Risk Assessment-Based Individualized Treatment (RABIT): A Comprehensive Approach to Dental Patient Recall

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Abstract: Patient recall should be a tool to support prevention, allow early intervention, and ensure long-term dental health. Although the concept of patient-customized recall intervals has increased in popularity, recommendations vary significantly. Concepts of risk assessment-derived recalls are described in the literature separately for caries, periodontal disease, and edentulism, but no published guidelines exist for creating patient-centered recall systems that integrate all risks. Further, no recommendations exist regarding oral cancer risk assessment and recall intervals. The evidence shows that recall intervals of less than twelve months do not impact stage and tumor size at diagnosis although increasing this interval may significantly affect the outcome. The typical approach to recall scheduling is that the interval before the next oral health review should be chosen when no further treatment is indicated or on completion of a specific treatment journey. This article advocates a modified approach that supports individualized risk-based recall schedules not only after active therapy is completed but also during the course of treatment. The design of individualized recall schedules would address a patient's risk for caries and periodontal disease and the need to perform periodic oral cancer screenings. Evidence is also presented regarding the timing of recalls for edentulous patients. This article describes design principles for a Risk Assessment-Based Individualized Treatment (RABIT) system, presents an example of an electronic health record (EHR) recall module implemented at one dental school, and identifies barriers to implementation. As EHRs become more prevalent in dental practice, it is expected that the software industry and the profession will collaborate to include RABIT-like concepts in software management packages.

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Patient recall should be a tool to support prevention, allow early intervention, and ensure long-term dental health. A recall visit is defined as "the planned, unprecipitated return of a patient who was last seen in good oral health"; a recall examination is defined as "the examination performed at this return appointment."[1]

The Commission on Dental Accreditation (CODA) expects academic dental institutions "to develop and implement definitions, practices, operations, and evaluation methods so that patient-centered comprehensive care is the norm."[2] Evidently, recalls are an integral part of the patient-centered comprehensive care approach that dental schools should develop and integrate in the curricula: standard 2-23.o specifically requires graduates to be competent in "evaluation of the outcomes of treatment, recall strategies, and prognosis." CODA standards also require that students' competencies "must be reflective of an evidence-based definition of general dentistry" and, as stated in the new 5-2 standard, "Patient care must

be evidenced-based, integrating the best research evidence and patient values."[2]

Dental treatment is driven by the patient's main complaint and/or diagnosis.[3] In order to justify the rationale for providing preventive treatments during recall appointments, what drives these interventions should be defined. If determination of future oral disease development risks becomes an integral part of the diagnostic process (see CODA standard 2-23),[2] these risks will dictate how to manage the recall schedule and the treatments that should be provided during these sessions. Academic dental institutions therefore face a challenge to develop strategies to incorporate the best available evidence regarding patient recalls in the didactic and clinical curricula. The didactic knowledge should be applied in the clinical environment to develop recall schedules. In order to address these challenges and to create sustainable recall systems, dental schools have to develop a multi-level approach. The didactic curriculum should incorporate best evidence addressing a) how

to determine the recall schedule frequency; b) what are the risks that should be monitored during recall appointments; c) how to perform risk assessment; and d) what are the preventive treatment protocols to mitigate these risks. At the same time, clinical management systems such as the electronic health record (EHR) should support development of recall schedules driven by the patient's individual risk level and based on the above-mentioned evidence.

This article presents a road map that shows the best evidence for developing, teaching, and incorporating in the clinic the concept of risk assessment-based recall schedules. The link between the didactic curriculum and clinical patient care is demonstrated by the development and implementation of an electronic recall module integrated into the EHR; this system was implemented in the predoctoral clinic at Case Western Reserve University School of Dental Medicine.

What Is the Optimal Recall Interval?

A six months recall visit interval was advocated as early as 1879 by the American Academy of Dental Science. At the beginning of the twentieth century, the American Dental Association (ADA) distributed the first oral health patient brochure recommending visiting the dentist at least twice a year and added that, if a predisposition to "unhealthy teeth and gingivae" exists, the visits should be more frequent.[4] The six months interval was also promoted by a toothpaste commercial in the 1930s,[4] later becoming a standard in the dental insurance industry.

