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Evaluation of a preventive program based on caries risk among mentally challenged children using the Cariogram model

Y.B. Patil[1], S. Hegde-Shetiya[2], P.V. Kakodkar[2] and R. Shirahatti[2]

[1]*Lecturer, Department of Public Health Dentistry, School of Dental Sciences, Karad, India;* [2]*Department of Public Health Dentistry, Dr D.Y. Patil Dental College and Hospital, Pune, India*

Objectives: To assess the caries risk and to evaluate the risk based preventive program at the end of 10 months amongst the mentally challenged children using the Cariogram model. ***Basic research design:*** Longitudinal field trial with before and after comparison. ***Participants:*** 54 children (7-17years old) with mild to severe mental disability constituted the study sample. ***Clinical setting:*** Brahmadutta School, for the mentally challenged children situated in Pimpri (Maharashtra) India. ***Interventions:*** Phase I: Information of the Cariogram parameters (caries experience, diet content, diet frequency, plaque amount, mutans streptococci, fluoride program, saliva secretion and saliva buffer capacity) were collected, which were used to generate the individual caries profile, based on which the children were divided into 5 risk groups. Phase II: Risk based preventive program was implemented. Phase III: At the end of 10 months, caries profile was generated again. ***Main outcome measures:*** The effectiveness of the preventive program was assessed by comparing the baseline and follow-up caries profile. Wilcoxon Signed Ranks test was used for statistical analysis. ***Results****:* As compared to the baseline, there was a 57% increase in the number of children in "low caries risk group" and for the caries risk factors diet content, diet frequency, plaque amount and Mutans streptococci count had significantly lower values. At follow-up, only 4 new carious lesions developed. ***Conclusion****:* The preventive program was effective in improving the caries risk factors and increasing the "chance to avoid caries" from a mean of 44% to 87%.

Key words: *Cariogram, mentally challenged children, risk based preventive program, India*

Introduction

Census data (2001) indicates that about 2.13% are disabled in India and 0.22% are mentally challenged (Shah *et al.*, 2009). The mentally challenged face immense difficulty in their day to day lives. Their oral health is also severely affected and the major contributing factors are: difficulty in maintaining oral hygiene and in seeking dental treatment. Poor neuro-muscular co-ordination compromises the maintenance of oral hygiene. Their access to oral health care services is hindered for several reasons including: *accessibility to health services infrastructure is poor; dependence on care-givers for travel; dental health care providers have neither special training nor attitude to provide treatment; dental clinics lack facilities to handle such patients and finally these patients themselves have low expectation of health care services* (Shah *et al.*, 2009).

The prevalence of dental caries in children with various handicapping conditions is reportedly higher than that of normal children and in particular, among the various handicaps, mentally challenged children have the highest rate (Gupta *et al.*, 1993; Rao *et al.*, 2001). When the individual components of mean dmft/DMFT for the mentally challenged children were analysed, the "decay" component contributed majorly, followed by the "missing" and then "filled" (Nunn, 1987; Rao *et al.*, 2001) indicating that a high proportion of carious lesions are untreated and when treatment is provided, it is more likely in the form of extractions rather than restorative care (Rao *et al.*, 2001). Mentally challenged children need early and intensive preventive intervention.

Brahmadutta School is a special school for 54 mentally challenged children in Pimpri in the state of Maharashtra, India. The school authorities stated that there was no preventive dental program in the school nor had children visited the dentist regularly. A dental survey among these children revealed the presence of untreated decay. To improve the status of the dental caries and provide them with preventive services the authors felt that the concept of risk assessment and risk management (Petersson, 2003) should be implemented.

The Cariogram tool was used for this purpose. It is an interactive computer program, conceptualized by Bratthall in 1997, which assesses and graphically illustrates a caries risk profile for an individual, simultaneously taking into account the interaction of the different caries causing factors of that individual. It also provides recommendations for targeted preventive measures to overcome new caries formation (Petersson, 2003). Several studies have validated the efficiency of Cariograms as a caries risk assessment tool (Hansel-Petersson *et al.*, 2002, 2003; Petersson, 2003; Petersson and Bratthall, 2000; Zukanovic *et al.*, 2007).

