



Research article

Dental follow-up and maintenance index: the development of a novel multidisciplinary protocol



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ABSTRACT

Objectives: To develop a comprehensive yet simple dental follow up and maintenance protocol based on existing guidelines and recommendations.

Methods: A multidisciplinary team reviewed available maintenance and follow up guidelines and recommendations then developed a single protocol for adult dental patients.

Results: The protocol includes ten questions that categorize dental patients into one of three risk categories. Based on the risk category, each patient is assigned a recall interval and recommendations for in office and at home dental care.

Conclusions: Development of a single multidisciplinary follow up and maintenance protocol.

1. Introduction

Comprehensive dental care, defined by Farlex medical dictionary, is the management of dental disease to restore health, function and aesthetics; in addition to prevention and early detection of complications [1]. For the past decades, patients attending various dental centers (i.e. educational institutes, private practices and primary health care centers) are anticipated to be treated comprehensively to address their chief complaint and dental needs as recommended by various international dental societies. During this process, dental patients are expected to demonstrate dedication, in addition to investing time and resources which varies based on the treating center, dental provider and case complexity. Afterward, and upon completion of assigned dental treatment plan, patients are strongly advocated to follow a dental discipline-customized, long-term maintenance protocol for a more favorable prognosis and early detection of new onset dental disease.

The concept of dental maintenance was historically introduced to ensure longevity of restored oral health and success of provided dental

care. It was based on dental discipline-specific guidelines that dictate patient dental visits according to their needs (dental visit duration ranges between 15-60 min on average) at variable time intervals in addition to at-home dental care to improve efficacy. These guidelines have been established and are currently in use for daily dental practice. However, the literature lacks a consensus on a more comprehensive and multidisciplinary maintenance protocol for dental patients which requires extra effort to combine and implement more than one protocol in a single office visit for some cases. In addition, maintenance of extensive dental work requires frequent and extended visits which impose a challenge on dental providers in centers with higher patient volume such as primary care centers.

The aim of this paper was to develop a comprehensive, user-friendly dental maintenance index combining current dental disciplines' guidelines for adults in a single, user-friendly protocol. In addition, disciplines with no formulated maintenance protocol such as oral medicine and dental behavioral sciences were considered and included as well. We believe that successful application of this index will result in a more

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improved structure, efficient and time-saving maintenance plan for dental patients with an easier decision-making process for dental health care providers as applicable.

2. Background and review of existing maintenance protocols

2.1. Oral radiology

Radiographs are an imperative tool in the diagnostic armamentarium of dentists and dental specialists [2, 3]. They assist in the detection and characterization of various oral diseases and conditions and play a major role in the treatment planning and follow up phases. However, the radiographic needs should be tailored for any particular patient and weighed against potential risks associated with radiation exposure [4]. Therefore, the decision to obtain a radiograph is based largely on the dental practitioner clinical judgement whom should take into consideration the patient's needs, medical/dental history, clinical findings, and general health to determine the type, number, and frequency of radiographs needed [4].

The first guidelines to prescribe radiographs for the dental patient were introduced in 1987 by a panel of dental experts [4]. These guidelines have been under continuous review by the American Dental Association (ADA) in collaboration with the Food and Drug Administration (FDA) and other specialty organization with the latest released in 2012 (discussed in details under Material and Methods) [4]. The main goal of these guidelines is to assist dental practitioners in optimizing patient care, minimizing radiation exposure, and using resources effectively [4]. Based on the latest guidelines, patients are categorized into new and recall patients taking into account patient's age and vulnerability to known risk factors [4]. These guidelines are currently considered as the standard of care for long-term follow up of dental patients.

2.2. Restorative dentistry and cariology

Prevention and early detection of carious lesions marks the new scope of restorative dentistry in the twenty-first century. It starts with risk assessment to determine the patient's potential risks to develop new caries lesions based on existing oral environment [5, 6]. This concept is paramount in order to prevent restoration failures due to secondary caries which is considered as the most common cause for replacement of dental restorations [7, 8]. One integral component of this process is to maintain the balance between pathological and protective factors with focus on prevention and oral hygiene practices. To serve this purpose, Caries Management by Risk Assessment (CAMBRA) was developed as an evidence-based system to help dental practitioners in determining patient's risk for new caries lesions [6, 9, 10]. In addition, it allows for caries prevention and management through remineralization and repair of existing incipient lesions [9, 11]. However, successful implementation of CAMBRA requires data collection pertaining to factors such dietary habits, salivary characteristics, and bacterial load related to each patient [12, 13]. These factors must be considered during treatment planning phases to customize treatment options offered to dental patients on a case by case basis accounting for caries risk (Table 1).

