prior to the GA referral is a strong predictor of follow-up attendance. As such, it comes as no surprise that many children attending for caries management under GA do not attend for follow-up after GA. In fact, previous studies in different populations reported that the dental attendance rate following GA treatment ranges between 13% and 77% (Jamieson and Vargas 2007; Hosey et al., 2009; Mathu-Muju et al., 2010; Sheehy et al., 1994).

In the USA, some authors attempted to tackle the issue by introducing an oral health intervention for those families during their GA referral to varying success. Picard et
al. (2014) reported that 78% of families that have received information delivered in
the form of visual aids and 52% of those that received verbal advice during their
referral attended a follow-up visit two weeks after GA. However, longer term
follow-up was not as successful, as Primosch et al. (2001) reported, only 31% of
those given verbal and written advice during their GA referral attended a follow-up
visit six months after GA.

To the author’s knowledge, no similar interventions have been evaluated in the UK.
Protocols for following-up the children after the treatment remain different from one
service provider to the other, with most opting to discharge the children to their
GDP. For example, a study of service providers in Yorkshire and Humber has
revealed that almost three quarters of the service providers discharge the child to the
GDP after treatment, 10% provide follow-up visits, 10% provide follow-up over the
phone or other methods and around 5% do not provide any form of follow-up (Ni
Chaollai et al., 2010). It is important to note that the study also reported that over
half of the discharge letters provided to the GDPs did not include any instructions
regarding follow-up and recommended preventive care. At KCH, children are
discharged to the referring GDP following the GA procedure. The discharge letter
contains information regarding the treatment provided, but does not include
recommendations for follow-up and preventive care.

2.6.4 Families’ call for more support with caries prevention

Lewis et al. (2010) noted that it is important to remember that despite economic
difficulties, preoccupation with daily life, and the sense of inevitability of tooth
decay in younger children, parents are indeed interested in improving their
children’s oral health, but sometimes struggle to find the support necessary.
Children attending for dental extraction under GA are clearly at high risk for
developing more caries. It is therefore disappointing to note that despite that, they
seem to learn very little regarding caries prevention during their GA referral
experience. Furthermore, follow-up after treatment is poor.

Families of children undergoing dental extractions under GA do need support.
During semi-structured interviews, parents of such a cohort in the US reported
feeling helpless to stop dental caries in their children and considered it an inevitable
disease, citing socioeconomic difficulties and stress as an important reason why (Amin et al., 2006). Parents of the same cohort in England might feel the same.

Families of children referred for treatment under GA in England are indeed requesting support to improve their oral health. Parents surveyed in Wales suggested leaflets (89%) or an internet website (67%) as a platform to deliver oral health education (Karki et al., 2011). At KCH in London, a majority (78%) of parents requested help in promoting oral health in their families (Olley et al., 2011). They suggested methods such as: toothbrushing programmes in schools/nurseries (60%), oral health programmes at their pre-operative assessment clinic (55%), internet website (64%), leaflets (63%), and DVDs (49%).

The author’s MSc research confirmed previous findings, as the majority of parents interviewed demanded more information on how dental caries can be prevented, and requested more support (Aljafari et al., 2014). They suggested that the delivery of oral health education to children and families through the internet, schools, or video-games might be acceptable and hence should be investigated as part of support to be provided to those families.

2.6.5 The Paediatric dental GA service pathway at King’s College Hospital (KCH)

King’s College Hospital (KCH), is one of the biggest providers of paediatric dental GA services in England. The hospital’s main catchment area includes the London Boroughs of Lambeth, Southwark and Lewisham. The Paediatric Dentistry department runs two types of GA lists for children, one is an extraction only list, and the other is an oral rehabilitation list that includes various types of dental treatment. Children are usually discharged to their GDP following the GA unless the paediatric dentistry specialist decides otherwise. Young children with dental caries are mostly placed on the extraction only list to provide radical treatment. The number of children admitted for dental extractions under GA has been steadily increasing. Hospital records show that 620 children were admitted in 2009-2010 and 790 in 2010-2011.
Olley et al. (2011) reported that the children attending KCH for dental extractions under GA were seven years of age in average and that the female to male ratio was six to five. Most were white British (43%) or black British (41%). The rest were from other ethnicities and 15% had lived in another country previously. The children seemed to come from households across the socioeconomic spectrum. A third of accompanying parents were unemployed, 23% of the remainder had non-manual professions, 22% had skilled manual professions, and 20% were unskilled or partly skilled. The majority of parents (64%) lived in London and planned to stay at their current address for more than ten years.

Figure 1 displays the GA pathway at KCH once a child is referred by a GDP. The pathway has three main steps: assessment by paediatric dentistry specialist, medical pre-assessment, and GA procedure. Medical pre-assessment is offered to all children due to the fact that the hospital is positioned in a multicultural area with various ethnicities of children referred for treatment under GA. This takes place in a medical pre-assessment clinic at the Day Surgery Unit (DSU), and is overseen by trained medical nurses that will do the necessary medical history checks, height and weight records and request any further investigations such as blood tests for every child. Unfortunately, cooperation between the paediatric dentistry department and the clinic is limited, and the family is not offered any oral health education or support during the appointment, despite the appointment being one of the rare times such hard-to-reach families come in contact with health professionals.

The utilisation of a step of within the hospital’s GA pathway to deliver an educational oral health intervention is an option that should be considered. After all, this is a time when the families might have dental health in mind and seizing the opportunity might provide a ‘teachable moment’ in which to provide preventive support (Flocke et al., 2014). Within the KCH GA care pathway, the medical pre-assessment appointment might present the most suitable stage of care to deliver such an intervention for the following reasons:

1. Families of children referred for dental extraction under GA were not being provided with any oral health support during this appointment. Utilising it to deliver support for prevention fulfils the NHS’s recommendation of making every contact with patients count (Bailey et al., 2012).
2. Parents have suggested in a previous study that they will welcome an intervention during this appointment (Olley et al., 2011).

3. The scheduling of patients for dental assessment by paediatric dentistry specialists does not allow the families to receive an extensive oral health intervention on the day of dental assessment upon referral.

4. The day of the GA procedure is not an appropriate time for delivering an oral health intervention, as the child and the family as a whole tend to be more anxious and preoccupied with preparation for surgery.

5. Families would be unlikely to attend a separate appointment to receive an oral health intervention, as they are well known to be poor dental attendees (Hosey et al., 2009).

Figure 3: Children’s General Anaesthesia care pathway at King’s College Hospital
2.7 Promoting oral health in high-caries-risk children

It has become apparent that high-caries-risk children in England, specifically those referred for GA, are in desperate need of support. The issue of caries risk in children is, as discussed, a product of various socioeconomic and behavioural factors. As such, this section will explore the importance of a multidimensional children’s oral health promotion strategy. Furthermore, it will look at the role of targeted oral health interventions, an important component of oral health promotion.

2.7.1 Definition of health promotion

Health promotion can be defined as ‘the process of enabling people to increase control over, and to improve, their health to reach a state of complete physical, mental and social well-being’ (WHO 1986). Health promotion in a society is achieved by multiple levels of action including ‘upstream’ actions such as reducing socioeconomic inequality, and ‘downstream’ actions such as health interventions targeting specific health determinants.

Promoting oral health in young children from high-risk families can be an extremely complicated process that requires the cooperation of multiple partners across the board. Oral health promotion strategies can include components that are either universal, aimed at the whole population, or targeted, aimed at high-risk individuals or populations. Those two approaches have its strengths and weaknesses as discussed by Rose (1992). Watt (2005) suggested that the best approach to preventing oral diseases would be to use a combination of targeting high-risk individuals, identified by screening, and high-risk populations, identified by socioeconomic or epidemiological factors.

2.7.2 Importance of multidimensional health promotion

The Ottawa Charter remains perhaps the most important source-document for health promotion planning. This document, issued in 1986 by the WHO, laid out the organisation’s strategy to reduce health inequalities and promote health (WHO 1986). The charter included five main points of action:
1. Building a healthy public policy, meaning that the responsibility for health promotion does not only fall on health policy makers, but all national policies need to aim to improve the health of the population.

2. Creating a supportive environment, whether that is the natural environment, built environment, community, or workplace.

3. Strengthening community action and enhancing social support.

4. Developing personal skills, including: provision of information, health education, and enhancement of life skills.

5. Re-orienting health services to improve support provided to individuals and communities, and improve communication between the health sector and broader social, political and economic components.

2.7.2.1 Recommendations for health promotion in the UK

To tackle health inequalities in the UK, the government launched an independent inquiry under Sir Donald Acheson in the 1990s (Watt and Sheiham 1999). The Acheson report was published in 1998 (The Stationery office 1998), and consisted of 39 recommendations that fall in line with what the Ottawa Charter supported, 24 of which were related directly or indirectly to oral health. These recommendations included: health promotion in schools, improvements in foods provided both at school and to the community at large, elimination of food poverty, increasing breast feeding, programmes on smoking cessation, reducing accidents, easing access to services for the elderly, and water supply fluoridation.

More recently in England, the Secretary of State for Health sanctioned an independent review to propose the most effective evidence-based strategies for reducing health inequalities (Marmot 2010). The review ‘Fair society, healthy lives’ by Marmot (2010) suggested six points of action:

1. Give every child the best start in life.
2. Enable all children and adults to maximise their capabilities and have control over their lives.
3. Create fair employment and good work for all.
4. Ensure a healthy standard of living for all.
5. Create and develop healthy and sustainable places and communities.
6. Strengthen the role and impact of ill health prevention.
The review also stressed that action needs to be multiagency and multidimensional, involving the central and local government, the NHS, private sectors and community groups. In addition, the review introduced the concept of ‘proportionate universalism’, which means that health promotion action needs to be universal, but with a scale and intensity that is proportionate to the level of disadvantage.

2.7.2.2 Children’s health promotion in England

2.7.2.2.1 National level programmes

In an effort to promote children’s health, a number of national initiatives have been sanctioned. For example, the ‘Healthy Child Programme’ is a general health promotion initiative created to provide a universal access health visitors service, as well as a more limited family nurse partnership service targeting high-risk families (Department of Health 2009b). However, the programme remains of limited access and is still a work in progress, as there are only 4,000 visitors in England, and only 16,000 families served by the family nurse partnership programme (Department of Health 2013).

The National healthy schools programme is another example. It was developed in 1999, and aims to support children in developing healthy behaviours, raise pupil achievement, reduce health inequalities, and promote social inclusion (National Centre for Social Research 2011). The schools taking part in the programme were expected to develop a school policy that will achieve 41 criteria that fall under four main themes: provision of personal, social and health education, encouragement of healthy eating, encouragement of physical activity, and promotion of emotional wellbeing. A report evaluating the impact of the programme on schools that have taken part in the programme for two years has suggested that although changes on school level were noticeable, the extent of the effect on individual pupil’s was questionable, as no changes in pupils’ health related knowledge or behaviour were noticed (National Centre for Social Research 2011). The authors suggested that it might be that the timeframe for evaluation was too short (two years), or more likely, that the powerful parental and societal influences are simply beyond the school’s control.
Sure Start is another example. The programme started in 1999 as a wide initiative to improve the wellbeing and school readiness of children from a disadvantaged background, but has since been reduced to provision of child care, health support and parenting support through 3,500 Sure Start centres spread across the country, mainly in socially deprived areas (Johnson 2011). The impact of the programme on five-year-old children and their families was evaluated in 2010 (Department of Education 2010). The results suggested that the programme does have a positive effect on parental wellbeing and children’s health. Parents of children taking part had greater life satisfaction and displayed better parenting skills, while the children were less likely to suffer from obesity. However, no impact was detected on many other child wellbeing outcomes. It is difficult to confidently rely on the outcomes of this evaluation, as authors used data collected two years prior by different researchers as a control group.

A qualitative investigation that involved parents from South London participating in the ‘Sure Start’ programme has suggested that those parents had an adequate knowledge on maintaining oral health; however, they lacked knowledge on the amount of sugar in different foods (Daly et al., 2010). The parents in that investigation also reported various barriers to applying that knowledge, including lack of confidence in parental skills, lack of motivation, widespread availability of sugary foods, and lack of local child-friendly dentists. It was interesting to note that along with costs, the study reported that dental anxiety emerged as a big factor in dental attendance. The authors concluded that the ‘Sure Start’ programme was reported to help parents overcome these barriers through social support and improvement of parental skills.

2.7.2.2 Local level programmes
In addition to the aforementioned national initiatives to promote children’s health, there have been reports of a few local initiatives to promote oral health in different areas around the country. For example, CDS services in east London started the ‘Happy teeth’ initiative in 2009, a school-based oral health intervention that consists of fluoride varnish applications and school dental screenings for three- to six-year-old children, combined with oral health promotion for parents (Evans et al., 2013b). The programme proved acceptable to the school staff, participating parents, and
children that took part, but about one-third of those invited did not take part. The authors suggested that it might be due to the multicultural nature of the study area, as many parents might have benefited from information in other languages, while others might have been hesitant to take part since the presence of alcohol in fluoride varnish was made explicit.

Another example is the ‘Baby teeth do matter’ oral health promotion programme in Manchester (Brocklehurst et al., 2013). The programme was directed towards children with poor oral health and dental attendance and included networking with local schools and ‘Sure Start’ centres to promote dental attendance, providing families attending their dental appointments with oral health advice, brochures, and stickers, and finally, providing local dentists with a recommended pathway of care for young children presenting with or without dental caries in an effort to reduce the demand on the hospital GA service. Within two months almost 3,500 children were reported to have accessed care for the first time at the 200 participating dental clinics. Interviews with participating dentists suggested that they thought the programme was successful. Communication with other dentists and health professionals, simplicity of advice, and locality of programme leadership were noted as keys to success (Brocklehurst et al., 2013). It is important to note that this programme provided participating dentists with suitable financial incentives, which could be a vital part in designing any GDP based oral health promotion programme.

2.7.2.2.3 Current limitations

A common issue with all the initiatives that have been discussed is that they are all commissioned and monitored locally, meaning they do not offer universal coverage and there are significant variations in how these initiatives are funded and applied locally. Changes in wider economic and political atmosphere also contribute to this inconsistency. Moreover, none of those initiatives have oral health at the heart of the programme. Hence the amount of support the participating families receive regarding oral health is questionable at best, while providers of the support such as teachers, nurses, health visitors, etc. do not seem to be receiving appropriate training and guidance in relation to oral health.
2.7.2.3 Childsmile – an example of a successful children’s oral health promotion strategy

To explore how future oral health promotion for children in England can be planned and approached, it is useful to examine how oral health promotion for children in Scotland has been delivered.

2.7.2.3.1 Overview of children’s oral health in Scotland

Children’s oral health in Scotland used to be amongst the worst in Europe. In 2004, about half (49%) of five-year-old children were reported to have had obvious caries experience with an average dmft of almost five in those affected (Merrett et al., 2004). Moreover, the same authors reported that the distribution of the disease was closely related to socioeconomic deprivation, as evident by the fact that almost 70% of five-year-olds from the most deprived socioeconomic class (Depcat 7), according to the Scottish IMD (McLoone 1995), had obvious caries experience. Distribution of the disease varied between different areas. Finally, Merrett et al. (2004) reported that in Greater Glasgow, which includes many deprived areas, 58% of the children had caries. Registration for dental health was poor amongst young children (30%) (Shaw et al., 2009), and focus on prevention was minimal.

2.7.2.3.2 Overview of the Childsmile programme

The first elements of the Childsmile programme were initiated in 2006, following the Scottish Executive’s 2005 policy document ‘An action plan for improving oral health and modernising dental services in Scotland’ (Scottish Executive Health Department 2005). This plan aimed to address the high incidence of dental caries in children, the inequality in its distribution, the poor access to dental care in some families and the lack of focus on dental prevention in government and health policies (Macpherson et al., 2010). The programme was developed in accordance with the points of action recommended in the Ottawa Charter and the process involved different stages before the programme was fully rolled out. The programme consists of three main parts (Macpherson et al., 2010):

1. **Childsmile core**: a universal programme to that provides free toothbrushes, fluoride toothpaste, and feeding cups to all children through health visitors and nurseries. In addition, all children in nurseries are given the opportunity
to participate in a supervised toothbrushing initiative with a 1,000 ppm fluoride toothpaste.

2. **Childsmile practice**: a targeted intervention that is focused on children from socioeconomically deprived areas. Children identified as being at risk are referred to the programme by their health visitor. Dental health support workers provide the family with support including facilitating regular dental attendance, dental health advice and education, and linking families to other health improvement initiatives. Upon attendance at the local dental practice, Extended Duty Dental Nurses (EDDNs) provide toothbrushing and diet advice, and fluoride varnish and fissure sealant are applied as required.

3. **Childsmile nursery/school**: Another targeted initiative that also focuses on the most deprived areas. It entails bi-annual application of fluoride varnish to children in nurseries and schools. Oral health education is also delivered and registration of children with a local dentist is facilitated.

### 2.7.2.3.3 The impact of Childsmile on Scottish children’s oral health

A few studies have already evaluated the impact that Childsmile had on the oral health of children in Scotland. For example, a study suggested that the percentage of three-year-old children in Greater Glasgow and the Clyde with obvious decay experience dropped from 26% in 2006 to 17% in 2009, following the initial phase (McMahon *et al.*, 2011). Another study documented the close relationship between improvements in the oral health of five-year-old children and the introduction of toothbrushing programmes (Macpherson *et al.*, 2013). A more recent study by Blair *et al.* (2015) has suggested that any oral health inequalities between children in Glasgow and other parts of Scotland have been largely eliminated, although a socioeconomic gradient in disease burden continues to exist.

One can get an even better understanding of the impact that Childsmile might have had by looking at the reported oral health of children in Scotland in 2014; obvious caries experience in five-year-olds dropped to 32% across the country and to 35% in greater Glasgow, the average dmft dropped to almost four, and the inequality in distribution of the disease according to socioeconomic deprivation was reduced, although direct comparison with deprivation data from 2004 is not possible due to changes in the indices used (The Scottish Dental Epidemiology Co-ordinating
Committee 2014). These findings cannot be directly linked to the implementation of Childsmile. However, it is fairly likely that these improvements are indeed linked to the programme, as concluded by noting the long absence of any improvements in children’s oral health prior to its introduction, and the absence of improvement in other parts of the UK where the programme was not introduced.

2.7.3 The role of targeted oral health interventions

A health intervention can be defined as any effort to promote positive health practices or reduce negative health practices, leading to improved health. Examining the Ottawa Charter, the Acheson report, the Marmot review, and the Childsmile programme, it can be concluded that a successful oral health promotion strategy needs careful planning, multiple stakeholder involvement and political and economic commitment on a national level. In order to reduce oral health inequality while improving the oral health of the population overall, two parallel approaches are required: universal oral health promotion to be provided to children, and, a targeted approach that focuses on children deemed to be under high risk. We have seen that families of children under high caries risk, such as those referred for dental extractions often display poor oral health knowledge, literacy, attitudes, and practices. As such, there is a need to design a variety of targeted oral health interventions to address those issues.

2.7.3.1 Strengths and limitations of targeted interventions

Rose (1992) suggested a high-risk approach where high-risk individuals are identified through screening and provided with preventive advice and care accordingly. Rose argued that this approach has several strengths: first, the preventive care delivered is tailor-made to the high-risk individual’s needs. Second, there are no interferences with care provided for individuals not at risk, and as such it might be more cost effective. Moreover, such an approach is more popular with health professionals, as it fits well with the traditional clinical approach to prevention. Finally, the high-risk approach might reduce the risk to benefit ratio, as less individuals are exposed to an intervention unnecessarily.
In the same time, Rose also acknowledged the limitations of this high-risk approach. For a start, screening for high-risk individuals might be difficult and costly and not always sensitive or specific enough. However, this might not be an issue in the case of children referred for dental extractions under GA, as they have already attended for dental care and have been identified as high-risk due to their caries experience, which remains the strongest predictor of the development of more caries (Litt et al., 1995; Mejare et al., 2014). As such, no additional costs for screening are needed.

However, other limitations to the high-risk approach discussed by Rose do apply in the case of high-caries-risk children referred for dental extractions under GA. The first limitation discussed was the possible cost of the intervention. Hence, assessing cost effectiveness of developed interventions will be necessary. The second limitation was the poor effect this high-risk approach might have on the oral health of the population as a whole; as the number of children referred for GA is relatively small compared to the whole population, targeting only those children will probably leave only a small effect on the prevalence of the disease in the population as a whole. Finally, and perhaps most importantly, the impact of a high-risk approach on the root causes of diseases influenced by behavioural choices, such as dental caries, is questionable, and at best temporary, unless complemented by a wider population approach that supports good health. Individuals are not expected to significantly change and sustain their behaviour if unhealthy cultural norms continue to exist. This is why targeting high-risk individuals should be supplemented by a universal approach across the population to create a suitable healthy environment.

Despite the presence of such important limitations, health researchers should not give up on developing, researching, and delivering targeted oral health interventions to high-risk individuals. Not only do health care workers have an ethical and moral duty to encourage good oral health in those individuals, but it is important to realise that relying solely on a population approach has its own limitations such as acceptability, practical feasibility and costs (Rose 1992). Most importantly, a population-based approach on its own fails high-risk individuals, and in fact increases health inequalities (Roberts-Thomson 2012; Lorenc et al., 2013).
2.7.3.2 The impact of oral health interventions for children

It is important that oral health interventions start early on, as it is suggested that the age of 19 to 31 months is the time most critical in oral colonisation by Mutans Streptococci (Caufield et al., 1993). There are many examples of targeted oral health interventions that aimed to improve the oral health of children around the world. Such interventions frequently targeted parents in preschool children, and children, parents, or both in school children. However, evidence for reduction of caries incidence remains more limited.

2.7.3.2.1 Impact on oral health knowledge and practices

Surveying the literature, it is clear that targeted interventions that included the delivery of oral health advice frequently led to improvements in knowledge, and in many cases, oral health practices. Dickin et al. (2013) delivered eight interactive diet lessons to parents of three- to eleven-year-old children from low-income families in the USA and reported positive changes in the families’ dietary practices. In an RCT in the UK, mothers of eight-month-old infants that were provided with oral health education through health visitors reported that their children had a lower intake of sugary drinks, better toothbrushing habits, and better rate of registration with a dentist (Hamilton et al., 1999). Establishing long-term contact with some low-families to deliver an intervention in multiple occasions is sometimes difficult. Martignon et al. (2006) reported that even a one-time, 40-minute, oral health session given to parents of children from low-income families in Colombia led to positive changes in children’s plaque control, parents’ oral health knowledge and reported oral health related behaviour. Those improvements were remarkable one month following the intervention, and were still present six months after, although there was a relative decrease, making their long-term retention questionable.

It is important that children themselves are targeted. A Cochrane review of interventions to improve oral health at primary schools has suggested that they have had a positive effect on children’s oral health knowledge, and plaque score (Cooper et al., 2013). Only one of the studies in the review was in the UK. In that study, researchers evaluated an oral health education programme for ten-year-old children that consisted of four oral health education sessions along with three home projects (Worthington et al., 2001). The authors reported that the programme was found to
increase the children’s oral health knowledge and improve their plaque scores for up to seven months.

There are examples of oral health interventions directly targeting children starting at an age as early as three years old. In The USA, an interactive oral health education for children aged three to five years improved their oral health knowledge immediately after the intervention (Grant et al., 2010). However, those improvements were not sustained after two weeks. In Israel, providing six-year-old children with one-on-one toothbrushing instructions during sessions that took place over a period of three weeks was reported to increase their toothbrushing efficacy for up to four months (Livney et al., 2008). In Ireland, toothbrushing messages were delivered on television during children’s programming for a period of six weeks (Friel et al., 2002). The messages included: using the right amount of toothpaste, brushing twice a day for at least three minutes, and using a new toothbrush if the old one is worn out. In addition, the messages were supplemented by an interactive oral health talk that was delivered by a dental nurse to around 1,500 seven- to twelve-year-old children. The children taking part in the interactive talk were found to have developed a significantly better understanding of effective toothbrushing, irrespective of their age.

It is important that interventions targeting children utilize interesting, novel and interactive methods, as those methods are more engaging and might have the potential to provide motivation beyond mere education. A four-armed trial in Brazil delivered oral health education to children aged seven to nine years using four different methods reported that children that received oral health education through an interactive ‘smiling robot’ showed more improvements in their oral hygiene practices compared to those that learned through oral presentations or tooth models (Rodrigues et al., 2003).

2.7.3.2.2 Reduction in caries incidence

Despite some evidence for improvements in oral health knowledge and practices, evidence for reductions in caries incidence remains more limited and of poorer quality. In the UK, Blinkhorn et al. (2003) reported that providing oral health education sessions to preschool children and their mothers every four months for a
period of two years led to better oral health knowledge and toothbrushing skills. However, there were no statistically significant differences in plaque levels or caries experience. In another study in the UK, delivering verbal advice on oral hygiene and diet, as well as providing free toothbrushes and a 440 ppm toothpaste for families of infants, during a home health check-up visit at the ages of eight months and twenty months, did not lead to significant reductions in caries incidence (Whittle et al., 2008), although this could be due to the low fluoride content in the toothpaste used. In Belgium, a six-year programme for primary school children that included the provision of an oral health examination and a one-hour caries prevention lesson once every year failed to reduce caries or improve oral health practices (Vannobbergen et al., 2004), although that might have been due to the low frequency of the lessons given or the lack of an interactive learning approach. In Indonesia, giving eight- to twelve-year-old children residing in rural areas weekly supervised toothbrushing sessions and monthly oral health education (Hartono et al., 2002), led to significantly better oral health knowledge and lower plaque scores than those that did not. However, again, there was no difference in caries experience.

Some studies did report a reduction in caries experience. However, their methodological rigour might be questioned. Studies in Brazil and Chile reported that educating mothers of young infants on good oral health practices led to significant reductions in caries incidence when compared to control groups (Gomez and Weber 2001; Gomez et al., 2007; Feldens et al., 2007). However, a relatively large number of participants were lost to follow-up in those studies. In Australia, giving information leaflets to mothers at three points of time: during pregnancy; when the infants were six months old; and when they were 12 months old led to reduced caries experience, as only 1.7% of the children in the study group had caries in their upper incisors at the age of 20 months, compared to 9.6% of those in a control group (Plutzer and Spencer 2008). However, it is important to note that the study was not blinded. In the UK, Kowash et al. (2000) reported that delivering a 15-minute interview to mothers discussing diet, oral hygiene, or both, every three to six months until the child was three years old improved their oral health practices and reduced the likelihood of the child developing caries in comparison to a control group. However, there was a risk of bias in recruitment, as the two groups were recruited separately.
The inclusion of fluoride delivery as part of oral health interventions targeting children seems to be an important component if caries experience is to be reduced. In the USA, providing low-income families of preschool children with oral health education, regular fluoride varnish applications, and arrangement of regular dental attendance, led to improvements in the children’s plaque scores and reported dietary behaviour (Minah et al., 2008). Furthermore, examination of children revealed that those that received the intervention were less likely to have cavitated caries lesions, as well as a lower count of Streptococcus Mutans. In Sweden, parents of two-year-old children from an immigrant population were visited on three occasions in one year, provided with instructions on diet and oral hygiene, and given 0.25 mg sodium fluoride tablets and discounted-price 1,000 ppm toothpastes (Wennhal et al., 2005). Comparison with children from a control group one year after the intervention revealed that more children from the study group were caries free, and their parents reported better dietary and oral hygiene practices. However, the children taking part were not followed up after the eruption of permanent teeth to assess if the consumption of fluoride tablets at such a young age led to any signs of fluorosis.

Two programmes in China targeted children and parents together. Tai et al. (2009) provided six-year-old children and their mothers with regular oral health education classes, pamphlets, free toothpaste and dental care for three years. At the end of the trial, children from the study group reported higher frequency of toothbrushing and regular dental visits, and also had lower DMFT scores at the end of the trial than the control counterparts. Rong et al. (2003) provided preschool children, their parents, and their teachers, with multiple oral health education sessions. In addition, teachers were asked to supervise a toothbrushing session for the children once a day using 1,100 ppm fluoride toothpaste. Following the intervention, children had lower dmft scores than a control group. Moreover, the parents reported better oral health knowledge and more frequent toothbrushing at home.
2.8 The case for an oral health education intervention for children referred for dental extractions under GA

Looking at the examples of oral health interventions to promote oral health in children around the world, it can be noticed that delivering oral health education was a prominent component in most if not all of them. It frequently led to improved oral health knowledge and practices, although achieving reductions in caries experience was more limited unless fluoride was delivered as part of the intervention. This part of the literature review will further discuss oral health education, its importance as part of targeted oral health interventions and wider oral health promotion, its strengths and weaknesses, and why, despite its limitations, it needs to be delivered to high-risk children attending for dental extractions under GA.

2.8.1 Definition of oral health education

Oral health education can be defined as ‘any learning activity which aims to improve individuals’ knowledge, attitudes and skills relevant to their oral health’ (Stillman-Lowe 2008). It is important to fully understand oral health education, its evaluation, its relationship to behaviour change, and subsequently, its role in oral health promotion.

2.8.2 Importance of oral health education

A comprehensive review published in 2006 looked into the effectiveness of various health interventions that aim to improve health outcomes by improving knowledge, attitudes, and behaviours (Cancer Care Research Centre et al., 2006). Oral health practices were not exclusively reported on in this review. However, the review did report on healthy diet interventions provided at an individual (allocating target individuals to intervention or control), community (allocating schools, workplaces, or other community settings to different interventions), and population level (targeting the whole population, such as mass media interventions).

The reviewers concluded that there was good evidence that traditional, video or computer-based teaching methods on a community level (universal) were successful at improving children’s dietary knowledge, especially when parents were involved.
In addition, nutritional counselling interventions on an individual level (targeted) were found to have a positive effect in changing dietary habits. However, none of studies involved children. Meanwhile, there were no reviews of interventions on a population level to promote healthy eating. Furthermore, the reviewers noted that there was a lack of research that explores the effectiveness of interventions according to socio-economic or cultural differences.

In regards to oral health, Kay and Locker (1996) reviewed more than one hundred papers that investigated oral health education and concluded that only a few studies had enough quality to make firm conclusions on the impact of oral health education. However, the findings suggested that education frequently led to better knowledge, attitudes and, to a lesser extent, intermediate health outcomes, such as reduced plaque score. The more recent review by Watt and Marinho (2005) suggested that well-designed oral health education resulted in improved plaque score for up to six months. Finally, Habbu and Krishnappa (2015) reviewed more recent studies, and reached similar conclusions as education was found to improve knowledge, attitudes and plaque scores, while one study demonstrated reduced caries incidence.

Two issues that can be noted in those oral health education reviews are that the quality of research has been generally poor, as very few properly designed Randomised Controlled Trials (RCTs) where included, and that it is really difficult to estimate how much the education component of an oral health intervention contributed to any clinical changes, as interventions often include components other than education as can be seen in the examples of interventions listed earlier.

2.8.3 Importance of including children in oral health education

Oral health education needs to target children directly. Habits are formed early in life, and establishing positive oral health habits during childhood is very important. Birch and Fisher (1998) suggested that children’s dietary preferences are influenced by social and cultural norms, advertising and modelling. Food and drinks producers are aware of this, and as such, children in England are bombarded with advertisements promoting cariogenic foods (Rodd and Patel 2005). The impact such
advertisement can have on children’s food consumption patterns has been well established (Coon and Tucker 2002).

Moreover, children are suggested to be ‘spending influencers’, meaning that they influence their parents shopping habits by making requests, demands, hints and eventually participating in joint decision making in family purchases (Beder 1998). ‘Pester power’ is a term used to define the children’s influence on their parents shopping. A study in Manchester has suggested that children as young as seven years old have a strong input into their diets and can impede their parents’ efforts to limit the intake of cariogenic foods (Roberts et al., 2003). This study did not include younger participants, but other authors suggested that children might have such ‘power’ from an age as young as four years (Kenway 2001). Similar trends were noted during the present author’s earlier work (Aljafari et al., 2014). Interviewed parents of children attending for dental extractions under GA tended to feel that their children are resisting their efforts to promote better diet and oral hygiene. The parents said they needed more allies on their side to help promote good oral health practices in their children. They suggested that children need to receive positive oral health messages in schools and in the media.

Furthermore, children, especially older ones, might be able to teach their parents when they learn new things. The results of a study by Evans et al. (2001) showed that ten-year-old children educated about Asthma at their schools transmitted their knowledge to their parents at home.

### 2.8.4 Limitations of oral health education

Oral health education has the ability to improve knowledge, attitudes and in some cases change behaviours leading to improved clinical outcomes such as plaque score, at least on short term. Evidence for improvements in knowledge seems strong, but education in its pure form might not be sufficient to achieve and sustain behaviour change and subsequently improve oral health. Indeed, Kay and Locker (1996) concluded that there is a lack of good quality evidence on its clinical benefits. Watt and Marinho (2005) and Habbu and Krishnappa (2015) confirmed these findings.
Another limitation of oral health education is that universal delivery of education on its own not only fails to produce health benefits on a population level, but carries the risk of increasing health inequalities, as people interested in education and that have the means to apply it will benefit, while those that don’t will not (Schou and Wight 1994). Unfortunately, those that do not necessarily have the interest or the means are frequently the ones that need it the most. As such, targeting of high-risk individuals is necessary to reduce health inequalities.

In light of this, it is clear that promoting healthy practices in high-caries-risk children referred for dental extractions under GA and their families will require much more than simply providing oral health education that aims to improve knowledge. Adair et al. (2013) provided a simple helpful example on how promoting healthy practices can be extremely complicated and requires action on many levels to ensure all the pre-requirements for a healthy behaviour are available. The example was establishing toothbrushing in a child twice a day. Not only do the child and the parents need to know toothbrushing twice a day is recommended, but the whole local environment, community and society will have to play a role: Schools need to promote health, local authorities need to make sure families have access to toothpaste and a healthy local environment, cultural and religious groups need to endorse health behaviour, and national policies need to address social inequality.

Nevertheless, oral health education remains an important part of universal oral health promotion, and a vital component in targeted oral health interventions. Its perceived failings in leading to behaviour change on its own should not lead to an underestimation of its role (Nutbeam 2000). Indeed, the issue might lie in researchers’ understanding of what to realistically expect as an outcome from health education. The model for oral health promotion outcomes suggested by Nutbeam (1998) includes four levels:

1. Health promotion action (education, community development, media communication).
2. Health promotion outcomes or intervention impact measure (knowledge, attitudes, personal skills).
3. Intermediate health outcomes (healthy behaviours, healthy environments).
4. Health and social outcomes (reduced morbidity, mortality, better quality of life and social equity).

Oral health education on its own is unlikely to have a great impact on intermediate health or health and social outcomes, but should rather be assessed by evaluating its impact on oral health promotion outcomes such as knowledge, attitudes and personal skills.

2.8.5 Understanding education, knowledge and behaviour change

Despite the limitations of oral health education, it remains an important part of oral health promotion. Knowledge remains an important pre-requisite for behaviour change as suggested by several behavioural theories proposed to explain how healthy behaviours can be encouraged, adopted, and sustained.

In a study by Veramire et al. (2010) an overview of several behavioural theories was provided, including: Health Belief Model, Protection Motivation Theory, Health Locus of Control, Social Cognitive Theory, Theory of Planned Behaviour, Theory of Reasoned Action, Implementation Intentions, Trans-theoretical Model, Stages of Change, Theory of Interpersonal Behaviour, Problem Behaviour Theory, and Model of Personal Investment. The large number of theories explaining behaviour change suggests that the issue is complicated. In fact, to date psychologists don’t seem to agree on one of them. Those theories were sometimes built on each other and often overlap, nevertheless, there are many disagreements on what social, emotional and cognitive factors influence behaviour change.

2.8.5.1 The Theory of Planned Behaviour

The Theory of Planned Behaviour, proposed by Ajzen (1991), has perhaps been the one most widely used to predict behaviour change in oral health research. According to this theory, initiating behaviour is influenced by three main factors: The first is the individual’s beliefs and attitudes towards the behaviour. The second is what is known as ‘normative beliefs and subjective norms’, meaning the individual's perception of social normative pressures as well as judgment of significant others for
a particular behaviour. Finally, the third factor is ‘perceived control’, which refers to the perceived ease or difficulty of performing the particular behaviour.

The Theory of Planned Behaviour seems to be more suitable to predict intention and not behaviour. However, as Schwarazer (2008) suggested in the ‘Health action process approach’ model, it is important to distinguish between developing intention to perform certain behaviour, and the actual performance and maintenance of the behaviour. Schwarazer explained that motivation is sufficient to develop intention, but a volition process is required when intention is present to lead to actual behaviour. In light of this, doubts were cast over this theory’s ability to explain behaviour. In their review, Renz and Newton (2009) reported that this theory was able to predict only 20-30% of variation in oral health behaviour. Furthermore, a meta-analysis by McEachan et al. (2011) confirms such suggestions, as this theory again was poor in predicting behaviour.

2.8.5.2 The Social Learning Theory

The Social Learning Theory proposed by Bandura (1977) suggested that behaviour is learned through self-monitoring, skill training, modelling, and visualization. Interestingly, this theory stresses the importance of modelling classified into three categories: live, verbal, and symbolic: which means modelling through the media, including televisions and computers. Furthermore, the theory suggests that behaviour is driven by the personal values that individuals attach to an outcome, as well as their beliefs of consequences of not engaging in said behaviour and whether or not it can achieve desired outcome. In this theory, self-efficacy, which is defined as ‘the individual’s subjective belief on how easy or difficult the behaviour can be’, is also viewed as an important explanatory variable in predicting behaviour change. Renz and Newton (2009) have reported that this theory has been fairly good in predicting oral health behaviour, especially when the emphasis was placed on self-efficacy.

2.8.5.3 The COM-B model

Perhaps the most appropriate theory to demonstrate the importance of oral health education is the COM-B model developed by Michie and West (2013). In this theory, behaviour change requires three components: first, having physical and
psychological capability to perform behaviour, including knowledge, second, having the opportunity (appropriate physical and social environment) to perform behaviour, finally, having a conscious and automatic (innate) drive to achieve behaviour change.

Asimakopoulou and Newton (2015) have suggested that to achieve behaviour change in an individual we need to first identify the component of COM-B that needs to change, followed by considering which domain (capability, opportunity or motivation) needs to be addressed, and then finally applying a behaviour change technique. In the case of high-caries-risk children referred for GA, it is apparent that many seem to be struggling in all three domains, as evident by the socio-economic difficulties, poor beliefs and attitudes, and evidence of poor oral health knowledge discussed earlier. It can be concluded that oral health education on its own will likely be insufficient to achieve and sustain behaviour change in this cohort. However, the fact that knowledge is an important component necessary for behaviour change, coupled with the fact that there is evidence suggesting those families have gaps in their oral health knowledge, as well as negative beliefs, and poor attitudes indicates that oral health education is a necessary component when promoting oral health in those families, and needs to be delivered to them as part of a targeted oral health intervention, and ideally, within a wider universal oral health promotion initiative.

Furthermore, it is important to design oral health education in a way that doesn’t solely address gaps in knowledge, but extends further to motivate patients and influence their attitudes and beliefs. As Stillman-Lowe (2008) suggested, successful oral health education needs broader understanding of the target’s surrounding environment and community, and needs to take into account beliefs and attitudes. As such, she noted that providers of oral health education need to provide the information in an understandable, relevant, and non-authoritarian way, and that the advice should also be targeted and tailored rather than universal, general and generic. In addition, she suggested that the advice should be realistic in amount, and aim toward gradual improvement and provide positive reinforcement when success is achieved by the patient. Finally, she argued that practical demonstrations involving the patient are necessary to make education more interesting.
2.8.6 What messages should children referred for dental extractions under GA receive?

It is important that oral health education delivered to high-risk individuals is based on sound evidence. Levine and Stillman-Lowe (2004) issued guidance on key oral health messages that need to be delivered to prevent various oral health conditions. When dental caries was concerned, they suggested that to prevent dental caries, two key messages are really needed. The first is reducing the frequency and amount of sugar consumption, while the other is increasing the availability of fluoride, whether by toothbrushing with fluoride toothpaste, water fluoridation or other supplements.

In England, the third edition of DBOH should be the main source for the oral health messages that need to be delivered as part of oral health education. The third edition of DBOH published in 2014 (Public Health England et al., 2014), included recommendations for the general public and those under high caries risk. Any educational oral health intervention delivered to high-caries-risk children during their GA referral should draw its messages from this source. The recommendations of DBOH to reduce caries risk can be categorised as follows: healthy diet advice, toothbrushing advice, delivery of fluoride, and regular dental attendance. As far as this thesis is concerned, we will discuss the recommendations for children older than three years old and younger than 11.

2.8.6.1 Healthy diet

The third edition of DBOH advocates that the frequency and amount of sugary food and drinks should be reduced. Reduction of consumption of free-sugar, defined as ‘monosaccharides and disaccharides added to foods and beverages by the manufacturer, cook or consumer, and sugars naturally present in honey, syrups, fruit juices and fruit juice concentrates’, has also been recommended by the WHO (WHO 2015).

In fact, the findings of two systemic reviews commissioned by the WHO to investigate the effect such sugars had on two important health outcomes, body weight and dental caries, suggested that there is good evidence that increased consumption of free-sugars leads to increased body weight and caries development in children (WHO 2015). As such, the WHO suggested that the intake of those
sugars is reduced throughout life to less than 10% of total energy intake. Indeed, the WHO further recommended that the intake of such sugar is reduced to less than 5% of total energy intake, though such recommendation requires further discussion.

In addition to the reduction of free-sugar intake, which can in turn reduce caries risk, the third edition of DBOH suggests promoting a diet that is generally healthy. This includes promoting the consumption of more fresh fruits and vegetables, fish, and water, while consuming less saturated fats and low amounts of salt (less than six grams daily).

2.8.6.2 Toothbrushing with fluoride toothpaste
There is strong evidence that children under high risk need to brush their teeth at least twice daily, one of them just before sleep (Duckworth and Moore 2001), with 1,350 - 1,500 ppm fluoride toothpaste (Walsh et al., 2010). Those under the age of seven need to be supervised by their parents and need only a pea sized amount, while those older can brush on their own if deemed capable and use the brush length of toothpaste (Bentley et al., 1999). There is also some evidence to suggest that the child should not rinse following brushing to allow the teeth to be exposed to fluoride for a longer period (Chestnutt et al., 1998).

2.8.6.3 Application of fluoride varnish and regular dental attendance
Children that are under high risk are advised to have fluoride varnish applied to their teeth at least twice a year (Marinho et al., 2009). Moreover, they should be advised to attend for regular dental check-ups more frequently and up to four times a year as per the NICE guidelines (National Institute for Clinical Excellence 2004)

In addition, other preventive measures might be prescribed by the dentist, including fissure sealing permanent molars with a resin sealant when erupted (Ahovuo-Saloranta et al., 2008), and rinsing with a daily fluoride mouthwash for children aged eight years or older (Marinho et al., 2003)
2.8.6.4 Differences from recommendations of second edition of DBOH

It should be acknowledged that during the preparation of the protocols of the studies in this thesis the third edition of DBOH was not yet published. As such, the second edition (Department of Health 2009a) was used as basis for the oral health education delivered to children in chapter 6. The two editions have similar recommendations as those discussed with the only notable difference being the recommended frequency of fluoride varnish application in the second edition being three to four times a year instead of two or more.

2.8.7 Dental extractions under GA – a teachable moment?

NHS England has recommended that health care workers make every contact with the public count by encouraging and helping them make healthier choices and achieve positive behaviour change (Bailey et al., 2012). We have already explored the poor oral health practices and the deficiencies in the oral health knowledge of families of high-caries-risk children referred for extractions under GA. As such, we have the ethical as well as professional obligation of providing them with information and motivation to change during their attendance for health care, especially at such an important stage in care for those children.

In fact, capitalising on the GA referral to deliver oral health education to those families might have an advantage unique to its timing and setting, as this can be what is deemed a teachable moment. A teachable moment can be defined as ‘health behaviour change messages that leverage the salient features of a patient’s particular circumstance to create powerful or persuasive advice’ (Flocke et al., 2014). As such, health workers are asked to seize moments when an individual has a certain health concern to deliver advice regarding healthy behaviour related to this health issue. Perhaps the best example is in smoking cessation. McBride et al. (2003) reported that smoking cessation interventions most likely to succeed were those delivered to smokers during hospitalisation for health problems such as diabetes, cancer or others. Tang et al. (2014) reported that a similar intervention to patients referred for assessment of suspected head and neck cancer was deemed acceptable by 94% of the participants and led 36% to stop smoking.
However, the impact of an intervention during what is deemed a teachable moment can vary according to the individual’s perceived risk, understanding of self-concept and emotions (McBride et al., 2003). As such, teachable moments were reported to be less successful in changing dietary behaviour such as consumption of fruits and vegetables or physical activity when delivered in a primary health care setting (Flocke et al., 2014). Perhaps due to the reduced perceived risk of the situation at such stage. No such studies investigated the acceptability or effectiveness of a teachable moment to reduce caries risk. In the case of high-caries-risk children and their families, the GA referral might be an appropriate time for a teachable moment. Drawing parallels with the previous examples in health care, it is possible that delivery of advice at this stage might leave a more powerful impact on the family, as it is a serious stage in care for high-risk children were perceived risk and emotions might be high.

2.8.8 Which method of oral health education delivery is best?

In addition to exploring the correct content and timing of oral health education, it is important to explore the methods that can be used for its delivery. Examining the oral health interventions discussed earlier, it can be noted that the researchers delivered the educational component to children or their parents using three wide categories: written, verbal and interactive methods.

2.8.8.1 Written delivery of oral health education

Some authors found benefits in using written education. The study by Plutzer and Spencer (2008) discussed earlier reported that children of pregnant mothers benefited from their mothers’ use of oral health education leaflets, as they were less likely to develop caries in their first year of life. Redmond et al., (2001) reported that 11- to 12-year-old children found the delivery of oral health education using designed leaflets acceptable and led to increased toothbrushing frequency as reported by the children. However, there was no further assessment of impact on oral health knowledge.

Despite the findings of those two studies, the use of written delivery of education to patients might not always be appropriate, especially in deprived high-caries-risk
families. A Cochrane review that assessed the delivery of information to patients discharged from acute hospital setting included two studies where information was delivered to the parents of children. The findings suggested that written information should ideally be supplemented by verbal advice, as the readability of written advice was questioned, especially in populations with lower health literacy (Johnson et al., 2003).

Previous work by Lewis and Newton (2006) suggested that dental leaflets distributed for use by the public in England might be of poor quality, as many of them did not have appropriate visual design or clarification of aims and objectives, although the readability of language was quite appropriate, as it was suitable for those with the reading abilities of an average nine-year-old child or older.

In light of the findings of those previous studies, it is unlikely that the use of written methods in families of high-caries-risk children referred for dental extractions under GA will be an effective way to supply them with oral health education. High-risk families do indeed struggle with having adequate health literacy to use health information, as discussed earlier in this literature review. Furthermore, using written methods of education will not give the young children, especially those younger than nine years, a chance to be included.

### 2.8.8.2 Personal one-on-one verbal delivery of oral health education

A Cochrane review of one-on-one dietary interventions for children and adults performed in dental environment included only five studies that were found to meet the inclusion criteria (Harris et al., 2012). The reviewers noted that four out of the five studies reported a significant change in dietary behaviour. However, they also pointed out that in two studies, the dietary intervention was a part of a wider promotion programme that might have influenced the outcomes.

The reviewers concluded that one-on-one dietary interventions in the dental setting can change behaviour, with evidence stronger in regards to increasing fruit and vegetable consumption and reducing sugar intake. They recommended more research in this area, with greater methodological rigour in the design, statistical analysis and reporting. More importantly, only one of the studies included in the review involved children. However, that study, by Hausen et al., (2007), involved
supplying the children with toothpaste and toothbrushes, and regular fluoride varnish application. As such, the impact of the education component cannot be measured and, in fact, Harris et al., (2012) noted that more research involving children specifically is needed.

It can be noted that most of the educational interventions discussed earlier in this literature review (Hamilton et al., 1999; Kowash et al., 2000; Gomez and Weber 2001; Wennhal et al., 2005; Feldens et al., 2007; Gomez et al., 2007; Minah et al., 2008; Whittle et al., 2008) had a personal one-on-one verbal education element. A one-on-one approach can be tailored and interactive. In fact, Kasila et al. (2006) suggested that education using a personalised one-to-one counselling approach might be better than simply giving children or their parents oral health information in the form of printed advice.

Another advantage of a personal approach is that it can be delivered in ways that have been reported to improve support for behaviour change. Weinstein et al. (2004; 2006) used a ‘motivational interview’ which consisted of a personalised counselling session with six follow-up phone calls to deliver oral health support to parents of infants aged six to eighteen months old from a low-income community. They reported that this approach was more effective in reducing the risk of developing new caries lesions than written and video-based information. However, Ismail et al., (2011) reported findings that contradicted Weinstein’s work. In their study, there were no differences in reported behaviour or caries risk reduction between motivational interviewing or information DVD’s two years after the intervention. Those contradictory findings might be due to differences in the quality of the intervention provided, or the ease of access for dental care in the population that has been studied as noted by Ismail et al. (2011). Moreover, it is possible that there was a bias in the sample recruited in Weinstein’s studies, as families agreeing to take part in a lengthy intervention that includes six phone calls might be the ones that have a stronger will to change their behaviours. A very recent meta-analysis by Borrelli et al. (2015) confirmed that the jury is still out on using motivational interviewing to prevent dental caries in children, as at this stage, there is not enough evidence to support it.
It can be concluded that adding a personal touch to oral health education, when based on sound theoretical principals, might facilitate better motivation to learn and change behaviour. However, one has to keep in mind that the availability of appropriately trained educators might be an issue depending on the setting of education delivery. Furthermore, the financial costs of recruiting such trained manpower might be an issue. As such, the cost effectiveness of different scenarios of education delivery is also an important issue into that should always be investigated.

Most importantly, one has to understand the limitations of delivering advice or providing motivation for behaviour change while other obstacles in the oral health care systems and the surrounding cultural and social environment are in place.

