DEVELOPING A CARIES RISK ASSESSMENT MODEL FOR PATIENTS ATTENDING UNIVERSITY MALAYA DENTAL CLINIC

Original Article

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ABSTRACT

Aim: In response to the introduction of an integrated dental education program at University of Malaya (UM) in 2011, a study was conducted to develop a caries risk assessment model (CRA) for use in non-surgical caries management for Year 3 and 4 students of the new integrated program. **Methods:** The CRA model was based on risk indicators used by dental students in the Preventive Dental Clinic (PDC). Patients aged 15 years and above who attended the PDC for the first time in year 2009 and 2010 were used as study sample. Four hundred and fourteen patient names were identified from the student PDC logbook. Of the 414, 359 dental records had complete data and included in the analysis. Data were analysed using SPSS version 17.0. Chi-square test was used for group comparison and associated factors for coronal caries were analysed using Multiple Logistic Regression (MLR). **Results:** The final model showed that adults, brushing teeth once daily, and not having dental prosthesis/appliance were 3.31 (CI=1.64-6.69), 2.53 (CI=1.19-5.40), and 2.25 (CI=1.25-4.10) more likely to develop coronal caries, respectively, than adolescents, brushing teeth at least twice a day, and having dental prosthesis/appliance. **Conclusions:** The results indicate that age group, toothbrushing frequency and dental prosthesis status are significant indicators for coronal caries among patients. Outcomes of the study contributed towards bridging the gap between cariology and preventive modules in the new integrated dental program.

Key words: Dental caries, Malaysia, risk assessment.

INTRODUCTION

Dental caries management involves both surgical and non-surgical intervention (1-3). For non-surgical intervention, patient risk-based analysis has been considered as a practical approach for oral disease early prevention strategy (2, 4, 5). Evidence from literature suggests that caries risk assessment as a form of risk-based analysis is useful to formulate the right treatment plan, review visits and types of preventive care (2-6). It also helps clinicians to promote successful treatment outcome and identify high risk patients for early prevention (6). For patients, risk assessment of oral disease by dentist promotes patient compliance. It also reduces the need for complex clinical intervention, cost, and promotes patient satisfaction in dental treatment (7, 8).

According to Burt (2005) (9), risk is the probability for an outcome to take place following an exposure to a factor. The outcome usually refers to health outcome, disease occurrence or even mortality. As health gain or disease occurrence involves a time frame, the term 'risk' refers to the probability that a certain event will occur within a given period of time following an exposure to a causative factor (10).

As dental caries is a multi-factorial disease, studies to explore interactions between caries risk indicators and disease occurrence are often based on multi-factorial modelling (11-14). For caries, the etiologic factors are known as 'risk factors' while the non-etiologic factors as 'risk indicators' (15). In the present study, the term 'caries risk indicators' was used to refer to the etiologic factors, i.e. high-sugar diet, and the non-etiologic factors, i.e. socio-demographic variables. In the present study, caries risk assessment model was developed based on significant association between caries risk indicators and presence of coronal caries. The risk indicators comprised patient's biological, behavioural, environmental, and lifestyle characteristics. Patient's family history was also included (14, 16, 17).

Globally, greater attention has been given to the identification of oral disease risk indicators in dental practice for a positive dental health outcome (4, 16, 17). However, little is known about caries risk assessment in the Malaysian setting. The University of Malaya (UM) dental educators argued that it was crucial to implement caries risk assessment approach in dental caries

management in the undergraduate curriculum. Utilising a caries risk assessment model to treat caries would also facilitate the integration of surgical and non-surgical caries management in the new integrated dental program which took effect in 2011. Thus, the study aimed to develop a caries risk assessment model for those aged 15 years and above for use by the dental students. The model was based on potential caries risk indicators currently used in the Preventive Dental Clinic (PDC). Findings from this study would help towards closer integration between cariology and preventive dentistry modules in the new integrated curriculum.

METHODOLOGY

This study was a cross-sectional study based on patient records as a source of secondary data. Dental records of adult patients who attended the PDC for the first time in year 2009 and 2010 were included in the study. The inclusion criteria were patients aged 15 and above who were treated by dental students. The exclusion criteria were missing dental records, patients with full dentures and patients aged less than 15 years.