Although many dentists still recommend the biannual check as the standard recall schedule for all patients, there is no scientific evidence that supports this schedule as a blanket recommendation.[1,4-10] The services provided during these recall appointments usually include a ten-minute exam,[11] scaling, and polishing[12] irrespective of the patients' oral condition.[11,13] This pattern is particularly apparent in countries such as the United Kingdom, where dentistry is covered by state insurance and where half the services reported consist of an exam and scaling with polishing.[1,8] In North America, reduced coverage by insurance carriers led to debate regarding the rationale for a biannual exam.[1,14] Other studies found that the majority of dentists still recommend a six months recall schedule for all patients.[12,13] Setting the optimal revisit interval

is not unique to dentistry, with primary care physicians facing the same dilemma; similar to dentistry, patient factors accounted for but a small part of the considerations for revisits interval.[15]

A review published in 1977 in *Lancet*[10] that aimed to inform physicians regarding dental diseases and recalls as part of a comprehensive prevention program identified dental caries, periodontal diseases, malocclusion, and oral malignancies as the main areas of concern. In the early 1980s, it was suggested that dental recalls should be based on caries risk,[16] but because no protocols to determine the risk and to establish a recall schedule were available, the practitioner had to rely on subjective evaluation. As more evidence regarding the need to create individualized risk-based recall schedules emerged,[6,9,17-26] the debate regarding how the risk and the optimal recall interval should be determined continued. A study published by the National Institute for Clinical Excellence (NICE) in the United Kingdom recommended recall schedules that varied between three and twenty-four months based on evaluation of patients' needs. Current recommendations based on the NICE study indicate that a recall schedule should be instituted after active therapy is completed.[18]

Oral Disease and Risk Assessment

Risk assessment has been defined as the process by which qualitative or quantitative assessments are made of the likelihood of adverse events occurring as a result of exposure to specified health hazards or by the absence of protective factors.[17] Although the concept of risk assessment and patient-customized recall intervals has increased in popularity, there is still significant variability in recommendations proposed in different parts of the world.[1] In the United Kingdom, it was recommended that an interval of up to three years be used for low-risk patients,[27] whereas in Finland it was suggested that an interval of up to two years be instituted for low-risk adolescents.[24] In Denmark, a significant segment of municipal health services adopted an eight-month recall interval,[28] whereas in the United States, intervals between twelve and twenty-four months were advocated for low caries-risk patients.[1,4,29]

The diversity of oral disease patterns across regions reflects distinct risk profiles and therefore potentially different preventive oral health care pro-

grams.[30] These differences are related to lifestyle, environmental factors, and prevalence of chronic diseases such as diabetes that increase risk factors of oral pathologies. Dietary habits, smoking, and poor oral hygiene standards also vary among countries and regions and define specific regional risk profiles for the local population.[30]

Currently, the concept of risk assessment-derived recalls is well established; however, the main questions remain: what are the risks that should be assessed and what the recall schedule should be? The literature mentions four main themes that should be evaluated within a recall system.

Caries

Worldwide, the prevalence of dental caries among adults is high in most countries.[30] Studies show that it takes two to four years for caries to progress through the enamel, with 50 percent of initial lesions not progressing at all over a four-year period.[10] These findings lead to recommended recall intervals of up to twenty-four months for children and adults.[4,10,18,31,32] In children with deciduous dentition, no significant association between dental check frequency and caries progression has been reported, while for mixed dentition the results vary.[7] There is growing evidence that older people experience caries at a rate that is at least as great as adolescents, and the older population may be considered at even more risk than children and young adults because root surface caries is prevalent in this age group as opposed to those twenty years old or younger. It is estimated that the incidence of root caries in those aged over sixty-five is 23.7 percent.[33,34] A negative relationship between root caries lesions and recall frequencies has also been reported.[35]