2.8.8.3 Interactive delivery of oral health education

The final possible method to deliver oral health education is by using interactive elements. When it comes to oral health interventions targeting children, it can be noted that elements of play and interaction (Friel et al., 2002; Rodrigues et al., 2003; Grant et al., 2010) have been frequently used to deliver oral health education. In fact, there is some evidence to suggest that this is the way forward in children’s oral health education.

In an RCT, delivering oral health education to children aged three to five years using a combination of puppet shows, food matching games, and toothbrushing songs was reported to be better in improving the children’s oral health knowledge than standard verbal advice (Makuch and Reschke 2001). In another study, the delivery of oral health education to children aged five to ten years using simple written flash cards was compared to education using the same flash cards incorporated into a game (Maheswari et al., 2014). Children that took part in the game had better oral health knowledge and lower plaque scores up to three months after the delivery of the intervention. However, it should be noted that neither of those two studies reported on blinding during analysis, leaving a risk of bias.

Video-games are a modern interactive method that has been utilised for years for the delivery of education to children by teachers and health researchers in various fields. However, the use of such methods in oral health education of children has been extremely limited, as will be discussed in the next section of this literature review.
2.9 The potential role of video-games in oral health education

Delivering oral health education to children, as part of oral health interventions, often utilises interactive elements. Video-games used for education, known as ‘serious games’, have been used in education for a significant amount of time. As such, it is worth investigating how such games can be utilised in oral health education for high-risk children, such as those attending for dental extractions under GA.

2.9.1 Access to audio-visual media in the UK

Children and their families are nowadays more exposed to various audio-visual media outlets than ever before. Access to media related commodities such as televisions, computers, tablets, and mobile phones, is widespread and steadily increasing, and the use of those commodities by children is constantly on the rise. Different industries have realised the importance of capitalising on these trends, and have increased their efforts for advertisement through those digital devices. In 2014 alone, seven billion pounds were spent on digital advertising; a marked increase from 2013 (Internet Advertising Bureau 2014a).

According to the national UK household census, almost 96% of households with children had home computers in 2011, while 100% had televisions and 90% had one or more mobile phone (Office of National Statistics 2011). In addition, 96% of those households had internet access in 2014 (Office of National Statistics 2014). Consoles dedicated to video gaming are also very common; OFCOM (2014) reported that 84% of households with five- to fifteen-year-old children had at least one such console. Meanwhile, the use of tablets is also becoming increasingly common. In 2014, 18 million people in the UK had a touch-tablet, suggesting a staggering 63% increase in the number of owners in just one year (Internet Advertising Bureau 2014b). A large number of those individuals live in households with children, as the report by OFCOM (2014) showed that 70% of households with children aged five to fifteen years, and 65% of those with children aged three to four years, had a tablet at home. Moreover, the report also showed that almost a quarter
of five- to seven-year-old and a third of eight- to eleven-year-old children had their own personal tablet.

Available data suggests that there is relatively good access to audio-visual media across the socio-economic spectrum in the UK. Indeed, according to OFCOM (2014), 74% of families falling in the most deprived socioeconomic class had a computer at home, 55% had a tablet and 81% had a video gaming console in 2014.

2.9.2 Children’s use of video-games

Not only are audio-visual devices widely present in households with children, but children of all ages have been reported to frequently use them for various purposes. The OFCOM (2014) report showed that more than a third of three- to four-year-old (37%), two-thirds of five- to seven-year-old (66%), and the majority of eight- to eleven-year-old children (81%) use video-game consoles. While in the same report, 32%, 58% and 78%, respectively, were reported to use computers, and 39%, 54%, and 67%, were reported to use tablets. The report also noted that children use those devices for various purposes, including: watching television, listening to music, accessing the internet, doing school work and playing video-games. The average five- to fifteen-year-old child in the UK was said to watch television content for fourteen hours a week, listen to the radio for six hours, surf the internet for twelve and a half hours and play video-games for nine and a half hours (OFCOM 2014).

It is clear that the average child is spending a lot of time playing video-games. These games are best defined as ‘games played by electronically manipulating images produced by a computer programme on a monitor or any other display’ (Oxford Dictionary). A report in 2012 suggested that almost 90% of six- to nine-year-old children play such games using various media devices (The Parliamentary Office of Science and Technology 2012). The average five- to seven-year-old child in the UK is reported to play those games for almost seven hours a week, and this increases to approximately nine hours a week for those aged eight to eleven years (OFCOM 2014). Even younger children are frequently playing those games, as three- to four-year-olds are reported to play for six hours every week (OFCOM 2014). Similar findings can be seen in other developed countries. Almost 90% of American children and teens play video-games (Prot et al., 2012), with the average eight- to
ten-year-old child spending an hour per day playing such games (The Kaiser Family Foundation 2010).

2.9.3 The benefits of using video-games in education

Learning that is fun is believed to be more effective (Lepper and Cordova 1992). It is widely believed that using video-games as a form of education might improve the learning process. Video-games used in education are known as ‘Serious Games’. Griffiths (2002) suggested that these games can attract participation by individuals across demographic boundaries, assist children in setting goals, ensure goal rehearsal and provide feedback and reinforcement, provide an element of interactivity, allow participants to experience novelty, curiosity and challenge, and are fun and simulating for participants, amongst a host of other advantages. Oblinger (2004) reiterated such suggestions, and noted that video-games that follow fundamental principles of pedagogy can carry several advantages over other methods of delivering education, including: providing a user-tailored approach, multi-sensory support, problem-based learning, activation of prior knowledge, immediate feedback, motivation through challenge, and provision of a social environment involving communities of players.

Two reviews of evidence (Mitchell and Savill-Smith 2004; Vogel et al., 2006) recommended the use of video-games in education for the same potential advantages noted by Griffiths (2002) and Oblinger (2004). Moreover, using video-games in education might have other advantages that extend beyond achieving learning goals. In fact, these games have been reported to have a positive impact on cognition (such as improving spatial skills) neural processing efficiency, problem solving skills, and creativity (Wouters et al., 2013; Granic et al., 2014). They have also been suggested to positively influence motivation, emotions, social skills and language development (Granic et al., 2014).

A systemic review published in 2012 reported on 129 papers evaluating serious games (Connolly et al., 2012). The review concluded that there was good evidence that learning through these games could indeed be an enjoyable process that increases knowledge and provides motivation. However, this review did not include studies in children younger than 14. Furthermore, the reviewers noted that most
studies have been poorly designed, and that there was not enough RCTs comparing video-games to traditional methods of education. As such, there was not enough empirical evidence that the improvements in knowledge were any better than those associated with traditional learning. A meta-analysis of nine recent studies revealed that despite the abundance of studies in this field, there is a lack of empirical evidence regarding improvements in knowledge and motivation when playing video-games compared to traditional methods (Girard et al., 2013). The authors again recommended that studies in the future are experimental in design, comparing video-game education to traditional education, and collect longitudinal data when possible.

**2.9.3.1 Benefits of using touch-tablets in educational video-games**

The introduction of touch-tablets (such as the iPad) can further enhance the experience of learning. It is reported that children as young as four years old are able to interact with such technology, and freely navigate applications in various ways to find their favourite content (Aziz 2013; Beschorner and Hutchison 2013). In addition, young children seem to be enjoying this technology; teacher observation of three- to six-year-old children using an iPad in a school class suggested they find it easy to use and highly interesting (Couse and Chen 2010). The use of tablets in education is very recent, and empirical evidence remains scarce. A study in 2013 that included providing math education to ten-year-old children, suggested that they find those devices as acceptable as paper and pen education, while perceiving better motivation and self-efficacy (Kyanka-Maggart 2013).

**2.9.4 The use of video-games in health education**

Realising the potential serious games might have in education, health professionals started researching the use of such games in patient education. In recent years, there have been examples of serious games developed to educate patients on nutrition (Casazza and Ciccuzzo 2006; Cullen et al., 2005), hygiene (Farrell et al., 2011), exercise (Papastergiou 2009), asthma (Huss et al., 2003; Nabors et al., 2012), diabetes (DeShazo et al., 2010), stroke (Williams et al., 2014), cancer (Beale et al., 2007), skin cancer prevention (Hornung et al., 2000), and surgery preparation (Rassin et al., 2004; Hosey et al., 2014).
A 2008 review that looked into 25 games to promote health-related behaviours (including healthy diet, physical activity, or other health-related behaviour) suggested that the use of such games can induce positive outcomes (Baranowski et al., 2008). The reviewers noted that two studies involved games promoting a healthy diet to children, both were RCTs, and both led to a small but significant change in dietary habits (Baranowski et al., 2003; Turnin et al., 2008). However, it is noticeable that both studies targeted schools and not high-risk individuals. Another review in the following year (Papastergiou 2009), reported that the variety of video-games educating children and adults on various health issues seemed capable of improving users’ knowledge and motivation, but evidence for behaviour change remained poor.

A more recent review has shown that among 38 studies and a total of 195 health outcomes, video-games improved 69% of psychological therapy outcomes, 59% of physical therapy outcomes, 50% of physical activity outcomes, 42% of health education outcomes, 42% of pain distraction outcomes, and 37% of disease self-management outcomes (Primack et al., 2012). The reviewers noted that although video-games showed the potential to improve health outcomes, most studies were of poor quality, and only 11% included blinding. As such, more rigorous randomized controlled trials are needed.

2.9.5 The use of video-games in children’s health education

Many of the studies reviewed by Baranowski et al. (2008), Papastergiou (2009), and Primack et al. (2012) targeted children, and provided them with education on chronic childhood diseases. Asthma is the most studied example. Rubin et al. (1986) were one of the earliest to report on the issue, and found that their game improved children’s asthma-related knowledge and behaviours. However, their study was small and un-blinded. Huss et al. (2003) reported no improvements in either knowledge or clinical outcomes, but their failure to detect improvements might have been due to the high knowledge of participants at baseline. Nabors et al. (2012) reviewed six other studies that investigated the use of computer technology to educate schoolchildren on asthma. The studies by Yawn et al. (2000), and McPherson et al. (2006) reported changes in children’s knowledge and attitudes
comparable to those in control groups receiving more traditional education. Bartholomew et al. (2000) reported that their computer game improved inner city children’s knowledge, attitudes and self-efficacy, and led to less frequent hospitalisation, but the effect size reported in their study was very small.

Diabetes is another example; a trial that evaluated the use of a diabetes education video-game in diabetic children reported that the children taking part showed improvement in self-care behaviours, but the game did not help them achieve statistically significant changes in knowledge, or need for emergency medical appointments (Brown et al., 1997). However, the study sample might have been too small to achieve statistically significant differences. Furthermore, it was in a group of well controlled diabetic children, and hence cannot provide insight into the impact of such games in those that display less control.

### 2.9.6 Video-games providing education on nutrition or hygiene

Perhaps the best examples to examine when attempting to extrapolate findings to oral health education are those including hygiene and nutrition education. Farrel et al. (2011) developed a video-game to educate nine- to twelve-year-old children in the UK on hand washing, respiratory hygiene, and antibiotic resistance. In their study, Almost 1,600 children played the game, mostly over the internet, but most dropped out at some point. The authors reported that the game lead to improved knowledge in only some aspects, but acknowledged that the small effect was most likely due to the unexpected high baseline level of knowledge. In addition, the authors acknowledged that the educational message in some game segments was unclear.

Most nutritional games were designed to target schools, and did not target high-risk children in particular. Baranowski et al. (2003) developed a nutrition education game for eight- to twelve-year-old children in the USA. The game’s goal was to promote the consumption of fruit and vegetables in schools. An RCT to evaluate the game reported that on average, children in the study group had one more fruit or vegetable intake per day after the intervention compared to those in a control group. It is interesting to note that those with the lowest intake at the baseline benefited the
most. The studies by Turnin et al. (2008) targeting children in French schools, and by Amaro et al. (2006) in Italian schools, reported small but significant improvements in the children’s dietary knowledge and behaviour. The study by Kreisel et al. (2004) in German schools also suggested that children from both groups had improved knowledge, and this improvement was retained for up to three months. However, the results of this study can be questioned, as the intervention group was offered both the computer package and the written information, meaning that the exact role of the package alone could not be measured. Delgado-Noguera et al. (2011) pooled the results of previous RCTs that delivered computer based interventions to improve fruit and vegetable consumption in schools and reported that the pooled results of those trials indicate potential effectiveness in improving fruit and vegetable consumption.

Pempek and Calvert (2009) provided a dietary education game directly to children from low-income minority background in the US. Their study failed to show significant differences in dietary knowledge or snack selection between the game and a control group that received no intervention. However, the very small study sample of ten participants in each group makes their results unreliable.

2.9.7 The use of video-games in children’s oral health education

Evidence for the use of video-games in delivering oral health education to children is very scarce. In 1998, the author’s supervisor and a computer science student in Glasgow developed a prototype video-game to educate children on healthy food selection (Petale 1998). In 2000, the game was tested by 26 four-year-old nursery school children taking part in a community oral health education campaign. The children were divided randomly into an intervention group playing the video-game and a control group not receiving any intervention. The game failed to achieve a significant change in healthy food selection, measured by children selecting items to go into the ‘healthy basket’ (Roebuck et al., 2000). This was an exploratory study, and the lack of positive results might have been due to the very simplistic design of the game and the measuring tool, the very young age of the participants, or the sample size being too small to reach significance.
In 2007, an upgraded prototype videogame was developed by C. Rice as part of his MSc research project, and also supervised by the author’s supervisor (Rice and Hosey 2008). The game included information for children regarding healthy food selection and toothbrushing. A group of five- and six-year-old children in two schools in Stornoway, Scotland tested that game in an RCT. Eighty-six children participated in this blind trial. The results showed that both the control group (who had written advice) and the intervention group (who played the video-game) improved their dietary knowledge. However, there was no difference between the two groups, and none reported better dietary behaviour, as indicated by their reported school time snack selection. It is important to note that a healthy school eating programme, part of Childsmile, was introduced during data collection in this study. Children were given healthy snacks (fruits) at school as part of this programme, and this might have contaminated the results relating to snack selection.
2.10 The role of fluoride varnish in targeted oral health interventions

Increasing exposure to fluoride has been a regular component of many targeted oral health interventions aimed at children under caries risk. In addition to the lack of oral health knowledge in families of high-caries-risk children referred for dental extractions under GA, which might be addressed by providing oral health education, families reported poor exposure and familiarity with fluoride varnish (Karki et al., 2011; Olley et al., 2011; Aljafari et al., 2014). As such, improving access to fluoride varnish should be a part of the efforts to promote oral health in those families.

The application of fluoride varnish constitutes a cornerstone in preventing dental caries, and is recommended by the third edition of DBOH (Public Health England et al., 2014). Furthermore, it has become the method of choice to deliver topical fluoride to children in many caries prevention programmes, such as Childsmile (Macpherson et al., 2010). Yet its use in England seems to be limited to the dental setting, by a GDP, and to regularly attending low-risk children that need it the least. As such, there is a need to investigate how high-caries-risk children can be targeted to receive fluoride varnish more often. Since dental attendance at primary dental care might be part of the issue in those families, researchers should investigate how fluoride varnish application can be expanded to other settings accessed by those high-risk children and their families.

In the case of high-caries-risk children referred for dental extractions under GA at KCH, there is a chance to deliver fluoride varnish at a medical pre-assessment appointment held in a medical hospital care setting prior to their GA appointment. Application of fluoride varnish at that stage of care not only gives the child its well established clinical benefits on a short-term, but might familiarise the family with the relatively easy treatment, and improve their demand for it in primary dental practice upon their discharge to regular care following GA.
2.10.1 Evidence for the effectiveness of fluoride varnish in reducing caries risk

Fluoride varnish was first developed in the 1960s. Since then, its caries preventive benefits have been well documented. It is presently recommended as the best method of professional fluoride application (Miller and Vann 2008). A Cochrane review in 2009 included a meta-analysis of seven studies and reported that the use of fluoride varnish has the potential to reduce caries in permanent teeth by 46% and in primary teeth by 33% (Marinho et al., 2009). The review suggested that these reductions can be seen regardless of baseline level of caries or fluoride exposure. However, the amount of benefits can vary.

2.10.2 Delivering fluoride varnish as part of an oral health intervention

Weintraub (2003) suggested that the application of fluoride varnish is a good choice for community based oral health programmes if personnel are available. Different authors reported on oral health programmes that involved application of fluoride varnish in schools, nurseries, and other sites outside the dental setting. Many authors that evaluated such programmes have reported positive findings. In Germany, application of fluoride varnish twice a year in schools led to significant reductions in dmft values after four year of the programme (Dohnke-Hohrmann and Zimmer 2004). RCTs in deprived high-risk communities in Australia, Brazil, Sweden and the United States all reported reductions in caries increment when fluoride varnish was used delivered outside the dental setting (Skold et al., 2005; Weintraub et al., 2006; Slade et al., 2011; Arruda et al., 2012).

However, other authors cast doubts regarding the benefits of using fluoride varnish as a universal public health measure. A recent RCT in China suggested that the delivery of fluoride varnish to pre-school children in parent education centres provides no benefits (Jiang et al., 2014), but it should be noted that the study was performed in a in a low-risk population. Another RCT in Greece suggested that delivering varnish in nurseries doesn’t provide further benefits once regular toothbrushing has been established (Agouropoulos et al., 2014). In England, a large cluster randomised trial carried out in schools reported no differences in caries rates.
in the first molars of children who received fluoride varnish three times a year for three years and those who did not (Milsom et al., 2011).

The differences in the findings of the aforementioned studies can be explained by the differences in the cohort of children targeted. Studies involving children coming from high-risk communities were more likely to report benefits than those where a universal approach was used. It can be concluded that the use of fluoride varnish in oral health programmes extending beyond the dental setting seems to be of benefit, but only if appropriate targeting of high-caries-risk children is achieved.

Of course other factors, such as: high baseline exposure to fluoride through regular toothbrushing with a fluoride toothpaste or water fluoridation, protocols for gaining parental consent, and the presence of cultural differences in different populations, might also play a role in the amount of benefits reported. For example, in the aforementioned study in England, 50% of the original sample did not provide consent (Milsom et al., 2011). Analysis by the authors suggested no socioeconomic differences between responders and non-responders, but other factors might have come into play. Application of fluoride varnish to school children in east London was hindered by the exclusion of a third of the population since their parents did not provide consent (Evans et al., 2013b). The authors suggested cultural reasons or language barriers might have been the cause. This is a real issue in fluoride varnish delivery in schools in England, especially if we draw parallels to the findings of the study by Monaghan et al. (2011) that compared the results of two consecutive dental health surveys in Wales, the first with an opt-out and the second with an opt-in consent, as they clearly suggested that parents of children with caries were less likely to provide positive consent once it was introduced.

2.10.3 Delivering fluoride varnish in health care settings

Targeting of children for oral health education and fluoride varnish application in health care settings is another possible way to improve exposure that has been recommended by the WHO (Petersen 2004). In England, the utilisation of such settings to promote oral health has been minimal despite the recommended common risk approach advocated by Sheiham and Watt (2000). Moreover, medical staff
might be lacking the skills and knowledge needed to provide support with oral health to the public (Adams 1996). Results of a survey by Richards et al. (2014) that included health professionals, such as: General Medical Practitioners, nurses and pharmacists, suggested that their knowledge of caries prevention advice was poor, as only 28% of them were able to answer ten relatively simple questions regarding reduction of sugar, oral hygiene and the use of fluoride toothpaste. The authors noted that the question regarding the correct concentration of fluoride toothpaste emerged as a major issue.

The introduction of oral health care programmes for children in primary care practices in deprived communities in the USA provides an example for utilising a health care setting to promote oral health. In these programmes introduced in the early 2000’s, primary care providers, such as medical practitioners, paediatricians and nurses were trained to provide oral health education, as well as apply fluoride varnish. Such programmes were reported to be a cost-effective approach (Stearns et al., 2012) that significantly reduced caries risk in children that attended those visits regularly (Pahel et al., 2011). Moreover, they have significantly improved access to fluoride varnish, especially in younger children (Okunseri et al., 2009; Rozier et al., 2010) and were deemed to be highly satisfactory according to the families (Rozier et al., 2005).

Such an approach has not been researched in England. It is important to understand that the adoption of such an approach based on a USA model is not straightforward. Health care systems vary between the two countries. As such, it is possible that the notable increase in access to fluoride varnish and ultimately reduced caries risk was due to the poor provision of free dental services in the USA, in comparison to medical services (Okunseri et al., 2009). Meanwhile, both services are free for children under the NHS in England so the issues in access are probably different.

2.10.4 The importance of skill-mix in delivering oral health care

Skill-mix in health care can be defined as ‘mix of posts, grades or occupations in an organization’ (Buchan and Dal Poz 2002) Early in the 1990’s, the Nuffield report recommended that dental care is provided by ‘a dental team with an interchangeable
mix of skills provided by those best suited to exercise them by virtue of their training and experience’ (The Nuffield Foundation 1993). Over the years, the numbers and roles of auxiliary dental professionals in the UK, such as therapists, hygienists and dental nurses, has slowly grown. According to the GDC’s report of 2013, Dental Care Professionals (DCPs) constituted 61% of the dental workforce in England (General Dental Council 2014). The report showed that dental nurses were the most numerous members within those professionals, constituting 48% of the total dental workforce.

Yet despite the potential advantages of this role expansion (Williams et al., 2010), it still lags behind the inclusion of auxiliary professionals in medical care (Gallagher and Wilson 2009), where for many years the inclusion of auxiliary professionals has left the service users more satisfied (Laurant et al., 2005), and reportedly receiving a better preventative care (Tolley and Rowland 1995). Various factors, most prominently legal and financial, have limited the adoption of such a skill-mix model in dental practice in England (Brocklehurst and Tickle 2011).

2.10.4.1 The potential role for Dental Nurses with Additional Skills (DNASs) in fluoride varnish application

The GDC first suggested that dental nurses can take a larger role in patient care in the first edition of the GDC’s ‘Scope of Practice’ issued in 2009, and these suggestions have been further reaffirmed recently in the second edition of the same document (General Dental Council 2013). Appropriately trained dental nurses, termed Dental Nurses with Additional Skills (DNASs), were to take part in different tasks, including the delivery of oral health education, and the application of fluoride varnish once prescribed by a dentist, or as part of a structured oral health programme. In light of this, the Primary Care Commissioning (2009) document provided practical guidance on the role of DNASs in applying fluoride varnish.

Yet the utilisation of DNASs in fluoride varnish application, both in the dental setting and outside it, remains less than desired. Hatim and Kendall (2102) proposed that DNASs are not being utilised by GDPs to provide fluoride varnish due to issues with remuneration. The application of fluoride varnish falls under the dental examination band (NHS Choices 2015); hence, referring a child to a DNAS for
application does not generate any extra financial income to the GDP. Carter et al. (2012) reported that DNASs are not being utilised due to the lack of community programmes for varnish application, the lack of referrals by GDPs, the lack of supervision by GDPs, and the DNASs concerns regarding insurance and consent.

In Scotland, Gnich et al. (2014) reported that the poor utilisation of EDDNs in providing fluoride varnish has made some of them lack the confidence and motivation to take part in fluoride varnish application. Furthermore, the perception of the service users might also be an issue. In a qualitative study, some of the participants interviewed about their views regarding the use of skill-mix in dentistry indicated they have some concerns regarding the provision of dental treatment to children by someone other than the dentist, as they thought one possible bad experience at that age matters (Dyer and Robinson 2008).

This underutilisation comes despite evidence suggesting that DNASs inclusion can enhance productivity in primary dental care practice (Galloway et al., 2002), as well as potentially increase the rates of fluoride varnish application. A study in Bradford and Airedale revealed that dental practices where DNASs were employed were more likely to deliver fluoride varnish than those where they were not (Csikar et al., 2014).

In light of the well-documented dental care access issues in high-risk populations, the role of DNASs in oral health education and fluoride varnish application should extend beyond providing care in primary dental practice. Those nurses can provide the human resources needed to extend such services into the community through schools, community centres, and medical care facilities, to improve exposure. Perhaps the best example for the utilisation of DNASs outside the dental setting is the utilisation of EDDNs in the Childsmile programme in Scotland, as discussed earlier (Macpherson et al., 2010).

2.10.5 Acceptability of fluoride varnish application

Treatment acceptability can be defined as: ‘judgements by laypersons, clients, and others of whether treatment procedures are appropriate, fair, and reasonable for the problem or client’ (Kazdin 1981). Health service providers are always striving to provide the best services and products to their users. Measuring the acceptability of
different treatments provided to patients is an important part of treatment evaluation, and should always be used when planning new services, improving existing services, or measuring service quality (Newton 2001b). As such, this might be an important aspect that should be investigated when the delivery of fluoride varnish in a new setting, such as the medical pre-assessment clinic, is planned.

Despite the importance of assessing treatment acceptability, only very little research is available on the acceptability of various preventive treatments used in paediatric dentistry (Hyde et al., 2009). More specifically, despite the extensive research into various clinical aspects of fluoride varnish use, little research has been conducted to explore the perceptions of children receiving the treatment and their parents. The Cochrane review discussed earlier, acknowledged the need for more research on this topic of interest in the future (Marinho et al., 2009).

2.10.5.1 Parental acceptability of fluoride varnish application
Adams et al. (2009; 2012) presented two studies that compared the parental acceptability of five different preventive treatments in high-caries-risk children from ethnic minority groups (Hispanic and Africa American) in the US. The treatments included were: fluoride toothbrushing, fluoride varnish, Xylitol sweeteners for children, Xylitol gum for mothers, and Chlorhexidine mouthwash for mothers. The results of both studies suggested that all treatment methods were acceptable to the parents. In the first study, fluoride varnish and toothbrushing were the most acceptable, while the parents in the second study favoured toothbrushing followed by fluoride varnish. It is worth noting that in those studies, the participants’ children did not actually receive the treatments. Instead, the participants were only given verbal and video information regarding each treatment.

2.10.5.2 Children’s acceptability of fluoride varnish application
A series of studies provided some insight regarding acceptability of fluoride varnish in preschool children, as measured by the success or failure of the application. Zhou et al., (2012; 2013) reported that 10% of their sample of 456 children refused to receive varnish by a nurse, either partially or completely. Negative response to the application was noted in the form of saying no, crying, moving head, and pushing away. Humphris and Zhou (2014) reported that only 12 out of 238 three- to five-
year-old children (5%) refused to receive fluoride varnish in a nursery setting. Their findings suggested that dental anxiety, lack of previous varnish applications, and poor quality behavioural management by the dental nurse were good predictors of failure.

Only one author investigated children’s perceptions of varnish application beyond mere success and failure. Berg et al. (2006) performed a study where two different types of fluoride varnish (white and brown) were applied to 60 children aged four to seventeen years. Older children and their parents reported that they preferred the colour and bubble-gum taste of the white varnish over the brown varnish (Duraphat®). Young children (those seven years old or less) were also reported to have preferred the colour of the white varnish, but disliked the taste of both types of varnish. However, the sample of this study was children attending for routine recall appointments. As such, it was performed in a normal dental setting and did not focus specifically on the perceptions of high-caries-risk children, who might have different views on fluoride varnish that impact their experience and might complicate the delivery of the treatment in a non-dental setting.
2.11 **Summary of the literature review**

- Dental caries is a preventable disease, yet it’s the most common disease of childhood in the world. In England, almost a third of five-year-olds have at least three teeth with caries. The presence of caries in a child is the best predictor of risk of developing further caries in the future.

- Socioeconomic and cultural circumstances of families can have a negative impact on their oral health knowledge, attitudes, beliefs, and practices. Disadvantaged children, such as those socioeconomically deprived, or from an ethnic minority or immigrant background, have been known to be more likely to have caries.

- KCH mainly serves the South London Boroughs of Lambeth, Southwark, and Lewisham. These boroughs are amongst the most deprived in England, and are home to a large community of ethnic minorities and immigrants.

- Child dental health care in England is free and mainly provided by GDPs. Child registration in the Boroughs of Lambeth, Southwark, and Lewisham remains poor.

- DBOH provides guidance on preventive care in England, it recommends: twice daily toothbrushing with 1450 ppm fluoride toothpaste, reduced sugar intake, and three-monthly fluoride varnish application in high-caries-risk children, but the GDPs are reported to struggle in implementation, especially in families that they perceive as poorly motivated or non-compliant.

- Targeting children for fluoride varnish application in schools in some deprived and multicultural parts of London was complicated by poor return of consent. It is possible that some high-caries-risk children might have been excluded.

- Children from poorer areas are more likely to have extractions rather than fillings, and receive the least oral health advice or treatment. Many end up needing dental extractions, often under GA, in a hospital setting. This is now the commonest reason for a child hospital admission in the UK.
Follow-up attendance after GA is poor, and repeat treatments are often needed despite radical treatment, suggesting failure in improving oral health practices and preventing further dental caries after the procedure.

Parents of children receiving dental extractions under GA at KCH have reported not receiving appropriate oral health advice regarding fluoride toothpaste and fluoride varnish, and struggling to implement good dietary and oral hygiene practices in their children. Moreover, they seemed to not be aware of the potential cariogenicity of fruit juices. They requested support, and demanded oral health education that is inclusive of their children.

NHS England services are being restructured to improve focus on prevention. The current hospital GA pathway does not formally include prevention. The use of a medical pre-assessment appointment, which is a part of the pathway at KCH, was suggested by parents of children receiving dental extractions under GA as one of the acceptable approaches for delivering preventive care.

Health education is an important component of health promotion, as recommended by the Ottawa Charter, and good health knowledge is a building block needed to help an individual achieve behaviour change, according to recent behavioural theories.

There is strong evidence that delivering oral health education to children can improve their oral health knowledge and reduce plaque scores, but evidence for long-term clinical outcomes remains scarce.

Parents of children receiving dental extractions under GA at KCH and elsewhere in the UK suggested that audio-visual media might be an acceptable method for oral health education delivery.

Video-games have been reported to have several advantages in general and health education. However, much of the evidence for their use in education has been of poor quality, with only few blinded Randomised Controlled Trials.
Chapter 3:

Aims and objectives
3.1 Aims

The research undertaken in this thesis aims to contribute towards improving the support for caries prevention provided for high-caries-risk children within the General Anaesthesia (GA) extraction pathway at King’s College Hospital (KCH) in South London. Specifically, it aims to develop and assess an oral health education video-game that provides them with contemporary health advice, as well as, assess the children’s compliance and views on fluoride varnish application within a medical pre-assessment appointment that is part of the GA pathway at KCH.

3.2 Objectives

1. To explore the challenges referring General Dental Practitioners (GDPs) perceive in providing preventive care and promoting oral health in high-caries-risk children referred for dental extractions under GA and their families, as well as and their opinion on what the hospital can do to help.
2. To further develop a prototype video-game used by Rice (2009) so that it becomes appropriate for use as part of an oral health intervention for high-caries-risk children referred for dental extraction under GA at KCH.
3. To perform a Randomised Controlled Trial (RCT) to assess this method of education in comparison to one-on-one verbal education delivered by a Dental Nurse with Additional Skills (DNAS), in terms of acceptability, impact on children’s dietary knowledge and parents oral health knowledge, and finally, impact on children’s reported oral health practices.
4. To assess children’s compliance and views on applying Duraphat® fluoride varnish at the medical pre-assessment clinic as part of the oral health intervention.
3.3 **Rationale**

Delivering child-friendly oral health education and application of fluoride varnish as part of the GA pathway for children receiving dental extractions has the following potential strengths:

1. Might address the reported oral health knowledge gaps in those families.
2. Captures a group that does not access dental care often and makes every contact with them count, as recommended by NHS England.
3. Achieves cost-effective identification of high-caries-risk children, as the presence of caries is one of the strongest predictors of developing more in the future.
4. Eliminates the risk of increasing health inequalities that might be associated with universal oral health education delivery, as only high-caries-risk children are targeted.
5. Utilises a critical stage of care in what might present a ‘teachable moment’ for the families.
6. Offers the children the caries prevention advantages of fluoride varnish on the short-term.

3.4 **Research plan**

The objectives of this thesis will be achieved by performing three research steps that will be discussed in the next three chapters. Chapter 4 will discuss a qualitative study to explore the challenges in promoting caries prevention in high-caries-risk children faced by GDPs in Lambeth, Southwark, and Lewisham. Chapter 5 will discuss the development of an oral health education video-game for high-risk children referred for dental extractions under GA, and the piloting of a phase II RCT to compare it to one-on-one verbal education delivered by a DNAS. Finally, Chapter 6 will present the RCT, which took place at a medical pre-assessment clinic that those children attended. In addition to the comparison of the two methods of education, all children taking part in the RCT received Duraphat® fluoride varnish application to assess their compliance and views on application in such setting.
Chapter 4:

General Dental Practitioners’ views on promoting oral health in high-caries-risk children - a qualitative study
4.1 Introduction

GDPs play an important role in promoting oral health and providing dental care to children in England. Previous investigations suggested that despite the availability of an evidence-based toolkit for caries prevention (Public Health England et al., 2014), GDPs around the country are struggling in its practical implementation (Pearce and Catleugh 2013; Witton and Moles 2013; Elouafkaoui et al., 2015). More particularly, some evidence suggests that many high-caries-risk children referred for treatment under General Anaesthesia (GA) at King’s College Hospital (KCH) do not seem to have received sufficient oral health education or preventive care from their GDPs (Olley et al., 2011, Aljafari et al., 2014).

This chapter will present a qualitative investigation into the views and experiences of local GDPs in promoting oral health in high-caries-risk children referred for GA at KCH. The findings of this study have been published in BMC Oral Health, a peer reviewed journal. The full manuscript can be found in Appendix 3.

4.1.1 Research questions

- What preventive care do GDPs provide for high-caries-risk children that they refer for dental extractions under GA?
- What are the challenges they face in the provision of preventive care for those children and in promoting oral health in their families?
- What in their opinion, can be done to promote oral health in those families to prevent re-referral for treatment under GA?
- How can the hospital play a role in providing preventive care and education of these children?

4.1.2 Aims of study

4.1.2.1 Primary

1. To identify the primary dental care practices referring high-caries-risk children for dental extractions at KCH.
2. To explore the challenges local GDPs face in providing preventive care for high-caries-risk children and their families; defined as those children referred for extraction of carious teeth under GA.

3. To seek their opinion on possible approaches for oral health promotion in those families in the future.

4.1.2.2 Secondary

1. To inform the modifications for the video-game used in the upcoming chapters
4.2 Methods and methodology

4.2.1 Design

The study is a qualitative investigation, utilising face-to-face semi-structured interviews, with GDPs in the London Boroughs of Lambeth, Southwark, and Lewisham, that have referred children to KCH for dental extractions under GA.

Stewart et al. (2008) noted that qualitative methods are progressively taking a larger role in dental research. They stated that these methods are better than quantitative methods, such as surveys and questionnaires, when it comes to obtaining a deep understanding and interpretation of human behaviour, beliefs, and attitudes. Moreover, they noted that those methods are an important component of staged research, especially in research topics where little data is available. In that instance, they are used to explore areas of interest and develop hypotheses that can be later tested using quantitative methodology. In a series of papers published in 2008, the importance of qualitative methods was pointed out, and they were recommended as valid methods for obtaining data in oral health research (Burnard et al., 2008; Gill et al., 2008a; 2008b; Stewart et al., 2008).

The difficulties GDPs face in promoting oral health in high-caries-risk children referred for extractions under GA might be complex. No previous studies addressed the specific issue in the country or more specifically in the target population in Lambeth, Southwark, and Lewisham. However, some authors did explore the GDPs’ approach to caries prevention, and many used a qualitative methodology. For example, Threlfall et al. (2007b; 2007c) used semi-structured interviews to explore the GDPs approach to preventive care provided to children in Lancashire, but that was prior to the introduction of Delivering Better Oral Health (DBOH) in 2007. Humphreys et al. (2010) used focus groups to identify the barriers foundation-year dentists perceived in delivering oral health education. However, this took place in Wales, where dental health is run separately from England. Pearce and Catleugh (2013) used clinical scenarios with open-end questions to explore the GDPs application of DBOH in Lancashire, but their investigation did not focus on high-risk children, and did not provide insight into the underlying causes for their findings that suggested that GDPs were inconsistent in DBOH application.
Meanwhile, Elouafkaoui et al. (2015) explored the barriers to applying preventive care as perceived by GDPS using a structured questionnaire. However, that was in Scotland where the dental care system and preventive guidelines are different. In addition, Witton and Moles (2013) used a structured questionnaire to explore possible barriers to applying prevention guidelines, as perceived by GDPS in Plymouth. However, applying their questionnaire for the GDPS in Lambeth, Southwark, and Lewisham would have significant limitations, as there are marked differences in the setting of their study in Southwest England, and this study, in those inner city London boroughs. Furthermore, Witton and Moles (2013) themselves acknowledged the need for a follow-up qualitative investigation to their study to achieve a deeper understanding, and pick up on any points that were not included in their questionnaire.

Due to the discussed benefits of qualitative methods in gathering opinions and exploring views and practices, their utilisation in similar studies in other parts of the UK but not in England after the introduction of DBOH, and the lack of validated tools to assess the barriers to caries prevention in high-caries-risk children faced by GDPS in Lambeth, Southwark, and Lewisham, qualitative methods were deemed as the acceptable way to reach the answers to the research questions. Subjects were interviewed using a semi-structured interview (DiCicco-Bloom and Crabtree 2006) that was carefully designed in collaboration with the research supervisors and that took into consideration the findings of previous research, in order to provide the author with the information needed, and give the subjects space to express their opinions freely.

4.2.2 Ethical approval and Funding

The study was granted full approval by King’s College London (KCL) Biomedical Sciences, Dentistry, Medicine and Natural and Mathematical Sciences research ethics committee (BDM REC) on the 7th of February, 2013 (Reference number: BDM/12/13-34). Appendix 1 contains all the correspondence with the research ethics committee.
4.2.3 Location and time frame

The targeted informants in this study were GDPs working in the referral area for KCH, one of the biggest hospitals in London. It includes the South London Boroughs of Lambeth, Southwark and Lewisham, provided they had referred children for dental extractions under GA. These boroughs are some of the most highly deprived in England, ranking 15th, 17th and 24th respectively in deprivation in 2010 (Department for Communities and Local Government 2011).

These boroughs are also known to be culturally diverse, containing people from various ethnic minorities (Office of National Statistics 2012a) and immigrant backgrounds (Office of National Statistics 2012b). The National Census in 2011 reported that 33-38% of adult residents in those areas were born outside the UK (Office of National Statistics 2012b). The rate of child registration for dental care is poor, and highly associated with social deprivation in those areas (Gallagher et al., 2009).

4.2.4 Identifying referring practices

The number of children that have received dental extractions under GA at KCH from the beginning of April 2011 to the end of March 2012 was obtained upon request from the hospital database. The author then excluded the children that were 11 years or older as they were more likely to have been referred for dental extractions due to other causes (Orthodontic extractions, surgical extractions).

The hospital database displayed the names and addresses of all the primary dental care practices that referred those children, as well as the number of children referred by each practice (range: 1-24 children). The author used those addresses to determine the practices that were in the Boroughs of Lambeth, Southwark, and Lewisham, and those outside them, as only GDPs in those three boroughs were to be invited to take part.

Next, in an effort to visualise the referring practices, the author converted the addresses of all referring practices, as well as of KCH, to geographical coordinates (Longitude and latitude) using a dedicated website for such conversion (http://www.doogal.co.uk/LatLong.php). The generated data were input in QGIS, a geographic information systems software, to map out all the practices. Two maps
were generated: the first is of all referrers in London, and the second is of referrers in the Boroughs of Lambeth, Southwark, and Lewisham only.

4.2.5 Participants

Purposive sampling based on the dental practices’ GA referral rates according to the hospital’s database was used. To categorise referral rates, the author sorted the practices in Lambeth, Southwark, and Lewisham to three categories:

1. **High referrers**: those who have referred 15 or more children.

2. **Medium referrers**: those who have referred five to fourteen children.

3. **Low referrers**: those who have referred one to four children.

4.2.5.1 Inclusion criteria

1- The participant must have referred children for dental extractions under GA at KCH.

2- The participant must be practicing in Lambeth, Southwark, and Lewisham.

3- The participant must have given consent to take part in the study.

4.2.5.2 Exclusion criteria

1- GDPs who have not referred children for dental extractions under GA at KCH.

2- GDPs referring children outside the Lambeth, Southwark, and Lewisham area.

3- GDPs who do not want to take part in the study.

4.2.5.3 Recruitment process

Invitation letters and information leaflets that detailed the aims and design of this research project were sent by post to practices from all three categories. The aim was to collect the opinions of dentists of various ages, work experience, gender, and referral rates. The author followed the posted invitation letters with a phone call a week later to inquire about willingness to participate. If the GDP agreed to participate, the author arranged a date and time appropriate for the GDP to perform a face-to-face semi-structured interview at the GDP’s dental practice. Following a
brief introduction, there was an opportunity for clarification and questions prior to obtaining written consent, and commencing the interview.

4.2.6 The interview

A copy of the interview sheet used can be found in Appendix 2. The interview was designed by the author and discussed with both supervisors: Professors Marie Therese Hosey and Jennifer Gallagher. The interview was designed using simple language and included open-ended questions to best capture the participants’ views and opinions. It was divided into four main discussion topics:

1. Experience with referral of children for treatment of caries under GA, including reported referral rate, and criteria for referral.

Pine et al. (2004) reported that GDPs in England might lack confidence in treating children, while Aspinall and Blinkhorn (2007) reported that GDPs elsewhere in England had referred some children for treatment under GA although they could have been possibly managed under local anaesthesia with good behavioural management or inhalation sedation. The number of children referred for dental extractions under GA at KCH is increasing every year. This section of the interview aimed to explore whether GDPs in the local boroughs were facing any unique issues that lead to their decision to refer a child for GA and whether they are generally referring children that fit into the criteria for referral as advised by Davies et al. (2008).

2. Preventive dental care provided for children form high-caries-risk families, including: the preventive advice on oral hygiene and diet that they give, the use of fluoride varnish, and the barriers they face in delivering such care to this cohort. The participants were also asked about their views on how to improve preventive care provided for high-risk families.

Threlfall et al. (2007b) reported that the oral health advice families received from GDPs elsewhere in England was poor. Statistics by the NHS Prescribing and Primary Care Team (2014) reveal that application of fluoride varnish in England remains poor, as it was provided in only 25% of courses of treatment for children. A similar situation applies in Lambeth, Southwark, and Lewisham, parents of high-risk
children referred for dental extractions under GA had gaps in their oral health knowledge and did not seem to be familiar with fluoride varnish application (Olley et al., 2011; Aljafari et al., 2014), despite having already visited the GDPs.

Naturally, challenges to good implementation of the caries prevention recommendations in DBOH (Public Health England et al., 2014) reported by GDPs elsewhere in England (Pearce and Catleugh 2013; Witton and Moles 2013) might apply to GDPs in Lambeth, Southwark, and Lewisham. However, there is a possibility that the unique socioeconomic and cultural makeup of those boroughs (Office of National Statistics 2012a; 2012b) presents local GDPs with different issues. In fact, studies elsewhere in the UK reported that GDPs provision of preventive care can be affected by their perception of recipient (Threlfall et al., 2007c; Humphreys et al., 2010; Gnich et al., 2015).

3. Opinion on current efforts taken by the hospital when children are referred for caries treatment under GA, including their opinion on discharge letter content, and how preventive advice might be better provided to children at the hospital.

The current GA referral pathway (Adewale et al., 2011) used in KCH does not explicitly provide children referred for dental extractions under GA with any oral health education or support for caries prevention. In addition, there is a possibility that KCH is not only communicating poorly with the families, but further with the referring GDPs. Indeed, Ni Chollai et al. (2010) reported that discharge letters for similar treatment in hospitals in Yorkshire and Humber were of poor quality.

4. Follow-up of children following caries treatment under GA: including the participants experience with the attendance of these children after the GA, and their opinion on how regular preventive care can be improved and retreatment rates can be reduced.

Hosey et al. (2009) reported that only 13% of children receiving dental extractions under GA in a hospital in Glasgow returned for a follow-up visit three months after the GA. No previous studies investigated the attendance of those children for follow-up at their GDPs following GA treatment at KCH. However, it is anticipated that their attendance for such follow-up might be less than optimal, as Olley et al.
(2011) reported that they were irregular dental attenders, and that 60% of them asked for help with arranging regular dental care following the GA. As such, it was important to investigate what GDPs think might facilitate better follow-up arrangements.

In addition to those four main topics, participants were asked to give their basic information. This included gender, age, years practicing dentistry, years practicing in their relevant area, and post. This was to ensure that a representative sample is being recruited, and that none of the categories in any of those variables is being over-represented. The participants were also given the chance to express any other suggestions that they might have regarding care for children undergoing caries management under GA.

The design of the interview was re-assessed by the author and the research supervisors after transcripts of the first five interviews were available to ensure relevant data were being collected. At this stage, a further question regarding the participant’s familiarity with the second edition of DBOH (Department of Health 2009a) was added to the semi-structured interview.

4.2.7 Participants’ confidentiality and privacy

All interviews were audio recorded for later verbatim transcription; transcripts were prepared by a transcription agency and then re-checked by the author to ensure accuracy. All interview recordings and transcriptions were anonymised prior to analysis. Informants are quoted only by their age and referral rate. At all stages of research, data were stored using a password protected computer and a secure locked cabinet, all correspondence between research team members was done using secure KCL emails only.

4.2.8 Measures

4.2.8.1 Primary:

All primary outcome measures are qualitative data obtained through audio-recorded interviews. They include:
• The challenges GDPs face in the provision of oral health care to children from high-caries-risk families, and possible approaches to overcome them.
• The GDPs opinion on how the hospital can improve preventive care and oral health education delivered to children referred for GA and their families during the GA referral pathway, encouraging regular attendance.

4.2.8.2 Secondary:
• Input for further studies in this thesis.

4.2.9 Data management and analysis
Descriptive statistics were used to present the basic characteristics of the informants. Framework Analysis, a rigorous approach for ordering, synthesising and presenting qualitative data (Ritchie and Lewis 2003), was used to report on the interviews. Microsoft Office Excel was used as the platform for analysis. An analytical framework was informed by relevant literature, interview schedule and emerging text of the interviews. Steps of analysis included familiarisation with raw data, development of a theme index, theme refinement, charting into the relevant part of the framework and finally developing explanations and looking for applications to wider theory. The author met regularly with his supervisors during data collection and analysis to discuss the process of coding and theme assignment and any disagreements were solved by discussion. All three domains of the Consolidated Criteria for Reporting Qualitative Research (COREQ) (Tong et al., 2007) were used as a guide to ensure quality of the research process and the presentation of findings.
4.3 Results

4.3.1 Referrals for dental extractions under GA at KCH (2011-2012)

4.3.1.1 Total number of referrals

One thousand and two children aged ten years or younger were referred to KCH to receive dental extractions under GA between the beginning of April 2011 and the end of March 2012.

The names of 166 dental practices that referred 695 of the children were available. Seven of those practices fell into the high referral category, 36 fell into the medium referral category, and 123 fell into the low referral category. The number of children referred by each practice ranged from one to twenty four. The names of the referring practices of the remaining 307 children were recorded as ‘missing’ on the hospital database. Those missing values represent children that have a practice code attached to their referral that does not have a corresponding description in the hospital’s database reference tables.

Figure 4 is a map of London that shows the geographical location of all primary dental care practices that have referred children under ten years old to KCH for dental extractions under GA in the financial year 2011-2012.
4.3.1.2 Referrals from the Boroughs of Lambeth, Southwark, and Lewisham

Out of the total 1,002 children, 714 were referred from practices in the Boroughs of Lambeth, Southwark, and Lewisham. The names of 84 practices that have referred 505 children were available. This represents 79% of the total number of practices in this catchment area according to Gallagher (2012). Six practices fell into the high referral category, 31 fell into the medium referral category, and 47 fell into the low referral category. The names of the referrers of the remaining 209 were noted as ‘missing’ in the hospital database. Figure 5 shows the geographical location of practices in Lambeth, Southwark, and Lewisham that have referred children under ten years old to KCH for dental extractions under GA in the financial year 2011-2012.
Tables 1 and 2 summarise the discussed findings.

Table 1: Number of children ten years or younger referred for dental extractions under GA at KCH in 2011-2012

<table>
<thead>
<tr>
<th></th>
<th>Referrer available</th>
<th>Referrer missing</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lambeth, Southwark, and Lewisham</strong></td>
<td>505</td>
<td>209</td>
<td>714</td>
</tr>
<tr>
<td><strong>Non Lambeth, Southwark, and Lewisham</strong></td>
<td>190</td>
<td>98</td>
<td>288</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>695</td>
<td>307</td>
<td>1002</td>
</tr>
</tbody>
</table>
Table 2: Number of practices referring children ten years or younger for dental extraction under GA at KCH in 2011-2012

<table>
<thead>
<tr>
<th></th>
<th>High referrer</th>
<th>Medium referrer</th>
<th>Low referrer</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lambeth, Southwark, and Lewisham</td>
<td>6</td>
<td>31</td>
<td>47</td>
<td>84</td>
</tr>
<tr>
<td>Non Lambeth, Southwark, and Lewisham</td>
<td>1</td>
<td>5</td>
<td>76</td>
<td>82</td>
</tr>
<tr>
<td>Total</td>
<td>7</td>
<td>36</td>
<td>123</td>
<td>166</td>
</tr>
</tbody>
</table>

The aim of this categorisation was to ensure that the author invites, captures and explores the views and experiences of dentists with different referral patterns. A drawback of the list is that it provides the referral numbers of a practice and not individual dentists; it also doesn’t reveal the number of dental units/dentists in each practice, which can be an important factor in the number of referrals. Hence, each dentist subsequently interviewed was also asked about their estimated referral frequency.

4.3.2 Recruitment process

Data collection took place from the 18th of February till the 15th of April of 2013. Fifty one dental practices were invited by a posted letter to take part in the study. Those included: all six high referral practices, fourteen medium referral practices, and 31 low referral practices in Lambeth, Southwark, and Lewisham. Invitations were sent with the aim of achieving balance and representation across the groups.

Follow-up phone calls were made to all invited practices one week after the letter was mailed to inquire regarding willingness to participate. Establishing direct
communication with potential informants in many cases was challenging due to their preoccupation; in many cases the author had to phone the practice multiple times to talk to the GDPs. In the end, the author was able to make contact by phone with 25 GDPs from 21 practices. Messages were left with the receptionists for the remaining 30 practices after multiple attempts to speak to the GDPs directly failed.

