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DENTAL CARE UNDER GENERAL ANAESTHESIA IN PUBLIC ORAL HEALTH SERVICES: LONGITUDINAL PERSPECTIVES

Nora Savanheimo

ACADEMIC DISSERTATION

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To my family

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LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following original articles, which are hereafter referred to in the text by their Roman numerals. New hitherto unpublished results are also presented to compare the treatment process from 2001 to 2010 based on reanalyses of the data of 0–13-year-old groups of generally healthy children over the three sample years.

I Savanheimo N, Vehkalahti MM, Pihakari A and Numminen M. Reasons for and parental satisfaction with children's dental care under general anaesthesia.
International Journal of Paediatric Dentistry 15: 448-454; 2005.

II Savanheimo N and Vehkalahti MM. Preventive aspects in children's caries treatments preceding dental care under general anaesthesia.
International Journal of Paediatric Dentistry 18; 117-123; 2008.

III Savanheimo N, Sundberg SA, Virtanen JI and Vehkalahti MM. Dental care and treatments provided under general anaesthesia in the Helsinki Public Dental Service.
BMC Oral Health 12: 45; 2012. doi:10.1186/1472-6831-12-45.

IV Savanheimo N and Vehkalahti MM. Five-year follow-up of children receiving comprehensive dental care under general anesthesia.
BMC Oral Health 14: 154; 2014. doi:10.1186/1472-6831-14-154.

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ABBREVIATIONS

AAPD	American Academy of Pediatric Dentistry
ANOVA	One-way analysis of variance
ASA	American Society of Anesthesiologists
CI	Confidence interval
DGA	Dental general anaesthesia
GA	General anaesthesia
GH	Generally healthy
MC	Mentally, physically, and/or medically compromised
mths	Months
NA	Non-applicable
NICE	National Institute for Health and Care Excellence
OR	Odds ratio
p	P-value
PDS	Public Dental Service
PHE	Public Health England
r	Correlation coefficient
SD	Standard deviation
UK	United Kingdom
USA	United States of America
wk	Week
wks	Weeks
yr	Year
yrs	Years

ABSTRACT

Dental care under general anaesthesia in public oral health services: longitudinal perspectives
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This study aimed to evaluate the dental general anaesthesia (DGA) process in public oral health services. The specific aims were to describe the characteristics of the patients treated under DGA, assess the reasons for having DGA, describe the dental care that preceded DGA, describe the treatments performed under DGA, and evaluate the dental care subsequent to having DGA. Special considerations were given to generally healthy children and adolescents, because DGA could be avoided for some of them.

Three study groups of DGA patients treated by Helsinki Public Dental Service (PDS) comprised the present data. Study group 1 included all generally healthy patients aged 0–16 years that were treated under DGA in 2001 (n=102). Study group 2 included all generally healthy patients aged 0–13 years that were treated under DGA in 2004 (n=199), and the study group 3 included all patients including those that were not generally healthy treated under DGA in 2010 (n=349). The data were obtained from patient documents and from a questionnaire given to the parents of children who had received treatment under DGA in 2001. The three study groups were restricted to include only 0–13-year-old generally healthy patients to allow longitudinal comparisons to be made. Subgroups of 0–5 and 6–13-year-olds were also compared. The restricted study groups consisted of 100, 199, and 192 patients for 2001, 2004 and 2010 respectively.

Most but not all of the patients treated under DGA in the Helsinki PDS were generally healthy children in 2010. The majority (86%) of the adult DGA patients, however, were mentally, physically and/or medically compromised. A comparison of the 0–5-year-old generally healthy DGA children showed that the proportion of immigrants increased from 30% in 2004 to 51% in 2010. Parents reported in the questionnaire in 2001 that the first difficulties in the child's dental care were noticed when the child was younger than three years of age for 39% of that study group. Conscious sedation had been used for more than half of the patients when attempting to treat them before giving them DGA. Nearly one out of three (31%) of the patients in the 2001 study group had missed one or more appointments. Parents ranked 'dental fear' followed by pain as the most important reason for previous unsuccessful dental treatments for generally healthy children in 2001. The

most frequent reasons for the referrals in 2004 and 2010 for treatment under DGA were extreme uncooperation, extreme dental fear and need for extensive treatments. The reason of 'avoidance of dental fear' was introduced as a factor in 2010. Restorations, followed by tooth extractions, dominated the treatment-mix performed under DGA. The treatment need was extensive, and for immigrants even more extensive than for non-immigrants. The generally healthy 0–13-year-olds that were treated under DGA in 2004 were followed-up for a mean of 47.6 (13.7 SD) months. The first visit of the patients to their home dental clinic after having DGA generally occurred on a far later date than that recommended. The mean time elapsed to the first operative treatment need was 18.5 (14.1 SD) months. During the five-year follow-up, one out of six patients needed no operative treatment, after the treatment under DGA, and for one out of four patients the first treatment need occurred no earlier than two years after DGA. The first treatment need occurred within a year after DGA for 39% of the children and for half of these during the first six months. More than half (53%) of patients expressed dental fear and 54% were uncooperative during the follow-up. Familiarization in order to control dental fear was given to only 13% of the patients. Emergency treatment was given to 52% of the patients and 65% missed at least one appointment.

The dental care of the patients before DGA had been very difficult because of extreme uncooperation and dental fear, and those were the main reasons that led to the use of DGA. The difficulties in dental care had begun at an early age. Most of the patients could be treated under normal dental settings after DGA, but they still needed special attention due to their cooperation problems and dental fear. Familiarization to dental care in order to control dental fear was rare. Some children required new treatment as early as within six months of DGA, which calls for an evaluation of the treatment regimen performed under DGA. Missing appointments were common before and after DGA. Preventive treatments were underused during the whole DGA process.

DGA could probably be avoided for generally healthy children. However, this requires multiprofessional collaboration for earlier intervention for those children considered to be at high risk of caries. Special attention is needed with immigrant families to integrate them into the dental health care system in Finland. Success for the whole DGA process requires the reassurance, encouragement and motivation of children, and their parents, complemented by the commitment of children's home dental clinics to intensified preventive care. DGA is an essential part of the PDS care, even if there are some aspects of the DGA process that need more considerations and improvements. DGA should provide a chance for generally healthy children to get out of the vicious circle of unsuccessful dental care and to help the children return back to routine dental care.

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This work was initially carried out at the Department of Oral Public Health, Institute of Dentistry later to be known as the Department of Oral and Maxillofacial Diseases, Faculty of Medicine, University of Helsinki, and also at the Oral Health Care Department, City of Helsinki Health Department/Centre, which was later known as the Department of Social Services and Health Care. During the last two years this work has been carried out as part of the Doctoral Programme in Oral Sciences in the Doctoral School in Health Sciences.

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The grants for this work awarded by the Finnish Dental Society Apollonia, the Finnish Dental Association, Helsinki City Health Department/Centre, the Finnish Women Dentists' Association, Terveyskeskushammaslääkäriyhdistys and the Municipality of Suomussalmi are gratefully acknowledged. I warmly appreciate the cooperation of the parents of the children that were treated under DGA in 2001 for answering the questionnaire.

I am very lucky to have such many wonderful friends and a dear family that supported me over this time. The time spent on this work has been away from the precious time with you. Thank you all for your endless understanding, encouragement and patience.

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Espoo, March 2016



Nora Savanheimo

INTRODUCTION

Dental general anaesthesia (DGA) is one of the behaviour guidance modalities that are used in dental care. The American Academy of Pediatric Dentistry (AAPD) state that when the decision is made to use DGA to provide treatment for a patient, the dentist must take into consideration: alternative behavioural guidance modalities, dental needs of the patient, the effect on the quality of dental care, the patient's emotional development, and the patient's medical status (AAPD 2011).

Generally, the use of DGA has increased all over the world. Studies from United States of America (USA), Belgium, Australia, Sweden, New Zealand and Croatia have reported an increase in the number of the patients treated under DGA over time (Vermeulen et al. 1991, Thomson 1994, Jamieson and Roberts-Thomson 2006, Klingberg et al. 2006, Roberts et al. 2009, Kovacić et al. 2012). On the other hand, data from the National Health Services in England, Wales and Scotland suggest that there appears to be a decline in the use of DGA from 1960s to 2000s largely as a result of a reduction of its provision in general dental practice (Department of Health 2000, Pine and Macpherson 2002, Moles and Ashley 2009). The hospital admissions for children with dental caries have again increased in England, in the 2010s, which makes dental caries the most common reason for children aged between five and nine to be admitted to hospital (Faculty of Dental Surgery 2015).

There have been two treatment types of dental care given under DGA. The first is mostly tooth extractions, including even simple extractions. The second treatment is comprehensive indicating that all the necessary treatments are performed in a single appointment. Therefore the indications and the reasons for DGA vary between countries, cultures, and health care services. Even though DGA is a very efficient treatment modality, it has its risks, both regarding mortality and morbidity, which need to be considered before giving the DGA treatment.

DGA is often considered as a last resort by public oral health services in Finland. It has been offered mainly to children, adolescents, and adult patients with mentally, physically, or medically compromising conditions. The treatment approach has been comprehensive and conservative. No statistics are available for the whole country about the use of DGA in oral health services in either the public or the private sector.

Parents of young children and caregivers of disabled patients have reported a high degree of satisfaction after treatment under DGA (Podesta and Watt 1996, Acs et al. 2001, Sheller et al. 2003, Anderson et al. 2004, Escribano-Hernández et al. 2012, Almaz et al. 2014). It surely is a huge relief for the patient to have comprehensive dental care completed in a single appointment under DGA. One of the challenges that adequate dental care must meet is how to maintain the accomplished oral health after DGA.

The present study attempts to clarify and enumerate the reasons that lead to treatment under DGA, describe DGA dental care given to the patients, and evaluate long-term outcomes of DGA treatments in the Helsinki Public Dental Service (PDS). The special focus in this study was on generally healthy children between 0–13 years of age, because at least for some of them treatment under DGA can be avoided.

REVIEW OF THE LITERATURE

The American Society of Anesthesiologists (ASA) has defined general anaesthesia (GA) as 'a drug-induced loss of consciousness during which patients are not arousable, even by painful stimulation. The ability to independently maintain ventilatory function is often impaired. Patients often require assistance in maintaining a patent airway, and positive pressure ventilation may be required because of depressed spontaneous ventilation or drug-induced depression of neuromuscular function. Cardiovascular function may be impaired' (ASA 2014b).

The Ovid Medline database was used for the literature search of the articles published in English using the search subject headings 'Dentistry' and 'Anesthesia, General' separately and combined. The search was restricted to those published before August 2015. The articles regarding comprehensive DGA and which presented the reasons for DGA and/or described the treatments performed under DGA were selected based on their abstracts. Most of them were found by Ovid Medline literature search, but the older publications, which were not found in the first place because of a missing abstracts, were subsequently found by a manual search. The oldest article found in this scope was published in 1964. Most of the studies on comprehensive treatment under DGA have been performed in Europe (the majority of these were from the United Kingdom (UK)), this is followed by in North America, and then Asia. The articles are presented in order of their year of publication (Table 1).

Table 1. Studies on comprehensive dental treatment given under general anaesthesia: publication, country, time of data collection, number of patients, patient characteristics, such as age ('+' indicates that there were few patients older than the upper age limit mentioned), health conditions (generally healthy=GH, mentally, physically, and/or medically compromised=MC), main reasons for dental general anaesthesia (DGA), the most frequent treatments and if preventive treatments were performed under DGA. The terms and definitions used to describe age and the main reasons follow the descriptions in the original publications.

Author(s), yr	Country, time	n	Patient age, yrs	Health condition	Main reasons	The most frequent treatments	Preventive treatments performed
O'Sullivan & Breen, 1964	Ireland, NA	170	Children	NA	NA	Filling therapy, extractions, endodontics	No
Allen & Sim, 1967	USA, NA	NA	2–8	GH, MC	Rampant caries (includes psychologically inadequate), congenital defects, mental retardation	NA	NA

Table 1 continues on the next page

Author(s), yr	Country, time	n	Patient age, yrs	Health condition	Main reasons	The most frequent treatments	Preventive treatments performed
Rule et al., 1967	UK, 1959–1965	225	1–15	GH, MC	Maladjusted, mentally retarded	Filling therapy, extractions	No
Leagault et al., 1972	Canada, 4 yrs	300	1.5 – 14.7	GH, MC	Extensive treatment, management problem, one visit comprehensive treatment	Filling therapy, extractions, endodontics	Yes
Robertson & Ball, 1973	UK, 1970–1972	100	3–adult	GH, MC	NA	Filling therapy, extractions	Yes
Nazif, 1976	USA, 84 wks	80	1–16	GH, MC	Medical history	Filling therapy, extractions, endodontics	No
Smith et al., 1978	USA, 1972–1976	318	0–18	GH, MC	Normal but unmanageable, mentally retarded, physically handicapped	Filling therapy, extractions	Yes
O'Brien & Suthers, 1983	Australia, 12 yrs	1316	0–15+	GH, MC	Non-cooperation, very young children, large treatment need	Filling therapy, endodontics, extractions	Yes
Enger & Mourino, 1985	USA, 1977–1982	200	1–52	GH, MC	Rampant caries, management problem, medically compromised child	Filling therapy, extractions, endodontics	Yes
Mitchell & Murray, 1985	UK, 1979–1983	96	0–25+	GH, MC	Mental and physical handicap, anxious, mental handicap, physical handicap	Filling therapy, extractions	Yes
Roeters & Burgersdijk, 1985	Netherlands, 1968–1980	248	Children	MC	Mental retardation/ uncooperation, extensive treatment	Filling therapy, extractions	Yes
Grytten et al., 1989	Norway, 1975–1983	1067	0–74	GH, MC	Dental anxiety, medical reason	Filling therapy, extractions, endodontics	Yes
Boulanger, 1990	Belgium, NA	46	1–14	GH, MC	Non-cooperative healthy children, unmanageable handicapped	NA	NA
Roberts 1990	UK, 1988–1989	508	1–16+	GH, MC	NA	Filling therapy, extractions	No
Tarján et al., 1990	Hungary, NA	180	2–16	GH, MC	Mental retardation, dental fear	Filling therapy, extractions, endodontics	No

Table 1 continues on the next page

Author(s), yr	Country, time	n	Patient age, yrs	Health condition	Main reasons	The most frequent treatments	Preventive treatments performed
Holt et al., 1991	UK, 1989 January - May	103	0–10+	GH, MC	Surgical treatment, extensive treatment, management problems, child's young age making management difficult	Extractions, filling therapy	No
O'Sullivan & Curzon, 1991	UK, 1984–1987	80	2–11	GH, MC	Behaviour problems/caries	Filling therapy, extractions, endodontics	Yes
Vermeulen et al., 1991	Belgium, 1983–1988	933	1–79	GH, MC	Rampant caries, fear, handicap, infection, medical problem	NA	NA
Bohaty & Spencer, 1992	USA, 1978–1980, 1988–1990	NA	0–12	GH, MC	Extensive dental decay, management problems, medically and/or physically compromised	Filling therapy, endodontics, extractions	Yes
Thomson 1994	New Zealand, 1989–1994	406	1–17	NA	Dental caries	Extractions, filling therapy, endodontics	Yes
Sheehy et al., 1994	USA, NA	44	Mean 4.5 yrs	GH, MC	Nursing caries, extensive treatment/management problems, medically compromised	NA	NA
Nunn et al., 1995	UK, 1983–1993	265	0–26+	GH, MC	Intellectually impaired (+ autism), multiple handicap, dental phobia	Filling therapy, extractions, endodontics	Yes
Pohl et al., 1996	Germany, 1992–1995	320	0–60	GH, MC	Mentally handicapped, epilepsy, psychosis, unknown cause for handicap, perinatal hypoxia	Extractions, filling therapy	Yes

