Early dental caries risk assessment and prevention in pre-school children: evaluation of a new strategy for dental care in a field study

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The aim of the present field study was to evaluate a new strategy for the dental care of pre-school children which includes an early caries risk assessment and early preventive care. One hundred and sixty-seven children were studied from 1 to 6 years of age (intervention group). A group of 125 children from the same clinic (historical control) was used as a comparison group. On the basis of the clinical examinations of the children and the interviews with the parents when the children were 3 years of age, the children in the intervention group were divided into four different risk groups: no ($n = 95$), low ($n = 33$), moderate ($n = 30$), and high caries risk ($n = 9$). Only 8 of the 95 children who had been placed in the no caries risk group at 3 years of age developed manifest carious lesions in their primary cuspids and molars by 6 years of age. At 6 years of age 81% in the intervention group were free of manifest carious lesions, compared with 55% in the comparison group ($P < 0.001$). Furthermore, the mean numbers of defs were 0.6 for children in the intervention group and 2.7 in the comparison group. Thus, this field study indicates that early primary prevention (before the onset of caries attack) and a structured and systematic approach to dental care for pre-school children result in good oral health for the children and may be economically profitable for a society with organized public dental service for pre-school children. ☐ *Caries prevalence; epidemiology; field study; pre-school children; risk assessment*

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A decrease in caries prevalence in the child population was anticipated in the late 1970s (1) and has since been confirmed in the Scandinavian countries by many authors (2–4). The prevalence of caries in children, however, increases from 3 years of age to the age when the primary dentition exfoliates, even though they attend dental service programs yearly (2, 5, 6). Furthermore, it has been shown that the progression rate of proximal carious lesions in primary molars is comparatively high (7, 8). Thus, dental caries remains a common disease during childhood.

In Sweden the county councils are responsible for providing dental care free of charge for all individuals between 0 and 19 years of age (9). Organized dental care, including prevention and annual visits to a Public Dental Service (PDS) clinic, are supposed to begin at 3 years of age, whereas the guiding principles for children below this age should be health promotion and disease prevention. During the 1990s the PDS in Sweden was faced with budget cutbacks. This resulted in the cessation of dental care activities for children less than 3 years old in many parts of Sweden. There is therefore a need to provide dental care efficiently and to change the clinical and administrative routines in the PDS clinics.

During the past decade several authors have suggested that all children should have their first dental visit at 1 year of age (10–14). Such an early visit gives the dental staff an opportunity to give parents anticipatory guidance and instructions in preventive care that are relevant for their young child. There is as yet no documentation, however, showing that such early appointments and dental care significantly reduce caries prevalence during early childhood and prevent future caries experience in the general population of pre-school children.

In the community of Jönköping, Sweden, a series of longitudinal studies on oral health and its determinants in pre-school children has been conducted (6, 15–19). In these studies 661 children were followed up from 1 to 6 years of age. Results from these investigations were used to develop guidelines for the dental care of pre-school children on the basis of risk assessment and preventive dental care. The aim of the present field study was to evaluate a new strategy for dental care in pre-school children, which included early caries risk assessment and early preventive care, and to evaluate the total time spent by dental personnel in the dental care of 1- to 6-year-old children.

Subjects and methods

Background

In the previous series of longitudinal studies in pre-school children born in 1987 and living in the districts of

Table 1. Caries prevalence in the primary dentition of children 1, 2, and 3 years of age in the neigborhood of the test clinic and of the three other clinics

	Test clinic	Three other clinics
No. of children	127	430
Children with initial or manifest caries at 1 year of age (%)	1.8	0.2
Children with initial or manifest caries at 2 years of age (%)	14.3	7.4
Children with manifest caries at 3 years of age (%)	19.7	10.7

four different PDS clinics in the community of Jönköping it was shown that the children living in one of these districts had more carious lesions at 1, 2, and 3 years of age than the children living in the other three districts (Table 1). This first clinic was chosen for the present investigation. The number of immigrants in the neighborhood of the clinic was equivalent to the average number of immigrants in Sweden (approximately 20%). The new strategy for dental care for 3-year-old children implemented in 1990 was soon modified to begin with 1-year-old children.