Seven of the GDPs contacted by phone declined to take part. Four of them cited time constraints as the reason, two (both low referrers) requested to be contacted by email to arrange for an interview but never replied, and one (high referrer) refused to participate without giving a reason. In the end, 18 GDPs from 14 different practices agreed to take part and were subsequently interviewed. Thematic saturation was reached following these interviews and hence no further invitations were sent.

‘Thematic saturation’ occurs when the content of new interviews repeats that of previous interviews and is a common method of determining if sufficient data have been collected in qualitative research (Crabtree and Miller 1999). Figure 6 is a flowchart that simplifies the recruitment process.

![Figure 6: Participants’ recruitment process](image-url)
4.3.3 Informants’ basic information

4.3.3.1 Age and Gender
The average age of participants interviewed was approximately 42 years (SD=13.8 years) with an age range extending from 26 to 73 years. Out of the 18 participants, ten were males (55.6% of the sample) with an average age of 47 years (SD: 14.7 years) and an age range of 26 to 73 years. The remaining eight participants (44.4% of the sample) were females, they had an average age of 37 years (SD: 11.1 years) and an age range of 29 to 63 years.

4.3.3.2 Post and experience of participants
On average, participants had 17 years of experience (17.22 years, SD: 13.48, Range: 2-43 years) as a dentist and 12 years (11.94 years, SD: 12.85, Range: 1-40 years) of experience as a GDP in their respective areas. Seven participants (38.9% of sample) were the principal dentist of their practice, while the remaining 12 (61.1% of sample) were associate dentists. The average experience a principal had was 29 years (range: 14-43 years, SD: 9.63), while associates had on average ten years of experience (Range: 2-38 years, SD: 9.89)

4.3.3.3 Referral rates of participants
Five dentists (27.8% of sample) were from high referral practices, while six (33.3% of sample) were from medium referral practices, and seven (38.9% of sample) were from low referral practices

4.3.4 Main findings
Approximately five and a half hours of audio tape were available for analysis. The mean length of each interview was 18 minutes (range: 10-30 minutes). Analysis of qualitative data revealed that GDPs perceive challenges to the provision of preventive care and to the promotion of oral health amongst this cohort of children that can be attributed to every element involved in their oral health care: starting with the individual (child), and ending with wider public policy. The perceived challenges can be categorised as follows:

1. Child’s young age, poor cooperation, and high treatment need.
2. Parental skills to face up to modern day challenges and poor attitudes towards good oral health.
4. NHS primary care practice remuneration, constraints and training,
5. Inadequate secondary care communication and engagement.
6. Failure in establishing national policy to grasp the width and depth of the problem.

Figure 7 represents a summary of the results and displays the aforementioned perceived challenges.

Figure 7: Challenges to promoting oral health of high-risk children, as perceived by GDPs in Lambeth, Southwark, and Lewisham

Following are the details of those challenges and a discussion of possible approaches for the future.
4.3.4.1 Child’s young age, poor cooperation, and high treatment needs

4.3.4.1.1 Young age

Informants reported that children being referred for dental extractions under GA are usually of younger age. They perceived that as a barrier towards communication with the child and guidance through dental treatment in primary care setting, as one informant explained when asked why he’d refer children for GA:

‘It is mostly because they are actually too young and just don’t quite understand what they need to do, or what we are doing most of the time.’ ³ P9, 26 YO, Medium referrer

4.3.4.1.2 Lack of cooperation

In addition, informants agreed that lack of cooperation is another issue that they face when it comes to children referred for GA. Many explained that they always try to provide treatment for children at the practice first, and if that fails, resort to referral:

‘As a rule in this practice, we’ll try to treat everybody here if we can; there are those that will not allow us.’ ³ P13, 48 YO, Low referrer

However, Informants differed in the amount of clinical time they were willing to dedicate to assess a child’s cooperation. Only a few pointed out they will use more than one appointment to acclimatize the child before attempting restorative treatment, as one informant pointed out:

‘Sometimes we book a review appointment to see if the next appointment they will be a bit better, if we notice we’re not getting anywhere and there is a lot of work to be done, we think it’s in the best interest of the child to send them to the hospital.’ ³ P4, 37 YO, High referrer

4.3.4.1.3 Complex treatment needs

Informants also perceived that those children usually have complex treatment needs, which they tended to define as needing multiple dental extractions, leading to their referral. As one informant noted:
‘The main reason for referring a child would be number of lesions and the complexity of care; also maybe multiple extractions may be required for the child.’ P10, 49 YO, Medium referrer

‘I consider the child needs, for example: multiple treatments in many different teeth and the teeth are in a neglected state, then I would consider that.’ P15, 34 YO, Low referrer

### 4.3.4.1.4 Impact of child factors on provision of preventive care

The presence of these factors makes the provision of any preventive dental care, such as fluoride varnish application, appear time-consuming. This limits the amount of preventive care provided to those children, as one dentist explained:

‘I mean like to actually prepare a child for fluoride treatment varnish and all that it does require quite a bit of time and it is not just open your mouth, you know, they could be uncooperative.’ P12, 57 YO, Low referrer

In addition, the late presentation of those children means they frequently present in pain. In informants’ view, this suggests that the families are less interested in preventive care. One dentist explained the issue:

‘A lot of them will be in pain and all they want to do is just get rid of that pain and they are happy.’ P9, 26 YO, Medium referrer

In summary, informants reported that children referred for treatment under GA are usually of young age, poor cooperation, and present with multiple caries lesions. As one dentist explained her referral criteria:

‘Their age, how decayed their teeth are and how cooperative they’re going to be with us.’ P3, 29 YO, High referrer

These factors, in informants’ view, reduce the priority for oral health promotion and preventive care in the view of both the GDP and the parents.
4.3.4.2 Parental skills to face modern day challenges and poor attitudes towards good oral health

4.3.4.2.1 Poor dental attendance
Informants noted that many of those children are referred on their first dental appointment. An informant explained:

‘It’s usually first contact when we see these kinds of referral cases, it’s usually they’ve never seen a dentist before.’ P10, 49 YO, Medium referrer

Many expressed frustration with those families’ infrequent dental attendance and felt that they view dental appointments as ‘emergency services’ only, leading to late presentation and mounting to neglect, as an informant explained:

‘They just access you purely for emergencies and you begin to see that you are just supervising neglect here so you might as well just succumb to their requests because the child is effectively being abused.’ P13, 48 YO, Low referrer

‘The general scenario is that it is usually a neglected state, it is an emergency appointment, and the families are just like passers-by.’ P15, 34 YO, Low referrer

In informants’ opinion, the parents’ lack of understanding of a GDP’s role in promoting oral health is what leads for to this pattern of infrequent attendance. An informant explained:

‘It’s more what they think a dentist really is, I think, I think it is just fix it if it’s causing pain and that’s about it rather than preventing it.’ P9, 26 YO, Medium referrer

4.3.4.2.2 Poor attitudes towards dental health and dental care
Informants believed that those parents see the GA pathway as perhaps the ‘easy way out’. Many reported that parents walk in specifically asking for their child to be referred for treatment under GA:
‘... There are parents who will go to the practice and demand: I don’t want to be treated, I just want you to send me to the hospital, that’s what my other daughter did and that’s what my other son had and it was one and they took it all out.’ *P13, 48 YO, Low referrer

This makes treatment under GA, in the informants’ view, run in ‘familial lines’, as one informant explained:

‘(speaking about parents asking for GA) ... That will come and will follow the same family lines and sometimes you refuse the referral but somebody else will do the referral, so you think well I might as well.’ *P13, 48 YO, Low referrer

Parental anxiety was also perceived as a factor that might be contributing to this attitude towards dental care. As some informants noted, some parents avoid attending dental appointments themselves and appear to be transmitting their anxiety to their children:

‘It appears to be sometimes mothers are more scared than their kids so they just want everything to be done at the Hospital.’ *P2, 32 YO, High referrer

‘... They also teach them that it’s scary to come to the dentist, they are scared parents and the children learn this, the same behaviour, they don’t come to check-ups.’ *P14, 39 YO, Low referrer

4.3.4.2.3 Deficiencies in oral health knowledge

In addition to poor attitudes towards dental care, the informants perceived that in many cases, the families are not familiar with prevention of dental caries, especially when it comes to the hidden sources of sugar and the use of fluoride:

‘They don’t consider any other source of sugars in the food and the drinks, like juices, fizzy drinks.’ *P6, 33 YO, High referrer

‘... They are not very well educated about caries and caries risk, and you know, nutrition or diet or fluoride, you know, at the onset on the teeth.’ *P18, 43 YO, Low referrer
However, even when oral health advice is given, informants felt that parents consistently fail to adhere to it. This reinforced their perception that those families have poor attitudes towards the importance of oral health as well as poor parenting practices. As such, an undercurrent of despair and frustration can be felt talking to the informants, as they struggle to promote oral health in those families.

‘I tell you what, we sometimes tell them here and they walk out and their parents give them sweets, I’m like, hey I just told you! ‘Yeah, but he was a good boy’. Waste of time!’ *P7, 59 YO, Medium referrer

‘We can just say (Advice) but they don’t follow most of the time, they don’t follow and sometimes they come again and they say that was never told before.’ *P2, 32 YO, High referrer

This trend left the informants feeling pessimistic about the value of any efforts for oral health education at their practices, as a couple of informants explained:

‘There’s only so much we can do here, if it’s not done here, we can’t ban sweets, you can’t make them illegal, it’s the only way to make a difference.’ *P3, 29 YO, High referrer

‘You know, we do so much here, I don’t think there’s anything else we can do, I really don’t think so, there’s a limit how much one can keep troubling the parents you know.’ *P7, 59 YO, Medium referrer

In summary, it is clear that the informants perceived that parents of this cohort of children have negative attitudes towards dental care, lack oral health knowledge and display what they consider poor parenting practices. These perceptions form yet another challenge for the GDPs in providing care and promoting oral health in those children.

4.3.4.3 Social inequality, exclusion, and cultural barriers in immigrant families

4.3.4.3.1 The impact of social inequality on oral health
Informants reported that the social inequalities in oral health were obvious. They described a divide between children who were caries free, regular attenders that
receive preventive care, and those with multiple caries lesions and poor attendance that do not receive the preventive care they desperately need:

‘You have two sets of patients, one absolutely perfect, and nothing to be done. They come in, Duraphat® varnish, oral hygiene instructions, a clean-up, out. And other ones, gross, there’s nothing in-between.’ P7, 59 YO, Medium referrer

They perceived children referred for caries treatment under GA come from families in difficult socio-economic conditions. A couple of informants explained:

‘The parents they’re too busy. The child is with a babysitter or something. And as we know social class, usually lower classes, the best way to please the child is to give it a sweet. And that’s how they escape.’ P1, 73 YO, Medium referrer

‘We get those patients coming to us with various social backgrounds, broken families and crime or whatever you want to call it.’ P11, 51 YO, Medium referrer

Establishing rapport with parents from what the informants perceived as a difficult background was reported to be challenging, and this was seen as a hindrance to the delivery of oral health advice. It was interesting to note, however, that informants felt that establishing rapport with the children was easier:

‘We have a lot of people who come from difficult backgrounds in the family. Sometimes I actually cannot even make rapport with the parents so I would make rapport with the kid.’ P15, 34 YO, Low referrer

4.3.4.3.2 Difficulties in communication and cultural barriers

In what might reflect an issue more local to the practices’ catchment area, many informants pointed out that children from immigrant families, usually attending the dentist for the first time, constitute a large portion of those referred for caries treatment under GA:
‘I've been in [Location] for twenty three years … The individuals who do attend with a high caries incidence are those people who come from outside the UK.’ P10, 49 YO, Medium referrer

‘Most of these people that I see with rampant decay are actually people coming from outside.’ P12, 57 YO, Low referrer.

‘The new patients in the practice tend to be new immigrants they tend to have higher caries experience.’ P13, 48 YO, Low referrer

Informants generally felt that failure to reach immigrant families earlier and to establish a regular pattern of dental attendance is mainly due to difficulties in communication. However, those difficulties were not just limited to language, but also to cultural and social factors that they felt affect the parents understanding of the role of a GDP:

‘The biggest block has always been communication for these people. So even when they've arrived here, knowing we have a full range of facilities, there's a little bit of anxiety in, in going out and seeking help etc.’ P10, 49 YO, Medium referrer

‘One thing I say, it’s generally the families where they don't speak too much English, that’s where I notice a lot of the decay in the baby teeth and things like that.’ P3, 29 YO, High referrer

‘The trouble usually is the barrier is not language per se, it is attendance, because they don’t see the dental situation as a priority.’ P13, 48 YO, Low referrer

The availability of interpreter services might need better promotion within the community, before communication with the oral health care providers is established, as a 49-year-old dentist in Southwark explained:

‘We have one opportunity in [Location] which we utilise very well; they actually provide an interpreter service for our patients. Regrettably it's not very well publicised, so it's only when the patient comes in, that we can help them with that, if the patients were to know more about this
through their community centres or whatever, I think they could link up the service and they'd come much sooner. • P10, 49 YO, Medium referrer

It appears that the interviewed GDPs feel that they are facing difficulties in establishing the essential health worker-patient rapport and communication with the parents of high-caries-risk children due to what they perceive as difficult social backgrounds or cultural differences.

4.3.4.4 NHS primary care practice remuneration, constraints and training

4.3.4.4.1 Poor preventive care remuneration

Informants almost unanimously agreed that funding of preventive care in primary practice was a major challenge they are facing. There was a consensus between them that the current NHS Unit of Dental Activity (UDA) remuneration system doesn’t provide enough support for preventive care and favours a treatment rather than prevention approach:

‘The UDA system has never been, I don’t think has the incentive to encourage preventative dentistry, because it is not being rewarded... You are not going to be paid more if you bring a patient in three times a year and apply topical fluoride, but you will be paid more if that patient came in with cavities.’ • P13, 48 YO, Low referrer

‘Well they said it rewards preventative treatment, we don’t think so’.

P12, 57 YO, Low referrer

‘I think generally the whole NHS system is unfair to be honest with you. Not only children even adults.’ • P7, 59 YO, Medium referrer

The lack of what they considered adequate funding reduced their willingness to spend time with those children providing dental care, and made some of them favour their referral. As a couple of informants pointed out:

‘I know a lot of colleagues that are not actually doing any of the preventative because they don’t have any financial motive behind it.’

P15, 34 YO, Low referrer
‘I hate to say this about my profession; they would tend to not bother referring because they don't want the hassle and a remuneration fall in the NHS is not attractive.’ *P11, 51 YO, Medium referrer

‘There are cases where I need to do two root canal treatments, a couple of filings and there’s no incentive for me, I could have just sent someone straight to the hospital.’ *P8, 31 YO, Medium referrer

Perhaps the new approaches to remuneration that are being currently piloted carry some promise in improving the situation. Two informants in this study were taking part in the pilots and seemed to be pleased with how preventive care is covered, as one noted:

‘My practice is not part of the UDA system, we are part of the new pilot so that is why I went for that, because I have always from day one felt that it was a wasted journey (the UDA system).’ *P13, 48 YO, Low referrer

The other participant stressed out the importance of introducing a skill-mix approach in the provision of primary dental care:

‘I think the new system is definitely going to provide more prevention, because it's actually focusing on prevention, it's rewarding the dentist for prevention. I think the other thing it's doing is helpful skill-mix which means that the dentist can delegate for the child to receive fluoridation on a regular basis.’ *P10, 49 YO, Medium referrer

4.3.4.4.2 Lack of training and support for implementation of toolkit for prevention

In addition to issues with remuneration, some informants were not familiar with the second edition of DBOH, the most recent evidence-based preventive dentistry guidelines at the time (Department of Health 2009a). They blamed the lack of direct promotion for that, as one dentist noted:

‘No I did not know of this, because no leaflets or information were sent to the surgery anymore.’ *P17, 63 YO, Low referrer.
This unfamiliarity was reflected in inaccurate recommendations given to patients regarding fluoride toothpaste concentration, and variable frequency and criteria, including age and caries risk, for fluoride varnish application. For example, when asked about what toothpaste recommendations are given to children, an informant responded:

‘depends how old they are but, normally if it’s above six-year-olds and they are high-risk then I tell them to use 1150 ppm just a smear of adult toothpaste and that’s it, otherwise 950 to 1000 ppm.’  
P9, 26 YO, Medium referrer

‘For under six I normally say use the kiddies’ ones, 1000 ppm.’  
P8, 31 YO, Medium referrer

There was no consensus between informants when asked about the criteria or frequency of fluoride varnish application. When asked, informants gave various answers. For example, some said they would apply it to all children:

‘All the kids.’  
P7, 59 YO, Medium referrer

‘Every day, too much, it’s beginning to clog up our drains.’  
P13, 48 YO, Low referrer

‘Even if the children have a low decay, we tend to just put it on their teeth.’  
P3, 29 YO, High referrer

Meanwhile, others reported that they would apply varnish only in children they consider under higher caries risk:

‘I use it with the high-risk patients that have more than five fillings, we use it in every visit. If the patient doesn’t have any caries we never use it.’  
P14, 39 YO, Low referrer

‘For sort of medium to high-risk patients.’  
P8, 31 YO, Medium referrer
Some informants were still not using fluoride varnish at all, either due to what they perceived as lack of training or lack of time and resources, interestingly, despite being low referrers:

‘I mean delivering fluoride is quite a difficult business… it’s difficult out here … We don’t really have even the time to allocate to a child’.  
P12, 57 YO, Low referrer.

In one instance, fluoride varnish was not used due to lack of belief in the evidence:

‘I don’t apply fluoride varnish, I don’t believe it in, you don’t need it.’  
P1, 73 YO, Medium referrer

In perhaps a reflection of inadequate training, oral health advice that informants provided to those children tended to revolve around reducing intake of obvious sources of sugar (i.e. sweets), and frequency of toothbrushing. The advice doesn’t seem to be tailored to each patient.

‘Proper brushing, just take care, do not eat sweets.’  
P2, 32 YO, High referrer.

‘We usually give them like written information about sugar and oral hygiene instructions, we insist a lot about food.’  
P14, 39 YO, Low referrer.

Moreover, only a few informants mentioned providing advice on toothbrushing supervision, toothpaste fluoride concentration (dose) and not rinsing after brushing. The following quotes provide some examples:

‘If the kids aren’t old enough to brush then we normally tell the parents to have a look at it afterwards or you go over it after.’  
P3, 29 YO, High referrer

‘Most importantly we try to stress that the child must have supervised brushing last thing at night.’  
P10, 49 YO, Medium referrer

‘I tell them not to rinse the toothpaste; the Department of Health says that.’  
P14, 39 YO, Low referrer
It was interesting to note that the cohort of patients seemed to be well distributed between practices. All informants, including those from high referral clinics reported that the number of children they individually refer is low. This can have important implications on planning future strategies to improve the oral health of this cohort:

'I think to specify actual extractions under GA would only be about five a year.'  
\textit{P5, 30 YO, High referer}

'Overall we don’t have a high referral rate to the hospital.'  
\textit{P10, 49 YO, Medium referer}

'Well it’s very, very rare that I have kids for general anaesthesia.'  
\textit{P15, 34 YO, Low referer}

In summary, despite the availability of preventive care guidelines, the perceived inadequate primary care funding, and apparent inadequate GDP training are challenges GDPs face in applying those guidelines and promoting oral health in those children. The number of high-caries-risk children reported to be seen by each individual GDP seems to be low and that should be factored in planning oral health promotion.

\textbf{4.3.4.5 Inadequate secondary care communication and engagement}

\textbf{4.3.4.5.1 The need for better communication between primary practice and the hospital}

The informants reported issues in communication between the hospital and both referring GDPs and families. Many of them found discharge letters lacking sufficient information. They reported that it would be useful, and potentially improve post-operative follow-up, if more information was provided in these letters, the type of information can be divided into two categories:

(i) Information about care provided in hospital including details on treatment provided and rationale:

‘The discharge letters are very interesting, especially from paediatrics, you get this sheet with a box: x, y and z extracted, thank you very much, please proceed. It would be good to see: has this patient been
seen? What has been done apart from their exodontia or filling? Have they had advice? We don’t know where we are picking it up from!’
P13, 48 YO, Low referrer

‘I think it is quite brief. I mean it’s normally just a little chart that says we’ve extracted this, this, that and that. So there’s no detail about why they’ve chosen those teeth or anything like that which could be a bit better. I think I had a couple of cases where parents did not know why a couple of teeth were taken out and I hadn’t written in for them to be taken out.’
P9, 26 YO, Medium referrer

(ii) Information regarding needed post-operative recall: Information regarding preventive care and maintenance needed following completion of treatment under GA would be helpful:

‘I think they should also indicate the things they would like us to focus on, advice and maintenance.’
P4, 37 YO, High referrer

‘They never give any post-operative advice on to do this or do that, very little it comes... they are too busy there, they just simply say these teeth have been taken out.’
P3, 73 YO, Medium referrer.

The communication of such information enforces the GDPs sense of continuity of treatment and might improve their efforts to follow-up with those children after GA. One informant explained:

‘... Unless it specifically says in the letter that they need to come back for further treatment, that’s when we will normally give them a ring or we will send a letter to say come back for treatment, otherwise, if it doesn’t say anything like that, then we’d only just leave it for a recall to be sent out to them.’
P3, 29 YO, High referrer
4.3.4.5.2 The need for oral health education for families during the Child’s hospital GA referral

Information should also be communicated to parents. One informant thought that parents were viewing their child’s treatment under GA as an end point in the dental care journey, after which attendance is not required:

‘Some patients think their teeth have been taken out, I don’t have any problems, and I don’t need to see the dentist until I have a problem. So the recall becomes a wasted cycle.’ P13, 48 YO, Low referrer

‘Quite often the mothers think the rotten ones have gone out and it’s clear and clean, then don’t need to go for a while.’ P11, 51 YO, Medium referrer

Providing the family with information on the importance of recall after treatment under GA has been completed can give them a sense of continuity in treatment:

‘I think if the hospital emphasizes to the parents: okay we’ve done the treatment, we just want them to come to the surgery again within three weeks or whatever, they know they have to come back here again for the routine appointment.’ P7, 59 YO, Medium referrer

The informants also suggested that more efforts to promote oral health need to be taken by the hospital upon the child’s referral. They noted that this is one of the rare chances to capture the families of those children to deliver an oral health intervention. In their opinion, those families might be more responsive to advice delivered by the hospital compared to the local dentist due to some form of perceived hierarchy:

‘I think the parent takes the credentials of the hospital at a higher value than those of a practitioner so when they go to the hospital and someone says, ‘Come back and we need to see you because we need to review the health’ they're more like a shot. And if you could capture them then and provide more prevention advice as well I think that would have a far bigger effect than trying to say, ‘Right, now go and...’
see your dentist’. And I don’t think they always make that journey to us.’ P10, 49 YO, Medium referrer

‘Patients take what comes from the hospital as a gospel, when it comes to the practice, not necessarily, you are just a dentist.’ P13, 48 YO, Low referrer

‘I find when you speak in the hospital to the children and parents they do listen a little bit more, and they come back to me and say I need this treatment to be followed up.’ P12, 57 YO, Low referrer

The timing to apply a hospital intervention was also discussed with the informants. Some thought that a post-operative review visit at the hospital is the best time, as children would have been relieved from any pain they might have had and the family would be more likely to listen. As an informant explained:

‘I think if there would be like a post review appointment at the hospital ... somebody to just have a chat with them, the child is not going to be undergoing any treatment and is aware of what’s happening and then maybe like a therapist or something to just keeps them motivated.’ P4, 37 YO, High referrer

‘I don’t think before they have their treatment anyone is listening because all they want to know is when is my appointment to come in to have these teeth taken out and when is this going to happen, how long am I going to be waiting.’ P5, 30 YO, High referrer

Others stressed out the importance of making every contact with those families count, and suggested the medical pre-assessment appointment as the time to apply an intervention, since these families are bad attenders. An informant explained:

‘I wonder whether it should be an extra visit, because obviously you do a pre-med assessment anyway, I don’t think an extra visit is needed. See the more you bring a patient in the less likely you are to get them to turn up in my experience because parents have to take time out of
work, if they are working. So you want to bring them in, fewer episodes but useful.  

4.3.4.5.3 The need to target children in oral health education

Some informants also suggested that the inclusion of children in oral health education is important, as they have found from their own personal experience. One informant explained his experience with face-to-face advice using visual aids by saying:

I tell you what I’ve done a lot of, and that is going to schools and teaching oral health. I’ve done a lot of that, I did it a couple of months ago and it’s amazing when you’ve got children’s attention, when you’ve got a good simple message with teaching aides it does get home because the mothers come back to the teachers and say: ‘oh my son says he doesn’t want any more fruit juice, my son has been brushing’. The feedback has been good. So I think we mustn’t dismiss targeting the children directly face to face teaching.

Another informant commented on the idea of using an oral health education video-game by saying:

‘If you make any particular funny video, you know, movie that would still help a lot. These patients I found them, children very good memory, they have got very good memories so anything can be memorised by children about their, you know, their own body’.

In summary, informants thought that establishing better communication between them, the hospital and families help continue the cycle of care after the GA procedure. Hospital referral is one of the rare chances to capture those families and the opportunity should be seized to provide them with oral health education and encourage regular dental attendance.
4.3.4.6 Failure in establishing national policies that grasp the width and depth of the problem

4.3.4.6.1 The unhealthy surrounding environment

In an apparent call for change in wider public policies, informants noted that those children are being surrounded by an unhealthy environment, making oral health promotion at the dentist alone difficult. For example, one dentist described the large amounts of sugary drinks being promoted for children at the local store by saying:

‘There are three aisles of sweet drinks and it is what they (the children) are drinking.’ P11, 51 YO, Medium referrer

Informants demanded wider efforts to create a healthier environment for those families. Policies are needed to ensure oral health promotion starts in the community using various outlets such as media and schools before those families even step into the dental practice:

‘I think it is tricky, once you get them to come to the dentist they are more likely to come back, that’s just the first thing. So I think just general motivation and things on a broad spectrum: posters and adverts on TV and all that will obviously help.’ P9, 26 YO, Medium referrer

‘If I can be radical and sometimes if you want to be effective you have to be radical, then we need to be strongly present in the schools and educate the children. Parents we would love to educate but it's about media with them.’ P10, 49 YO, Medium referrer

4.3.4.6.2 Lack of multiagency involvement

Informants felt isolated in their efforts to promote oral health, they noted that in order to tackle the issue, there is a need to broaden the involvement of others in primary care setting, including general practices, maternity wards, etc. In addition, a common risk factor approach can be followed, so that dentists are not isolated in their ‘nagging’ as one informant put it:

‘I say long term the sugar is not good for their general health, obesity and other problems down the road. So I tried to give it the holistic
Schools in particular were thought to be an integral part of any approach to oral health promotion as children are perceived to be more receptive to oral health advice within that environment. In one informant’s words:

‘I think the best way to educate these children and their parents is to go around to schools and basically talk to the school nurse, give them leaflets, give them a book, fifteen/twenty minutes in each class and show how to brush the tooth.’

In summary, the informants were feeling alone in their efforts for oral health promotion in those families. They requested more to be done by policy makers to ensure oral health promotion is a multidimensional multiagency effort.
4.4 Summary of findings

1. The children receiving dental extractions under GA at KCH in 2011-2012 were referred from 166 primary practices scattered across South London. Most came from practices in the Boroughs of Lambeth, Southwark and Lewisham.

2. GDPs in Lambeth, Southwark, and Lewisham, list multiple challenges that they consider to be hindering oral health promotion efforts in high-caries-risk children. These are: the child’s young age, poor cooperation, and high treatment need; perceived poor attitudes towards oral health and lack of skills in parents; language and cultural barriers; deficiencies in primary dental care remuneration; poor communication within the GA pathway; national policy failures.

3. Some dentists felt that applying fluoride varnish to children is difficult and time consuming.

4. The dentists perceived that high-caries-risk families lacked awareness regarding regular attendance, hidden sugars and the delivery of fluoride. They wanted more advice to the families as part of the hospital GA pathway.
Chapter 5:

Development of an oral health education video-game and planning and piloting the RCT evaluation
5.1 Introduction

This chapter will discuss how a video-game delivering oral health education for children (Barney’s Healthy Foods), was modified and further developed by the author to make an educational video-game suitable for use by high-caries-risk children referred for extractions under General Anaesthesia (GA) at King’s College Hospital (KCH), during their medical pre-assessment appointment. It will also describe how the methods of a phase II Randomised Controlled Trial (RCT) to assess the game have been planned and piloted in a small group of children.

‘Barney’s Healthy Foods’ was developed by Rice (2009) for use in primary schools in Scotland, and was used as a basis for the development of a new video-game that was used in this thesis. ‘Barney’s Healthy Foods’ underwent various adjustments that were introduced by the author in light of the findings from Colm Rice’s MSc research (Rice 2009), the availability of new video-game design technology, the recommendations of Delivering Better Oral Health (DBOH), an evidence-based toolkit for prevention (Public Health England et al., 2014), and finally, the findings of the qualitative studies performed by the author, involving parents (Aljafari et al., 2014), and GDPs.

Following the development of the new game, it was used in a pilot study for the upcoming phase II RCT, with the aim of assessing children’s interaction with it and correcting technical difficulties, as well as, assessing the feasibility of the RCT study’s protocol, assessing blinding and randomisation methods, and finally, familiarising all members of the research team with the methods and research procedures of the RCT.
5.2 Video-game development

5.2.1 The decision to modify ‘Barney’s Healthy Foods’

As discussed in the literature review, there were two previous stages in the development of the prototype oral health education video-game. The first was ‘Holly’s Kitchen’, a short video-game developed by Petale (1998) to teach nursery children about healthy food choices. The second was ‘Barney’s Healthy Foods’, a game developed by Rice (2009) to teach school children in the Isle of Lewis in Scotland about healthy food choices and toothbrushing.

‘Barney’s Healthy Foods’ was selected as a basis for developing the video-game to be used in the current intervention. The author of the game, Colm Rice, was contacted to acquire his consent. This choice was made on the basis of several factors. Firstly, the game was developed for children whose age range is close to the average age of children referred for dental extraction at KCH as reported by Olley et al. (2011). Secondly, it was relatively recent, and utilised good and easy to learn computer technology. Thirdly, it was developed in line with the Scottish school curriculum, and followed sound general principles of education. Fourthly, it was developed using input from nutritionists, dental professionals, school teachers, and school children. Finally, it was assessed in a phase I RCT with promising results.

Nonetheless, major adjustments to ‘Barney’s Healthy Foods’ were necessary in light of: children’s feedback from the phase I RCT (Rice 2009), the availability of newer video-game design technology, the availability of DBOH, an evidence-based toolkit for prevention (Public Health England et al., 2014), and finally, the findings of the interviews with parents and GDPs performed by the present author.
5.2.2 Overview of original video-game prototype (Barney’s Healthy Foods)

‘Barney’s Healthy Foods’ included a series of animated interactive quizzes that aimed to educate children on healthy diet selection by encouraging the consumption of fruits and vegetables and the avoidance of foods and drinks that were high in free-sugars or saturated fats. The game also promoted regular twice daily toothbrushing. The game’s main character was a cartoon dog named ‘Barney’, and the children were guided through the game by an avatar named ‘Dino the Dinosaur’ to ease the understanding of the game tasks in those that may not be able to read. Evidence suggests that the use of an avatar in children education can improve the learning experience (Johnson et al., 2000). Figure 8 shows ‘Dino the Dinosaur’, and Figure 9 shows an example game-play screenshot.

![Dino the dinosaur, ‘Barney’s Healthy Foods’ avatar](image)

Figure 8: Dino the Dinosaur, ‘Barney’s Healthy Foods’ avatar
In addition, the game delivered oral health education that was in line with the primary school curriculum for Scottish school children aged 5-7 years. Oral health education programmes that are well integrated into a national school curriculum have been shown to lead to improvements in children's oral health knowledge (Chapman et al., 2006).
The original game went through four stages of development and evaluation as follows (Rice 2009):

1. Collection of qualitative input from experts to inform design: this was achieved by performing structured interviews with four paediatric dentists, a dental public health consultant, a dental therapy trainer, two dieticians and two school primary teachers.

2. Designing of the video-game, taking expert opinion into consideration: Microsoft PowerPoint was chosen as an appropriate platform for the design process, due to its ease of use and the researcher’s familiarity.

3. User-group assessment of video-game functionality, engagement, and ease of navigation: Six six-year-olds used the game for one week at school while being observed by their school teachers and the researcher then had structured one-on-one interviews.

4. Phase I blind RCT to evaluate the game’s effectiveness in improving dietary knowledge and snack selection by five- to six-year-old school children. The game was as effective as written advice in improving dietary knowledge. However, it failed to improve snack selection, although the results might have been contaminated by a healthy eating school programme that was rolled out during the trial.

5.2.3 Adjustments to develop a new video-game:

In order to develop the game used in this thesis, adjustments were introduced to the video-game prototype ‘Barney’s Healthy Foods’. These adjustments can be categorised into four categories: adjustment of the game’s animations, alterations of the game’s content, change of video-game software programme, and finally, introduction of new game platform (touch screen tablets).
5.2.3.1 Adjustment of the game’s animation

As Griffiths (2002) suggested, researching the use of video-games is complicated by the rapidly improving technology. By the time a video-game has been developed and assessed, new technology has already become available, offering new ways for design and rendering the game ‘outdated’ in the eyes of many. This was also the case in this research project; ‘Barney’s Healthy Foods’ was first developed in 2007, meaning that by the time the current thesis project started in 2012, it was five years old. More recent technology was available for designing the game’s animation. Moreover, the original prototype video-game was designed in Scotland for a population different than the one targeted in this thesis. Hence, a few adjustments to the game’s animation were introduced by the current author.

5.2.3.1.1 Development of new avatars for the game

The video-game prototype’s avatar ‘Dino the Dinosaur’ was replaced, as feedback from children taking part in the phase I RCT revealed that many might have not been satisfied with his appearance, and thought he had unnatural scary teeth (Rice 2009). ‘CrazyTalk 7’, an animation software programme, was used to develop three new avatars (a hamster, a cat, and a dog), the idea being that they are typical pets. The cat was subsequently removed, as some children in the pilot did not find the animation ‘friendly’. The remaining characters were given the names ‘Fluffy the Hamster’ and ‘Ben the Dog’ by children taking part in the pilot study. The details of the pilot study will be discussed later in this chapter. Figures 10 and 11 display the use of CrazyTalk 7 to develop the animated avatars. Figures 12 and 13 display the new avatars: ‘Fluffy’ and ‘Ben’, respectively.
Figure 10: The use of CrazyTalk 7 to develop new avatars (stage 1)

Figure 11: The use of CrazyTalk 7 to develop new avatars (stage 2)
Figure 12: Fluffy the Hamster

Figure 13: Ben the Dog
5.2.3.1.2 Recording a new voice-over for the avatars

The original video-game prototype had an avatar speaking with a Scottish accent. The new avatars were given new voice-overs using a voice actor with an English accent to become more suitable for children in London. To achieve this, the original game’s dialogue, as well as the new content, were transcribed verbatim by the author, read by the voice actor, and then finally manipulated using ‘Audacity’, a sound-editing software programme. This produced a voice tone more appropriate for the new game avatars. Figure 14 displays the interface for ‘Audacity’.

![Figure 14: Interface of Audacity - A software programme for sound editing](image)

5.2.3.1.3 Introduction of new animations during game-play

The video-game prototype featured a constant background of a grass field all throughout the segments of the game. This matched the Isle of Lewis in Scotland, but not London. Hence, new backgrounds were introduced to make the game more interesting and pleasant for the children, as well as make it more closely related to their home environment. Visual and auditory features of video-games are an important aspect of what makes them interesting and appealing (Salen and Zimmerman 2004).
Each game segment was given a different background to represent the physical location in which that segment might take place (i.e. breakfast in the house, toothbrushing in the bathroom, etc.). Figures 15, 16, and 17 display examples of the changes in animation that have been introduced.

Figure 15: An example of new animations (1)
Figure 16: An example of new animations (2)
That’s right he has to brush his teeth.

Figure 17: An example of new animations (3)
5.2.3.2 Adjustment of the game’s content

5.2.3.2.1 Reduction of game length

The original video-game prototype had ‘easy’ and ‘difficult’ modes, and a segment called ‘catching the fairy’, which aimed to enhance the child’s hand-eye coordination as part of the learning goals for that age group at school. The presence of these segments has made game-play too time-consuming (approximately 45-60 minutes) for the hospital GA setting. Moreover, it might have been too long when compared to a child’s average attention span during play, which Moyer and Gilmer (1955) suggested is around half an hour.

The RCT will target children referred for extraction under GA during their medical pre-assessment appointment. Asking them and their parents to spend an hour using the oral health education video-game, not including the time needed to complete the measures used in the study, would be unrealistic. Hence, the segment ‘catch a fairy’ was removed, and the ‘easy’ and ‘difficult’ modes of the game were combined into one continuous game-play called ‘A day in the life of Barney’, that includes helping children identify healthy foods for breakfast, snacks, drinks, and dinner, as well as a segment on toothbrushing. This has cut down the time needed to complete the game significantly to about 30 minutes or less.

Figure 18 shows the opening screen of the new video-game (Fluffy the Hamster version).
Figure 18: Fluffy the Hamster’s opening screenshot
5.2.3.2.2 Addition of content in light of DBOH recommendations, recent research, and the author’s qualitative research

‘Barney’s Healthy Foods’ contained health messages promoting the consumption of fruits and vegetables, discouraging the consumption of foods and drinks high in free-sugars or saturated fats, and encouraging toothbrushing twice a day. These messages are indeed recommended by DBOH (Public Health England et al., 2014).

However, there was a need to include other oral health messages into the developed game to make it fully compatible with the recommendations of DBOH (the second edition at the time the study began) as discussed in (2.9.6), and to take into consideration the needs of the specific population that will be targeted. This was suggested by the findings of the qualitative studies that involved the parents (Aljafari et al., 2014) and then the referring GDPs (Chapter 4 of this thesis).

The new messages that were added can be summarised as follows:

1. **Reduce the consumption of fruit juice.**

Fruit juice contains free-sugars, and its cariogenicity has been well established as suggested by the work of Duggal and Curzon (1989) and Marshall et al. (2003). The second edition of DBOH recommended that its consumption should be reduced in frequency and amount (Department of Health 2009a). Despite that, the general public seems to still lack awareness on this issue, as an online survey that involved 2,000 people in the UK suggested that the British public underestimates the amount of sugar that fruit juices can contain, while overestimating or correctly guessing the amount of sugar in other more obvious sources, such as fizzy drinks (Gill and Sattar 2014).

More importantly, parents of children referred for extractions under GA at KCH, who were previously interviewed by the author, were unaware of the potential cariogenicity of fruit juice (Aljafari et al., 2014). In light of this, a game segment encouraging children to limit the consumption of fruit juice to meal times was added. Figure 19 displays a screenshot of a segment educating children on drinking juice only with their meals, and drinking water between meals if thirsty.
2. Toothbrushing should be using a 1,450 ppm fluoride toothpaste, without rinsing afterwards, and with supervision in children younger than seven years.

The second edition of DBOH recommended that children under high caries risk should use 1,350-1,500 ppm fluoride toothpaste. Moreover, it recommended that children spit and don’t rinse following toothbrushing, and that those six years old or younger should be supervised by their parents (Department of Health 2009a). Olley et al. (2011) reported that only 45% of families of children referred for dental extractions under GA at KCH received advice on using fluoride toothpaste and that 54% of the children six years old or younger brushed their teeth unsupervised. As such, a segment educating children and their parents regarding those recommendations was added as can be seen in Figure 20.
Figure 20: Screenshot of some of added messages on toothbrushing in the video-game

3. **Application of fluoride varnish at your GDP can reduce caries risk.**

The second edition of DBOH recommended that children under high caries risk receive fluoride varnish three to four times a year (Department of Health 2009a). Yet application of fluoride varnish by GDPs in Lambeth, Southwark, and Lewisham is less than optimal (NHS Prescribing and Primary Care Team 2014), and some of the GDPs interviewed in Chapter 4 reported not using fluoride varnish at all. As such, many families of children referred for dental extractions under GA at KCH did not seem to be familiar with fluoride varnish application or its benefits (Olley et al., 2011; Aljafari et al., 2014). In light of this, advice on regular use of fluoride varnish was added to the game.
4. Attend your GDP three to four times a year for routine check-ups and preventive care.

The National Institute for Clinical Excellence (NICE) guidelines for dental recall recommend that high-caries-risk children are seen for regular check-ups every three to four months (National Institute for Clinical Excellence 2004). Yet there is evidence that those families do not attend for preventive dental care regularly (Olley et al., 2011). Furthermore GDPs interviewed in chapter 4 suggested that the parents needed to be given information about regular follow-up. In light of these findings, a message to encourage parents to arrange regular dental care for their children was added.

Figure 21 displays the addition of advice on regular dental attendance and fluoride varnish application.
5.2.3.3 Change of the video-game’s software programme

‘Barney’s Healthy Foods’ was designed using Microsoft PowerPoint. Although this software programme allows for a simple designing process, it has its drawbacks when it comes to playing the game. Firstly, the software programme must be pre-installed on the computer to be able to play the game, and not all household computers are fitted with it. Secondly, using different versions of the programme, or different operating systems (Windows, IOS) might affect the gaming experience. Finally, the child can ‘outplay’ the game, meaning that they can skip through parts of the game without engaging with the questions, by simply clicking through.

In light of this, it was necessary to convert the game to another software programme that addresses these weaknesses. HTML5 is a free universal software programme that is pre-installed on all computers, smart phones, and tablets to display internet websites’ contents. This was chosen due to its universal spread, easy use and difficulty of ‘outplaying’. ‘iSpring converter’ is a software programme that was used to perform the conversion. This software programme allowed the author to design the game using PowerPoint, and then convert it to HTML5 and make it available for the children.

5.2.3.4 Introduction of a new game platform (tablets)

In addition to changing the game’s software programme, the game was made available on a touch tablet (iPad). The decision to use a touch tablet to deliver the game comes in light of several facts: firstly, there has been a big surge in the use of touch screen tablets in recent years, especially amongst children (OFCOM 2014). Secondly, it has been suggested that the use of those tablets makes gaming experiences easier and more interesting for children (Couse and Chen 2010), and finally, the use of those tablets allowed for easier set-up in the research location. Figure 22 shows the game ready on an iPad.
Figure 22: Fluffy the hamster on an iPad
5.3 Planning evaluation of the oral health education video-game

5.3.1 Planning the study design

As evident in the literature review, the use of video-games in oral health education in children is a new area of research, and as such, there is minimal evidence available on their use. It is important that any newly developed intervention undergoes rigorous assessment through a series of trials before its benefits are established. The Medical Research Council (MRC) has developed a framework providing guidance to researchers on developing and assessing interventions. It advises researchers to carefully develop interventions by: taking the evidence-base into account, assessing feasibility and piloting through a series of studies, evaluating effectiveness, cost-effectiveness, and any other aspects that help understand the process of the intervention, before finally, disseminating the findings, delivering recommendations, and continuing to evaluate the long-term effects of the intervention (Medical Research Council 2008).

The MRC suggested that clinical trials assessing interventions can be categorised into four phases. The initial study by Rice (2009) to evaluate the prototype oral health education video-game, which involved a sample of schoolchildren not taking into account their caries risk, can be considered as the phase I RCT for this method of oral health education delivery, and fits well with the MRC’s definition of phase I trials as: ‘those testing a new intervention in a small group of healthy individuals’ (Medical Research Council 2014).

That meant that it was time to perform a phase II RCT, which the MRC has defined as: ‘trials that test new treatments in a larger group of people who usually have the condition for which the treatment is to be used, to see whether the treatment is safe and has some effect on that condition. Usually less than one hundred people are involved at this stage’ (Medical Research Council 2014). In the case of dental caries, high-caries-risk children attending for extraction under GA fit well with the requirement that the population being studied should have the condition for which the treatment is to be used.
Next, it was decided that it is necessary to measure this novel education method’s acceptability. The MRC stressed the importance of assessing acceptability as part of a new intervention’s evaluation, and suggested that this is frequently overlooked (Medical Research Council 2008). While interventions deemed acceptable are not necessarily effective, those that are not acceptable won’t be used by the target population, even if they were clinically effective.

When the aim of a study is to develop a new intervention that seems to be acceptable enough to the target population, prior to further researching its clinical impact, acceptability of the intervention is can be assessed during a small and limited pilot stage. However, in this thesis, the aim extends beyond simply developing a new acceptable intervention. The research aims to investigate whether a video game can be an acceptable alternative to the more traditional one-on-one oral health advice delivery in the eyes of children and parents. In this case, establishing whether there are any significant differences in the families’ acceptability of those two methods forms an important part of the evaluation process, and helps establish a proof of concept for using video games as an oral health education tool in the future. As such, reliable statistical power will be required, and that could not be provided as part of a cohort pilot study. Instead, acceptability needs to be measured and compared as part of the main RCT.

In addition, it was decided to measure the oral health education video-game’s effectiveness in terms of increasing dietary knowledge, and improving oral hygiene and dietary habits on a short-term. Measuring those outcomes fits well with the model to evaluate oral health promotion interventions suggested by Nutbeam (1998). The model includes four levels of action: (i) health promotion action (e.g. Education); (ii) health promotion outcomes (e.g. health literacy, knowledge, self-efficacy); (iii) intermediate health outcomes (e.g. health behaviour); and finally, (iv) health and social outcomes (e.g. reduction of caries).

The planning of the study had to take into consideration the burden it will place on the participants volunteering to take part. This is a population that is well known to be difficult to follow-up (Primosch et al., 2001; Lee et al., 2002; Jamieson and Vargas 2007; Hosey et al., 2009, Mathu-Muju et al., 2010). In addition, the design
had to take into consideration the chronological and financial framework of the PhD programme of the study.

5.3.2 Selection of outcome measures

Selecting the measurement tools used in the upcoming phase II RCT has been difficult, considering the population targeted. The tools selected were those deemed most appropriate to measure acceptability, improvement in dietary knowledge, and change in oral health practices, while engaging the families in a positive way about oral health, and simplifying data collection and the time needed to complete the outcome measures.

5.3.2.1 Acceptability

Researchers in different fields have developed various tools to measure how acceptable their interventions or services are to their patients. Tools such as those developed by Heise (1997), Hankins et al. (2007) and Browne et al. (2010) take the form of multiple-item questionnaires that measure patient satisfaction. However, those tools have been made to assess specific services or interventions, and hence, cannot be reliably borrowed to be used in evaluating other interventions, such as the one planned in this thesis.

The Visual Analogue Scale (VAS) was first developed in 1921 (Hayes and Patterson 1921). It is a scale that has been well validated for measuring various feelings (McCormack et al., 1988), and more recently, it has been validated for use in measuring patients’ satisfaction (Brokelman et al., 2012; Singer and Thode 1998). Moreover, it has been recently used in a study measuring satisfaction of families referred for dental GA (Hosey et al., 2014), although the full results are yet to be published. In addition to being validated and reliable, the VAS is a low-burden measure, is easy to understand, does not require very high literacy, and can be completed quickly. This makes it a good fit for families of high-caries-risk children. Hence, it was selected as the measure of acceptability to be used in the upcoming phase II RCT, and was made one of the primary outcome measures.

The use of VAS in children has been under discussion, with some authors suggesting it can be used by young children (McGrath 1989; Szyfelbein et al., 1985) and others suggesting its best suited for children seven years of age or older, due to
cognitive ability (Beyer and Aradine 1988; Shields et al., 2003). Hence, the children’s VAS used in the RCT was to be supplemented with a happy and sad face at either end in an effort to simplify the process for younger children taking part in the upcoming trial.

However using the VAS scale might have its limitations. People tend to mark the scale towards its ends leading to a potential ceiling effect as suggested by Brokelman et al., (2012). Nonetheless the VAS ceiling effect of (42%) reported by Brokelman et al., (2012) remains significantly less than that expected in if a Likert scale is used as an alternative measure, which Haverkamp et al. (2008) reported had a ceiling effect of 79%, and is also easier to complete in a group that might struggle with literacy, and in children.

To supplement the acceptability measured by the VAS scores and provide insight into any issues that need to be tackled by future oral health game developers, participants playing the video-game were to be asked to provide brief qualitative feedback regarding the game. Qualitative methods have indeed been recommended as an approach to measuring satisfaction by Sitzia and Wood (1997). However, there is a risk that participants give socially acceptable answers, thus the interview approach is important to ensure they feel comfortable in giving their responses.

5.3.2.2 Dietary knowledge

Measuring the dietary knowledge of children is challenging. A comprehensive review of studies across different health fields revealed that a multitude of tools have been used to measure dietary knowledge in children (CONTENTO ET AL., 2002). Unfortunately, the reviewers noted that the 12 studies that targeted preschool children and the 20 that targeted school children did not reach a consensus on a universal reliable validated tool. In addition, almost all of the studies evaluating those measures might be outdated, as they were undertaken more than twenty years ago, at a time where commercial foods and drinks available and marketed were different. More importantly, the measures used in those studies have been designed to evaluate the impact of specific interventions, and measure specific aspects of nutrition knowledge, in a specific population and a certain age range (CONTENTO ET AL., 2002). In fact, none of the studies in the review involved investigating the issue of dietary habits from an oral health perspective. As such, it is unlikely that any of
them will make a good measure if adapted for use in the population, setting, and context of the RCT in this thesis.

In the same review, it can be noted that the studies assessing dietary knowledge in preschool children always used pictorial tools, while those for school children mostly included multiple choice questions (Contento et al., 2002). As the RCT is going to involve children as young as four, it was decided that a pictorial quiz would be the most appropriate format. The use of such a quiz format might also help reduce the impact of any differences in literacy and reading skills. In fact, both studies that evaluated the earlier prototypes of this video-game used food item pictures to assess participants’ dietary knowledge gains (Roebuck et al., 2000; Rice and Hosey, 2008).

