

# Variation in clinical time spent by dentist and dental hygienist in child dental care

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Wang NJ. Variation in clinical time spent by dentist and dental hygienist in child dental care. *Acta Odontol Scand* 1994;52:280-289. Oslo. ISSN 0001-6357.

In a field project in the Public Dental Service in Norway, 4000 children aged 5 to 18 years were examined and given preventive care by dental hygienists. The study describes the clinical time spent providing child dental care when hygienists examined all children and referred to dentists those children who required care hygienists were not qualified to deliver. Of all clinical time spent, 56% was dentist time and 44% was hygienist time. A high proportion of children without dental caries did not consume dentist resources at all. More than 40% of the dentist time was consumed by the 10% of the children with most new decayed teeth. In conclusion, the project showed that in a child population with low caries increment, a substantial proportion of children received all dental care from hygienists, so that dentist resources were saved for other groups. However, although hygienists were used as first-line personnel, a considerable quantity of dentist time was spent on dental care for children.

□ Age; personnel combinations; recall interval; resources

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In the Public Dental Service in Norway, dental care for children is delivered either by a dentist (assisted by a dental assistant) or by a dental hygienist.

The national health authorities in Norway have advised that procedures that both dentists and dental hygienists are qualified to perform should be delegated to hygienists, to increase efficiency (1). In addition to focusing on efficiency, political intents require resources to be redistributed from the healthy part of the population to groups with health problems (2).

In 1991 in Norway, 70% of the 5-year-olds, 60% of the 12-year-olds, and 45% of the 18-year-olds had no caries treatment need at the dental examination (3). This suggests that delegating routine examinations of children from dentists to dental hygienists in populations with low caries increments may be appropriate. The amount of dental hygienist resources necessary to provide such care and the proportion of children for whom hygienists can provide care influence the efficiency of the delegation.

Dental hygienists in Norway are less expensive to train and have lower salaries than dentists. They have 2 years of university

training and work under the general supervision of dentists. According to law, hygienists are permitted to perform all procedures for which the responsible dentists find them qualified (4). Irreversible procedures are not part of hygienist training, and delegation of restorative procedures does not occur. As the volume of restorative caries treatment decreases, the relative number of procedures that only dentists are qualified to perform decreases. Redistribution of work between personnel categories in child dental care has implications for future manpower requirements and for education of dental personnel.

Delegation of dental examination to hygienists is currently practiced to different extents depending on the availability of hygienists and the dentists' opinions about their performance capabilities. National statistics indicate that the relative numbers of hygienists and dentists vary considerably between districts in Norway (5). In the Public Dental Service, more hygienists per dentist have been shown to reduce dentist time spent for child dental care (6, 7). Few data are available concerning the volume of examinations provided by hygienists and the time

required by hygienists to render these services. Simulations based on estimated time has demonstrated savings of dentist resources when examinations are delegated to hygienists (8). Although not directly transferable to Scandinavian settings, U.S. studies suggest that hygienists increase the dentists' productivity (9-11).

The number of dental hygienists in Norway at present is limited, and in the Public Dental Service the number of hygienists corresponds to 15% of the number of dentists (5). Resources are thus not available to use hygienists for examination of all children. When planning and implementing use of hygienists, one strategy could be to have the hygienists care for those children to whom they are qualified to give all care. This would save extra visits for the children and administrative costs for the dental services. It would thus be useful to be able to identify groups of children for which hygienists are qualified to provide care.

To examine the extent to which clinical work can be delegated to dental hygienists and the consequences for resource spending, a field project launched by the Directorate of Health was carried out in the Public Dental Services in Norway. The purpose of the study was to describe the clinical time spent providing child dental care when hygienists examined all 5- to 18-year-old children and referred to dentists those children who required care hygienists were not qualified to deliver. An additional purpose was to examine how the proportion of children given all care by hygienists and the time spent by hygienists and dentists providing child dental care varied with the children's age, dental health, and dental health behavior and with the length of the interval since the previous dental examination.