The aim of the study was to assess the caries risk and evaluate the risk based preventive program at the end of 10 months among the mentally challenged children of Brahmadutta school (India) using the Cariogram model.

Correspondence to: Dr Yojana B Patil, Department of Public Health Dentistry, School of Dental Sciences, Karad, Maharashtra, India. Email: dryojanapatil@yahoo.com

Method

The study model was based on a four step strategy for risk assessment and risk management (Petersson, 2003). Firstly, various caries risk factors were identified systematically; secondly these factors were analysed to generate a caries risk profile. Then, a risk-based preventive program was identified and followed. The final stage was an analysis of the effectiveness of the program including whether there was a reduction in both the risk factors and the development of new carious lesions.

This study was conducted on all 54 children from the Brahmadutta School for Mentally Challenged children, Pimpri, Maharashtra, India. The study design was approved by the Institutional Ethics committee, Dr D.Y. Patil Dental College and Hospital, Pimpri, Pune, India. Details of the study were explained to parents/guardians and written informed consent obtained from them. The study was conducted in 3 consecutive phases between June 2007 and May 2008. Phase I was completed in one month, phase II in 10 months and phase III in one month.

The Cariogram is based on 10 parameters: 2 parameters ("Related diseases" and "Clinical judgement") were kept constant at score "1", while information on the other 8 parameters was gathered from the study sample in Phase I.

Phase I started with each child's parent or guardian being interviewed to collect information regarding the medical history, medication, use of fluoride toothpaste and any other fluoride supplements. Then the parent or guardian was given a diet diary for listing with time, everything the child ate or drank in each of 3 consecutive days (Friday to Sunday). After 3 days the diet diary was collected and analysed by circling in red, the foods sweetened with added sugar or concentrated natural sugars. The count of circled items was divided by 3 to obtain the mean daily frequency of sugar exposure (Nizel and Papas, 1989).

Saliva was later collected in the school between 10.30 and 11.30am. Since the children were mentally challenged it was difficult for them to follow the instruction of chewing and collecting the saliva. Teahers gave their help and children were given a practice session before final collection. One child at a time chewed on a sugar-free gum base for 5 minutes to stimulate saliva. Saliva was collected in a measuring cup and the flow rate was calculated by dividing the volume (millilitres) of saliva by 5 and expressed as ml/min. Immediately after saliva collection the buffer capacity was recorded by the colorimetric method. In a test tube 1ml of collected saliva was added to 3ml of HCl (0.005mol/l). After 2 minutes, the pH indicator strip (Qualigens, India) was dipped into the test tube and the buffering capacity was recorded by comparing the colour change with the manufacturer's guide. For microbiological analysis 1ml of the saliva was used to culture Mutans Streptococci and Lactobacilli on Mitis Salivarious Bacitracin Agar and Rogosa SL Agar respectively using the plate method in the laboratory (Hegde *et al.*, 2005).

In the clinical examination, caries experience was recorded using the DMFT index and the amount of plaque was recorded using the Loe and Silness index (1964).

Each Cariogram parameter was given a score (Table 1) and entered into the Cariogram computer program to generate individual caries profiles. According to a weighted formula, the program generated the pie diagram in which *bacteria* (based on a combination of amount of plaque and Mutans streptococci)**,** *diet* (based on diet content and frequency), *susceptibility* (based on fluoride programme, saliva secretion and saliva buffer capacity) and *circumstances* (past caries experience and general disease) factors were represented by the sectors labelled with their percentages. In addition, there was a sector respresenting the *chance of avoiding caries*. Based on this sector, the children were classified into one of the 5 caries risk groups: 0-20% (counter-intuitively high risk), 21-40%, 41-60%, 61-80%, 81-100% (low risk) (Petersson, 2003).