Since 1995, risk-based prevention of dental caries has been promoted,[36] and algorithms aimed at helping clinicians to determine the risk level were developed,[37] but it was not until 2007 that the Caries Management By Risk Assessment (CAMBRA) protocol was established.[38-40] Because of significant regional variations in caries prevalence and risk factors, the predictive validity of any prevention model will depend strongly on the characteristics of the population.[41] Individualized risk-based dental exam frequencies were found beneficial in reducing the number of fillings in the mixed dentition, compared with a non-individualized twelve months recall policy.[8,42] Although 73 percent of dentists surveyed in a dental network in the United States reported performing caries risk assessment for children, only 14 percent reported assessing risk using a special form.[43] Regarding adults, 69 percent of the network dentists said they evaluate patients with caries risk assessments (CRA), but only 57 percent of the patients evaluated with CRA received individualized caries prevention.[44]

Another survey in the United States found that 72 percent of the dentist respondents performed some type of risk assessment, but only 27 percent of this group documented the outcome. Furthermore, only 51 percent of the respondents provided a management plan based on the patient's risk status.[37] The conclusion is that, despite risk assessment and prevention protocols being in place, not all dentists are aware of the importance of specific caries-risk factors, and clinical practice is not yet driven by individualized preventive recommendations.[43,44] These discrepancies can be at least partially explained by the costs that caries-risk assessment generate for patients in relation to recall schedules and prevention; the annual cost for the low-risk patient is $109, for the medium-risk patient $445, and for the high-risk patient $1,117.[45] Because caries experience is more extensive and severe in lower socioeconomic groups[1,46] (that is, there are more patients who will be diagnosed at high risk for caries in these population tiers), it seems that the increased prevention costs affect the most vulnerable population.

Periodontal Disease

Currently, it is accepted that a healthy periodontium is characterized by lack of inflammatory signs, maintenance of the periodontal attachment level, stable bone level, and, where present, functional dental implants.[47,48] Despite widespread perception that scaling and polishing should be provided at each recall appointment,[1,8,12] there is insufficient evidence to reach "any conclusions regarding the beneficial and adverse effects of routine scaling and polishing for periodontal health and regarding the effects of providing this intervention at different time intervals."[49] Although other studies have shown that regular maintenance slows progression of disease, a study using rubber cup failed to reveal any benefit in the prevention of gingivitis from dental prophylaxis procedures during recall examinations. These findings apply to all age groups from childhood to adulthood.[50]

Although poor oral hygiene and plaque accumulation have a positive epidemiologic correlation

with gingivitis and severity of periodontal disease, oral hygiene is a weak predictor of periodontal disease at the individual level. This can be explained by variations in individual predisposition to develop the disease given the same risk factor.[51] Some studies report that established recall plans and patient education regarding periodontal maintenance seem to provide long-term benefits,[52] while others show mixed results regarding the relationship between dental check frequency and probing depth.[7] A systematic review found no significant relation between recall frequency and other measures, i.e., bleeding, presence of plaque and calculus, bone score, gingivitis, and periodontal health.[7] However, another systematic review found statistically significant differences in favor of scaling and polishing provided at more frequent intervals than twelve months for parameters such as plaque, calculus, and gingivitis.[47] Recall frequency and periodontal outcomes in deciduous and mixed dentitions have not been investigated.[7] Current recommendations support implementation of periodontal risk assessment based on systemic and local risk factors;[17,22,23] however, studies performed in private practice reveal extensive risk estimation variation across offices.[19]

Complete Edentulism

The American College of Prosthodontists (ACP) recommends that patients who wear complete dentures should be checked annually for maintenance of optimum denture fit and function, for evaluation of oral lesions and bone loss, and for assessment of oral health status. It also is recommended that dentures should be cleaned annually by a dental professional using an ultrasonic cleaner to minimize biofilm accumulation.[53] This recommendation is based on mounting evidence regarding the relationship between proper complete denture oral hygiene and overall systemic health, especially in dependent elderly patients.[54] Residual ridge resorption, mucosal lesions, denture stomatitis, and occlusal changes also are mentioned as reasons that support the annual check recommendation. No published guidelines regarding recommended frequency of denture relines and rebases exist; therefore, the ACP taskforce suggests that the annual recall schedule will identify patients who will benefit from such a procedure.[53]