## Materials and methods

### *Districts*

The field project in the Public Dental Service in Norway was carried out in the period 1989 to 1991 (12). The districts were chosen by the Directorate of Health as typical of districts in northern and southern Norway.

The districts were Northern Troms Dental Health District in rural, northern Norway and Solvang Dental Clinic in urban, southern Norway. All personnel in the districts, 12 dentists and 7 dental hygienists, were instructed to comply with the routines. According to statistics from 1991, the dental health of the children in the two districts was similar. In 1991, 68% of the 5-year-olds, 62% of the 12-year-olds, and 40% of the 18-year-olds in the districts had no new caries on dental examination.

### *Participants*

The study population comprised all children 5 to 18 years of age in the districts in 1991. Every second record in the files on children was included in the material. From 2030 records, data were copied by previously calibrated dental students following written instructions.

One hundred and eighty-eight records were not filled in according to the criteria given and were excluded from the material. From the remaining 1842 records, those of the children who were not given care in accordance with the described routines were excluded. Twenty-one children were examined by dentists, 29 children were not completely treated, 44 children had recall intervals shorter than 8 months, 69 children had recall intervals longer than 20 months, and 37 children who were examined only once in the 3-year period were thus excluded.

### *Routines*

All the children were examined by dental hygienists and, if required, referred to dentists for care. The dental hygienists examined the children and provided preventive care as necessary on one or more visits. The hygienists referred all children they did not feel competent to handle to dentists. In the project period the dental hygienists continued to refer to dentists on the basis of clinical judgement; no written criteria are used in the Public Dental Service. The hygienists determined the recall interval for the children for whom they provided all care, and the dentists determined the interval for

the children they treated. In both cases, the interval was decided after clinical assessment of each child.

At all routine examinations during the 3-year period the clinicians kept records in accordance with written criteria developed for the present research purpose. For each child, data on the second treatment sequence in the 3-year period were selected for analysis. It was felt that data from the first treatment sequence, when new routines were introduced, might be atypical. A treatment sequence was defined as a routine examination and any consequent dental treatment. All care of a child was defined as care the clinicians deemed necessary and planned to provide, on the basis of assessment of the child.

#### Variables

*Time.* The time spent by the dentists and the dental hygienists was registered in the records after every patient visit. The time was rounded up to the next 5 min for each visit. All time spent by the hygienists and all time spent by the dentists were summed for the treatment sequence. Time registered included all time used to give the child dental care and time for the associated paper work but excluded orthodontic treatment, which was provided by specialists.

*Age.* The age of the child was calculated by subtracting the year of birth from the year of the examination.

*Decayed teeth.* The number of new decayed teeth at examination was used as an indicator of the child's dental health. The number of new decayed deciduous teeth was used in children younger than 7 years of age and the number of new decayed permanent teeth in older children.

*Dental health behavior.* Dental health behavior was registered by the clinical examiners in accordance with the criteria established by the Directorate of Health (13). Each of the four items tooth brushing, interdental hygiene, use of fluoride vehicles, and information on sugar consumption was ranked by the hygienists on a scale on which 0 was good, 1 was satisfactory, and 2 was poor (13). To indicate dental health be-

Table 1. Description of the variables included in the analyses

	<i>n</i>	Mean	SD
New decayed teeth (DT/dt)	1617	1.1	1.9
Age (5-18 years)	1642	11.4	4.0
Recall interval (8-20 months)	1578	15.3	3.0
Hygienist minutes	1628	35.4	21.5
Dentist minutes	1642	44.6	71.1
Dental health behavior (%)			
Good	538	34	
Medium	832	52	
Poor	226	14	

havior, an additive index was constructed on the basis of the registrations of the four items. The scores were added, giving a range from 0 to 8. The children were then categorized as having good (values 0 to 2), medium (values 3 to 5), or poor (values 6 to 8) dental health behavior.