Up to date, no restorative maintenance protocol has been developed and applied in daily dental practice. However, CAMBRA could function as an important follow-up tool on patients after concluding all restorative treatments.

2.3. Periodontics

Periodontal maintenance (PM) is key to achieve a successful and lasting periodontal treatment and peri-implant health [14]. Hence, a well-structured program allows for close monitoring of periodontium, dental implants and evaluation of existing restoration and prosthesis to reduces the risk of future attachment loss or failure. For this reason, the American Academy of Periodontology (AAP) issued a position paper with

Table 1. Risk assessment parameters for dental caries based on CAMBRA modified from Young and Featherstone, 2010 [10].

Pathological factors
Visible cavities or radiographic penetration of dentin
Radiographic evidence of approximal enamel lesions
White spots on smooth surfaces
Restorations placed in the last 3 years
Risk Factors (biological predisposing factors)
High <i>Mutans Streptococci</i> and <i>Lactobacelli</i> load*
Visible, heavy plaque on teeth surfaces
Frequent consumption of carbohydrate-containing food items (>3x daily between meals)
Deep pits and fissures
Recreational drug use
Inadequate saliva flow by observation or measurement**
Saliva reducing factors (medications/radiation therapy/systemic disease)
Exposed roots
Orthodontic appliances
Protective factors
Lives/work/school fluoridated community
Fluoride toothpaste at least once daily
Fluoride toothpaste at least 2x daily
Fluoride mouth rinse (0.05% NaF) daily
5,000 ppm fluoride toothpaste daily
Fluoride varnish in last 6 months
In-office fluoride topical application in the last 6 months
Chlorhexidine mouth rinse prescribed/used one week each for the last 6 months
Xylitol gum/lozenges 4x daily in the last 6 months
Calcium and phosphate paste during last 6 months
Adequate saliva flow
* By culture of chairside bacterial kits.
** Stimulated salivary flow rate of 0.7 mL/min. or less.

therapeutic goals for PM program including prevention or minimizing recurrence of disease progression in patients previously treated for periodontitis, peri-implantitis, or other types of gingivitis [15]. In addition, implementation of PM could prevent or reduce the incidence of tooth or implant loss by monitoring existing dentitions and prosthetic replacements of natural teeth and increase the probability of locating and treating other emerging oral diseases in a timely manner [15].

PM protocol includes a wide range of parameters covering several entities (medical/dental history, radiographs, soft and hard tissue examination) for comprehensive patient assessment. It also includes periodontal and implant evaluation, with dental prophylaxis, supra-gingival scaling, selective sub-gingival and root planning to be completed as needed during the patient visit [15]. At the same visit, review of plaque control measures and oral hygiene instructions are discussed and reinforced for individual patients [15]. Typically, and upon customizing PM schedule, several factors are considered such as patient's current overall dental and specifically periodontal statuses, degree of compliance and clinician judgment to determine the office visit intervals which best fit patient needs [15].

Several studies have evaluated the role and impact of long-term maintenance on patient's periodontal health. Nyman et al. evaluated the effect of PM on patients treated with periodontal surgery and demonstrated treatment failure due to gingival inflammation and recurrence of periodontal disease in absence of long-term follow up [16]. Axelsson et al. reported on non-compliant patients in a supervised PM program who were more susceptible to clinical attachment loss and recurrence of periodontal disease [17]. At the same time, patients enrolled in a maintenance program had stabilized periodontium without further destruction disregard the treatment rendered [18]. Moreover, there was less clinical attachment loss and fewer teeth loss in the same patients population [15, 19]. Therefore, PM has been implemented for

patients with dental implants and periodontal disease by majority of dental practitioners [20].