Table 1 continues on the next page

Author(s), yr	Country, time	n	Patient age, yrs	Health condition	Main reasons	The most frequent treatments	Preventive treatments performed
Wong et al., 1997	UK, 1985–1995	586	≤ 17	GH, MC	Behavioural problems, medical complications or combination of mental/physical disabilities/medical complications, solely physical disabilites, solely mental disabilites	Filling therapy, extractions, endodontics	Yes
Ananthanarayan et al., 1998	Canada, 1992–1994	139	13–58	MC	Uncooperation	Filling therapy, extractions	Yes
Harrison & Roberts, 1998	UK, 1991–1996	1000	1–24	GH, MC	Inability or unwillingness to undergo treatment under local anaesthesia only, or combined with inhalation sedation	Extractions, filling therapy, endodontics	Yes
Alcaino et al., 2000	Australia, 1996	189 in 1984; 777 in 1996	< 16	GH, MC	1984: caries, dental anomaly; 1996: caries	NA	NA
Ibricevic et al., 2001	Kuwait, 1997–2000	96	3–31	GH, MC	NA	Filling therapy, endodontics, extractions	Yes
Jamjoom et al., 2001	Saudi Arabia, 1995–1997	555	2–22	GH, MC	Rampant caries, unable to accept treatment using local anaesthesia	Filling therapy, extractions, endodontics	No
Vinckier et al., 2001	Belgium, NA	98	2–6	GH	Rampant caries in a young, uncooperative child, rampant caries with a high level of anxiety	Filling therapy, extractions, endodontics	Yes
Davidson et al., 2002	New Zealand, 1997–1999	292	<6	NA	NA	Filling therapy, endodontics, extractions	Yes
Tate et al., 2002	USA, 1990–1992, 1994–1998	241	1–23	NA	NA	Filling therapy, extractions, endodontics	No
Al-Eheideb and Herman, 2003	USA, 1993–1995	54	Mean 4.5 yrs	GH, MC	Caries (Poor behavior/inability to cooperate, developmental problems	Filling therapy, endodontics	Yes

Table 1 continues on the next page

Author(s), yr	Country, time	n	Patient age, yrs	Health condition	Main reasons	The most frequent treatments	Preventive treatments performed
Limeres Posse et al., 2003	Spain, 1997–2001	234	4–57	MC	Physical and/or behavioural alterations of the patients	Extractions, filling therapy, endodontics	Yes
Sheller et al., 2003	USA, 1990–2000	23	1–6	GH, MC	NA	Filling therapy, extractions	No
Anderson et al., 2004	New Zealand, 8 mths	95	2–8	GH	Severe caries	Filling therapy, extractions, endodontics	Yes
Camilleri et al., 2004	UK, 1996–2000	945	1–16	GH, MC	Inability to accept treatment under local anaesthesia only, or combined with inhalation sedation	Extractions, filling therapy	Yes
Drummond et al., 2004	New Zealand, 1997–1999	292	1–5	GH, MC	NA	Filling therapy, endodontics, extractions	Yes
Del Machuca Portillo et al., 2005	Spain, 1997–1999	57	2–35	GH, MC	NA	Filling therapy, extractions, endodontics	Yes
Al-Malik & Al-Sarheed, 2006	Saudi Arabia, 1999–2001	182	2–16	GH, MC	Behavior management problems and unable to be treated under local anesthesia, extensive caries and young child, medically compromised	Filling therapy, extractions, endodontics	Yes
Kwok-Tung & King, 2006	China, 1982–1999	656	0–9+	GH, MC	Behavioral management problems	Filling therapy, extractions, endodontics	No
Tsai et al., 2006	Taiwan, 2002	184	2–15	GH, MC	Inability to accept treatment under local anaesthesia	Filling therapy, endodontics, extractions	No
Barberia et al., 2007	Spain, 1994–2003	47	2–12	GH, MC	NA	Filling therapy, extractions, endodontics	No
de Nova Garcia et al., 2007	Spain, 2005	30	6–16	MC	Extensive treatment need, bad behaviour	Filling therapy, extractions, endodontics	Yes

Table 1 continues on the next page

Author(s), yr	Country, time	n	Patient age, yrs	Health condition	Main reasons	The most frequent treatments	Preventive treatments performed
Schroth and Smith, 2007	Canada, 1996–2005	339	1–11	NA	NA	Filling therapy, endodontics, extractions	Yes
Ba'akdah et al., 2008	Saudi Arabia, NA	90	1–13	GH, MC	Very young with extensive caries, behaviour problems/medical problems	Filling therapy, extractions, endodontics	Yes
Needleman et al., 2008	USA, NA	90	2–10	GH	young age, uncooperative behaviour, significant dental caries, and/or psychological problems	Filling therapy, extractions, endodontics	No
Silvo et al., 2008	Finland, 2002–2004	150	2–6	GH	Young age, behavioural management problems	Filling therapy, extractions, endodontics	Yes
Cortiñas-Saenz et al., 2009	Spain, 2006–2007	112	2–64	GH, MC	NA	Filling therapy, extractions, endodontics	Yes
Lee et al., 2009	Taiwan, 2004–2005	297	1–17	GH, MC	NA	Filling therapy, endodontics, extractions	Yes
Roberts et al., 2009	USA, 1990–2008	3298	Children	GH, MC	Well child/acute situational anxiety	NA	NA
Amin et al., 2010	Canada, 2005–2007	269	≤6	GH	Extensive dental decay, behaviour management problems	Filling therapy, endodontics, extractions	No
Johnson et al., 2010	USA, 2002–2006	240	<6	GH	NA	Filling therapy, endodontics, extractions	Yes
Stanková et al., 2011	Czech Republic, 2006–2008	1836	2–18	GH, MC	Patients with multiple caries	Extractions, filling therapy	No
Kovacić et al., 2012	Croatia, 1985–2009	1054	5–54	MC	NA	Filling therapy, extractions, endodontics	No
Peretz et al., 2012	Israel, 2007–2009	121	2–20	MC	NA	Filling therapy, extractions, endodontics	Yes
Jankauskienė et al., 2013	Lithuania, 2010–2012	144	2<6	GH	Need for excessive treatment, dental fear and uncooperativeness, immature	Filling therapy, extractions, endodontics	Yes

Table 1 continues on the next page

Author(s), yr	Country, time	n	Patient age, yrs	Health condition	Main reasons	The most frequent treatments	Preventive treatments performed
Kolisa et al., 2013	South Africa, 2009–2010	78	1–12	GH, MC	NA	Filling therapy, extractions, endodontics	No
Almaz et al., 2014	Turkey, NA	120	<7	GH	Uncooperation, very young	Filling therapy, extractions, endodontics	Yes
Baghdadi, 2014	Saudi Arabia, NA	67	3–10	GH	Acute situational anxiety, uncooperative behavior, psychologically threatening invasive procedures	Filling therapy, endodontics, extractions	Yes
El Batawi et al., 2014	Saudi Arabia, 2011	431	2–10	GH, MC	Lack of cooperation and/or the amount of dental work required	Endodontics, filling therapy, extractions	No
Escanilla-Casal et al., 2014	Spain, 2010–2011	86	2–19	GH, MC	Cerebral palsy, extensive oral health problems with difficult behaviour management	Extractions, filling therapy, endodontics	Yes
Chen et al., 2014	Taiwan, 2001–2010	96	2–14	MC	NA	Filling therapy, endodontics, extractions	No
Sari et al., 2014	Turkey, 2007–2011	234	4–18	GH, MC	NA	Filling therapy, extractions	Yes
Tahmassebi et al., 2014	UK, 1997	263	1–16	GH, MC	Highly anxious, but otherwise healthy with inability or unwillingness to undergo treatment under local anaesthesia only or combined with sedation, very young with extensive caries, chronically sick with physical and/or learning difficulties, significant comorbidity	Filling therapy, extractions	No
Taskinen et al., 2014	Finland, 2010–2011	66	3–68	GH	Dental fear, need for extensive dental care	NA	NA

Table 1 continues on the next page

Author(s), yr	Country, time	n	Patient age, yrs	Health condition	Main reasons	The most frequent treatments	Preventive treatments performed
Amin et al., 2015	Canada, 2005–2008	278	≤6	GH, MC	NA	Filling therapy, endodontics, extractions	No
Lehtonen et al., 2015	Finland, 1997–2013	32	Preschool-age children	MC	NA	Filling therapy, extractions, endodontics	Yes

Characteristics of the patients treated under DGA

The majority of the earlier studies on comprehensive DGA has concentrated on children as seen in Table 1. The patients' health conditions described in the studies that are listed mostly consider either both generally healthy and mentally, physically and/or medically compromised patients or solely the latter. Of the studies in Table 1, only nine focus on generally healthy children treated under DGA, and all of these investigations were published after 2000.

Reasons for DGA

The most common reasons reported for comprehensive treatment under DGA have been the following: uncooperation, mentally compromising conditions, physically compromising conditions, and medically compromising conditions, the need for extensive treatment, dental fear and caries (Table 1). There is a great variety, in how the reasons are described, especially within compromising conditions. Some studies report mentally, physically and/or medically compromising conditions as background factors, whereas others consider them as criteria for DGA.

Indications for DGA

The reasons for DGA are linked with the indications for this measure. Several instances have published indications for DGA over years. Perhaps the best known in dental paediatrics is the Guideline on behaviour guidance for the pediatric dental patient by the AAPD, first published in 1990. This guideline has been revised and updated several times, the latest version was published in 2011 (AAPD 2011). In addition to other behaviour guidance techniques (Table 2), the guideline includes objectives and indications for the use of DGA (Table 3).

Table 2. Behaviour guidance techniques according to the American Academy of Pediatric Dentistry (AAPD 2011).

Basic behaviour guidance

- Communication and communicative guidance
- Tell-show-do
- Voice control
- Nonverbal communication
- Positive reinforcement
- Distraction
- Parental presence/absence
- Nitrous oxide/oxygen inhalation

Advanced behaviour guidance:

- Protective stabilization
- Sedation
- General anaesthesia

Table 3. Considerations, objectives, indications, and contraindications for dental general anaesthesia according to the American Academy of Pediatric Dentistry (AAPD 2011).

The decision to use general anesthesia must take into consideration:

- alternative behavioral guidance modalities;
- dental needs of the patient;
- the effect on the quality of dental care;
- the patient's emotional development;
- the patient's medical status.

Objectives: The goals of general anesthesia are to:

- provide safe, efficient, and effective dental care;
- eliminate anxiety;
- reduce untoward movement and reaction to dental treatment;
- aid in treatment of the mentally, physically, or medically compromised patient;
- eliminate the patient's pain response.

Indications: General anesthesia is indicated for:

- patients who cannot cooperate due to a lack of psychological or emotional maturity and/or mental, physical, or medical disability;
- patients for whom local anesthesia is ineffective because of acute infection, anatomic variations, or allergy;
- the extremely uncooperative, fearful, anxious, or uncommunicative child or adolescent;
- patients requiring significant surgical procedures;
- patiens for whom the use of general anesthesia may protect the developing psyche and/or reduce medical risk;
- patients requiring immediate, comprehensive oral/dental care.

Contraindications: The use of general anesthesia is contraindicated for:

- a healthy, cooperative patient with minimal dental needs;
- a predisposing medical conditions which would make general anesthesia inadvisable.

The most recent indications for the use of GA in paediatric dentistry in the UK were published by Royal College of Surgeon's in 2008. The guideline gives two indications for the use of DGA in children, which are not absolute and require a degree of judgement on the part of the dental surgeon: 'the child needs to be fully anaesthesised before dental treatment procedures can be attempted', and 'the surgeon needs the child fully anaesthesised before dental treatment can be performed' [sic] (Davies et al. 2008). Table 4 describes the general considerations, circumstances and conditions suitable for GA and those circumstances and conditions, which rarely justify GA according to the Royal College of Surgeon's guideline. The AAPD and the UK indications for DGA in children differ from each other, the latter being more detailed than the former.

Table 4. General considerations, circumstances and conditions suitable for general anaesthesia (GA) and those which rarely justify GA in the UK according to the Royal College of Surgeon's guideline for the use of GA in paediatric dentistry (Davies et al. 2008).

General considerations:

- The co-operative ability of the child.
- The perceived anxiety and how the child has responded to similar procedures.
- The degree of surgical trauma anticipated.
- The complexity of the operative procedure.
- The medical status of the child.

Circumstances and conditions suitable for GA:

- Severe pulpitis requiring immediate relief.
- Acute soft tissue swelling requiring removal of the infected tooth/teeth.
- Surgical drainage of an acute infected swelling.
- Single or multiple extractions in a young child unsuitable for conscious sedation.
- Symptomatic teeth in more than one quadrant.
- Moderately traumatic or complex extractions e.g. ankylosed or infra-occluded primary molars, extraction of broken-down permanent molars.
- Teeth requiring surgical removal or exposure.
- Biopsy of a hard or soft tissue lesion.
- Debridement and suturing of orofacial wounds.
- Established allergy to local anaesthesia.
- Post operative haemorrahage requiring packing and suturing.
- Examination under GA, including radiographs, for a special needs child where clinical evidence exists that there is a dental problem which warrants treatment under GA.

Circumstances and conditions which rarely justify GA:

- Carious, asymptomatic teeth with no clinical or radiographic signs of sepsis.
- Orthodontic extraction of sound permanent premolar teeth in a healthy child.
- Patient/carer preference, except where other techniques have already been tried.

Extenuating circumstances that override the above limitations are:

- Physical, emotional, learning impairment or a combination of two or more of these.
- Children who have attempted treatment using LA alone or LA combined with conscious sedation and been unable to co-operate.
- Medical problems which are better controlled with the use of GA.

No specific indications for adult patients were found in the literature search. The articles on adult patients focus on mentally, physically and/or medically compromising conditions, and for some of these patients, DGA may be the only option for delivering treatment available. DGA is a treatment option and is therefore usually a matter of personal choice for generally healthy adults in Finland. All patients pay out-of-pocket for such service in the private sector. The published guidelines regarding adult patients focus mostly on the use of DGA and appropriate treatment planning (Ghezzi et al. 2000, Wong 2009, American Association of Oral and Maxillofacial Surgeons 2012, American Dental Association 2012, Stronczek 2013).

Safety of DGA

The indications for DGA in the UK are not as strict as in many other countries. Earlier, the ability to administer DGA was part of undergraduate education and training, but in the 1980s this was judged to be insufficient to achieve the necessary competence (Poswillo 1990). Moreover, there were several deaths associated with DGA from 1970s to 1990s, when performing simple treatments on healthy children (Poswillo 1990, Department of Health 2000, Cantlay et al. 2005).

Many recommendations have been published in order to achieve the safer provision of DGA, the most widely known being the 'Poswillo Report' published by the Department of Health in 1990. Four of the several principal recommendations of the report were 'the use of GA should be avoided wherever possible', 'the same general standards in respect of personnel, premises and equipment must apply irrespective of where the general anaesthetic is administered', 'all anaesthetics should be administered by accredited anaesthetists who must recognise their responsibility for providing dental anaesthetic services' and 'sedation be used in preference to GA wherever possible' (Poswillo 1990).

