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Preventive aspects in children's caries treatments preceding dental care under general anaesthesia

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Background. In Helsinki Public Dental Service (PDS) the Special Oral Health Care Unit (SOHCU) provides comprehensive dental treatments under general anaesthesia (GA). For the present study, all dental treatment given under GA for generally healthy children ($n = 102$) below 16 years of age (range 2.3–15.8) during a 1-year period and dental treatment and visits of these children in the preceding 2 years in Helsinki PDS was recorded in detail. These children were referred to the SOHCU because of serious difficulties in dental care due to large treatment needs or failures in psychological and chemical management, including sedation.

Aim. To describe treatments given to generally healthy children under GA and to evaluate preventive aspects of their dental care in the preceding 2 years.

Design. The study was cross-sectional and retrospective. Data came from the patients' individual records.

Results. Treatments under GA included an average of 6.0 restorations (SD = 2.7, range 0–12) and 1.7 extractions (SD = 2.1, range 0–10). In the 2 preceding years, these children had visited dentist an average of 5.1 times (SD = 2.7, range 1–14) with an average of 2.4 restorations (SD = 1.9, range 0–12) and 0.5 extractions (SD = 1.4, range 0–10). Of the restorations made, 36% were temporary. Of all visits, those with an operative approach accounted for 35%, preventive for 37%, operative and preventive for 5%, and visits with total uncooperation for 23%. Of the children, 90% had at least one preventive visit. Children treated under conscious sedation in the preceding 2 years received less prevention ($P = 0.02$). Remaining without preventive measures was most likely for those children exhibiting visits with total uncooperation (odds ratio = 4.6; $P = 0.004$) and for those receiving numerous temporary fillings (odds ratio = 4.1; $P = 0.0005$).

Conclusions. The uncooperative high-caries children pose a demanding challenge to PDS. The early identification of high-caries risk and efforts of intensive preventive care are in key position to reduce the number of children receiving treatment under GA due to high levels of dentinal decay.

Introduction

The most common indications for children's dental care under general anaesthesia (GA) are the extensive need of dental treatments, the presence of dental fear or problems related to general health, conditions following extensive orofacial or dental trauma, and noncooperation due to a child's young age in the treatment of early childhood caries[1–5]. For adolescents, untreated severe tooth decay is largely a consequence of long-term avoidance of dental care[6]. The well-known risk factors preceding the onset of dental caries at early ages are less-than-daily tooth brushing, the lack of fluorides, the presence of visible plaque, and a cariogenic diet[7,8]. To ignore these factors over the long-term may result in an extensive need of operative treatments and also treatments under GA. Earlier studies have shown that children with caries in their primary dentition run an increased risk of developing future carious lesions[9,10].

To our knowledge, no previous study exists about the visits and treatments prior to GA treatment; however, changes in oral health-related quality of life following children's dental treatment under GA have been reported[11]. Our earlier study showed that the most important factors leading to the use of GA, as reported by the parents, are dental fear and repeated unpleasant experiences during dental care[12].

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The aim of this study was to describe caries treatments given to generally healthy children under GA and to evaluate preventive aspects of their dental care in the preceding 2 years. Our hypothesis was that dental care for this specific group of high-caries patients mainly consists of operative treatments at the expense of dental prevention.

Materials and methods

Background

General anaesthesia treatments (around 200 per year) are a small but essential part of the Helsinki Public Dental Service (PDS). In 2001, a total of 128 410 patients visited Helsinki PDS, of them 59 041 were below 16 years of age[13]. Majority of patients treated under GA came from this age group. In the Helsinki PDS, any dentist facing serious difficulties with a child's dental treatment, such that dental treatment does not succeed under local anaesthesia or conscious sedation, can refer that child to Special Oral Health Care Unit (SOHCU) of the PDS. The SOHCU specialist will assess treatment options individually for every child referred.

Children referred to SOHCU receive their GA appointment within a week in cases of pain, swelling, or trauma, or in 2–3 months with a preceding consultation appointment first. Dental treatment under GA in Helsinki PDS is comprehensive and aims to cut the progress of caries. Therefore, the child and the parents receive proper instructions on home-care and diet at three occasions in the SOHCU: at the consultation appointment, immediately after the GA, and at the follow-up appointment with a dental hygienist.