2.4. Endodontics

The objectives of post treatment follow-up of endodontically treated teeth include monitoring of treatment outcome and integrity of the coronal seal. It is well recognized that the scope of endodontic treatment ranges from vital pulp therapy to root canal treatment, including non-surgical and surgical re-treatments. Hence, the success of endodontic treatment in regression of inflammation is defined by criteria specific to each treatment modality.

In general, changes in clinical signs and symptoms of inflammation accompanying pulpal and apical inflammation support the initial gauge of endodontic treatment response [21]. The reduction in pain or swelling severity, if present, indicates successful treatment, reduction of infection load and allow for acute inflammatory reaction to subside [21]. Cases presenting with a draining fistula from a chronic apical abscess are clinically monitored for obliteration of the tract and resuming normal mucosal architecture [21]. However, the inconspicuous nature of apical inflammation, merely due to its hidden location within the jaw, dictates the need for radiographic follow up alongside clinical examination [21].

Apical health has been long considered as the gold standard to measure endodontic treatment outcome [21, 22]. A particular treatment is considered successful when there are no clinical signs and symptoms of inflammation associated with the treated tooth and the periapical lesion has responded to rendered treatment. The periapical lesion is described as “*healed*” when normal radiographic features of roots, periodontal ligament, and the surrounding alveolar bone have been restored [23]. In general, most apical lesions tend to heal within the first year of treatment [24]. However, larger lesions may require up to 4 years to achieve complete healing [25]. Based on these parameters, endodontic maintenance visits are scheduled more frequently in the first year following treatment, often every 3–6 months, then tapered off to once every 6–12 months, depending on clinical and radiographic findings. Radiographic evidence of reduction in lesion size associated with a clinically functional tooth may suggest a “*healing*” lesion and the tooth should continue to be observed biannually. An apical radiolucency that remains unchanged in size over several evaluations in the absence of clinical signs and symptom suggests a “*persistent*” lesion related to chronic inflammation or healing by scar tissues [26]. The outcome of such cases is termed “*uncertain*” and the recommended follow-up protocol is clinical and radiographic evaluation every 6 months up to 4 years. If no changes noted during this period, then the radiographic lesion is considered “*post-treatment disease*” [21]. Clinical evidence of worsening inflammation, or radiographic evidence of increase in lesion size or emerging new lesion, indicate active inflammation and periapical tissue breakdown suggesting treatment failure and warrant further investigation to confirm diagnosis and etiology.

One component of evaluating endodontically treated teeth is evaluation of coronal restoration quality which is key in maintaining function. Ng et al in 2011 reported presence of cast restoration and both proximal contacts as significant factors in determining tooth survival after root canal treatment; while root canal treated teeth with temporary restoration over were 7–8 times more likely to be extracted [27]. The presence of a satisfactory permanent coronal restoration was also reported to be a major postoperative prognostic factor influencing periapical health and preventing subsequent bacterial contamination [28]. All of these previously mentioned factors are evaluated on regular basis for patients with endodontically treated teeth to ensure treatment longevity.

2.5. Prosthodontics

Patients with dental restorations and prostheses (tooth-borne or implant-borne) require a customized life-long maintenance protocol to maintain oral health, limit risk of secondary oral diseases (caries,

periodontitis, irreversible pulpal damage and peri-implantitis) and improve the longevity of existing dental restorations, prostheses and supporting teeth or implants [29, 30]. Targeted, regular, professional and home care maintenance protocols could reduce the risk of dental prostheses failure and associated complications [31]. Current evidence suggests that patients with complex tooth-borne restorations are at 27% higher risk of caries incidence compared to patients with less complex single crowns [31, 32, 33]. Furthermore, patients with less than ideal compliance with maintenance of dental prostheses demonstrate increased plaque level deposits and risk for tooth loss due to periodontal disease [33]. Consistently, regular maintenance of tooth-borne removable prostheses with oral hygiene, proper denture care and storage are as important on gingival health and mucosa underlying removable prostheses [31, 34].

Up to date, there is minimal evidence to support well adapted guidelines of maintenance regimen for patients with tooth-borne or implant-borne fixed and removable prostheses [29, 30]. However, recent clinical practice guidelines were developed based on systematic reviews, expert opinions and consensus for recall purposes with focus on risk for failure of tooth and implant borne prostheses [29, 30, 35].