The Pictorial Dietary Quiz (PDQ) developed by Rice and Hosey (2008) might be the most appropriate tool to be used in the RCT in this thesis, as it was piloted and refined in a group of school children in Scotland, and was used evaluate the oral health education video-game that was used as a precursor to the video-game used in this thesis. The PDQ is a 70 items quiz that requires the child to score each food item as healthy or unhealthy. The maximum score a child can achieve is 70 points. Rice and Hosey (2008) suggested that a difference of five points on the scale might be clinically significant.

As the PDQ was developed in Scotland, the author replaced a few food and drink item brands that were particular to Scotland with similar items available in England. It is important to acknowledge that using the PDQ has its limitations: it only measures dietary knowledge in terms of recognition of healthy and unhealthy items, and does not measure not more complicated knowledge on issues such as healthy food consumption frequency. Also, it might still need to undergo further stages of validation in the future to optimise its use. In addition, some older children might find it too simple, as it was originally used in children five to seven years old.

5.3.2.3 Dietary and oral hygiene practices

The author needed a tool to measure the dietary practices of children that is validated, fits with the study age group, is easy to use and analyse, and is retrospective so that it is possible to measure the participants’ dietary practices prior
to the provision of oral health education at the medical pre-assessment clinic. In addition, the tool needed to place the least interference with the pathway of care, and the least burden possible on the participants, to ensure that families that are difficult to reach are more likely to take part.

There are a few methods used to assess individual dietary practices. Wreiden (2003) noted that weighted dietary records, where consumed foods and drinks are weighted and logged in for up to seven days, remain the golden standard. However, as one might expect, this method is expensive to undertake and places a heavy burden on the participants. As such, estimated food records, discussed by Wreiden (2003), might present a cheaper and easier option. However, neither method fits with the design of the RCT planned in this thesis, as their use would require that high-caries-children are approached and handed those diaries prior to the medical pre-assessment appointment if dietary patterns prior to the intervention on the day of the appointment are to be recorded.

Asking the parents for a twenty-four-hour dietary recall is another method for dietary evaluation that could fit into the design of the RCT in this thesis. The method is easy and relatively fast. However, previous research by Karvetti and Knuts (1985) revealed that it is not reliable on an individual level, and is only of value when comparing large groups or populations. Wrieden (2003) noted that this method of dietary recording carries the risk of not being representative of an individual’s diet, is dependent on their memory, and carries the risk of bias in recording bad foods.

The exclusion of diet diaries and dietary recall leaves food frequency questionnaires. According to Wrieden (2003), those questionnaires are usually food checklists of varying complexity that participants complete to indicate their dietary habits for a certain amount of time. The burden placed on the participants in order to complete such tools varies according to their complexity. An ideal tool to be used in this research project needs to be of low-burden to the participating families, not only so that it fits well within the research design, but since low-income families in South London have previously reported that they prefer simple food frequency questionnaires, because they are easier to complete and require less effort (Holmes et al., 2008).
A comprehensive review by the National Obesity Observatory provided a list of food frequency questionnaires recommended for use in dietary assessment in the UK (National Obesity Observatory 2010). The ‘Day in the Life Questionnaire’ developed by Edmunds et al. (2002), the ‘Synchronised Nutrition and Activity Program™’ developed by Moore et al. (2008), the ‘Child Nutrition Questionnaire’ by Wilson et al. (2008), and the ‘Family Eating and Activity Habits Questionnaire’ developed by Golan et al. (1998) have all been recommended for the use in children. However, none have been designed to gather information regarding the dietary practices of children less than six years old. As such, they will not be appropriate for use in younger high-caries-risk children attending for GA.

The ‘Child and Diet Evaluation Tool – CADET’ developed by Cade et al. (2006) can be used to report on the dietary intake of children as young as four. As such, it fulfils the age requirement. However, this might be a time-consuming tool that might also require good literacy and careful reporting. Furthermore, it consists of two parts to be completed by the parent and a teacher at school, and requires special training for administering and data analysis (National Obesity Observatory 2010). As such, it might not be suitable for use in high-caries-risk children and their families within the current research project’s framework.

The Children’s Dietary Questionnaire (CDQ) developed by Magarey et al. (2009) is a week-long food frequency questionnaire that was developed and validated in Australia. The CDQ is made from four different sections: Fruit and vegetable intake; fat from dairy intake, including full fat milk, yogurt and custard; sweetened drinks including fruit juice and soft drinks; and, non-core foods, including crisps, chips, cakes, processed meats, sweeties, etc. it can be noted that two of those sections might be of special interest in regards to oral health: sweetened drinks and non-core foods.

The CDQ was chosen as the most appropriate tool to record the dietary practices of the population of high-caries-risk children in this thesis. It was designed for investigating the diets of children aged four to sixteen years old, it is easy to complete and analyse, it places only a reasonable burden on participants, and it has been recommended by the UK’s National Obesity Observatory as a method of dietary assessment in public health research (National Obesity Observatory 2010).
However, it should be noted that the CDQ does have some potential weaknesses, namely: it might have poor correlation for some items, and does not yet have a validated UK version. As such, some of the food items in the questionnaire were renamed in UK English. Nonetheless, there is a risk that culinary and cultural differences between the UK and the country of development, Australia, impact its suitability. The CDQ is free for public use. Nonetheless, its author (A. Magarey) was contacted and has granted permission for its use.

5.3.2.3.1 Child-recorded dietary and toothbrushing practices

In addition to the CDQ, children were to be asked to draw or write down their snacks at school for up to five days after the intervention. These snack diaries were first used in the phase I study (Rice 2009). Asking children to draw in order to collect data in research has its advantages. As Marshman and Hall (2008) noted, drawing is a non-verbal mean of communication that can be used in children from young ages, as it is an activity they are usually familiar with.

Children were also to be asked to report on their toothbrushing frequency for up to two weeks after the intervention using a toothbrushing diary. The diaries to be used were those used in the ‘Childsmile’ programme in Scotland (Childsmile 2013), due to their availability, and child-friendly design. The director of Childsmile, Professor Lorna Macpherson, was contacted to gain permission to use the toothbrushing diaries.

Jamieson et al. (2004) reported that child-reported toothbrushing habits correlated well to oral health in six- to nine-year-old children, and suggested such a self-reported method might be a reliable and valid tool in oral health epidemiology. Another more recent study suggested that this is a valid proxy variable to oral hygiene in children aged 12 years (Gil et al., 2015).

Using snack and toothbrushing diaries can provide insight into the children’s dietary and oral hygiene habits, and also can keep them feeling involved. In fact, Gilchrist et al. (2013) suggested that written and drawn diaries can be used to involve children in research. However, as with all self-reported measures, their reliability is questionable. Children might just record the ‘correct’ rather than the ‘true’ answer, furthermore, the mere effect of participating in the research study might cause them
to improve their dietary selections or toothbrushing habits, in what is known as the ‘Hawthorne effect’ (Parsons 1974). Unfortunately, direct observation of oral health practices at home is not possible, and researchers have to continue relying on self-reports.

It was to be expected that diary completion and return rates might not be ideal. Therefore, age appropriate books were to be given as incentives to motivate the children to complete and return their diaries. Rice and Broome (2004) suggested that school supplies such as: pens, pencils, erasers and notebooks are some of the suitable incentives for four- to twelve-year-old children taking part in research. Furthermore, SMS messages were to be used as reminders for the parents one day prior to the family’s GA visit, and pre-paid mail envelopes were to be provided to those who do not bring the diary back in person so that they can mail it later.
5.4 User group assessment and pilot study for RCT

5.4.1 Introduction

Once the video-game was developed, a pilot study was conducted in preparation for the RCT to evaluate its use in children referred for dental extraction under GA.

5.4.1.1 Aims

1. Assess user group (children) interaction with the new video-game, note any feedback, and notice and address any technical difficulties encountered during game-play.
2. Assess the feasibility of the planned RCT protocol in terms of physical location and procedure for recruitment, and familiarise the author and the dental nurses participating in the RCT with the standard operating procedure.
3. Assess the blinding and randomisation methods to be used in the planned RCT.

5.4.2 Methods

The pilot study was covered by the ethical approval for the RCT, which was granted by the National Research Ethics Service Committee London – Dulwich on the 2nd of November 2011 (REC Reference number: 11/LO/0220). The pilot was also covered by KCH’s Research and Development Department approval (R&D Reference number: KCH12-013). The relevant forms can be found in Appendix 1.

The pilot took place at the medical pre-assessment clinics at the Day Surgery Unit (DSU) at KCH. A convenience sample of families fitting the inclusion criteria for the upcoming RCT was recruited. The pilot followed the same design, methods, and procedure as the RCT, all of which will be discussed in details in Chapter 6. However, there were a few exceptions: first, the participants were not requested to complete the Children’s CDQ or PDQ, as ethical approval for those measures was still pending. Second, the participants were not asked to attend the three-month follow-up visit after GA. Finally, the introduction of blinding and randomization was gradual so that the research team can become familiar with the research process.
In addition, children’s interaction with the game was observed by the author to note any technical problems. At the end of game-play, the child was shown three short video-clips of the hamster, the dog and the cat and asked if they liked them and to give a name for each character. The Dental Nurses with Additional Skills (DNASs) performed those tasks for participants recruited after blinding was introduced.

5.4.3 Results

Data collection took place from May 15th to June 12th 2013. Ten participants were recruited in total, including four boys and six girls. The age of the children that took part ranged between four and nine years, with the average age of the sample being 6.6 years (6.3 years for girls, and 7 years for boys). The sample included four children that identified as White British (40%), two as Black British (20%), one as Black Caribbean (10%), one as South Asian (10%) and two as others (20%).

The first four participants were not randomised, nor was the author blinded. Blinding was introduced starting at the fifth participant, followed by randomisation at the seventh participant.

The aims set out for this pilot study were addressed as follows:

1. **Assessment of children interaction with the new video-game and note any feedback**: the author noted a few technical errors that were encountered during game-play and corrected the game’s design accordingly. In addition, children seemed to prefer the hamster and the dog, and to dislike the cat. They suggested a few names for the hamster and the dog, of which ‘Fluffy the hamster’ and ‘Ben the dog’ were chosen.

2. **Assessment the feasibility of the planned RCT protocol in terms of physical location and procedure for recruitment**: the research team became familiar with the setting and procedure for recruitment after introducing minor adjustments to the physical setting as recruitment progressed.

3. **Assessment of the blinding and randomisation methods**: the research team became familiar with the process. No significant difficulties were noted.
4. Familiarise the author and the dental nurses participating in the study with the research procedure: by the end of the pilot study, the team had practiced the procedure and standardised their approach.

5. As the control group in the RCT will be given one-on-one verbal education by the DNAS, the research team used the pilot to ensure both nurses taking part give the same advice that is consistent with the content of the video-game, and in accordance with the second edition of DBOH (Department of Health 2009a). This was further ensured by a third research-trained nurse that acted as an observer for the process of recruitment for a few participants midway through the RCT.
5.5 **Summary**

5.5.1 **New video-game development**

The new video-game was produced by modifying the appearance and oral health messages of ‘Barney’s Healthy foods’ (Rice 2009). The modifications were informed by:

1. Feedback from the study by Rice (2009).
2. New video-game design technology.
3. Recommendations of the second edition of DBOH (Department of Health 2009a)
4. The oral health education needs of the population targeted as reported by a KCH cohort study (Olley et al., 2011) and a qualitative study (Aljafari et al., 2014) that involved their parents.
5. The opinions of the GDPs interviewed in the study in Chapter 4.

5.5.2 **Evaluation planning and piloting**

1. The appropriate design and outcome measures for the RCT evaluating the video-game were chosen as informed by the available literature.
2. User group’s interaction with the video-game was assessed and any arising technical errors were addressed.
3. The methodology for the RCT was piloted in a small group of children attending for dental extractions under GA.
4. The research team was familiarised with the RCT’s methods and procedures.
Chapter 6:
Evaluation of an educational oral health intervention for high-caries-risk children referred for GA – a Randomised Controlled Trial
6.1 Introduction

In this chapter, the new oral health education video-game will be evaluated in a representative sample of children referred for dental extractions under General Anaesthesia (GA), using a blind Randomised Controlled Trial (RCT) methodology.

The oral health education video-game was compared to one-on-one verbal advice delivered by a Dental Nurse with Additional Skills (DNAS), at the child’s medical pre-assessment appointment approximately two weeks prior to their treatment under GA. This is a medical setting where no oral health support has been traditionally offered. In addition to receiving oral health education, the children received a Duraphat® fluoride varnish application to assess their compliance and views on receiving this treatment at such setting.

This trial has been registered in the International Standard Randomised Controlled Trial database (No: ISRCTN94617251). Furthermore, its protocol has already been published in Trials. The complete manuscript can be found in Appendix 3.

6.1.1 Research questions

1. Would an oral health education video-game be an acceptable method to deliver oral health advice to high-caries-risk children referred for extractions under GA and their families?
2. Can the use of such oral health education method improve their dietary knowledge and would that be reflected in their oral health practices?
3. Are children compliant with Duraphat® fluoride varnish application at the medical pre-assessment clinic, a hospital medical setting?
4. What do high-caries-risk children referred for extractions under GA think of having Duraphat® fluoride varnish applied to their teeth in such a setting?

6.1.2 Aims

6.1.2.1 Primary aim

1. To assess children’s and parents’ acceptability of an oral health education video-game in comparison to one-on-one verbal oral health education delivered by a DNAS.
2. To assess the video-game’s potential to improve children’s dietary knowledge and dietary and oral hygiene practices, in comparison to one-on-one verbal oral health education delivered by a DNAS.


6.1.3 Secondary aim

1. To establish proof of concept for the use of video-games in delivering oral health education for children.
6.2 Methods

6.2.1 Design

This study was a two-armed blind phase II RCT that recruited children referred for dental extractions of decayed teeth under GA and their parents. The participants were randomised into two groups:

(i) **Study group:** the child and parent underwent self-directed ‘play’ using the oral health education video-game on an iPad, and received a copy of the game on a DVD to run it on a home Personal Computer (PC).

(ii) **Control group:** the child and parent received one-on-one verbal oral health education from a DNAS, whom carries a health promotion qualification.

In addition, children from both groups received a Duraphat® fluoride varnish application in a hospital medical setting to evaluate their compliance and views on the treatment.

6.2.2 Content of oral health education:

The oral health education delivered to both groups was similar in content, and this was arranged and practiced in the pilot study discussed in Chapter 5. All messages delivered were in accordance with the recommendations for high-caries-risk children in the second edition of Delivering Better Oral Health (DBOH) (Department of Health 2009a), which were presented in full with supporting evidence in (2.9.6). To summarise, the oral health education included:

- **Diet:** help with identification of foods and drinks with high free-sugar or saturated fat content, advice to reduce the consumption of those foods and drinks and increase consumption of fruits and vegetables. Special attention was paid to recommending the reduction of the consumption of sweetened drinks, namely fruit juice and drinks, between meals, and advising the consumption of water when thirsty between meals.

- **Toothbrushing with fluoride toothpaste:** instructions on proper technique for brushing teeth for two minutes twice a day, advice on using a 1450 ppm
toothpaste, spitting but not rinsing following toothbrushing, and ensuring parental supervision of children younger than seven years. As part of the one-on-one verbal education, the DNASs used a tooth-model to demonstrate toothbrushing technique to the control group.

- **Advice on fluoride varnish application:** education on benefits of application in caries prevention and advice on requesting that it is provided by the GDP.

- **Advice on regular attendance:** instructions on importance of regular dental check-ups for the child every three to four months to prevent future caries, as recommended in the National Institute for Clinical Excellence (NICE) guidelines (National Institute for Clinical Excellence 2004).

### 6.2.3 Setting

The participants were recruited at the medical pre-assessment clinic at the Day Surgery Unit (DSU) at King’s College Hospital (KCH) in London. All children scheduled for GA, whether medical or dental, attend this clinic approximately two to three weeks prior to their surgery for a medical evaluation of fitness. The clinic is run by medical nurses, who go through the child’s medical history, record height and weight, and request any additional blood tests or medical investigations needed. Figure 23 is a photograph of the room where the study took place.

![Figure 23: Medical pre-assessment clinic waiting area](image)
Children and their families do not receive any support with their oral health during this visit. In fact, at the beginning of data collection at the clinic, the author noted that families attending this clinic were being exposed to dietary advice that contradicts caries prevention. Figure 24 shows a poster that was displayed in the waiting area of the clinic at the outset of the trial. It can be noted that fruit juices, dried fruits, and canned fruits full of sweet syrup, were all being recommended as healthy foods that should be consumed five times a day.

Figure 24: Diet advice poster in medical pre-assessment clinic waiting area prior to trial commencement
6.2.4 Ethical considerations

Ethical approval was first granted by the National Research Ethics Service Committee London – Dulwich (Reference number: 11/LO/0220), and by the Research and Development Department at KCH (R&D Reference number: KCH12-013). An amendment to introduce some of the measures that were used in the RCT was requested and granted approval by the National Research Ethics Service Committee London – Dulwich and Research and Development Department at KCH prior to the commencement of the trial. Funding was provided through King’s College London’s (KCL) PhD funds. Ethical approval correspondence can be found in Appendix 1.

Informed consent was sought from each participating parent or guardian and assent was sought from the children themselves. Participants were able to withdraw from the trial at any time and this did not affect access to their treatment at the hospital. All information disclosed in the study was kept confidential, and participants were not identifiable in any material published as part of the study in any way. All data were stored without any identifying details. At all stages of research the data were stored using a password-protected computer and a secure locked cabinet. All correspondence between research team members was conducted using secure e-mails.

6.2.5 Participants

The target population was children referred for extraction of decayed teeth under GA. Families were invited to take part in the study at the child’s attendance at the medical pre-assessment clinic prior to their GA appointment.

6.2.5.1 Inclusion criteria

The child and his/her family were included if:

1. The child was scheduled for extraction of decayed teeth under GA.
2. The child was four to ten years old.
3. The child did not suffer from any learning disabilities, or medical conditions complicating his/her oral health status.
4. Both parent and child had enough English proficiency to consent and take part.

5. The parent or guardian provided consent.

The child and family were excluded if:

1. The child is referred for treatment of other dental conditions under GA.
2. The child has a medical condition affecting his/her oral health, or a learning disability.
3. The child is accompanied by an adult that cannot give consent.
4. The child has been participating in another study.
5. The parent/guardian or the child lack English proficiency to consent or understand the advice delivered.

### 6.2.5.2 Sample size

The sample size calculation was based on the primary outcome measure in this study, which was the acceptability of the oral health education method using a Visual Analogue Scale (VAS) (Hayes and Patterson 1921). The VAS is a continuous 100 mm line, with the score 0 mm indicating complete dissatisfaction with the intervention and 100 mm indicating complete satisfaction. To the author’s knowledge, this is the first study measuring child’s and parent’s acceptability of the use of video-games in oral health education.

Acceptability was chosen as the primary outcome measure and used as the basis for the power calculation in this study due to the following reasons:

1. The importance of assessing users’ views on the video game, as this is a new method of oral health education that needs to be compared to the more traditional one-on-one delivery, in terms of recipient’s satisfaction, to establish proof of concept for using such games in oral health education.
2. Developing a new intervention (video-game) that is deemed less acceptable than verbal oral health education carries the risk of making it less likely to be used by the population in the future outside a research context, even if the current study, where all the participants are exposed to the intervention in a sort of “supervised” research environment, establishes that it is as effective.
3. The VAS is a well established measure that was determined to be the most reliable to be used as the basis for the power calculation, as it was used successfully in other studies that investigated interventions acceptability (Brokelman et al., 2012; Hosey et al., 2014).

Assuming the population to have a standard deviation (SD) of 25 mm, similar to findings of a patient satisfaction study in another field (Brokelman et al., 2012), and aiming to detect a difference of at least 15 mm between the groups to indicate its clinically significant, a sample of 45 participants in each group was to be needed to provide 80% power, at the 5% significance level, to detect effects of size 0.6 and above. It is also important to point out that this number of participants also provided enough power to detect differences in scores on the Pictorial Dietary Quiz (PDQ), another primary outcome measure used in the study. According to the results of the phase I RCT by Rice (2009), recruitment of 42 participants in each group was considered to be sufficient to detect a difference of five points on this 70 points quiz.

Minimal drop-out was anticipated at the stage those two measures were to be collected, as they were to be completed on the day of recruitment at the medical pre-assessment clinic. However, more significant drop-out was to be anticipated at later stages of data collection (GA day and three months after GA). Hosey et al. (2014) anticipated a 20% drop-out rate in the same population at KCH on the day of GA treatment, while Hosey et al. (2009) reported that up to 87% of participants from a similar cohort in Glasgow did not attend follow-up for a study three months after GA. Nonetheless, such drop-out rates at later stages were not to affect the power calculation, which as discussed was based on measures taken on the same day of recruitment.

6.2.6 Randomization and blinding

A computer-generated simple randomization grid was used to allocate the participants to the two groups. The grid was supplied by a statistician, Mr. Manoharan Andiappan, and the randomization process was overseen by Prof. Marie Therese Hosey. The allocation of participants was performed by the two DNAs taking part in this study.
The author remained blind all through data collection, input, and statistical analysis. Only after data collection was complete was the randomisation revealed to enable between group analyses, but the allocation remained concealed until after the analysis was complete.

6.2.7 Procedure

1. Every week, the author obtained a list of all children attending the medical pre-assessment clinic for GA for dental purposes. Those who were younger than four years, or older than ten years, were then excluded.

2. The author went through the clinical notes of the remaining children to determine their eligibility to participate. At that stage, children that were having treatment for dental conditions other than caries, those with medical conditions affecting dental health or with learning disabilities, and those that were participating in other studies, were identified and excluded. In addition, all children accompanied by parents/guardians that required an interpreter to provide consent for the GA procedure were also excluded. However, the total number of those children was recorded. The author also recorded the different languages of the non-English speakers. South London is a culturally and ethnically diverse area, and keeping records of the languages spoken by those children and their families can help assess the local area’s future need for versions of the video-game in different languages.

3. On the day of the medical pre-assessment clinic, the author approached all potential participants, invited them to take part, and explained the study for them. At this stage, children accompanied by adults who could not provide consent for them (i.e. Aunt, older sister, etc.), and those that did not display enough English proficiency to take part, were excluded. The author aimed to approach every potential participant matching the inclusion criteria. However, some potential participants were missed, as they arrived and left their appointment while a participant was taking part in the study.

4. Parents that verbally displayed their agreement to take part were consented, and their child was assented. The participant’s basic characteristics including: age, gender, ethnicity, and accompanying guardian, were recorded. The number of teeth to be extracted, as reported in the GA consent form, was noted. Finally, the family’s postcode was used to determine their
neighbourhood’s deprivation score according to the 2010 English Index of Multiple Deprivation (IMD) (Department for Communities and Local Government 2011).

5. The author then administered the following baseline measures: (i) Pictorial Dietary Quiz (PDQ), completed by the child. This is the same quiz used in phase I RCT by Rice (2009). (ii) Children Dietary Questionnaire (CDQ) (Magarey et al., 2009), completed by the parent. (iii) The parents were asked about their familiarity with fluoride varnish, and, (iv) their perception on frequency of regular dental appointments recommended for their child. Finally, (v) details of the child’s most recent snack at school were provided by the child.

6. After the baseline measures were completed, the author introduced the participants to the DNAS and left to ensure he remained blind to group allocation. The DNAS then allocated the participants to either the video-game group or the control group according to the randomisation grid. The DNAS then provided one-on-one verbal oral health education to those in the control group, while those in the oral health education video-game group underwent a self-directed play on the iPad.

7. Duraphat® fluoride varnish was applied on the child’s teeth, followed by giving out related post-operative instructions. The procedure was done with the child standing up straight, and in accordance with the guidance of Primary Care Commissioning (2009).

8. The DNAS then administered post-intervention measures to both groups including: (i) Child’s and parent’s acceptability of oral health education received on the VAS. (ii) PDQ, completed by the child. (iii) Qualitative feedback on oral health education received, (iv) Child acceptability of Duraphat® fluoride varnish application on the VAS, and (v) child qualitative feedback on fluoride varnish application. Finally, (vi) the success of varnish application was recorded by the operator.

9. The child was then given a booklet by the DNAS that contained: (i) a toothbrushing diary, and, (ii) a snack diary, which was to be returned on the day of the GA appointment. The booklet given to children from the study group also contained (iii) a sheet at the end where they could write five ‘secret passwords’ that have been inserted by the author in different
segments of the DVD version of the game. Return of a completed password sheet indicated that the child played the video-game at least once at home. Children from the control group received a simple colouring page instead.

10. The author went to the DSU on the day of the child’s GA appointment to collect the booklet. Parents were reminded to bring the booklet via an SMS one day prior the GA. They were also offered a pre-paid post envelope with the author’s address to mail the booklet if they have not brought it on the day. In addition, children were given story books as a token of appreciation for their participation.

11. The author telephoned the participating parents three months after their child’s GA procedure and (i) completed the CDQ to measure any changes in dietary practices at home, (ii) asked parents about their familiarity with fluoride varnish, (iii) their perception on frequency of regular dental appointments recommended for their child, and, (iv) whether they have actually arranged for follow dental care after their child’s GA. Parents were also offered a review appointment with the author, at the paediatric dentistry department. Children that attended were asked to (v) retake the PDQ to assess long-term retention of dietary knowledge. Finally, (vi) Attendance rates from either group were noted.

6.2.8 Outcome measures

6.2.8.1 Outcomes of oral health education

1. Parent’s and child’s acceptability of oral health education method, as indicated using a VAS.

2. Improvement in the child’s dietary knowledge, measured by the change in PDQ score taken at baseline, immediately following oral health education, and three months after GA.

3. Reported change in child’s diet at home, measured by CDQ taken at baseline and three months after GA.

4. Reported child’s toothbrushing frequency and snack selection, as indicated by children’s toothbrushing and snack diaries.

5. Change in parent understanding of frequency of regular dental care needed for the child, measured at baseline and three months after GA.
6. Attendance of follow-up three month after GA, and any arrangement for follow-up with other dental care providers.
7. Parent and child qualitative feedback on oral health education received.

6.2.8.2 Outcomes of Duraphat® varnish application in medical setting

1. Success of fluoride varnish application.
2. Child’s acceptability of Duraphat® fluoride varnish application in a hospital medical setting, as indicated using a VAS.
3. Child’s qualitative feedback on fluoride varnish application.
4. Change in parent’s familiarity with fluoride varnish between baseline and three months after the child’s GA.

The VAS, PDQ, CDQ, and snack and toothbrushing diaries used, can all be found in Appendix 2. Figure 25 displays the procedure of RCT and the measures completed at each stage.
Figure 25: Outline of measure completion
6.2.9 Statistical Analysis

SPSS 20 was used to handle the quantitative data. Descriptive statistics for all explanatory variables at baseline were recorded and provided overall and by study group. Analysis of Variance and Chi-square tests were used to highlight any significant imbalances between the groups at baseline.

An Independent Samples Student t-Test was to be used to compare the two groups VAS, PDQ, CDQ, toothbrushing, and healthy snack selection scores whenever a normal distribution was present, while a Mann-Whitney-U test was to be used when the data did not follow a normal distribution. A Paired Samples Student t-Test was to be used to compare baseline and post-intervention CDQ scores. Only completed pairs of data were analysed. Linear multivariate regression was to be used to measure changes in PDQ and snack selection scores taken at three points (baseline, post intervention, and three months after GA). A Chi-square test was to be used to assess differences in dichotomous outcome variables whenever present.

Verbal feedback provided by the parents and children on the intervention was written down verbatim by the DNAs. The qualitative data were then typed into Microsoft Office Excel by the author, and analysed using a simple content analysis (Richie and Lewis 2003).

The Consolidated Standards of Reporting Trials (CONSORT) statement (Schulz et al., 2010) was used for guidance to ensure appropriate reporting of the RCT’s methods and results.
6.3 Results

6.3.1 Recruitment

Recruitment took place between October 2013 and October 2014, at the medical pre-assessment clinic at KCH’s Day Surgery Unit. The total number of potential participants scheduled to attend during the recruitment period was 464. This number was determined by going through the medical pre-assessment clinic appointment lists every week. It represents the total number of children aged four to ten years that were scheduled to attend the pre-assessment clinic within the research time frame, in preparation for receiving dental extractions under GA.

After checking the child’s hospital notes, 38 children (8%) were excluded due to the parent/guardian lacking enough English proficiency to provide consent. The different languages spoken by those parents were noted and can be seen in Table 3. A further 13 potential participants (3%) were excluded due to learning disabilities. Seven of those children had been reported in their hospital notes to suffer from autism, and six from other conditions affecting their learning capabilities. Finally, seven potential participants (1.5%) were excluded due to the fact they were taking part in other research projects.
Table 3: Languages of potential participating families excluded from recruitment

<table>
<thead>
<tr>
<th>Language</th>
<th>Number of excluded potential participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spanish</td>
<td>7</td>
</tr>
<tr>
<td>Mandarin</td>
<td>5</td>
</tr>
<tr>
<td>Turkish</td>
<td>4</td>
</tr>
<tr>
<td>Somali</td>
<td>3</td>
</tr>
<tr>
<td>Arabic</td>
<td>2</td>
</tr>
<tr>
<td>Bengali</td>
<td>2</td>
</tr>
<tr>
<td>Lithuanian</td>
<td>2</td>
</tr>
<tr>
<td>Polish</td>
<td>2</td>
</tr>
<tr>
<td>Urdu</td>
<td>2</td>
</tr>
<tr>
<td>Others</td>
<td>7</td>
</tr>
<tr>
<td>Unknown</td>
<td>4</td>
</tr>
</tbody>
</table>
On the days that recruitment was taking place, 88 potential participants (19%) did not attend their pre-assessment appointment, and hence, were also excluded. One hundred and thirty four potential participants (29%) were missed by the author, mainly due to the fact that they attended at the same time another child and family were being approached and volunteering to take part in the study. The process of recruiting, applying the intervention, and completing the required measures on the day takes approximately one hour for each child; hence, any other potential participants attending within that hour were not approached. In a few cases, potential participants have been missed due to them attending at a different time than their scheduled appointment. Finally, seven participants (1.5%) were excluded due to the legal guardian not accompanying them on their appointment. The remaining 177 potential recruits (38%) were approached by the author and invited to take part.

Fifty eight parents (33% of approached) declined to take part. The majority of them (67%) indicated that time constraints were the reason, examples include: car parking difficulties, picking up another child from school, and returning the child to school. Other reasons for declining participation included: the child’s unwillingness to take part (7%), or parent’s belief no oral health education was needed (7%). The remaining parents did not offer a specific reason for declining to take part (19%).

One hundred and nineteen families (67% of approached) agreed to take part in the study and were consented. However, ten of them withdrew consent due to time constraints or the child being sent out by the medical pre-assessment nurse for blood tests at the main hospital’s phlebotomy department. None of those participants had been randomised. In the end, a total of 109 children and their families (62% of approached, 23% of total potential participants) completed baseline measures, were randomised, and received their allocated intervention. Their results were reported in data analysis.
Figure 26 is a CONSORT flow chart that summarises the recruitment process and the progress of participants through the stages of data collection.
6.3.2 Sample Description

6.3.2.1 Assignment to oral health education groups
One hundred and nine children and their families took part in the study. Fifty five of the participants were assigned to the study group and received oral health education via the video-game, while 54 were assigned to the control group and received one-on-one verbal oral health education from a DNAS.

6.3.2.2 Gender of children recruited
Sixty one of the children recruited were male (56%) and 48 were female (44%). There was a good balance between the two groups in terms of gender, as can be seen in Table 4.

Table 4: Distribution of children recruited according to gender

<table>
<thead>
<tr>
<th>Child’s Gender</th>
<th>Study group (N=55)</th>
<th>Control group (N=54)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>30 (55%)</td>
<td>31 (57%)</td>
</tr>
<tr>
<td>Female</td>
<td>25 (45%)</td>
<td>23 (43%)</td>
</tr>
</tbody>
</table>

6.3.2.3 Accompanying guardian
The participating guardians were mostly mothers. Eighty seven mothers constituted 80% of the sample while 20 fathers constituted 18%. In two cases, the child’s legal guardian was not a parent (2%). Table 5 shows the accompanying guardians for children in each oral health education group.
Table 5: Comparison of accompanying guardians recruited by oral health education group

<table>
<thead>
<tr>
<th>Accompanying guardian</th>
<th>Study group (N=55)</th>
<th>Control group (N=54)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mother</td>
<td>44 (80%)</td>
<td>43 (80%)</td>
</tr>
<tr>
<td>Father</td>
<td>9 (16%)</td>
<td>11 (20%)</td>
</tr>
<tr>
<td>Others</td>
<td>2 (4%)</td>
<td>0 (0%)</td>
</tr>
</tbody>
</table>

6.3.2.4 Age of children recruited

Children recruited had an age that ranged between a minimum of four and a maximum of ten years, with the average age being 6.5 years (SD=1.55 years) at the time of recruitment. Males were on average 6.4 years old (SD=1.53), while females were on average 6.6 years old (SD=1.60). Figure 27 shows the age distribution of participants in total, and Figure 28 shows the age distribution by gender.

![Figure 27: Distribution of child participants according to age](image-url)
Table 6 compares the average age of children in the two oral health education groups. The groups seem to be well-balanced in terms of child’s age in general. However, it’s noteworthy that females in the study group were about a year older than their peers in the control group, as indicated by an Independent Samples t-Test. [P=0.02].

<table>
<thead>
<tr>
<th></th>
<th>Study group (N=55)</th>
<th>Control group (N=54)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td><strong>Mean age</strong></td>
<td><strong>Standard deviation</strong></td>
</tr>
<tr>
<td>Male</td>
<td>6.50</td>
<td>1.43</td>
</tr>
<tr>
<td>Female</td>
<td>7.08</td>
<td>1.53</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>6.76</td>
<td>1.49</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td><strong>Mean age</strong></td>
<td><strong>Standard deviation</strong></td>
</tr>
<tr>
<td>Male</td>
<td>6.23</td>
<td>1.63</td>
</tr>
<tr>
<td>Female</td>
<td>6.04</td>
<td>1.52</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>6.15</td>
<td>1.57</td>
</tr>
</tbody>
</table>
6.3.2.5 Ethnicity

The children recruited came from various ethnic backgrounds, reflecting the multicultural nature of KCH’s catchment area. White British was the most common ethnicity, with 27 children (24.8%) belonging to that group. Sixteen described themselves as Black African (14.7%), fifteen as Black British (13.8%), nine as Black Caribbean (8.3%), twelve as South Asian (11%), seven as Asian (6.4%), ten as Other White (9.2%), and finally, thirteen as Other/Mixed Ethnic Background (11.9%). Figure 29 summarises the distribution of ethnicities of the participating children.

![Ethnicity Distribution](image-url)
The two groups were fairly well-balanced in regards to ethnicity as can be seen in Table 7 below.

### Table 7: Comparison of ethnicities of children by oral health education group

<table>
<thead>
<tr>
<th>Child’s Ethnicity</th>
<th>Number of cases</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Study group</td>
<td>Control group</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(N=55)</td>
<td>(N=54)</td>
<td></td>
</tr>
<tr>
<td>White British</td>
<td>17 (31%)</td>
<td>10 (19%)</td>
<td></td>
</tr>
<tr>
<td>Black British</td>
<td>7 (13%)</td>
<td>8 (15%)</td>
<td></td>
</tr>
<tr>
<td>Black African</td>
<td>8 (15%)</td>
<td>8 (15%)</td>
<td></td>
</tr>
<tr>
<td>Black Caribbean</td>
<td>4 (7%)</td>
<td>5 (9%)</td>
<td></td>
</tr>
<tr>
<td>South Asian</td>
<td>5 (9%)</td>
<td>7 (13%)</td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>2 (3%)</td>
<td>5 (9%)</td>
<td></td>
</tr>
<tr>
<td>White Others</td>
<td>5 (9%)</td>
<td>5 (9%)</td>
<td></td>
</tr>
<tr>
<td>Others/Mixed</td>
<td>7 (13%)</td>
<td>6 (11%)</td>
<td></td>
</tr>
</tbody>
</table>

#### 6.3.3 Socioeconomic status

The majority of the children came from neighbourhoods that can be classified as socially deprived according to the 2010 English Index of Multiple Deprivation (IMD) (Department for Communities and Local Government 2011), as 38 (35%) came from neighbourhoods within the most deprived quintile, and 51 (47%) came from neighbourhoods in the second most deprived quintile. Only ten children (9%) came from neighbourhoods in the third deprivation quintile, four (4%) from the second least deprived quintile, and six (5%) from the least deprived quintile. Figure 30 is a bar chart of the children’s distribution according to their neighbourhood’s
deprivation rank quintiles. Neighbourhoods in the first quintile are the most deprived and the ones in the fifth quintile are the least.

Figure 30: Children’s distribution according to their neighbourhood’s deprivation rank quintiles.

Children in both oral health education groups matched well when it comes to neighbourhood deprivation scores, as 82% of children from either group came from neighbourhoods in the most or second most deprived quintiles. Table 8 shows the children’s distribution according to their neighbourhood’s deprivation rank quintile in each oral health education group.
Table 8: Comparison of children’s neighbourhood deprivation scores by oral health education group.

<table>
<thead>
<tr>
<th>Neighbourhood’s deprivation quintile</th>
<th>Number of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Study group</td>
</tr>
<tr>
<td></td>
<td>(N=55)</td>
</tr>
<tr>
<td>First quintile (most deprived)</td>
<td>16 (29%)</td>
</tr>
<tr>
<td>Second quintile</td>
<td>29 (53%)</td>
</tr>
<tr>
<td>Third quintile</td>
<td>4 (7%)</td>
</tr>
<tr>
<td>Forth quintile</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Fifth quintile (least deprived)</td>
<td>6 (11%)</td>
</tr>
</tbody>
</table>

6.3.4 Number of teeth to be extracted under GA

Children in the sample had on average 6.7 primary teeth to be extracted under GA (Range: 0–20, SD: 4.1). Ten children also had permanent teeth to be extracted, with an average of 3.1 teeth per child (Range: 2–4, SD: 0.99). The two groups matched well in the number of teeth to be extracted. Tables 9 and 10 display the mean number of primary and permanent teeth to be extracted in each group.

Table 9: Average number of primary teeth extracted by oral health education group

<table>
<thead>
<tr>
<th>Study group (N=55)</th>
<th>Control group (N=54)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>Standard deviation</td>
</tr>
<tr>
<td>6.56</td>
<td>4.07</td>
</tr>
</tbody>
</table>
Table 10: Number of participants and average number of permanent teeth extracted by oral health education group

<table>
<thead>
<tr>
<th></th>
<th>Study group (N=55)</th>
<th>Control group (N=54)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cases</td>
<td>Mean</td>
<td>Standard deviation</td>
</tr>
<tr>
<td>6</td>
<td>3.33</td>
<td>1.03</td>
</tr>
</tbody>
</table>

6.3.5 Acceptability of oral health education method

Parents and children were asked by the dental nurse to rate the acceptability of the oral health education method they received on a 100 millimetre VAS. Data for all 109 parents and children were available for analysis.

6.3.5.1 Parental acceptability of oral health education method

Figure 31 displays the distribution of parental VAS scores given for the oral health education they received in the sample as a whole. The figure clearly indicates that the data were not following a normal distribution, as most participants tended to give scores at the higher end of the scale indicating high acceptability. Therefore, the use of non-parametric statistics to describe and analyse the data was necessary.
Parents from the control group gave the one-on-one verbal education they received from the DNAS a median score of 97.5 out of a possible 100 (Mean: 93.7; Range: 42-100, SD: 10.2). Parents from the study group rated the oral health education video-game slightly lower, with the median score being 91.0 (Mean: 84.7; Range: 0-100, SD: 19.9). Table 11 shows parental VAS scores for each group. Figure 32 shows the distribution of these scores. An Independent Samples Mann-Whitney-U Test revealed that although the difference in score between groups is relatively small, it is statistically significant [P=0.003].
Table 11: Parental VAS scores for oral health education method’s acceptability

<table>
<thead>
<tr>
<th></th>
<th>Study group (N=55)</th>
<th>Control group (N=54)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Score range</td>
<td>0-100</td>
<td>42-100</td>
<td>0-100</td>
</tr>
<tr>
<td>Median</td>
<td>91.0</td>
<td>97.5</td>
<td>95.0</td>
</tr>
<tr>
<td>Mean</td>
<td>84.7</td>
<td>93.7</td>
<td>89.1</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>19.9</td>
<td>10.2</td>
<td>16.4</td>
</tr>
</tbody>
</table>

Figure 32: VAS scores for parental acceptability of oral health education by group
6.3.5.2 Child’s acceptability of oral health education method

Figure 33 displays the distribution of VAS scores for child’s acceptability of oral health education received. Again, it is clear that the data were following a non-normal distribution. Hence non-parametric statistics were also applied.

![Figure 33: Overall VAS scores for child’s acceptability of oral health education](image)

The median score given by the children in the control group was 99 (Mean: 86; Range: 0-100, SD: 27), and in the study group was 97 (Mean: 83.3 Range: 0-100, SD: 25). An Independent Samples Mann-Whitney-U test showed that the difference between the two groups was not statistically significant [P=0.34]. Table 12 shows the VAS scores for the child’s acceptability of oral health education method in each group, and Figure 34 shows the distribution of those scores.
Table 12: Child’s VAS scores for oral health education method’s acceptability

<table>
<thead>
<tr>
<th></th>
<th>Study group (N=55)</th>
<th>Control group (N=54)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Score range</strong></td>
<td>0-100</td>
<td>0-100</td>
<td>0-100</td>
</tr>
<tr>
<td><strong>Median</strong></td>
<td>97.0</td>
<td>99.0</td>
<td>98.0</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>83.3</td>
<td>86.0</td>
<td>84.6</td>
</tr>
<tr>
<td><strong>Standard deviation</strong></td>
<td>25.2</td>
<td>27.0</td>
<td>26.0</td>
</tr>
</tbody>
</table>

Figure 34: VAS scores for child’s acceptability of oral health education by group
7.1.1.1 Qualitative feedback on oral health education video-game

Parents and children in the study group were asked by the DNAs to provide feedback in a few words regarding the video-game. The DNAs noted these comments down in written form, and these comments were later uploaded to Microsoft Excel and coded, then themes were derived using a simple thematic data analysis. Care was taken to ensure the study IDs were not linked to the data input at the time, to ensure that the author remained blind to group allocation.

The two main themes apparent were advantages and disadvantages of the current oral health video-game.

**Advantages:** Children seemed to find the video-game ‘enjoyable’, ‘exciting’ and ‘helped them learn something new’. In the words of participant 86, an eight-year-old, she learned that ‘you can have things some times, just not all the time’.

Parents found the video-game to be ‘informative’ and ‘engaging’ for their children. As mum 111 said: ‘children like video-games so they will listen carefully to the information in the game, it is very informative’.

**Disadvantages:** Children older than seven years frequently noted that the video-game was ‘too easy’ for them, and some seemed to be bored towards the end. The video-game might also be too slow for some children, with dialogue lines used by the avatar being too long, resulting in some children skipping without listening to the complete dialogue. Meanwhile, younger children sometimes required more guidance to complete the video-game, as was noted with participant 67, a five-year-old boy that struggled with selecting game segments and needed help with them. Parents of older children seemed to agree that the video-game was ‘too easy’ for their children. They thought the game is best suited for children five to seven years old.

7.1.1.2 Home use of oral health education video-game

Children in the study group had a sheet at the end of their toothbrushing and snack diaries where they were asked to fill in five passwords that were given to them at the end of each video-game segment. Data were available for the 34 children that have returned their diaries. Fifteen children (44%) completed the password sheet, while
16 (47%) did not. Three children were early recruits that did not receive the password sheet (9%).

A comparison between the 15 children that returned their diaries with completed password sheets, and the 16 children that returned their diaries but did not complete the password sheet, revealed that there are no significant differences in any baseline characteristics or game acceptability, except age. An Independent Samples $t$-Test showed that children that completed the password sheet were significantly older (mean=7.7 years; SD=1.6) than those that did not (mean=6.0 years; SD=1.5) \[P=0.005\].

### 7.1.1.3 Comparison of video-game acceptability by age

Qualitative feedback has suggested that older children might find the game too easy, perhaps affecting acceptability of this oral health education method. Hence, the 55 participants in the study group were split into two age groups (4-6 years, 7-10 years) and compared in terms of parental and child’s video-game acceptability VAS scores. The results showed that both age groups reported good acceptability of the video-game, and there were no significant differences between groups in either parental or child scores. Table 13 summarises these findings.

<table>
<thead>
<tr>
<th>Parent and child video-game acceptability VAS scores according to age</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Children (4-6)</strong></td>
</tr>
<tr>
<td>N=24</td>
</tr>
<tr>
<td><strong>Parent video-game acceptability</strong></td>
</tr>
<tr>
<td>Median</td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td><strong>Child video-game acceptability</strong></td>
</tr>
<tr>
<td>Median</td>
</tr>
<tr>
<td>Mean</td>
</tr>
</tbody>
</table>
7.1.2 Effect of oral health education method on dietary knowledge

The 70-item PDQ was used to evaluate changes in dietary knowledge. The quiz was scored by giving the child one point for each correct answer. All 109 children completed the quiz at baseline, and 105 completed the quiz immediately following the intervention. Those completed datasets were analysed.

Table 14 shows the baseline and immediate post-education scores for each group. Using a Paired Samples t-Test, a statistically significant improvement in the dietary knowledge of children from both groups was detected. The score of children in the control group improved by a mean of 7.6 (Range: -7 to +30, SD: 9.2) [P<0.001, 95%CI: 5.1-10.1], while the score of children in the study group improved by a mean of 4.8 (Range: -3 to 26, SD: 6.4) [P<0.001, 95%CI: 3.0 to 6.6].
Table 14: Pictorial Dietary Quiz scores at baseline and immediately after oral health education

<table>
<thead>
<tr>
<th></th>
<th>Study group (N=55)</th>
<th>Control group (N=54)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Score range</td>
<td>27-66</td>
<td>31-66</td>
<td>27-66</td>
</tr>
<tr>
<td>Mean</td>
<td>56.0</td>
<td>53.4</td>
<td>54.7</td>
</tr>
<tr>
<td>SD</td>
<td>9.6</td>
<td>10.6</td>
<td>10.1</td>
</tr>
<tr>
<td><strong>Post Intervention</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>4</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Score range</td>
<td>41-68</td>
<td>44-69</td>
<td>41-69</td>
</tr>
<tr>
<td>Mean</td>
<td>60.6</td>
<td>61.1</td>
<td>60.9</td>
</tr>
<tr>
<td>SD</td>
<td>6.0</td>
<td>5.1</td>
<td>5.5</td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>-3 to +26</td>
<td>-7 to +30</td>
<td>-7 to +30</td>
</tr>
<tr>
<td>Mean</td>
<td>+4.8</td>
<td>+7.6</td>
<td>+6.2</td>
</tr>
<tr>
<td>SD</td>
<td>6.4</td>
<td>9.2</td>
<td>8.0</td>
</tr>
<tr>
<td>95% CI</td>
<td>3.0 to 6.6</td>
<td>5.1-10.1</td>
<td>4.7-7.8</td>
</tr>
<tr>
<td><em>t</em>-Test P Value</td>
<td>&lt;0.001*</td>
<td>&lt;0.001*</td>
<td>&lt;0.001*</td>
</tr>
</tbody>
</table>

An Independent Samples *t*-Test revealed that there were no statistically significant difference between the two groups in terms of the amount of dietary knowledge improvement [P=0.7]. Figure 35 is a box-plot displaying the change in the quiz score following the intervention.
Completion of the PDQ three months following the GA procedure was poor, as only 11 families (10%) attended the follow-up appointment. Table 15 displays the average PDQ scores three months after GA and changes from baseline. A noticeable but not statistically significant difference between the two groups can be seen, as the mean change in the control group was +9.4 while it was -2.3 in the study group. These findings are not meaningful due to the large drop-out rate. The differences noted should be dismissed, as they are attributed to the fact that one child in the control group performed outstandingly better than at baseline in such small sample.
Table 15: Pictorial Dietary Quiz scores three months after GA

<table>
<thead>
<tr>
<th>Score at three month follow-up</th>
<th>Study group</th>
<th>Control group</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of participants</td>
<td>4</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Score range</td>
<td>56-65</td>
<td>41-65</td>
<td>41-65</td>
</tr>
<tr>
<td>Mean</td>
<td>61.3</td>
<td>58.6</td>
<td>59.5</td>
</tr>
<tr>
<td>SD</td>
<td>3.9</td>
<td>8.4</td>
<td>7.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Change from baseline score</th>
<th>Range</th>
<th>Study group</th>
<th>Control group</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-5 to -1</td>
<td>-3 to 32</td>
<td>-5 to +32</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>-2.3</td>
<td>+9.4</td>
<td>+5.2</td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>1.9</td>
<td>12.6</td>
<td>11.4</td>
<td></td>
</tr>
</tbody>
</table>

7.1.2.1 Recognition of fruit drinks and fruit juice cariogenicity

Examining how the oral health education delivered affected the child’s scoring for fruit drinks and juice items in the PDQ was of particular interest, as they seemed to be hidden sources of free-sugars that parents were not very aware of when interviewed in the MSc study (Aljafari et al., 2014).

There were three items in the PDQ that were fruit drinks. Table 16 displays the numbers of children from either group that deemed at least one of them a healthy food item. Although the children from the study group appear to have been better at identifying fruit drinks as unhealthy at baseline, the difference was not statistically significant once a Chi-square test was performed [P=0.1]
Immediately after receiving oral health education, more children irrespective of their group scored all fruit drinks as ‘unhealthy’. However, much more children did so in the control group (78%) than in the study group (56%). The difference was statistically significant once missing data were excluded and a Chi-square test was performed [P=0.037]. Table 17 displays the numbers of children by group that had at least one incorrect answer after receiving oral health education.