Several further guidelines followed this report and after a recommendation in the report entitled 'A Conscious Decision', was published in 2000, thus DGA services have only been allowed in a hospital setting since 2002 (Department of Health 2000, Cantlay et al. 2005). According that report the overall provision of DGA has declined from the 1960s and since the 1990s the use of conscious sedation has increased.

DGA in the USA and Canada can be provided on the premises of the dental practice by trained dental anaesthesiologists. Dentists must complete at least 24 months of formal residency training in anaesthesiology, and meet specific re-certification criteria every 6 years in order to have certification in dental anaesthesiology, (The American Dental Board of Anesthesiology, 2015). DGA in Finland is administered in both dental surgeries and in hospitals with strict indications, and it has always been provided by specialized anaesthesiologists in both settings.

Even though anaesthesia-related mortality is rare in dentistry nowadays (Deegan 2001, Perrott et al. 2003, D'Eramo et al. 2008), morbidity after having treatment under DGA occurs. The most common symptoms in otherwise healthy children reported by their parents are agitation, irregularities in sleeping, nausea or vomiting, diarrhoea, bleeding, pain, sore throat and fever (Needleman et al. 2008, Mayeda and Wilson 2009). Whether exposure to general anaesthetics during a critical period of neuronal development is associated with neurocognitive and behavioural deficits later in life is a topic that is currently under intensive scientific investigation (Sinner et al. 2014).

Dental care preceding DGA

There is little information about dental care before DGA. A structured interview study in the UK was performed among mothers of 150 children, who were referred to have multiple teeth extractions under DGA (Hunter et al. 1997). The mothers reported that for nearly 40% of the children the child's teeth had already been decayed by the time of the first visit to a dentist at a mean age of 2.5 years. Further, only one third of the mothers reported that their children had had previous restorative care. A Finnish study reported that children had experienced between one and 11 unsuccessful dental visits over a period of one year prior to undergoing treatment under DGA, and conscious sedation had been used for 21% of them in order to facilitate the dental treatment (Silvo et al. 2008).

Treatments under DGA

Treatment approaches in DGA

Although it is a gross simplification, there are two ways of performing the DGA treatments. First is the comprehensive approach in which the patient receives all the necessary dental treatments under GA including restorations, tooth extractions, endodontics and preventive measures. Comprehensive DGA has been provided only as a last resort in many countries. The second approach consists of mostly tooth extractions. The policies vary from country to country and are dependent on treatment needs, health care services provided for the residents, and the resources that are available, access to those resources and cultural differences.

Comprehensive treatment under DGA

The majority of the studies on the topic of comprehensive DGA indicate that the most frequent treatments are fillings (Table 1). Eight studies report that extractions were the most frequent treatments performed, and of those three studies were from the UK. Preventive treatments (prophylaxis, fissure sealants, professional tooth cleaning, and/or topical application of fluoride) seemed to be rather common at the DGA visit.

Treatments under DGA in relation to the patient's health condition

In the studies reviewed treatments under DGA were compared between mentally, physically and/or medically compromised and generally healthy patients. The treatments performed on the mentally, physically and/or medically compromised patients include more teeth extractions and/or fewer conservative treatments (Harrison and Roberts 1998, Ibricevic et al. 2001, Tsai et al. 2006, Lee et al. 2009, Loyola-Rodrigues et al. 2009, Escanilla-Casal et al. 2014, Tahmassebi et al. 2014, Sari et al. 2014). However, a minority of studies reported more extractions for generally healthy patients compared to mentally, physically and/or medically compromised patients and these studies were conducted in the UK and Saudi Arabia (Camilleri et al. 2004, Al-Malik and Al-Sarheed 2006). The reasons for more aggressive treatment policy for mentally, physically and/or medically compromised patients may have lain in the fear of the patient incurring future infections combined with the anticipation of possible uncooperation that would disallow any dental treatment without DGA for such patients.

Treatments under DGA in relation to the patient's background

Several other personal background factors can influence the extent of the DGA treatments. Living in areas with a higher socioeconomic status and water fluoridation of the water supply seemed to diminish the need for treatment under DGA (Jankauskienė et al. 2013, Kamel et al. 2013). Another factor, which may influence the need for treatment under DGA is an immigrant background. In Denmark, patients with non-Danish origins had more teeth treated under DGA than those of a Danish origin (Haubek et al. 2006).

Tooth extractions under DGA

DGA in the UK has been used mainly for extractions. The treatment policy is either to extract all the carious teeth under DGA whether restorable or not, or to perform the restorations in normal dental settings (Kakaounaki et al. 2011, Bhujel et al. 2014).

Extractions performed under DGA could have been completed using inhalation sedation and/or local anaesthesia in many of the cases (Crawford 1990, Shaw et al. 1996, Blain and Hill 1998). A pre-operative assessment has been reported to reduce the number of patients having DGA for tooth extractions in the UK (Landes and Clayton-Smith 1996, Grant et al. 1998, Tyrer 1999). This was also shown in a study from Spain (Limeres Posse et al. 2003).

Some underlying reasons for frequent extractions under DGA have been suggested. These include socioeconomically deprived and/or indigent background leading to belated attendance, and vast distances to travel to the nearest dental care (Jamieson and Roberts-Thomson 2006, Moles and Ashley 2009, Peerbhay and Barrie 2012).

On the other hand, some public sector clinics in the UK, have provided a comprehensive DGA service since 1970 (Robertson and Ball 1973, O'Sullivan and Curzon 1991, Wong et al. 1997). The recent UK recommendation was given in the Royal College of Surgeon's

guideline for the use of GA in paediatric dentistry, which was published in 2008. The guideline calls for comprehensive planning to ensure that all the treatments required are carried out under a single GA (Davies et al. 2008).

The comprehensive treatment approach is slowly gaining place in other countries too. In China and Croatia, where treatments under DGA have mostly been for tooth extractions, the content of treatments performed under DGA is also changing to a more comprehensive approach (Kwok-Tung and King 2006, Kovacić et al. 2012).

Dental care after DGA

The nine earlier follow-up studies that investigated generally healthy children's dental care after they were treated under comprehensive DGA are presented in Table 5.

Most of these studies emanate from the USA, and these have focused on children up to 7 years of age. The follow-up periods varied from six months to three years. The postoperative review visit has been ruled to be within two weeks except for one study that was carried out in Finland, and the most common interval instructed for recall visits was six months. The attendance varied widely for both postoperative review visits (17–100%) and for recalls (5–100%). Generally, the attendance of recalls after DGA seemed to be very prolonged, as those studies that reported the 100% attendance had reached the children only once within two years. Caries relapse was reported to be high, and was as much as 79% in one of the studies. The repeat DGA was reported by three of the studies, the attendance of which ranged from 0–20%.

A study from the USA investigated reasons for repeat treatment and DGA for generally healthy children who were under 6 years at the time of their first DGA (Sheller et al. 2003). Those authors broadly divided the reasons into patient and parent factors and gave recommendations for improving the DGA process (Table 6). The strategy of aggressive treatment of caries aimed at improving success entailed more tooth extractions in favour of conservative care. This strategy is expected to be more efficient as it needs less theatre time, and reduces the probability of acute infections after tooth amputations and fractures of fillings. However, early loss of primary teeth may lead to problems in the eruption of secondary teeth and lead to subsequent orthodontic treatments (Proffit et al. 2007, Bhujel et al. 2014). It is, therefore, not surprising that this strategy has raised contradicting opinions.

Table 5. Follow-up studies on the generally healthy children's dental care after comprehensive dental general anaesthesia (DGA) and the follow-up factors presented in those studies: children's age, follow-up period, postoperative and recall visit (instructed time for them and attendance of the children), the proportion of children with caries relapse and repeat DGA.

Author (s), yr	Country, DGA yr, sector	n	Patient age	Follow-up period	Postoperative review visit, % of the children	Recall visit(s)	Caries relapse, % of the children	Repeat DGA
Berkowitz et al., 1997	USA, NA, public	84	1–5 yrs	6 mths	Not scheduled	4–6 mths, 29% (24/84)	54% (13/24)	NA
Almeida et al., 2000	USA, NA, public	42	1–4 yrs	2 yrs	1 wk, 100%	every 6–9 mths over 2-yrs, 19/42 did not return by the end of one yr, all returned in 2 yrs	79% (33/42), mean time 17.7 mths	17%
Eidelman et al., 2000	Israel, 1995–1997	34	Mean 34.4 mths	2 yrs	1 wk, NA	every 6 mths; all returned within 2 yrs (after telephone conversation)	57% (19/34)	NA
Worthen & Mueller, 2000	USA, 1994–1995, public	244	1–12 yrs	6 mths	10–14 days, 48%	3–6 mths, 15%	NA	20%
Chase et al., 2004	USA, NA, public	79	2–7 yrs	6 mths	Not scheduled	6 mths, 72% (57/79)	37% (21/57)	NA
Foster et al., 2006	USA, 2000	448	1–5 yrs	2 yrs	2 wks, 17% (76/448)	every 6 mths, 43% (193/448)	53%, (103/193)	NA
Jamieson & Vargas, 2007	USA, 1998–2002, public	217	2–7 yrs	3 yrs	2 wks, 54%	every 6 mths, 13% first recall; 3 years, 5%	26%	0 %
Silvo et al. 2008	Finland, 2002–2004, public	150	2–6 yrs	1 yr	3 mths, 58%	NA	50% caries relapse, fracture of the filling, or toothache (26/52 visiting PDS during follow-up)	1%
Amin et al., 2010	Canada, 2005–2007, private	269	≤ 6 yrs	2 yrs	7–14 days, 90%	in 1–12 mths 62% (166/269), in 13–24 mths, 13% (36/269)	24% (40/166) in 12 mths, 53% (19/36) in 13–24 mths	NA

Table 6. Patient and parent factors for repeat dental general anaesthesia (DGA) and recurrent caries, and recommendations for improved success according to Sheller et al. 2003.

Patient factors associated with the repeat DGA were:

a. 100% involvement of maxillary central incisors at time of initial DGA;
b. continued use of the bottle at the time of the DGA;
c. poor cooperation in the medical/dental setting;
d. difficult personality as described by parent.

Parent factors associated with recurrent caries were:

a. adult not brushing the child's teeth;
b. dysfunctional social situation;
c. failure to return for postoperative dental appointment after initial treatment.

Strategies for improved success with high-caries risk patients include:

a. aggressive treatment of caries;
b. active postoperative follow-up and education of caregivers.

The DGA process in the PDS

There appears to be little information of various aspects of DGA process in PDS. This is specially for generally healthy children and adolescents for whom more information is needed because at least for some of them, DGA could be avoided. Generally, the outcome and process assessment in health care entails that 'evaluation procedures that focus on both the outcome or status (outcomes assessment) of the patient at the end of an episode of care - presence of symptoms, level of activity, and mortality; and the process (assessment, process) - what is done for the patient diagnostically and therapeutically' (U.S. National Library of Medicine). The DGA process can be divided to three stages, namely: before, during and after DGA. These various steps need to be evaluated separately in order to evaluate and improve the process. Approaches to evaluating the outcome of the DGA process are presented in Table 5. Other approaches are how the restorations performed under DGA have survived afterwards (O'Sullivan and Curzon 1991, Eidelman et al. 2000, Ng et al. 2001, Tate et al. 2002, Al-Eheideb and Herman 2003, Drummond et al. 2004, Barberia et al. 2007, Schüler et al. 2014), and what is the compliance to dietary and/or self-care recommendations after DGA (Sheehy et al. 1994, Peretz et al. 2000, Primosch et al. 2001, Amin and Harrison 2006, Peerbhay 2009). Further, studies on changes in the levels of the mutans streptococci and lactobacilli (Twetman et al. 1999, Primosch et al. 2001, Chase et al. 2004, Litsas 2010) in addition to several studies on oral health-related quality of life regarding DGA, have been published (Jabarifar et al. 2009, Jankauskienė and Narbutaite 2010, Thomson and Malden 2011, Gaynor and Thomson 2012, Almaz et al. 2014, Cantekin et al. 2014, Jankauskienė et al. 2014, Ridell et al. 2015). However, the literature search found no available research on what kind of visits the generally healthy children had after having DGA, and how they manage themselves at those subsequent visits.

AIMS OF THE STUDY

The general aims of this research were to assess the reasons that led to DGA, describe DGA patients dental care, and evaluate the long-term outcome of DGA in the Helsinki PDS. Parallel comparisons from 2001 to 2010 are presented on DGA for 0–13-year-old generally healthy children.

The specific aims were:

1. to describe the characteristics of the patients treated under DGA (I, III, IV);
2. to assess the reasons for eventually having DGA (I, III, IV);
3. to describe the dental care that preceded DGA (I, II);
4. to describe the treatments performed under DGA (II, III, IV);
5. to evaluate the dental care after DGA (IV).

The working hypotheses were as follows:

1. dental fear is the main reason for having treatment under DGA;
2. the dental care that preceded DGA has mostly consisted of operative treatments;
3. patients receive intensified preventive care after DGA;
4. after DGA, most of the patients can be treated in normal dental settings.

SUBJECTS AND METHODS

Oral health services in Finland

Oral health services in Finland are provided by both the public and the private sector. All citizens and residents in Finland have been entitled to PDS since the inception of the Primary Health Care Act in 1972, but the Municipalities could restrict the dental care of adult patients by defining an upper limit for their age until 2003. All services at the PDS are free of charge for patients below 18 years of age. Adults pay out-of-pocket, but the fees are highly subsidized by the government through social insurance funding. The fees in the public sector are below those in private sector, even though the latter are partly subsidized by the government. A total of 1.7 million patients visited PDS in Finland in 2009 (Widström et al. 2015), and 1.0 million received compensation from The Social Insurance Institution of Finland for their private dental care (Statistical Yearbook of the Social Insurance Institution 2010).

PDS in Finland

The citizens and residents are entitled to PDS according to their individual needs. The Finnish Government issued a decree on maternity and child health clinic services, school and student health care, and preventive oral health care for children and young people (Decree 338/2011). The intruments of this decree allow the determination of the minimum number of the check-ups for children at their home dental clinic, which is defined by the area of residence or by the school attended. The oral health check-ups are scheduled for families, who are expecting their first child, for children aged 1–2 years, 3–4 years, and 5–6 years. Oral health check-ups are also available to children that are in their first, fifth and eight grades in primary and secondary school, which corresponds to the ages of 7–8 years, 11–12 years, and 14–15 years, and for certain groups of students. If the individual need for dental care is greater, the check-ups are scheduled more often. The PDS aim to ensure sufficient preventive care services in order to prevent marginalization and regional inequalities. Nearly all parents choose public sector services over private services for their children.

One of the challenges that oral health services in Finland meet nowadays is increasing numbers of patients in the population that have a foreign background. The Helsinki Metropolitan Area contains almost half of foreign-language residents in Finland (Selander 2013). In 2013, the proportion of foreign-language residents in Helsinki was 12%, within the wider Helsinki metropolitan region it was 8%, and elsewhere in Finland 3%. As many as 133 different mother tongues were registered in Helsinki in 2013, this linguistic

diversity poses a challenge not only in communication, but also because of cultural differences. Almost 80 of the mother tongues had fewer than 100 speakers.