Intervention and comparison groups

This study is classified as a non-randomized study with historical controls in accordance with the Swedish Council on Technology Assessment in Health Care (20). Thus the oral health variables of the 6-year-old children in the study (called the intervention group; $n = 167$) were compared with those of children in the same clinic, who were 6 years of age in 1990 (called the comparison group; $n = 125$) before the new strategy was implemented. In the comparison group there was no systematic assessment/treatment of patients at risk. Data on the number of children free from manifest carious lesions and mean number of defs at 6 years of age in the comparison group were collected from the database for oral health variables in Jönköping County, which is based on examinations by several different dentists.

Intervention group

All children in the neighborhood of the selected PDS clinic and born in 1992, a total of 193 children, were chosen to participate in the present field study. At 6 years of age 24 children had moved from the community, and 2 children (both caries-free at 7 years of age) were not examined, due to non-appearance. Thus, a total of 167 children were examined at 6 years of age. The children were, on the average, 72 months (range, 70–76) old at the clinical examination.

Clinical examination and diagnostic criteria

One and the same dentist (L.-K. Wendt) carried out all the examinations of the 3- and 6-year-olds. The examiner was calibrated for clinical and radiographic examination of children 1–6 years of age in connection with a study running parallel to the present study (6). Caries was registered clinically and radiographically in accordance with a modification of the criteria stated by Koch (21) and described in detail by Wendt et al. (6). For the defs (decayed, extracted, and filled surfaces) index, molars extracted owing to caries were counted as five surfaces. So that teeth that exfoliated during the study period would not affect the results, only registrations of caries on any of the surfaces of the primary cuspids and molars were used in the analyses at 6 years of age.

A radiographic examination was always made in 3- to 5-year-olds if the child had new visible carious lesions (initial or manifest) and proximal contacts between molars. At 5 years of age all children who had proximal contacts between their molars and who were assessed as having a moderate to high caries risk (see below) were examined radiographically. At 6 years of age all the children in the four groups were examined radiographically. At the radiographic examination two posterior bitewing radiographs were taken, and a special film-holder (Kwik-Bite, Trollhätteplast, Sweden) was routinely used.

Design of the study

Parents and children had their first appointment with the dental assistant at the Child Welfare Center when the children were 1 year of age and at the PDS clinic when the children were 2 years of age. On these two occasions the parents were interviewed about the oral hygiene and dietary habits of their children, and the buccal surfaces of the upper incisors of the children were inspected. Children with initial or manifest carious lesions or with visible plaque were immediately treated by the dentist at the PDS clinic. In light of the interview and the clinical examination information about preventive dental care was given to those parents who needed information. All the parents were encouraged to start brushing their children's teeth twice a day at 1 year of age with a small amount of fluoridated toothpaste.

At 3 years of age all the children were invited for an interview and a dental examination by the dentist. On the basis of the examination and the interview, the children were assigned to one of the following four risk groups: i) no caries risk, ii) low caries risk, iii) moderate caries risk, and iv) high caries risk. The risk assessment was made in accordance with the following four background factors: 1) odontological factors such as visible caries, visible plaque, and gingivitis; 2) behavioral factors such as oral hygiene habits, dietary habits, and use of fluoride; 3) social factors such as difficulty in understanding the language and attitudes and the dental knowledge of the parents; and finally, 4) medical factors such as chronic disease and/or medication with drugs that have an inhibiting effect on saliva secretion. The results of the risk assessment at 3

Table 2. The caries risk assessment was based on the clinical examination and interview at 3 years of age. The children were divided into four risk groups in accordance with caries prevalence and number of risk factors