Oral Cancer

Prevalence of precancerous oral lesions varies even among regions and ethnic groups in the same country. The prevalence of leukoplakia in Cambodia is reported to be 1.1 percent, whereas in Sweden it reaches 3.6 percent.[30] Epidemiological data on the transformation of leukoplakias suggest an overall transformation rate of 4-6 percent over ten to twenty years,[55] but there is a lack of reliable indicators that predict the imminence of transformation of precancerous to cancerous lesions.[8,56,57] Oropharyngeal cancer is more common in developing than in developed countries; however, an increase in the incidence of these cancers has been reported in several European countries as well as in the United States.[58,59] Around 90 percent of these malignancies are squamous cell carcinomas, and more than 97 percent of the cases recorded in the United States occur among adults thirty-five years or older.[57]

Due to the relatively low prevalence of oral cancer, screening will lead to a low yield and a high proportion of false positive referrals.[60,61] Most studies did not find a direct association between diagnostic delay and clinical stage[62-65] or tumor size.[66,67] A recent report concluded that, in asymptomatic patients seeking dental care, there is insufficient evidence to determine whether screening by means of visual and tactile examination to detect potentially malignant and malignant lesions alters disease-specific mortality.[57] Dental check recall intervals of less than twelve months do not impact stage and tumor size at diagnosis, although increasing this interval may significantly affect this outcome.[8]

In light of published evidence and the lack of defined recommendations regarding oral cancer risk assessment and recall intervals, the prudent practitioner should include oral cancer screening in each comprehensive exam performed on patients who are placed on recall schedules dictated by caries risk, periodontal risk, or presence of complete dentures.[57] There is insufficient evidence that commercial devices based on autofluorescence and tissue reflectance enhance detection of potentially malignant lesions beyond that achieved through visual and tactile examination.[57] Due to the potential catastrophic outcomes of oral malignancies, screening for oropharyngeal cancer becomes the major factor for determination of any recall schedule; therefore, the intervals should be no longer than twelve months for adults,[8] particularly those thirty-five years or older; this is shorter than the recommendation of a recall interval of up to twenty-four months driven by caries low-risk for adult patients.[4,18]

In summary, the following principles reflect the current evidence and guidelines regarding recalls.

First, a recall schedule should be created at the completion of the active treatment phase. This determination is based on the following statements: a) a recall visit is defined as the planned, unprecipitated return of a patient who was last seen in good oral health;[1] and b) the interval before the next oral health review should be chosen either at the end of an oral health review if no further treatment is indicated or on completion of a specific treatment journey.[18] Second, recall schedules should be individualized and based on risk evaluation. Third, protocols and guidelines for risk determination and appropriate recall schedule design exist for caries activity, periodontal disease, and maintenance of complete dentures. No such guidelines exist for oral malignancy, but evidence suggests that adult patients will benefit from annual exams.[8]

The RABIT Concept

Challenges in Implementation

To date, there are no published guidelines regarding practical implementation of evidence-based risk assessment recall systems that are versatile enough to be adopted in any practice size. This article aims to provide a roadmap that will help both practitioners and the software industry to design systems that will assist in operating comprehensive dental recall programs from within the EHR. Parameters for such a system, designed at Case Western Reserve University School of Dental Medicine for adult patients treated in the Comprehensive Care Clinic, will illustrate the practicality of implementation of the RABIT concept in the EHR.

In order to create a system that is efficient and user-friendly, the following barriers have to be overcome. First, the dental practice should have an EHR that is designed to[68] do the following: apply a philosophy of user-centered design (this means that the EHR will be flexible enough to allow end-users to define customized parameters necessary to operate the recall system); integrate the relevant patient information needed to automatically create individualized recall schedules; and display and generate information (screen pop-ups, reports) regarding the recalls for a specific patient or a group of patients. The level of integration required to perform these functions is called "task-oriented information integration," and currently it is considered a vision that, in general, has not been realized.[68]

Second, the Code on Dental Procedures and Nomenclature (known also as the Current Dental Terminology [CDT] code) has no diagnostic codes and specifically lacks risk assessment diagnostic codes. The practitioner will have to define in the EHR ad hoc risk diagnostic codes that will be used as "generators" of the recall schedules.