Subjects

The data covered 1-year dental treatments under GA and in the preceding 2 years for children up to 16 years of age who were referred to the SOHCU because of serious difficulties in dental care due to large treatment needs or failures in psychological and chemical management, including sedation. For the present study, those treated under GA due to serious general or mental diseases, or to medically compromising conditions were excluded. In total, the data included 102 generally healthy patients (47 boys and 55 girls) treated under GA during 1 year. Dental caries (dt + DT) described the number of all decayed teeth, primary and permanent. As described earlier the mean number of dt + DT was 7.7 (SD = 3.0), with no difference according to gender and age[12]. For the corresponding age groups, the official statistics by the Helsinki PDS in 2001 gave as the mean numbers of dt + DT and dmft or DMFT for 0- to 6-year-olds, 0.4 and 0.4, and for 7- to 12-year-olds, 0.7 and 0.8, and for 13- to 15-year-olds, 0.8 and 2.2, respectively[13].

We determined a child's age on the day of treatment in GA with an accuracy of 1 month. In the analyses, age was categorized into two: those below 7 years of age, and those aged 7–16 (the latter being obligatory ages for school attendance in Finland). Children's mean age at the time of GA treatment was 6.4 (SD = 2.6) years; 6.9 (SD = 3.1) for boys and 6.0 (SD = 2.1) for girls ($P = 0.06$)[12].

Treatments under GA

Patients' individual records related to the GA appointment served as the data source. Based on the dental chart, the numbers of teeth were recorded separately for primary and permanent teeth. As described earlier the mean number of primary teeth for the age group below 7 years was 17.7 (SD = 3.0), and of permanent teeth, 0.8 (SD = 2.1); for the age group 7–16 years, 10.1 (SD = 5.8) and 13.1 (SD = 6.7), respectively[12]. Regarding the treatments given under GA, we drew from the patient records the numbers of teeth filled and the size of the fillings, the numbers of teeth extracted separately for primary and permanent teeth, and the number of sealants placed.

Treatments and visits in the preceding 2 years

Data of dental treatments and visits and missed appointments in the preceding 2 years at Helsinki PDS were based on patients' individual records. The time was restricted to 2 years, because electronic dental records from that time were available. One child's previous dental record was missing. We recorded the

Table 1. Description of dental treatments the children (*n* = 102) received under GA according to gender and age.

Treatment	All *n* = 102 Mean (SD)	Boys *n* = 47 Mean (SD)	Girls *n* = 55 Mean (SD)	< 7 years *n* = 63 Mean (SD)	7–16 years *n* = 39 Mean (SD)
Restorations (all)	6.0 (2.7)	6.3 (2.6)	5.8 (2.7)	6.0 (2.6)	6.0 (2.8)
By type of restoration					
1 surface restoration	2.7 (2.2)	2.7 (2.3)	2.6 (2.0)	2.5 (2.2)	2.9 (2.1)
2 surface restorations	2.8 (2.0)	3.0 (2.2)	2.6 (1.9)	3.0 (2.1)	2.5 (1.9)
3 surface restorations	0.4 (0.9)	0.4 (0.8)	0.4 (1.0)	0.4 (0.9)	0.5 (0.9)
4–5 surface restorations	0.1 (0.4)	0.1 (0.3)	0.1 (0.4)	0.1 (0.4)	0.2 (0.4)
By type of tooth					
Restorations of primary teeth	4.9 (3.1)	4.8 (3.3)	4.9 (2.9)	5.9 (2.7)	3.2 (2.9)*
Restorations of permanent teeth	1.2 (2.2)	1.5 (2.5)	0.9 (1.7)**	0.1 (0.6)	2.8 (2.7)***
Tooth extractions (all)	1.7 (2.1)	2.0 (2.3)	1.5 (1.9)	1.5 (1.8)	2.1 (2.5)
Primary teeth	1.5 (1.9)	1.7 (2.2)	1.3 (1.7)	1.5 (1.8)	1.5 (2.2)
Permanent teeth	0.3 (0.8)	0.3 (0.7)	0.2 (0.8)	0.0 (0.0)	0.6 (1.1)
Sealants	0.4 (1.1)	0.4 (1.1)	0.4 (1.1)	0.2 (0.7)	0.8 (1.5)

Statistical evaluation by ANOVA, separately for differences by gender and age. *$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

number of restorations, temporary restorations and extractions and visits, and the use of conscious sedation. We classified the visits as follows:

1 Operative visit solely: the patient had received dental treatment (restoration or temporary restoration or tooth extraction or all) successfully.
2 Preventive visit solely: the patient had received at least one of the following: proper homecare instructions, fluoride varnish, sealant treatment, and cleaning of the teeth by dental staff.
3 Both operative and preventive visit: including options 1 and 2.
4 Total uncooperation: a visit where a patient's uncooperation restricted or prevented dental treatment altogether.
5 Missed appointments: the patient failed to show to appointment or call about cancelling it.