Caries risk group	Caries-free	Initial carious lesions	Manifest carious lesions	Zero risk factors	Few risk factors (1–3)	Several risk factors (>3)
1. No caries risk	X			X		
2. Low caries risk	X				X	
3. Moderate caries risk						
Alternative 1	X					X
Alternative 2		X		X		
Alternative 3		X			X	
4. High caries risk						
Alternative 1		X				X
Alternative 2			X	X		
Alternative 3			X		X	
Alternative 4			X			X

Table 3. Manifest caries prevalence in the primary cuspids and molars of 6-year-old children in accordance with the risk assessment at 3 years of age. The children were divided into four caries risk groups on the basis of the criteria given in Table 2

		Caries prevalence (manifest caries) at 6 years of age			
Caries risk at 3 years of age	No. of children	No carious lesions (%)	No. of defs (mean)	Children with six or more defs (%)	No. of defs in children with manifest caries (mean)
No caries risk	95	92	0.1	0	1.5
Low caries risk	33	84	0.3	0	1.8
Moderate caries risk	30	63	0.8	3	2.2
High caries risk	9	33	4.4	56	6.7
All children examined	167	81	0.6	4	2.9

years of age are shown in Table 2, and the number of children in the different risk groups in Table 3.

Children with *no caries risk* were those who were caries-free at 3 years of age, had no risk factors, and were predicted to develop no carious lesions until 6 years of age. They were recalled yearly to the dental assistant for check-ups.

Children with *low caries risk* were also caries-free at 3 years of age but had 1–3 risk factors for developing caries, such as visible plaque or no use of fluoride. They were recalled for individual preventive dental care twice a year by the dental assistant. The most frequent preventive dental care at these visits was the practical training of the parents in how to brush the child's teeth. At the end of every visit a fluoride varnish (Duraphat®, Inpharma AS, Lier, Norway) was applied to the child's teeth.

Children with *moderate caries risk* were those who had more than three risk factors (alternative 1) or initial or arrested carious lesions at 3 years of age (alternative 2 or 3). For the different alternatives, see Table 2. They were recalled once yearly to the dentist for examination and four to five times a year to the dental assistant for individual preventive care such as information, parental training in toothbrushing, professional tooth cleaning, and application of the fluoride varnish.

Children with a *high caries risk* had initial carious lesions and several risk factors (alternative 1) or manifest carious lesions (alternatives 2–4) at 3 years of age They were immediately called to the dentist for restorative treatment and preventive dental care and were thereafter called to the dental assistant once a month to continue preventive dental care. Children belonging to this group were examined at least once a year by the dentist. Children with high caries risk were treated with a combination of 0.2% chlorhexidine and 0.2% sodium fluoride gel. The parents were encouraged to brush the teeth of the child

Table 4. Manifest caries prevalence in the primary cuspids and molars of 6-year-olds in the intervention and comparison groups in the present study, compared with the data from two other studies using the same diagnostic criteria

Children	Intervention group	Comparison group	Holst et al. (1999)	Wendt et al. (1999)
No. of children	167	125	213	575
Year born	1992	1984	1987	1987
Free from manifest caries	81%	55%	44%	57%
Mean number of defs	0.6	2.7	2.7	2.0

once a day with the clorhexidine-fluoride gel and once a day with conventional fluoridated toothpaste. This treatment continued for 6 to 12 months.

The judged severity of a single risk factor was not applicable for children with intake of sugar-containing liquids at night. Children with this habit were considered to have moderate caries risk, even if they had no carious lesions at 3 years of age.

If the dental assistant detected new carious lesions in a 4- or 5-year-old child, the child and the parents were immediately called to the dentist for examination, treatment, information to the parents, and a discussion on how to continue the preventive dental care. Every visit to the PDS clinic ended with a topical application of fluoride varnish.

The dentist again examined all the children in the four groups when they were 6 years old. In connection with this examination the parents were provided with anticipatory guidance in what to expect in their child's dental future.