DGA as part of PDS

Conscious sedation is widely used in Finland when treating patients with difficulties in dental care. The recommendations for the use of conscious sedation follow the European Academy of Paediatric Dentistry guideline on sedation in paediatric dentistry (Hallonsten et al. 2005). Conscious sedation is the first treatment option for many patients when difficulties in dental care occur. The strict criteria regulate the patient selection to DGA in PDS; only those patients whose dental treatment would otherwise be too demanding or unsuccessful receive DGA treatment. DGA services in Finland are available in hospitals and in the larger public and private dental clinics, with some regional differences in the accessibility and the organization of these services. The physical status of patients is evaluated according to the ASA classification system (ASA 2014a) presented in Table 7, in order to determine the suitable treatment facility i.e. dental clinic or hospital. Generally, PDS clinics provide DGA service for ASA 1 and 2 category patients, whereas ASA 3 and over patients are treated in hospitals. The public and private dental clinics do not usually have their own anaesthesia team, so they commission and outsource such services according to need. The PDS clinics in rural areas do not have their own DGA service, and therefore such service is provided by the region's central hospital.

Table 7. Physical status of the patients according to the American Society of Anesthesiologists (ASA).

Definitions of the ASA classification:

1. Normal healthy patient
2. Patient with mild systemic disease
3. Patient with severe systemic disease
4. Patient with severe systemic disease that is a constant threat to life
5. Moribund patient who is not expected to survive without the operation
6. Declared brain-dead patient whose organs are being removed for donor purposes

The PDS in Finland follow the indications for DGA for children that were published by the AAPD (2011). In addition to these indications, the Helsinki PDS provides the DGA service for adolescents who are at risk of marginalization due to dental problems and who are in need of extensive dental treatment. This provision extends to adults with intellectual, physical, mental or medical disabilities when other treatment modalities including sedation do not help in achieving successful dental treatment (Närvä et al. 2013).

DGA in the Helsinki PDS system

The provision of DGA in the Helsinki PDS system is determined by a comprehensive process, and preventive care is considered as an essential part of it. Any PDS dentist that is facing serious difficulties with a patient's dental care, can refer that patient to the DGA service. A consultation visit follows a referral and precedes DGA. During the consultation either a specialist or a dentist that specializes in paediatric dentistry, or a general dentist experienced in DGA will assess the treatment options for every patient, design individual treatment plan, and give proper instructions on oral self-care, including dietary advice. Other specialized dentists are consulted when needed. Sometimes the assessment is performed by a specialized dentist belonging to another field as and when required, such as an oral and maxillofacial surgeon. The reasons for treatment under DGA are recorded at the consultation appointment. The waiting time for the DGA appointment varies according to the patient's situation: in cases of pain, swelling, or trauma the appointment is organized within a week, otherwise patients receive their DGA care between three to four months. The dental treatments under DGA are performed by a specialist or a dentist that specializes in paediatric dentistry, or a general dentist experienced in DGA and/or when needed a specialized dentist of other fields than paediatric dentistry. About one month after having treatment under DGA a postoperative review visit is scheduled to a dental hygienist or a dental nurse in order to repeat and complete the preventive care instructions. At that appointment fearful and uncooperative children are familiarized with the dental surgery and equipment. If the child is cooperative, then professional tooth cleaning and/or topical application of fluoride are performed. Finally, the child and his/her parent or guardian are given instructions to contact their home dental clinic, or the recall visit is scheduled at the postoperative review visit. This preventive care visit is scheduled for about 2–3 months after the postoperative review visit.

The majority of the adult patients who are treated under DGA in the Helsinki PDS are mentally, physically and/or medically compromised. Therefore, practices for these patients after DGA vary according to their background, dental status and individual treatment plan. Intensified preventive care can also be organized in the institutional homes of these DGA patients.

Study subjects, design and data collection

Three study groups of DGA patients in the Helsinki PDS provided the data for the present study. Table 8 shows the inclusion of the DGA patients, data sources and study designs according to group that were described in articles (I–IV). In addition, the study groups were restricted to include 0–13-year-old generally healthy patients for the present longitudinal comparisons (Table 9).

Table 8. Dental general anaesthesia (DGA) patients and their inclusion criteria, data sources and study designs according to study group as published in articles (I–IV).

Study group	n	Inclusion criteria	Age (years)	Data source	Study design
1	102	All generally healthy DGA patients treated in 2001	0–16	Questionnaire to parents, patient documents	Retrospective
2	199	All generally healthy DGA patients treated in 2004	0–13	Patient documents	Prospective
3	349	All DGA patients treated in 2010	0–68	Patient documents	Cross-sectional

Table 9. Study groups of dental general anaesthesia patients for three separate sampling periods restricted to include generally healthy patients aged 0–13-years for comparisons.

Study group	n	Year	Age Mean (SD)	Boys n	Girls n	0–5 yr n	6–13 yr n	Immigrant status	
								Yes n	No n
1	100	2001	6.2 (2.3)	45	55	46	54	NA	NA
2	199	2004	6.2 (2.7)	111	88	115	84	50	149
3	192	2010	6.5 (2.4)	102	90	95	97	73	119

Study group 1 (I, II)

The parents of the patients were asked for and gave their written consent to extract data from their children's dental records for the study in accordance with the Helsinki Declaration for medical research 1964. The data covered all generally healthy patients aged 0–16-years who were treated under DGA in Helsinki PDS during 2001 (n=102). The data were collected from patient records related to treatment under DGA including the preceding two years and from a questionnaire given to the parents of the patients. During the DGA parents were asked to fill in the questionnaire or it was mailed to their home address afterwards to be returned in a prepaid envelope. The patient's background data covered gender and birth date determined to an accuracy of one month.

Questionnaire

The multiple-choice and open-ended questions covered previous experiences of the child's dental care: the time of the first difficulties in dental care, the number of unsuccessful dental treatments and/or emergency appointments, and the seriousness of the previous difficulties using a 0–10 scale with 0 representing 'no serious difficulties' and 10 representing 'extremely serious difficulties'. Parents assessed the order of importance of

the five reasons given for unsuccessful dental treatments (pain, the dental staff's poor conduct, dental fear, the child's traumatic experiences of other medical appointments, or else) by ranking these in order (1–5) with 1 representing 'the most important reason'. In the analyses, the most important reason was given 5 points and the least important reason 1 point. The importance score was created by summing these scores given for each reason for each group. The questionnaire also included parental opinions about the accessibility to the DGA service for the child and the parent's own conscious sedation and/or DGA history.

Patient documents

Treatments performed under DGA were recorded as the number of restorations and tooth extractions performed, and the number of sealants placed. The data from the preceding two years included the use of conscious sedation and previous DGA, and the visits, which were recorded as follows:

a. Operative visit solely: the patient had received dental treatment (restoration/temporary restoration/tooth extraction/all) successfully.
b. Preventive visit solely: the patient had received at least one of the following: proper instructions on oral self-care, topical application of fluoride, sealant treatment, and professional tooth cleaning.
c. Both operative and preventive visit: including options a and b.
d. Total uncooperation: a visit where a patient's uncooperation restricted or blocked out dental treatment altogether.
e. Missed appointments: the patient failed to show-up at the appointment or call to cancel or reschedule it.

Restricted sample for comparisons

The age categories in the present comparison were equated to 0–5 and 6–13 years, based on the eruptional stages of the dentition (Haavikko 1970). After that, the present study included all 0–13-year-olds (n=100).

Study group 2 (IV)

Baseline data

The target population comprised all 0–13 years of age patients (n=199), that received treatment under DGA in Helsinki PDS in 2004, and who were generally healthy or who had only minor medically compromising conditions such as allergy, atopy, asthma or history of recurrent otitis, adenotomy or tympanostomy. The data were extracted from each patient's dental records together with the documents related to GA and health history, which were supplied by the parents or guardians as a prerequisite to the DGA visit.

The personal background data covered age, gender, whether the individual was an immigrant or not, and the history of previous conscious sedation and/or DGA. Age, to an

accuracy of one month, was categorized in the analyses as 0–5 and 6–13 years. Immigrant status was defined in terms of nationality and/or a native language.

The reasons for DGA were recorded as extreme uncooperation, extreme dental fear and need for extensive treatment, and each patient could have multiple reasons. The treatments given under DGA were recorded separately and were the following: filling therapy, tooth extractions, endodontics (pulpotomies and root-canal treatments), fissure sealants, and prophylaxis (professional tooth cleaning and/or topical application of chlorhexidine or fluoride, or minor removal of calculus). Prophylaxis and fissure sealants were combined under the heading of 'prevention'.

Follow-up data

Data sought and recorded during the follow-up covered the time of the postoperative review visit, the time of the first visit to the patient's home dental clinic and the time when the first operative treatment need was diagnosed i.e. the patient needed filling(s), endodontics, or extractions or any combination of these. All time intervals were calculated to an accuracy of one month.

Further recordings during the follow-up included the numbers of treatments by type, similarly as at the DGA visit, and the numbers of dental visits throughout the follow-up. These were recorded separately for the following options, which thereby allowed several alternatives for each visit:

a. all visits, excluding orthodontic or solely radiographic visits;
b. visits in which the patient received preventive treatment including professional tooth cleaning and/or topical application of chlorhexidine or fluoride, minor removal of calculus, proper instructions on oral self-care or dietary advice or fissure sealants made;
c. visits with total uncooperation, i.e. a visit in which the patient's lack of cooperation restricted or hindered dental treatment;
d. visits with dental fear, i.e. an appointment in which the patient's behaviour manifested signs of dental fear;
e. conscious sedation;
f. emergency visits;
g. repeat DGA;
h. visits to guide patient in controlling his/her dental fear, e.g. visits to familiarize patient with the dental surgery and equipment; and
i. missed appointments.

The length of the follow-up

The length of the follow-up from the DGA visit (baseline) to the end (maximum 5 years) was determined individually for each patient: i.e. the time from DGA visit to his/her most recent dental visit during the 5-year follow-up. Drop-outs included patients with no visits

after DGA (n=6), or after postoperative review visit (n=5); thus the final follow-up data included 188 patients.

Sample for comparisons
No restrictions were needed to make comparisons.

Study group 3 (III)

The data covered all patients treated under DGA in Helsinki PDS in 2010 (n=349) and were collected from patient referrals and related documents. These data recorded mentally, physically, and medically compromised patients under the following headings, which allowed multiple recordings per patient, namely: a) intellectual disability; b) behavioural disorders; c) mental disorders; d) physical limitations such as diseases of the nervous system or senses or musculoskeletal or connective tissue; and e) other chronic medical conditions such as endocrine, nutritional, metabolic, infectious, circulatory, cardiac, digestive or respiratory system diseases. Allergies and surgical operations were not recorded.

Background data
The personal background data covered age to an accuracy of one month, gender, whether the individual was an immigrant or not, and the history of previous conscious sedation and/or DGA. The age was categorized in the analyses as 0–5, 6–12, 13–17, and 18–68 years. The first three were based on the eruptional stages in the dentition (Haavikko 1970), and the fourth was based on the age when patients start to pay fees for treatment. Immigrant status was defined in terms of nationality and/or a native language.

The reasons for DGA were categorized as extreme uncooperation, extreme dental fear, need for extensive treatment, avoidance of dental fear (for very young patients with no previous treatment experiences), extensive surgical procedures, a strong emetic reflex, and ineffectiveness of local anaesthesia. Multiple reasons were allowed.

Treatments under DGA
The treatments performed under DGA were recorded as follows: filling therapy, tooth extractions, endodontics (pulpotomies and root canal treatments), periodontal therapy, surgical procedures, radiography, miscellaneous treatments, prophylaxis (professional tooth cleaning and/or topical application of chlorhexidine or fluoride), and fissure sealants. Prophylaxis and fissure sealants were combined under the heading of ‘prevention’.

Restricted sample for comparisons
The present comparisons restrictions were made according to age and medical status. The age grouping categories equated to 0–5 and 6–13 years. After restrictions, the sample included all 0–13-year-old generally healthy patients (n=192).

The content of the comparisons

New, unpublished, results of the DGA process in the Helsinki PDS include comparisons of characteristics of the generally healthy 0–13-year-old patients, their reasons for DGA, previous conscious sedation and DGA, and treatments they received under DGA from 2001 to 2010.

Statistical analyses

Descriptive statistics included frequencies as percentages, means and standard deviations (SD). Chi-square tests and Fisher's exact tests served for assessment of the statistical significance of differences in frequencies between the compared groups. Evaluation of the differences in the mean values between two groups were performed by t-tests, or between means of more than two groups by one-way analysis of variance (ANOVA), Mann-Whitney tests (between two groups) and Kruskall-Wallis tests (more than two groups) were also used when the data was not normally distributed. Pearson's correlation coefficient (r) measured the strength of associations between selected variables and Fisher's transformation was applied to test $r \neq 0$. Logistic regression modelling served for evaluation of various factors on the dichotomized outcomes as odds ratios (OR) and their 95% confidence intervals (95% CI).

RESULTS

Characteristics of the patients treated under DGA

Characteristics of DGA patients (I, III, IV)

Study group 1 included a total of 102 patients (46% male), whose mean age at the time of DGA treatment in 2001 was 6.4 (2.6 SD) (I). The second study group included 199 patients (56% male), and the mean age at the time of DGA treatment in 2004 was 6.2 (2.7 SD) in 2004 (IV). Finally, 53% of the patients in the third study group (n=349) were male, and 75% of the patients in this study group were under 18-years old (III). The vast majority (86%) of the adult DGA patients were mentally, physically and/or medically compromised.

Table 10. Comparison of the characteristics (%) of the generally healthy 0–13-year-old patients by age group and by year.

Characteristics of the patients	**Total**	**0–5 yr**	**6–13 yr**	*p* by age
Gender	**%**	**%**	**%**	
2001	n=100	n=46	n=54	
Male	45	39	50	*0.276*
Female	55	61	50	
2004	n=199	n=115	n=84	
Male	56	61	49	*0.091*
Female	44	39	51	
2010	n=192	n=95	n=97	
Male	53	55	51	*0.558*
Female	47	45	49	
p by year	*0.211*	*0.044*	*0.974*	
Immigrant status	**%**	**%**	**%**	
2004	n=199	n=115	n=84	
Yes	25	30	17	*0.026*
No	75	70	83	
2010	n=192	n=95	n=97	
Yes	38	51	26	*<0.001*
No	62	49	74	
p by year	*0.004*	*0.003*	*0.137*	

Statistical evaluation by chi-square tests for differences by age group and by year.

Characteristics of generally healthy 0–13-year-olds

Table 10 shows the comparison of the characteristics of the generally healthy 0–13-year-olds in the three study groups by age group and by DGA year. There were no differences according to gender between any of these study groups by age group. Among 0–5-year-olds more boys were treated in 2004 as compared with 2001 and 2010 (61% vs. 39–55%; p=0.044). Immigrants predominated in 2004 and 2010 in the age group 0–5-year-olds (30% vs. 17%; p=0.026 and 51% vs. 26%; p<0.001). The proportion of the 0–5-year old immigrants increased from 30% in 2004 to 51% in 2010 (p=0.003).

