Risk Assessment

Full Summary

Description and Use:

Risk assessment is a strategy for improving the efficiency and effectiveness of prevention procedures and programs. Risk assessment protocols that are based on statistical models that include a collection of risk factors/indicators are used to collectively predict an individual’s risk of disease. These models can be used to determine high risk individuals/groups to develop appropriate treatment plans for intervention upon identified risk factors, determine appropriate intervals for patient recall and identify high risk individuals for preventive treatments. While risk assessment models are generally used to predict dental caries risk at the individual level, their utility may be greatest when applied at the population level. Dental caries management by risk assessment is an evidence based dental caries management protocol where by clinicians can identify the underlying cause of disease based on (risk indicators – signs of disease, risk factors – biologic predisposing factors including clinical and behavior variables, and protective factors – a variety of clinical, behavioral and therapeutic components).

Unfortunately there is no consensus in the literature concerning the use of the terms "risk factor" and "risk indicator". The types of variables used to predict risk of dental caries are generally individual level risk factors such as socio-demographic, behavioral and clinical variables which will vary in their predictability by the age and population under study. However, community level risk factors such as for low income patients, percentage of children participating in a free or reduced cost school lunch program and number of neighborhood grocery stores have also been shown to be significantly associated with dental caries among school children.

Risk assessment models have primarily focused on coronal caries risk among young children and to a lesser extent, the risk of root caries among older adults. Past dental caries experience has shown to be the single best predictor of future dental caries experience across various prediction models, while other contributing risk factors vary depending on the particular population under study.
Several tools are available for dental caries risk assessment, two of these are fillable forms the Caries-Risk Assessment Tool (CAT) from the American Academy of Pediatric Dentistry\(^2\) and Caries Management by Risk Assessment (CAMBRA) which is available for different age groups and suggests a bacterial culture for particular subgroups\(^{10}\). Cariogram is a computer based program that produces a pie-chart illustrating the contribution of a patient’s risk factors within broad categories and his/her future susceptibility to disease based on a predetermined algorithm\(^{11}\).

**Effectiveness and Efficacy:**

The effectiveness of the risk assessment model is most often based on measures of sensitivity (SN), specificity (SP) and positive and negative predictive values (PPV and NPV, respectively). Each of these parameters varies based on the age range under study and variables in the prediction model. The index most predictive of future dental caries depends highly upon the patient’s dentition, and the presence of sealants and/or restorations\(^9\).

**Toddlers to Preschool**

Among young children (toddlers to preschool) the predictive ability of risk assessment models to correctly classify children using combination of risk factors has generally been shown to be high with SN and SP greater than 0.80\(^9,^{12}\). However, once children reached 2.5 years previous dental caries experience alone appears to be the single best predictor of dental caries. Few studies have evaluated noncavitated lesions; however, these have repeatedly been shown to be predictive of future dental caries for individuals and may be useful in identifying high risk groups prior to dental caries initiation\(^{13,14}\). Carious lesions in the deciduous teeth have been assessed as a predictor of future dental caries in the permanent dentition. Although the quality of studies is heterogeneous, dental caries in the primary teeth is a strong predictor of future dental caries experience with SN=62% and SP=79%, on average\(^1\). While, mutans streptococci and lactobacillus count in saliva are often assessed as potential predictors they have shown poor accuracy (combination of sensitivity and specificity) when used as the sole predictor. Similarly, the presence of visible plaque on the labial surfaces of anterior teeth shows poor sensitivity with a high specificity (SN=26%, SP=88%), distinguishing children who will not develop dental caries, however poorly identifying those who will\(^1\). These results corroborate results from oral hygiene data suggesting that children (1-3 yrs) who brush at least once a day...
with fluoridated tooth paste, are less likely to develop dental caries by age 3 than those with poor oral hygiene\(^1\). Dietary factors are consistently observed to be important predictors in risk assessment models for young children. It is well known that sugar is a necessary cause for the demineralization. However, the association between sugar and dental caries is much weaker among children who have had consistent exposure to fluoride, whether intake of sugar is measured as total amount or frequency of intake\(^{15}\).