Treatment time

The time required for regular treatment was obtained from the record of each child. This was possible because all treatments were carefully reported. Time was rounded up to the nearest 5 min for each visit. All time spent by the dentist and all time spent by the dental assistant were recorded separately for each member of the team. Time registered included all the time given to each child (time for examinations, dental treatment, prophylactic care, fissure sealing of primary molars, and non-appearance) and the time for the associated paper work. To interview the parents, to provide anticipatory guidance, and to clinically examine each child at 3 and 6 years of age, each member of the team (dentist and dental assistant) needed 20 min—a total of 80 min for both occasions.

Statistical method

The chi-squared test was used for the statistical evaluation. The level of significance was set at $P < 0.001$.

Results

Intervention group

The results are shown in Tables 3 and 4.The mean number of primary cuspids and molars in the 6-year-old children in the intervention group was 11.99 (range, 11.0–12.0). In one child a primary molar had been extracted owing to caries. Eighty-one per cent were free from manifest carious lesions in the primary cuspids and molars and 68% from initial and manifest carious lesions. The mean number of defs was 0.6. Proximal manifest carious lesions were registered in 16%, and the mean number of proximal defs was 0.3. Filled surfaces were found in 9% of the children, and the mean number of restored surfaces was 0.3. A total of 24 children (17%) had 164 primary tooth surfaces sealed. Radiographic examinations were performed in 59 of the children when they were 5 years of age. Proximal carious lesions were detected in 18 of these children (manifest caries in 8). Thus, signs of proximal carious lesions could not be found in 41 of the children. Of these 41, 1 child had developed proximal carious lesions at 6 years of age. The mean manifest caries increment between 3 and 6 years of age in the no caries risk group was 0.1, compared with 0.3, 0.8, and 3.8 in the low, moderate, and high caries risk groups, respectively.

Variation between intervention and comparison groups

The oral health variables of the 6-year-olds in the intervention group and in the comparison group are presented in Table 4. In the intervention group 81% of the 6-year-olds were free from manifest carious lesions, compared with 55% in the comparison group. Mean number of defs was 0.6 and 2.7, respectively. The differences were significant ($P < 0.001$).

Treatment time

The yearly mean treatment time needed for each child between 1 and 6 years of age (including the time needed for dental treatment at 6 years of age) was 12 min for the dentist and 42 min for the dental assistant.

Discussion

The results of the present investigation show that chair-side information (that is, an interview of the parents and a clinical examination of the child) can provide comprehensive knowledge of the child's future dental health without bacteriological or salivary tests. This is in accordance with studies in Finland (22, 23) and with the North Carolina Study (24, 25), which concluded that an experienced clinician could predict caries risk reasonably well without using any time- or money-consuming methods. In the present investigation only 8 of 95 children who were predicted to have no caries risk at 3 years of age developed manifest carious lesions in primary molars and cuspids by 6 years of age, and 5 of 6 children with six or more manifest carious lesions at 6 years of age had been predicted at 3 years of age to have high caries risk. A great number of the children, however, who had been assessed to have low, moderate, or high caries risk at 3 years of age were still free from manifest carious lesions in the primary molars and cuspids at 6 years of age. As the intention of the new strategy for dental care was to keep as many children as possible free from carious lesions, individual preventive programs were designed for all children assessed to have any caries risk at 3 years of age.

A weakness of the present study is that we did not use a randomized control group. According to Horowitz (26), however, 'the studies that are done [to reduce the

incidence of early childhood caries should] determine the practical, real-world effectiveness of various behavioural and chemotherapeutic interventions, rather than the true efficacy interventions under ideal, controlled conditions. This because it may be possible to predict, in part, which population groups or even which children are likely to develop early childhood caries. With the knowledge that various categories of caries preventive agents are likely to reduce the incidence of early childhood caries, justification does not exist for withholding treatments in control groups'.

Nevertheless, the use of a historical control group creates some problems. As the control group was not stratified into risk groups, the risk classification cannot be evaluated. An additional concern is that the caries reduction can be due to a general decrease in caries prevalence. However, this may not be the case, as the time elapsed between the examination of the children in the comparison and the intervention group was relatively short. Moreover, the caries prevalence in the comparison group is similar to the caries prevalence in pre-school children in other studies in Sweden within the time period (26, 27). Furthermore, the children in the intervention and comparison groups lived in an area where no changes in the social structure had occurred in the past decade.