Reasons for DGA

Reasons reported by parents (I)

The summed scores for the importance of the reasons for unsuccessful dental treatments in previous dental care were used to give parental data. The parents ranked the following factors as the most important reasons: dental fear (mean 4.0; 1.7 SD), followed by pain (mean 2.4; 2.0 SD). The parents rather infrequently cited dental staff's behaviour or the child's traumatic experiences of other medical appointments as the reasons for unsuccessful dental treatments that lead to DGA. Of the children, 21% had parents, who had experienced dental care under conscious or DGA.

Reasons for DGA referrals in 2004 and 2010 (III, IV)

The most frequent reasons for the referrals were extreme uncooperation, extreme dental fear and need for extensive treatment. Other reported reasons in the 2010 study were the novel reason of avoidance of dental fear, extensive surgical procedures, strong emetic reflex and ineffectiveness of local anaesthesia (III). The respective percentages for 0–13-year-olds in 2004 were extreme uncooperation 82%, extreme dental fear, 56% and the need for extensive treatment, 43% (IV). The corresponding percentages for 0–68-year-olds in 2010 were 65%, 37% and 26% (III).

Reasons for DGA in generally healthy 0–13-year-olds

Comparison of the reasons in referrals for DGA between 2004 and 2010 are shown by age group in Table 11. The ranked order for the reasons was the same in both study years. Extreme uncooperation was more frequent in 2004 in 6–13-year-olds than younger patients (p=0.001). Extreme dental fear was more frequent for 6–13-year-olds than younger patients (p<0.001) in both study years. Need for extensive treatment was more frequent in 0–5-year-olds in 2004 than for the 6–13-year-olds (p<0.001). Generally, these three reasons were less frequently used in referrals in 2010 than in 2004.

Table 11. Comparison of the reasons (%) for dental general anaesthesia (DGA) in 2004 and 2010 for generally healthy 0–13-year-old patients by age group.

Reasons for DGA	Total	0–5 yr	6–13 yr	*p* by age
Extreme uncooperation	**%**	**%**	**%**	
2004[a]	n=198	n=115	n=83	
Yes	82	75	93	*0.001*
No	18	25	7	
2010	n=192	n=95	n=97	
Yes	69	75	64	*0.104*
No	31	25	36	
p by year	*0.003*	*0.994*	*<0.001*	
Extreme dental fear	**%**	**%**	**%**	
2004[a]	n=198	n=115	n=83	
Yes	56	45	70	*<0.001*
No	44	55	30	
2010	n=192	n=95	n=97	
Yes	34	22	46	*<0.001*
No	66	78	54	
p by year	*<0.001*	*<0.001*	*0.001*	
Need for extensive treatment	**%**	**%**	**%**	
2004[a]	n=198	n=115	n=83	
Yes	43	56	27	*<0.001*
No	57	44	73	
2010	n=192	n=95	n=97	
Yes	33	36	30	*0.385*
No	67	64	70	
p by year	*0.031*	*<0.001*	*0.615*	

[a]Records on reasons for DGA were missing for one patient. For each patient, one or more reasons for referring to DGA were documented. Statistical evaluation by chi-square tests for differences by age group and by year.

Table 12. Comparison of the reasons (%) for dental general anaesthesia (DGA) in 2004 and 2010 for generally healthy patients in age group 0–5-year-olds by immigrant status.

Reasons for DGA	Total	Immigrant	Non-immigrant	*p* by immigrancy status
Extreme uncooperation	**%**	**%**	**%**	
2004	n=115	n=35	n=80	
Yes	75	77	74	*0.700*
No	25	23	26	
2010	n=95	n=48	n=47	
Yes	75	75	74	*0.952*
No	25	25	26	
p by year	*0.994*	*0.822*	*0.929*	
Extreme dental fear	**%**	**%**	**%**	
2004	n=115	n=35	n=80	
Yes	45	54	41	*0.196*
No	55	46	59	
2010	n=95	n=48	n=47	
Yes	22	25	19	*0.492*
No	78	75	81	
p by year	*<0.001*	*0.006*	*0.011*	
Need for extensive treatment	**%**	**%**	**%**	
2004	n=115	n=35	n=80	
Yes	56	63	52	*0.304*
No	44	37	48	
2010	n=95	n=48	n=47	
Yes	36	37	34	*0.725*
No	64	63	66	
p by year	*<0.001*	*0.006*	*0.044*	

Statistical evaluation by chi-square tests for differences by age group and by year.

Reasons for DGA in generally healthy 0–5-year-olds by immigrancy

The comparison of the DGA reasons in 2004 with those of 2010 in 0–5-year-olds by immigrant status are shown in Table 12. There were no differences in the reasons according to immigrant background. The reasons of extreme dental fear and need for extensive treatment had decreased for both immigrants and non-immigrants from 2004 to 2010.

Dental care preceding DGA

Previous dental care reported by parents (I)

Parents indicated that the first difficulties in their child's dental care had manifested when the child was younger than three years of age and this accounted for 39% of the children in the 2001 study group. Further, 32% of the children in the 2001 study group had experienced four or more unsuccessful dental treatments and 16% emergency appointments in the preceding two years before DGA. Parents reported no serious difficulties for 25% of children in their previous dental care. The seriousness of the previous difficulties was ranked for the remaining 75%, the median was 8 on the 0–10 scale. Parents of the 7–16-year-olds rated the seriousness to be greater than the corresponding factor by parents of the 0–6-year-old children (8.0 vs. 6.7; p=0.02). Accessibility to the current DGA was reported as easy by 93% of the parents.

Dental care in the preceding two years before DGA (II)

The patients had a mean of 5.1 (2.6 SD) visits and 0.6 (1.4 SD) missed appointments in the preceding two years before DGA in 2001. Approximately a third (31%) of the patients had missed one or more appointment and these no-show appointments were more frequent among the 7–16-year-olds than in the younger age group of 0–6-year-olds (1.3 vs. 0.2; p=0.003). A mean of 1.8 (2.1 SD) were visits solely for restorations and/or extractions, 1.9 (1.4 SD) with solely prevention, and visits with both these treatments 0.3 (0.6 SD). A mean of 1.2 (1.2 SD) were visits for complete uncooperation when no treatments could be completed.

As much as 59% of the DGA patients of the 2001 study group were uncooperative during at least one visit in the preceding two years. Compared with cooperative DGA patients, the uncooperative individuals had more visits (5.6 vs. 4.4; p=0.02) and fewer missed appointments (0.4 vs. 1.0; p=0.04).

Most (90%) of the DGA patients had at least one visit during which preventive treatment was given. Compared with uncooperative patients, the cooperative patients had more visits that during which a solely preventive treatment was given (2.2 vs. 1.6; p=0.03). There were three highly prominent subgroups related to receiving no preventive treatment in

dental care in the two years that preceded DGA: patients who had visits during which they manifested total uncooperation (OR=4.6; p=0.004), those who received greater numbers of temporary fillings (OR=4.1; p<0.001), and those who had fewer visits (OR=2.7; p=0.004).

Previous conscious sedation and DGA for generally healthy 0–13-year-olds 2001, 2004 and 2010

Comparisons of the three study periods are presented by age and by year in Table 13. About half of the DGA patients (50–65%) had received conscious sedation in their previous dental care. Preceding their DGA treatment in 2004 more 6–13-year-old patients had received conscious sedation than the younger ones (80% vs. 54%; p<0.001). A higher proportion of 6–13-year-old patients treated under DGA in 2004 had received conscious sedation in their previous dental care compared to 2001 and 2010 study groups (48–60% vs. 80%; p<0.001).

Between 4 to 13% of the DGA patients had undergone a DGA that preceded their DGA in 2001, 2004, or 2010. An earlier DGA in either 2004 or in 2010 was more common for the 6–13-year-olds than younger children (p=0.004 and p<0.001, respectively), and in 2001 for the 0–5-year-olds than older children (p=0.036). Comparison by year showed differences in both age groups; in the 0–5-year-olds previous DGA was most frequent in 2001 (10% vs. 0–6%; p=0.006) and in 6–13-year-olds more frequent in 2004 than in other years (23% vs. 0–8%; p<0.001).

Table 13. Comparison of the use of (%) conscious sedation and dental general anaesthesia (DGA) in the previous dental care for generally healthy 0–13-year-old patients by age group and by year.

Previous dental care	Total	0–5 yr	6–13 yr	*p* by age
Previous conscious sedation	**%**	**%**	**%**	
2001[a]	n=86	n=42	n=44	
Yes	50	52	48	*0.666*
No	50	48	52	
	n=199	n=115	n=84	
2004				
Yes	65	54	80	*<0.001*
No	35	46	20	
	n=192	n=95	n=97	
2010				
Yes	55	51	60	*0.197*
No	45	49	40	
p by year	*0.036*	*0.887*	*<0.001*	
Previous DGA	**%**	**%**	**%**	
2001[a]	n=86	n=42	n=44	
Yes	5	10	0	*0.036*
No	95	90	100	
	n=199	n=115	n=84	
2004				
Yes	13	6	23	*<0.001*
No	87	94	77	
	n=192	n=95	n=97	
2010				
Yes	4	0	8	*0.004*
No	96	100	92	
p by year	*0.002*	*0.006*[X]	*<0.001*	

[a]Records on previous conscious sedation missing for 14 patients. Statistical evaluation by chi-square tests for differences by age group and by year. [X] = Fisher's exact test applied.

Treatments under DGA

Treatments performed (II, III, IV)

Restorations, followed by tooth extractions, dominated in the treatment-mix performed under DGA in 2001, 2004 and 2010. The mean number of treatments (restorations, tooth extractions and fissure sealants) in 2001 was 8.1 (3.1 SD) (II). Filling therapy comprised 63%, tooth extractions 20%, endodontics 11%, and fissure sealants 6% of treatment mix provided under DGA in 2004, and the mean number of treatments (restorations, tooth extractions, endodontics and prevention) was 9.5 (4.2 SD) (IV). The aggregated means were 10.5 (4.0 SD) for 0–5-year-olds and 8.2 (4.0 SD) for older patients ($p<0.001$) (IV). Immigrants received more treatments than the non-immigrants (10.7; 4.5 SD vs. 9.2; 4.0 SD; $p=0.037$). Restorations comprised 57%, tooth extractions 24%, preventive measures 5%, radiography 5%, endodontics 4%, periodontics, surgical and miscellaneous treatments 5% of a total of 3435 treatments performed in 2010, and the mean number of treatments (restorations, tooth extractions, endodontics, prevention and periodontics) was 9.8 (5.0 SD) per patient (III).

There were two factors related to the provision of preventive treatments during the DGA session (III). Those patients, who had been treated previously under conscious sedation were more likely to receive preventive treatment under DGA (OR=2.3; $p=0.005$) than their counterparts who had not received conscious sedation. Those patients, who had tooth extractions performed under DGA, were less likely to receive preventive treatment under DGA (OR=0.9; $p=0.022$) than their counterparts who had no extractions.

Treatments performed for generally healthy 0–13-year-olds

Table 14 compares the percentages of 0–13-year-old DGA patients who received various types of treatments for the three time periods of 2001, 2004, and 2010. Almost all received filling therapy, two out of three had tooth extractions, less than half had endodontics and one out of five had fissure sealants. Filling therapy and endodontic treatments dominated for 0–5-year-olds in 2004 and 2010, whereas sealants dominated all three years for 6–13-year-olds. Comparison of the DGA treatments by year showed that among 6–13-year-olds filling therapy was more frequent in 2001 than for the later years (100% vs. 88–92%; $p=0.015$), whereas endodontics was more frequent in 2004 than for 2010 (48% vs. 36%; $p=0.018$).

A comparison of mean numbers of restorations, tooth extractions, endodontics and sealants received by age group and by year are shown in Table 15. Restorations and endodontics dominated as treatments in the 0–5-year-olds in 2004 and 2010 and sealants in all years in 6–13-year-olds. Comparing the DGA treatments by year revealed that among 6–13-year-olds endodontics was more frequent in 2004 than in 2010 (1.3 vs. 0.7; $p=0.003$).

Table 14. Comparison of the generally healthy 0–13-year-old patients (%) who received various treatments under dental general anaesthesia by age group and by year.

Treatments received	Total	0–5 yr	6–13 yr	*p* by age
Filling therapy	**%**	**%**	**%**	
2001	n=100	n=46	n=54	
	99	98	100	*0.276*
2004	n=199	n=115	n=84	
	95	98	92	*0.027*
2010	n=192	n=95	n=97	
	92	97	88	*0.017*
p by year	*0.038*	*0.862*[X]	*0.015*[X]	
Tooth extractions	**%**	**%**	**%**	
2001	n=100	n=46	n=54	
	64	61	67	*0.547*
2004	n=199	n=115	n=84	
	71	72	70	*0.766*
2010	n=192	n=95	n=97	
	62	57	68	*0.109*
p by year	0.153	0.059	0.900	
Endodontics	**%**	**%**	**%**	
2004	n=199	n=115	n=84	
	48	58	33	*<0.001*
2010	n=192	n=95	n=97	
	36	47	25	*0.001*
p by year	*0.018*	*0.115*	*0.203*	
Prophylaxis	**%**	**%**	**%**	
2004	n=199	n=115	n=84	
	4	2	7	*0.055*
2010	n=192	n=95	n=97	
	6	4	7	*0.370*
p by year	*0.432*	*0.413*[X]	*0.985*	
Sealants	**%**	**%**	**%**	
2001	n=100	n=46	n=54	
	17	9	24	*0.041*
2004	n=199	n=115	n=88	
	21	10	35	*<0.001*
2010	n=192	n=95	n=97	
	21	13	30	*0.004*
p by year	*0.665*	*0.761*	*0.425*	

Statistical evaluation by chi-square tests for differences by age group and by year. [X] = Fisher's exact test was used.

Table 15. A comparison of the mean (SD) number of treatments generally healthy 0–13-year-old patients received under dental general anaesthesia by age group and by year.