Ethical consideration

The City of Helsinki Health Centre granted ethical permission for this study. Parents gave their written consent to their child's enrolment and to drawing details from their child's dental records for this study.

Statistical analyses

Statistical analyses included *t*-test and analysis of variance (ANOVA) for the evaluation of differences between the subgroups in mean values and the chi-squared test in frequencies. The logistic regression model showed the strength of factors related to ending up with no prevention during the past 2 years. For the model, number of visits was coded as its reversed form to describe as having had fewer visits. The terms of the model provided odds ratios (OR) and their 95% confidence intervals (95% CI).

Results

Table 1 describes the treatments given under GA by gender and age. The mean number of restorations was 6.0 (SD = 2.7) and tooth extractions, 1.7 (SD = 2.1), both with no gender and age differences. Treatments for primary teeth dominated among restorations and extractions made.

In the preceding 2 years, these children had visited the dentist an average of 5.1 (SD = 2.6) times. Of the children, 90% had at least one visit with a preventive approach, with no gender differences. Table 2 shows details of the visits and the dental treatments received. The 7- to 16-year-olds had more missed appointments (1.3 vs. 0.2; $P = 0.003$) and more dental visits for preventive care solely (2.3 vs. 1.6; $P = 0.05$). There were no differences in the degree of caries in children who had more or less visits with preventive approach.

Of all appointments in the preceding 2 years, those with an operative approach only accounted

Table 2. Description of the number and content of visits and treatments in the 2 years preceding children's (*n* = 101) dental care under general anaesthesia.

	All *n* = 101	Below 7 years *n* = 63	7–16 years *n* = 38	*P*-value*	Cooperative *n* = 41	Uncooperative *n* = 60	*P*-value†
All visits	5.1 (2.6)	4.7 (2.6)	5.7 (2.7)	0.19	4.4 (2.8)	5.6 (2.4)	0.02
Missed appointments	0.6 (1.4)	0.2 (0.5)	1.3 (2.1)	0.003	1.0 (1.9)	0.4 (0.9)	0.04
Visits by content							
Restorations and extractions; no prevention	1.8 (2.1)	1.8 (2.2)	1.9 (1.9)	0.07	1.9 (2.5)	1.7 (1.8)	0.69
Restorations, extractions, and prevention	0.3 (0.6)	0.3 (0.7)	0.1 (0.3)	0.16	0.2 (0.5)	0.3 (0.6)	0.96
Prevention solely	1.9 (1.4)	1.6 (1.1)	2.3 (1.6)	0.05	2.2 (1.2)	1.6 (1.4)	0.03
Total uncooperation	1.2 (1.2)	1.0 (1.1)	1.5 (1.4)	0.25	0	2.0 (0.9)	
Treatment							
Restorations	1.6 (2.5)	1.7 (2.7)	1.4 (2.1)	0.07	1.8 (2.5)	1.4 (2.4)	0.38
Temporary restorations	0.9 (1.2)	0.9 (1.3)	0.8 (1.2)	0.75	0.8 (1.3)	1.0 (1.2)	0.41
Extractions	0.5 (1.4)	0.6 (1.3)	0.4 (1.6)	0.72	0.9 (2.1)	0.3 (0.6)	0.05

Statistical evaluation by ANOVA.*difference by age; †difference according to cooperation.

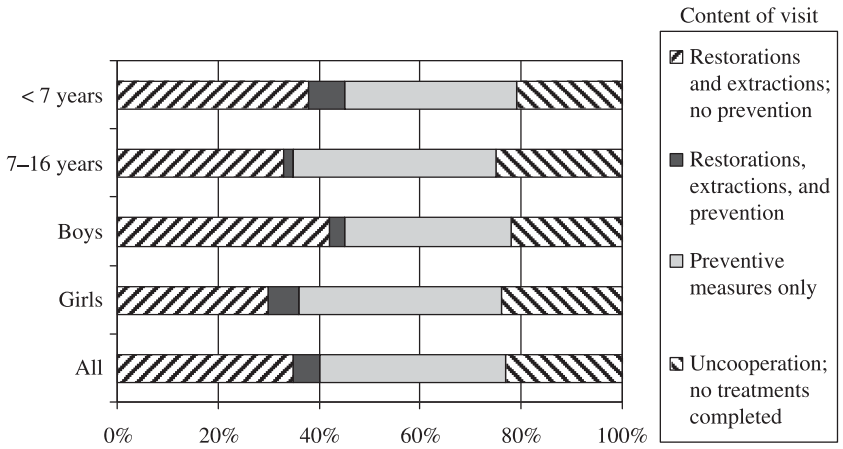

Fig. 1. Distribution (%) of dental visits by their content in the 2 years preceding children's (*n* = 101) GA treatment and by age and gender.

for 35%, those with a solely preventive approach, for 37%, those with both an operative and preventive approach, for 5%, and those with total uncooperation, for 23% (Fig. 1).

In the preceding 2 years, 59% of children had been totally uncooperative at least in one visit. Table 2 shows that the uncooperative children had more visits (5.6 vs. 4.4; $P = 0.02$) and fewer missed appointments (0.4 vs. 1.0; $P = 0.04$). The cooperative children had more visits with a solely preventive approach (2.2 vs. 1.6; $P = 0.03$).

Half of the children had been treated under conscious sedation during the preceding 2 years. Treatment under conscious sedation was more frequent among children under 7 years of age than in the older age group (57% vs. 34%; $P = 0.04$). Those treated under conscious sedation during the preceding 2 years had fewer preventive visits (1.9 vs. 2.6; $P = 0.02$) and more operative visits (3.0 vs. 1.7; $P = 0.008$).

Missed appointments accounted for 11% of all appointments; 5% for children under 7 years of age, and 18% for the 7- to 16-year-olds. Of the children, 31% had missed one or more appointments. Those who had received treatment under conscious sedation had fewer missed appointments ($P = 0.001$).

A logistic regression model revealed three strong factors related to receiving no prevention in the dental care in the past 2 years (Table 3). Children exhibiting visits with total uncooperation (OR = 4.6; $P = 0.004$) and those receiving greater numbers of temporary fillings

Table 3. Odds ratios for children (*n* = 101) receiving no preventive measures during dental care in the 2 years preceding their caries treatment under general anaesthesia, as explained by their gender and age, dental findings, and visit history, by means of a logistic regression model.

	Estimate of strength		Odds ratio (OR) and its 95% confidence interval		
Factors and their categories	**Estimate**	**SE**	**OR**	**95% CI**	***P*-value**
Gender: 1 = boy, 2 = girls	0.15	0.87	1.2	0.2,6.4	0.86
Age in years	0.06	0.16	1.1	0.8,1.5	0.70
No. of teeth with decay	0.19	0.15	1.2	0.9,1.6	0.20
Dental care in past 2 years					
Fewer visits	0.99	0.34	2.7	1.4,5.2	0.004
No. of visits with uncooperation	1.52	0.53	4.6	1.6,12.8	0.004
No. of temporary restorations	1.41	0.40	4.1	1.9,9.1	0.0005
Constant term	–18.72	5.46			

(OR = 4.1; $P = 0.0005$) were most likely to remain without preventive measures. In addition, those with fewer visits were more likely (OR = 2.7; $P = 0.004$) to end up to no-prevention care.

Discussion

The present study supports earlier findings of children treated under GA due to high levels of dentinal decay[14–16]. High-caries adolescents are most likely to miss appointments[17] and their treatment courses often remain incomplete[18]. In this present study, the 7- to 16-year-old children had missed more appointments than had the younger ones, thus supporting previous findings of an increase in missed appointments after age 12[17]. A possible explanation could be that younger children tend to come to appointments with their parents, but the older children usually must manage their visits by themselves.

As shown earlier for Sweden, children with behaviour management problems are younger, have missed more appointments, and have received restorative treatment without local anaesthetics[19]. Unfortunately, Finnish dentists use local anaesthetics least for patients under 13 years of age[20] which may later arise behaviour management problems. For this present study, appointments with total noncooperation accounted for 23% of all appointments. Together with missed appointments (11%), this means wasted resources of PDS. In Helsinki PDS, missed appointments generally accounted for 6% of all appointments in 2001[13].

In Helsinki PDS, conscious sedation is largely used when treating children with cooperation problems in dental care. Half of the patients in our study had received dental treatment under conscious sedation in the 2 years preceding the GA treatment, but these children had few preventive appointments. This finding is in line with earlier findings among 6-year-old noncooperative high-caries patients whose dental visits mostly served for operative treatment[18].