The result can also be compared with those of three recently published Swedish studies, using the same diagnostic criteria as in the present study (6, 27, 28). In the study by Hugoson et al. (27) 48% of the 5-year-olds were caries-free (initial carious lesions included), compared with 68% of the 6-year-olds in the present study. Holst et al. (28) found a mean of 2.7 defs in 6-year-olds, compared with 0.6 in the present study (Table 4). An earlier study by Wendt et al. (6) on the oral health of 6-year-olds in the same area as that of the present study showed a lower frequency of caries-free children. In that investigation 57% of the 6-year-olds were free from manifest carious lesions in primary molars and cuspids, and the mean number of manifest defs was 2.0. This should be compared with 81% and 0.6, respectively, in the present study (Table 4). Furthermore, only 4% of the children in the present study had developed six or more carious lesions by 6 years of age, and the mean number of defs in the primary molars and cuspids of children with manifest carious lesions was 2.9, compared with 11% and 4.6 defs in the earlier investigation in the same area (6). In the present study only 1 of 41 children who were caries-free at the radiographic examination at 5 years of age had developed proximal carious lesions by 6 years of age. This is in agreement with a study by Roeters et al. (29). In that study only 10% of the 5-year-olds who were caries-free at the clinical examination had proximal carious lesions detected at the radiographic examination. This should be compared with 59% of the 5-year-olds who had visual dentinal carious lesions or restorations. It therefore seems unnecessary to examine radiographically caries-free children annually, even if their caries risk is assessed to be moderate. It should be remembered, however, that both in the study by Roeters et al. (29) and in the present study the caries prevalence in the child population was low, and the children received regular preventive dental care. In a study of 5-year-olds Moberg Sköld et al. (30) detected almost twice as many carious lesions when the clinical recording was supplemented with bitewings. In their study, however, the PDS clinic did not use risk assessment and rarely examined pre-school children radiographically.

Several studies have shown that children with caries in the primary dentition are more likely to develop caries in their permanent teeth (31, 32). Furthermore, it has been shown that caries-related habits established during infancy are maintained throughout childhood (19) and that conditions established in the early pre-school years provide the foundation for caries-related habits in later childhood and even adult years (33). Thus, it seems reasonable to presume that the most important target groups for instituting preventive dental care are infants and toddlers. The intention is therefore to continue to examine the children in the present study regularly to ascertain whether preventive dental care during early childhood will also prevent dental carious lesions in the permanent dentition in later childhood.

The annual time spent per child from 1 to 6 years of age (including the dental treatment and prophylactic care needed at 6 years of age) was about 12 min for the dentist and about 42 min for the dental assistant (including the time needed to assist the dentist). As far as we know, no previous study has investigated the time needed for dental treatment of children in the pre-school ages (from 1 to 6 years of age). In a study by Holst et al. (34) of 1- to 4-year-olds with traditional recall intervals (once yearly), the yearly treatment time was 15 min for the dentist and 23 min for the dental assistant, and in a study by Gisselsson et al. (35) of 4- to 6-year-old children the yearly treatment time for children with traditional recall intervals was 60 min for the dentist and 60 min for the dental assistant. The low treatment time for the dentist in the present study is probably due to the low need for restorative treatment and the extended recall intervals of children with no or low caries risk. It should, however be remembered that all the children in the study visit the PDS clinic at least once yearly.

To conclude, this field study indicates that early primary prevention (before the start of caries attack) and a structured and systematic approach to dental care for pre-school children results in good oral health for the children and may be economically profitable for a society with an organized public dental service for pre-school children. However, the effect of early risk assessment should be further investigated to improve evaluation of the risk classification system and the risk reductions achieved by preventive programs as well as economical consequences.

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