Table 17: Number of children scoring at least one fruit drink item as healthy after receiving oral health education

<table>
<thead>
<tr>
<th></th>
<th>Study group (N=55)</th>
<th>Control group (N=54)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missing</td>
<td>4 (7%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>At least 1 fruit drink healthy</td>
<td>21 (39%)</td>
<td>12 (22%)</td>
</tr>
<tr>
<td>All fruit drinks unhealthy</td>
<td>30 (55%)</td>
<td>42 (78%)</td>
</tr>
</tbody>
</table>

Orange juice was a separate item in the PDQ. Table 18 displays the numbers of children from either group that considered it healthy at baseline. It can be noted that most children scored juice as healthy at baseline (75% in video-game group, 78% in verbal education group), and there was no significant difference between the groups [P=0.74]. However, a Chi-square test revealed that immediately following oral health education, more children in the control group (26%) scored orange juice as unhealthy in comparison with those in the study group (8%) [P=0.014], as can be seen in table 19.
Table 18: Number of children scoring orange juice as healthy at baseline

<table>
<thead>
<tr>
<th></th>
<th>Study group (N=55)</th>
<th>Control group (N=54)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orange juice healthy</td>
<td>41 (75%)</td>
<td>42 (78%)</td>
</tr>
<tr>
<td>Orange juice unhealthy</td>
<td>14 (25%)</td>
<td>12 (22%)</td>
</tr>
</tbody>
</table>

Table 19: Number of children scoring orange juice as healthy after receiving oral health education

<table>
<thead>
<tr>
<th></th>
<th>Study group (N=55)</th>
<th>Control group (N=54)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missing</td>
<td>4 (8%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Orange juice healthy</td>
<td>47 (84%)</td>
<td>40 (74%)</td>
</tr>
<tr>
<td>Orange juice unhealthy</td>
<td>4 (8%)</td>
<td>14 (26%)</td>
</tr>
</tbody>
</table>

7.1.2.2 Impact of child’s age on changes in dietary knowledge

As expected, there was a significant correlation between the child’s age and baseline PDQ score [Pearson product-moment correlation coefficient $r= 0.57$; n=109; P<.001]. The author split the participants into the same age groups mentioned earlier (4-6 years and 7-10 years). Analysis showed that both methods of oral health education led to a statistically significant improvement in PDQ scores in both age groups. However, an Independent Samples $t$-Test showed that four to six years old children showed significantly more improvement overall (8.9) than those that were seven to ten years old (3.0) [P<0.001; 95%CI=3.2-8.6]. This is most likely due to their lower baseline PDQ scores allowing for more improvement after receiving oral health education. There were no significant inter-group differences. Tables 20 and 21 display changes in PDQ scores for children aged four to six years, and seven to ten years, respectively.
Table 20: Pictorial Dietary Quiz scores at baseline and immediately after the intervention for ages 4-6

<table>
<thead>
<tr>
<th>Children aged 4-6</th>
<th>Study group (N=24)</th>
<th>Control group (N=35)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Score range</td>
<td>27-66</td>
<td>31-66</td>
<td>27-66</td>
</tr>
<tr>
<td>Mean</td>
<td>49.7</td>
<td>49.7</td>
<td>49.7</td>
</tr>
<tr>
<td>SD</td>
<td>10.4</td>
<td>10.9</td>
<td>10.6</td>
</tr>
<tr>
<td><strong>Post Intervention</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Score range</td>
<td>41-66</td>
<td>44-68</td>
<td>41-68</td>
</tr>
<tr>
<td>Mean</td>
<td>57.1</td>
<td>59.9</td>
<td>58.8</td>
</tr>
<tr>
<td>SD</td>
<td>6.3</td>
<td>5.7</td>
<td>6.0</td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>-3 to +26</td>
<td>-7 to +30</td>
<td>-7 to +30</td>
</tr>
<tr>
<td>Mean</td>
<td>+6.9</td>
<td>+10.2</td>
<td>+8.9</td>
</tr>
<tr>
<td>SD</td>
<td>8.8</td>
<td>9.8</td>
<td>9.5</td>
</tr>
<tr>
<td>95% CI</td>
<td>+3.1 to +10.7</td>
<td>+6.8 to +13.6</td>
<td>+6.4 to +11.4</td>
</tr>
<tr>
<td>t-Test P Value</td>
<td>&lt;0.001*</td>
<td>&lt;0.001*</td>
<td>&lt;0.001*</td>
</tr>
</tbody>
</table>
Table 21: Pictorial Dietary Quiz scores at baseline and immediately after the intervention for ages 7-10

<table>
<thead>
<tr>
<th>Children aged 7-10</th>
<th>Study group (N=31)</th>
<th>Control group (N=19)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline</strong></td>
<td>Missing</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Score range</td>
<td>40-66</td>
<td>42-65</td>
<td>40-66</td>
</tr>
<tr>
<td>Mean</td>
<td>60.9</td>
<td>60.3</td>
<td>60.6</td>
</tr>
<tr>
<td>SD</td>
<td>5.1</td>
<td>5.4</td>
<td>5.2</td>
</tr>
<tr>
<td><strong>Post Intervention</strong></td>
<td>Missing</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Score range</td>
<td>50-68</td>
<td>56-69</td>
<td>50-69</td>
</tr>
<tr>
<td>Mean</td>
<td>63.5</td>
<td>63.2</td>
<td>63.4</td>
</tr>
<tr>
<td>SD</td>
<td>3.9</td>
<td>2.9</td>
<td>3.5</td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td>Range</td>
<td>0 to +10</td>
<td>-4 to +19</td>
</tr>
<tr>
<td>Mean</td>
<td>+3.1</td>
<td>+2.9</td>
<td>+3.0</td>
</tr>
<tr>
<td>SD</td>
<td>2.5</td>
<td>5.2</td>
<td>3.7</td>
</tr>
<tr>
<td>95% CI</td>
<td>+2.1 to +4.0</td>
<td>+0.4 to +5.4</td>
<td>+1.9 to +4.1</td>
</tr>
<tr>
<td>t-Test P Value</td>
<td>&lt;0.001*</td>
<td>0.025*</td>
<td>&lt;0.001*</td>
</tr>
</tbody>
</table>

*Statistically significant
7.1.3 Effect of oral health education method on reported dietary practices

7.1.3.1 Changes in Children’s Dietary Questionnaire (CDQ) scores

One hundred and eight parents (55 in the study group and 53 in the control group) completed all four sections of the CDQ at baseline. Table 22 displays the CDQ scores at baseline. It is important to note that CDQ scores do not represent a certain number of servings, but rather a score that is calculated and then compared to a recommended threshold, according to the developers’ instructions (Magarey et al., 2009). Nonetheless, it is worthwhile explaining how those scores are calculated in each of the four sections.

1. Fruit and vegetable score: sum of items measuring fruit and vegetable variety per day (number of varieties in the last week divided by seven), the number of different fruits and vegetables on the previous day, the number of occasions on the previous day that either fruits or vegetables were consumed, and the number of days in the last week that either fruits and/or vegetables were eaten divided by seven (Score range: 0-28; recommended threshold: ≥14)

2. Fat from dairy score: sum of items measuring the frequency of full fat milk, flavoured milk, yoghurt/custard, and cheese, on the previous day (Score range: 0-15; recommended threshold: 0).

3. Sweetened drinks score: sum of items measuring the frequency of fruit juice/soft drinks the previous day, and their frequency in the previous week divided by seven. (Score range: 0-5.9; recommended threshold: ≤1)

4. Non-core foods score: sum of the frequency of non-core food items in the previous week divided by seven (Score range: 0-10.3; recommended threshold: ≤2)
Table 22: Children’s Dietary Questionnaire scores at baseline

<table>
<thead>
<tr>
<th></th>
<th>Study group (N=55)</th>
<th>Control group (N=54)</th>
<th>Total</th>
<th>Recommended threshold for a healthy diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missing</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Fruit and vegetable intake</td>
<td>Score range</td>
<td>0.0-25.43</td>
<td>0.7-23.9</td>
<td>0.0-25.43</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>9.7</td>
<td>9.5</td>
<td>9.6</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>5.3</td>
<td>5.2</td>
<td>5.2</td>
</tr>
<tr>
<td>Fat from dairy intake</td>
<td>Score range</td>
<td>0-11</td>
<td>0-14</td>
<td>0-14</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>3.9</td>
<td>4.1</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>3.1</td>
<td>3.0</td>
<td>3.1</td>
</tr>
<tr>
<td>Sweetened drinks intake</td>
<td>Score range</td>
<td>0-5.7</td>
<td>0-5.7</td>
<td>0-5.7</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>2.4</td>
<td>2.3</td>
<td>2.4</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>1.6</td>
<td>1.6</td>
<td>1.6</td>
</tr>
<tr>
<td>Non-core foods intake</td>
<td>Score range</td>
<td>0.1-5.0</td>
<td>0.3-5.6</td>
<td>0.1-5.6</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>2.4</td>
<td>2.2</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>1.3</td>
<td>1.4</td>
<td>1.4</td>
</tr>
</tbody>
</table>
It was interesting to note that children participating in the study had poor diets according to the CDQ recommended threshold scores. They were not having the recommended intake of fresh fruits and vegetables, exceeded the recommended intake of fat from dairy, and more importantly from an oral health perspective, they exceeded the recommended intake of sweetened drinks and non-core foods.

Fifty nine parents (55%) completed the CDQ three months after the GA procedure (28 in the study group, 31 in the control group). Contact with the rest of the sample was not possible despite multiple attempts over the phone. Those 59 completed sets of data were analysed using a Paired Samples t-Test to look for changes in dietary practices at home, as reported by the parents.

A Paired Samples t-Test revealed that parents of children in the study group reported a statistically significant reduction in sweetened drinks intake three months after GA [P=0.008; 95%CI=-1.1 to -0.2]. This was the only statistically significant finding when data were analysed on group level. When data for both research groups were pooled, Paired Samples t-Tests showed that there were statistically significant improvements in the dietary practices of children in the sample as a whole three months after GA, as reported by their parents. These improvements include reduced intake of fat from dairy [P=0.037; 95%CI=-1.3 to 0], sweetened drinks [P=0.019; 95%CI=-0.8 to -0.1] and non-core foods [P=0.046; 95%CI=-0.6 to 0]. However, those improvements were not enough to make the children’s scores fall within the healthy score range recommended for the CDQ, except in the case of non-core foods. Tables 23, 24, 25, and 26 summarise changes in the CDQ scores three months after GA.
Table 23: Children’s Dietary Questionnaire fruit and vegetable scores three months after GA

<table>
<thead>
<tr>
<th>Fruit and vegetable intake</th>
<th>Study group (N=55)</th>
<th>Control group (N=54)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missing</td>
<td>27 (49%)</td>
<td>23 (43%)</td>
<td>50 (45%)</td>
</tr>
<tr>
<td>Score range</td>
<td>0.4-21.1</td>
<td>3.4-19.6</td>
<td>0.4-21.1</td>
</tr>
<tr>
<td>Mean (Recommended ≥14)</td>
<td>9.8</td>
<td>9.5</td>
<td>9.6</td>
</tr>
<tr>
<td>SD</td>
<td>5.3</td>
<td>3.5</td>
<td>4.4</td>
</tr>
<tr>
<td>Mean change from baseline</td>
<td>+0.5</td>
<td>+0.5</td>
<td>+0.5</td>
</tr>
<tr>
<td>SD</td>
<td>5.2</td>
<td>5.3</td>
<td>5.2</td>
</tr>
<tr>
<td>95% CI</td>
<td>-1.5 to 2.6</td>
<td>-1.5 to 2.4</td>
<td>-0.9 to 1.9</td>
</tr>
<tr>
<td>t-Test P value</td>
<td>0.60</td>
<td>0.61</td>
<td>0.46</td>
</tr>
</tbody>
</table>
Table 24: Children’s Dietary Questionnaire fat from dairy scores at three months after GA

<table>
<thead>
<tr>
<th>Fat from dairy intake</th>
<th>Study group (N=55)</th>
<th>Control group (N=54)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missing</td>
<td>27 (49%)</td>
<td>23 (43%)</td>
<td>50 (45%)</td>
</tr>
<tr>
<td>Score range</td>
<td>1-8</td>
<td>1-9</td>
<td>1-9</td>
</tr>
<tr>
<td>Mean (Recommended: 0)</td>
<td>2.5</td>
<td>3.1</td>
<td>2.8</td>
</tr>
<tr>
<td>SD</td>
<td>1.7</td>
<td>1.7</td>
<td>1.7</td>
</tr>
<tr>
<td>Mean change from baseline</td>
<td>-0.6</td>
<td>-0.7</td>
<td>-0.7</td>
</tr>
<tr>
<td>SD</td>
<td>2.4</td>
<td>2.5</td>
<td>2.4</td>
</tr>
<tr>
<td>95% CI</td>
<td>-1.5 to 0.3</td>
<td>-1.7 to 0.2</td>
<td>-1.3 to 0</td>
</tr>
<tr>
<td>$t$-Test P value</td>
<td>0.19</td>
<td>0.11</td>
<td><strong>0.037</strong>*</td>
</tr>
</tbody>
</table>

238
Table 25: Children’s Dietary Questionnaire sweetened drinks scores at three months after GA

<table>
<thead>
<tr>
<th>Sweetened drinks intake</th>
<th>Study group (N=55)</th>
<th>Control group (N=54)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missing</td>
<td>27 (49%)</td>
<td>23 (43%)</td>
<td>50 (45%)</td>
</tr>
<tr>
<td>Score range</td>
<td>0-4.4</td>
<td>0-6.3</td>
<td>0-6.3</td>
</tr>
<tr>
<td>Mean (Recommended: ≤1)</td>
<td>1.4</td>
<td>1.7</td>
<td>1.6</td>
</tr>
<tr>
<td>SD</td>
<td>1.2</td>
<td>1.4</td>
<td>1.3</td>
</tr>
<tr>
<td>Mean change from baseline</td>
<td>-0.6</td>
<td>-0.3</td>
<td>-0.5</td>
</tr>
<tr>
<td>SD</td>
<td>1.2</td>
<td>1.7</td>
<td>1.5</td>
</tr>
<tr>
<td>95% CI</td>
<td>-1.1 to -0.2</td>
<td>-0.9 to 0.3</td>
<td>-0.8 to -0.1</td>
</tr>
<tr>
<td>t-Test P value</td>
<td>0.008*</td>
<td>0.33</td>
<td>0.019*</td>
</tr>
</tbody>
</table>
Table 26: Children’s Dietary Questionnaire non-core foods scores at three months after GA

<table>
<thead>
<tr>
<th>Non-core foods intake</th>
<th>Study group (N=55)</th>
<th>Control group (N=54)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missing</td>
<td>27 (49%)</td>
<td>23 (43%)</td>
<td>50 (45%)</td>
</tr>
<tr>
<td>Score range</td>
<td>0.6-4.9</td>
<td>0.9-3.6</td>
<td>0.6-4.9</td>
</tr>
<tr>
<td>Mean (Recommended: ≤2)</td>
<td>1.9</td>
<td>2.0</td>
<td>1.9</td>
</tr>
<tr>
<td>SD</td>
<td>0.92</td>
<td>0.80</td>
<td>0.85</td>
</tr>
<tr>
<td>Mean change from baseline</td>
<td>-0.2</td>
<td>-0.4</td>
<td>-0.3</td>
</tr>
<tr>
<td>SD</td>
<td>1.0</td>
<td>1.3</td>
<td>1.2</td>
</tr>
<tr>
<td>95% CI</td>
<td>-0.6 to 0.2</td>
<td>-0.9 to 0.1</td>
<td>-0.6 to 0</td>
</tr>
<tr>
<td><em>t</em>-Test P value</td>
<td>0.24</td>
<td>0.11</td>
<td><strong>0.046</strong></td>
</tr>
</tbody>
</table>

An Independent Samples *t*-Test was used to detect differences between the two research groups in terms of the amount of CDQ score change three months after GA. The analysis showed no statistically significant differences in the amount of CDQ score change between the two groups in any category, including: Fruit and vegetable intake [P=0.98], fat from dairy [P=0.84], sweetened drinks [P=0.39] and non-core foods [P=0.62]. Figures 36, 37, 38 and 39 are box-plots that compare research groups in terms of changes in CDQ scores in each of its four sections.
Figure 36: Changes in CDQ fruit and vegetable score

Figure 37: Changes in CDQ fat from dairy score
Figure 38: Changes in CDQ sweetened drinks score

Figure 39: Changes in CDQ non-core foods score
7.1.3.1.1 Comparison between participants that completed phone follow-up three months after GA and those that did not

A comparison was made between those that completed the CDQ over the phone three months after GA, and those that did not, in terms of: child’s basic characteristics, VAS score for acceptability of oral health education, baseline and immediately post-education PDQ scores, and baseline CDQ scores.

There were no statistically significant differences in terms of child’s basic characteristics including ethnicity, neighbourhood deprivation, gender, or number of teeth to be extracted. Tables 27, 28, and 29 display those results.

Table 27: Comparison of ethnicities according to phone follow-up completion three months after GA (pooled sample)

<table>
<thead>
<tr>
<th>Child’s Ethnicity</th>
<th>Completed follow-up (N=59)</th>
<th>Did not complete follow-up (N=50)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missing</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>White British</td>
<td>14 (24%)</td>
<td>13 (26%)</td>
</tr>
<tr>
<td>Black British</td>
<td>6 (10%)</td>
<td>9 (18%)</td>
</tr>
<tr>
<td>Black African</td>
<td>9 (15%)</td>
<td>7 (14%)</td>
</tr>
<tr>
<td>Black Caribbean</td>
<td>5 (8%)</td>
<td>4 (8%)</td>
</tr>
<tr>
<td>South Asian</td>
<td>8 (14%)</td>
<td>4 (8%)</td>
</tr>
<tr>
<td>Asian</td>
<td>4 (7%)</td>
<td>3 (6%)</td>
</tr>
<tr>
<td>White Others</td>
<td>4 (7%)</td>
<td>6 (12%)</td>
</tr>
<tr>
<td>Others/Mixed</td>
<td>9 (15%)</td>
<td>4 (8%)</td>
</tr>
</tbody>
</table>
Table 28: Comparison of neighbourhood deprivation according to phone follow-up completion three months after GA (pooled sample)

<table>
<thead>
<tr>
<th>Neighbourhood’s deprivation quintile</th>
<th>Completed follow-up (N=59)</th>
<th>Did not complete follow-up (N=50)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; quintile (most deprived)</td>
<td>24 (41%)</td>
<td>14 (28%)</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt; quintile</td>
<td>23 (39%)</td>
<td>28 (56%)</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt; quintile</td>
<td>7 (12%)</td>
<td>3 (6%)</td>
</tr>
<tr>
<td>4&lt;sup&gt;th&lt;/sup&gt; quintile</td>
<td>3 (5%)</td>
<td>1 (2%)</td>
</tr>
<tr>
<td>5&lt;sup&gt;th&lt;/sup&gt; quintile (least deprived)</td>
<td>2 (3%)</td>
<td>4 (8%)</td>
</tr>
</tbody>
</table>

Table 29: Comparison of age and number of extractions according to phone follow-up completion three months after GA (pooled sample)

<table>
<thead>
<tr>
<th></th>
<th>Completed follow-up (N=59)</th>
<th>Did not complete follow-up (N=50)</th>
<th>t-Test P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missing</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Mean age</td>
<td>6.2 (SD=1.6)</td>
<td>6.7 (SD=1.5)</td>
<td>0.11</td>
</tr>
<tr>
<td>Mean primary teeth extracted</td>
<td>6.6 (SD=4.2)</td>
<td>6.8 (SD=3.9)</td>
<td>0.81</td>
</tr>
<tr>
<td>Mean permanent teeth extracted</td>
<td>0.32 (SD=1.0)</td>
<td>0.24 (SD=0.9)</td>
<td>0.65</td>
</tr>
</tbody>
</table>
When the data from both groups were pooled, a Mann-Whitney-U test revealed no significant differences between those who completed the CDQ three months after GA and those that did not, in terms of parental or child VAS scores for acceptability of oral health education.

However, once a comparison was made on group level, it was noted that there was a statistically significant difference in child VAS score for acceptability of oral health education in the control group [Mann-Whitney-U test P=0.006]. Those that did not complete follow-up gave the verbal education they received from the DNAS a higher score. Further analysis using a Chi-square test showed that the completion of follow-up was not impacted by the nurse delivering the education [P=0.74]. There were no such differences in the video-game group. Table 30 shows the acceptability scores for the pooled sample, based on follow-up completion. Tables 31 and 32 provide the same comparison for each oral health education group (study and control), respectively.

Table 30: Comparison of oral health education acceptability scores according to phone follow-up completion three months after GA (pooled sample)

<table>
<thead>
<tr>
<th></th>
<th>Completed follow-up N=59</th>
<th>Did not complete follow-up N=50</th>
<th>Mann-Whitney U P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missing</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Parent education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>acceptability Median</td>
<td>94</td>
<td>95</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td>88 (SD=16)</td>
<td>90 (SD=17)</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>acceptability Median</td>
<td>97</td>
<td>99</td>
<td>0.18</td>
</tr>
<tr>
<td></td>
<td>82 (SD=29)</td>
<td>88 (SD=22)</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 31: Comparison of oral health education acceptability scores according to phone follow-up completion three months after GA (Study group)

<table>
<thead>
<tr>
<th></th>
<th>Completed follow-up N=28</th>
<th>Did not complete follow-up N=27</th>
<th>Mann-Whitney U P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missing</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Parent education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>acceptability</td>
<td>Median</td>
<td>91</td>
<td>91</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>84 (SD=20)</td>
<td>85 (SD=21)</td>
</tr>
<tr>
<td>Child education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>acceptability</td>
<td>Median</td>
<td>98</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>84 (SD=25)</td>
<td>82 (SD=26)</td>
</tr>
</tbody>
</table>

Table 32: Comparison oral health education acceptability scores according to phone follow-up completion three months after GA (Control group)

<table>
<thead>
<tr>
<th></th>
<th>Completed follow-up N=31</th>
<th>Did not complete follow-up N=23</th>
<th>Mann-Whitney U P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missing</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Parent education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>acceptability</td>
<td>Median</td>
<td>97</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>92 (SD=12)</td>
<td>96 (SD=7)</td>
</tr>
<tr>
<td>Child education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>acceptability</td>
<td>Median</td>
<td>95</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>79 (SD=32)</td>
<td>95 (SD=13)</td>
</tr>
</tbody>
</table>
Next, improvements in mean PDQ score following oral health education were compared using an Independent Samples \( t \)-Test. No significant differences were found between those that completed CDQ at follow-up and those that did not, when the comparison was made on a pooled sample level. Table 33 displays this comparison.

Table 33: Comparison of change in Pictorial Dietary Quiz score according to phone follow-up completion three months after GA (pooled sample)

<table>
<thead>
<tr>
<th></th>
<th>Completed follow-up N=59</th>
<th>Did not complete follow-up N=50</th>
<th>( t )-Test P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missing</td>
<td>2 (3%)</td>
<td>2 (4%)</td>
<td></td>
</tr>
<tr>
<td>Mean change in</td>
<td>+5.9 (SD=8.0)</td>
<td>+6.8 (SD=8.1)</td>
<td>0.57</td>
</tr>
<tr>
<td>dietary quiz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>score</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Finally, the baseline CDQ scores for those that completed phone follow-up three months after GA, and those that did not, were compared using an Independent Samples \( t \)-Test. When the sample data were pooled, those that completed follow-up were found to have similar baseline CDQ scores to those that did not in all but one CDQ section, as those that completed phone follow-up reported a significantly lower intake of sweetened drinks [\( P=0.02; 95\% CI=0.1-1.3 \)] at baseline than those that did not. Table 34 displays these results.
Table 34: Comparison of baseline CDQ score according to phone follow-up completion three months after GA (pooled sample)

<table>
<thead>
<tr>
<th></th>
<th>Completed follow-up</th>
<th>Did not complete follow-up</th>
<th>t-Test P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N=59</td>
<td>N=50</td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>0</td>
<td>1 (2%)</td>
<td></td>
</tr>
<tr>
<td>Mean Fruit and Vegetable score</td>
<td>9.1 (SD=5.1)</td>
<td>10.2 (SD=5.4)</td>
<td>0.31</td>
</tr>
<tr>
<td>Mean fat from dairy score</td>
<td>3.5 (SD=2.5)</td>
<td>4.5 (SD=3.5)</td>
<td>0.08</td>
</tr>
<tr>
<td>Mean sweetened drinks score</td>
<td>2.0 (SD=1.5)</td>
<td>2.8 (SD=1.7)</td>
<td>0.02*</td>
</tr>
<tr>
<td>Mean non-core foods score</td>
<td>2.3 (SD=1.4)</td>
<td>2.4 (SD=1.4)</td>
<td>0.65</td>
</tr>
</tbody>
</table>

7.1.3.2 Child-recorded snack diaries

At baseline, all 109 Children reported having a snack at school or at home the day before attending the pre-assessment clinic. Those snacks were given a score of zero if deemed unhealthy and one if healthy. Seventy four children (68%) in total reported a healthy snack, while the remaining 35 (32%) reported unhealthy snacks, making the average snack score 0.68. On a group level, 37 children in the study group (67%) reported healthy snacks at baseline, while 18 (33%) reported unhealthy snacks, making their average snack score 0.67. Meanwhile, 37 children in the control group (69%) reported healthy snacks at baseline, compared to 17 (31%) that reported unhealthy snacks, making their average snack score 0.69.

On the day of GA, 37 children from the control group (69%) brought back completed snack diaries, and a further five (9%) mailed it later. While 32 children (58%) from the study group returned the diary on the day of GA, and two (4%) mailed it later. This means that in total, 76 diaries (70%) were available for comparison with baseline snack selections. A Chi-Square test revealed that the difference in diary return rates between the two groups was not statistically significant [P=0.07].
The diaries recorded the child’s snack selection for up to five days after the day of receiving the intervention. In a similar manner to the scoring process at baseline, each healthy snack was given a score of one, and unhealthy snacks were given a score of zero, the sum score of snacks was then calculated, and the average snack score per day for each child was calculated by dividing that sum on the number of days completed in the diary. The mean snack selection score for the control group was 0.68, and for the study group was 0.71. Clearly, neither method of education significantly changed the children’s snack selection, nor were there statistically significant differences in post-education scores between the groups [Mann-Whitney-U test P=0.59]. Table 35 shows the snack diary score for each group, and the amount of change compared to baseline snack scores.

<table>
<thead>
<tr>
<th></th>
<th>Study group (N=55)</th>
<th>Control group (N=54)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-intervention</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mean score</td>
<td>0.67</td>
<td>0.69</td>
<td>0.68</td>
</tr>
<tr>
<td>SD</td>
<td>0.47</td>
<td>0.47</td>
<td>0.47</td>
</tr>
<tr>
<td><strong>Post-intervention</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>21 (38%)</td>
<td>12 (22%)</td>
<td>33 (30%)</td>
</tr>
<tr>
<td>Mean score</td>
<td>0.71</td>
<td>0.68</td>
<td>0.69</td>
</tr>
<tr>
<td>SD</td>
<td>0.27</td>
<td>0.39</td>
<td>0.34</td>
</tr>
<tr>
<td>Mean change</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>SD</td>
<td>0.50</td>
<td>0.51</td>
<td>0.50</td>
</tr>
<tr>
<td>Related Samples Wilcoxon Signed Rank Test P</td>
<td>0.95</td>
<td>0.89</td>
<td>0.76</td>
</tr>
</tbody>
</table>
7.1.3.3 Comparison of children that returned their diaries and those that did not

A comparison between children from both groups that returned their diaries on the day of GA and those that did not was made. There were no statistically significant differences between responders and non-responders in terms of: gender, age, number of teeth to be extracted, parental or child acceptability of oral health education, baseline or post intervention PDQ score, baseline snack score, or, baseline CDQ score in any section.

The only statistically significant difference between those who returned their diaries and those that did not was the amount of time between the child’s pre-assessment appointment and the scheduled GA appointment [Independent Samples t-Test P=0.03; 95%CI=1-17]. Children that returned their diaries waited on average 13 days for their GA, while those that did not waited on average 22 days.

7.1.4 Effect of oral health education method on toothbrushing frequency

Toothbrushing diaries used allowed the child to record their toothbrushing for up to two weeks after receiving the oral health education. A child was given one point for every time they brush their teeth, the sum score was calculated for each child, and then that sum was divided on the number of days completed in the diary to calculate the average score for daily toothbrushing. The maximum score a child can achieve is 2, indicating brushing twice a day, and the minimum is zero, indicating no toothbrushing.

Seventy six children (70%) returned completed toothbrushing diaries. This includes 42 children in the control group (78%) and 34 children (62%) in the study group. Children from both groups almost always reported brushing twice a day (Mean=1.9; median=2.0; SD=0.2). A Mann-Whitney-U test did not detect any statistically significant differences in toothbrushing scores between groups [P=0.44]. Table 36 summarises these findings.
Table 36: Reported daily toothbrushing frequency after the intervention

<table>
<thead>
<tr>
<th></th>
<th>Study group (N=55)</th>
<th>Control group (N=54)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missing</td>
<td>21 (38%)</td>
<td>12 (22%)</td>
<td>33</td>
</tr>
<tr>
<td>Median score</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Mean score</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
</tr>
<tr>
<td>SD</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
</tr>
</tbody>
</table>

7.1.5 Effect of oral health education method on attendance for regular dental care

Parents were asked prior to receiving oral health education how often their child should visit the dentist. Data were available for 106 (97%) parents, 54 from the study group and 52 from the control group, while the answers of three parents (3%) were missing. Forty nine parents in the study group (89%), and 36 parents in the control group (66.5%), thought that their child needs to be seen every three to six months, meaning that in total, 85 parents (78% of the pooled sample) thought that their child needs to be seen every three to six months. Table 37 displays the full results.
Table 37: Pre-intervention parental view on recommended child dental attendance

<table>
<thead>
<tr>
<th></th>
<th>Study group (N=55)</th>
<th>Control group (N=54)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missing</td>
<td>1 (1%)</td>
<td>2 (3%)</td>
<td>3 (2%)</td>
</tr>
<tr>
<td>Every 3-6 months</td>
<td>49 (89%)</td>
<td>36 (66.5%)</td>
<td>85 (78%)</td>
</tr>
<tr>
<td>Every year</td>
<td>3 (6%)</td>
<td>10 (18.5%)</td>
<td>13 (12%)</td>
</tr>
<tr>
<td>Only when there are problems</td>
<td>2 (4%)</td>
<td>5 (10%)</td>
<td>7 (7%)</td>
</tr>
<tr>
<td>Not sure</td>
<td>0 (0%)</td>
<td>1 (2%)</td>
<td>1 (1%)</td>
</tr>
</tbody>
</table>

Fifty nine (55%) parents completed a three month follow-up phone call (31 in control group, 28 in study group), and were asked again how often they thought their child should visit the dentist. Twenty six (93%) of those in the study group, and 22 (71%) of those in the control group, thought that their child needs to see the dentist every three to six months. A Chi-Square test revealed that there weren’t statistically significant differences in the responses of parents from the two groups [P=0.17]. The complete findings can be seen in Table 38 below.
Table 38: Three month post intervention parental view on recommended child dental attendance

<table>
<thead>
<tr>
<th></th>
<th>Study group (N=28)</th>
<th>Control group (N=31)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Every 3-6 months</td>
<td>26 (93%)</td>
<td>22 (71%)</td>
<td>48 (81.5%)</td>
</tr>
<tr>
<td>Every year</td>
<td>0 (0%)</td>
<td>1 (3%)</td>
<td>1 (1.5%)</td>
</tr>
<tr>
<td>Only when there are</td>
<td>1 (3.5%)</td>
<td>2 (7%)</td>
<td>3 (5%)</td>
</tr>
<tr>
<td>problems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not sure</td>
<td>1 (3.5%)</td>
<td>6 (19%)</td>
<td>7 (12%)</td>
</tr>
<tr>
<td>Total</td>
<td>28 (100%)</td>
<td>31 (100%)</td>
<td>59 (100%)</td>
</tr>
</tbody>
</table>

Despite the large proportion indicating they realize their child needs to be seen every three to six months, only 11 (four in the study group, seven in the control group) of the 59 parents that completed phone follow-up agreed to attend a follow-up appointment at the hospital. Furthermore, when asked whether they have contacted, or been contacted by, their GDP to schedule a follow-up appointment, only 15 indicated they had. Table 39 shows the full results.
Table 39: Number of parents that booked a check-up appointment with a GDP after three months

<table>
<thead>
<tr>
<th></th>
<th>Study group (N=28)</th>
<th>Control group (N=31)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Had appointment with GDP</td>
<td>7 (25%)</td>
<td>8 (26%)</td>
<td>15 (25%)</td>
</tr>
<tr>
<td>No appointments arranged</td>
<td>21 (75%)</td>
<td>23 (74%)</td>
<td>44 (75%)</td>
</tr>
<tr>
<td>Total</td>
<td>28 (100%)</td>
<td>31 (100%)</td>
<td>59 (100%)</td>
</tr>
</tbody>
</table>

7.1.6 Fluoride varnish application in a medical hospital setting

7.1.6.1 Parents’ familiarity with fluoride varnish

Out of the 109 parents taking part in the study, only 42 (38.5%) were familiar with fluoride varnish application at baseline, while 54 (49.5%) were not, ten (9%) were not sure, and data for three (3%) were missing. Three months after the child’s GA, a significantly larger number of parents were familiar with varnish, as 46 (78%) out of the 59 that completed phone follow-up indicated they are now familiar with fluoride varnish application, while the remaining 13 (22%) indicated they are not.

The increase in familiarity with fluoride varnish was not due to parents unfamiliar with the treatment at baseline not completing the follow phone call, but rather due to a genuine increase in familiarity as reported by parents; 22 (48%) of the parents that indicated that they were familiar with varnish three months after GA were unfamiliar with it at baseline, and four (9%) were unsure. Table 40 displays the baseline answers of parents that did complete the three month follow-up.
Table 40: Familiarity with fluoride varnish three months after GA

<table>
<thead>
<tr>
<th>Familiarity with varnish three months after GA</th>
<th>Answer at baseline</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Familiar</td>
<td>Not familiar</td>
</tr>
<tr>
<td>Familiar</td>
<td>19 (41%)</td>
<td>22 (48%)</td>
</tr>
<tr>
<td>Not familiar</td>
<td>4 (31%)</td>
<td>7 (54%)</td>
</tr>
<tr>
<td>Not sure</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

7.1.6.2 Child’s compliance with the application of Duraphat® varnish and reported acceptability

Out of the 109 children taking part in the RCT, 101 (92%) received a successful fluoride varnish application (Duraphat®), three did not accept due to poor cooperation (3%) and one did not fully complete the application (1%). The remaining four (4%) had fluoride varnish applied less than three months beforehand, and hence, were not offered the treatment and were excluded from the analysis. Children were asked to rate the application they received on a 100 mm VAS. Those that did not accept the varnish, or failed to complete the procedure, were included in the analysis, and were assumed to have given the application a score of zero.

The children gave fluoride varnish application a mean score of 62 (Median=82; Range=0-100, SD=40). Figure 40 displays the distribution of VAS scores. It is clear that the scores were not following a normal distribution, as children tended to mostly either completely like it, completely not like it, or somewhere in the middle.
Although the VAS is a continuous scale, it can be noted that children tended to give scores at three points (edges and middle). Hence, the VAS results were also split to three categories as follows: not acceptable (<30); somewhat acceptable (31-70); and very acceptable (>70). By this categorisation, 29 children (28%) found varnish not acceptable, 20 (19%) found it somewhat acceptable, and 56 (53%) found it very acceptable.

7.1.6.3 Comparison of acceptability according to operator

The two volunteering DNAs taking part in this project applied fluoride varnish to the first 26 children in this study, after which, they disclosed to the author that they will be more comfortable if he, a dentist, can apply the varnish to the children for the remainder of the study. As such, nurse 1 applied the varnish to 17 children, Nurse 2 to nine children, and the author to 79 children. Table 41 displays the acceptability scores given by the children for each operator. It can be seen that children gave the varnish better acceptability scores when applied by nurse 1, followed by the author and finally nurse 2, whom children gave very low scores. Unfortunately, direct
statistical comparisons cannot be made, as the sample numbers vary between the operators.

Table 41: Comparison of child fluoride varnish acceptability according to who applied it

<table>
<thead>
<tr>
<th>Fluoride Varnish acceptability score</th>
<th>Nurse 1 (N=17)</th>
<th>Nurse 2 (N=9)</th>
<th>Dentist (N=79)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>74 (SD=37)</td>
<td>34 (SD=49)</td>
<td>62 (SD=39)</td>
</tr>
<tr>
<td>Median</td>
<td>95</td>
<td>02</td>
<td>80</td>
</tr>
</tbody>
</table>

Table 42 displays a comparison of varnish acceptability by operator when the VAS scores were split into three categories (<30, 31-70, and >70). Once again, it is clear that there are differences between the operators, but statistical testing to confirm significance is not possible due to big differences in sample numbers.

Table 42: Comparison of number of children finding fluoride varnish acceptable according to who applied it

<table>
<thead>
<tr>
<th>Fluoride VAS 0-30 (not acceptable)</th>
<th>Nurse 1 (N=17)</th>
<th>Nurse 2 (N=9)</th>
<th>Dentist (N=79)</th>
<th>Total (N=105)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluoride VAS 31-70 (somewhat acceptable)</td>
<td>2 (12%)</td>
<td>0 (0%)</td>
<td>18 (23%)</td>
<td>20 (19%)</td>
</tr>
<tr>
<td>Fluoride VAS 71-100 (acceptable)</td>
<td>12 (70%)</td>
<td>3 (33%)</td>
<td>41 (52%)</td>
<td>56 (53%)</td>
</tr>
</tbody>
</table>
7.1.6.4 Qualitative feedback on fluoride varnish application
Children described the application process as ‘easy’. Two qualities of varnish were identified as themes that influence the child’s opinion. These are: taste and texture. Those who liked varnish described it as ‘yummy’. Meanwhile those that did not said that they found it ‘disgusting’ or ‘sticky’ and suggested different flavours such as ‘cherry’.

7.1.6.5 Adverse events
There were no Serious Adverse Events (SAE) during the course of the study. However, there was one Adverse Event (AE), as one child vomited due to a strong gag reflex while Nurse 2 was attempting to apply Duraphat® fluoride varnish. The issue was noted and dealt with accordingly, the application was discontinued, and the child was considered to have given the varnish an acceptability score of zero on the VAS.

7.1.7 The personal effect of the two nurses
The findings for the children in the one-on-one verbal education group were compared according to the dental nurse that provided the oral health education. Nurse 1 provided verbal education for 30 children, while nurse 2 provided that for 24 children.

There was a noticeable difference in the child’s acceptability of verbal education between the two nurses, as nurse 1 was given a mean score of 92 (median=99; SD=14), while nurse 2 was given a mean score of 78 (median=99; SD=36). However, this difference was not statistically significant when an Independent Samples Mann-Whitney-U test was performed [P=0.37]. There were no statistically significant differences in any of the other outcomes, including: parental acceptability, improvements in dietary knowledge, or reported changes in dietary practices at home. Tables 43 and 44 summarise this comparison.
Table 43: Comparison of the results of verbal education by nurse (part one)

<table>
<thead>
<tr>
<th></th>
<th>Nurse 1 (N=30)</th>
<th>Nurse 2 (N=24)</th>
<th>t-test P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean change in dietary quiz score</td>
<td>+8.5 (SD=9.5)</td>
<td>+6.6 (SD=8.9)</td>
<td>0.47</td>
</tr>
<tr>
<td>Mean change in CDQ fruit and vegetable score</td>
<td>+0.4 (SD=5.9)</td>
<td>+0.6 (SD=4.9)</td>
<td>0.93</td>
</tr>
<tr>
<td>Mean change in CDQ fat from dairy score</td>
<td>-1.2 (SD=3.2)</td>
<td>-0.1 (SD=1.8)</td>
<td>0.38</td>
</tr>
<tr>
<td>Mean change in CDQ sweetened drinks score</td>
<td>-0.5 (SD=1.6)</td>
<td>-0.1 (SD=1.7)</td>
<td>0.55</td>
</tr>
<tr>
<td>Mean change in CDQ non-core foods score</td>
<td>-0.2 (SD=1.1)</td>
<td>-0.3 (SD=1.5)</td>
<td>0.40</td>
</tr>
</tbody>
</table>

Table 44: Comparison of the results of verbal education by nurse (part two)

<table>
<thead>
<tr>
<th></th>
<th>Nurse 1 (N=30)</th>
<th>Nurse 2 (N=24)</th>
<th>Mann-Whitney-U P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent intervention VAS Median</td>
<td>96</td>
<td>99</td>
<td>0.62</td>
</tr>
<tr>
<td>Parent intervention VAS Mean</td>
<td>93 (SD=8)</td>
<td>94 (SD=12)</td>
<td></td>
</tr>
<tr>
<td>Child intervention VAS Median</td>
<td>99</td>
<td>99</td>
<td>0.07</td>
</tr>
<tr>
<td>Child intervention VAS Mean</td>
<td>92 (SD=14)</td>
<td>78 (SD=36)</td>
<td></td>
</tr>
<tr>
<td>Snack selection score Median</td>
<td>1.0</td>
<td>0.8</td>
<td>0.12</td>
</tr>
<tr>
<td>Snack selection score Mean</td>
<td>0.69 (SD=0.41)</td>
<td>0.70 (SD=0.37)</td>
<td></td>
</tr>
<tr>
<td>Toothbrushing score Median</td>
<td>2.0</td>
<td>2.0</td>
<td>0.053</td>
</tr>
<tr>
<td>Toothbrushing score Mean</td>
<td>1.85 (SD=0.15)</td>
<td>2.0 (SD=0.03)</td>
<td></td>
</tr>
</tbody>
</table>
7.2 Summary of findings

7.2.1 Educational intervention acceptability

1. Children and parents found both the oral health education video-game and the one-on-one verbal oral health education delivered by a DNAS acceptable. There were no statistically significant differences in the children’s rating of the two methods [P=0.34]. However, parents rated verbal education slightly higher [P=0.003].

2. Children that played the game said it had some advantages such as being fun, engaging, and educational, but some also noted that it had some disadvantages, such as being too difficult for some younger children, or too easy and boring for some older ones.

3. Only 15 children of the 55 given the video-game provided proof that they used the game at home, and they were older than those that did not [P=0.005].

7.2.2 Impact on dietary knowledge

1. Children from both groups were significantly better at identifying healthy foods after receiving the education [P <0.001], but there was no difference between them [P=0.7].

2. Younger children (less than seven years old) showed the greatest improvements [P<0.001].

3. Children in the verbal education group were significantly better at identifying fruit drinks [P=0.037] and juice [P=0.014] as unhealthy following the intervention.

7.2.3 Impact on dietary practices

1. The children taking part in the study had an unhealthy diet at baseline, including low consumption of fruits and vegetables and high consumption of sweetened drinks, non-core foods, and fat from dairy.

2. About 70% of the children returned their snack diaries on the day of GA, and neither the game nor the one-on-one verbal education had significantly changed their snack selection [P=0.95 and P=0.89, respectively].
3. Only 59 parents (55%) completed a follow-up phone call three months after their child’s GA.

4. In those that completed phone follow-up, a small but significant reduction in consumption of sweetened drinks was reported in the video-game group [P=0.008]. The change was not sufficient to make the child’s score reach the healthy CDQ threshold. There were no other significant changes in dietary practices either between or within the groups.

5. When the data for the sample completing phone follow-up is pooled, a small but significant reduction in the intake of sweetened drinks [P=0.019], non-core foods [P=0.046] and fat from dairy [P=0.037] can be noticed, but the reductions were not sufficient to make the child’s diet considered healthy according to the CDQ thresholds except in the non-core foods parameter.

4. Fifty (45%) parents did not complete the phone follow-up. These reported a higher intake of sweetened drinks at baseline than those who did respond [P=0.02].

### 7.2.4 Impact on toothbrushing frequency

1. According to the toothbrushing diaries returned, children reported brushing twice a day following the intervention, but there was no difference between the groups [P=0.44].

### 7.2.5 Dental attendance after GA

1. Most parents (78%) knew the recommended frequency of regular dental attendance for their children at baseline.

2. Only four parents in the video-game group (7%) and seven in the verbal education group (13%) attended follow-up three months after GA. A further seven (13%) in the video-game group and eight (15%) in the verbal education group reported that they had arranged follow-up elsewhere.

### 7.2.6 The delivery of fluoride varnish at the medical pre-assessment clinic

1. Less than 40% of the 109 parents indicated they were familiar with fluoride varnish at baseline. Three months after GA, 78% of the 59 parents that completed phone follow-up said they were now familiar with it. Half of
those that indicated they were now familiar with the treatment had not been familiar at baseline.

2. Application of Duraphat® fluoride varnish was unsuccessful in only four children (4%) out of the 105 offered the treatment.

3. The children found Duraphat® fluoride varnish acceptable, and although they described the treatment as easy, in some instances they did not like its taste or texture.

4. The two DNASs in this trial indicated they would feel more comfortable if the dentist took over applying the varnish soon after the start of the trial.
Chapter 7: Discussion
8.1 Study 1: General Dental Practitioners’ views on promoting oral health in high-caries-risk children referred for dental extractions under GA

8.1.1 Referrers of children to KCH for dental extractions under GA

One thousand and two children were referred to King’s College Hospital (KCH) for dental extractions under General Anaesthesia (GA) in 2011-2012. This is a 27% increase in comparison to 2010-2011. About two-thirds of them have been referred by primary dental care practices in Lambeth, Southwark, and Lewisham. Those represented 79% of all dental practices in those boroughs (Gallagher 2012). The remaining third were referred from practices scattered across South London.

The overwhelming majority of the practices referred four or less children in 2011-2012, relatively few practices referred a larger number, and even in those practices, the individual General Dental Practitioners (GDPs) interviewed noted that they rarely refer children for GA. This might suggest that the differences in referral rates might have been due to other factors, such as: the number of dentists in each practice, or the referral of some children to other hospitals in the case of practices relatively distant from KCH.

The large number of referring practices scattered across the geographical area, and the relatively low number of children GDPs reported that they refer per year, suggests that planning targeting of high-caries risk children in primary dental care setting to provide outreach oral health support might be difficult. On the other hand, if the number of children referred by each GDP is small, then this means that supporting the GDPs themselves to deliver better care for high-caries-risk children shouldn’t place a very substantial burden.

In this study, the aim was to identify referring GDPs in Lambeth, Southwark, and Lewisham, so that they can be invited to take part in qualitative interviews. As such, in depth exploration of the patterns of referral of children to KCH for GA was not
the main focus. Future researchers will need to explore the issue further, perhaps in collaboration with other GA service providers in South London, before appropriate support can be planned.

8.1.2 Barriers to caries prevention in high-caries-risk children as perceived by GDPs in Lambeth, Southwark, and Lewisham

When it comes to oral health care, high-caries-risk children seem to be stuck in a cycle of despair; they are being failed on multiple levels by everyone responsible for their care, whether its parents, health providers, local environment and society, or system and policies. There is an undercurrent of despair and helplessness in the GDPs interviewed, who see those children when they present for the first time to their surgeries with multiple decayed teeth, in pain, and typically coming from families who, in their eyes, have poor parenting skills or simply don’t speak English or have cultural differences. As such, oral health promotion in those children needs to be multi-agency and multidimensional, and does not just rest with the GDPs. Indeed, efforts for oral health promotion may fall heaviest on policy makers.

8.1.2.1 Child’s young age, poor cooperation, and high treatment need.

GDPs in Lambeth, Southwark, and Lewisham, seem to struggle when dealing with young children who require extensive treatment or display poor cooperation. These factors have been mentioned by GDPs in a couple of previous investigations elsewhere in England (Aspinall and Blinkhorn 2007; Threlfall et al., 2007a), and are indeed an indication for the use of GA in children according to the Royal College of Surgeons guidelines (Davies et al., 2008).

In a previous study, only 38% of families referred for GA stated that their GDP discussed other treatment options with them (Thomas et al., 2004). In this study, it was noticed that the amount of time and effort GDPs were willing to spend to establish if a child with such characteristics can receive treatment in the dental chair was variable. This suggests that not only are GDPs sometimes not allocating these children sufficient time to assess cooperation due to universal factors such as
financial implications, but other more personal factors varying between GDPs are influencing that decision.

8.1.2.1 Providing better care for young children in primary dental practice

The amount of training GDPs receive in the provision of paediatric dental care might be part of the issue. Aspinall and Blinkhorn (2007) reported that 40% of child referrals for GA by GDPs might have been possible to treat with behavioural management or under inhalation sedation. In addition, the findings of a previous multinational study suggested that GDPs from the UK lacked confidence in treating children and thought it was troublesome, stressful and time requiring (Pine et al., 2004). Furthermore, in another study, interviews with GDPs of different ages and experiences suggested that education and experience can affect the way GDPs choose to manage caries in primary teeth (Dailey et al., 2007).

Perhaps GDPs can be offered more training in behavioural management and inhalation sedation to provide them with the skills needed to provide treatment for children with severe caries. Another option to reduce the number of referrals might be to send paediatric dentistry specialists to provide care in primary dental care settings. Such specialist outreach in other health areas has been shown to improve access to care and patient satisfaction (Williams et al., 2010).

However, the findings of this study showed that high-caries-risk children are being referred from multiple primary dental care practices all over Lambeth, Southwark, and Lewisham, and in other parts of South London. As such, any outreach services need to be carefully planned to ensure cost-effectiveness and appropriate distribution in the local area. In addition, it is possible that sending paediatric specialists to primary dental practices might actually make GDPs even more reluctant to treat children with severe caries, due to over-reliance on the specialists.

8.1.2.2 Parents’ poor oral health knowledge, attitudes, and parenting practices.

Interviewed GDPs perceived that parents of this cohort of children frequently lack oral health knowledge, hold negative attitudes towards dental health, and are in need of parenting skills support. This may have impacted some GDPs’ motivation to provide preventive care to the children. Indeed, previous studies also suggested that
parental motivation and perceived improvements in oral health are crucial factors in the amount of time GDPs are willing to spend giving oral health advice (Threlfall et al., 2007c; Humphreys et al., 2010), putting high-caries-risk children of parents whom GDPs perceive have poor motivation or parenting skills at even further disadvantage.