During the past decade, caries occurrence in children has declined in Western Europe[21] probably due to preventive instructions and treatments[22]. Nevertheless, a minority of children has excessive amounts of caries[18,23]. Most of the children in the present study had received some preventive treatment in the 2 preceding years. Despite the number of operative and preventive treatments they received in those 2 preceding years, the present children's need for treatment remained severe until the GA appointment. Previous studies have shown that dentists' caries-preventive treatment practices do not necessarily correlate to patients' needs[18,23]. The high-caries children seem not to respond to normal preventive care, so there is a need for special preventive programmes for such patients[24], especially because previous studies have shown how

difficult it is to change parents' and their children's dietary and homecare habits and to improve the effectiveness of children's tooth brushing practices[25,26].

On the other hand, Hausen *et al*.[27] reported no additional benefit obtained by intensifying caries prevention as compared with basic prevention given to high-risk children treated at PDS. The problem among our high-caries children, however, was the prolonged lack of prevention for the uncooperative children. That again calls for new methods in dental care to encourage cooperation of such patients and, thus, ensure early detection, prevention, and treatment of dental caries among them. In addition, the numerous untreated caries lesions may have been painful and, thus, led to insufficient oral self-care as well.

The children in our study have certainly had problems in dental care even before the 2 years prior the GA treatment, but the electronic dental records covered the last 2 years only. Unfortunately, the records provide no information about parents' socio-economic status which, according to a recent study from Sweden, is related to a higher risk of caries among adolescents from working-class homes[28]. In Helsinki PDS, a new project under the theme 'Positive discrimination' was recently initiated to allocate healthcare resources and prevention to those city districts with the lowest socio-economic status. Nevertheless, early assessment of high-caries risk subjects and primary prevention (before the onset of caries) are key in reducing the number of high-caries patients[18,29,30] and should be emphasized in dental care for all children.

According to our findings, dentists seem to prefer operative treatment for uncooperative high-caries children. However, more emphasis on a solely preventive approach may instead introduce a gentler way of learning 'normal behaviour' in the dentist's chair, and thus cut the chain of failures at dental visits.

The uncooperative high-caries children pose a demanding challenge to PDS. The early identification of high-caries risk and efforts of intensive preventive care are in key position to reduce the number of children receiving treatment under GA due to high levels of dentinal decay.

What this paper adds
- Uncooperative high-caries children use lots of PDS resources.
- The preventive care for high-caries children failed to cut the progress of caries.

Why this paper is important to paediatric dentists
- To fill in the gap of knowledge about the visits and the treatments prior to GA treatment.
- To emphasize the role of early identification of increased risk of caries.
- To encourage dentists to cut the caries circle by intensive preventive efforts.

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References

1 Murray JJ. General anesthesia and children's dental health: present trends and future needs. *Anesth Pain Control Dent* 1993; **2**: 209–216.
2 Jamjoom MM, Al-Malik MI, Holt RD, El-Nassry A. Dental treatment under general anaesthesia at a hospital in Jeddah, Saudi Arabia. *Int J Paediatr Dent* 2001; **11**: 110–116.
3 AAPD. Clinical guideline on elective use of conscious sedation, deep sedation and general anesthesia in pediatric dental patients. *Pediatr Dent* 2003; **25**: 75–81.
4 Clewett JA, Treasure ET. A retrospective study of dental general anaesthesia carried out in children living in North Wales 1995–98. *Community Dent Health* 2004; **21**: 212–216.
5 Brander-Aalto K, Hölttä P, Alapulli H, Alaluusua S. General anaesthesia in paediatric dentistry. *Finnish Dent J* 2005; **5**: 250–256. (Abstract in English)
6 Skaret E, Weinstein P, Milgrom P, Kaakko T, Getz T. Factors related to severe untreated tooth decay in rural adolescents: a case-control study for public health planning. *Int J Paediatr Dent* 2004; **14**: 17–26.
7 Alaluusua S, Malmivirta R. Early plaque accumulation – a sign for caries risk in young children. *Community Dent Oral Epidemiol* 1994; **22**: 273–276.
8 Harris R, Nicoll AD, Adair PM, Pine CM. Risk factors for dental caries in young children: a systematic review of the literature. *Community Dent Health* 2004; **21** (1 Suppl.): 71–85.
9 Alaluusua S, Kleemola-Kujala E, Nyström M, Evälahti M, Grönroos L. Caries in the primary teeth and salivary *Streptococcus mutans* and lactobacillus levels as indicators of caries in permanent teeth. *Pediatr Dent* 1987; **9**: 126–130.
10 Li Y, Wang W. Predicting caries in permanent teeth from caries in primary teeth: an eight-year cohort study. *J Dent Res* 2002; **81**: 561–566.