2.6. Social, behavioral and medical considerations

Adopting a biopsychosocial model in medical or dental care, rather than a pure biomedical model (drill and fill), acknowledges the patient's subjective experience of the disease [36, 37]. Hence, application of dental treatment planning, provision of dental treatment, and maintenance of oral health could be more tailored, or patient centered. Variables such as social class, life stresses, self-efficacy, and locus of control have shown to be related to oral hygiene behaviors and dental health risks [38]. The effect of these variables is accentuated for patients suffering from systemic diseases with oral manifestations such as diabetes and kidney disease [39, 40]. Other social factors such as stress, have behavioral as well as biological effects on patient's oral health including engagement in unhealthy oral health habits, change in amount and composition of saliva, oral mucosal and periodontal lesions, and parafunctional habits which may affect occlusion and temporomandibular joint [41, 42]. Failure to incorporate and acknowledge the effects of social and behavioral factors into patient's maintenance plan may result in less than optimal patient care resulting from compromised patient's compliance or even the inability to follow dentist's recommendations.

In addition to the socio-behavioral component, patients with oral mucosal lesions and salivary gland diseases require continuous follow up to ensure disease control and remission. Patients with oral premalignant lesions require long-term monitoring if not excised for early detection of potential malignant transformation. Furthermore, patients with underlying systemic disease should be also monitored regularly to prevent any potential impact on oral environment whether in the form of oral manifestation or 1-way or 2-ways relation of oral and systemic diseases. Up to date, there is no report in the literature for a proper maintenance protocol that incorporates socio-behavioral entities or patients with systemic diseases or oral mucosal and salivary gland diseases.

3. Objectives

The main objective of this proposed patient protocol was to formulate an innovative and comprehensive index for follow-up and maintenance of dental patients.

4. Materials and methods

4.1. Maintenance protocol vision

As the wheel of dental advancement continues to roll, dental clinicians are expected to follow the same pace using the best available evidence. Dental patient maintenance has been one aspect of dentistry with

less supporting body of evidence and more weight on convenience and expert opinion especially when more than one discipline is involved. As such, variable maintenance protocols are offered, often narrow-focused, without consideration for the overall patient status. In addition, comprehensive and multi-specialty dental care is expected to facilitate both, active treatment as well as long-term maintenance plans. Keeping this in consideration, the idea of creating a unified maintenance index with all dental specialties included becomes a necessity and an important tool in academic institutions and private practices.

4.2. Phases to develop the maintenance protocol

The current proposal for a comprehensive dental maintenance protocol was developed by a multi-specialty team of seven faculty members from King Abdul-Aziz University – Faculty of Dentistry (KAU-FD) in Saudi Arabia. The team consisted of experts from each discipline of oral radiology, restorative dentistry and cariology, periodontics, endodontics, prosthodontics, socio-behavioral science, and oral medicine. This process was initiated by defining several dental terms for clarity and consistency as follows: A “completed case” was defined as: 1) no radiographic evidence of pathology requiring intervention; 2) complete elimination of active disease; 3) progressive radiographic evidence of healing periapical pathology following endodontic treatment and complete absence of positive findings on clinical examination; 4) stable occlusion with restored function and esthetics; 5) resolved or asymptomatic mucosal lesions and controlled systemic disease and/or disease is in remission. A “comprehensive treatment” was defined as involvement of at least three different dental disciplines in the treatment of a dental patient.

Following comprehensive review of the literature, multiple meetings and focus sessions took place in which content experts from each discipline explained the evidence-based follow-up protocol of their respective specialty. Among the available protocols, similarities in recall interval, types of radiographs prescribed, and maintenance practices were identified. Parameters with similar values were consolidated together in order to provide clear and coherent recall intervals (4 levels), radiographic prescription protocols, and a set of preventive measures. In cases where discrepancy was identified, experts from the involved specialties discussed how guidelines from their respective specialties could be combined in order to optimize the preventive measures and decrease recall frequency without affecting overall prognosis of the case. Finally, a consensus for a multidisciplinary maintenance protocol was established.