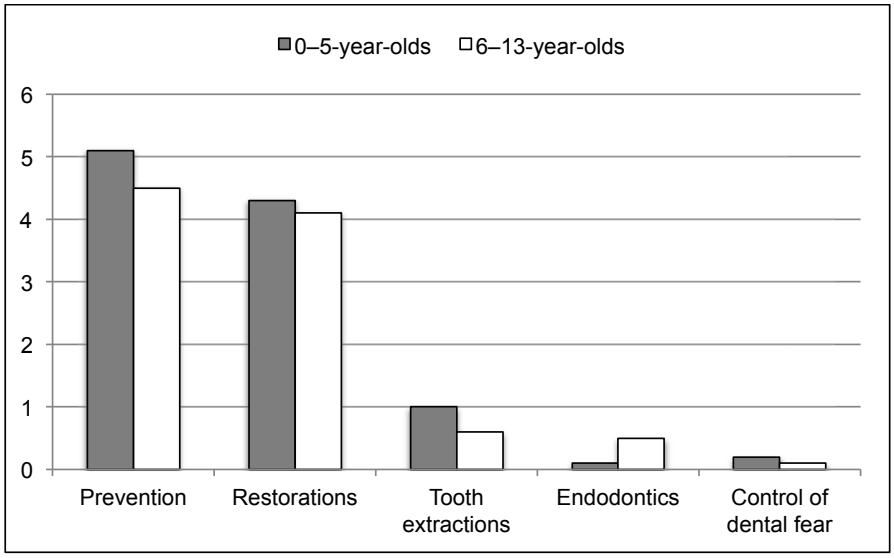
Treatments received	Total	0–5 yr	6–13 yr	*p* by age
Restorations				
2001	n=100	n=46	n=54	
Mean (SD)	6.0 (2.7)	6.0 (2.7)	6.0 (2.7)	*0.946*
2004	n=199	n=115	n=84	
Mean (SD)	6.0 (3.2)	6.9 (3.0)	4.8 (3.2)	*<0.001*
2010	n=192	n=95	n=97	
Mean (SD)	5.5 (3.1)	6.2 (3.0)	4.8 (3.1)	*0.002*
p by year	*0.264*	*0.626*	*0.051*	
Tooth extractions				
2001	n=100	n=46	n=54	
Mean (SD)	1.7 (2.1)	1.5 (1.8)	1.9 (2.3)	*0.262*
2004	n=199	n=115	n=84	
Mean (SD)	1.9 (2.0)	2.0 (2.0)	1.8 (2.0)	*0.431*
2010	n=192	n=95	n=97	
Mean (SD)	2.0 (2.3)	1.8 (2.2)	2.2 (2.4)	*0.204*
p by year	*0.510*	*0.350*	*0.358*	
Endodontics				
2004	n=199	n=115	n=84	
Mean (SD)	1.0 (1.3)	1.3 (1.4)	0.6 (1.0)	*<0.001*
2010	n=192	n=95	n=97	
Mean (SD)	0.5 (0.8)	0.7 (0.9)	0.4 (0.8)	*0.012*
p by year	*0.003*	*0.003*	*0.164*	
Sealants				
2001	n=100	n=46	n=54	
Mean (SD)	0.4 (1.1)	0.2 (0.7)	0.6 (1.3)	*0.030*
2004	n=199	n=115	n=84	
Mean (SD)	0.6 (1.3)	0.3(0.9)	1.0 (1.6)	*<0.001*
2010	n=192	n=95	n=97	
Mean (SD)	0.6 (1.3)	0.4 (1.1)	0.8 (1.4)	*0.012*
p by year	*0.438*	*0.515*	*0.276*	

Statistical evaluation by Kruskal-Wallis and Mann-Whitney tests.

Dental care after DGA (IV)

The generally healthy 0–13-year-old study group that was treated under DGA in 2004 was followed-up for a mean of 47.6 (13.7 SD) months. Nearly three quarters (74%) of the patients attended their scheduled postoperative review visit after having DGA. Immigrants attended the postoperative review visit more often than non-immigrants (85% vs. 70%; p=0.05). The time interval to the first visit to the patients' home dental clinic was 12.0 (11.8 SD) months for the 0–5-year-olds and 7.2 (5.9 SD) months for the 6–13-year-olds (p<0.001). The mean time that had elapsed from DGA to the first operative treatment need was 18.5 (14.1 SD) months. Those 11% who were treated under repeat DGA received it 22.5 (12.6 SD) months after the initial DGA. It was found that 13% of the patients in follow-up needed no operative treatment during their follow-up period, whereas for 25% the first treatment need occurred no earlier than 2 years after DGA treatment. Over one third (39%) needed operative treatment during the first year after DGA, and half of these during the first 6 months. Figure 1 shows the comparison of the two types of visits and dental treatments performed to generally healthy 0–13-year-old patients during the follow-up as stratified by age. Of the mean of 9.7 (5.6 SD) number of visits per patient, 4.9 included prevention and 0.2 control of dental fear. The mean number of the treatments was 5.3 (4.9 SD), including 4.2 (4.2 SD) fillings, 0.8 (1.2 SD) tooth extractions and 0.3 (1.1 SD) endodontics. The differences between the age groups were not statistically significant.

Figure 1. Five-year follow-up of the visits and the treatments after DGA: mean numbers of visits (prevention and control of dental fear) and treatments (restorations, tooth extractions and endodontics) of the generally healthy 0–13-year-old patients by age.



Over half (53%) of the patients expressed dental fear and 54% were uncooperative during the follow-up. Boys had more visits in which they manifested total uncooperation than the girls (62% vs. 45%; $p=0.03$). Emergency treatment was given to 52% of the patients and 65% missed at least one appointment. Conscious sedation was used for 18% and familiarization for 13% of the patients. Visit during which preventive treatment was performed occurred for 97% of patients during the follow-up period. These preventive visits were the more frequent the longer the follow-up was ($r=0.48$; $p<0.001$)

DISCUSSION

The present study evaluated the DGA process data in the Helsinki PDS for the three study groups for the years 2001, 2004 and 2010. This report is based on the articles (I–IV) and on the further reanalyses and comparison of the data for the years 2001, 2004 and 2010, which were restricted to 0–13-year-old generally healthy children.

Extreme uncooperation, extreme dental fear and need for extensive treatment were the main reasons for generally healthy children to end up being treated under the DGA, these children's difficulties with dental care began at an early age. Conscious sedation was widely used in situations in which cooperation problems and dental fear impacted upon treatment before DGA was given. Unfortunately, operative treatments had dominated over prevention for uncooperative children. The treatment need under DGA was extensive, and this was especially the case for immigrants in comparison to non-immigrants.

Most of the generally healthy children could be treated by routine dental care after DGA. Nonetheless, many of them still continued to challenge at dental appointments with manifestations of cooperation problems and dental fear. The scheduled intensified preventive care and familiarization plan were not actualised as children/their parents or guardians failed to contact child's home dental clinic after the postoperative review visit. The extensive and comprehensive DGA treatment seemed to keep any further need for treatment at a similar level to that of the general population. Over half of the children needed no operative treatment within one year after DGA and 13% needed no operative treatment at all. However, the first need for treatment occurred within six months for one fifth of the children.

Methodological aspects

The strength of the present study is in its longitudinal perspective (ten years) on generally healthy children's comprehensive treatment under DGA. The results offer valuable new information of DGA as part of PDS care in addition to giving a comparison of the aspects of the DGA process over ten years.

The length of the follow-up (5-years) after DGA for generally healthy children used in the present study was longer than in any earlier study (Berkowitz et al. 1997, Almeida et al. 2000, Eidelman et al. 2000, Worthen and Mueller 2000, Chase et al. 2004, Foster et al. 2006, Jamieson and Vargas 2007, Amin et al. 2010). The drop-out rate of the patients in the present study was very small as 94% of the patients remained in follow-up. Earlier studies have reported following 5–72% of the patients after DGA (Berkowitz et al. 1997, Worthen and Mueller 2000, Chase et al. 2004, Foster et al. 2006, Jamieson and Vargas 2007, Amin et al. 2010). There are two exceptions i.e. two studies reported that all of the

patients could be followed (Almeida et al. 2000, Eidelman et al. 2000). The follow-up in these two studies entailed attending only one recall in two years however.

One limitation of the present study might be that the data are based on PDS patient records, which unfortunately do not include information of patient's socioeconomic status. Further, patients having appointments in the private sector could be a confounding variable that was not included in these data. In addition, the datasets of patient records are kept and administered independently in each community, thus those patients who moved to another city were lost from the Helsinki PDS records. On the other hand, the PDS patient records that were used were, and still are, very valuable for follow-up, since the Helsinki PDS clinics and the DGA unit have a joint patient record system. Thus following these patients' dental care is not solely dependent on attending specific appointments. Generally, the patient records can be taken as reliable because there are statutory rules and a protocol for the recordings and treatment codes used in patient documents in Finland. In addition, part of the dentists' salary in the public sector is remuneration for treatments they perform (procedure fee) and these are reported as treatment codes in the patients' files. However, the recording practices of individual dentists may vary, in particular for the coding of prevention and familiarization of the patients in dental care, and for which procedure fees are not paid, so these activities may have been underrepresented in the patient datasets of the present study.

Discussion of the results of the present study

Characteristics of the patients treated under DGA

The special focus of the present study was on generally healthy children, who comprised a large proportion of the patients treated under DGA in PDS. These DGA patients are, however, a small minority of the entire patient population: in the Helsinki PDS only 349 received DGA out of 160 000 patients in 2010 (III). The comparison of the characteristics of the study patients from 2001 to 2010 showed that the number of the generally healthy children treated under DGA doubled. This may partly be due to the improved resources and probably also due to changes in referral practices.

The proportion of immigrants is increasing in Helsinki. The foreign-background residents (foreign nationals and also Finnish nationals born abroad) formed 7.7% of the population in Helsinki in 2003 (Ranto 2005), this proportion had increased to 10.7% in 2009 (Tikkanen 2010) and to 12.4% at the beginning of 2013 (Selander 2013). The age-structure of people of foreign origins is younger than that of the general population that lives in Helsinki. A comparison of the 0–5-year-old generally healthy DGA children in the present study showed that the proportion of immigrants increased from 30% in 2004 to 51% in 2010. Both percentages were thus much greater than for the overall immigrant proportions in Helsinki for those respective years. Immigration in Finland started later

than in many other European countries. Studies from Denmark, Norway and Sweden, where PDS are provided free of charge for children as in Finland, have reported higher prevalence of caries in children with an immigrant background (Sundby and Petersen 2003, Skeie et al. 2005, Christensen et al. 2010, Wigen and Wang 2010, Jacobsson et al. 2011, Stecksén-Blicks et al. 2014). On the other hand, it was reported in Sweden as early as the mid-1980s that the most common immigrant groups used dental services less frequently than the native Swedes (Widström and Martinsson 1985). These cultural and demographic factors surely pose a challenge to dental care. A multiprofessional collaboration programme that provides information on dental care and prevention in the Helsinki PDS has thus been implemented to reduce inequalities of use of health services by immigrant families. A complementary programme of education about cultural disparities has also been organized for PDS personnel.

The adult patients treated under DGA formed one fourth of all the DGA patients in 2010. There were few immigrants in this age group. The majority of the adult patients were mentally, physically, or medically compromised.

Reasons for DGA

The three most frequent reasons for DGA recorded in the PDS dentist's referrals for all DGA patients were extreme uncooperation, extreme dental fear and need for extensive treatment in 2004 and 2010. Extreme uncooperation was the most frequent reason among all generally healthy children in this study. It can be assumed that at least some of the uncooperation problems of these patients were due to their dental fear. However, not all children with dental fear present behaviour guidance problems in dental care (Klingberg et al. 1995, Arnrup et al 2002, Baier et al. 2004). Consequently, dental fear needs to be recognized early and taken care of before it emerges as uncooperation.

Comparisons of the reasons for DGA between 2004 and 2010 showed that the extreme uncooperation, extreme dental fear and need for extensive treatment reported in referrals were less frequent in 2010 than in 2004. A new reason 'avoidance of dental fear' was noted for 27% of 0–5-year-olds in referrals in 2010 (III). This may indicate that more resources had been made available for DGA care by 2010. Thus, dentists do not necessarily try to treat young children with need for extensive treatment in normal dental settings, but refer these children to the DGA immediately.

Extreme dental fear was more frequent among the 6–13-year-olds than among the 0–5-year-olds in 2004 and 2010. One explanation is that dental fear will have had more time to develop in the older age group especially in cases of prolonged problems. Comparison of the reasons in 2004 and 2010 among generally healthy 0–5-year-olds revealed no differences between immigrants and non-immigrants. Dentist speaking a language different from that of the child and his/her parents and the dental care being performed using an interpreter, makes the dental visit even more challenging to the child than in

cases where everyone speaks the same language. Sometimes the situation arises in the case of emergency care in which the interpreter is unavailable. The Ministry of Social Affairs and Health of Finland has published vocabulary of health care in several languages for immigrants (The Ministry of Social Affairs and Health 1993), and Helsinki PDS for dental care. These documents are available to professionals who treat patients with no common language.

Dental fear was ranked by the parents in 2001 as the most important reason for unsuccessful dental treatments before DGA, and this was followed by pain. Painful or unpleasant dental treatment experiences may lead to dental fear and anxiety (Townend et al. 2000, Rantavuori et al. 2002, Versloot et al. 2004, Klingberg 2008, Taskinen et al. 2014), and restorative treatment without local anaesthesia are related to behaviour management problems (Klingberg et al. 1994). However, painless dental care should be taken for granted. Unfortunately, in Finland dentists underuse local anaesthesia when restoring teeth: only 24% of the children at age six and 35% under the age of 13 were reported to have received local anaesthesia (Varsio et al. 1999, Palotie and Vehkalahti 2003). These proportions are in line with a Swedish study, where only 31% of the dentists reported always using local anaesthesia during restorative treatment for children and adolescents (Wondimu and Dahllöf 2005). In contrast, 90% of Danish dentists have reported using local anaesthesia 'always' or 'often' when restoring a child's teeth (Rasmussen et al. 2005).

A child's dental fear and anxiety have been reported to be related to his or her parental dental fear and anxiety (Themessl-Huber et al. 2010, Olak et al. 2013). One fifth of the parents of the DGA patients in 2001 had been treated under conscious sedation or DGA for their own dental care needs, which indicates that dental fear can have a familial component. Even so, it can be assumed that the parents did not differ from general population with respect to their dental fear, as it has been reported that of Finnish adults aged 30 years and older between 5 and 19% were very afraid and between 16 and 59% somewhat afraid of visiting a dentist (Lahti et al. 2007).

Treatment under DGA for adult patients was the only treatment option because of uncooperation and/or dental fear. Therefore, there is a possibility to decrease adult DGAs by the timely treatment of dental fear earlier.

Dental care preceding DGA

Only scant little information exists about children's dental care before DGA. The parents of the DGA children in 2001 study group reported that problems in dental care began as early as younger than three years of age for their children, and this proportion accounted for more than one-third of the generally healthy children. A study from the UK, reported that 40% of children treated under DGA already had decayed teeth by the time of their first visit to the dentist (Hunter et al. 1997). This situation calls for early intervention to

treat the problems in dental care. Unfortunately a qualitative study from Canada showed that the parents, whose children had been treated under DGA, had not consulted a dentist at the currently recommended age for the child for a variety of reasons (Amin and Harrison 2006).

The parents and guardians of all preschool children (<7 years) in Helsinki PDS receive a note to book an appointment for a dental check-up when the child is 1-year-old, 3-year-old and 5-year-old. However, there is no follow-up to find whether or not the appointment had been kept. According to Helsinki PDS statistics 51% of the 3-year-olds and 54% of 5-year olds had check-ups in PDS in 2001, and 3% and 10% of these respectively were at high risk for caries. The check-ups in 2004 were performed on 45% of 3-year-olds and 44% of 5-year-olds, and the corresponding proportions of high caries-risk children for 3-year-olds and 5-year-olds were 4% and 9%. This highlights the need for an overhaul of the PDS practices. The children regularly visit child health centres, therefore the multiprofessional collaboration with the public health nurses could be used to identify and contact earlier those children who were high-risk-for-caries.

A quality recommendation for health promotion was published in 2006 by the Ministry of Social Affairs and Health of Finland in order to support work of the local authorities (The Ministry of Social Affairs and Health 2006). This publication includes a chapter of oral health promotion. There are also eight Current Care Guidelines in dentistry published in Finland by the Finnish Medical Society Duodecim. One of them is the Current Care Guideline for prevention of dental decay, which was first published in 2009, and later revised in 2014 (Caries (control): Current Care Guidelines Abstract, 2014). Recently, Public Health England (PHE) published an evidence-informed toolkit for local authorities entitled: 'Local authorities improving oral health: commissioning better oral health for children and young people', and National Institute for Health and Care Excellence (NICE) a public health guideline entitled 'Oral health: local authorities and partners' in England (NICE 2014, PHE 2014). Both these in-depth guidelines provide valuable approaches to improve the oral health of communities, and also recognising the high-risk groups. Even though the health care systems differ, the guidelines provide valuable review of possible ways to improve oral health in Finland. Consideration is still needed when choosing public health interventions, as some of them may actually increase health inequalities (Lorenc et al. 2013).