**Elementary to Adolescent**

Among school aged children and adolescents prior carious lesions are the single best predictor of dental caries risk, with little to no additional benefit in model performance by the inclusion of additional risk factors\(^1,5,16-18\). Beck et al.\(^{17}\) compared the selection and performance of predictors between 3 risk assessment models (any dental caries risk, high dental caries risk and an etiologic dental caries risk model) among a population of 4,117 children from two cities followed for 3 years. The authors found substantial variation in the final selection of significant predictors between each model based on city and school grade. For example, race and education were significant predictors in one population but not another, while among participants form Aiken, South Carolina in first grade race was a significant predictor in the “any risk” model but not among those in Grade 5. Parents’ education has additionally been shown to increase predictability in some studies\(^{19,20}\). The literature clearly highlights limitations in generalizability of risk assessment models and the need for population specific risk factor models. Furthermore, in the permanent teeth, risk of developing a carious lesion is highest immediately following eruption\(^1\), which calls for the use of prevention to protect teeth vulnerable to decay\(^{21,22}\).

**Adults and the Elderly**

Studies among adults have focused on evaluating risk of root caries among older adults\(^9\). Indicators of past dental caries experience remain the strongest predictors of risk of dental caries among older adult populations, irrespective of additional predictors\(^9\). There have been no reported studies evaluating dental caries risk assessment in young adults.

**Recommendations for community-based protocol:**
One risk assessment model cannot be used across all populations. Rather, in order to obtain accuracy, models should be developed based on age, population characteristics and levels of disease. Amstutz et al. sampled children in classrooms across North Carolina, and examined the relationship between various community level socio-economic indicators with dfs + DMFS score. The authors found wide variation, up to 36-fold, in df and DMF scores (depending on grade level) across the state. Tellez et al. evaluated the association between neighborhood factors and carious lesions among a population of low-income African Americans. The authors reported a decreased severity of dental caries with higher number of churches, while observing an increased severity in dental caries associated with number of grocery stories. While seemingly paradoxical, grocery stores in low income areas are generally small stores with limited availability of fresh food, often offering an abundance of refined and processed foods. Limited evidence for the added predictive power of additional variables in risk assessment models within certain populations does not indicate that potential risk indicators/factors should be ignored in individualized risk assessment treatment plans. The failure of these risk factors to show predictive power in statistical models may simply highlight a weakness of the data available to evaluate their role in the risk of dental caries.

Cost:

Badovinac et al. evaluated a dental caries risk assessment model in identifying high risk children in 1st grade for sealant application to avoid carious lesions in the first permanent molars by 4th grade. Using a threshold of dmfs +DMFS>0 (any dental caries history) in a simulation of 100 children, the authors found that 69.4% of dental caries in 4th grade could have been prevented and 44.5% of children who would not have developed decay, would have had sealants placed. The authors’ cost analysis showed an overall savings of $4,038.42 in program costs versus applying sealants to all 100 children irrespective of their dental caries risk profile. Similarly, Griffin et al. conducted a cost analysis of 3 different sealant programs: seal all, seal none or seal children assessed to be at high risk. The authors concluded that either sealing all or those at high risk was less costly than sealing none. However, as the SN and SP of the risk assessment model increased, sealing those at high risk became the most cost effective program. Hence, dental caries risk assessment provides a method to identify high risk groups to maximize true positives while minimizing false positives (incorrectly identifying high risk
individuals and providing treatment to those who would not go on to develop dental caries) to improve cost efficiency when resources are limited. Furthermore, the cost could further be minimized by utilizing allied health professionals for sealant placement.

Safety:

Dental caries risk assessment provides a method to identify high risk groups to maximize the allocation of limited resources such as application of sealants while ethically withholding services from low risk populations. The use of a dental caries risk assessment dental caries the potential for misclassification of individuals as false positives (classifying an individual as high risk who would not go one to develop dental caries) and false negatives (incorrectly classifying an individual as low risk who would go on to develop dental caries). Dental caries risk assessment can be used to maximize true positives while minimizing false negatives to mitigate potential safety concerns of withholding care from misclassified individuals who will later develop carious lesions which may lead to tooth loss.

Summary and Recommendations:

Based on findings from the literature, dental caries risk assessment can be effective in identifying individuals at high risk of developing dental caries who need preventive services and the management of risk factors. The current literature has focused heavily on the development of risk assessment models for dental caries among populations of young children and to a lesser extent to root caries among older adults. Past dental caries experience has shown to be the single best predictor of future dental caries experience irrespective of age across various prediction models. Other variables vary in their predictability by the age and population under study. Hence, one risk assessment model cannot be used across all populations. Dental caries risk assessment provides a non-invasive and patient acceptable method to identify high risk groups to maximize the allocation of limited resources in community prevention programs. Dental caries risk assessment can be used to maximize true positives while minimizing false negatives to mitigate potential safety concerns (i.e. withholding care).
References: