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ORIGINAL ARTICLE

Caries risk assessment in young adults: A 3-year validation of clinical guidelines used in Public Dental Service

GUNNEL HÄNSEL PETERSSON[1], EWA ERICSON[2], PER-ERIK ISBERG[3] & SVANTE TWETMAN[4,5]

[1]*Department of Cariology, Faculty of Odontology, Malmö University, Malmö, Sweden,* [2]*Public Dental Service, Region Skåne, Malmö, Sweden,* [3]*Department of Statistics, University School of Economics and Management, Lund University, Lund, Sweden,* [4]*Department of Cariology, Endodontics, Pediatric Dentistry and Clinical Genetics, Faculty of Health and Medical Sciences, University of Copenhagen, Copenhagen, Denmark, and* [5]*Maxillofacial Unit, Halland Hospital, Halmstad, Sweden*

Abstract

Objectives. To validate a risk classification model according to the Public Dental Service (PDS) guidelines with the actual 3-year caries outcome in terms of predictive values. ***Materials and methods.*** All 19-year-old patients registered at eight public dental clinics in Skåne, Sweden were invited to participate ($n = 1699$). The study group who completed the baseline examination consisted of 1295 subjects, representing 10% of the age group attending the public dental care in the region. A risk classification of each patient in four categories was made by the patient's regular team according to the guidelines. At the follow-up 3 years later, 75.8% were accessible. The final examinations included bitewing radiographs and the actual caries increment for 982 patients was calculated. ***Results.*** At baseline, 11.9% were assessed as being at 'high' or 'very high' risk. The dropouts had significantly more caries than the remaining patients ($p < 0.05$). The general disease activity was low, but those grouped into the two highest risk groups displayed significantly more new caries than those at lower risk ($p < 0.05$). With a cut-off value $\Delta DFS > 0$ vs $DFS = 0$, the sensitivity was 81% and the specificity 56% for 'low' risk vs any risk. By combining the 'low' and 'some' risk categories, the PDS model generated an improved specificity (94%). ***Conclusions.*** The risk assessment scheme used by the Public Dental Service for young adults relied basically on past and current caries activity and 65–70% of the patients were correctly classified. The model was most effective to screen out patients with low caries risk.

Key Words: *risk classification, guidelines, risk model*

Introduction

Caries risk assessment (CRA) denotes the clinical process of establishing the probability for an individual patient developing new caries lesions (enamel or dentin) in the near future [1]. Consequently, this is a basic component in the decision-making process for adequate prevention and management of dental caries [2]. In general, the use of risk models is typically more accurate than using few or single risk factors, with an accuracy generally ranging between 60–90% [1,3]. Several risk assessment methods and models are available for the general practitioner, taking risk factors and risk indicators, such as socio-economy, behavior, general health, diet, oral hygiene, microbiological composition of plaque and past caries experience, into consideration and balanced against the protective factors the patient may be exposed to [4–7]. An ideal CRA system should be easy to use in daily practice and have high validity and reliability, but to our knowledge and according to a newly published article by Tellez et al. [8], the only validated system in a prospective cohort trials up to now is the Cariogram [8–11]. In Sweden, the Public Dental Service (PDS) in the Skåne Region has adopted and implemented guidelines for risk assessment in adults based on past and present caries, periodontal conditions, general risk and technical risk [12]. The examining dentist or dental hygienist scores the risk of each individual patient into one of four risk categories ('low risk', 'some risk', 'high

Correspondence: Dr Gunnel Hänsel Petersson, Faculty of Odontology, Malmö University, SE-205 06 Malmö, Sweden. Tel: +46 40 6658529. Fax: +46 40 6658577. E-mail: gunnel.hansel-petersson@mah.se

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Table I. Guidelines for risk assessment in adults issued by the Public Dental Service in the Skåne region. Patients are categorised based on caries risk, periodontal risk, general risk and technical risk. The highest score obtained decides the final classification.

Low risk	Some risk	High risk	Very high risk
Caries			
• no progression last 2 years	• progression of enamel lesions within 2 years • 1–2 new cavities	• several new lesions and/or progression of lesions • 2–3 new cavities	• massive progression • ≥ 3 new cavities • extensive need of restorative care
Perio			
• healthy periodontium • no bleeding pockets > 5 mm • no radiographic bone loss	• bleeding pockets > 5 mm • slight radiographic bone loss	• bone loss > 1/3 of root length • initial furcation involvement • subgingival calculus	• bone loss > 1/3 of root • furcation involvement • vertical bone pockets
General			
• no disease, medication or unfavorable habits	• slightly compromised health • fear of dental treatment	• moderate medical condition • frequent cancels or no-shows • communication problems	• medical problems • dental avoidance
Technical			
• few proximal fillings	• few restorations with risk of fracture • deep fillings with potential endodontic complications	• root fillings/deep fillings of mixed quality • risk of endo treatment • evidence of parafunction	• crowns/prosthetics of questionable quality • large treatment need • parafunction, bruxism

risk' or 'very high risk') based on this protocol, paired with their own clinical judgment. The aim of this study was to validate this risk classification, made by the patients' regular dental team using PDS guidelines, with the actual caries outcome over a 3-year period in terms of predictive values. The hypothesis was that the PDS model should be proven adequate to distinguish between those with low risk from those with the higher risk categories.

Materials and methods

Study group

In 2006, an invitation to take part in a prospective, longitudinal study over 3 years was sent to all public dental clinics in the Skåne region, located in southern Sweden. Based on geographic regions, city and rural areas, socio-economic areas and small and large clinics, eight dental clinics were selected to be as representative as possible for the whole region. All 19-year-olds registered at the eight dental clinics were potentially eligible (n = 1699) and invited to participate in the study. The actual study group who completed the baseline examination during 2006–2007 consisted of 1295 subjects representing 10% of all 19 year-olds persons living in the region at the time when the study was performed. The material is further described in Hänsel Petersson et al. [12]. On average, 76% of all registered 19-year olds at the eight clinics were enrolled, ranging from 64% in a low or mixed socioeconomic urban area to 87% in a rural upper socioeconomic district. All the participants were residents in areas with low natural fluoride content in the drinking water supply, but they reported use of fluoridated dentifrice on a regular basis. The study design was approved by the Ethical Committee, Lund University, Sweden.

Caries risk classification after clinical examination

Prior to the study implementation, each selected clinic was visited by the principal investigator (GHP) and all dental personnel were provided detailed information on the aim and performance of the study. All clinical examinations were performed in connection with the subject's ordinary recall visit at the clinic. After written and verbal information about the outline of the study, written consent was given by the participants. The clinical visual-tactile examination, including bitewing radiographs, was carried out by the regular dentist or dental hygienist according to WHO criteria [13]. Caries prevalence and experience was registered at the decayed-filled-teeth/surface (DFT/DFS) level. In addition, periodontal status was recorded through bleeding on probing and horizontal/vertical bone loss. Based on the findings, the estimated risk level was classified in four categories according to the 'adult guidelines for risk assessment of oral diseases' issued by the Public Dental Service (PDS); 'low risk', 'some risk', 'high risk' or 'very high risk'. The criteria used for the different risk categories are shown in Table I.

Follow-up

The follow-up was scheduled 3 years later and 982 patients (75.8%) were accessible and re-examined

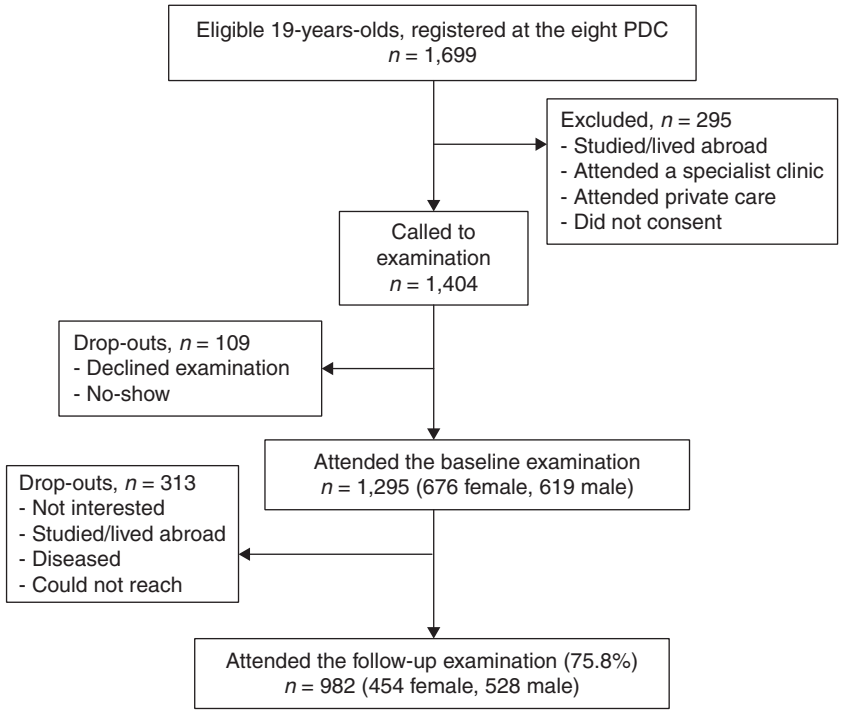

Figure 1. Flow-chart indicating attrition and reason for drop-outs.

with bitewing radiographs using the same criteria as at baseline. When possible, each patient was re-examined by the baseline team, but this was not always the case due to practical reasons. The actual caries increment for each young adult during the 3-year period was calculated. A flow-chart with the main reasons for exclusion and drop-out is shown in Figure 1. Many of the participants attend the PDS on a regular basis and all decisions on preventive and restorative dental care were solely the responsibility of the patient's regular public dental team during the entire study period.

Statistical methods

All data were processed with the IBM-SPSS software (version 19.0, Chicago, IL). Differences between risk categories and between baseline and follow-up examinations were calculated using Pearson Chi-square test. Caries data were analyzed with a one-way ANOVA. For the selected cut-off points, predictive values were calculated with Omnistat (Trelleborg, Sweden). The area under the ROC-curve (AUC) was computed for the different threshold levels of the risk categories. A *p*-value less than 0.05 was considered statistically significant.

Results

The mean DFS value for the 1295 originally included young adults at baseline was 4.9 (SD = 5.6) and the corresponding value for the 313 'dropout' individuals was 6.7 (SD = 6.9). This difference was statistically different ($p < 0.05$). The baseline DFT and DFS value for the 982 remaining persons was 3.1 (SD = 3.1) and 4.3 (SD = 5.0), respectively, and 25.4% were registered with no obvious signs of decay ('caries free', DFS = 0).

At baseline, the majority (88.1%) was classified as 'low' or 'some risk', while 11.9% were assessed as being at 'high' or 'very high risk'. From a retrospective interview, we found out that the vast majority (93.2%) of the 19-year olds was categorised primarily on their caries situation. Periodontal risk was evident in 4.4% of the subjects, general risk in 0.1% and technical risk in 2.3% of the patients. Sixty-five per cent did not develop any new lesions over the 3-year study period and, consequently, the incidence rate was 35% with a mean ΔDFS of 1.04 (SD = 2.07). A frequency diagram of the skewed ΔDFT distribution, ranging from 0–15 new decayed teeth, is shown in Figure 2. The caries increment in relation to the assessed risk category at baseline is presented in Table II. Those grouped into the two highest risk categories displayed significantly more caries (DFT, DFS and DFSa) than those considered being of lower risk ($p < 0.05$). With a cut-off value ΔDFS > 0 vs DFS = 0, the sensitivity was 81% and the specificity 56%, while the positive and negative predictive values were 50% and 85%, respectively (Table III). For the different threshold levels, the calculated area under the ROC-curve was 0.71.

Discussion

Caries risk assessment is a basic component in modern caries management. According to a questionnaire

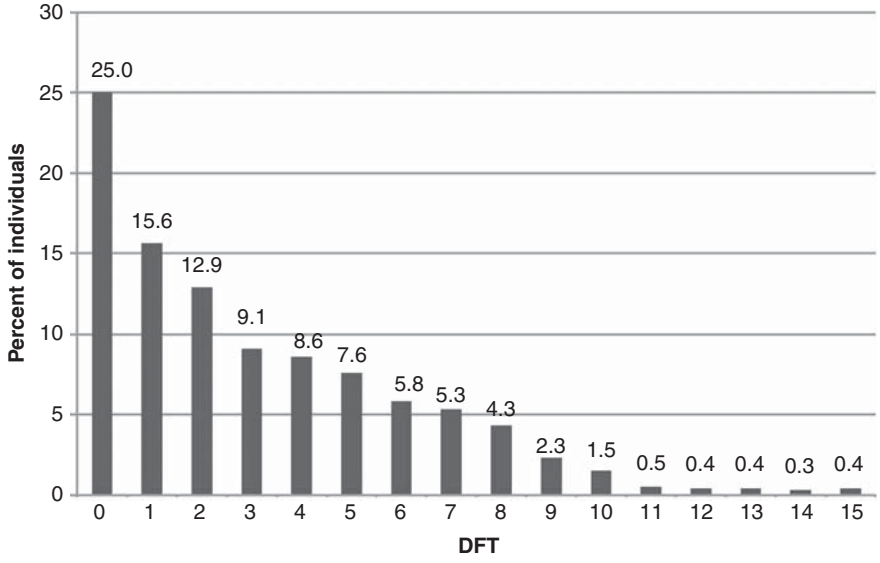

Figure 2. Percentage distribution of new decayed, filled teeth (DFT) during the 3-year study period.

by Riley et al. [14], risk assessment of children was carried out by 76% of all dentists, but only 14% took the advantage of structured models or protocols. Similarly, 69% of the dentists performed any kind of caries risk assessment on their adult patients [15]. Little is, however, known on the accuracy of this 'intuitive' way of risk assessment more than it is merely based on the past caries situation [16], but also published protocols or guidelines seem seldom validated for their effectiveness. Thus, the present study brings novel information on the routine use of a clinical scheme for risk grouping in public dental clinics in an age group not earlier studied.

The main findings were that the caries criteria in the scheme (past and present caries activity) totally dominated the risk assessment, albeit the magnitude and influence of the dentist's intuitive component could not be estimated, and that 65–70% of all patients were correctly classified. This means that the PDS model was only partly adequate to distinguish between those with low risk from those with higher risk categories. The obtained predictive values were, however, in the same range, and no better or no worse, as the outcome of a systematic review, compiling 12 prospective caries risk assessment trials [1,3]. The relatively high sensitivity on expense of a mediocre specificity displayed here was likely explained by the high proportion of young adult patients categorized as 'some risk'. When the 'low' and 'some risk' categories were combined, the specificity increased to an impressive 94%. In most studies, the specificity is higher than the sensitivity, indicating that caries risk assessment models actually are more effective in selecting patients at low risk than those with high caries risk. This 'negative' way to use caries risk assessment seems, however, to be adopted by few [17]; most reports are still focused on finding the true high-risk individuals. A significant proportion of patients who regularly attend general dental practice have repeated examinations without any need for treatment. Thus, it would be desirable to screen out these patients to concentrate the resources on those with greatest need. It should also be stressed that the general level of disease activity was relatively low in the present study population; in fact, the majority did not develop any obvious signs of decay, while those at high risk had a mean increment of 1.0 new surfaces per year. Another important fact is that the participants were treated with individually targeted preventive measures during the course of the study and,

Table II. Percentage distribution of caries risk according to the PDS guidelines, number of individuals, and mean caries increments (Δ) over 3 years expressed as mean DFT, DFS, DFSa (approximal) ± SD in the various risk groups (n = 982).

Risk group at baseline	ΔDFT (SD)	ΔDFS (SD)	ΔDFSa (SD)	ΔDFT = 0 (%)
Low risk (42.7%)	0.21 (0.56)	0.29 (0.87)	0.06 (0.31)	84.7
Some risk (45.4%)	0.76 (1.15)	1.27 (2.05)	0.54 (1.10)	54.5
High risk (10.4%)	1.25 (1.52)	2.87 (3.54)	1.49 (2.07)	36.3
Very high risk (1.5%)	1.27 (1.58)	2.87 (3.04)	1.53 (2.10)	20.0
ANOVA/Chi-square	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$

DFT, Decayed Filled Teeth; DFS, Decayed Filled Surfaces; DFaS, Decayed Filled approximal Surfaces; ANOVA, analysis of variance.

Table III. Sensitivity, specificity and predictive values calculated from a threshold level new caries/no new caries.

Risk category	*n* (%)	ΔDFS > 0 (%)	ΔDFS = 0 (%)
Low	419 (42.7)	64 (15.3)	355 (84.7)
Some	446 (45.4)	203 (45.5)	243 (54.5)
High	102 (10.4)	65 (63.7)	37 (36.3)
Very high	15 (1.5)	12 (80.0)	3 (20.0)

SE, sensitivity; SP, specificity; PPV, positive predictive value; NPV, negative predictive value. Values in table denote number of patients (%).
Low vs Some + High + Very high: SE = 81; SP = 56; PPV = 50; NPV = 85.
Low + Some vs High + very high: SE = 22; SP = 94; PPV = 66; NPV = 69.
Low + Some + High vs Very high: SE = 4; SP = 100; PPV = 80; NPV = 66.

provided that this was effective, it could contribute to a biased validation. Previous reports, however, have found a poor association between risk grouping and individualized prevention and that actually 15% of the high risk patients did not receive any preventive treatment at all [15,18].

The 24% attrition rate was considered acceptable with the 3-year duration time in mind. The main reasons for dropping out were migration and not responding to the follow-up invitation. The fact that the drop-outs were more caries prone and scored higher risk categories than those who remained in the study needs some attention, although not unexpected in the light of well-known socioeconomic determinants of caries. The attrition indicated that the caries prevalence was relatively lower in the final material compared to the full baseline group which, in turn, may affect the predictive values. The positive predictive value obtained here could, therefore, be underestimated and the negative predictive value somewhat over-estimated. It must, however, be pointed out that the sensitivity and specificity values were not influenced by the drop-outs.

In conclusion, the risk assessment scheme used by the Public Dental Service for young adults relied basically on the caries criteria. Less than 15% were considered being at 'high' or 'very high' risk and an acceptable sensitivity was obtained for 3-year caries incidence on the expense of a mediocre specificity. By combining the two lower risk groups, the model was effective to screen out patients at low caries risk. The amount of individualized preventive intervention offered and given to the patients in the various risk groups needs to be further clarified.

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