The sample size calculation was based on Malaysian adult caries prevalence in 2000 (18). Based on a 5% error, the minimum sample size was 138. There were 414 patients who attended the PDC in 2009 and 2010. In order to overcome the problem of incomplete data, it was decided that all the 414 patients were included in the study as long as the final sample above 138. The dental records were identified. Of the 414 dental records, only 359 had complete data. Patient's information on caries experience and caries risk indicators was extracted from the oral health Risk Assessment Form (RAF) in the dental record. The information was transferred into a standard form to facilitate data entry. The RAF was a clinical pathway framework designed by the UM dental faculty to help students in patient management. It consists of a range of dental caries indicators that students can specify for each patient. The form is easy to complete and suitable to use by the students. The RAF is also used in patient oral health education and as a means to evaluate changes in patient's caries risk and oral health status.

In UM, Year 3 and 4 dental students are encouraged to bring their new patients to the PDC for oral health education. Each patient will be assessed by the student based on the RAF caries risk indicators which included socio-demographic factors (age, gender, ethnicity), oral health behaviours (tooth brushing frequency, sugar intake, smoking status), oral health status (DMFT score), oral hygiene status, and presence of prosthesis. Laboratory-based microbial investigation and salivary test were not included as these were not available for undergraduate students during routine patient caries risk assessment.

For analysis, age was categorised into adolescent (15-20 years old), adult (21-59 years old) and elderly (60 years old and above). For ethnicity, patients were categorised into Malay, Chinese and other, i.e. Indians, Aborigines and non-Malaysians. Tooth brushing frequency was categorised into brushing once per day and two or more times per day. Intake of sugary diet was categorised into low-sugar diet (≤3 times of sugary food consumption per day including main meals) and high-sugar diet (≥ 4 times per day including main meals) groups. Smoking status was categorised into smoker (habitual smoker) and non-smoker. Occasional or past smokers were considered as non-smokers.

For oral hygiene status, percentage plaque score was recorded using the Plaque Control Record by O' Leary et al., 1972 (19). Oral hygiene levels were categorised into excellent (plaque level = 0-20%) and fair to poor (plaque level ≥21%). Patients with dental prosthesis or appliances, i.e. partial dentures or removable/fixed orthodontic appliances were grouped into 'yes' (having dental prosthesis/appliance) and 'no' (no dental prosthesis/appliance). For caries experience (DMFT), only the decay (DT) component of coronal caries was used as the outcome variable. Coronal caries was recorded at the D3 level (cavitation into dentine) on occusal pits or fissures, and smooth surfaces of the tooth. In the study, a tooth with a temporary fillling or sealant with decayed margins was recorded as having coronal caries. In cases where the crown had damaged due to caries with roots remaining, it was assumed the caries had originated from the crown and thus recorded as coronal caries (20). As Malaysia piped water supply is fluoridated, it was assumed that almost all patients were exposed to fluoridated drinking waters at 0.5 ± 0.1 ppm.

DATA ANALYSIS

The Statistical Package for Social Sciences (SPSS) for Window version 17 was used for data analysis. In the analysis, the decay component of coronal caries was used as the dependent variable. Age, gender, ethnicity, oral hygiene status, intake of sugary diet, tooth brushing frequency, presence of dental prosthesis and smoking status were used as the independent variables. Univariate analysis of coronal caries prevalence between categories of the independent variables was assessed using chi-square test. Variables with significant association at univariate analysis were further analysed using multiple logistic regression (MLR) to develop a model for coronal caries. In the multivariate analysis, model exploration was conducted using backward and forward methods. The final model was based on the enter method using significant variables obtained from the exploration process. Approval to conduct the study was obtained from the Medical Ethics

Committee of UM Dental Faculty. The significant level was set at p<0.05.

RESULTS

Of the 414 patient records, only 359 fulfilled the study criteria, with 86.7% response rate. The sample comprised more female (54.3%) than male patients (45.7%). The majority were adults (60.7%), followed by elderly (23.7%) and adolescents (15.6 %). In terms of patient ethnicity, there were more Malay (43.2%) than Chinese patients (40.9%), followed by other (15.9%). More than half of the patients had low sugar diet (51.3%) and the rest had high sugar diet (48.7%). Almost two-thirds of the patients had poor-to-fair oral hygiene levels (64.9%) and the rest

had good-to-excellent oral hygiene levels (35.1%). A large majority brushed teeth twice or more a day (84.7%). About one-quarter (25.6%) of the patients wore dental prosthesis or appliance. One out of ten patients was smoker (10.6 %).

Table 1 shows univariate analysis of the caries risk indicators to determine the independent role of each factor on coronal caries. Three caries risk indicators were significantly associated with coronal caries, i.e. ethnicity, age group, and wearing prosthesis or appliance. Tooth brushing frequency had a near significant association with DT. Malays had the highest proportion of coronal caries (82.9 %), followed by Chinese (66.7 %) and other ethnic groups (64.9%). The difference was statistically significant (p=0.003). Adults had the highest proportion of coronal caries (83.9%), followed by adolescents (62.5%) and elderly (54.1%). The difference was

Table 1: Univariate analysis to determine the independent role of each variable as a factor associated with coronal caries (N =359)

Risk Indicator	Coronal Caries			
	Total n (%)	Yes n (%)[a]	No n (%)[a]	p-value[a]
Gender				
Male	164 (45.7%)	119 (72.6%)	45 (27.4%)	0.700
Female	195 (54.3%)	145 (74.4%)	50 (25.6%)	
Ethnicity				
Malay	155 (43.2%)	128 (82.9%)	27 (17.4%)	
Chinese	147 (40.9%)	98 (66.7%)	49 (33.3%)	0.003*
Other[1]	57 (15.9%)	37 (64.9%)	20 (35.1%)	
Age group				
Adolescent	56 (15.6%)	35 (62.5%)	21 (37.5%)	
Adult	218 (60.7%)	183 (83.9%)	35 (16.1%)	<0.001*
Elderly	85 (23.7%)	46 (54.1%)	39 (45.9%)	
Oral Hygiene				
Good to Excellent	126 (35.1%)	90 (71.4%)	36 (28.6%)	0.505
Fair to Poor	233 (64.9%)	174 (74.7%)	59 (25.3%)	
Sugar Diet				
Low	184 (51.3%)	129 (70.1%)	55 (29.9%)	0.131
High	175 (48.7%)	135 (77.1%)	40 (22.9%)	
Brushing frequency[2]				
Once	39 (10.9%)	23 (59.0%)	16 (41.0%)	0.058
Twice and more	304 (84.7%)	230 (75.7%)	74 (24.3%)	
Presence of prosthesis & appliances				
Yes	92 (25.6%)	57 (62.0%)	35 (38.0%)	<0.001*
No	267 (74.4%)	206 (77.2%)	61 (22.8%)	
Smoking status				
Smoker	38 (10.6%)	29 (76.3%)	9 (23.7%)	0.681
Non smoker	321 (89.4%)	235 (73.2%)	86 (26.8%)	

[1] Other consists of Indian (n=50), Aborigines (n=5) and non-Malaysians (n=2)
[2] Sample do not equal to N=359 due to missing data
[a] Non-parametric statistics: Chi-square test
*The level of statistical significant was set at p=0.05

statistically significant (p<0.001). Similarly, patients without prosthesis or appliance had higher proportion of coronal caries (77.2%) than patients with prosthesis or appliance (62.0%) (p<0.001). Patients who brushed once a day (59.0%) had higher proportion of DT compared with patients who brushed two times or more (75.7%) (p=0.058).

Table 2 shows the results of MLR for a model associated with coronal caries after adjusting for age, presence of dental prosthesis, and brushing frequency. According to the model, adults were 3.31 more likely to develop coronal caries compared to adolescents. Patients without dental prosthesis or appliance were 2.25 more likely to develop coronal caries than patients who wore prosthesis or appliances. Patients who brushed once a day were 2.53 more likely to develop coronal caries than patients who brushed twice or more a day. The Hosmer & Lemeshow test was not significant indicating a good model fit with good overall predictive accuracy (classification table=76.7 %). The area under the ROC curve was 0.7 indicating a fair model discrimination test.