Design Principles for RABIT

The RABIT approach differs from the current recall approach by recognizing several points. First, risk assessment is done as part of the initial diagnosis; recall schedules should be automatically generated in the EHR, immediately following risk determination. This approach will ensure that patients with complex treatment plans will have the risk factors addressed and reevaluated also during the active treatment phase and not only after completion of treatment. Second, multiple recall schedules that address different risk factors need to be implemented; not every recall appointment should include the same prophylactic treatments and/or recommendations. For example, a patient can be scheduled for quarterly appointments because of his or her periodontal situation, whereas the caries risk dictates a twelve months recall schedule for evaluation of this risk.

Third, following periodic reevaluation, the risk for a particular category may change requiring a new recall schedule for that category. Fourth, whenever possible, recall appointments driven by different risk factors should be combined into single recall appointments in order to enhance efficiency and patient compliance. Fifth, the electronic recall system should automatically delete caries risk- and periodontal risk-driven recall schedules when a patient becomes edentulous.

Methods of Implementation

These recommendations are based on the RABIT system designed at Case Western Reserve University School of Dental Medicine for adult patients treated in the Comprehensive Care Clinic (adult patients are defined in this clinic as patients older than sixteen years). Figure 1 summarizes the RABIT system design implemented in the GSD academic practice management software (General Systems Design, Cedar Rapids, IA, USA) in a flowchart format. It is beyond the scope of this article to present the process of risk levels definition that was followed; therefore, a detailed discussion regarding this process is not presented. The risk levels for each risk category, however, have been developed according to existing evidence.[8,17,23,38-40,53,69] (Table 1).
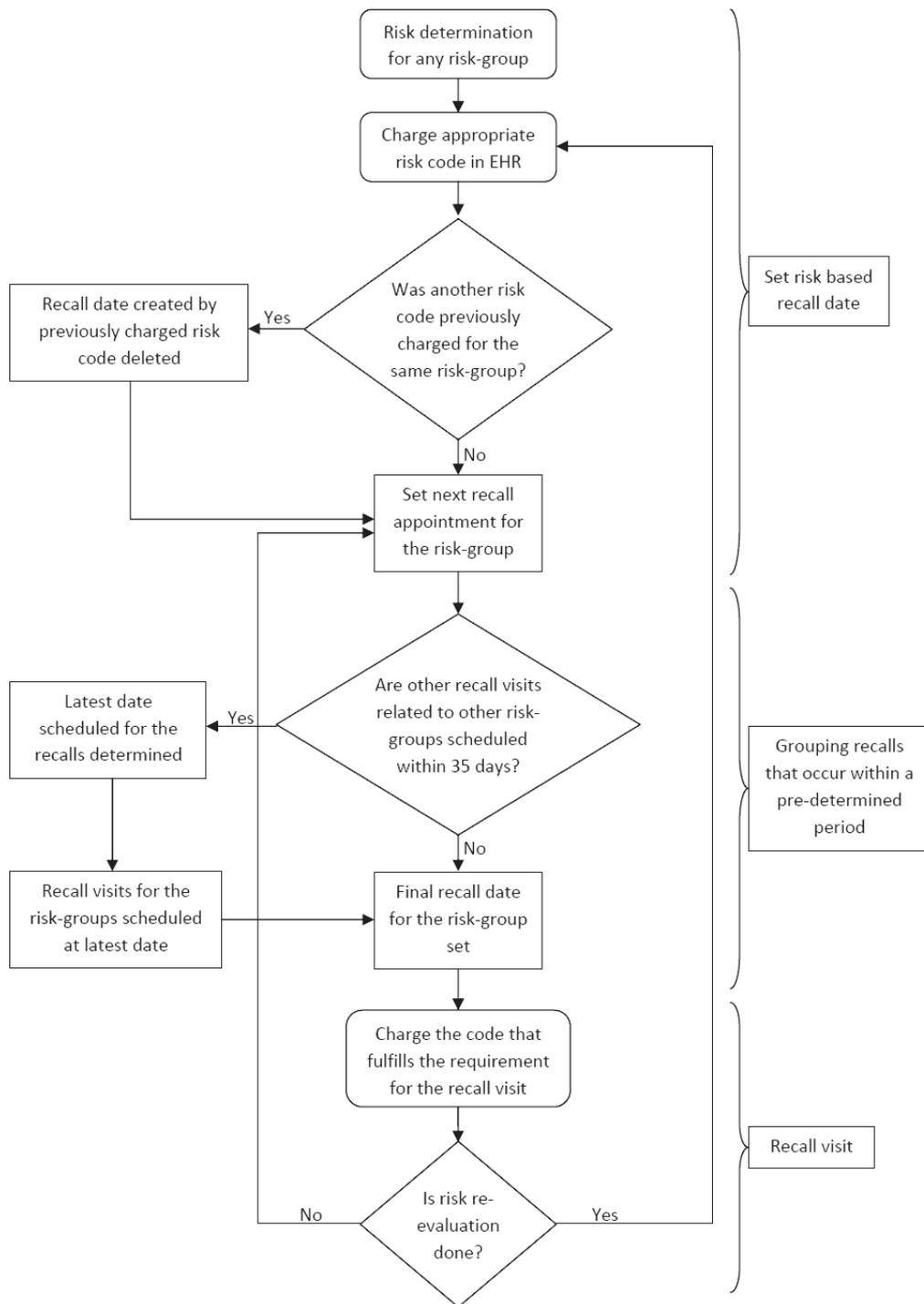
Figure 1. Functional flowchart for the RABIT system