11 Anderson HK, Drummond BK, Thomson WM. Changes in aspects of children's oral-health-related quality of life following dental treatment under general anaesthesia. *Int J Paediatr Dent* 2004; **14**: 317–325.
12 Savanheimo N, Vehkalahti MM, Pihakari A, Numminen M. Reasons for and parental satisfaction with children's dental care under general anaesthesia. *Int J Paediatr Dent* 2005; **15**: 448–454.
13 City of Helsinki Health Centre. *Official Statistics*. Helsinki, Finland, 2001.
14 Smallridge JA, Al Ghanim N, Holt RD. The use of general anaesthesia for tooth extraction for child outpatients at a London dental hospital. *Br Dent J* 1990; **168**: 438–440.
15 Vermeulen M, Vinckier F, Vandenbroucke J. Dental general anesthesia: clinical characteristics of 933 patients. *J Dent Child* 1991; **58**: 27–30.
16 Vinckier F, Gizani S, Declerck D. Comprehensive dental care for children with rampant caries under general anaesthesia. *Int J Paediatr Dent* 2001; **11**: 25–32.
17 Skaret E, Raadal M, Kvale G, Berg E. Missed and cancelled appointments among 12–18-year-olds in the Norwegian Public Dental Service. *Eur J Oral Sci* 1998; **106**: 1006–1012.
18 Varsio S. Caries-preventive treatment approaches for child and youth at two extremes of dental health in Helsinki, Finland. Academic Dissertation, University of Helsinki, 1999. Available at http://ethesis.helsinki.fi/julkaisut/laa/hamma/vk/varsio/.
19 Klinberg G, Vannas Löfqvist L, Bjarnason S, Norén JG. Dental behavior management problems in Swedish children. *Community Dent Oral Epidemiol* 1994; **22**: 201–205.
20 Palotie U, Vehkalahti M. Restorative treatment and use of local anesthesia in free and subsidized public dental services in Helsinki, Finland. *Acta Odontol Scand* 2003; **61**: 252–256.
21 Downer MC, Drugan CS, Blinkhorn AS. Dental caries experience of British children in an international context. *Community Dent Health* 2005; **22**: 86–93.
22 Petersson HG, Bratthall D. The caries decline: a review of reviews. *Eur J Oral Sci* 1996; **104**: 436–443.
23 Helminen SKJ, Vehkalahti MM. Does caries prevention correspond to caries status and orthodontic care in 0- to 18-year-olds in the free public dental service? *Acta Odontol Scand* 2003; **61**: 29–33.
24 Splieth CH, Nourallah AW, König KG. Caries prevention programs for groups: out of fashion or up to date? *Clin Oral Investig* 2004; **8**: 6–10.
25 Hunter ML, Hood CA, Hunter B, Kingdon A. Reported infant feeding, oral hygiene and dental attendance patterns in children aged 5 years and under referred for extraction of teeth under general anaesthesia. *Int J Paediatr Dent* 1997; **7**: 243–248.
26 Peretz B, Faibis S, Ever-Hadani P, Eidelman E. Dental health behavior of children with BBTD treated using general anesthesia or sedation, and of their parents in a recall examination. *J Dent Child* 2000; **67**: 50–54.
27 Hausen H, Kärkkäinen S, Seppä L. Application of the high-risk strategy to control dental caries. *Community Dent Oral Epidemiol* 2000; **28**: 26–34.
28 Källestål C. The effect of five years' implementation of caries-preventive methods in Swedish high-risk adolescents. *Caries Res* 2005; **39**: 20–26.
29 Brambilla E, Garcia-Codoy F, Strohmenger L. Principles of diagnosis and treatment of high-caries-risk subjects. *Dent Clin North Am* 2000; **44**: 507–540.
30 Wendt L-K, Carlsson E, Hallonsten A-L, Birkhed D. Early dental caries risk assessment and prevention in pre-school children: evaluation of a new strategy for dental care in a field study. *Acta Odontol Scand* 2001; **59**: 261–266.