*Recall interval.* The recall interval was the time in months from the previous examination until the current examination. In the districts under study, the length of recall intervals for children with low disease activity was recommended to be 16 to 18 months. It is hypothesized that the length of the interval independently affects the time used to give children dental care by being a proxy variable for more complicated and thus time-consuming examinations and treatments.

Descriptive statistics of all the variables are given in Table 1.

#### Statistical methods

Data were examined by bivariate tabulation and charting, analysis of variance, multiple logistic regression analysis, and multiple linear regression analysis, using the JMP software package (SAS Institute Inc, Cary, N.C., USA). In some of the bivariate analyses, the number of new decayed teeth was dichotomized to no new decayed teeth versus one or more new decayed teeth. Logarithmic transformations of skewed variables were used to obtain normal distributions. When the associations between the variables were not linear, the independent variables

Table 2. Study variables on the basis of care provider

	Children given all care by hygienists			Children with hygienist and dentist time		
	<i>n</i>	Mean	SD	<i>n</i>	Mean	SD
New decayed teeth	706	0	0	911	2.0	2.2
Age	706	10.6	4.1	936	12.0	3.8
Recall interval	683	15.9	2.7	895	14.9	3.1
Hygienist minutes	706	31.7	18.2	923	38.2	23.4
Dentist minutes	706	0	0	936	78.2	79.0
Dental health behavior (%)						
Good	292	42		246	27	
Medium	350	50		482	54	
Poor	54	8		172	19	

were included in the multivariate regression as dummy variables.

In the logistic regression ratios are reported. An odds ratio of 1 indicates that the independent variable does not affect the dependent variable. The dependent variable in the logistic regression was the dentist time dichotomized as more than 0 min versus 0 min. The variable was coded as 0 for children given dental care by both dental hygienist and dentist and 1 for children given all care by the hygienist.

The level of statistical significance was set at 5%.

## Results

### Description

Forty-three per cent of the children were given all dental care by the dental hygienists, whereas 57% of the children were also referred to dentists. Table 2 shows, by care provider (hygienist versus hygienist and dentist), the number of new decayed teeth, age of the children, dental health behavior, length of recall interval, and time spent by hygienists and dentists. The hygienists spent 44% of all the time used for children's dental care to examine the children and to give all care to 43% of them. The dentists used the remaining 56% of the time to give the care that the hygienists were not qualified to provide. For the 57% of the children who were given care by both dentists and hygienists,

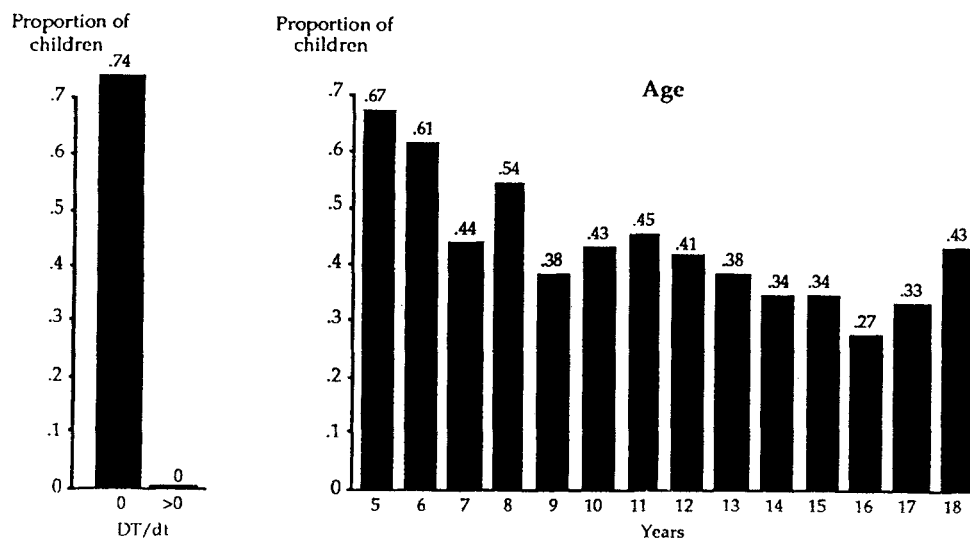
33% of all time spent was hygienist time, and 67% was dentist time.