4.3. Description of discipline-specific maintenance protocols

• Radiographic Assessment

The current ADA guidelines for radiographic prescription can be applied to both conventional and digital radiographs; however, it won't address prescription of advanced imaging modalities such as cone beam computed tomography (CBCT) [4]. For the purposes of this paper, a selective component of the guidelines which deals with dentate or partially dentate adult patients in relation to recall plan will be addressed. These guidelines recommend for diagnostically adequate radiographs; otherwise appropriate modifications should be made based on three major

factors: 1) patient's age; 2) patient's status; and 3) patient's caries risk [4]. The status of a patient is related to the type of encounter with the dental system which divides patients into “new” and “recall” subjects [4]. Also, caries risk divides patients into subjects with no or increased risk for caries with recommendation of posterior bitewing radiographs (once every 24–36 months and posterior bitewing radiographs once every 6–18 months respectively) [4]. The guidelines also recommend selective periapical radiographs as needed for assessment of periodontium, existing restorations and bone pathology [4].

In order to establish a more simplified protocol, oral radiology guidelines were unified with CAMBRA guidelines for radiographic prescription (Table 2). According to the CAMBRA guidelines, patients are categorized based on their caries risk assessment into 4 categories: low, moderate, high and extremely high. Therefore, the proposed maintenance index advises patients with low risk to receive bitewing radiographs every 24–36 months. Patients with moderate risk will require bitewing radiographs every 18–24 months, 6–18 months intervals for high risk and 6 months intervals for extremely high-risk patients. To further simplify the current index, high and extremely high caries risk categories were combined and recommended to receive bitewing radiographs every 6–12 months depending on the dentist's clinical judgement. In addition, the use of lower limit of each time interval was suggested based on geographic factor considering higher prevalence of caries within Saudi Arabia [43].

• Caries Risk Assessment

In general, the process of determining caries risk for a particular patient is conducted through a multi-level data collection of factors with influence on caries development process [9, 10, 12]. This includes detailed medical history, with focus on local or systemic factors in which potentially may impact salivary flow rate and quality of saliva (e.g. Sjogren disease and anxiety), in addition to current medications. Clinical examination to detect signs of caries, such as white spot lesions, or classic cavitations was also included [13]. In order to facilitate the assessment process, adjunctive tests are often included such as salivary flow rate, bacterial species characterization and plaque index determination. Other parameters, such as habits (e.g. dietary style) and oral hygiene practices (e.g. use of fluoride-containing products) are also considered.

Following data gathering, patients can be categorized into one of four distinctive caries risk levels. When protective factors tend to exceed pathological factors (Table 1), the patient is considered at *low risk* for caries [9, 12]. Hence, patients with no disease indicators would require a comparison of protective and pathological factors using CAMBRA form for caries risk assessment. Patients with more evident pathological factors are considered at a *moderate risk* for caries. Furthermore, a patient is considered at *high risk* if there is at least one of the following conditions (also known as disease indicators): a) active white spot lesions; b) proximal radiolucencies detected on bitewing radiographs; c) evident cavitations; and/or d) history of dental restorations in the past 3 years. Patients with one or more of the four previously mentioned conditions in addition to reduction in stimulated salivary flow level (stimulated salivary flow rate equal to or less than 0.7 mL/min), would fall in the *extremely high* caries risk category.

Table 2. Suggested management guidelines for patients with carious lesions according to CAMBRA modified from Young and Featherstone, 2010 [10].

Risk status	Follow up frequency (months)	Radiographs	At-home fluoride use	Professional fluoride varnish application	0.12% Chlorhexidine mouth rinse
Low	3	Bitewing radiographs for posterior teeth if contacts are not visible clinically and select periapical radiographs as needed	OTC toothpaste (2x)	Optional	
Moderate	3		OTC toothpaste (2x)* and fluoride rinse	Optional	
High	6		Prescription toothpaste (2x)	Three times/year	Yes
Extremely high	12		Prescription toothpaste (2x) and rinse	Three times/year	Yes

* 2x = twice per day.

Once the patient's caries risk category has been assigned, management strategies including fluoride application, chlorhexidine mouth rinse, radiographs frequency as well as follow-up protocols can be applied [11, 12] (Table 1). Based on CAMBRA guidelines, patients are anticipated to maintain the assigned risk level for at least three years before reassessment is attempted; however, the authors believe that caries risk assessment should be reassessed on an annual basis after concluding active treatment [12].