In phase II, the preventive measures based on that caries risk and the investigator's clinical judgement were used to design the preventive program which is detailed in Table 2.The preventive program was conducted by the principal investigator with the help of dental interns in a fully equipped mobile dental van.

Phase III at the end of 10 months of the preventive program saw data for the Cariogram parameters collected again in a similar manner to phase I. The effectiveness of the preventive program was evaluated by comparing the baseline and follow–up caries profile.

Data were analysed using SPSS version 10. The frequency, percentage, mean and standard deviation were calculated for the parameters. Wilcoxon Signed Rank test that was used for statistical analysis with the level of significance fixed at 5%.

Results

The 54 children included 37 boys and 17 girls both at the baseline and follow-up. Their mean age at baseline was 11.9 years (sd 2.71, range 7-17) and their mental disability ranged from mild to severe (IQ scores 20-70).

Table 3 shows the distribution of children according to the categorization of the Cariogram at the baseline and follow-up with comparative statistics. It shows that at the end of the preventive program: the caries experience score changed for only two children, who developed new carious lesions; the lactobacillus count ranged between very low and low only; diet, frequency score of 0 was recorded for many children (76%); an increase in the number of children (n=49) with plaque score of 1 was recorded; Mutans streptococci counts reduced to very low and low levels; all children were exposed to maximum fluoride program (Table 1). No difference was noted in the caries experience score, saliva secretion score and saliva buffering capacity in comparison to the baseline. The distribution for 'chance of avoiding caries' was fairly uniform at baseline but clearly skewed towards lower risk at follow-up with 47 children having moved out of the 2 greatest risk categories and the lowest risk category increasing from 11 to 47 of the 54 children. The preventive program reduced caries risk ($p<0.05$).

Figure 1 shows the mean baseline and follow-up percentages for each Cariogram factor contributing to caries risk. The susceptibility sector had an impact of (31%) followed by bacteria (12%), diet (7%) and circumstances (6%). At, follow-up the contribution of these sectors had

Table 1. Parameters in Cariogram

Sector	*Parameter*	*Data used.*	*Score*
Circumstances	Caries experience	DMFT index	0: DMFT = 0 1: DMFT = 1 2: DMFT = 2 3: DMFT ≥3
Circumstances	Related diseases	The general condition of the sample was mentally challenged (score 1 was selected for all participants).	0: No disease, healthy 1: General disease which can indirectly influence the caries process to a mild degree. 2: General disease which can indirectly influence the caries process to a high degree.
Diet	Diet, content	Salivary Lactobacillus count cultured on Rogosa SL agar plate in the laboratory.	0: $\leq 10^3$ CFU/ml 1: 10^4 CFU/ml 2: 10^5 CFU/ml 3: $\geq 10^6$ CFU/ml
Diet	Diet, frequency	Number of sugary meals and snacks per day. Data obtained from 3 day diet chart filled by the parents.	0: Maximum 3 meals/day 1: 4-5 meals/day 2: 6-7 meals/day 3: More than 7 meals/day
Bacteria	Plaque amount	Loe and Sillness Plaque index, 1964	0: 0 1: 0.1 - 0.9 2: 1.0 - 1.9 3: 2.0 - 3.0
Bacteria	Mutans streptococci	Salivary levels of Mutans streptoccoci cultured on mitis-salivarius bacitractin (MSB) agar plate in the laboratory.	0: <20,000 CFU/ml saliva 1: 20,000 - 100,000 CFU/ml saliva 2: >100,000 – 1 million CFU/ml saliva 3: >1 million CFU/ml saliva
Susceptibility	Fluoride program	Data on fluoridation program collected by interviewing parents.	0: Maximum fluoride programme. 1: Fluoride supplements. 2: Only fluoride toothpaste 3: Avoiding fluoride, no fluoride.
Susceptibility	Saliva secretion	Flow rate of stimulated saliva.	0: > 1.1 ml/min 1: >0.9 - 1.1 ml/min 2: 0.5 - 0.9 ml/min 3: ≤ 0.5 ml/min
Susceptibility	Saliva buffer capacity	Salivary buffer capacity using colorimetric method	0: pH ≥6.0 1: pH 4.5 – 5.5 2: pH ≤4.0