### All care by hygienists

Fig. 1 describes how the proportion of children who were given care by the hygienists only—that is, the children who were not consuming dentist resources—varied with number of new decayed teeth, age of the children, children's dental health behavior, and length of recall interval. All the independent variables had in the bivariate analysis significant effect on the proportion of children given care by hygienists only ( $p < 0.05$ ).

Fig. 1 shows that, whereas children with new caries were referred to dentists, dental hygienists delivered all dental care to 74% of the children without new caries. For children without new decayed teeth the multivariate association between age, dental health behavior, recall interval, and the probability that a child was given all care by dental hygienists is shown in Table 3. The probability of a child without new decayed teeth being referred to a dentist was higher in the age groups 7 to 11 years and lower in the age groups 5 and 6 years than in the other age groups. The odds that all care was given by the hygienist decreased slightly with shorter recall interval. Children without new decayed teeth who were referred to dentists did not differ significantly from children who were given all care by hygienists with regard to den-

## New decayed teeth



## Dental health behavior

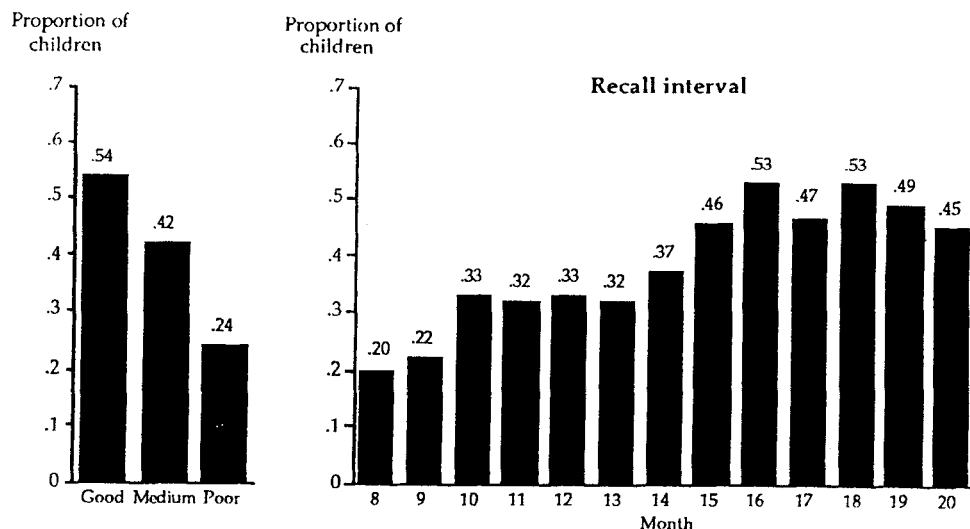


Fig. 1. Proportion of children given dental care only by hygienists by number of new decayed teeth, age, dental health behavior, and length of recall interval.  $P < 0.05$  for all variables.

tal health behavior. The three independent variables explained 4% of the variation in the probability that a child without decayed teeth received all treatment from hygienists.