8.1.2.2.1 Providing parenting support
Recent evidence suggests that parenting skills and style are indeed closely related to children’s dietary habits, as well as oral health (Hooley et al., 2012; Peters et al., 2012). As such, it might be of value to further explore the specific issues encountered in families of high-caries-risk children in Lambeth, Southwark, and Lewisham. In fact, a group of researchers in KCH are currently exploring the issue, and investigating appropriate methods to provide those families with the support they need.

An approach that cost-effectively targets high-risk families in the area, and employs a combination of interventions such as home visits, skill-building workshops, and help with day care will be needed, as suggested by Morrison et al. (2014). Those interventions need to improve parental knowledge, skills, understanding, sense of acceptance in society, and support, as suggested by Kane et al. (2007). Home visits are of particular importance (Kendrick et al., 2013). The ‘Healthy Child Programme’ (Department of Health 2009b), offering home visits and family-nurse partnerships in England, might provide a chance to reach some of the families in Lambeth, Southwark, and Lewisham, and we need to make sure that oral health support is not excluded, that it reaches the right families, and that it is tailored to the families’ needs.

8.1.2.2.2 Improving parents oral health knowledge
GDPs felt that parents lack awareness on hidden sources of free-sugars and the use of fluoride. This comes in agreement with the findings from interviewing the parents of children referred for dental extraction under GA at KCH during the author’s MSc study (Aljafari et al., 2014), and is further confirmed by the findings of other authors such as Olley et al. (2011) and Karki et al. (2011).
In addition, GDPs seemed to be particularly frustrated with the irregular attendance of those families, which comes as no surprise as Olley et al. (2011) already reported on the poor dental attendance record for this cohort of families, and the rate of child registration for dental care in the area is known to be poor, and associated with social deprivation (Gallagher et al., 2009).

**8.1.2.3 Social inequality and failure to tackle cultural differences**

Socioeconomic difficulties adversely affect high-risk individuals’ attitudes, beliefs, and practices (Sabbah et al., 2009). In addition to difficulties in establishing rapport with deprived families that GDPs perceived as having poor oral health attitudes, they specifically noted that they have difficulties communicating with immigrant families. These difficulties were not limited to language barriers, but were also related to what they perceived as cultural differences in valuing regular dental care. In a recent study in Manchester, GDPs perceived similar difficulties with the immigrant population in their areas (Goodwin et al., 2015b)

The areas of Lambeth, Southwark, and Lewisham, are indeed home for a multiethnic multicultural population (Office of National Statistics 2012a; 2012b). Earlier research in those boroughs has indeed suggested that ethnic minorities perceive barriers to dental services, including language, cultural misunderstandings, costs, and dentist mistrust (Newton et al., 2001a), and children from immigrant families are known to be more likely to have dental caries (Skeie et al., 2006).

However, it is debatable whether the GDPs’ observations in this thesis are accurate or a form of stereotyping. A previous study at KCH reported that only 15% of children referred for dental extractions under GA had lived in another country (Olley et al., 2011), but this did not take into account immigrant parents. In this thesis, less than one tenth of the families attending for extractions under GA were excluded due to English language competency.

**8.1.2.3.1 Improving GDPs competency in caring for families in a multicultural area**

It is possible that the frustration of some GDPs might have lead them to victim blaming. In light of this, in addition to providing support to the families, it might be time to re-examine the paradigm and determine if GDPs in Lambeth, Southwark,
and Lewisham, and around England, need new tools to improve their communication and understanding of high-caries-risk families.

GDPs in Lambeth, Southwark, and Lewisham, and in other areas in England, might require support to achieve what is known as ‘cultural competency’ in their clinician-patient relationship. Betancourt et al. (2003) defined cultural competency as ‘understanding the importance of social and cultural influences on patients’ health beliefs and behaviours, considering how these factors interact at multiple levels of the health care delivery system and, devising interventions that take these issues into account to assure quality health care delivery to diverse patient populations’.

To fully address the socio-cultural barriers to oral health care, not only is there a need to achieve competency at a clinician-patient level, but also at an organisational and structural level. As such, future interventions can include the recruitment of ethnic minorities into health care, further development of interpreter services and translated educational materials, and the provision of education on cross-cultural issues to health care workers and policy makers (Betancourt et al., 2003). Naturally, interventions to improve such competency need to be tailored to the local areas and populations, depending on their cultural make-up and oral health needs. However, national guidance and goal-setting will be necessary.

8.1.2.4 Deficiencies in GDPs’ training, and primary care remuneration and organisation

The role of GDPs in the provision of preventive care and oral health promotion within the primary dental care setting cannot be ignored. A study in 2013 suggested that leading a prevention oriented primary dental care practice, where parents are invited to register children upon birth, can affect their oral health practices, including age of dental registration and oral hygiene habits (Richards 2013).

Unfortunately, at the moment, preventive efforts provided at a primary care level, especially for high-risk children might be falling short. Advice provided by the GDPs in those families seems to be generic rather than tailored. The main focus seems to revolve around sugary foods avoidance and frequency of toothbrushing, as reported earlier by Olley et al., (2011), Threlfall et al. (2007b), and Pearce and Catleugh (2013).
Furthermore, a few still don’t use fluoride varnish; they cited lack of training, evidence, resources, and time, as reasons for this. This trend was noted in the Randomised Controlled Trial (RCT) in this thesis, as many parents taking part did not know about fluoride varnish despite their contact with the GDPs. It is further confirmed by the poor fluoride varnish application rates in the Boroughs of Lambeth, Southwark, and Lewisham (NHS Prescribing and Primary Care Team 2014), and the poor familiarity with fluoride varnish displayed by families of high-caries-risk children referred for GA in these boroughs and across England (Karki et al., 2011; Olley et al., 2011; Aljafari et al., 2014 Goodwin et al., 2015a).

This failure to provide appropriate preventive care comes despite the presence of Delivering Better Oral Health (DBOH), which some GDPs seemed to not be familiar with. Francke et al., (2008) reported that the implementation of clinical guidelines is impacted by personal, financial, organisational, and policy factors. Witton and Moles (2013) confirmed that similar factors might be impeding the implementation of DBOH by GDPs in England. To improve the preventive care provided for high-caries-risk children in England, and more specifically in Lambeth, Southwark, and Lewisham, it might be worthwhile to look at addressing the GDPs’ training needs, introducing an efficient skill-mix model and most importantly, providing them with better preventive care remuneration.

8.1.2.4.1 Addressing GDPs training needs

Richards and Toy (2007) noted that even though the Department of Health has issued DBOH as the evidence-based source that GDPs need to follow in delivering preventive treatment, it has failed to support them, or oral health professionals generally, in practically implementing these preventive measures (Richards and Toy 2007).

Some GDPs in the study in this thesis thought that the application of fluoride varnish was a difficult procedure, yet in the RCT study, all but four children received a varnish application successfully. Granted, the varnish was applied by a dentist with training in treating paediatric patients, but the application of varnish remains a simple procedure that was elsewhere applied very successfully by suitably trained dental nurses (Zhou et al., 2012; Zhou et al., 2013; Humphris and Zhou 2014).
A few GDPs had some concerns regarding the evidence for the benefits of fluoride varnish application. This was also reported by GDPs in a very recent and similar study in Manchester (Goodwin et al., 2015a). It was noticed by the author in this thesis that it was older GDPs that tended to reject the evidence for fluoride varnish, or think it was too difficult to apply. This is perhaps because they qualified before the application of varnish was part of dentistry training, but such a trend needs to be confirmed in studies recruiting a larger sample.

8.1.2.4.2 Utilisation of skill-mix in primary dental care

In addition to addressing the training needs of GDPs, there is a need to introduce an efficient and cost-effective skill-mix model in primary dental practice in England. The financial and organisational barriers that have made the application of such a model in dental care in England (Brocklehurst and Tickle 2011) lagging behind its application in medical care (Gallagher and Wilson 2009) need to be tackled head on, now that the majority of the dental care workforce are not dentists (General Dental Council 2014). This can be specifically important in delivering preventive care, as some evidence suggests that the use of carefully planned skill-mix models in medicine has led to more satisfactory services (Laurant et al., 2005) that provide better preventive care (Tolley and Rowland 2005).

As such, it is time to include dental therapists, hygienists, and nurses, in the provision of children’s dental care through carefully planned models that ensure cost-effectiveness. Delegating the delivery of preventive care at primary practice, such as fluoride varnish application, to Dental Nurses with Additional Skills (DNASs) can be acceptable and feasible. However, the financial and organisational issues that impede the utilisation of skill-mix models in England need to be addressed. In addition, it's noteworthy that the DNAS in the RCT study preferred that the dentist applies the fluoride varnish. DNASs might need to receive better training that includes more information regarding the consent and insurance process, and how to behaviourally manage children. Furthermore, they need to be allowed to build self-confidence through practical experience achieved by regular delegation of
preventive tasks to them, to the point that performing preventive tasks by a DNAS becomes the accepted standard procedure in primary practice.

Once DNASs are successfully integrated into the delivery of fluoride varnish to children, not only will that increase the rates of fluoride varnish application, but it might also free up the GDPs to perhaps invest more time and effort into providing complicated care for children with caries. In fact, such a ‘replacement’ application of skill-mix can be quite efficient, as suggested by Laurant et al. (2005).

8.1.2.4.3 Providing better preventive care remuneration

Even if GDPs are to receive the appropriate training and staff support, practical changes in the delivery of care to children are unlikely unless these changes are accompanied by changes in dental care remuneration to make the GDPs feel adequately compensated for their efforts, especially when it comes to providing preventive care and oral health advice. In fact, better remuneration was more important than training in the study by Clarkson et al. (2008). The current UDA dental contract (Sihra and D'Cruz 2014) does not seem to provide the remuneration for preventive care that the GDPs are looking for.

Improving focus on prevention has been determined as an NHS England goal (NHS England 2014b), and providing a fairer remuneration for preventive dental care remuneration has indeed been recommended by Steele et al. (2009) in their independent review. Dentistry remuneration reforms are in fact currently being piloted. Early evaluations of those new remuneration systems have shown promising results, as they were found acceptable to primary dental care staff and patients, and encouraged the use of a skill-mix in providing care (Department of Health 2014). In fact, the GDPs interviewed in this study who were on the new remuneration pilots, were happy with the support for preventive care that they have been receiving. However, at this stage, evidence available on the clinical impact of switching to those pilots, especially in high-risk children, remains limited, and the issue will need to be thoroughly investigated before these pilots can be safely accepted as a success.
8.1.2.5 Inadequate hospital communication and engagement with referring primary practice upon GA referral

The interviewed GDPs suggested that hospitals need to play a larger role in promoting oral health in children referred for dental extractions, rather than just provide the surgical treatment. They thought that providing an oral health intervention for those children when they attend for extractions under GA might be of benefit, and can constitute the missing link in communication between families, primary, and secondary care. The GDPs also noted the importance of improved direct communication between them and the hospital.

8.1.2.5.1 Delivering oral health advice to families during the child's hospital GA care pathway

The GDPs perceived that families of high-caries-risk children in Lambeth, Southwark, and Lewisham, that are referred for dental extraction under GA, are not aware of some basic elements in caries prevention, namely: the need for regular attendance, hidden sources of free-sugars such as juices and drinks, and the use of fluoride toothpaste. They suggested that more should be done to educate families on oral health upon their referral to the hospital, as they might take the advice better when delivered in that setting, and this in turn can improve attendance for regular care following the GA. In the words of one GDP, he perceived that his patients take the advice from the hospital as ‘A gospel’.

Previous research at KCH involving the cohort of families in question indeed confirms the GDPs’ views on their oral health knowledge (Olley et al., 2011; Aljafari et al., 2014). Moreover, the GA pathway in England, and more specifically at KCH, did not offer any support for prevention of a chronic disease that should not be just managed surgically. In fact, the findings of Olley et al. (2011) and Aljafari et al. (2014) suggested that the parents themselves have also requested more support for caries prevention, and Olley et al., (2011) noted that the medical pre-assessment appointment, that is part of the GA pathway at KCH, was viewed as one of the acceptable moments to deliver support.

The GDPs also noted that, in their experience, direct delivery of advice to children might be helpful, although some were sceptic of the value of any education at all. Parents have also previously requested that some advice is delivered to their children
(Aljafari et al., 2014). Available literature suggests that children have some input into their dietary and oral health practices (Birch and Fisher 1998; Beder 1998; Roberts et al., 2003), and can in fact, teach their parents in some cases (Evans et al., 2001), as one participant noted.

However, the findings of the RCT in this thesis showed that although the introduction of an educational oral health intervention targeting children and their parents as part of the GA pathway at KCH was acceptable and seemed to improve dietary knowledge, it was not sufficient to significantly alter their dietary practices or encourage dental attendance. The intervention remains for the time being only one piece of a very large puzzle, and reliance on services at the hospital only, or primary dental care only, to alleviate the situation, is unlikely to lead to improved oral health for this cohort of children. Routine dental attendance following the GA will need to be encouraged and arranged using more proactive methods.

8.1.2.5.2 Lack of communication with referring primary practice

The participating GDPs noted that they were not satisfied with the current format of the discharge letters sent to them following the child’s referral. In fact, a recent audit at KCH has recommended a new form of discharge letters that includes more information on recommended preventive care following the GA, but this has not been applied yet.

Communication between primary and secondary care is not a problem localised to KCH only; in fact, a previous study in Yorkshire reported that over half of these letters did not include demands to the dentist to provide preventive care and advice following discharge (Ni Chollai et al., 2010). The issue is not limited to the UK or to dental care providers only, as can be concluded by examining the reviews by Kripalani et al. (2007) and Hesselink et al. (2012).

To address the issue, electronic databases, structured discharge letters, or the employment of staff dedicated to liaising care between the two services, have been suggested, but evidence for their clinical impact remains poor (Hesselink et al., 2012). This might be especially true when such interventions are applied to improve the care pathway for a cohort known for poor follow-up attendance such as high-
caries-risk children referred for dental extractions. As such, those interventions need to be developed and tested in a research-informed manner.

8.1.2.6 Failure in establishing oral health promotion policies

In addition to all the barriers perceived by the GDPs in Lambeth, Southwark, and Lewisham, already discussed, the participants felt isolated in their efforts in the absence of national support and policies that promote oral health and reduce inequalities. Policy makers need to have the lead role in improving dental care and promoting oral health in high-caries-risk children and their families. The effort has to be coordinated on a national level, involving multiple stakeholders and partnerships, and including a variety of targeted and universal interventions, if the issue of dental caries in young children is to be addressed.

The GDPs noted that we are living in a culture where parents and children are constantly bombarded by sugary foods and drinks. These foods are heavily marketed (Rodd and Patel 2005). Promoting oral health needs in those families should start before they attend primary dental care services, by which time it is too late for many. The interviewed GDPs felt isolated; there is a need to broaden the spectrum of personnel involved in oral health care, including nurses, health visitors, medical practitioners, and school teachers. It is time to step up oral health promotion efforts as is recommended in the Ottawa Charter (WHO 1986).

Public Health England (PHE) has recently recommended adopting an integrated approach that includes various partners to achieve oral health improvements (Public Health England 2014a). The best example to study might be the ‘Childsmile’ programme in Scotland, where a collaborative approach to the delivery of oral health promotion, involving toothbrushing in nurseries and schools, fluoride varnish application, and improving access to primary dental care, continues to improve the oral health of young children and reduce inequalities (McMahon et al., 2011; Macpherson et al., 2013; Blair et al., 2015).
8.1.3 Limitations

It is possible that the informants were providing the views they assumed will be professionally or socially acceptable. To minimise the risk, the interviewer followed the recommendations discussed by Gill et al. (2008), and made his best efforts to assure the informants felt comfortable, including scheduling the interview in their own practice at the time they find appropriate. Furthermore, the interviewer felt good rapport with the interviewees and conducted the interviews in a calm non-judging manor. The informants appeared to provide forthright and candid responses and gave the impression that they wanted to do better for those children and their families, but felt helpless to do so, and frustrated that they could not do more than refer for tooth extraction.

8.1.4 Generalisability

The sample might be representative of referring GDPs in Lambeth, Southwark, and Lewisham, as it has included participants that were from all three referral rate categories, as well as participants with a wide age range, from both genders, and with a wide range of local experience. However, this was a qualitative study with a small sample, and its generalisability needs to be confirmed by using quantitative surveys with a larger sample. The contents of such surveys can be guided by the findings of this study.

Establishing phone communication with many potential participants was difficult due to their work time arrangements. There is a possibility none-respondents have a different opinion to those that took part. However, there are no apparent reasons to assume there were any significant differences between them, as in the end, the sample provided good diversity, and most of those with whom contact was established were happy to take part. Only few GDPs refused, and they might have had different opinions.

Twenty percent of the primary dental practices in those boroughs did not refer any children for dental extractions under GA in 2011-2012, according to Gallagher (2012). It would be interesting to investigate whether that is because they refer to other hospitals, have no children requiring such treatment, or perhaps handle those
families in a different manner. It is also possible that those practices were under what the hospital database referred to as ‘missing’.

The generalisability of the findings beyond Lambeth, Southwark, and Lewisham should be dealt with carefully. The results might be generalisable to GDPs in other inner city areas of England with a socioeconomic and cultural setting similar to those boroughs. Beyond that, it is likely that socioeconomic and cultural differences in other areas influence the challenges local GDPs face when promoting oral health in a similar cohort.
8.2 Study 2: An educational oral health intervention for high-caries-risk children referred for GA

The importance of oral health education during the GA referral at the hospital has been one of the issues discussed by the GDPs, and has also been raised by parents of high-caries-risk children attending for GA at KCH (Olley et al., 2011; Aljafari et al., 2014). To address this, an oral health education video-game designed for Scottish school children and designed to fit with the primary school curriculum for six-year-olds was modified to include the recommendations of England’s evidence-based toolkit for caries prevention, and fit the needs of children attending for dental extractions under GA at KCH.

8.2.1 Acceptability of oral health education

8.2.1.1 Parental acceptability

Parents found the video-game slightly less acceptable than one-on-one verbal oral health education. Perhaps they felt more involved when the advice was delivered by a person, or perhaps older generations still value the personal care aspect of one-on-one verbal education. There is no denying that even the most well designed video-games cannot replace the personal touch of one-on-one advice, where the messages can be tailored to each individual patient and the conversation could be stirred by the patient’s inquiries. As such, many authors tended to use this approach to provide education to families of high-risk children, and in fact proved it to be a successful method of education (Hamilton et al., 1999; Kowash et al., 2000; Gomez and Weber 2001; Wennhal et al., 2005; Feldens et al., 2007; Gomez et al., 2007; Minah et al., 2008; Whittle et al., 2008).

However, it is also important to note that although the difference in parental acceptability was statistically significant, it was likely not large enough to declare clinical significance. In fact, a previous study to evaluate the minimum clinically significant difference in the Visual Analogue Scale (VAS) score when measuring patient satisfaction reported that a difference of at least 11 millimetres on the VAS is
needed to distinguish between participants that are ‘pleased’ with a treatment and those that are ‘mostly satisfied’ (Singer and Thode 1998).

Furthermore, there is a risk that parents tended to give verbal education better acceptability scores because the acceptability measure was collected by the DNAS that delivered the education herself. Bias in future studies can be reduced if another researcher collects acceptability scores. Sadly, this was not possible in this study, as re-introduction of the blind author to collect this measure following the delivery of education carried the risk of un-blinding, and involving another researcher to the team to collect this measure was neither practical nor financially possible, and would have further inconvenienced participating families already short on time.

8.2.1.2 Children’s acceptability of oral health education

The results of this study suggest that children found receiving oral health education through a video-game interesting, engaging and as acceptable as receiving one-on-one verbal oral health education from a DNAS. Some older children said that they found the game too easy, and some younger ones too hard. However, this did not impact their evaluation of the game, as both younger and older children rated it favourably. Nevertheless, gaining the user’s interest and demanding the right amount of effort are an important aspect of video-game design and evaluation, as noted by Connolly et al. (2008). As such, developing oral health video-games with narrower age ranges might be useful in the future.

The fact that children seemed to enjoy learning through a video-game comes in agreement with the findings of other authors that have assessed educational video-games, as discussed in a review by Connolly et al. (2012). Furthermore, by providing evidence in the form of an RCT comparing those games to traditional verbal education, this study has addressed an important deficit in educational video-game research. Connolly et al. (2012), Primack et al. (2012), and Girard et al. (2013) all noted that more RCTs were needed in assessing educational video-games.

However, it is important to note that less than half (44%) of those that returned their password sheets had filled in the passwords indicating usage of the game at least once at home. One can suspect that even fewer of those that did not return the diaries and password sheets played the game at home. Computer access in UK
family homes is almost universal (96%) (Office of National Statistics 2011). This means that access to computers is not likely to have been the reason more than half of the children did not play the game at home. It is possible that some children did not remember to fill in the password sheet, as it was tucked away at the end of their snack and toothbrushing diary booklet to avoid un-blinding the author upon collection (please see Appendix 2 for the booklet design).

More likely, the children might have found the game interesting enough to use during a hospital appointment, an activity they traditionally might not find very exciting, but not interesting enough once they were at home surrounded by traditional audio-visual entertainment and other distractions. As such, extensive cooperation between oral health researchers and commercial video-game designers is needed to design educational video-games that are interesting enough for the child to play at home multiple times. Repetition after all might be a key ingredient for learning according to multiple learning theories as noted by Weibell (2011).

8.2.2 Impact of oral health education on children’s dietary knowledge

Children from either group showed a statistically significant improvement in recognition of healthy food items immediately following the intervention. This confirms the results of the phase I RCT that assessed this game’s earlier prototype used by Rice and Hosey (2008), and comes in agreement with the results of several studies suggesting that dietary education through video-games can improve knowledge (Baranowski et al., 2003; Kreisel et al., 2004; Amaro et al., 2006; Turnin et al., 2008). It contradicts the results of a similar study in low-income families in the US, by Pempek and Calvert (2009). Their study probably failed to demonstrate significant gains in knowledge due to their small sample size (ten participants in each group), although the contents of their game or measurement tool also might have been the issue.

When the children taking part were split into two groups according to age, it was apparent that children that are six years or younger had more significant gains in knowledge following the education than those that were older, regardless of the education method. This is probably due to their lower dietary knowledge at baseline.
allowing for larger improvements. Older children displayed smaller, but still significant improvements. However, it is pleasing to find that the target age group for the original Scottish game seemed to improve the most. In future studies in the same cohort, researchers might want to use a different approach to education and knowledge measurement in each age group.

The findings of this thesis are limited by the fact that improvements were measured immediately following the delivery of the education. Unfortunately, it was not possible to demonstrate if these improvements are sustained over time as only 11 children in the whole sample (10%) completed the Pictorial Dietary Quiz (PDQ) three months after GA. Collecting a PDQ measurement on the day of GA, which is usually about two to three weeks after the pre-assessment appointment was an option that was considered, since high drop-out rates at three-month follow-up were indeed anticipated. However, this was not included in the study design as it is established that parents and children might be anxious while awaiting surgery (Kain et al., 1996; Gazal and Mackie 2007), and anxiety in turn might influence their cognitive performance (Eysenck et al., 2007). In addition, families tend to be busy on the ward on the day of GA as the child is being prepared for the procedure by the dentists, medical nurses and anaesthetists.

8.2.2.1 Impact on the perception of fruit drinks and juice

Fruit juices and drinks are known to contain cariogenic sugars (Duggal and Curzon 1989; Marshall et al., 2003), yet large portions of the UK public (Gill and Sattar 2014) and more specifically families of children referred for dental extractions under GA at KCH (Aljafari et al., 2014) seem to be oblivious to their potential cariogenicity.

In this thesis, children that received verbal education from the DNAS were significantly better than those that played the video-game in recognising fruit drinks and juice as unhealthy items following education. At face value, this seems to be a shortcoming of the advice provided in the game, which indeed might be the case, and clearer advice on fruit drinks might be necessary in any future version of the game. However, there are also several factors that are likely to have led to such outcomes, and need to be taken into consideration.
First, the PDQ measuring tool had its limitations in assessing the children’s understanding of a healthy diet, as it only assessed their ability to sort foods and drinks into healthy and unhealthy, without taking healthy frequency of consumption into consideration. Such food classification can be problematic for many food and drink items. In regards to fruit juices, the video-game clearly conveyed the message that they should be avoided between meals and replaced by water, but did not strictly describe them as unhealthy. As has been suggested by Duggal et al., (2001), reducing frequency of sugar consumption is more important than reducing the amount.

Second, it is possible that the DNAs taking part, knowing that consumption of fruit juice and drinks was one of the main messages to be delivered in this research project, and knowing the presence of fruit juice and drinks items in the PDQ, made it absolutely clear to the child and their family that they are unhealthy. This again demonstrates the power of one-on-one interaction, as advice can be better tailored to the recipient’s needs.

8.2.3 Impact of oral health education on children’s dietary practices

8.2.3.1 The unhealthy diet of the children in this study

Perhaps an important finding in this study was that the children that took part in this study appeared to have an unhealthy diet at home, as indicated by their baseline Children’s Dietary Questionnaire (CDQ) scores. Parents reported that their children consumed less fruits and vegetables, but consumed more sweetened drinks, fat from dairy and non-core foods than is recommended by the CDQ healthy thresholds. This goes on to show the importance of exploring ways to deliver dietary advice and support for a healthy diet in those families.

Previous studies suggested that children with high caries risk might have unhealthy diets at home. For example, Dye et al. (2004) reported that children with caries were more likely to consume less fruits and vegetables than recommended, while Evans et al. (2013a) reported that children with Early Childhood Caries (ECC) consume more sweetened drinks, including fizzy and fruit drinks, than other children. The
association remained even after adjusting for socio-economic factors. Moreover, Llena and Forner (2008) reported a positive association between excessive consumption of sweet snacks, soft drinks and industrial bread, and caries experience. While a negative association was found with the consumption of more healthy foods such as cheese and nuts.

With this in mind, it is worth taking into consideration that such poor dietary habits not only increase the risk of dental caries, but are also considered risk factors for other health issues such as obesity. In fact, obese and overweight children were reported to be more likely to suffer from caries (Sharma and Hedge 2009; Hayden et al., 2013), especially in industrialised countries (Hayden et al., 2013) such as the UK. Hence, future initiatives for oral health education and dietary interventions in these families might want to employ a ‘common risk factor’ approach, as described by Sheiham and Watt (2000). Designing health education video-games that take this concept into consideration is possible by establishing cooperation between teams of health professionals. When appropriately trained health educators are not available due to costs, or cannot communicate with some families due to language barriers, video-games utilising a common risk factor approach with different languages might be a simple and perhaps cost-effective alternative.

8.2.3.2 Impact on children’s dietary practices as reported by the parents

The findings of this thesis suggest that neither method of education was able to produce a meaningful change in those children’s dietary practices. The children that completed follow-up from the video-game group did report a statistically significant reduction in sweetened drinks consumption, and analysis of data for the pooled sample detected small but significant reductions in the consumption of sweetened drinks, non-core foods and fat from dairy in the families that completed follow-up, but those statistically significant findings are unlikely to be of clinical significance for a variety of reasons:

1. Only 55% of the participants completed the CDQ over the phone three months after their child’s GA. It is likely that the participants that did not complete their phone follow-up were less motivated to introduce positive
changes. In fact, two things are noticeable: first, the families that did not complete phone follow-up reported consuming significantly more sweetened drinks at baseline, indicating perhaps they might be the ones whose diet is more resistant to change. Second, the 45% drop-out rate almost matches the percentage of families reported to have repeat GA treatment in the same child or another sibling at KCH in the study by Olley et al. (2011).

2. The reported changes in CDQ scores were small and not enough to bring the children’s scores to match the scores recommended by the CDQ developers (Magarey et al., 2009) in any food category, except only marginally in non-core foods consumption. As such, the intervention did not help those children adopt a healthier diet that is clinically significant.

3. Child-reported snack diaries did not note any significant changes in children’s snack selection in either group.

4. It’s possible that participants who did complete phone follow-up three months after GA were affected by Hawthorne’s effect (Parsons 1974).

5. There is a possibility that the positive changes in diet noticed were due to the GA experience itself. A previous qualitative study has suggested that parents do indeed feel motivated to change their children’s oral health practices following dental treatment under GA (Amin and Harrison 2006). However, another study by the same authors noted that such motivation to change is usually short termed, as many parents feel impeded by wider parenting skills issues, and familial and social restrictions (Amin and Harrison 2009). As such, even if the oral health education provided in this study had a role to play in the reported dietary change, these changes will not be supported and sustained unless education is supported by wider oral health promotion in those families.

The dietary advice given to the children included recommending reducing sweetened drinks intake and sugary and fatty food items such as cakes, chips, hotdogs and others. Making it understandable how a reduction in sweetened drinks and non-core food items might be related to the education received. However, some might question why the consumption of fat from dairy has been reduced, as neither the video-game nor the verbal education strictly recommended reduction in milk intake or a switch to skimmed milk, as this was not a main focus point for children.
in the second edition of DBOH, on which the advice was based (Department of Health 2009a).

The most likely explanation for the reduction in CDQ fat from dairy scores is that this section of the questionnaire doesn’t only measure intake of full fat milk, but also the intake of flavoured milks, yogurts and custards, all of which contain sugar, the ingredient that was constantly targeted in the dietary advice included in the video-game or delivered by the DNAS. It is possible that parents reduced their child’s intake of such food items after receiving the message to reduce sugar. Another possibility is that they were just reporting what they thought the author wanted to hear.

8.2.3.2.1 Comparison with previous studies

Previous developers of diet education video-games targeting children such as Baranowski et al. (2003), Amaro et al. (2006), and Turnin et al. (2008), reported small but significant changes in the dietary patterns of their subjects. However, their results might not be suitable for direct comparison with the findings of this thesis, as they all targeted school children across the socioeconomic board and not a high-risk population. Furthermore, their subjects were generally older than those in this study.

Perhaps the two most comparable studies are the study by Pempek and Calvert (2009) and Rice and Hosey (2008). The video-game developed by Pempek and Calvert (2009) was not sufficient to introduce a significant change in snack selection, but that might have been due to their sample consisting of only ten children in each group. In the study by Rice and Hosey (2009), no significant improvements in snack selection were noted in the children that played their game, although that could have been the result of contamination by a healthy-school diet initiative. As such, this current study might provide a more solid piece of evidence that using video-games in dietary education has the same well-known limitations of other methods of oral health education, and is not likely to lead to sustained and clinically significant changes in the dietary habits of high-risk children.
8.2.3.3 Impact on children’s snack selection

Examining the children’s reported dietary changes provided more information on the possible effects of the education delivered on dietary patterns. Almost two-thirds of the children reported having a healthy snack at school the day prior to recruitment. This might contradict the findings reported earlier by scoring the CDQ, but two more likely explanations are that children’s snacks at schools are in some instances more regulated by their school, or that some children were simply drawing what they thought was a healthy snack.

The snack diaries revealed no significant changes in children’s snack selection following oral health education by either method. This again reflects that this educational intervention alone was not sufficient for behaviour change in this cohort of children or their parents. However, it is possible that the lack of noticeable improvement was due to the fact that about two-thirds of the children reported having had a healthy snack at baseline. The return rates for those diaries were reasonable (70%), and seemed to only be influenced by the number of days that the family had to wait between their medical pre-assessment appointment and the GA procedure. The longer the wait, the less likely they were to bring the diaries back, perhaps reflecting the difficulties in following up such families on a long term.

One issue that was noticed during data collection was that different schools were running different policies on snacking, with some, for example, providing fruits to children and others not, and some allowing snacks from home and others not. This inconsistency has very likely influenced the findings of this study. Furthermore, there is always a risk that children have just been drawing what they thought is the right answer. Future researchers might need to partner with school staff to ensure more reliable data are being recorded.

8.2.4 Impact on children’s toothbrushing frequency

Children from both groups reported good toothbrushing following the intervention with no significant differences between them. It was encouraging to see the children motivated to brush their teeth and fill and return their diaries. Some evidence does suggest that self-reported oral hygiene measures in children are reliable and valid (Jamieson et al., 2004; Gil et al., 2015). However, the extent to which these findings
can be trusted is questionable, as a Hawthorne effect of taking part, and inaccurate reporting, cannot be ruled out. In addition, it was not possible to compare those results to the participants’ oral hygiene practices prior to the intervention.

Furthermore, although parents have been given advice on using 1450 ppm fluoride toothpaste by both the video-game and the nurse, no measures were taken to assess that they did so at home, and its possible children were brushing with the wrong fluoride concentration toothpaste. As such, future studies should include measuring such outcome. Innovative methods should be considered, such as taking photos with a smart phone or perhaps using video cameras to record children’s daily diaries, allowing recording of toothpaste type, toothbrushing frequency and diet at home. In fact, video diaries have indeed been used to record children’s diaries in dental health research (Rodd et al., 2013), although gender, age and ethnic background of children willing to take part appeared to be a possible limitation.

8.2.5 Impact on dental attendance

Most parents knew their children should attend for regular dental care at baseline, indicating that GDPs were not quite right when they suggested otherwise. Although the overwhelming majority of parents indicated that they believe their child needs to attend the dentist regularly (80% said every 3-6 months and 12% every year), only a minority of families ended up attending their child’s follow-up appointment. Attendance of a follow-up visit three months after GA was poor and there were no significant differences between the two oral health education groups.

Despite the author leaving messages on parents phones and attempting phone calls at several times, only 59 parents (55%) eventually completed phone follow-up. These difficulties in achieving contact over the phone demonstrate the scale of the issue in establishing communication with high-risk families in Lambeth, Southwark, and Lewisham. In fact, during the author’s MSc, parents of a similar cohort of children noted that they are not likely to find talking on the phone about oral health acceptable due to time constraints (Aljafari et al., 2014).
Only 11 (10%) attended their follow-up appointment. A further 15 (14%) indicated they have arranged for a routine visit at their local GDP. Meaning that in total, less than 40% of the families had any type of follow-up visit planned. Families of high-caries-risk children receiving dental extractions under GA have been previously identified as poor dental attenders (Olley et al., 2011; Goodwin et al., 2015a). The poor follow-up attendance in this study does not come as a surprise, as in an earlier study in Glasgow only 13% of children taking part in a study evaluating GA pre-medication attended a dental follow-up visit three months after GA (Hosey et al., 2009).

It was hoped that delivering advice on dental attendance during the child’s referral might improve the rates of follow-up attendance, but that seems to have failed. As far as the author knows, there are no reports of similar interventions aiming to improve GA follow-up in England. However, there are a couple of examples involving a similar cohort of families in the USA. In the first example, a preventive intervention including verbal and written advice was provided to children before GA, but failed to establish better attendance, as only 31% attended a six month follow-up visit (Primosch et al., 2001). In the second example, families were provided with a pre-GA intervention that either comprised of verbal advice only or advice supplemented with visual aids. 78% of those in the visual aids group and 52% of those in the verbal advice group attended follow-up after two weeks (Picard et al., 2014). The differences in findings between the two examples are less likely to be due to the nature of the intervention, and more likely to be due to the significant differences in the length of follow-up.

Clearly, the issue of poor dental attendance in families of children referred for GA extractions is not a product of a lack of understanding of importance of dental attendance, but rather a product of other social, economic and cultural factors that need to be investigated in the UK population and addressed appropriately through wider oral health promotion. The findings of a previous case-control study in the US that compared follow-up attenders with non-attenders in a similar cohort suggested that access to regular care prior to GA is the best predictor of follow-up attendance (Amin and Harrison 2007).
Interventions to improve those families’ dental attendance might need to be more proactive. Discharge from the hospital following the GA procedure might need to not only be accompanied with raising the families’ awareness on the importance of dental attendance and establishing communication with them to arrange appointments using letters, text messages, or phone calls, but rather look to address the poor communication and integration between primary and secondary dental care providers, to ensure there is a continuity of curative and preventive care provided as part of the GA pathway.

8.2.6 Familiarity of families referred for GA extractions with fluoride varnish

Despite the children being under high caries risk, and having already gone through the GA referral pathway, only 38.5% of their parents reported that they were familiar with fluoride varnish. It is disappointing that those who require the most attention to prevention seem to receive no advice or exposure to such an important modality of preventive dentistry, even after contact with GDPs and paediatric dentistry specialists. This comes in agreement with previous investigations in this cohort (Olley et al., 2011; Aljafari et al., 2014) and a very recent investigation in six hospitals in Manchester, where no more than 40% of GA attenders stated they received advice on fluoride varnish (Goodwin et al., 2015a; 2015b).

By a combination of providing advice on fluoride varnish application and practical application, the study seemed to increase awareness regarding fluoride varnish, as 78% of those who completed phone follow-up three months after GA stated they are familiar with it. The results suggest that this increased awareness was genuine and not due to more parents who were unfamiliar at baseline being lost to follow-up. Nonetheless, the results should be taken carefully, since the changes in familiarity in those lost to follow-up cannot be measured. Furthermore, even though parents were now familiar with fluoride varnish, it doesn’t seem that this awareness made them more inclined to attend follow-up to receive that treatment.
8.2.7 Compliance with Duraphat® fluoride varnish application at the medical pre-assessment clinic

The application of fluoride varnish in this hospital medical setting was possible, as evidenced by the fact that the application was unsuccessful or discontinued in only four children out of the 105 that were offered the treatment. The findings come in line with previous studies that also suggested low rates of rejection of the application by children (Zhou et al., 2012; 2013) and (Humphris and Zhou 2014). The feasibility of application in those high-caries-risk children means that there is an opportunity to explore targeting them for varnish delivery in other similar settings, as well as possibly local schools or through home visits, once an appropriate approach to targeting and dental personnel training has been established.

The author was hoping that the two DNAs were ready to take over the task of delivering fluoride varnish. However, this has not been the case. The DNAs were keen to delegate the application of fluoride varnish back to the author, a dentist, shortly after the commencement of the trial. The author opted to respect the will of the nurses, as they had volunteered to take part in this research project. The issue was not due to the lack of skills or self-confidence in their abilities to complete the procedure. The nurse that works as a paediatric nurse was given high acceptability scores by the children. Therefore, the issue seemed to be due to a lack of confidence and understanding of applying varnish in a new non-dental setting and in a research project context. It is worthy to mention that although both nurses have completed training to apply fluoride varnish, neither has performed the treatment regularly in their departments prior to the study. This is still not standard practice at KCH, and as such might have contributed to their decision.

Such barriers to the utilisation of DNAs in the delivery of fluoride varnish to children have been noted before. Indeed, in an investigation at KCH, Carter et al. (2012) reported that lack of confidence in consent and insurance was one of the concerns DNAs had with the application of fluoride varnish. In fact, even in Scotland where Extended Duty Dental Nurses (EDDNs), the equivalents of DNAs in England, have been more frequently asked to participate in the delivery of fluoride varnish, nurses that received training but haven’t been regularly asked to
deliver the treatment reported that they were lacking in self-confidence (Gnich et al., 2014).

As such, this will be an important issue to address before DNAs can be relied on to deliver fluoride varnish as part of oral health promotion programmes in England. DNAs will perhaps need to receive better education on the process of varnish delivery and child management, as well as be allowed to gain more practical experience in delivering the treatment to children in a dental setting. Self-confidence will need to be built by asking dentists to delegate the treatment to them in the dental setting. Naturally, the financial and organisational barriers impeding this task delegation in England will also need to be addressed.

8.2.8 Children’s views on Duraphat® fluoride varnish application

In regards to the acceptability of Duraphat® varnish application from the children’s perspective, they seemed to have varying opinions. The average VAS score was 62 out of a 100, indicating that they find the treatment marginally acceptable. However, differences in acceptability were noted according to the person delivering the treatment, although those differences couldn’t be confirmed statistically. This reveals the importance of personal experience in behaviourally managing children, even during what we view as a relatively simple procedure such as fluoride varnish application. This perhaps sheds a light on why some GDPs interviewed earlier perceived that fluoride varnish application in children can be difficult.

Qualitative data collected in this study suggested that taste and texture play an important role in the child’s acceptability of fluoride varnish. Although the children described the procedure as ‘easy’, they sometimes complained about the taste or texture, calling varnish ‘disgusting’ or ‘sticky’. This comes in agreement with the only similar study in the field by Berg et al. (2006), where young children complained about the taste of two brands of fluoride varnish. In fact, taste is recognised as an important aspect of medicine acceptability (Davies and Tuleu 2008). As such, there might be a need to look into how the child’s experience of varnish application can be improved.
Some might question the importance of research to improve the taste and texture of fluoride varnish, as acceptability scores did not seem to influence the success rate of the application. However, listening to patient input on treatments and health services provided should be an important part of providing quality health care, and in fact, the Department of Health has recommended that feedback on treatments and services from children themselves should be sought (Department of Health 2010). Furthermore, providing varnish that is more acceptable to children might make the task of applying it easier for oral health workers with less experience in managing children.

8.2.9 Discussion of recruitment

Recruitment for this study lasted for approximately one year (October 2013-October 2014), during which a total of 464 potential participants were identified. As discussed in the findings, there were 1,002 children below the age of ten attending KCH for dental extractions under GA in the year 2011-2012. Following the trends of the last few years, one would expect the total number of children referred in 2013-2014 to have been even higher.

The discrepancy between the total number of children referred and the number of potential participants identified is due to several factors: first, children younger than four were excluded. In 2011-2012 there were 155 children (15%) aged less than four on the GA extraction list. Second, children seen at the pre-assessment clinic before nine am or after four pm were excluded, as recruitment had to take place during the work hours of the DNAS who had volunteered to take part. Third, some participants attended on days that either the author or the nurses were not available. Finally, the hospital introduced changes to the pre-assessment process during the final two months of recruitment. Those changes included moving the pre-assessment process from the Day Surgery Unit (DSU) to the paediatric dentistry department, and rescheduling the times those patients are seen every week, making the availability of the dental nurses during this period even more limited.

As expected in such a culturally diverse area of London (Office of National Statistics 2012a; 2012b), some of the potential participants had to be excluded due to the parent lacking English proficiency to consent (8%). There was a variety of
languages spoken, and a predominant foreign language within the referred children could not be determined. It is worth noting that lack of English proficiency in parents doesn’t necessarily mean that the child lacks the English skills as well. However, these findings do complicate the research consent process as well as the efforts to deliver verbal education to those children and their parents, as many oral health promotion trained professionals speaking different languages will be needed. Video-games can be translated to a variety of languages, and can be an option that should be discussed in delivering education to this cohort upon their referral.

The relatively low percentage of non-English speaking parents in this study might contradict, to some extent, the reported difficulty in English communication some GDPs perceived they face in our first study. These findings suggest that the issue is more about cultural differences than language. GDPs might require better training and support for working in a diverse community, and health services need to be reoriented to be able to tackle cultural and social barriers.

A significant number of potential participants (19%) did not attend their appointments although attendance is necessary as children will not be allowed to undergo the GA procedure prior to being pre-assessed. This comes as no surprise in this cohort of patients. As discussed earlier, GDPs are struggling with the attendance patterns of these families. In addition to those excluded or not attending, 29% of the potential participants were missed, mostly due to attending while the research team was with a research participant, or attending at a time different than their scheduled appointment time.

The rate of consent (67%) is comparable to a previous study in this cohort at KCH (Aljafari et al., 2014), but lower than studies reported in other UK centres (Hosey et al., 2009; Karki et al., 2011). This is most probably due to the relatively long time that participants were asked to invest to take part in the study. Nevertheless, there is a possibility that the local population attending KCH is more difficult to recruit, or that those that declined to take part had a different outlook that is not represented by those that consented.
8.2.10 Limitations

Looking back, this study had limitations that need to be addressed in future research. Those limitations were related to the oral health education video-game design and the methods and measures used.

8.2.10.1 Video-game design and content

- The oral health education video-game was modified entirely by the author and the study was conducted within the financial framework of a PhD project. As such, it serves as a prototype video-game to establish proof of concept of this new method of patient oral health education rather than an end product.

- The current game heavily relied on the structure and educational content provided in the original prototype (Barney’s Healthy Foods), as the prototype was developed using input from a group of experts. Nonetheless, their input might need to be updated, and the educational game would benefit in the future by establishing wider cooperation with public health experts, nutritionists, child psychologists, and teachers, to further update the game’s educational content.

- The production of better, more appealing, and sophisticated oral health education games that capture children’s attention is possible, but will require cooperation with video-game designers, and will therefore be more costly and may lead to copyright issues that might affect the access of children that need it the most.

- The advice on fruit drinks delivered during the game could have been better presented, as children that played did not improve their identification of fruit drinks as unhealthy food items as much as those in the verbal education group.

- Delivering the game in other languages in some families where English might have been a second language was not possible.
8.2.10.2 Measurement tools

8.2.10.2.1 Using the VAS in measuring acceptability

- The VAS might have a potential ‘ceiling effect’, as many parents and children gave out a perfect score of 100. Nonetheless, the ceiling effect reported in a previous study using VAS to measure satisfaction (Brokelman et al., 2012) was lower than that reported when using a Likert scale (Haverkamp et al., 2008).

8.2.10.2.2 Using the PDQ in measuring dietary knowledge

- The PDQ only assesses identification of ‘healthy’ or ‘unhealthy’ foods. A good diet is more about having balanced nutrients. Prevention of dental caries is more influenced by daily frequency of sugar intake rather than just the amount (Duggal et al., 2001). Future research might address the issue by developing tools that allow more categories for food classification. For example: allowing the child to class each food as green (safe to eat sometimes); orange (safe to eat sometimes); and, red (an unhealthy food that should be always avoided).

- The scores were influenced by the child’s age, older children showed less improvement after receiving education than those that were younger and had lower baseline scores.

- The lower room for improvement for those with high PDQ scores suggests that this tool might need further refinement to improve its sensitivity.

- The PDQ requires validation in different ages, genders and ethnic groups. Unfortunately, a golden standard tool for measuring dietary knowledge in children that the PDQ can be measured against does not exist.

8.2.10.2.3 Using the CDQ to measure dietary changes

- The CDQ has been validated in Australia but has not yet been validated in England. Some items have been renamed in UK English, but there is a chance cultural patterns of dietary intake are a factor.

- There might be an issue with fully understanding the clinical relevance of its scores, as they are calculated using mathematical equations and do not
represent an actual amount or number of servings. As such, the diet is only evaluated by comparison to the CDQ’s recommended thresholds.

- As a self-reported measure, there is a risk that parents taking part in the study were just giving what they thought was the right answer.
- The questionnaire was not originally designed for exploring dietary habits in relation to oral health.

8.2.10.2.4 Using snack and toothbrushing diaries in children

- These are self-reported measures. Nonetheless, they remain one of the acceptable ways to involve children in research as discussed by Gilchrist et al. (2013). Furthermore, some evidence suggests toothbrushing diaries in children might be reliable (Jamieson et al., 2004; Gil et al., 2015)
- Children might have reported what they thought to be the right answer.

8.2.10.3 Research methods

1. The families might have been influenced by taking part in the study, known as the Hawthorne effect (Parsons 1974).
2. The oral health education delivery method acceptability scores were collected by the DNAS. As such, there is a risk of bias, in that the participants might have rated the verbal oral health education higher since the scores were collected by the deliverer herself. Future researchers should consider having the scores collected by a second blind researcher to reduce the risk of bias.
3. The changes in dietary knowledge were noted immediately following the intervention. Poor attendance for follow-up prevented the measurement of long-term retention.
4. The study did not assess certain aspects of parental knowledge on tooth brushing, namely, the concentration of fluoride in the toothpaste used for toothbrushing and the importance of spitting and not rinsing after brushing. Future research needs to investigate this issue and can use innovative methods such as photos or video diaries to document toothbrushing practices (Rodd et al., 2013)
5. The study did not record information regarding the families’ previous GA experience.
6. The study did not look into clinical outcomes. However, it is very unlikely either intervention would have an impact on such an end-point oral health promotion outcome according to Nutbeam’s (1998) model, when they failed to address a lower level outcome (health behaviour).

8.2.11 Generalisability

8.2.11.1 Representation of children attending for dental extractions under GA at KCH

The study sample is likely to have been representative of four- to ten-year-old children attending for dental extractions under GA at KCH, in terms of age, gender, ethnicity and treatment needs. However, children younger than four years, whom in 2011-2012 constituted 15% of the children attending for dental extractions under GA, and those older than ten years, have not been represented in this study. The average age of children recruited (six years) is close to the average age of those recruited in a previous study recruiting the same age range at KCH (seven years) (Aljafari et al. 2014). In another larger study that included children attending the same service at KCH of all ages, the average age was also seven years, and the standard deviation of three years (assuming a normal distribution of values) indicates that two-thirds of children that attended the service were four to ten years old (Olley et al., 2011).

The study also compares well with those two previous studies in terms of ethnicity, although direct comparisons are complicated by differences in the categories that were recorded. The current study included more categories than the previous ones, including: Black African, Black Caribbean, White Others, and Others. White British was the most prevalent ethnicity in both this study (25%) and Olley et al. (2011) (43%). In addition, 37% of participants in this study were recorded as Black (British, African or Caribbean) compared to 41% recorded as Black British in Olley et al. (2011) and 41% as Afro-Caribbean in Aljafari et al. (2014).

Less than 10% of potential participants at KCH did not speak English, and those have not been represented. This might be an advantage for delivering oral health education using video-games, as these games can easily be translated to other languages in the future. Furthermore, the families that were approached but did not
provide consent might have cultural factors or attitudes towards oral health that are different from those that did consent. As such, their representation is questionable.

8.2.11.2 Representation of children attending for dental extractions under GA in England

The sample compares well to children attending for dental GA across the UK in terms of reported treatment needs, but the slightly higher number of teeth extracted per patient in this study (6.7) is probably due to a shift towards more radical treatment under GA in the recent years. In addition, the average age of participants was close to the average age of service users across the country, although that includes some younger and older children outside the age range of this study. This can be concluded by comparing the findings to studies in Scotland (six years, 5.3 teeth) (Macpherson et al., 2005), Liverpool (six years, 4.6 teeth) (Albadri et al., 2006), Leeds (six years, 4.3 teeth) (Kakaounaki et al., 2011), and London (seven years, 4.0 teeth) (Camilleri et al., 2004).

Despite the comparable age and treatment needs, the study sample is unlikely to be representative of children undergoing the same treatment in all other locations in England. South London has an ethnic, socioeconomic, and cultural profile that is unique (Office of National Statistics 2012a; 2012b).