• Periodontal Assessment

The long-term preservation of human dentition has been linked to the frequency and quality of recall maintenance. According to Merin's classification system, four types of post-treatment patients were identified and associated with specific PM intervals (Table 3) [44]. Improvement or deterioration of the periodontal statuses were also considered and included within the same system. For all four categories, the recall interval within the first year is suggested to be at 3-months blocks [44].

Overall, patients presenting without any additional attachment loss following periodontal therapy may be sufficiently maintained every 6 months [15]. However, most clinical studies suggest that patients with history of periodontitis would require maintenance visits at shorter intervals (4 times/year) [15]. An interval of 3 months for these patients appears to be mandatory and effective to help decrease the risk of periodontal disease relapse and ensure successful long-term surgical and non-surgical periodontal therapy outcome. The fact that bacterial pathogens return to pre-treatment levels within 9–11 weeks as evident in the literature, this was considered when establishing the maintenance index intervals [15].

In order to create a successful maintenance index, ensuring patient compliance is key for better treatment outcome and decrease risk of disease recurrence. Several studies reported poor patients compliance with PM, which create additional challenges for dental providers [15]. Wilson et al. evaluated nearly 1000 patients for 8 years in a private periodontal practice in order to understand patients' compliance with PM [45]. At the end of the study, only 16% of subjects complied with assigned maintenance schedule, 49% were erratic compliers and 34% failed to show for any maintenance therapy [45]. This study is a classic periodontics literature which changed the way to look at patient's compliance and still applies to today's periodontal patients. As such, the suggested PM intervals reflects these factors.

• Endodontic Assessment

Once clinical signs and symptoms subsided, periapical health will dictate the frequency of follow-up visits following completion of root canal treatment. Teeth with preoperative diagnosis of apical periodontitis typically require more frequent evaluations to monitor treatment response. During the first-year post root canal treatment, the first follow up visit is traditionally scheduled for 3 months and includes clinical assessment of patient reported signs and symptoms as well as quality of

coronal restoration. Radiographic assessment of periapical status is recommended as well every 6 months for the first year. If a healing periapical lesion was noted, a bi-annual radiograph is still warranted. However, a healed lesion would only require an annual radiographic follow-up. Larger periapical lesions should be monitored for up to 4 years to ensure optimum healing. New symptom onset or progression of apical radiolucency at any time point may indicate treatment failure, requiring further assessment and treatment [21].

Maintaining a satisfactory coronal restoration after root canal treatment is mandatory to supports healing and tooth survival. A satisfactory restoration requires adequate proximal and occlusal contacts, no evidence of marginal discrepancy, discoloration, or recurrent caries, and has no history of decementation [46]. The coronal restoration should be inspected and maintained at every follow-up visit.

• Prosthodontic Assessment

The most updated clinical practice guidelines for maintenance of tooth and implant borne prostheses were published in 2016 [29,30,35]. These guidelines included recommendation for patient recall intervals, professional in-office and at-home care protocols [35]. The proposed recall intervals for patients vary, and ranges between 3 to 6 months depending on their risk to develop new disease onset and complications. Most of the available supporting evidence for these recommendations were extracted from non-experimental, descriptive studies and expert reports [35]. In-office professional care would include thorough assessment of teeth, supporting tissue and prostheses; selective prescription of topical fluoride, chlorhexidine mouth rinse and a night guard in addition to professional prostheses cleaning, repair or replacement as needed [35]. At-home recommendations would include patient education on oral and prosthesis care, and instructions on the use of removable prostheses [35].

In the current proposal, the guidelines developed by Birda et al. were modified and incorporated as part of a more comprehensive maintenance regimen [35]. The Birda et al. guidelines recommended for patients with dental prostheses follow up visits every 3–6 months based on their risk to develop secondary complications. However, there are no clear guidelines on which patient category would qualify for more frequent maintenance visits.