## Dental hygienist time

Table 4 describes how the time spent by

dental hygienists per child varied with number of new decayed teeth, the children's age and dental health behavior, and the length of the recall interval. The mean time spent by hygienists on different groups of children was relatively constant, but within the groups the variation was wide (Table 4). The shortest hygienist time per child was spent on the

Table 3. Children without new decayed teeth ( $n = 909$ ). Probability that a child was given all care by hygienists. Multivariate logistic regression. 0 = referred to dentist; 1 = all care by hygienists. Odds ratios, unstandardized regression coefficients and standard errors

	Probability of all care given by hygienists		
	Odds ratio	Unstandardized regression coefficient	Standard error
Age, 5-6 years	0.57	-0.57*	0.16
Age, 7-11 years	1.96	0.67*	0.11
Age, 11-18 years	0.90	-0.11	0.12
Dental health behavior	1.06	0.06	0.13
Interval	0.94	-0.06*	0.03
Constant		-0.35	
			$R^2 = 0.04$

\*  $p < 0.05$ .

youngest and oldest children, children with good dental health behavior, and children with recall intervals of 15 to 18 months.

All the independent variables—number of new decayed teeth, age, dental health behavior, and length of recall interval—had independent significant effects on hygienist time (Table 5). The proportion of the variation in hygienist time spent per child explained by the independent variables was low (10%).

#### Dentist time

Table 4 describes the dentist time per child for children who were given treatment by dentists—that is, the children who after examination by the hygienists were referred to dentists. The mean time spent by hygienists on different groups of children varied widely, and within the different groups there was also wide variation. The dentist time per child increased with number of new decayed teeth and varied from less than 1 h in 6-, 9-, 10-, and 11-year-olds to more than 2 h in 16-year-olds. Dentist time increased with poorer dental health behavior, from 1 h in children with good dental health behavior to nearly 2 h in children with poor dental health behavior. More time was spent on children whose recall interval was longer than 18 months than for other children, and least time on children with an interval of 15 to 17 months.

The number of new decayed teeth, age of the child, and whether the recall interval was longer than 18 months were significantly related to dentist time when the other variables were controlled for (Table 5). Dental health behavior had no independent effect on dentist time when the number of new decayed teeth and length of interval were controlled for. All the independent variables explained 39% of the variation in dentist time per child.

## Discussion

### Methodologic considerations

The present project intended to control established working routines minimally and to examine the resource consumption under normal working conditions. The participating districts were invited by the Directorate of Health to implement the described routines because clinical facilities and personnel were available. As the districts were not randomly selected, the results cannot be generalized on statistical grounds. However, there is reason to believe that the analytical models provide reasonable specification of the underlying processes (14). In these districts the dental health of the children was similar to the national average, and the productivity was within the range reported from other clinics.

Table 4. Hygienist time per child. Dentist time per child who was referred to dentist. By number of new decayed teeth, age, dental health behavior, and length of recall interval

	Hygienist minutes			Dentist minutes		
	<i>n</i>	Mean	SD	<i>n</i>	Mean	SD
New decayed teeth (no.)						
0	956	33	20	250	50	52
1	223	36	21	223	50	41
2	149	34	20	149	59	49
3	109	40	22	109	86	57
4	67	40	26	67	120	83
5	51	47	28	51	168	108
6	20	42	27	20	153	70
7	20	47	27	20	221	110
8	7	37	24	7	302	139
9	6	43	20	6	208	57
10	2	38	11	2	370	106
11	1	55	-	1	80	-
12	3	100	106	3	188	51
13	2	25	7	2	290	325
16	1	45	-	1	210	-
Age (years)						
5	124	29	16	41	70	59
6	115	33	27	45	51	48
7	115	40	21	64	70	84
8	113	32	16	52	62	55
9	129	36	22	80	54	40
10	115	40	28	65	59	61
11	122	36	20	67	52	53
12	122	37	21	72	77	75
13	118	36	23	73	79	69
14	111	38	21	73	80	60
15	131	36	23	87	100	109
16	101	38	28	74	144	117
17	139	32	15	93	83	75
18	87	31	12	50	90	85
Dental health behavior						
Good	538	32	18	246	60	57
Medium	832	36	21	482	78	76
Poor	226	42	27	172	107	102
Recall interval (months)						
8	25	41	41	20	88	69
9	36	39	39	28	79	59
10	46	44	44	31	70	80
11	80	43	43	54	90	91
12	168	45	45	113	84	75
13	120	39	39	81	76	67
14	110	35	35	69	76	88
15	120	31	31	65	64	56
16	159	31	31	74	70	75
17	245	31	31	129	70	75
18	293	32	32	139	76	77
19	136	34	34	70	97	91
20	40	38	38	22	141	135

$p < 0.05$  for associations.