The use of conscious sedation in dental care is recorded in the patient files in Finland. However, there are no nationwide data of the frequency of the use of sedation, which also varies from clinic to clinic for both the public and the private sectors. The National Institute for Health and Welfare collects statistics on primary health care, and The Social Insurance Institution of Finland of the compensation fees paid for private practice services, but these reports are not detailed enough to show the use of conscious sedation. The present study reported that the conscious sedation over the three time periods was used widely, as 50% or more of children were treated under conscious sedation in their

previous dental care. Conscious sedation in 2004 was used more frequently in previous dental care of the generally healthy children compared to 2001 and 2010, and it could even be as high as 80% of the 6–13-year-olds. The referral practices for DGA after 2004 seemed to have changed and the children were referred to DGA earlier than before. The use of conscious sedation seems to have regional variation in Finland, as a study on the PDS of the nearby city of Vantaa reported that 21% of the children were treated under conscious sedation before DGA (Silvo et al. 2008).

The competence and interests of dentists in treating patients with dental fear and cooperation problems differ so there are no strict criteria to indicate when the children should be referred to DGA. A study on Helsinki PDS in 2001 reported that more than half of the dentists used conscious sedation when treating a 6-year-old or younger child with behaviour management problems after the first unsuccessful visit and one out of every three dentists used conscious sedation after 2–3 unsuccessful visits (Snäll 2002). Two out of every five dentists reported trying to treat children between seven and 15 years of age without conscious sedation once and half of the dentists 2–3 times. The study on Vantaa PDS reported that before DGA, children had experienced between 1 to 11 unsuccessful dental visits (Silvo et al. 2008). Over a third of these patients (34%) had been referred to DGA after the first unsuccessful visit, 24% after the second, and 19% after the third unsuccessful visit. It is plausible that these multiple unsuccessful visits with or without conscious sedation will lead to developing dental fear, thus an improvement in treating patients with dental fear and/or uncooperation in addition to changing referral practises would be welcomed.

Cost-analyses that compare conscious sedation against DGA have raised some interests. Studies from the USA and UK have compared these two treatment options (Lee et al. 2000, Jameson et al. 2007), but the financial systems of the USA and the UK are not comparable to that used by the Finnish system, and the study from the UK also considered advanced conscious sedation. A study from Vantaa PDS showed that if the child's dental treatment would have needed over four appointments (with or without conscious sedation) during one period of care, the DGA treatment would have been more cost-effective than the traditional visit-after-visit care (Silvo et al. 2008). They calculated this as based on the time spent by the professionals and the expenses of the treatments. Nevertheless, the comparison of these two treatment options and the costs are not straightforward. It must be taken into account that when the dental treatment succeeds with basic behaviour guidance techniques, the patient will simultaneously learn to control his/her dental fear. These behavioural guidance techniques have to be repeated over several separate appointments after DGA.

As much as 90% of the patients of the 2001 study group had at least one visit during which preventive treatment were given within two years prior to having DGA. Of the mean of 5.1 visits, preventive treatments were given in 2.2 of the visits, which for high caries-risk children is not enough. Preventive treatments preceding DGA were even rarer

for uncooperative children. These findings are in line with previous studies, which have shown that the caries-preventive treatment practices of dentists do not necessarily correlate with meeting the needs of high-caries patients and dentists tend to concentrate on operative treatments (Varsio et al. 1999, Helminen and Vehkalahti 2003). Dentists should consider the possibility to start first with the preventive treatments in order to familiarize the child to dental care,. This approach could possibly decrease the number of missed appointments, which occurred in the previous dental care for 31% of the children in the 2001 study group.

Treatments under DGA

The DGA care for patients in 2001, 2004 and 2010 study groups was comprehensive and conservative, and it also included some preventive treatments. Restorations dominated over tooth extractions and endodontics in the study groups of all three periods, this frequency order being the same as reported in most of the earlier studies, which consider comprehensive DGA (see Table 1).

The mean number of restorations in the 2001, 2004, and 2010 study groups for generally healthy children varied between 5.5–6.0, compared with a range of between 1.7–2.0 tooth extractions, 0.4–0.6 fissure sealants and between 0.5–1.0 for endodontics in 2004 and 2010. Comparison of the children receiving various treatments under DGA as well as the mean number of the treatments performed showed differences between age groups, which indicated different eruptional stages at the dentition. Filling therapy and endodontics dominated for 0–5-year-old generally healthy children in 2004 and 2010, and for 0–13-year-olds sealants in all three compared periods. The 6–13-year-olds received more endodontics in 2004 than in 2010. The overall number of the treatments children received under DGA was great, and for immigrant children it was even greater than for non-immigrants. This finding is in line with that given in a report from Denmark (Haubek et al. 2006).

Dental care after DGA

The long-term outcome of the DGA process was positive as most of the patients could subsequently be treated under routine conditions of dental care. Over one tenth of the patients in follow-up needed no operative treatment during their follow-up period, and for one fourth the first treatment need did not arise until two years after the DGA treatment. Unfortunately, the critical phase in the DGA process seems to be the childrens' return to their home dental clinic. Although three out of four of the children and their parents attended the postoperative review visit at the recommended time, the first visit to home dental clinic was far later than originally scheduled. This delay adversely affected the scheduled intensified preventive care and familiarization plan.

Certain measures and factors to achieve better compliance in returning to the scheduled postoperative visit have been suggested. These include having a home dental clinic and a

consultation visit before the DGA treatment (Primosch et al. 2001, Mathu-Muju et al. 2010). Both these factors already exist in the Helsinki PDS, and can partly explain the better compliance of returning to postoperative review visits than reported in the majority of the earlier studies. However, the problem facing the Helsinki PDS is the delay in the post-DGA appointments to the home dental clinic. This highlights the need for improving the procedures in the DGA process. The parents or guardians of the children and the oral health care professionals in child's home dental clinic must commit to further intensified preventive care and for the children to become familiarized to normal dental care after DGA. The visit to the home dental clinic after DGA should not rely on the parents to organize it, so either an automatic recall system should be implemented, or the appointment time given to parents during the postoperative review visit.

The immigrant children unexpectedly showed better compliance in attending the postoperative review visits than did the non-immigrants after DGA. In other respects the immigrant children did not differ from non-immigrant children in follow-up.

The mean time elapsed to the first treatment need after DGA was 18.5 months. Unfortunately for 39% of the children, the first treatment need occurred within a year of having the treatment under DGA and for half of these during the first six months, which can be considered as alarming. The Vantaa PDS study reported that 50% of the children who visited dental care within one year of having DGA were treated for new caries lesions, fracture of the filling, or toothache (Silvo et al. 2008). The reason or reasons for the treatment need in the present study (e.g. fracture of the filling, extraction needed, recurrent caries or new caries lesion in earlier sound or unerupted tooth) were not recorded, so the reasons that lead to treatment need so soon can not be identified from these results. More endodontics were performed in generally healthy children in 2004 than in 2010, therefore one might expect this to influence upon an early treatment need. However, the treatments given under DGA in the 2004 study group did not explain the variation in time elapsed from DGA to the first subsequent need for treatment (IV). A study from Canada that was published in 2010 reported that the number of extractions, pulpotomies, and preformed metal crowns performed under DGA were not associated with a caries relapse (Amin et al. 2010). However, the significance of the recalls was pointed out in that study. Of the patients who attended at least one recall within one year, fewer had caries lesions than those who attended recalls at a later date. This finding is reinforced by data from a study in the USA, which showed that those patients who failed to attend the postoperative visit were more likely to relapse (Foster et al. 2006).

The early need for operative treatments in the present study and the large proportion of emergency treatments after DGA calls for more evaluation of the treatments performed under DGA. One factor that can contribute to the early need for operative treatments, can be that radiographs were not taken under DGA in the 2004 study group. A study from the UK showed that four out of seven intra-operative radiographs led to a change in the treatment plan (Keene et al. 2012). The practice has been changed in the Helsinki PDS

since 2004, and in 2010 as many as 172 radiographs were taken from among a total of 349 patients. Other factors that contribute to the outcome are proper assessment, long-lasting materials, and better treatment practices. In addition, competence of the dentist in performing the dental assessment prior DGA and the treatments given under DGA can contribute to the outcome of DGA. The guidelines from Great Britain and Ireland for the management of children referred for dental extractions under general anaesthesia, was first published in 2011, and have since been recently reviewed (Adewale et al. 2016). These state that the 'dental assessment should ideally be performed by a specialist in paediatric dentistry or a dentist who can demonstrate the necessary competences to carry out comprehensive treatment planning for children who require general anaesthesia. Where the assessing dentist is not a specialist, support from a specialist or consultant should be readily available, if required, through established clinical networks. Access to other specialities, such as orthodontics, oral surgery and maxillofacial surgery should also be available for all children'.

There are no national guidelines that consider the competences of the dentist performing assessments and the DGA treatments in Finland. The major reason is that there is a shortage of specialized dentists in paediatric dentistry, which is a sub-speciality in addition to there being shortages in all other specialist fields in dentistry in the whole country (The Ministry of Social Affairs and Health 2013). For example, 0.2% of all dentists in Finland, 0.7% in the UK, and 1% in Sweden, have a speciality in paediatrics (Kravitz et al. 2015, The Finnish Dental Association 2015). The assessment and the treatments in the Helsinki PDS are performed by either a specialist or dentist specializing in paediatric dentistry, a general dentist experienced in DGA, or sometimes by a dentist specialized in other fields, for example oral and maxillofacial surgeon. If needed, the assessment and the treatments under DGA given to children, adolescents and adults are performed in collaboration with dentists of several specialities.

The mean time elapsed after DGA to the detection of new caries in early childhood caries children in USA was 17.7 months (Almeida et al. 2000), but that study included only 42 subjects. Another study from USA reported notable success for early childhood caries children, of whom only 26% developed new caries within 3 year after DGA (Jamieson and Vargas 2007). Unfortunately the small number of the children in follow-up after 3 years (only 5% of the sample) does not allow the generalizations of those findings to be made. Emergency visits were needed for over half of the children after DGA in the 2004 study. A study from USA reported that 13% of the 217 children treated under DGA returned for an emergency visit during a 3-year follow-up (Jamieson and Vargas 2007).

Most of the generally healthy children in the 2004 study were treated under routine dental care after DGA as only 11% had to have a repeat DGA. Nevertheless, many of the DGA patients continued to challenge their dental care by manifesting uncooperation and dental fear. Additionally two-thirds of patients missed their scheduled appointments. The 2004 study group differed from those of 2001 and 2010 study groups as conscious sedation had

been used more in their previous dental care. Moreover, uncooperation and dental fear were more frequent reasons for DGA for children in 2004 than in 2010. This could indicate that the children of the 2004 study group had more problems in dental care before the DGA treatment than had the children in other two study years. However, this difference can not be inferred from the study data.

DGA should be considered as a new starting point for dental care. However, DGA does not diminish dental fear as reported for children younger than 7 years of age (Klaassen et al. 2009), thus dental fear must be controlled after the DGA treatment. Unfortunately, as many as 87% of the children in 2004 study group, were not given familiarization in order to control their possible dental fear during the follow-up after postoperative review visit. One reason for why dentists did not use the familiarization strategy may be because dentists gave operative treatments in preference to prevention. Another reason is that the children and the parents or guardians did not show up for their scheduled recall appointments. Failure to turn up for appointments have been shown to be associated with children's dental fear and behavioural management problems (Klingberg et al. 1994, Klingberg et al. 1995, Skaret et al. 1999), this vicious circle clearly shows the need for new strategies to reach such patients after DGA. Missing appointments can also be a sign of a dental neglect. A systematic review of features for dental neglect by Bhatia and colleagues identified the following factors: 'delay in seeking treatment for significant dental caries or trauma, failure to complete a recommended course of treatment, or allowing the child's oral health to deteriorate avoidably' (Bhatia et al. 2014). Dental neglect has been defined by the British Society of Paediatric Dentistry as 'the persistent failure to meet a child's basic oral health needs, likely to result in the serious impairment of a child's oral or general health or development' (Harris et al. 2009), and dental neglect forms one category of child maltreatment. Dental neglect has been identified in 10% of the children in Sweden treated under DGA (Kvist et al. 2014b). However, Swedish dentists reported a suspicion of child maltreatment being both an ethical and a clinical dilemma (Kvist et al. 2014a).

The Child Welfare Act in Finland stipulates that all health professionals must report any suspicion of child maltreatment to social services. If the 7–18-year-old misses a dental appointment twice in the Helsinki PDS, the parents or guardians are contacted by phone to in order to ascertain the reason for missing appointments and to schedule a new appointment. If the parents or guardians can not be contacted by this means, a letter is sent to them which details the missed appointments and of the importance of the oral health care with a request to book a new appointment time. If the parents or guardians still do not get in touch, then a new appointment time will be sent by letter again reminding them of importance of oral health care and the parent's or guardian's responsibility for the child's welfare and health care. This note also describes the obligations under the terms of the Child Welfare Act for health professionals to report to social services, when the dental appointments are still ignored or missed.

Almost all children received prevention after DGA. Even so, the high-caries risk children might have benefited from receiving more frequent preventive care guidance, since during the approximate 48 months follow-up, the children had a mean of 9.7 visits to the PDS and of those visits 4.9 included prevention. This preventive care intensity was similar to that reported for 3-year-olds in USA (Almeida et al. 2000). The authors of that study found no significant effect of the interval upon the development of new caries lesions in early childhood caries. Short-term improvement in compliance with dietary and/or oral self-care recommendations after DGA have been reported by parents from USA, Israel, and Canada (Sheehy et al. 1994, Peretz et al. 2000, Primosch et al. 2001, Amin and Harrison 2006, Peerbhay 2009, Almaz et al. 2014), but such compliance must be continuously reinforced.

The DGA process in the PDS

The DGA process in Helsinki PDS seemed to have changed and improved from 2001 to 2010. However, there are some aspects that still need more consideration. The preventive dental treatments before DGA were underused for these children, especially for the uncooperative patients. The treatments performed under DGA and the materials used must be evaluated to ensure any early treatment for an impairment that arises after DGA. The scheduled intensified preventive care plan after DGA did not materialize for many of these children. The difficulties also continued after DGA as over half of the children expressed uncooperation and dental fear at their dental visits and two thirds missed their appointments. The presence of these behavioural management problems, familiarization with dental care in order to control dental fear was infrequent.

Despite the aspects in the DGA process that still require improvement, the DGA treatment is an essential part of the PDS care. It gives a chance for generally healthy children to get out of the vicious circle of unsuccessful dental care and to help the children return back to routine dental care.