In addition, the possibility of applying such an educational oral health intervention at some point during the GA pathway in other centres is questionable, as not all service providers arrange for a medical pre-assessment appointment prior to the GA procedure. In fact, since the conclusion of the trial, KCH has changed the setting of medical pre-assessment. It is no longer provided in the DSU by medical nurses. Instead, it is provided at the paediatric dentistry department by dental nurses. Despite this, families still don’t receive oral health advice.
8.3 The way forward with supporting caries prevention in high-caries-risk children attending for dental extractions under GA

8.3.1 Why should oral health education be delivered within the GA pathway?

The introduction of oral health education as part of the GA pathway addressed an issue raised by the GDPs in this thesis, and aimed to address gaps in the oral health knowledge of high-caries-risk children and their families, in a way that they previously thought might be acceptable (Karki et al., Olley et al., 2011; Aljafari et al., 2014). This met the recommendations of the NHS to make every contact with health services count in terms of health promotion (Bailey et al., 2012); if high-caries-risk children are unfortunate enough to seep through the health system cracks and end up needing GA, then the least we can do is attempt to provide them and their families with the support they need at this potentially ‘teachable moment’ (Flocke et al., 2014).

The findings of the RCT study suggest that oral health education, whether delivered using a video-game or through one-on-one advice, is acceptable to children and parents as part of the GA pathway. Moreover, both methods of education significantly improved the dietary knowledge of children in short term. These improvements in knowledge are in themselves an acceptable oral health promotion outcome, as suggested in the evaluation model developed by Nutbeam (1998).

However, it is important to acknowledge and understand the limitations of delivering oral health education in a one-off intervention. First, oral health education should ideally be delivered to the targeted individuals on multiple occasions. It is a well established that the process of learning is improved by repetition (Weibell 2011). Looking at previous educational oral health interventions targeting children, such as those reported by Worthington et al. (2001) and Blinkhorn et al. (2003), it is clear that reinforcement of oral health messages on multiple occasions was a key component to ensure long-term retention of acquired knowledge, and provide support for behaviour change. Unfortunately, the findings of the current study
demonstrate that delivering oral health messages on multiple occasions to this cohort of the population, within the hospital capabilities and within the current dental system in England, might be extremely complicated, as only very few were willing to return to the hospital for a follow-up visit.

More importantly, it is important to understand the limitations of a targeted educational approach to oral health promotion, and concede that such an intervention, even if successful in addressing the oral health knowledge gaps in those families on a long term, forms only a small component in the wider oral health promotion that they need. As such, future work needs to continue exploring other approaches to targeted oral health promotion interventions in those families, as well as advocate for more universal interventions across society.

8.3.2 How should oral health education be delivered within the GA pathway in the future?

The parents in this thesis were slightly happier with a personal approach to the delivery of oral health education, and the children seemed to better learn about the cariogenicity of some important items. Although children seemed to be satisfied with the game, not many provided evidence to have played it at home, and a question arises whether those deprived high-risk families will undergo self-guided play if the game was simply offered to them outside the structure of a research project.

The author suggests further research might be directed towards theory-based personal one-on-one consultations as a method to deliver advice to high-caries-risk children and their families as part of the GA pathway. Video-games can be used as an adjunct to the advice given, or as a relatively less expensive option when GA service providers lack trained personnel or financial resources to provide a personal one-on-one consultation, or in the cases where personal communication with the families is not possible due to language barriers.

The touch of personal care, compassion, and understanding remains invaluable when delivering advice to individuals. In fact, a very recent review assessing interventions to improve the adherence of children with asthma medication reported that delivering patient-centred care and improving collaboration and understanding
between the families and the health provider might be the keys to success (Klok et al., 2015). However, as Harris et al. (2012) acknowledged in their review, good quality evidence on the impact and optimum delivery of one-on-one advice to promote better oral health remains scarce and the area requires further exploration.

8.3.3 Can families be introduced to fluoride varnish within the GA pathway?

In regards to the application of fluoride varnish in a medical setting that is part of the GA pathway, this thesis confirmed that families of high-caries-risk children attending for GA are not familiar with fluoride varnish. This was noted before in KCH (Olley et al., 2011; Aljafari et al., 2014), England (Goodwin et al., 2015a), and Wales (Karki et al., 2011). It also showed that delivery at the medical pre-assessment appointment was feasible and that the commonly used Duraphat® varnish was marginally acceptable to high-caries-risk children. Not all GA service providers in England have a medical pre-assessment appointment that can be used for the delivery of an educational oral health intervention, and they will need to explore other possibilities for the delivery of preventive care support within their GA pathway.

An issue that stood out during the research performed in this thesis was that the DNAsSs in this study, who have received the training necessary for the practical application of fluoride varnish, seemed to be apprehensive of the process in a new setting and in a research context. As such, future researchers might need to start by evaluating whether DNAs at KCH, and elsewhere in England, need better training and an increase in their participation in varnish application in the dental setting before they are sent out to apply varnish to children as part of oral health interventions in other settings.

8.3.4 What is next in promoting caries prevention in high-caries-risk children attending for GA?

There is a need to continue exploring how better support for prevention in the GA pathway can be achieved. It is important to reach a state where the provision of preventive and curative care are no longer separated, but rather form a continuous
cycle. The use of the medical pre-assessment appointment to deliver an educational health intervention and fluoride varnish was acceptable and seemed to improve some knowledge outcomes, but did not lead to substantial diet changes or improved dental attendance in high-caries-risk children. Research is needed to further explore the underlying causes of caries in those children, the patterns of GA referral in Lambeth, Southwark, and Lewisham, and possible venues for collaboration with other agencies that might be involved in those children’s care, so that appropriate support can be planned.

An outstanding issue, in the author’s opinion, is to explore how those children can be efficiently followed-up after their GA procedure. The intervention used in this thesis failed to do so, and interviewed GDPs complained about poor communication with secondary care. This is an issue that needs to be addressed in future work by exploring how the primary and secondary care systems can be better integrated. In addition, GDPs, paediatric dentists, nurses and other health professionals need to continue to promote good oral health and encourage attendance upon the child’s referral. Naturally, the socioeconomic and cultural factors that might be linked to poor dental attendance will also need to be addressed by policy makers.

What is perhaps needed now is to explore a more proactive method to follow-up those children after their GA. At the moment, children receiving treatment under GA at KCH are simply discharged and have to wait for an appointment letter or text message from their referring GDP. This is not enough in those children. In fact, even personally calling the parents, as the author did in this study, was not enough to improve follow-up attendance rate. As such, there is a need to consider working with other agencies that might be caring for those children and their families, such as health visitors, medical care providers and social workers, to improve regular dental attendance. As it stands, the issue does not have an easy solution, and one approach might not hold the answer. For example, less than 30% of parents in the study by Olley et al. (2011) supported home visits.
8.3.5 What is the importance of wider oral health promotion?

The children taking part in this study were from various ethnic backgrounds, and the majority were living in neighbourhoods that are deprived. It is important to understand that addressing the preventive gaps in the GA pathway is unlikely to be successful unless it was supported by wider oral health promotion that tackles the issue of childhood caries from its roots and reduces oral health inequalities. Health professionals, at KCH and elsewhere in England, need to continue to improve the support they provide for high-caries-risk children, but also need to understand that dental caries in children is a disease that is heavily impacted by economic, social, and cultural factors. As such, tackling the issue, in South London and in England, will require establishing and implementing national multidimensional and multiagency oral health promotion strategies that are mindful of the social and cultural determinants of health and that address inequalities.

As Rose (1992) suggested, there is a need for two approaches to health promotion: a universal approach, targeting the whole population and creating a healthy environment, and a high-risk approach targeting those under risk only. Neither approach provides all the answers on its own. Targeting high-risk children, without universal oral health promotion that creates a healthy environment and changes the social norms cannot lead to sustained positive behaviour change in those individuals (Batchelor and Sheiham 2002). While universal oral health promotion without targeting high-risk groups and individuals fails to deliver improvements in deprived high-risk individuals, and in fact, increases health inequalities (Lorenc et al., 2013), as people that are better educated and more socially and economically privileged tend to uptake advice more readily than those that are not, leading to a concentration of benefits (Roberts-Thomson 2012).

This thesis focused on creating a single targeted oral health education intervention for a high-risk cohort, to address the gaps in their oral health knowledge and in oral health advice delivery within the current GA care pathway. In the future, such an intervention can be considered as a way to introduce the families to the oral health messages that they haven’t been receiving from their GDPs. However, it needs to be viewed as only one component in a more holistic approach to oral health promotion.
Future oral health promotion strategies in England should follow the general principles of health promotion as outlined by the Ottawa Charter for health promotion (WHO 1986), and need to combine universal oral health promotion measures with a group of targeted interventions aimed at high-risk individuals and sub-populations (Watt 2005). Marmot (2010) recommended that those actions need to be ‘upstream’, tackling the social and cultural determinants of the disease, supplemented by ‘downstream’, focused on oral health determinants. Furthermore, implementation needs to be with a gradient according to deprivation, in what’s known as the principle of ‘proportionate universalism’ (Marmot 2010).

Unfortunately, implementing successful oral health promotion strategies that recognise the toll of social inequality not only requires a strong evidence base and the will of health professionals, but also depends on the national policy makers’ social, economic and political directions, and remains an issue in England, as was perceived by the GDPs interviewed in this thesis. In fact, Allen et al. (2013) acknowledged that most of the social determinants of health are outside the immediate reach of health care workers, and that the points of action recommended in the Marmot review (Marmot 2010) are mainly focused on actions that need to be taken outside of the health care system.

Nevertheless, health professionals can have an important role in promoting health and reducing inequalities. The International Association for Dental Research has indeed recognised the need to take action that ensures that the challenges of poor focus on advocating for better social policies, constant separation of general health and oral health promotion, and insufficient evidence on oral health promotion programme development and monitoring, are addressed (Sgan-Cohen et al., 2013).

Allen et al. (2013) recommended that health professionals drive health promotion and reduce inequalities with six points of action: increasing workforce awareness by education, training and increased uptake of health professionals from deprived or minority backgrounds, building relationships with deprived communities and individuals, addressing inequalities in NHS budget and organisation, improving partnerships within the health service and with non-health sectors, advocating for change on an individual, community and policy level, and finally, seizing the opportunities in the current health system.
8.4 The way forward with using oral health education video-games

8.4.1 Why do we still need oral health education?

In light of the findings of the RCT and the known limitations of isolated oral health education, some might question the decision to deliver oral health education to those families in the first place. However, several facts address that question. First, there is an ethical obligation for health workers to deliver evidence-based advice to those who need it. Second, earlier research with the same cohort revealed that parents of children with high-caries-risk have gaps in their oral health knowledge (Aljafari et al., 2014). Third, knowledge is a vital component in building towards behaviour change, as indicated by the COM-B model, in which psychological capabilities, including knowledge, were deemed a basic component (Michie and West 2013). Fourth, delivering oral health advice remains an important component of oral health promotion (Public Health England et al., 2014). Finally, the Ottawa charter for health promotion stressed the importance of helping individuals improve personal skills as part of health promotion, and this can be achieved through provision of information, health education and enhancement of life skills in an appropriate manner (WHO 1986).

8.4.2 Why involve children in oral health education?

Some might also question the need to develop and provide oral health education to children in what can be a child-friendly method such as video-games, since it is assumed that parents are responsible for the families’ oral health practices. To answer this, it is first important to note that parents did indeed take part in the oral health education provided in the RCT regardless of the group they were assigned to; those in the video-game group were required to guide the child through the game. Moreover, parents might have also learned indirectly, as some evidence suggests that children can transmit knowledge to their parents (Evans et al., 2001).

More importantly, there is some evidence that children play a role in shaping their own oral health practices from a young age; Roberts et al. (2003) suggested that children aged seven and older possess some control over their dietary selections in
what is commonly known as ‘pester power’. It is important to note that Roberts et al. (2003) did not include children younger than seven, and other authors have suggested that children as young as four years old have a ‘pester’ or ‘nag’ power over their family’s food shopping (Kenway and Bullen 2001). Moreover, Birch and Fisher (1998) suggested that even though young children have an innate preference for sugary foods, their dietary preferences are influenced by social and cultural norms, advertising and modelling.

In fact, companies producing foods and drinks, more specifically those producing unhealthy foods and drinks, have understood the importance of advertising directly to children for a long time. Rodd and Patel (2005) noted how these companies have been targeting children through mass media using child-friendly characters. It was estimated that almost 32 million pounds were spent to advertise products during child programming air-time in the UK in 2004 (OFCOM 2004). Since then, some restrictions have been put in place in an effort to tackle increasing child obesity (OFCOM 2007), yet we can still see such advertising not only on TVs, but on the streets, in shops and on food packaging. Providing oral health education in a child-friendly manner, such as by using video-game with child-friendly characters, might be an interesting method to gain their attention and expose them to some positive media advertising to counter those millions of pounds spent on targeted advertising of unhealthy foods.

8.4.3 What is the role of video-games in future oral health promotion?

Video-games are widely played by young children all over England, as discussed in the literature review (OFCOM 2014). Moreover, they have been used in general education (Oblinger 2004) and health education (Primack et al., 2012) to a fairly successful degree. The findings of this study suggest that the use of such games to deliver oral health education to children is acceptable and can improve their knowledge. However, it will be limited by the well-known limitations of oral health education in general (Kay and Locker 1996; Watt and Marinho 2005; Habbu and Krishnappa 2015).
At this stage, it has to be acknowledged that video-games remain unable to completely replace one-on-one consultations when individuals are targeted, as it might be very difficult to design oral health education video-games that provide the fully interactive and tailor-made messages that one-on-one interaction with a health care professional might provide.

One exception might be in delivering information to families that do not speak English. For example, those attending for dental extractions under GA at KCH are not receiving much one-on-one preventive advice due to the language barrier, and suitable written materials are not available, and even if they were available, they might not be the best option due to known limitations related to readability in groups with poor health literacy (Johnson et al., 2003) such as high-caries-risk families. As such, translated video-games might be considered in this group.

Other than cases where a language barrier exists, video-games at this stage might be more suitable for the delivery of either universal population messages, over the internet for example, although this carries the risk of widening inequalities (Schou and Wight 1994; Lorenc et al. 2013). As such, a directed population approach (Watt 2005) targeting populations at risk as identified by socioeconomic factors, through schools, in the community, or in health care settings such as dental and medical care waiting rooms and wards, might be more appropriate, especially in the absence of initiatives for one-on-one support. Those games can be designed to provide general health advice and motivation to children, and can utilise a common risk factor approach when appropriate, such as in the case of dietary advice (Sheiham and Watt 2005).
8.5 The way forward with delivering fluoride varnish to high-caries-risk children

8.5.1 Why do we need to deliver fluoride varnish to high-caries-risk children outside the dental setting?

GDPs interviewed in this thesis reported that high-caries-risk children referred for dental extractions under GA attend their dental practices when it is too late. Olley et al. (2011) noted that only 38% of those children referred to KCH reported that they have been attending for dental care regularly. In fact, the findings of the 2013 CDHS suggested that 12% of five-year-old children across England have either never attended or did not regularly attend for dental care (Health and Social Care Information Centre 2015c). More specifically in Lambeth, Southwark, and Lewisham, registration for child dental care across the boroughs remains poor and correlated with deprivation (Gallagher et al., 2009). As such, there is a need to investigate interventions that can improve the access and attendance of high-caries-risk children for fluoride varnish application both inside and outside the dental setting.

Fluoride varnish has well established benefits to caries prevention (Marinho et al., 2009) and its delivery outside the dental setting could improve exposure in high-risk communities. The delivery of the treatment is relatively easy, and as seen in this thesis, the overwhelming majority of children accepted to receive it in a non-dental setting. Similar successful results have been reported by others earlier (Zhou 2012; 2013; Humphris and Zhou 2014). However, preparing suitably trained and experienced DNAss is needed if they are to provide the workforce necessary for the expansion of the delivery of fluoride varnish in England.

8.5.2 Where can we target high-caries-risk children?

Issues such as optimum targeting of high-risk-populations, establishing good protocols for consent, and addressing any cultural differences will need to be addressed. In the USA, oral health workers opted to reach high-caries-risk children by providing fluoride varnish in primary medical care and in paediatric practices (Okunseri et al., 2009; Rozier et al., 2010). In Scotland they delivered it to schools
in socially deprived areas (Macpherson et al., 2010). However, those targeting approaches that worked in some countries could not be adopted in other countries without a research informed approach. As such, there is a need to investigate what targeting approach might be the most suitable in England. Moreover, cultural, social and economic variations exist within England itself. As such, investigating approaches and partnerships needed to deliver varnish to high-risk children locally in Lambeth, Southwark, and Lewisham will be needed.

In this study, high-caries-risk children were identified by their attendance for dental extractions under GA, and targeted at that stage. The presence of caries is indeed one of the strongest predictors of more caries (Litt et al. 1995; Mejare et al., 2014). Hence this was an accurate and cost-effective method of targeting. However, this episode of contact with the child should, hopefully, happen only one time in his or her life. As such, it does not provide an opportunity for delivering fluoride varnish to those children on a regular basis. In addition, not all high-caries-risk children end up attending for GA. Moreover, children at risk should ideally be identified before the disease develops. Hence, other approaches need to be investigated.

Schools might be an option for fluoride delivery. Indeed, parents of this cohort have previously asked for more caries prevention efforts in their children’s schools (Olley et al., 2011; Aljafari et al., 2014). However, in this thesis, it was noted that high-caries-risk children referred for GA are being referred from practices scattered across the map, and one has to wonder if a similar situation in schools, where only a few high-risk-children are present in each class, can be targeted cost-effectively. Furthermore, obtaining positive consent in high-risk families might be an obstacle as noted in the studies by Milsom et al. (2011) and Evans et al. (2013b). An opt-out approach would probably remove such issue, but might not be possible as fluoride varnish is after all considered a drug. As such, it is necessary to continue to work on improving communication with the children’s parents, raising awareness of the importance of varnish in the community, and addressing any cultural or other concerns regarding the treatment that parents might have in multicultural areas such as Lambeth, Southwark, and Lewisham.

Another option would be through home visits to identified high-risk families, perhaps such as those targeted in the ‘family nurse partnership programme’
(Department of Health 2013). The delivery of oral health advice and fluoride varnish should be done as part of the wider oral health promotion delivered to those families to reduce costs. However, a competent health visitor work force with training in caries prevention will be needed. Moreover, parents surveyed by Olley et al. (2011) did not seem to like home visits.

Finally, a third option would be to utilise the primary medical care setting, but further research is needed to determine possible venues that are accessed by high-caries-risk children and their families, the impact such an approach would have on improving their exposure to the treatment, as well as the approach’s cost-effectiveness.
8.6 Summary of recommendations for future research

8.6.1 Barriers to preventive care faced by GDPs in England

- Use quantitative methods to further survey local GDPs regarding the difficulties they face in delivering care for high-caries risk children and acceptable interventions to tackle them. The qualitative findings in this thesis can be used as a resource.
- Further investigate local GA referral patterns to inform appropriate action.
- Explore possible models for paediatric dentistry specialists’ outreach, and the implementation of successful skill-mix models.
- Explore the delivery of interventions to improve cultural competency on a patient-practitioner and organisational level.
- Explore the value of improving GDPs’ training on the delivery of preventive care and guideline implementation.
- Explore whether the planned changes in NHS remuneration that are currently being piloted are successful in improving preventive care delivered to high-caries-risk children in Lambeth, Southwark, and Lewisham.
- Investigate the issue of fluoride varnish application in primary care to reveal exactly which children are or are not receiving the treatment at the moment, and how any inequalities can be addressed.

8.6.2 Supporting prevention in high-caries-risk children attending for GA at KCH

- Further explore the underlying factors leading to caries in high-caries-risk children referred for extractions under GA in the South London community.
- Focus on exploring the delivery of one-on-one support at the medical pre-assessment clinic, perhaps using theory-based approaches such as motivational interviewing (Weinstein et al., 2006). The video-game can be used as an adjunct or in cases of lack of resources or in families that are not proficient in English.
Explore more proactive ways to follow-up the children following discharge, perhaps by using health visitors or dental health support workers.

Explore better methods of communication between primary and secondary care, including formatted discharge letters or integrated electronic patient records.

Develop interventions to promote oral health that include collaboration with other agencies such as health visitors, social workers, schools and medical care providers. The author is aware of researchers at King’s College London (KCL) evaluating the provision of support in maternity wards, and other researchers planning the delivery of interventions that might support better parenting skills.

Continue to advocate for a national multidimensional oral health promotion strategy.

8.6.3 The use of video-games in oral health education

Design video-games in collaboration with a wider team of health professionals to ensure precise health messages can be included and a common risk factor approach can be ensured.

Design video-games in collaboration with video-game design specialists to improve gaming experience for children.

Develop validated tools that are appropriate for measuring children’s oral health knowledge for different ages, genders, ethnicities and cultures.

Assess the use of video-games in delivering universal or population targeting oral health education as part of wider oral health programmes.

Develop and test such games in others countries and various languages. Potential differences between societies in terms of acceptability and access to technology should be noted. The author intends to investigate such issue in his home country of Jordan.

It should be noted that researching video-games in education is complicated by a unique issue, as Griffiths (2002) noted, the commercial world of gaming evolves so quickly, and it is difficult for health education games to catch up, as by the time an education game has been developed and assessed, newer
technology allows better and more appealing games that render older games outdated and not as interesting to users.

8.6.4 Application of fluoride varnish in non-dental settings

- Perform deeper qualitative exploration to understand how DNASs and other health professionals can be given the skills and more importantly the confidence to become an active part of the fluoride varnish delivering workforce.
- Explore other venues and collaborations that can help target high-caries-risk children for the delivery of fluoride varnish.
- Compare the children’s acceptability of Duraphat® varnish with other brands of fluoride varnish or newly developed varnishes with different flavours and less sticky texture, provided that efficiency in reducing caries incidence has not been impacted.
- Compare different brands of varnish in terms of their impact on the operator’s perceived ease of application. Easier and quicker application of varnish might make it less worrying for GDPs, DNASs or any other professionals anxious about delivering the treatment to children.
Chapter 8: Conclusions
After examining the findings of the research undertaken in this thesis it can be concluded that:

1. General Dental Practitioners (GDPs) in South London feel frustrated and isolated in their efforts, and perceived multi-level challenges to providing preventive dental care to high-caries-risk children that need dental extractions under General Anaesthesia (GA). These challenges were related to the child, the parents, the social and cultural environment in the local area, the GDPs’ training and support for preventive guidelines implementation, communication with secondary care upon child referral for treatment under GA, and finally, national health policies and preventive care funding.

2. The delivery of oral health education as part of the hospital’s care pathway for children referred for dental extractions under GA, whether through a personal one-on-one approach or a video-game, was highly acceptable to the children and their parents. The oral health education delivered, regardless of the method, improved the children’s dietary knowledge immediately afterwards. However, long-term retention could not be confirmed due to the very poor attendance rate for follow-up visits.

3. The use of verbal one-on-one oral health education might be a more suitable method of delivery within the context of the GA care pathway, as it was slightly more acceptable to the parents than the video-game, and led to better identification of fruit juices and fruit drinks as cariogenic by the children.

4. Achieving long-term positive changes in those children’s oral health practices using an educational oral health intervention alone seems very unlikely, regardless of the method of education delivery. Neither education delivery method led to good attendance for follow-up dental care after the GA procedure, and the improvements in the dietary practices of the children that completed follow-up three months after the GA were minimal, while non-responders, who reported consuming more sweetened drinks at baseline, might represent families that are even less likely to introduce significant changes in their dietary practices.
5. The majority of parents of children referred to King’s College Hospital (KCH) for dental extractions under GA were unfamiliar with fluoride varnish application. Applying fluoride varnish to the children as part of the hospital’s care pathway was feasible and acceptable to them, and familiarised their parents with this preventive modality. Some children did not like the varnish’s taste or texture. Although that doesn’t seem to impact the successful completion of treatment delivery, future research to improve these properties of fluoride varnish might lead to improved patient experience.

6. Dental Nurses with Additional Skills (DNASs) taking part in this study preferred delegating the application of fluoride varnish back to the dentist a short while after the study commenced. It is important that future research further investigates the readiness of DNASs in England to take on a role in the application of fluoride varnish in any oral health programmes targeting children.

7. The overall findings of this study highlight the difficulties in promoting oral health in this cohort of children within the current system for care. Local GDPs were not providing the preventive care and oral health education those children need due to a variety of challenges. The introduction of a preventive oral health intervention as part of their hospital visit was acceptable to the families and addressed an issue raised by the parents previously and the GDPs in this thesis, but failed to address the children’s long term caries prevention needs. Future research needs to explore how the challenges noted by the GDPs in this thesis can be addressed, and also explore other approaches and possible collaborations to provide appropriate support to those children and their families.
References


OFCOM (2004): *Child obesity - food advertising in context. Children's food choices, parents' understanding and influence, and the role of food promotions*. Available from:
[Accessed 8 June 2015]

OFCOM (2007): *Television Advertising of Food and Drink Products to Children - Final statement*. Available from:


OFFICE OF NATIONAL STATISTICS (2005): *Children’s Dental Health in the United Kingdom, 2003*. Available at:

OFFICE OF NATIONAL STATISTICS (2011): *Chapter 4 - Housing and Consumer Durables (General Lifestyle Survey Overview - a report on the 2011 General Lifestyle Survey)*. Available from:


Appendix 1: Ethical Approval

Dr Ahmad Aljafari
Dental Institute - 1st Floor
Dental Extension
Bessemer Road
London SE5 9RS

07 February 2013

Dear Dr Aljafari

BDM/12/13-34 Improving Post-operative care for children undergoing dental general anaesthesia - a qualitative investigation.

Review Outcome: Full Approval

Thank you for sending in the amendments/clarifications requested to the above project. I am pleased to inform you that these meet the requirements of the BDM RESC and therefore that full approval is now granted.

Please ensure that you follow all relevant guidance as laid out in the King’s College London Guidelines on Good Practice in Academic Research (http://www.kcl.ac.uk/college/policyzone/index.php?id=247).

For your information ethical approval is granted until 07 February 2014. If you need approval beyond this point you will need to apply for an extension to approval at least two weeks prior to this explaining why the extension is needed, (please note however that a full re-application will not be necessary unless the protocol has changed). You should also note that if your approval is for one year, you will not be sent a reminder when it is due to lapse.

Ethical approval is required to cover the duration of the research study, up to the conclusion of the research. The conclusion of the research is defined as the final date or event detailed in the study description section of your approved application form (usually the end of data collection when all work with human participants will have been completed), not the completion of data analysis or publication of the results. For projects that only involve the further analysis of pre-existing data, approval must cover any period during which the researcher will be accessing or evaluating individual sensitive and/or un-anonymised records. Note that after the point at which ethical approval for your study is no longer required due to the study being complete (as per the above definitions), you will still need to ensure all research data/records management and storage procedures agreed to as part of your application are adhered to and carried out accordingly.

If you do not start the project within three months of this letter please contact the Research Ethics Office.

Should you wish to make a modification to the project or request an extension to approval you will need approval for this and should follow the guidance relating to modifying approved applications: http://www.kcl.ac.uk/innovation/research/support/ethics/applications/modifications.aspx.

The circumstances where modification requests are required include the addition/removal of participant groups, additions/omissions/changes to research methods, asking for additional data from participants, extensions to the ethical approval period. Any proposed modifications should only be carried out once
full approval for the modification request has been granted.

Any unforeseen ethical problems arising during the course of the project should be reported to the approving committee/panel. In the event of an untoward event or an adverse reaction a full report must be made to the Chair of the approving committee/review panel within one week of the incident.

Please would you also note that we may, for the purposes of audit, contact you from time to time to ascertain the status of your research.

If you have any query about any aspect of this ethical approval, please contact your panel/committee administrator in the first instance (http://www.kcl.ac.uk/innovation/research/support/ethics/contact.aspx). We wish you every success with this work.

With best wishes

Yours sincerely

Catherine Fieulletteau
Senior Research Ethics Officer

Cc: Professor Marie Therese Hosey
02 November 2011

Prof Marie Therese Hosey
Head of Paediatric Dentistry
Kings College London
Dental Institute
Bessemer Road
London SE5 8RS

Dear Prof Hosey,

Study title: Cheap and cheerful oral health prevention for children who need teeth out under general anaesthesia

REC reference: 11/LO/0220

Protocol number: 3

Thank you for your letter of 23 September 2011, responding to the Committee’s request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Ethical review of research sites

NHS sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion" below).

Non-NHS sites

The Committee has not yet been notified of the outcome of any site-specific assessment (SSA) for the non-NHS research site(s) taking part in this study. The favourable opinion does not therefore apply to any non-NHS site at present. We will write to you again as soon as one Research Ethics Committee has notified the outcome of a SSA. In the meantime no study procedures should be initiated at non-NHS sites.

Conditions of the favourable opinion

The favourable opinion is subject to the following conditions being met prior to the start of

The Research Ethics Committee is an advisory committee to the London Strategic Health Authority
The National Research Ethics Service (NRES) represents the NRES Directorate within
the National Patient Safety Agency and Research Ethics Committees in England
Management permission or approval must be obtained from each host organisation prior to
the start of the study at the site concerned.

Management permission ("R&D approval") should be sought from all NHS organisations
involved in the study in accordance with NHS research governance arrangements.

Guidance on applying for NHS permission for research is available in the Integrated
Research Application System or at http://www.ritforum.nhs.uk.

Where a NHS organisation’s role in the study is limited to identifying and referring potential
participants to research sites ("participant identification centre"), guidance should be sought
from the R&D office on the information it requires to give permission for this activity.

For non-NHS sites, site management permission should be obtained in accordance with the
procedures of the relevant host organisation.

Sponsors are not required to notify the Committee of approvals from host organisations.

It is the responsibility of the sponsor to ensure that all the conditions are complied with
before the start of the study or its initiation at a particular site (as applicable).

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

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Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for
Research Ethics Committees (July 2001) and complies fully with the Standard Operating
Research Ethics Committees (July 2001) and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After ethical review

Reporting requirements

The attached document "After ethical review – guidance for researchers" gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators
- Notification of serious breaches of the protocol
- Progress and safety reports
- Notifying the end of the study

The NRES website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

Feedback

You are invited to give your view of the service that you have received from the National Research Ethics Service and the application procedure. If you wish to make your views known please use the feedback form available on the website.

Further information is available at National Research Ethics Service website > After Review

11/LO/0220  
Please quote this number on all correspondence

With the Committee’s best wishes for the success of this project.

Yours sincerely,

Dr David Jewitt
Chair

Email: Alene.Pointon@imperial.nhs.uk

Enclosures:  "After ethical review – guidance for researchers"

Copy to:

Brennan Keigh
King’s College London
keith.brennan@kcl.ac.uk

Dr Zoe Harris
Joint R&D Governance Manager KCH & GSTT
z.harris@kaha.net
11th February 2012

Professor Marie Therese Hosey  
Head of Paediatric Dentistry  
King’s College London Dental Institute  
Bessemer Road  
London SE5 9RS

Dear Professor Hosey,

Study Title: Cheap and Cheerful oral health prevention for children who need teeth out under general anaesthesia.

In accordance with the Department of Health’s Research Governance Framework for Health and Social Care, all research projects taking place within the Trust must receive a favourable opinion from an ethics committee and approval from the Department of Research and Development (R&D) prior to commencement.

- Ethics number: 11/L0/0220
- Sponsor: King’s College London
- Funder: King’s College Hospital (KCH Charity)
- End date (as per ethics application): 28/09/2012
- Protocol: Version 3
- Site: King’s College NHS Foundation Trust
- R&D approval Date: 11th February 2012

R&D have reviewed the documentation submitted for this project and I am pleased to inform you that we are approving the work to proceed within King’s College Hospital NHS Foundation Trust. The study has been allocated the Trust R&D registration number KCH12-013 Please quote this registration number in any communications with the R&D Department regarding your project.

Conditions of NHS Permission for research:

- The Principal Investigator must notify R&D of the actual end date of the project
- The Principal Investigator is responsible for ensuring that Data Protection procedures are observed throughout the course of the project.
- The project must follow the agreed protocol and be conducted in accordance with all Trust Policies and Procedures especially those relating to research and data management.
- R&D must be notified of any changes to the protocol prior to implementation.
- Please submit a copy of the progress report on the anniversary of the Ethics favourable opinion (2 November 2012)

If appropriate it is recommended that you register with the Current Controlled Trials website; [http://isrtn.org/](http://isrtn.org/)
Please ensure that you are aware of your responsibilities in relation to The Data Protection Act 1998, NHS Confidentiality Code of Practice, NHS Caldicott Report and Caldicott Guardians, the Human Tissue Act 2004, Good Clinical Practice, the NHS Research Governance Framework for Health and Social Care, Second Edition April 2005 and any further legislation released during the time of this study.

Members of the research team must have appropriate substantive or honorary contracts with the Trust prior to the study commencing. Any additional researchers who join the study at a later stage must also hold a suitable contract.

If the project is a clinical trial under the European Union Clinical Trials Directive the following must also be complied with:


Amendments
Please ensure that you submit a copy of any amendments made to this study to the R&D Department.

Annual Report
It is obligatory that an annual report is submitted by the Chief Investigator to the research ethics committee, and we ask that a copy is sent to the R&D Department. The yearly period commences from the date of receiving a favourable opinion from the ethics committee.

Should you require any further information please do not hesitate to contact us.

In line with the Research Governance Framework, your project may be randomly selected for monitoring for compliance against the standards set out in the Framework. For information, the Trust's process for the monitoring of projects and the associated guidance is available from the Trust's intranet or on request from the R&D Department. You will be notified by the R&D Department if and when your project has been selected as part of the monitoring process. No action is needed until that time.

Many thanks for registering your research project

Yours Sincerely,

Elizabeth Bruna
Research Governance Coordinator

cc. Sponsor: Mr Keith Brennan, King's College London, Hodgkin Building, Guy’s Campus, London SE1 1UL
Dear Marie,

Study title: Cheap and cheerful oral health prevention for children who need teeth out under general anaesthesia
REC reference: 11/LO/0220
Protocol number: NA
Amendment number: Am01: Amendment 1
Amendment date: 22 July 2013
IRAS project ID: 72817

The above amendment was reviewed at the meeting of the Sub-Committee held on 05 August 2013.

Ethical opinion

The members of the Committee taking part in the review gave a favourable ethical opinion of the amendment on the basis described in the notice of amendment form and supporting documentation.

Approved documents

The documents reviewed and approved at the meeting were:

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</table>
Membership of the Committee

The members of the Committee who took part in the review are listed on the attached sheet.

R&D approval

All investigators and research collaborators in the NHS should notify the R&D office for the relevant NHS care organisation of this amendment and check whether it affects R&D approval of the research.

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

We are pleased to welcome researchers and R & D staff at our NRES committee members’ training days – see details at http://www.hra.nhs.uk/hra-training/

11/LO/0220: Please quote this number on all correspondence

Yours sincerely
PP

Dr Michael Philpot
Chair
E-mail: claude.beckies@nhs.net

Enclosures: List of names and professions of members who took part in the review

Copy to: Dr Zoe Harris, Joint R&D Governance Manager KCH&GSTT
Dr Ahmad Aljafari, Registered Clinical Masters student with King's College London
Dear Professor Hosey,

Study Title: Dental prevention for GA extraction children  
REC Ref: 11/LO/0220  
R&D number: KCH12-013  
Amendment Number/Date submitted: AM01/14 August 2013  
REC approval date: 14 August 2013

I have received notice of the above amendment. It has been reviewed and recorded on the research database. Please regard this letter as acceptance of this amendment.

Amendment details:
- Protocol updated to v4 dated 14/05/2013  
- Change to start and end date  
- Additional local documents

A reminder of the conditions for the study to continue:

- The agreed protocol must be followed.  
- R&D must be notified of any changes to the protocol prior to implementation.  
- The Principal Investigator is responsible for ensuring that Data Protection procedures are observed throughout the course of the project.  
- The Principal Investigator and research team must have appropriate substantive or honorary contracts with the Trust. The Principal Investigator is responsible for ensuring that the team is covered.  
- The project must be conducted in accordance with the Research Governance Framework.  
- The Principal Investigator must notify R&D of the end date of the project.

Should you require any further assistance please email kch-tr.research@nhs.net.

Yours sincerely

Taffy Bakasa  
Research Governance Coordinator
Appendix 2: Measures

Study title: Improving Post-operative care for children undergoing dental general anaesthesia – a qualitative investigation.

REC Ref Number: BDM/12/13-34

Part I: (Please complete this part before audio recording)

Study number: ........

Clinic referral rate: ........

Clinic area Deprivation score: ............

Age: ........

Gender: ......

Post: .........................

Years of experience: ........

Year started working in area: ........

Year started working in current clinic: ........

Hospitals of paediatric GA referrals (according to participant): .........................
Part II: Semi-Structured Interview

A) Experience with children referral General anaesthesia referral
- Have they referred children for DGA before?
- How often do they see children needing GA referral?
- What helps them decide to refer a child for GA?

B) Care for high caries risk families
- What has been their experience with the attendance of these families?
- What advice did they give to those families?
- How often do they use duraphat?
- How can those families be motivated to maintain oral health?
- What do you think of the DOH toolkit (i.e. Have they ever heard of it)

C) Post-operative care for children undergoing dental general anaesthesia
- After the GA, did they receive a letter from the hospital to arrange appointments for these families?
- Did you know that families who have GA extractions at KCH have a 40% re-attendance rate?
  Do you have any ideas on how to improve on this?
- What is their opinion on the discharge letter?
- How do they arrange for these patients to be seen?
- What difficulties have they faced in arranging appointments for them?
- What is their opinion on their attendance?
- Did they notice any differences in motivation before and after general anaesthesia?
- What can be done to improve care for this cohort?
Research Title: Dental prevention for GA extraction children

Questionnaire for children:

1. Can you put a point on the line to show us how much you liked the advice you got?


2. Can you put a point on the line to show us how much you liked the fluoride (toffee banana) paste?


Thank You!!

Reference number: 11/LO/0220

Study number:
Research Title: Dental prevention for GA extraction children

Parental Questionnaire

1. Please indicate how helpful was the advice you and your child received today on preventing tooth decay (place a mark on the line):

Not helpful at all                                Extremely helpful

Reference number: 11/LC/0220                  Version: 3 Date: 15/07/13

Study number:
Draw and write down the snack you had at school yesterday!

My snack was..................................
Help Barney choose all the healthy foods
Help Barney choose all the healthy foods
Help Barney choose all the healthy foods
Help Barney choose all the healthy foods
Help Barney choose all the healthy foods
Help Barney choose all the healthy foods

Reference number: 11/LO/0220
Version 1: Date 15/07/13
Help Barney choose all the healthy foods
Research Title: Dental prevention for GA extraction children

Children dietary intake questionnaire

<table>
<thead>
<tr>
<th>Fruit (fresh, canned or stewed)</th>
<th>Tick</th>
<th>Vegetable (cooked or raw)</th>
<th>Tick</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit salad</td>
<td></td>
<td>Pumpkin</td>
<td></td>
</tr>
<tr>
<td>Peach</td>
<td></td>
<td>Cauliflower</td>
<td></td>
</tr>
<tr>
<td>Banana</td>
<td></td>
<td>Potato (Not hot chips)</td>
<td></td>
</tr>
<tr>
<td>Apricot</td>
<td></td>
<td>Peas &amp; beans</td>
<td></td>
</tr>
<tr>
<td>Pear</td>
<td></td>
<td>Lettuce</td>
<td></td>
</tr>
<tr>
<td>Nectarine</td>
<td></td>
<td>Celery</td>
<td></td>
</tr>
<tr>
<td>strawberries</td>
<td></td>
<td>Aubergine</td>
<td></td>
</tr>
<tr>
<td>Mango</td>
<td></td>
<td>Carrot</td>
<td></td>
</tr>
<tr>
<td>Melon</td>
<td></td>
<td>Broccoli</td>
<td></td>
</tr>
<tr>
<td>Grapes</td>
<td></td>
<td>Corn</td>
<td></td>
</tr>
<tr>
<td>Mandarin</td>
<td></td>
<td>Chickpeas, lentils</td>
<td></td>
</tr>
<tr>
<td>Plum</td>
<td></td>
<td>Tomato</td>
<td></td>
</tr>
<tr>
<td>Orange</td>
<td></td>
<td>Red, yellow or green Pepper</td>
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</tr>
<tr>
<td>Apple</td>
<td></td>
<td>Courgette</td>
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</tr>
<tr>
<td>Pineapple</td>
<td></td>
<td>Cabbage</td>
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</tr>
<tr>
<td>Kiwi fruit</td>
<td></td>
<td>Brussels sprouts</td>
<td></td>
</tr>
<tr>
<td>Berries</td>
<td></td>
<td>Sweet Potato</td>
<td></td>
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<tr>
<td>Dried fruits</td>
<td></td>
<td>Cucumber</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>Mushroom</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Vegetables in mixed dishes (soups, stews)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Mixed frozen vegetables</td>
<td></td>
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<td></td>
<td></td>
<td>Olives</td>
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<tr>
<td></td>
<td></td>
<td>Squash</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spinach</td>
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<td></td>
<td></td>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>

Reference number: 11/LO/0220

Study number: Version 1: Date 15/07/13
<table>
<thead>
<tr>
<th>Food/drink Item</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit juice/fruit drink.</td>
<td></td>
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<tr>
<td>Water.</td>
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<tr>
<td>Full fat milk (as a drink or on cereal).</td>
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<tr>
<td>Flavoured milk (as a drink or on cereal).</td>
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<tr>
<td>Cheese and/or cheese spread.</td>
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<tr>
<td>Yoghurt/custard.</td>
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<tr>
<td>Vegetables (raw or cooked).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit (fresh, canned, stewed or dried)</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>How many different types of fruits did your child consume in the past 24 hours?</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5+</th>
</tr>
</thead>
<tbody>
<tr>
<td>How many different types of vegetables did your child consume in the past 24 hours?</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Food/drink Item</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5+</th>
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<tbody>
<tr>
<td>Peanut butter or Nutella</td>
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<tr>
<td>Pre-sugared cereals (e.g. Coco Pops, Fruit Loops) or sugar added to cereal</td>
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<tr>
<td>Sweet biscuits/ cakes/ muffins/ doughnuts/ fruit pies.</td>
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<tr>
<td>Crisps or savoury biscuits.</td>
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<tr>
<td>sweets, fruit bars.</td>
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<tr>
<td>Chocolate (bar/block/coated biscuits).</td>
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<tr>
<td>Soft drink/cordial (not diet varieties).</td>
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<tr>
<td>Fruit juice.</td>
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<tr>
<td>Ice cream/Ice-blocks.</td>
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<tr>
<td>Pie/pasty sausage roll.</td>
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<tr>
<td>Pizza</td>
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<td>Hot chips/French fries.</td>
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<td>Hot dog/fritz/processed meats.</td>
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<tr>
<td>Takeaway (e.g., McDonalds, KFC).</td>
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<tr>
<td>Fruit (excluding juice)</td>
<td></td>
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</tr>
<tr>
<td>Vegetables (raw or cooked) eaten.</td>
<td></td>
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</tbody>
</table>
This Book Belongs to: ............

Complete the book and return it to the dentist on .......... when you come to the hospital and you will get a story book as a prize!
Please draw and write down the name of your snack at school. There is space for 5 drawings, so do this for every day this week! An adult can help you do this.

My snack at school was ..................................

Reference number: 11/LO/0220
Study number:
Version 1: Date 15/07/13
My snack at school was ................................
My snack at school was ..................................
My snack at school was .....................................

Day 4
My snack at school was ................................

Well Done! You have completed all Five days!
Go to the next page
Play the game at home to find out the five hidden passwords.

Fill in the passwords here!

The five passwords are:

1-
2-
3-
4-
5-
brush at least twice a day
use a pea-sized amount of fluoride toothpaste
spit don’t rinse

my toothbrushing diary
This diary belongs to:

Week 1
Monday Tuesday Wednesday Thursday Friday Saturday Sunday

Week 2
Monday Tuesday Wednesday Thursday Friday Saturday Sunday

fill in each time you brush your teeth

Is your toothbrushing getting better?
Appendix 3: Publications

Failure on all fronts: general dental practitioners’ views on promoting oral health in high caries risk children- a qualitative study

Ahmad K Aljafari, Jennifer Elizabeth Gallagher and Marie Therese Hosey

RESEARCH ARTICLE

Abstract

Background: Despite overall improvements in oral health, a large number of children in United Kingdom (UK) are affected by dental caries, and the implementation of oral health promotion in some families remains a challenge. As such, children from those families suffer high caries rates, and are frequently referred for tooth extraction under General Anaesthesia (GA), one of the commonest reasons for paediatric hospital admissions. The aim of this investigation is to explore referring primary care General Dental Practitioners’ (GDPs) views and experiences in trying to promote better oral health for those children.

Method: A qualitative study, utilizing face-to-face, semi-structured interviews with GDPs in three London boroughs who refer children for extraction of decayed teeth under GA selected based on referral rate. Qualitative Framework Analysis was used to present the results.

Results: Eighteen GDPs (56% male) were interviewed: average age 42 years (range: 26–73 years). Informants reported challenges to promotion of oral health categorised as: (1) children’s young age, poor cooperation, and high treatment need; (2) parental skills to face up to modern day challenges and poor attitudes towards good oral health; (3) social inequality, exclusion and cultural barriers in immigrant families; (4) National Health Services (NHS) primary care practice remuneration, constraints and training; (5) inadequate secondary care communication and engagement; and (6) failure to establishing national policy to grasp the width and depth of the problem.

Conclusion: GDPs feel frustrated and isolated in their efforts to promote oral health in those children. These findings suggest difficult challenges on all fronts. Reform of preventive dentistry funding and delivery, as well as a multiagency multidimensional approach that is mindful of the social determinants of children’s oral health and barriers to application of oral and wider health initiatives are needed to address this important public health issue.

Keywords: Early childhood caries, Dental prevention, Oral health promotion, Primary dental care, Qualitative research, High caries risk

Background

Dental caries is a disease that ideally is completely preventable. Yet, caries in early childhood is a worldwide problem [1,2]. A significant proportion of children in England suffer from the disease [3,4]. More worryingly, many children, especially those from poorer socioeconomic areas, end up requiring tooth extractions to manage the issue [5,6]. Indeed, tooth extraction, mainly under General Anaesthesia (GA), is the main reason for hospital admissions of 5–9 year old children [7]. Repeat treatments are frequent (20%-25% of cases) [8-10], in many instances due to failure in reducing risk and altering treatment patterns.

Children receiving dental extraction under GA are mostly considered to be of high caries risk as evident by their high treatment needs [9], yet focus on preventive dental care (any activity by which an individual avoids the development, progression and recurrence of an oral disease), and the wider concept of oral health promotion (any combination of oral health education and legal, fiscal, economic, environmental, organizational
and technical interventions designed to facilitate the achievement of oral health and the prevention of disease [11], continues to be inadequate. In a 2011 study, the majority (71%) of parents of children referred for tooth extraction under GA requested help in promoting oral health in their families, yet 61% had no plans for continuing dental care for their child. Only 45% indicated that they received advice on use of fluoride in toothpaste and fewer still were offered fluoride varnish (8%) or fissure sealants (10%) [10]. A previous qualitative study by the present authors supported those findings and further revealed that parental oral health knowledge, parenting skills, as well as previous advice received are all relevant factors in the oral health of those children [12].

The NHS provides free dental care for all children in the UK. Parents are advised to use a local GDP in a primary care setting. In cases where specialist or hospital care is needed, the child is generally referred but some will present in an emergency at dental hospitals. As such, GDPs provide routine dental care for children and play a vital role in promoting oral health. An evidence-based toolkit to inform appropriate preventive care has been available in the United Kingdom (UK) since 2007, with the latest edition being published recently [13].

However, it's been reported that GDPs are struggling to be thorough and consistent in their application [14], and have indicated that its delivery is difficult when adequate resources or staff support aren’t available [15].

It is important to realise that once a child develops dental caries they are more likely to develop more caries and more likely to suffer pain and sepsis [16,17]. Despite the ongoing debate on how GDPs can best manage caries in young children, one thing is clear: prevention is of paramount importance and a change in the approach to preventive care delivery and oral health promotion in this cohort of children is needed. The Steele Report in 2009 stressed the importance of reforming the way preventive care is provided under the National Health Service (NHS) [18]. Other authors stressed the need to design intensive preventive interventions for children suffering from the disease and assess their efficiency [16].

The aim of this investigation was to explore the GDPs’ experience and views in regards to providing preventive dental care for high caries risk children, as defined by those referred for tooth extraction due to caries, as well as explore their opinion on what is needed to promote oral health in that cohort.

Methods
This study involved a qualitative investigation utilizing semi-structured interviews. It was granted ethical approval by King’s College London Biomedical Sciences, Dentistry, Medicine and Natural & Mathematical Sciences research ethics committee (Reference number: BDM/12/13-34).

Information regarding the research team can be found in the (authors’ information) section.

The targeted informants in this study were GDPs working in the referral area for King's College Hospital (KCH), which includes the south London Boroughs of Lambeth, Southwark and Lewisham (LSL), provided they had referred children for management of caries under general anaesthesia. These boroughs are some of the most highly deprived in England, ranking 15th, 17th and 24th respectively in deprivation in 2010 [19]. They are also known to be culturally diverse, containing people from various ethnic minorities and immigrant backgrounds. The National Census in 2011 reported that almost 40% of adult residents in those areas were born outside the UK [20]. The rate of child attendance for dental care is poor, and highly associated with social deprivation in those areas [21].

Purposive sampling, based on GA referral rates to hospital, was used. A list of general dental practices that had referred children to King's College Hospital from March 2011 to March 2012 was obtained and practices were sorted into three categories:

1. High referrers: 15+ referrals a year (7 practices).
2. Medium referrers: 5–14 referrals a year (36 practices).
3. Low referrers: <4 referrals a year (123 practices).

Invitation letters and information leaflets that detailed the aims and design of this research project were sent by post to practices from all three categories. Our aim was to collect the opinions of dentists of various ages, work experience, gender, and referral rate. Researcher (AA) followed the postal invitation with a phone call one week later to inquire about willingness to participate. He then arranged to visit those who agreed to take part to perform the interview face to face in the informant’s own dental practice. Following a brief introduction, there was an opportunity for clarification and questions prior to obtaining written consent, and commencing the interview.