Table 5. Hygienist time for the children ( $n = 1531$ ). Dentist time for children who were referred to a dentist ( $n = 858$ ). Multivariate analysis. Degrees of freedom, sum of squares,  $F$  ratio, and level of statistical significance

	Degrees of freedom	Ln hygienist minutes		Ln dentist minutes	
		Sum of squares	$F$ ratio	Sum of squares	$F$ ratio
New decayed teeth	14	8.59*	2.80	168.47*	25.46
Age	13	11.17*	3.91	16.20*	2.64
Dental health behavior	2	2.21*	5.02	0.56	0.60
Interval	1	9.00*	41.00		
Interval ( $\leq 18$ months = 0, $> 18$ months = 1)	1			3.48*	7.36
			$R^2 = 0.10$		$R^2 = 0.39$

\* $p < 0.05$ .*All care by dental hygienists*

In this study, dental hygienists provided care for a large proportion of 5- to 18-year-olds; nearly half of the child population received dental care from dental hygienists only. As the proportion of children without new decayed teeth in this study was similar to the corresponding child population in the whole of Norway (3), the results suggest that nearly half of Norwegian children require only routine examination and the preventive care that hygienists can provide if the conditions are otherwise suitable. The results imply that if the proportion of children without new decayed teeth continues to increase, the proportion of children to whom hygienists can give all care will increase.

Twenty-six per cent of children without new caries were considered to require care that only the dentists were qualified to provide. This study does not explain why these children were referred to dentists. However, the fact that a higher proportion of referred children without new decayed teeth was aged 7 to 11 years may indicate that some referrals were for orthodontic reasons. It is also possible that in some cases a hygienist considered restorative treatment to be necessary and the dentist did not agree. For whatever reasons, a substantial proportion of children without new decayed teeth was seen by a dentist. The dentists gave 50 min of care to children without new decayed teeth, indicating that they required treatment for other reasons. This demand for dentist expertise for children without new

dental caries should be remembered when personnel resources are being allocated to child dental care.

The most important characteristic that determined whether hygienists delivered all care to children was the presence of new decayed teeth. It has been shown that experienced dentists are able to predict, in 68% of a child population, whether a child will develop cavities that need operative treatment at recall (15, 16). Clinical judgement of caries risk could therefore be one method of selecting children for recall to hygienists if hygienist resources are scarce.

*Clinical time*

This trial period lasted 3 years. The personnel was aware that their performance was being recorded, and their use of time may have been influenced by the project. However, any 'project effect' on time would have been non-differential, affecting all personnel groups and all children similarly, regardless of characteristics such as number of new decayed teeth or length of recall interval (17).

The relative amounts of hygienist and dentist time spent for child dental care in the project districts were nearly one hygienist hour per dentist hour. This indicates that at present in Norway, a team consisting of one dentist, one hygienist, and one dental assistant would be a suitable starting point if it is considered desirable to use hygienists as first-line personnel in child dental care.

### *Dental hygienist time*

Time spent by the dental hygienists did not vary much between groups of children. Regardless of age, dental health, dental health behavior, and recall interval, each child required a core amount of hygienist resources. This core time may constitute time for necessary paperwork and hygiene activities or it may reflect standardized treatment regimens. However, some hygienist time was related to dental health, dental health behavior, and recall interval. Approximately 10 min (25%) more time was used on a child with poor dental health behavior and new caries than on a child with good dental health behavior without caries. This indicates that the hygienists, to a certain extent, individualize routines and direct more, probably preventive, treatment towards children with caries and poor dental health behavior. Results from the Finnish Public Dental Service showed no focus on high-risk adolescents (18).