Table 2: Multiple Logistic Regression analysis (MLR) to determine the significant predictors for coronal caries

		Odds Ratio (95% CI)		
	p-value	B (SE)	Lower	Odds ratio	Upper
Constant		0.789 (0.296)	-	-	-
Adults	0.001	1.197 (0.359)	1.64	3.31	6.69
Not wearing prosthesis & appliances	0.007	-0.817 (0.303)	1.25	2.25	4.10
Brushing once	0.016	-0.930 (0.386)	1.19	2.53	5.40

Possible two-way interaction terms were not significant
Hosmer & Lemeshow test *p*-value= 0.27
Classification table: overall predictive accuracy = 76.7%
ROC value= 0.70

DISCUSSION

Despite the rich literature on risk assessment approaches for dental caries management, little is known about this approach on global adult populations, and there was no previous evidence on the suitable model involving Malaysian population.

In this study, a multi-factorial analysis of potential caries risk indicators had shown that age, tooth brushing frequency and dental prosthesis status were significant risk indicators for coronal caries.

Findings regarding tooth brushing frequency were similar to other studies whereby tooth brushing frequency was cited as one of the risk indicators for caries. Tooth brushing also correlates with lower prevalence and incidence of caries (21-23). Tooth brushing twice daily with fluoride toothpaste provides enamel protection against caries, reverses early caries lesions, neutralises saliva pH, removes plaque, and helps control oral malodour. These benefits can only be achieved with correct tooth brushing technique. According to Sutcliffe (24), an increase in the frequency of tooth brushing may not necessarily result in effective elimination of plaque if the brushing is ineffective. In the UM preventive dental clinic, patients are asked about plaque control and perception about oral health on the first visit. Then, they are taught the correct tooth brushing technique, usage of floss, benefits of fluoride toothpaste, and also given diet advice. At subsequent visits, dental plaque is re-assessed using a disposing tablet. Where necessary, methods for plaque control and oral health instructions are reinforced. Patients will be considered as being competent in plaque control when they are able to reduce plaque levels after 3 subsequent visits.

In this study, it was found that patients without dental prosthesis or appliance were significantly more likely to develop coronal caries than patients with dental prosthesis or appliances after controlling for other factors. This finding is unexpected and initially appears to contradict findings from other studies on similar topics where partial dentures (25, 26) and orthodontic appliances wearers (27) had higher risk for caries than those without prosthesis. However, findings from several recent studies on coronal and root caries have indirectly provided evidence to support our finding. Several researchers (25, 28, 29) had reported that significant associations between denture wearers and caries were only observed with root caries and not coronal caries. Studies that do not distinguish between coronal and root caries would not be able to provide such evidence. In fact, Yeung et al. (2000) (29) had conducted a 6-year follow up on a group of partial denture wearers and found significant association between contact point of the partial dentures and root caries but not coronal caries. However, they do not compare the partial denture wearers with group not wearing partial dentures. Thus, as far as this study is concerned, our finding may be considered justified as we included data on coronal caries only and compare those wearing dental prosthesis and those not wearing dental prosthesis.

The effect of removable prosthesis on mouth caries is still debatable (28). There were studies that reported root caries among partial denture wearers as the result of poor oral hygiene and thus recommended topical fluoride to fight against caries (25, 28, 29). In this study, we assumed all patients had exposure to fluoride from toothpaste and fluoride in the water supply. Additional use of topical fluoride by patients could not be verified. However, there

were possibilities that patients with dentures or orthodontic appliance had regular topical fluoride application as part of pre-prosthetic or orthodontics treatment. Thus, it could be argued that the low caries risk of patients with dentures and orthodontics appliance in the study was due to the caries reducing effect of professionally applied topical fluoride which they received as part of the treatment plan.