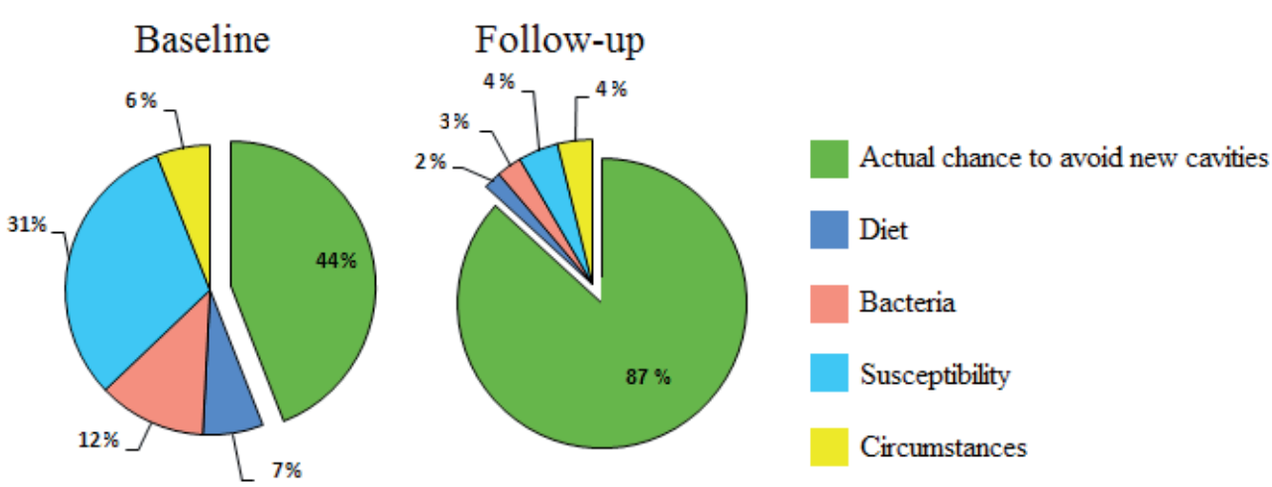

Figure 1. Cariogram sectors at baseline and follow up

Table 2. Preventive programmes based on assessed caries risk

	Caries risk	
	0-20% chance to avoid caries	*21-100% chance to avoid caries*
Primary Preventive procedures	Oral prophylaxis and topical application of 1.23% Acidulated phosphate fluoride gel at the beginning of the program, at the end of 3 months and 6 months. Supervised toothbrushing with fluoridated toothpaste*. Health education and diet counselling to the parents once every month. Pit and fissure sealant application in appropriate cases.	Oral prophylaxis and topical application of 1.23% Acidulated phosphate fluoride gel at the beginning of the program and at the end of 6 months. Supervised toothbrushing with fluoridated toothpaste*. Health education and diet counselling to the parents once every month. Pit and fissure sealant application in appropriate cases.
Secondary preventive procedures	Silver amalgam restorations, composite restorations, preventive resin restorations, glass ionomer restorations for appropriate cases.	Silver amalgam restorations, composite restorations, preventive resin restorations, glass ionomer restorations for appropriate cases.
Tertiary preventive procedures	Extractions and Root canal treatment for appropriate cases.	Extractions and Root canal treatment for appropriate cases.

*All were provided with free fluoridated toothpastes (Colgate Shakti containing Sodium Monofluorophoshate 1000 ppm) and toothbrushes

reduced to 4%, 3%, 2% and 4% respectively.