In addition to saving dentist time, one reason for using hygienists is to minimize costs. The salary of a hygienist is approximately 40% of the combined salaries of a dentist and a dental assistant. Thus, considering the personnel cost, to delegate procedures is profitable as long as hygienists do not spend more than 2.5 times as long as the dentist-assistant team spends for the same procedures. To perform the examinations and preventive care at the *same cost* as a hygienist did in this project, a dentist would have to spend no more than 15 min per child. As dentists are always assisted by assistants, it is probable that the dentists could provide routine examinations and preventive treatment in less time than hygienists. If dentists use the *same amount of time* as the hygienists on identical procedures, the personnel cost would be reduced by approximately 25% compared with a situation in which dentists perform all procedures. The time registered in this study did not include time allocated for administrative procedures. If hygienists use more time for administration than dentists, this reduces the efficiency of a delegation-based system.

### *Dentist time*

When dental hygienists were used systematically to perform first-line services, nearly half the children could be given all dental care without requiring any dentist time. At the other extreme, long individual treatment times were required for children with more than three decayed teeth, who constituted 11% of all the children and consumed 41% of dentist time. Another 41% of the dentist time was spent on the 30% of children with three or fewer decayed teeth. These numbers illustrate that a minority of the children consumed a large part of the resources. This is a consequence of the concentration of high caries activity in a small proportion of the children (15).

Children without new decayed teeth who were referred to dentists constituted 16% of the children and consumed 17% of all dentist time. Parts of this dentist time may have been related to trauma, orthodontic consultations, endodontic treatment, and rare conditions such as developmental anomalies and juvenile periodontitis. If this time is used for preventive care, it may suggest that unnecessary duplication of preventive procedures occurs.

The dentist time per child for the children who were referred to dentists was associated with the number of new decayed teeth. One additional new decayed tooth required on average an additional 20 min of dentist time. The average dentist time per child was 45 min, and the mean number of new decayed teeth was 1.1, which suggest that factors other than caries were also important for the amount of dentist time. This is in accordance with other Norwegian studies (19, 20). At recall, Norwegian children have had on an average one new decayed tooth for the last 6 years (3). If this continues, the finding suggests that the amount of dentist time required will not change dramatically in the short run, and even if a decrease in caries incidence occurs, dentist time will still be required.

Within the recommended range, the length of the recall interval did not influence dentist time. This suggests that the selection of children for long recall intervals was satis-

factory and did not lead to more complicated, time-consuming treatments. This is in accordance with suggestions by Sheiham (21) and findings by Wang et al. (22). No effect on treatment time was seen when recall intervals were increased from 12 to 24 months in low caries risk children (22). Intervals longer than 18 months were not planned and suggest either missed appointments by the children or a deficiency in the recall system. Intervals longer than planned were associated with prolonged time for dental care.

The model for work distribution implemented in these districts is in accordance with present recommendation by the health authorities in Norway. However, other models for distributing work between personnel categories may be as effective. Axelson advocates as cost-effective a need-based approach in which auxiliaries deliver preventive care to risk groups and risk individuals (7). The most widespread model used in the Norwegian Public Dental Service is that dentists examine children and on the basis of clinical judgment allocate the available hygienist resources. Under present conditions with low levels of dental caries in the child population, the resource consumption and efficiency of the dentist-based model has not been documented.

In conclusion, the project showed that in a child population with low caries increment, a substantial proportion of children received all dental care from hygienists, so that dentist resources were saved for other groups. However, although hygienists were used as first-line personnel, a sizable quantity of dentist time was spent on dental care for children.

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Received for publication 3 January 1994

Accepted 1 March 1994