There are several existing conceptual models that have been widely used to predict caries risks. There are the Caries-risk Assessment Tool by American Academy of Peadiatric Dentistry (30), Caries Management by Risk Assessment by California Dental Association (12) and computerised program i.e. Cariogram for caries risk program among Swedish schoolchildren (31). However, there are variations in terms of which model is best to predict caries and the existing models mainly focus on children. The model in the present study used a combination of a simple and low cost screening tool to predict caries risk for adults. It is quite similar to a screening model developed in Singapore where a group of researchers had successfully developed and validated caries risk assessment models for use in the community and clinical settings for early detection of high-caries groups. These models are divided into a screening and an extensive model (11). The screening model includes risk factors but without laboratory tests while the extensive model involves laboratory tests, i.e. microbial analysis, salivary test and plaque pH. The risk assessment model developed in our study seems practical for routine use by undergraduate students, in the community setting and private clinic. It may also be used as a screening tool to identify high-risk patients for caries for further assessment using laboratory tests.

Individual summary of caries risk assessment is often associated with preventive advice such as counselling, modified personal oral health behaviours, professional preventive procedures, and dental treatment (2, 32). The evidence from this study indicates the need for dental students to develop competence in prevention strategy by practicing risk assessment in patient's management. Furthermore, dental caries shares common risk factors with major chronic diseases such as obesity and diabetes which make risk assessment even more important (33, 34). By undertaking prevention therapy such as oral health education, it would benefit patient's oral health and also general health. Some researchers suggest that students' experience in delivering oral health education to patients during undergraduate training could help them expand the prevention concept into holistic patient management. They would also be more likely to become interested in the overall well-being of their patients (35).

Guiding students to undertake caries risk assessment in the PDC and to provide oral health education and prevention is not without difficulties. Past interviews with students, and through lecturers' observations, suggest that students remain doubtful over the benefit and effectiveness of patient oral health education. In general, students feel spending time in the PDC is less worthy and less compelling than treating patients. To overcome this, dental educators in UM have integrated caries risk assessment and clinical management of caries into theory and clinical curriculum for Year 3 and 4 of the new dental programme. Several dental schools which have started the integration have reported positive outcomes (2, 13). As such, the preventive framework for the new integrated curriculum for Year 3 and 4 would be directed at bridging the gap between surgical and non-surgical caries management taking into account the findings of this study.

UM dental faculty has incorporated caries risk assessment and oral health education as a competence requirement in the preventive dentistry module. Students must be competent in three key areas of plaque control advice, diet advice and smoking cessation as part of a holistic approach towards total patient care. For example, for every new patient, a student is expected to carry out caries risk assessment, formulate a diagnosis, conduct a relevant oral health education program and do follow-ups. Each case is verified by a lecturer using an evaluation sheet. Apart from treating sufficient number of cases in the clinic, the student is required to achieve a satisfactory grade in a required number of patients in the preventive module before they are allowed to sit for the final professional examination. In the examination, the preventive and cariology module questions are integrated with the aim to evaluate student's understanding on the theory and practical aspects of both modules.

This study has several limitations. Only information from the oral health RAF and caries charting from the dental records were available for assessment. These were completed by students and might contain some errors in the data recording and diagnosis. However, the students were required to verify their findings with a lecturer in charge throughout the session. Thus, any errors that might occur would have been kept to a minimum.

One may query the validity of the RAF used in the study and its limited information. The RAF was designed for use in the Malaysian setting based on literature review and through expert group discussions by dental public health lecturers in UM dental faculty. The risk indicators used in the RAF were comparable with other studies elsewhere (6, 13, 14). As such, it was deemed valid, relevant and suitable to be used as a data collection method in the faculty.

Further studies are recommended to evaluate the effectiveness, cost-benefit and health outcome of the model. Although indicators of risk are proven to be useful in caries management, more studies are required to establish the evidence of its effectiveness in long term management of high risk individuals (36). Future research should also focus on the acceptability of the caries risk assessment model by different stakeholders namely patients, students and lecturers.

CONCLUSION

The study indicates that patient's age, toothbrushing frequency and prosthesis status are the risk indicators in the caries risk assessment model for adults to predict coronal caries.

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