In this protocol, in order to categorize and assign patients with dental prosthesis for follow up intervals, several parameters are considered. These include type of existing prosthesis (fixed or removable prostheses), total number of units of fixed prostheses, presence of implant-supported prostheses, presence of prosthetic complication and parafunctional habit. For instance, the presence of removable prosthesis “tooth-borne or implant-borne” would categorize the patient as a prosthetically moderate complex case. Yet, the existing prosthesis should be functionally and aesthetically satisfactory. However, if the existing removable prosthesis resulted in a complication that did not warrant replacement, then this patient will fall under a prosthetically difficult case and thus require more frequent recall visits to ensure health of the oral environment and

Table 3. Merin's periodontal post-treatment classification system [36].

Merin post-treatment classification	Characteristics	Recall Interval
First year	<ul style="list-style-type: none"> • Routine therapy and uneventful healing. • Advanced case with complicated prosthesis, furcation involvement, poor crown-to-root ratio or poor patient compliance. 	3 months 1–2 months
Class A	<ul style="list-style-type: none"> • Excellent results well maintained for 1 year or more. • Good oral hygiene with minimal calculus. • No occlusal problems or complicated prostheses. • No remaining pockets, and no teeth with <50% of alveolar bone remaining. 	6 months - 1 year
Class B	<ul style="list-style-type: none"> • Generally good results maintained reasonably well for 1 year or more, but some negative factors are present. 	3–4 months
Class C	<ul style="list-style-type: none"> • Generally poor results post periodontal therapy and/or several negative factors. 	1–3 months

Table 4. Proposed 10-risk factors system used to assign dental patients to their respective DFMI category.

Category	Category A	Category B	Category C
Factor			
Systemic Disease*	<input type="checkbox"/> ASA I	<input type="checkbox"/> ASA II	<input type="checkbox"/> ASA 3 or higher
Compliance	<input type="checkbox"/> Good	<input type="checkbox"/> Inconsistent	<input type="checkbox"/> Poor
Plaque Index	<input type="checkbox"/> < 30%	<input type="checkbox"/> 30–40%	<input type="checkbox"/> > 40%
Bleeding on Probing	<input type="checkbox"/> < 10%	<input type="checkbox"/> 10–20%	<input type="checkbox"/> > 20%
Caries Risk Assessment	<input type="checkbox"/> Low	<input type="checkbox"/> Moderate	<input type="checkbox"/> High or extremely high
Root canal treated teeth	<input type="checkbox"/> No periapical pathology	<input type="checkbox"/> Asymptomatic periapical pathology	<input type="checkbox"/> Symptomatic periapical pathology
Fixed implant-borne Prosthesis	<input type="checkbox"/> None	<input type="checkbox"/> Single	<input type="checkbox"/> Multiple
Fixed Tooth-borne Prosthesis	<input type="checkbox"/> ≤ 4 units	<input type="checkbox"/> > 4 units	<input type="checkbox"/> Complicated
Removable Prosthesis	<input type="checkbox"/> None	<input type="checkbox"/> Uncomplicated	<input type="checkbox"/> Complicated
Para-functional Habits	<input type="checkbox"/> Absent	<input type="checkbox"/> Controlled	<input type="checkbox"/> Uncontrolled
Total number of checks**	<input type="text"/>	<input type="text"/>	<input type="text"/>
Patient Overall Risk	A – Low	B – Medium	C – High
Recall Interval	12 months	6 months	3 months

* ASA categorization will include modifiers that are considered on case-by-case basis.

** The higher category checked dictates the final patient risk assessment and not the number of checks in one category. Example: If checklist result is 9 in **category A** and 1 in **category B**, patient risk assessment is **medium risk**.

longevity of the existing prosthesis. An example would be a patient with an existing removable prosthesis with satisfactory occlusion, aesthetics and function (phonetics and mastication), yet associated with residual ridge resorption, flappy ridges or denture stomatitis, in which denture relining/rebasing, improving prosthesis home care and avoiding denture wear at night time could suffice [47]. Patients with fixed prosthesis “tooth-borne” typically fall under either prosthetically simple (less than 4-units) or moderate cases (4-units or more). However, the existing fixed prosthesis should be functionally and aesthetically acceptable. When the prosthesis is associated with a manageable biological (periodontitis, peri-implantitis and irreversible pulpitis) or aesthetic (porcelain chipping) complication without the need for replacement, regardless of the number of units, the patient’s case becomes more prosthetically challenging and at high risk of further complications.