Note: Boxes with rounded corners are the only steps that require human input; all other steps are automatically managed by the computer.

Table 1. Risk groups, generator codes, and recalls

Risk Group	Risk Description	Generator Risk Code	Recall Visit Interval	Specific Procedure to Be Performed During Recall Visit[a]	CDT Code for Procedure to Be Performed During Recall Visit
Caries risk assessment[b]	Caries extreme risk	CARIESEXTRISK	3 months	Fluoride varnish application[c]	1206
	Caries high risk	CARIESHIGHRISK	4 months	Fluoride varnish application[c]	1206
	Caries moderate risk	CARIESMODRISK	6 months	Fluoride varnish application[c]	1206
	Caries low risk	CARIESLOWRISK	12 months	Re-evaluation, problem focused[c]	0170
Periodontal risk assessment[b]	Periodontal high risk	PERIOHIGHRISK	3 months	Periodontal maintenance	4910
	Periodontal moderate risk	PERIOMODRISK	4 months	Periodontal maintenance	4910
	Periodontal low risk	PERIOLOWRISK	6 months	Prophylaxis	1110
Complete dentures	Immediate denture, maxillary	5130	3 months	Periodic exam	0120
	Immediate denture, mandibular	5140	3 months	Periodic exam	0120
	Interim denture, maxillary	5810	3 months	Periodic exam	0120
	Interim denture, mandibular	5811	3 months	Periodic exam	0120
	Permanent complete denture, maxillary	5110	12 months	Periodic exam	0120
	Permanent complete denture, mandibular	5120	12 months	Periodic exam	0120

[a]Each specific procedure is carried out in addition to an exam.
[b]For patients who are edentulous on both arches, a "NORISK" ad hoc code was created in the system. Charging this code deletes all previously established caries and periodontal risk recall schedules.
[c]Students are instructed to also provide nutritional counseling and home care recommendations according to the determined risk level.

Design of the RABIT system includes the following steps prior to implementation in the EHR:

1. **Risk group definition.** The practitioner should define what the risks are that should be monitored. At Case Western Reserve University School of Dental Medicine, it was determined that the risk groups are caries, periodontal status, and complete dentures (Table 1). Because no risk assessment guidelines exist for soft tissue lesions, a soft tissue examination to detect possible pathologies is part of any recall visit.

2. **Risk levels within each risk group.** For each defined risk group, the number of risk levels is determined. These risks are codified in the EHR with ad hoc codes that once charged in the system will generate recall schedules and are referred to as "generator codes." For some risk groups (caries and periodontal status), the presence of risk factors or absence of protective factors determines each risk level, while the edentulous group has a binary approach based on the presence or absence of dentures.