The interview schedule included open-ended questions and was divided into five discussion topics: (i) informants’ basic information, (ii) experience with referral of children for management of caries under general anaesthesia, (iii) preventive dental care provided for those children, (iv) views on the hospital service, and (v) views on promoting the oral health of those children.

The design of the interview was re-assessed by the researchers after the first five interviews. At this stage, a further question regarding the informant's familiarity with England’s preventive dentistry guidelines (Delivering Better Oral Health: An evidence-based toolkit for prevention) [13] was added.
All interviews were audio recorded and transcribed verbatim. All data were anonymised prior to analysis; informants are identified only by their referral rate, experience and gender. Descriptive statistics were used to present the demographics of informants. Framework Analysis, a rigorous approach for ordering, synthesising and presenting qualitative data [22], was used to report on the interviews. Microsoft Office Excel was used as the platform for analysis. An analytical framework was informed by relevant literature, interview schedule and emerging text of the interviews. Steps of analysis included familiarisation with raw data, development of a thematic index, theme refinement, charting into the relevant part of the framework and finally developing explanations and looking for applications to wider theory. The research team has met regularly during data collection and analysis to discuss the process of coding and theme assignment and any disagreements were solved by discussion. The consolidated criteria for reporting qualitative research (COREQ) [23] were used as a guide to ensure quality.

Results

Data collection took place between February and April, 2013. Fifty one dental practices were invited to participate. Those included all six high referral practices, 14 medium referral practices, and 51 low referral practices in LSL. Invitations were sent with the aim of achieving balance and representation across the groups. Establishing direct communication with potential informants in many cases was challenging, due to their commitment to providing clinical treatment during working hours and unavailability outside of those hours.

In the course of the study, the researcher was able to make contact by phone with 25 dentists from 21 clinics. Eighteen dentists from 14 different practices agreed to take part and were subsequently interviewed. Most of those that refused, identified time constraints as the reason. "Thematic saturation" occurs when the content of new interviews repeats that of previous interviews and is a common method of determining if sufficient data has been collected in qualitative research [24].

The average age of the informants was 42 years (42.3 years, Range: 26–73, SD: 13.8 years). Out of the 18 informants, 10 were male (55.6%). On average, they had 17 years of experience (17.2 years, SD: 13.5, Range: 2–43 years) as a dentist and 12 years (11.9 years, SD: 12.9, Range: 1–40 years) of experience practising in their respective neighbourhood. Seven informants (39%) were principal dentists. Five (28%) were from high, six (33%) from medium, and seven (39%) from low referral practices.

One thousand and two children underwent extraction of carious teeth under general anaesthesia at King's College Hospital between March 2011 and March 2012. Seven hundred and fourteen (71%) of them were from the LSL Boroughs. Names of referers of 307 children were recorded as missing on the hospital database, leaving 695 referred from 166 referring practices available. Eighty four of those practices were in LSL Boroughs representing 79% of the total number of practices in this catchment [25]. The number of children referred by each practice ranged from 1 to 24. Figure 1 shows the location of all referring practices in LSL Boroughs.

Analysis of qualitative data revealed that GDPs perceive challenges to the provision of preventive care and to the promotion of oral health amongst this cohort of children that can be attributed to every element involved in their oral health care: starting with the individual (child), and ending with wider public policy. These barriers can be categorised as follows: (1) child's young age, poor cooperation, and high treatment need, (2) parental skills to face up to modern day challenges and poor attitudes towards good oral health (3) social inequality, exclusion and cultural barriers in migrant families, (4) NHS primary care practice remuneration, constraints and training, (5) inadequate secondary care communication and engagement, (6) failure in establishing national policy to grasp the width and depth of the problem. (Figure 2) represents a summary of the results and displays the aforementioned challenges.

Following are the details of those challenges and a discussion of possible approaches for the future.

Child's young age, poor cooperation, and high treatment needs

Interviewers reported that children referred for treatment under general anaesthesia are usually of young age, poor cooperation, and present with multiple caries lesions. As one dentist explained about her referral criteria:

"Their age, how decayed their teeth are and how cooperative they're going to be with us. If 29 YO, High referrals"

These factors make the provision of preventive dental care, such as fluoride varnish application, appear time consuming. This limits the amount of preventive care provided to those children, as one dentist explained:

"I mean like to actually prepare a child for fluoride treatment varnish and all that it does require quite a bit of time and it is not just open your mouth, you know they could be uncooperative. If 29 YO, Low referrals"

In addition, the late presentation of those children means they frequently present in pain. In informants'
Figure 1 Map of referrals for XGA from LSL (March 2011 - March 2012).

Figure 2 GDP perceived challenges to promoting oral health of high risk children referred for GA tooth extraction (XGA).
view, this suggests that the families are less interested in preventive care. One dentist explained the issue:

“A lot of them will be in pain and all they want to do is just get rid of that pain and they are happy.” PM, 39 YO, Abakan reference

Thus, informants perceived that the late presentation of young children, in pain, and with multiple decayed teeth, reduces the priority for oral health promotion and preventive care in the view of both the GDPs and parents.

Parental skills to face up to modern day challenges and poor attitudes towards good oral health

Informants perceived that parents of this cohort of children have negative attitudes towards dental care and lack oral health knowledge. In addition, they felt that those parents display what they view as poor parenting practices. They expressed frustration with their infrequent dental attendance and felt that those families view dental appointments as “emergency services” only, leading to late presentation and mounting to neglect, as informants explained:

“They just access you purely for emergencies and you begin to see that look you are just supervising neglect here so you might as well just succumb to their requests because the child is effectively being abused.” PS, 38 YO, Low reference

“The general scenario is that it is usually a neglected state, it is an emergency appointment and the families are just like passers-by.” PS, 38 YO, Low reference

Informants believed that those parents see the GA pathway as perhaps the “easy way out”. Many reported that parents walk in specifically asking for their child to be referred for treatment under general anaesthesia:

“...There are parents who will go to the practice and demand: I don’t want to be treated, I just want you to send me to the hospital, that’s what my other daughter did and that’s what my other son and it was one and they took it all out.” PS, 38 YO, Low reference

Informants suggested that parental anxiety was a factor that might be contributing to this poor attitude towards dental attendance and care. They noted that parents avoid attending dental appointments themselves and appear to be transmitting their anxiety to their children:

“It appears to be sometimes mothers are more scared than their kids so they just want everything to be done at the Hospital.” PS, 32 YO, High reference

“... They also teach them that it’s scary to come to the dentist, they are scared parents and the children learn this, the same behaviour, they don’t come to check-ups.” PN, 39 YO, Abakan reference

Informants also reported that in many cases, families are not familiar with the concept of prevention of dental caries, especially when it comes to hidden sources of sugar and the use of fluoride:

“They don’t consider any other source of sugars in the food and the drinks, like juices, fizzy drinks,” SM, 32 YO, High reference

“... They are not very well educated about caries and carries risk, and you know, nutrition or diet or fluorides, you know, at the root of the teeth.” PM, 39 YO, Low reference

However, even when oral health advice is given, informants felt that parents consistently fail to adhere to it. This leads them to believe that those families have poor attitudes towards the importance of oral health and poor parenting practices. As such, an undercurrent of despair and frustration can be felt talking to the informants, as they struggle to promote oral health in those families.

“I tell you what, we sometimes tell them here and they walk out and their parents give them sweets. I’m like, hey I just told you! ’Yeah, but he was a good boy’. Waste of time!’” FS, 39 YO, Medium reference

“We can just say (Advice) but they don’t follow most of the time, they don’t follow and sometimes they come again and they say that was never told before.” FS, 32 YO, High reference

Social inequality, exclusion and cultural barriers in immigrant families

Informants reported that the social inequalities in oral health were obvious. They described a divide between children who were caries free, regular attendees that receive preventive care, and those with multiple caries lesions and poor attendance that do not receive the preventive care they desperately need:

“You have two sets of patients, one absolutely perfect, and nothing to be done. They come in, Duraphat varnish, oral hygiene instructions, a clean-up, and. And other ones, gross, there’s nothing in-between.” PP, 39 YO, Abakan reference

Establishing rapport with parents was reported to be challenging sometimes, and this was seen as a hindrance to the delivery of oral health advice. It was interesting to
note however that informants felt that establishing rapport with the children was easier:

"We have a lot of people who come from difficult backgrounds in the family. Sometimes I actually cannot even make rapport with the parents so I would make rapport with the kid." [P13, 38 YO, Low reference]

In what might reflect an issue more local to the practices' catchment area, many informants pointed out that children from immigrant families, usually attending the dentist for the first time, constitute a large portion of those referred for caries treatment under general anaesthesia:

"I've been in [Location] for twenty three years ... The individuals who do attend with a high caries incidence are those people who come from outside the UK." [P10, 49 YO, Medium reference]

"Most of these people that I see with rampant decay are actually people coming from outside." [P12, 37 YO, Low reference]

"The new patients in the practice tend to be new immigrants they tend to have higher caries experience." [P12, 40 YO, Medium reference]

Informants generally felt that failure to reach immigrant families earlier, and to establish a regular pattern of dental attendance, is mainly due to difficulties in communication. However, those difficulties were not just limited to language, but also to cultural and social factors that they felt affect the parents understanding of the role of the general dentist:

"The biggest block has always been communication for these people. So even when they've arrived here, knowing we have a full range of facilities, there's a little bit of anxiety in, in going out and seeking help etc." [P10, 46 YO, Medium reference]

"One thing I say, it's generally the families where they don't speak too much English, that's where I notice a lot of the decay in the baby teeth and things like that." [P10, 46 YO, High reference]

"The trouble usually is the barrier is not language per se, it is attendance, because they don't see the dental situation as a priority." [P10, 46 YO, Low reference]

**NHS primary care practice remuneration, constraints and training**

Funding of preventive care in primary practice was noted as a major issue. There was a consensus between informants that the current NHS England remuneration system doesn't provide enough support for preventive care for those children, and favours a treatment rather than prevention approach:

"Well they said it rewards preventative treatment, we don't think so." [P13, 39 YO, Low reference]

"You are not going to be paid more if you bring a patient to three times a year and apply topical fluoride, but you will be paid more if that patient came in with cavities." [P10, 49 YO, Low reference]

In addition, some informants were not familiar with the most recent evidence-based preventive dentistry guidelines (Delivering Better Oral Health: An evidence-based toolkit for prevention) [13]. They blamed lack of direct promotion for that, as one dentist noted:

"No I didn't know of this, because no leaflets or information were sent to the surgery anymore." [P17, 63 YO, Low reference]

This unfamiliarity was reflected in inaccurate recommendations given to patients regarding fluoride toothpaste concentration, and variable frequency and criteria, including age and caries risk, for fluoride varnish application. For example, when asked about what toothpaste recommendations are given to children, an informant responded:

"depends how old they are but, normally if it's above 6 year olds and they are high risk then I tell them to use 1500 PPM just a smear of adult toothpaste and that's it, otherwise 500 to 1000 PPM." [P9, 34 YO, Medium reference]

"For under six I normally say use the kids' ones, 1000 PPM." [P9, 31 YO, Medium reference]

There was no consensus between informants when asked about criteria and frequency of fluoride varnish application and they all gave variant responses:

"I use it with the high risk patients that have more than five fillings, we use it every in every visit. If the patient doesn't have any cavities we never use it." [P9, 39 YO, Low reference]

"Even if the children have a low decay, we tend to just put it on their teeth." [P9, 39 YO, High reference]

"After drying and very sparingly, for sort of medium to high risk patients." [P9, 31 YO, Medium reference]
"I normally do it for children 6 to sort of 16 or 17," *PN.*

26 YO, Medium reference.

Some informants were still not using fluoride varnish at all, either due to what they perceived as lack of training or lack of time and resources, interestingly, despite being low referrers.

"I mean delivering fluoride is quite a difficult business... it's difficult to see... We don't really have even the time to allocate to a child," *PIE.* 57 YO, Low reference.

In one instance, fluoride varnish was not used due to lack of belief in the evidence.

"I don't apply fluoride varnish, I don't believe in it, you don't need it," *PP.* 75 YO, Medium reference.

Oral health advice that informants provided to those children tended to revolve around reducing intake of obvious sources of sugar (i.e. sweets), and frequency of tooth brushing. The advice doesn’t seem to be tailored to each patient. Moreover, only a few informants mentioned providing advice on tooth brushing supervision, toothpaste fluoride concentration (dose) and not rinsing after brushing.

"Proper brushing, just take care, do not eat sweets," *PF.* 52 YO, High reference.

"We usually give them like written information about sugar and oral hygiene instructions, we insist a lot about food," *PIE.* 56 YO, Low reference.

It was interesting to note that the cohort of patients seems to be well distributed between practices. All informants, including those from high referral clinics reported that the number of children they individually refer is low. This can be of important implication on planning future strategies to improve the oral health of this cohort.

"I think to specify actual extractions under GA would only be about five a year," *PN.* 38 YO, High reference.

"Overall we don't have a high referral rate to the hospital," *PP.* 46 YO, Medium reference.

"Well it's very, very rare that I have kids for general anaesthesia," *PN.* 54 YO, Low reference.

Inadequate secondary care communication and engagement

The informants reported issues in communication between the hospital and both referring dentists and families. Many of them found discharge letters lacking sufficient information. They reported that it will be useful, and potentially improve post-operative follow up, if more information was provided in these letters, the type of information can be divided into two categories:

(i) Information about care provided in hospital: this includes details on treatment provided and rationale.

"It would be good to see: has this patient been seen? What has been done apart from the excision or filling? Have they had advice? We don't know where we are picking it up from," *PIE.* 48 YO, Low reference.

(ii) Information regarding needed post-operative recall.

Information regarding preventive care and maintenance needed following completion of treatment under general anaesthesia will be helpful.

"I think they should also indicate the things they would like us to focus on, advice and maintenance..." *PA.* 37 YO, High reference.

One dentist explained how providing the family with information on the importance of recall after treatment under GA has been completed can give them a sense of continuity in treatment:

"I think if the hospital emphasizes to the parents okay we've done the treatment, we just want them to come to the surgery again within three weeks or whatever, they know they have to come back here again for the routine appointment," *PF.* 59 YO, Medium reference.

The informants also suggested that more efforts to promote oral health need to be taken by the hospital upon the child’s referral. They noted that this is one of the rare chances to capture the families of those children to deliver an oral health intervention. In their opinion, those families might be more responsive to advice delivered by the hospital compared to the local dentist due to some form of perceived hierarchy.

"Patients take what comes from the hospital as a gospel, when it comes to the practice, not necessarily, you are just a dentist," *PN.* 46 YO, Low reference.

"I find when you speak in this hospital to the children and parents they do listen a little bit more, and they come back to me and say I need this treatment to be followed up," *PID.* 57 YO, Low reference.

Failure in establishing national policy to grasp the width and depth of the problem

In an apparent call for change in wider public policies, informants noted that those children are being
surrounded by an unhealthy environment, making oral health promotion at the dentist alone difficult. For example, one dentist described the large amounts of sugary drinks being promoted for children at the local store by saying:

“There are 3 aisles of sweet drinks and it is what they (the children) are drinking” [P1, SF YD, Midwive refer].

Informants felt isolated in their efforts to promote oral health, they noted that in order to tackle the issue, there is a need to broaden the involvement of others in primary care setting, including general practices, maternity wards, etc. In addition, a common risk factor approach can be followed, so that dentists are not isolated in their “nagging” as one informant put it:

“I say long term the sugar is not good for their general health, obesity and other problems down the road. So I tried to give it the holistic approach, it’s not just me the dentist nagging you will be nagged later on by the medicis down the road”. [P1, Si YD, Midwive refer]

Finally, informants demanded wider efforts to create a healthier environment for those families. Policies are needed to ensure oral health promotion starts in the community using various outlets such as media and schools before those families even step into the dental practice:

“I think it is tricky, once you get them to come to the dentist they are more likely to come back, that’s just the first thing. So I think just general motivation and things on a broad spectrum: posters and adverts on TV and all that will obviously help”. [P2, Si YO, Midwive refer]

In summary, there is evidence of failure on all fronts when it comes to promoting the oral health of those children and their families. GDPs are feeling frustrated with multiple challenges that hinder their oral health promotion efforts, and are left isolated without sufficient support from other elements involved in promoting the wellbeing of those children.

Discussion

When it comes to oral health care, high caries risk children seem to be stuck in a cycle of despair: they are being failed on multiple levels by everyone responsible for their care, whether its parents, health providers, local environment and society, or system and policies. There is an undercurrent of despair and helplessness in the GDPs we’ve interviewed, who see those children when they present for the first time to their surgeries with multiple decayed teeth, in pain, and typically coming from families who, in their eyes, have poor parenting skills or simply don’t speak English or have cultural differences. As such, oral health promotion in those children needs to be multi-agency and multidimensional, and does not just rest with the GDPs. Indeed, efforts for oral health promotion may fall heaviest on policy makers.

Interviewed GDPs perceived that parents of this cohort of children frequently hold negative attitudes towards dental health, lack oral health knowledge, and are in need of parenting skills support. Previous studies suggested that parental motivation and perceived improvements in oral health are crucial factors the amount of time GDPs are willing to spend giving oral health advice [26], putting high caries risk children of parents whom GDPs perceive have poor motivation or parenting skills at even further disadvantage. Those parents might be in need of support that focuses on improving their parenting skills and attitudes towards oral health. Indeed, recent evidence suggests that parenting skills and style are closely related to children’s dietary habits as well as oral health [27,28]. Perhaps more importantly, it might be time to re-examine paradigm and determine if GDPs need new tools to improve their communication and understanding of those families.

The GDPs also discussed how social inequalities take a toll on children’s oral health. The association between deprivation and oral health is well documented [29]. An issue that is reported in the present study, but perhaps more local to the hospital’s catchment area, is the difficulty in communication and service provision to children of immigrant families. It’s debatable whether these observations are accurate or a form of stereotyping. A previous study at SGM reported that only 1.5% of children referred for dental extractions under GA had lived in another country [10]. However, it may be that there was a bias in participants with immigrant parents choosing not to participate, which might explain the difference in findings. This is a new finding in other high income countries; a previous study reported a significant difference in caries prevalence between immigrants and native population of Norway, with caries prevalence in five year old immigrants reaching 80% [30]. Furthermore, earlier research has suggested that ethnic minorities perceive barriers to dental services, including language, cultural misunderstandings, costs, and dentist mistrust [31], which might explain the infrequent attendance and late presentation of those children.

The role of GDPs in the provision of preventive care and oral health promotion cannot be ignored. A study in 2013 suggested that leading a prevention oriented primary dental care practice, where parents are invited to register children upon birth, can affect their oral health practices, including age of dental registration and oral
hygiene habits [32]. Unfortunately, at the moment, efforts provided at a primary care level, especially for high risk children might be falling short. Advice provided to those families seems to be generic rather than tailored. The main focus seems to revolve around sugar foods avoidance and frequency of tooth brushing. Other researchers reported likewise [10,33]. Some interviewed GDPs also displayed a lack of familiarity with “Delivering better oral health: an evidence-based toolkit for prevention”, the most recent guideline for caries prevention [13]. A few still don’t use fluoride varnish; they cited lack of training, evidence, resources, and time as the reason for this. NHS statistics in recent years have shown an overall significant increase in the use of fluoride varnish by GDPs [34,35]. It is important to ensure that high caries risk children from challenged families are not left behind as they need it the most [34]. There is a need for better promotion of guidelines, as well as better training and support for GDPs on how these guidelines can be applied in general practice. Indeed, even though the Department of Health has provided the dentist with the evidence for preventive treatment, it has failed to support GDPs, or primary care services generally, in practically implementing these preventive measures [36].

One interesting observation in this study was that according to the interviewees, the number of children referred by individual dentists was surprisingly small and this fitted with the hospital activity data. The difference in numbers referred from practices might simply be caused by the size of each practice or its geographical location and proximity to the secondary care GA extraction centre. On the positive side, if the practice referrals are indeed lower then development of tailored oral health promotion for high risk referred families might not be as overwhelming to report or arduous to deliver as one might expect.

The interviewed GDPs suggested that secondary care providers should play a larger role in promoting those children with a higher risk rather than just provide the surgical treatment under GA. Providing an oral health intervention for those children when they attend for extractions under GA might be of benefit, and can constitute the missing link in communication between families, primary and secondary care. The informants also pointed out the importance of improved communication between primary and secondary care providers. A recent audit at KCH recommended a new form of discharge letters that includes more information on recommended preventive care. This problem is not localised to our hospital only; a previous study in Yorkshire reported that over a half of these letters didn’t include demands to the dentist to provide preventive care and advice following discharge [37].

There is a need for an improved financial support for preventive dentistry, as the 2006 NHS remuneration contract system hasn’t provided the support necessary. As mentioned in the Steele report: “We therefore recommend that the activity payments have a more sensitive banding structure and less range in value and explicitly recognise preventive activity” [18]. The new Steele pilot studies seems to provide better support for preventive dentistry and it was notable that the two dentists undertaking these were satisfied in this regard.

Finally, and perhaps most importantly, policy makers have the lead role in improving provided care and promoting oral health in those children and their families. Multiagency national level action is required to tackle the issue of dental caries in young children. This action should include an “upstream” approach that tackles the social and cultural determinants of the disease supplemented by “downstream” action focusing on oral health promotion [38]. We are living in a culture where parents and children are constantly bombarded by sugary foods and drinks, readily available and heavily marketed [39]. Promoting oral health needs in those families should start before they attend primary dental care services, by which time it is too late for many. The interviewed GDPs felt isolated; there is a need to broaden the spectrum of personnel involved in, including nurses, health visitors, medical practitioners, and school teachers. It is time step up promotion oral health promotion efforts as is recommended in the Ottawa Health Charter [40]. Public Health England has recently recommended adopting an integrated approach that includes various partners to achieve oral health improvements [41]. A further example, is the “ChildSmile” initiative in Scotland, who a collaborative approach to the delivery of oral health promotion, involving tooth brushing in nurseries and schools, fluoride varnish application, and improving access to primary dental care, has begun to improve the oral health of young children and reduce inequalities [42].

We acknowledge that this study has its limitations, the informants interviewed are all practicing in our hospital’s catchment area and the generalisability of their views might be questioned. Some of those invited didn’t agree to take part and might have different opinions. And finally, those interviewed might be providing the views they assume will be professionally or socially acceptable. Nevertheless, we strive to include dentists with different referral patterns, experience and age in this study.

The interviewer travelled to the informants’ practices to perform the interviews in an environment that is comfortable and non-threatening to them. They appeared to provide forthright and candid responses and gave the impression that they wanted to do better for those children and their families but felt helpless to do so and frustrated that they could not do more than refer for tooth extraction.
Conclusion
High caries risk children and their families are being failed on multiple levels. Improving their oral health has proven to be a complex issue that intertwines various factors related to our social, economic and political environment. In the present study, it can be concluded that GDPs in England feel frustrated and isolated, and are facing barriers that are related to the child, parents, social and cultural environment. Level of training, guideline implementation, secondary care communication, health policy and funding.

The depth of the issue leaves a lot of room for improvement, and the biggest burden falls on policy makers, who have the opportunity to promote initiatives that drive change. There is a need for a multi-agency multidimensional effort to relieve the social determinants of the disease, as well as broaden the width and depth of stakeholder involvement in oral health promotion that is acceptable to parents. In parallel, there is a need to re-evaluate how preventive dental care is funded, and how clinical guidelines can be implemented in practice. In addition, local action to promote the oral health of children referred for extraction under GA, and improve communication between primary and secondary care, needs to be investigated in a research informed manner.

Abbreviations
CERQ2: Consoliderised criteria for reporting qualitative research; GA: General Anaesthesia; GDPs: General Dental Practitioners; KGH: Kings College Hospital; LHC: Lambeth, Southwark and Lewisham NHS, National Health Services; UK; United Kingdom; XGA: Extractions under General Anaesthesia.

Competing Interests
The authors declare that they have no competing interests.

Authors’ contributions
All authors participated in the study design. AA was the main researcher responsible for data collection and analysis while NTR and JS acted as supervisors that have overseen the process. All authors contributed to writing and approval of this paper.

Authors’ information
AA is a PhD student that holds an MSc in Paediatric Dentistry. He has experience in performing interviews as well as training for qualitative data management and analysis. NTR is a Professor and an Honorary Consultant in Paediatric Dentistry. JS is a Professor of Oral Health Interventions and Honorary Consultant in Dental Public Health. All team members have experience in qualitative research and contributed to published qualitative studies.

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An oral health education video game for high caries risk children: study protocol for a randomized controlled trial

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Abstract

Background: Tooth decay is the most common chronic disease of childhood in the world. Many children develop caries early in their lives, and go on to develop further caries and sepsis as they grow up, indicating failure in prevention. As a result, many end up requiring general anaesthesia to undergo treatment for a disease that is completely preventable. Previous studies have suggested that the families of these children need better oral health education as well as better support in implementing healthy practices at home, as they feel impeded by broader life challenges. Parents of these children have suggested utilizing modern technologies, such as the Internet, DVDs and video games as methods of delivery of education that might fit in with their busy lifestyles. The aim of this investigation is to assess the acceptability and efficiency of an oral health education video game directed at these children and their families.

Methods/Design: A two-armed phase II randomized controlled trial will assess a children’s oral health education video game in comparison with verbal oral health education in terms of: family satisfaction, effect on oral health knowledge, and affect on dietary and oral hygiene habits. Up to 130 four- to ten-year-old children, referred for tooth extraction under general anaesthesia due to caries, will be recruited. A sample of 45 participants in each group will be needed to provide 80% statistical power. The primary outcome measures for this study are: (1) parent and child satisfaction with the intervention, as indicated using a visual analogue scale; (2) improvement in the child’s dietary knowledge measured by a pictorial dietary quiz; and (3) changes in the child’s diet and oral hygiene habits, measured using a children’s dietary questionnaire completed by the parent, and snacking and toothbrushing diaries completed by the child. Measures will be taken at baseline, directly after the intervention, and three months later.

Discussion: This study is a phase II randomized controlled trial of an oral health education video game for high caries risk children and their families. Few protocols such as this are available in this much-needed research area.

Keywords: Early childhood caries, Oral health education, Randomized controlled trial, Serious games

Background

Tooth decay is the most common childhood illness in the world [1]. Early childhood caries is commonly defined as the occurrence of any sign of dental caries on any tooth surface before the age of 6 years [2]. In England, 12% of children aged three [3], and 28% of children aged five, have dental caries [4]. The disease can gravely affect the quality of life of these children and their families [5]; furthermore, contracting the disease at an early age puts these children at greater risk of developing caries and sepsis in the future [6, 7]. For a significant proportion, the end result is dental extraction under general anaesthesia, which nowadays is the most common reason for hospital admission in children aged five to nine years in England [8]. Reported general anaesthesia repeat rates are fairly high (25%), despite rigorous examination and radical treatment [9]. Moreover, many of these children have siblings who have had similar treatment [10]. These findings

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suggest that there is failure in improving caries prevention in those children and their families postoperatively. Indeed, almost 80% of parents of these children requested more support in preventing dental caries in their children. Furthermore, 65% requested more help with caries prevention be included in subsequent hospital visits [10].

Previous studies suggested that these families display poor oral health knowledge as well as face difficulties in implementing healthy oral habits at home [11]. Given the suggested deficiency in oral health knowledge in these families, provision of oral health advice can be an important part of promoting oral health, and exploration of methods of advice delivery that are effective and acceptable to them is necessary. In a previous study, parents of children referred for extractions under general anaesthesia suggested that different methods for delivering oral health advice can be acceptable, including websites (64%), leaflets (63%), and DVDs (49%) [10]. In another study, similar findings were reported. 89% found leaflets and 67% found the internet acceptable methods for oral health advice delivery [12].

The use of video games is a less traditional method of oral health advice that should be considered and explored, as these games might have great potential. Evidence suggests that such games have several advantages over other methods of learning, including: multisensory support, problem-based learning, activation of prior knowledge, immediate feedback, and provision of a social environment involving communities of players [13]. Moreover, video gaming is widely practiced nowadays, especially by children. Almost 90% of American children and teens were reported to play such games on various platforms [14], with the average child aged eight to ten years spending an hour per day playing [15]. In the UK, more than 90% of six- to nine-year-old boys and girls are reported to play such games [16].

Health researchers have realised the potential games may have in delivering health advice. Previous research suggests that using such games to promote a healthy diet carries potential. For example, a study that used a game to promote intake of fruits and vegetables has reported that children had one more serving of fruit or vegetable per day after the intervention and that those with the lowest intake at the baseline benefited the most [17]. Another study assessed the effectiveness of a nutritional education computer package [18] in 8- to 11-year-olds in schools compared with traditional methods and supported that both methods increased the children's knowledge and that knowledge was retained three months later [19]. A review in 2008 that included 25 studies utilizing such games concluded that they can induce positive health-related outcomes [20]. A more recent review has suggested that among 38 studies and a total of 195 health outcomes, video games improved 69% of psychological therapy outcomes, 59% of physical therapy outcomes, 50% of physical activity outcomes, 42% of health education outcomes, 42% of pain distraction outcomes, and 37% of diet self-management outcomes [21]. The reviews also revealed that although these games show the potential to improve health outcomes, most studies are of poor quality and more rigorous randomized controlled trials are needed.

Evidence of the use of video games in oral health education in particular is scarce. A pilot study involving 26 four-year-old nursery children tested a prototype oral health education video game developed by one of the investigators (MTH) and an MSc computer science student [22]. The results suggested no difference in healthy food identification after using the video game, although the sample size was too small to reach significance. Teachers involved in the study viewed the game positively but recommended that it involve more interaction and additional material [23].

In 2008, two of the authors (CRT) and (MTH) developed a new prototype oral health education video game. The development process comprised of three steps first, collection of opinion from experts in the fields of paediatric dentistry, dental public health, nutrition and child education to inform the game's design. Second, designing the game using the aforementioned input and using Microsoft PowerPoint, and finally, assessment by six six-year-old children to test functionality, child engagement and navigation. The game was named 'Baner's healthy foods' and included an avatar to guide the child through it, as this has been suggested to improve the learning experience [24]. The game was also developed in line with the Scottish National Curriculum, as oral health education programmes that are well integrated into the National Curriculum have been suggested to lead to improvements in children's oral health knowledge [25]. The game was assessed in a phase-I randomized controlled trial (RCT) that included four- to seven-year-old children in two primary schools in Stornoway, Scotland. The results suggested that this method of oral health education delivery can be as effective as regular paper-based methods in improving children's recognition of healthy foods [26]. In light of those findings, the current study is a phase-II blind RCT that aims to assess an oral health education video game in comparison with verbal oral health education in terms of family satisfaction, effect on oral health knowledge, and effect on dietary and oral hygiene habits in high caries risk families.

Aims

Primary aim
The primary aims of this study are: (i) to assess the satisfaction of high caries risk children and their parents with
delivery of oral health education through an interactive video game, and (ii) to assess the game’s potential to improve the child’s oral health knowledge and dietary and oral hygiene practices.

**Secondary aim**
The secondary aim of this study is to establish proof of concept for the use of interactive video games in delivering oral health education for children.

**Research questions**
Would an oral health education video game be an acceptable method to deliver oral health promotion information to high caries risk children and their families? Can the use of such an intervention improve their oral health knowledge and would that improvement be reflected in their oral health practices at home?

**Null hypothesis**
The use of a video game to deliver oral health education to children is neither as acceptable nor as effective in improving the child’s oral health knowledge and practices as verbal education delivered by an extended dental nurse or trained health promoter.

**Methods**
**Modification of video-game prototype used in phase-I RCT**
In preparation for the phase-II RCT, a few modifications of the prototype video game used in the phase-I RCT were necessary. The aim was to update the game in light of the results of the phase-I RCT, newly available technology, dietary guidelines, and the population to be targeted in the phase-II RCT.

The research team updated the game content, including the addition of a segment that includes advice on the consumption of fruit juice and another that includes advice on fluoride, as previous findings by the authors have suggested that this cohort of children and their parents received little advice on these two issues [11]. In addition, the game’s graphics were updated, including the introduction of a new avatar (Fluffy the hamster). CrazyTalk7 was used to develop the new avatar, and a new voiceover was recorded and used. Fig. 1 is an example of these updates. Finally, the game’s software was updated to HTML5 (software automatically installed on every computer, Smartphone or tablet) and the game was installed on a tablet (iPad), because they are more popular amongst children [27], can make the gaming experience easier and more interesting [28], and allow for easier set-up in the research location.

Once these modifications were introduced, the researcher (AA) ran the game numerous times to ensure it ran smoothly without any technical difficulties. The game was then further tested by a user group within the pilot study.

**Pilot study**
The pilot study aimed to: (i) assess user group interaction with the updated video game and notice any technical difficulties, (ii) assess feasibility of the main study protocol; (iii) assess blinding and randomisation methods and (iv) familiarise all members of the research team with the standard operating procedure.

The pilot study followed the same design, recruitment criteria and methods as the planned phase-II RCT. However, the introduction of blinding and randomisation was gradual, so that the research team could be familiarised with the process. Data collection took place in May and June 2013.

Ten participants were recruited. Technical difficulties faced by the users during playing the video game were noted and corrected by the researcher (AA). In addition, the optimum physical setting for the study was determined and the team responsible for the day-to-day operations of the RCT (researcher (AA) and two trained dental nurses, both of whom had a health promotion qualification) became familiar with the recruitment, randomization and blinding processes.

**Phase-II randomized controlled trial protocol**

**Methods and design**
This study will be a two-armed blind RCT that will recruit children referred for dental extractions under general anaesthesia, as well as their parents. The participants will be randomized into two groups. In the study group, the child and escort will undergo self-directed ‘play’ about oral health using the video game on an iPad and receive a copy on a DVD to run it on a home personal computer. In the control group, the child and escort will receive verbal oral health advice from a dental nurse who has a health promotion qualification.

The participants will be recruited at the medical pre-assessment clinic at the day surgery unit at King’s College Hospital in London. All children scheduled for a procedure under general anaesthesia attend this clinic approximately two weeks prior to their surgery for a medical evaluation of fitness to undergo general anaesthesia.

**Ethical considerations**
Ethical approval was granted by the National Research Ethics Service Committee London, Dulwich (Reference number: 11/LO/0820), and by the Research and Development Department at King’s College Hospital (R&D Reference number: KCH12.013). Funding was provided through King’s College London PhD funds. Informed consent will be sought from each participating parent or guardian and assent will be sought from the children
themselves. Participants will be able to withdraw from the trial at any time and this will not affect access to their treatment at the hospital.

All information disclosed in the study will be kept confidential and participants will not be identifiable in any material published as part of the study in any way. All data are stored without any identifying details. At all stages of research, the data will be stored using a password-protected computer and a secure locked cabinet; and all correspondence between research team members will be conducted using secure email.

Participants
The target population will be children referred for extraction of decayed teeth under general anaesthesia. Families will be invited to take part in the study at their child’s attendance at the medical pre-assessment clinic prior to their general anaesthesia appointment.

The inclusion criteria are as follows: the child is four to ten years old, does not have any learning difficulties or medical conditions complicating oral health status and is scheduled for treatment of dental caries under general anaesthesia. A parent or guardian should provide consent and both parent and child should have English proficiency.

The exclusion criteria are as follows: the child is referred for treatment of other dental conditions under general anaesthesia, has learning difficulties or a medical condition affecting oral health, is accompanied by an adult that cannot give consent, or, has been participating in another study. Families where either the parent or guardian or the child do not have sufficient English proficiency to consent or understand the advice delivered will also be excluded.

Sample size
The primary outcome measure in this study is user satisfaction with the intervention, assessed using a visual analogue scale. This is constructed as a continuous 100 mm line, with a score at the 0 mm mark indicating complete dissatisfaction with the intervention and a score at the 100 mm indicating complete satisfaction. As far as we know, this is the first study measuring patient’s satisfaction with the use of video games for oral health education. Assuming that our population will have a standard deviation of 25 mm, which is similar to patient satisfaction measured in studies in other fields [29], and aiming to detect a difference of at least 15 mm between the groups to indicate its clinical significance, a sample of 45 participants in each group will be needed to provide 80% power, at the 5% significance level, to detect effects of size 0.6 and above. This number of participants is also sufficient based on our calculations using the results of the pictorial dietary quiz used in the phase-I RCT. Anticipating a 20% dropout rate [30], we intend to recruit approximately 108 participants.

Randomization and blinding
A computer-generated simple randomization grid will allocate the participants to the two groups. The randomization process will be overseen by the unblinded researcher (MTH). The allocation of participants will be performed by the two trained dental nurses responsible for applying the interventions to the participants. The researcher (AA) will remain blinded all through data collection and input. The statistician will also be blinded during the analysis. Only after data collection is complete will one researcher (MTH) break the randomization code to input the group allocation within the pre-existing data set and enable between-group analyses. The statistician and lead researcher (AA) will remain blinded.

Procedure for recruitment and application of intervention
Each week, the blind researcher (AA) will obtain a list of all children attending the medical pre-assessment clinic for general anaesthesia for dental purposes. Those who are younger than four or older than ten will be excluded.

Next, AA will go through the clinical notes of the remaining children to determine their eligibility to participate. At this stage, children who are having treatment for dental conditions other than caries, or with medical
conditions affecting dental health or learning difficulties, and those children participating in other studies can be identified and excluded. All children accompanied by parents or guardians that require an interpreter to provide consent for the general anaesthesia procedure will also be excluded. However, the total number of those children will be recorded. The research will also record the different languages of the non-English speakers. South London is a culturally and ethnically diverse area, and keeping records of the languages spoken by those children and their families will help assess the local area’s future need for versions of the video game in different languages.

On the day of the clinic, AA will approach all potential participants, invite them to take part, and explain the study to them. At this stage, children accompanied by adults who cannot provide consent for them (aunt or uncle, older sibling, etc.) and those who do not display enough English proficiency to take part will also be excluded. AA will aim to approach every potential participant matching the inclusion criteria; however, some potential participants will be missed, as they will arrive and leave their appointment while a participant is taking part in the study.

Parents who indicate their agreement to take part will be asked to provide written consent and their child will be asked for assent. AA will then administer these following baseline measures. A pictorial dietary quiz will be completed by the child. This is the same quiz used in the phase I pilot. (ii) A child’s dietary questionnaire will be completed by the parent. This is a validated measure used to report the dietary habits of children aged 4–16 years [31]. It includes four sections (covering intake of fruit and vegetables, dairy, sweet drinks, and non-core foods). Finally, details of the child’s most recent snack at school will be provided by the child.

After the baseline measures are completed, AA will introduce the participants to the dental nurse and leave, to ensure that he remains blinded to group allocation. The nurse will then allocate the participants to either the video-game group or the control group according to the randomization grid and will apply the intervention accordingly.

The nurse will administer postintervention measures to both groups including: (i) pictorial dietary quiz, completed by the child; (ii) child’s and parent’s satisfaction with intervention on a visual analogue scale; (iii) a booklet that contains a toothbrushing diary and a snack diary, to be returned on the day of the general anaesthesia procedure. The booklet given to children from the study group will also contain a page in which they can write five ‘secret words’ that have been inserted in the DVD version of the game. This will allow us to determine whether participants used the game DVD at home.

Children from the control group will have a simple colouring page instead. Finally, (iv) the nurse will ask the parent and child if they have any feedback on the intervention; this feedback will be written down verbatim (qualitative data).

AA will go to the day surgery unit on the day of the child’s general anaesthesia procedure to collect the booklet. He will also call the participating parents three months after their child’s general anaesthesia procedure and offer them a review appointment at the paediatric dentistry department. Upon attending, the parents of both groups will be asked to complete the children’s dietary questionnaire again, to measure any changes in dietary practices at home. The child will be asked to retake the pictorial dietary quiz to assess long-term retention of dietary knowledge. Attendance rates from both groups will be noted.

Fig. 2 is a summary of the recruitment process and the measures collected.

Outcome measures

Fig. 3 outlines the various measures completed in the phase-II RCT. The primary outcome measures are:

1. Parent and child satisfaction with the intervention, as indicated using the visual analogue scale.
2. Improvement in the child’s dietary knowledge measured by the change in pictorial dietary quiz score taken at baseline, postintervention, and after 3 months.
3. Change in child’s diet at home, measured by children’s dietary questionnaire taken at baseline and after 3 months.
4. Return of the child’s toothbrushing diary showing their level of engagement in toothbrushing, and return of snack diary showing reported healthy snack selection.

The secondary outcome measures are:

1. Parent and child verbal feedback on intervention in the form of qualitative data.
2. Completion of ‘secret words’ sheet by children in intervention group, indicating use of game DVD at home.
3. Attendance rates for review appointment after three months.

Statistical analysis

Descriptive statistics for all explanatory variables at baseline will be provided, overall and by study group. Analysis of variance and chi-square tests will be used to highlight any significant imbalance between groups. Student’s t test will be used to compare the two groups’ parent and child visual analogue scale scores.
indicating satisfaction with intervention. It will also be used to compare children’s dietary questionnaire, toothbrushing scores, and healthy snack selection scores. Since the children’s pictorial dietary quiz is the only measure taken at three points (baseline, directly after intervention, and three months later), its scores will be analyzed using linear multivariate regression.

Verbal feedback provided by parents and children on intervention will be written down verbatim and will be analyzed using simple content analysis.

**Discussion**

This is the first RCT designed to investigate the use of video games in providing oral health education focused on diet and oral hygiene to this cohort. This study will explore this novel intervention’s acceptability, effectiveness in increasing knowledge, and effectiveness in improving dietary and oral hygiene habits in the short term. This complies with the guidance of the UK Medical Research Council, which recommends that newly developed interventions are not only assessed for effectiveness but also acceptability, as this point is frequently overlooked [32]. Further studies will be necessary, to assess whether such an intervention can lead to sustained changes in dietary and oral hygiene habits and, eventually, positive clinical outcomes. As Nutbeam suggested, evaluating oral health promotion interventions includes four levels: health promotion action (e.g., education), health promotion outcomes (e.g., health literacy), intermediate health outcomes (e.g., health behaviour), and finally, health and social outcomes (e.g., plaque score) [33].

In our earlier research, parents of children with high caries risk displayed lack of knowledge on the prevention of dental caries [11]. Providing these families with
information is important, as knowledge is a vital component in working towards behaviour change, as indicated by social cognitive theory [34]. However, previous evidence suggests that oral health education alone is not enough to achieve clinically significant outcomes [35]. Promoting oral health in such families will require ‘upstream’ action that tackles the social and cultural determinants of the disease supplemented by ‘downstream’ action, focusing on oral health determinants. Nevertheless, delivering oral health advice remains an important part of oral health promotion [36]; the Ottawa charter for health promotion stressed the importance of helping individuals improve personal skills as part of health promotion, and this can be achieved through provision of information, health education and enhancement of life skills in an appropriate manner [37].

Providing oral health education directly to the child might be questioned, since it is assumed that parents are responsible for the families’ oral health practices. However, there is some evidence that children play a
role in shaping their oral health practices from a young age. Roberts et al. [38] suggested that children aged seven and older possess some control over their dietary selections in what is commonly known as ‘pester power’. It is important to note that Roberts et al. did not include children younger than 7, but other authors have suggested that children as young as 4 years old have a ‘pester’ or ‘tag’ power over their family’s food shopping [39]. Moreover, Birch and Fisher [40] suggested that even though young children have an innate preference for sugary foods, their dietary preferences are influenced by social and cultural norms, advertising and modelling. Providing children with oral health education through a potentially interesting method, such as video games, might provide them with a positive media influence. In addition, parents are indeed going to be part of the intervention in this study, as they will be required to guide the child through the game. Moreover, parents might learn indirectly, as some evidence suggests that children can transmit knowledge to their parents [41].

Selecting the measures used in this study has been difficult; considering the population targeted. This population is notoriously poor in attending dental clinics regularly [42, 43]. With that in mind, the phase-II RCT is designed to engage families in a positive way about oral health whilst simplifying data collection and reducing the time needed to complete the assessments. Despite this, we anticipate that following participants up at three months might be difficult; hence, we will offer telephone follow-up as an alternative.

The visual analogue scale is a low-burden measure that can be completed quickly and has been validated for use in measuring participants’ satisfaction [29, 30]. There is a risk that participants will feel inclined to give better scores for the nurse providing the control intervention. For this reason, qualitative data will also be collected. Nonetheless, it is recognised that parents might still give socially acceptable answers; thus, the interview approach is important, to ensure that participants feel comfortable in giving their responses.

Measuring the dietary knowledge of children is challenging. A comprehensive review of studies across different health fields reveals how diverse these measures are, with many being designed to measure specific aspects of nutrition knowledge [44]. There is a lack of nutrition knowledge questionnaires for children when oral health is in question. We have chosen to construct a pictorial quiz as this form of questionnaires was suggested as suitable for young children [44], is less likely to be affected by differences in literacy and was also piloted in the phase-I trial. A drawback might be that the quiz will only report recognition of unhealthy items and not knowledge of frequency. It might also be too easy for older children and too difficult for younger ones.

The children’s dietary questionnaire will record changes in dietary practices [31]. This is a 7-day recall dietary questionnaire that is validated and both easy to use and analyse. It contains items measuring consumption of sugary foods and drinks, fits our study design and participant age, and is recommended by the UK National Obesity Observatory [45]. However, it might have poor correlation for some items and has not been yet validated in the UK. Therefore, some of the food items have been altered to UK English to suit the population studied. Children’s snacking and toothbrushing practices will be measured using diaries. Diaries can keep the child involved but these self-reported measures might not be reliable and families might just record the ‘correct’ rather than the real answer [46]. We also anticipate that completion and return rates might not be ideal. Therefore, in this study, story books will be given as prizes to motivate the children, and text messages will be used as reminders for parents. Prepaid envelopes will be provided to those who do not bring the diary back in person, so that they can mail it.

We will not be able to approach all children attending for dental extraction of decayed teeth under general anaesthesia, as many might attend and leave the pre-assessment clinic while the researcher is in the process of applying the intervention to another child. However, the total numbers of those attending, approached and providing consent will be recorded, to reduce bias. Also, it is worth noting that the area served by King’s College Hospital is highly culturally diverse, with many immigrant families [47]. Families without sufficient English language skills will be excluded. These families’ usual languages will be recorded for future reference and can be considered in future versions of the video game.

**Trial status**

The phase-II trial commenced in October 2013 and the process of recruitment is still ongoing.

**Abbreviation**

RCT: Randomized controlled trial.

**Competing interests**

The authors declare that they have no competing interests.

**Authors’ contributions**

All authors contributed to the design of the study. CR and MFH developed the original video-game prototype. AA was responsible for video-game modifications and daily trial management and patient selection and recruitment, with MFH and JJS providing supervision. All authors contributed to writing and approval of the paper. All authors read and approved the final manuscript.

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RJ
Referring dentists’ views on preventive care for GA extraction children – qualitative investigation
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Objectives:
1) To explore the opinions of general-dental-practitioners (GDP) on improving preventive advice and oral health care for children undergoing dental treatment under general anaesthesia (GDA).
2) To inform further research and action.
Methods: Qualitative investigation, utilizing face-to-face semi-structured interviews. Sample consisted of GDPs in the Lewisham, Southwark and Lambeth areas referring children for GDA at King’s College Hospital, London, with different referral rates (High, medium and low), according to the hospitals’ 2011-2012 database. Descriptive statistics and framework analysis were used to present results.
Results: Fourteen GDPs (eight males and six females) were interviewed, their average age was 42.4 years (range 26-73), and had practiced in these areas a mean of 14.2 years (range 1-40). Participants reported that in many cases, children referred were first-time attendees; they noted that socio-economic barriers, and in some cases, communication difficulties (with immigrant families), limit the uptake of preventive advice. Many thought the current UDA payment system might be holding back preventive efforts for high caries risk children. Participants reported that they are familiar with the Department of Health’ toolkit for better oral health, however, some still don’t use fluoride varnish. Although participants were satisfied with the hospital’s post-GDA...
discharge letter, many noted that providing additional information: stressing prevention and importance of regular attendance to the child’s parent; might improve post-DGA attendance and preventive care.

**Conclusion:** GDPs suggested that providing families referred for DGA with oral health advice, together with initiatives to improve communication between hospital, GDPs and parents might improve post-operative prevention and follow up.
A phase II randomized controlled trial of an oral health education video game for high caries risk children.

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Introduction
Dental extractions under General Anaesthesia (GA) are the most common reason for hospital admission in children aged 5-9 in England [1]. A quarter had the treatment before. Many come from families where other siblings have [2,3]. There is consistent failure in promoting oral health in those families, and our previous research findings suggested that these families and referring dentists would like more oral health advice to be provided during the hospital GA referral [4,5].

Aims:
To compare an oral health education video game to verbal education in terms of family satisfaction and ability to improve dietary knowledge and habits.

Method:
A two-armed RCT involving 4 to 10 year-old children undergoing various teeth extractions under GA. Participants were assigned to a study group (oral health education video game) & a control group (verbal advice). The primary outcome measures were:
1. Parent and child satisfaction on a Visual Analogue Scale (VAS)
2. Improvement in child’s dietary knowledge measured by a pictorial quiz
3. Change in child’s diet and oral hygiene habits as reported by parent and child.

Measures were taken at baseline, post intervention, and three months later.

Results
109 children were recruited. Average age was 6.5 years and 56% were male. Groups were well matched in age, gender and ethnicity. Children and parents found both methods of education satisfactory, although parents seemed to slightly favour verbal delivery (P=0.003).

55% of parents completed phone follow-up after 3 months and reported changes in dietary practices, including less sweet drinks (P=0.019) and non-core foods consumption (P=0.046). Attendance for a three month follow-up visit was poor (11%).

Parent & Child satisfaction

Both groups showed significant improvement in recognition of healthy foods following the intervention (P<0.001).

Change in dietary knowledge

Change in dietary practices

Conclusions
Video games can be an acceptable and effective in improving oral health knowledge as verbal oral health education. However, further research on long-term retention of knowledge, impact on practices and ultimately clinical outcomes is needed. Application in high caries risk families should be part of a wider oral health promotion programme that supports and facilitates healthy behaviour.

References:

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