The comparison of the before and after individual caries profile using the Wilcoxon Signed Ranks test showed a significant difference for the caries risk factors in diet content ($Z= -5.72$, $p<0.001$), diet frequency ($Z= -4.14$, $p<0.05$), plaque amount ($Z=-5.72$, $p<0.001$), Mutans streptococci count ($Z=-5.37$, $p<0.001$) and the chance of avoiding caries ($Z=-6.45$, $p<0.05$).

At baseline, the mean DMFT was 2.05 (sd 0.29) and at follow-up 2.12 (sd 0.35). Overall, there were 109 decayed teeth, 12 missing teeth and none filled. During the preventive program, 93 decayed teeth were converted to filled, 10 were extracted and 6 decayed teeth were not treated as 4 subjects were too uncooperative. Only 4 new carious lesions developed in 2 subjects at the end of 10 months preventive program.

Discussion

The Cariogram model includes caries related factors which can be easily monitored, tested and evaluated by dental personnel. This computer software is available as a free download, is understandable and straightforward to operate. Most of studies using the Cariogram model are cross-sectional (Aguilera *et al.*, 2005; Tayanin *et al.*, 2005; Zukanovic *et al.*, 2007). However, a few longitudinal studies (Hansel-Petersson *et al.*, 2002; Petersson, 2003) were aimed at evaluating the effectiveness of the Cariogram to predict future carious lesions without any interventions performed during the follow-up period. Such a study design has an ethical dilemma: though the risk factors were identified initially, no interventions were performed and with no actions taken carious lesions definitely developed proving the Cariogram correct in predicting the future carious lesions but in turn the patient had suffered (Hansel-Petersson *et al.*, 2002). Hence, the present study was ethical in the sense that the risk factors were identified and a preventive program implemented.

The Cariogram only expresses the overall caries risk. It does not take into account problems such as fractures of teeth or fillings, discolorations, etc. which may necessitate new fillings (Bratthall, 2004). It proposes only primary preventive measures but the clinicians may use their judgement to modify these measures (Bratthall, 2004). Hence, to provide a comprehensive preventive program the secondary and tertiary levels of care were added.

In the present study, although the mean DMFT was low (2.05), the SiC (Significant Caries Index) was 4.93, indicating a skewed distribution with one third of the children having high caries status. In an Indian study among mentally disabled subjects aged 12-30 years the mean DMFT was 2.01 (Jain *et al.*, 2009). The DMFT of 12 and 15 year old normal children was 1.7 and 2.0 respectively in the Maharashtra region according to a national oral health survey (Bali *et al.*, 2004). Caries experience seems comparable with the normal children (Jovic *et al.*, 2007) and in the epidemiological data available there appears to be conflict regarding the caries susceptibility in disabled children; caries occurrence has been reported to be both higher and lower (Jain *et al.*, 2009). However, the severity of caries attack is essentially the same, but the presence of higher number of untreated decayed teeth among the disabled children can be attributed to their handicapping condition being a barrier to regular treatment (Nunn, 1987).

The extensive 10 month preventive program (Fluoride program, diet counselling, health education, modification of oral hygiene habits, oral prophylaxis and restorative care) contributed to a significant reduction in scores for Lactobacilli count, frequency of sugar intake, plaque amount and Mutans streptococci counts and a 57% increase in the number of subjects in lowest risk group for avoiding caries (Table 3).

It has been reported that the children are uncomfortable and hesitate when chewing paraffin resulting in reduced stimulation of saliva (Holm *et al.*, 1989; Tayanin *et al.*,

Table 3. Distribution of children according to the categorization of Cariogram and "chance of avoiding caries" at baseline and follow-up with comparative statistics