3. **Recall schedules definition.** Each risk level generates a unique recall schedule. For example, High Caries Risk generates a four-month recall schedule, whereas Low Perio Risk leads to a six-month recall schedule (Table 1).

4. **Procedures to be performed during a recall visit.** Because recall visits are generated by a specific generator risk code, procedures that should be completed during this specific appointment have to address the specific risks. After the procedures required to fulfill a recall appointment are completed, the next recall appointment will be automatically set in the system (Table 1).

5. **Combining recall appointments.** It is understood that, by specifically addressing multiple risk categories, the system will create multiple recall schedules. In order to enhance treatment efficiency and patient compliance, it is recommended to combine into one appointment recalls that address different risks. This can be done only if the recall schedules are not significantly altered. At Case Western Reserve University School of Dental Medicine, it was determined that two recall appointments that occur within thirty-five days will be automatically combined into one appointment by choosing the latest scheduled appointment date. For example, if a patient is scheduled for a recall appointment generated by the caries risk evaluation on January 10 and for a recall appointment generated by periodontal risk evaluation on February 1, the system will combine the two appointments

into one on February 1, during which preventive procedures for both risks will be performed. Following completion of the procedures, the system will schedule the next recall appointments according to the risks. For example, if the caries risk dictates a twelve-month recall visit and the periodontal risk a six-month recall visit, the system will schedule future appointments accordingly.

Discussion

Risk assessment-based recalls are considered the state-of-the-art practice. Current evidence has changed the paradigm of one-recall-interval-fits-all and emphasizes different risks that should be followed according to appropriate schedules. There is an obvious gap between understanding the risks and the need to individualize recall schedules and the implementation of such systems in practice. One study, for example, found that only 64 percent of U.S. prosthodontics residency programs had an active recall system although 91 percent believed recall to be important; only 57 percent of directors of programs with active recall systems reported that their system is effective.[70] In a separate report, residents in those programs acknowledged that well-established recall systems can provide benefits to patients, residents, and the institution, but those participating in programs that had a recall system perceived that its effectiveness could be improved.[71]

Currently, most software packages for practice management lack an efficient way to connect risk assessment and recall schedules.[72] The challenge is compounded by the fact that only 25 percent of general dentists in the United States use computing in the clinical environment and only 1.8 percent maintain completely electronic patient records.[68,72,73] The complexity of practice management software packages is one of the major barriers for chair-side computing.[73]

The RABIT concept described in this article addresses barriers related to creating recall schedules based on multiple risk categories, as well as barriers related to the operational characteristics of electronic records. Limitations to this approach may include restrictions imposed by insurance; also, this risk assessment does not include endodontic risks. Nevertheless, utilizing the RABIT concept, a practitioner or academic institution can create multiple risk categories (caries, periodontal disease, etc.)

to generate a unique patient risk profile and recall schedules aimed at monitoring and mitigating these risks. After the first stage of parameters definition, the decision process is automated in the software with minimal input necessary from the practitioner. The ease of operation from the practitioner's standpoint is shown in Figure 1 in the operational flow.

Conclusions

RABIT illustrates how a user-centered design approach can be applied to achieve task-oriented information integration[68] in a large dental practice such as a predoctoral comprehensive care clinic. This approach required the software vendor (General Systems Design, Cedar Rapids, IA, USA) and the Case Western Reserve University School of Dental Medicine clinic management to together define the principles that were implemented in the electronic recall module. The RABIT concept requires the following:
- Risk should be addressed during both active treatment and maintenance phases.
- For patients thirty-five years of age or older, the major factor for determination of any recall schedule is the need to screen for oropharyngeal cancer; therefore, the maximal recall interval should not exceed twelve months.
- An evidence-based, patient-centric approach that takes into account multiple risk categories should be implemented in designing the recall schedules.
- Individualized treatment that addresses the patient's risk profile should be updated and provided periodically.
- Software developers should work closely with end-users to integrate evidence-based therapeutic principles in electronic records. As EHRs become more prevalent in dental practice, it is anticipated that the software industry and the profession will collaborate to include RABIT-like concepts in management software packages.

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