CONCLUSION AND RECOMMENDATIONS

Prior to DGA generally healthy childrens' problems in dental care had begun at early age and the challenge arose for PDS to reach these high-caries risk children earlier. The dental care given before DGA had been very difficult because of uncooperation and dental fear, and those reasons also led to the use of DGA. Prevention would have served as a gentle way to familiarize children to dental care, but unfortunately operative treatments seemed to dominate over prevention especially with uncooperative patients. Most of the children could be treated under normal dental settings and procedures after DGA and two out of five needed no operative treatments within two years of DGA. However, some DGA treated children experienced new treatment needs as early as six months after DGA. The mean time after the DGA to the first visit to the home dental clinic was far longer than recommended and thus delayed the start of intensified preventive care and familiarization to dental care. Further, after children returned to their home dental clinic, familiarization and prevention was generally overlooked in the treatment course. More than half of the children still expressed uncooperation and dental fear at their dental visits and two thirds missed their appointments after DGA.

There are some aspects in DGA process that need more consideration, but DGA is an essential part of the PDS care. The availability of DGA gives a chance for generally healthy children to get out of the vicious circle of unsuccessful dental care and to help those children return back to routine dental care.

Some recommendations can be made based on the data of this study, which are the following:

1. DGA could probably be avoided for generally healthy children. Such a situation calls for the implementation of local strategies on oral health combined with collaboration among professionals for reaching the high-caries-risk children earlier. Special attention is needed with immigrant families to integrate them into dental care.

2. The first visits to dental care should be stress-free, comfortable and be designed to create confidence for every child in order to prevent dental fear and uncooperation in the future.

3. Preventive treatments could serve as a gentle less traumatic way to familiarize child with a dental care.

4. Painless care should be the primary objective as pain is an important reason for difficulties in dental care.

5. The DGA patients' problems in dental care had begun at early age, therefore it is important to seek and treat the uncooperation and dental fear effectively.

6. The treatment regimen performed under DGA should be planned to guarantee long-lasting oral health, in order to provide enough time to familiarize the child to dental care at subsequent appointments and avoid any emergency treatments after DGA.

7. During the whole DGA process, parents and guardians along with oral health care professionals in child's home dental clinic should be further committed to intensified preventive care for the child. The children should be reassured, encouraged and motivated to attend appointments and receive prevention and treatment.

SUMMARY

DGA is used in Finland when other treatment modalities are insufficient to perform dental care. The indications for DGA in Finland follow the international guidelines, and the dental care is comprehensive. All the necessary treatments, including preventive care, are performed at the same visit.

This study focused on DGA care performed in the Helsinki PDS. Helsinki PDS clinics provide DGA service for ASA 1 and 2 patients. The DGA process in the Helsinki PDS aims to ensure that as many patients as possible can be treated in the normal dental settings in the future.

The aims of the study were to describe the characteristics of the DGA patients, the parents' descriptions of their children's previous dental care, and to assess the dental care that precedes DGA, the reasons for having to resort to DGA, the treatments performed under DGA, and finally to evaluate the long-term outcome of DGA. The study used the data from generally healthy children and adolescents (0–13 years of age), for whom DGA may possibly have been avoided. The working hypotheses were that dental fear is the main reason for DGA, that the dental care that preceded DGA has mostly consisted of restorations and tooth extraction at the expense of preventive care, and that after DGA most of the patients can be treated under normal dental settings and procedures and that they receive intensified preventive care.

The patients' characteristics, the reasons for ending up having DGA, and the treatments performed under it were detailed and assessed in study groups for the sample years 2001, 2004, and 2010. The 2001 and 2004 study groups included only all of the generally healthy children treated under DGA during those years, whereas the 2010 study group comprised all the patients treated under DGA during that year including some less healthy patients. The dental care of the patients treated under DGA in 2001 for two years prior to DGA visit was evaluated. In addition, the parents' descriptions of these children's previous dental care experiences were assessed by means of a questionnaire. The patients' dental care for the 2004 study group were evaluated for five years following DGA. The longitudinal comparisons of the study groups consisted of the characteristics, reasons for DGA, previous conscious sedation and DGA, and also the treatments performed under DGA for generally healthy children.

Most of the patients treated under DGA in Helsinki PDS were generally healthy children in 2010. The majority of the adult DGA patients had chronic medical conditions, physical or intellectual disabilities, or mental or behaviour disorders or any combination of these. The proportion of immigrants among the 0–5-year-old populations of generally healthy DGA children increased from 30% in 2004 to 51% in 2010. The first difficulties in the child's dental care started before the age of three for about 40% of the children treated in

2001. Conscious sedation had been used when trying to treat them prior to DGA for more than half of the patients. Parents ranked dental fear followed by pain as the most important reason for previous unsuccessful dental treatments in generally healthy children in 2001. The most frequent reasons for the referrals for DGA treatment in 2004 and 2010 were extreme uncooperation, extreme dental fear and need for extensive treatment. A new reason 'avoidance of dental fear' became prominent in 2010. Restorations, followed by tooth extractions, dominated in the treatment-mix performed under DGA. The treatment need was extensive, especially so for immigrants compared to non-immigrants. The patients mean first visit to the respective home dental clinic after DGA occurred far later than recommended, thus delaying or disrupting the scheduled intensified preventive care. The mean time elapsed to the first subsequent operative treatment need (filling therapy, endodontics and/or tooth extraction) was 18.5 months. The first treatment needed during follow-up occurred within one year for 39% of the children, and for half of these during the first six months. Half of the patients had visits during which they expressed dental fear and/or uncooperation or needed emergency treatment. Familiarization in order to control dental fear was only given to 13% of the patients during appointments after postoperative review visit. Patients had missed at least one appointment before (31%) and after (65%) DGA process.

Compared to the working hypothesis mentioned earlier extreme uncooperation was the most frequent reason for having DGA, followed by dental fear. Prior dental care that involved DGA had mostly consisted of operative treatments at the expense of preventive care. Most of the patients were treated under normal dental settings after DGA, but when taking into account their baseline dental status and high risk of caries, the preventive care visits were largely overlooked. The findings presented the reasons for DGA and the treatments under it are consistent with the previous findings. A new reason category; 'avoidance of dental fear' was introduced.

This study presents new knowledge about dental care before and after DGA. The difficulties in dental care before DGA had begun at an early age. One out of six patients needed no operative treatment during the five year follow-up after DGA, and one out of four needed operative treatment after two years. On the other hand, two out of five needed operative treatment within a year of having DGA, and one in five even required treatment during the first six months. There were few preventive care visits with respect to patients' need. Familiarization to dental care received little attention, and difficulties in dental care also continued after DGA. DGA could probably be avoided in generally healthy children, if the PDS could reach these children and recognize their special needs earlier than hitherto has been the case. Special attention is needed with immigrant families. There are some aspects in the DGA process that still need improvement. However, DGA is an essential part of the PDS for those patients, whose dental care can not be performed otherwise.

TIIVISTELMÄ

Yleisanestesiassa tehtävään hammashoitoon päädytään Suomessa, kun muut keinot hammashoidon toteuttamiseen eivät riitä. Hoitoon ottamisen kriteerit noudattavat kansainvälisiä suosituksia, ja annettava hoito on kokonaishoitoa. Kaikki tarvittavat toimenpiteet, mukaan lukien ehkäisevä hoito, tehdään samalla käynnillä.

Tämä tutkimus kohdistui Helsingin kaupungin suun terveydenhuollossa toteutettavaan yleisanestesiahammashoitoon. Helsingin kaupungin suun terveydenhuollon hoitolat tarjoavat yleisanestesiahammashoitoa ASA 1 ja ASA 2 -potilaille. Yleisanestesiahammashoidon prosessi Helsingin kaupungin suun terveydenhuollossa pyrkii varmistamaan, että mahdollisimman moni potilas pystytään hoitamaan tavalliseen tapaan jatkossa.

Tutkimuksen tavoitteina oli kuvata yleisanestesiahammashoitopotilaiden taustoja, vanhempien kokemuksia lastensa aikaisemmasta hammashoidosta sekä arvioida yleisanestesiahammashoitoa edeltänyttä hammashoitoa, yleisanestesiahammashoitoon päätymisen syitä, yleisanestesiahammashoidossa tehtyjä toimenpiteitä ja lopuksi yleisanestesiahammashoidon pitkän aikavälin tuloksia. Tutkimuksessa käytettiin yleisterveistä lapsista ja nuorista (0–13-vuotiaat) koostuvaa aineistoa, koska heillä yleisanestesiahammashoito olisi mahdollisesti voitu välttää. Työhypoteeseina oletettiin, että hammashoitopelko on yleisin syy yleisanestesiahammashoitoon päätymiseen, potilaiden aikaisempi hammashoito on lähinnä keskittynyt paikkauksiin ja poistoihin ehkäisevän hammashoidon kustannuksella ja että yleisanestesiahammashoidon jälkeen suurin osa potilaista voidaan hoitaa tavanomaiseen tapaan vastaanotolla, ja he saavat tehostettua ehkäisevää hoitoa.

Potilaiden taustoja, yleisanestesiahammashoitoon päätymisen syitä sekä siinä tehtyjä toimenpiteitä arvioitiin yksityiskohtaisesti tutkimusryhmittäin vuosilta 2001, 2004 ja 2010. Vuoden 2001 ja 2004 aineistoissa olivat mukana vain kaikki kyseisenä vuonna yleisanestesiassa hoidetut yleisterveet lapset ja nuoret, kun taas vuoden 2010 aineisto koostui kaikista sinä vuonna yleisanestesiassa hoidetuista potilaista mukaan lukien yleissairaat potilaat. Yleisanestesiahammashoitoa edeltävää hammashoitoa arvioitiin vuonna 2001 hoidettujen potilaiden osalta kahdelta vuodelta ennen yleisanestesiahammashoitoa. Lisäksi näiden lasten vanhempien kokemukset aiemmasta hoidosta selvitettiin kyselytutkimuksella. Vuoden 2004 tutkimusryhmän potilaiden hammashoidon toteutumista arvioitiin viiden vuoden ajalta yleisanestesiahammashoidon jälkeen. Yleisterveiden lasten ja nuorten tutkimusryhmien väliset pitkittäisvertailut vuosien välillä käsittivät taustat, syyt, aiemmat esilääkitys- ja yleisanestesiahammashoidot sekä hoitotoimenpiteet.

Suurin osa Helsingin terveyskeskuksessa yleisanestesiassa hoidetuista potilaista vuonna 2010 oli yleisterveitä lapsia ja nuoria. Yleisanestesiassa hoidetuista aikuisista suurimmalla osalla oli krooninen yleissairaus, fyysinen tai älyllinen kehitysvamma, mielenterveyden tai käyttäytymisen häiriö tai useampi edellisistä. Ulkomaalaistaustaisten alle 6-vuotiaiden yleisterveiden lasten osuus kasvoi vuosien 2004 ja 2010 välillä 30 prosentista 51 prosenttiin yleisanestesiassa hoidetuista samanikäisistä potilaista. Hammashoitovaikeudet alkoivat jo ennen kolmatta ikävuotta noin 40 prosentilla vuonna 2001 yleisanestesiassa hoidetuista lapsista. Ennen yleisanestesiahammashoitoa yli puolta potilaista oli yritetty hoitaa esilääkityksessä. Vanhempien mielestä hammashoitopelko ja kipu olivat suurin syy aikaisempiin epäonnistuneisiin hammashoitoihin vuonna 2001 hoidetuilla yleisterveillä lapsilla. Lähetteiden perusteella yleisimmät syyt yleisanestesiahammashoitoon vuosina 2004 ja 2010 olivat hyvin vaikea yhteistyökyvyttömyys, hammashoitopelko ja laaja hoidon tarve. Uusi syy ”hammashoitopelon välttäminen” yleistyi vuonna 2010. Yleisanestesiassa tehtiin yleisimmin paikkauksia ja poistoja. Hoidon tarve oli suuri, etenkin ulkomaalaistaustaisilla verrattuna kantaväestöön. Yleisanestesiahammashoidon jälkeen potilaat palasivat omaan hammashoitolaansa paljon suositeltua myöhemmin, jolloin näille potilaille suunniteltu tehostettu ehkäisevä hoito viivästyi tai jäi toteutumatta. Ensimmäinen operatiivinen hoidontarve (paikkaus, juurihoito ja/tai hampaanpoisto) todettiin potilailla keskimäärin 18,5 kuukauden kuluttua yleisanestesiahammashoidosta. Potilaista 39 prosentille hoidontarvetta tuli ensimmäisen vuoden aikana ja heistä puolelle kuuden kuukauden sisällä. Puolella potilaista oli hammashoitopelko-, yhteistyökyvyttömyys- ja ensiapukäyntejä yleisanestesiahammashoidon jälkeen. Hammashoitoon totuttelemiskäyntejä hammashoitopelon hallitsemiseksi oli vain 13 prosentilla potilaista jälkikontrollin jälkeen. Yleisanestesiassa hoidetut potilaat olivat jättäneet tulematta ainakin yhden kerran hammashoitoon sekä ennen yleisanestesiahammashoidon prosessia (31 %) että sen jälkeen (65 %).

Aikaisemmin mainittuun työhypoteesiin verrattuna vaikea yhteistyökyvyttömyys oli yleisin syy yleisanestesiassa tehtävään hammashoitoon, ja hammashoitopelko oli toiseksi yleisin syy. Hammashoito ennen yleisanestesiaa oli keskittynyt operatiiviseen hoitoon ehkäisevän hoidon jäädessä vähäiseksi. Yleisanestesian jälkeen suurin osa potilaista pystyttiin hoitamaan tavanomaisesti, mutta ottaen potilaan suun lähtötilanne ja suurentunut kariesriski huomioon, ehkäisevän hammashoidon käyntejä oli tarpeeseen nähden liian vähän.

Nyt esitetyt havainnot yleisanestesiahammashoitoon päätymisen syistä ja yleisanestesiassa tehdyistä toimenpiteistä ovat yhteneväisiä aikaisempien tutkimustulosten kanssa. Uutena syynä ilmeni ”hammashoitopelon välttäminen”. Tämä tutkimus tuo uutta tietoa yleisanestesiahammashoitoa edeltävästä ja sen jälkeisestä hammashoidosta. Ennen yleisanestesiahammashoitoon päätymistä hammashoito-ongelmat olivat alkaneet jo hyvin varhaisessa vaiheessa. Yleisanestesiahammashoitoa seuraavina viitenä vuotena joka kuudes potilas ei tarvinnut operatiivista hoitoa, ja joka neljännelle operatiivisen hoidon tarvetta tuli kahden vuoden jälkeen. Toisaalta vuoden sisällä

yleisanestesiahammashoidosta operatiivista hoitoa tarvitsi kaksi viidestä, ja joka viides potilas tarvitsi hoitoa jopa puolen vuoden sisällä. Ehkäisevän hammashoidon käyntejä oli tarpeeseen nähden liian vähän. Totuttelu hammashoitoon jäi vähemmälle huomiolle, ja hankaluudet hammashoidossa jatkuivat myös yleisanestesian jälkeen. Yleisanestesiahammashoitoon päätyminen olisi ilmeisesti ehkäistävissä osalla yleisterveistä lapsista, mikäli suun terveydenhuolto tavoittaisi heidät ja tunnistaisi heidän erityistarpeensa aikaisemmin kuin tähän mennessä. Erityistä huomioita tulisi kiinnittää ulkomaalaistaustaisiin perheisiin. Yleisanestesiahammashoidon prosessissa on edelleen kehittämistä vaativia kohtia. Silti tämä hoitomuoto on tärkeä osa terveyskeskuksen suun terveydenhuollossa tarjottavaa hoitoa niille potilaille, joiden hammashoito ei muuten onnistu.

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