Cariogram parameter	*Baseline n (%) (n=54)*	*Follow up n (%) (n=54)*	*z value, p value*
Caries experience			
0: DMFT=0	17 (31)	16 (30)	z=-0.97
1: DMFT=1	9 (17)	8 (15)	p>0.05
2:DMFT=2	9 (17)	10 (19)	
3:DMFT ≥3	19 (35)	20 (37)	
Diet, contents (lactobacillus count)			
0= Very low	16 (30)	42 (78)	z=-5.72
1= Low	28 (52)	12 (22)	p<0.001*
2= Moderate	6 (11)	0	
3= High	4 (7)	0	
Diet, frequency			
0= Maximum 3 meals /day	29 (54)	41 (76)	z=-4.14
1= Maximum 5 meals/day	15 (28)	12 (22)	p<0.05*
2= Maximum 7 meals/day	6 (11)	1 (2)	
3= More than 7 meals/day	4 (7)	0	
Plaque amount			
0= 0	0	0	z=-5.72
1= 0.1-0.9	8 (15)	49 (91)	p<0.001*
2= 1.0-1.9	31 (57)	4 (7)	
3= 2.0-3.0	15 (28)	1 (2)	
Mutans streptococci			
0= Very low	14 (26)	36 (67)	
1= Low	21 (39)	17 (31)	z=-5.37
2= Moderate	13 (24)	1 (2)	p<0.001*
3= High	6 (11)	0	
Fluoride programme			
0: Maximum fluoride program	0	54 (100)	z=-6.21
1: Fluoride supplements	0	0	p<0.001*
2: only fluoride toothpaste	27 (50)	0	
3: No fluoride	27 (50)	0	
Saliva secretion			
0: > 1.1 ml/min	33 (61)	31 (57)	z=-2.77
1: > 0.9-1.1 ml/min	14 (26)	17 (31)	p>0.05
2: 0.5- 0.9 ml/min	5 (9)	5 (9)	
3: <0.5 ml/min	2 (4)	1 (2)	
Saliva buffering capacity			
0: pH ≥ 6.0	19 (35)	16 (30)	z=-0.83
1: pH 4.5-5.5	33 (61)	37 (69)	p>0.05
2: pH ≤ 4.0	2 (4)	1 (2)	
Chance of avoiding caries			
0-20%(high risk)	16 (30)	0	z=-6.45
21-40%	9 (17)	0	p<0.05*
41-60%	10 (18)	1 (2)	
61-80%	6 (11)	6 (11)	
81-100%(low risk)	11 (20)	47 (87)	

*statistical significance.

2005). Sugar-free gum base as a saliva stimulant was selected in the present study on account of children's arguably greater familiarity with chewing gums and greater ease in following instructions to chew and spit (Tayanin *et al.*, 2005). Even after the 10 month preventive program there was no change in the salivary flow rate and buffer capacity (Table 3) perhaps because the program's preventive measures provided a supplemental benefit but were not directed towards improving flow rate and buffer capacity.

Studies by Denloye (2000) and Nunn (1987) on mentally challenged children confirmed that they have very poor oral hygiene. Our study sample had moderate to high levels, but at the end of the preventive program most scores had reduced to low (Table 3).

With regards Figure 1, at baseline the mean chance to avoid caries was 44% while the susceptibility showed an impact of 31%. In the cariogram a heavy weight has been given to non-use of fluoride (Petersson, 2003). However, with the extensive fluoride program this sector reduced to 1/7th. Bacteria had an impact of 12% which reduced to a quarter (3%). Diet (7%) and circumstances (6%) sector reduced by two thirds. There were improvements in the scores for Mutans streptococci, plaque amount, diet frequency and content following the preventive program which reduced the mean percentages of the bacteria and diet sectors. The circumstances sector changed very little being based on general health and past caries experience. The general health was unchanged and there was insignificant change in DMFT at follow-up and less weight of the past caries by the Cariogram (Petersson, 2003) so little reduction in the circumstances sector was observed.

The present study was conducted during a single academic year so it was possible to provide preventive services for only 10 months. However, the long term effect of the preventive services on caries risk and risk factors using the cariogram will be evaluated. This program will be carried forward for 3 years following the similar protocol as mentioned and evaluation will be conducted at the end of every academic year.

Conclusion

Within the limits of the present study the results indicate that the preventive program was effective in improving the various caries risk factors and increasing the chance to avoid caries.

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