Once the prosthetic complexity is determined, the potential risk for secondary complications and frequency of recall visits should be established. An example would be a prosthetically simple case with low risk of developing complications typically require less frequent recall visits annually compared to more difficult cases. Another factor to consider is the presence of an uncontrolled parafunctional habit in a patient with existing prostheses which assigns the case as prosthetically complex and should be monitored frequently. Other parameters of the proposed index can be found in Table 4.

• Social and Behavioral Assessment

In order to incorporate social and behavioral parameters in the proposed maintenance protocol, questions on social and behavioral histories are suggested to be included as part of the patient’s medical record and diagnostic criteria. The main aim is to provide dental practitioners with information necessary to customize the maintenance plan according to patient’s needs. Social and behavioral history consist of three main sections: 1) social history; 2) behavioral history/assessment; and 3) patient’s perception of own oral health [38]. The social history section focuses mainly on demographics, socioeconomic status, barriers to care, and life stresses. Behavioral assessment covers matters such as dental anxiety, dental fear, adults and children cooperation level in the clinic. The last part of the social and behavioral history includes questions assessing patient’s compliance with the maintenance of oral care based on their individual evaluation/perception of personal oral health.

• Oral Mucosal and Systemic Disease Assessment

Historically, no consensus has been developed on the best practice for maintaining dental patients with systemic disease and/or oral mucosal or salivary gland disease. A glance at the available literature demonstrate case-by-case approach supported by expert opinion on how to follow up and set a recall schedule for patients with similar conditions. Handful of conditions including graft-versus-host disease (GVHD), medication-induced osteonecrosis of the jaw (MRONJ), vesiculo-bullous disease and oral cancer post-treatment complications were included in a special category and agreed upon by international scientific groups to suggest an annual follow up protocol [48, 49, 50, 51]. In addition, a statement by the ADA advised for oral screening of early signs and symptoms of oral cancer as well as signs and symptoms for oropharyngeal cancer for every patient on regular basis [52]. This include patients with known diagnosis of oral premalignant which requires a well-defined, close follow up to ensure early detection of disease progression. As such, most of the proposed maintenance protocols for patients with medical conditions and/oral diseases were based solely on literature reviews rather than position papers or group consensus. To develop the current comprehensive maintenance protocol, data from the literature and experts’ opinions were modified and incorporated.

4.4. Criteria for patients’ categories

In order to develop a comprehensive maintenance index which fits all patient categories, a panel of experts from each dental discipline convened and developed a list of critical questions closely related to decision-making process for patient’s dental treatment plan and prognosis. Afterward, a comprehensive list of questions was narrowed down to 10 vital questions/risk factors for simplicity purposes. These questions, which cover major aspects of the patients’ general health, dental needs and generate a reasonable overview of patients’ dental prognosis, were used as a foundation to formulate the multidisciplinary Dental Follow-up and Maintenance Index (DFMI) which will be discussed in detail in the next section (Table 4).

4.5. Index validation

In order to validate the proposed index, a pilot study was carried out on 138 senior dental students at KAU-FD. An introductory lecture was

given to study participants explaining all aspects of DFMI and instructions on how to apply it in a clinical setting. Afterward, participants were divided into 14 groups and were provided with mock cases to practice application of the index. At the end, a questionnaire was distributed to all groups and their feedback was recorded for analysis and index modification. Overall, the DFMI reliability was 85% across all groups. In addition, the needed time to fill-in all index sections ranged between 5-7 min.

5. Results

Considering the innovative nature of the current paper, the data of this proposed maintenance protocol is presented in the format of questions and answers and divided into 6 main domains as follows:

Q1: What is the main frame and components of the proposed index?

DFMI consists of two main components, case risk and case complexity. Case Risk (CR) is defined as an indicator for case probability to develop a specific dental complication. In this proposal, CR was used to categorize patients into 3 categories: A, B, or C which functions as a guide to assign patients to their specific maintenance index group with the corresponding recall interval. Case Complexity (CC), which is a numerical value, is defined as an indicator for case difficulty/severity level based on several parameters and identified by number of risk factors present in a particular case. It can be also used as a monitoring parameter to assess whether the patient oral conditions are worsening, stable or improving overtime.

Within DFMI, CR is assessed using a number of factors affecting this particular risk factor related to CC. For example, a patient with an DFMI score of B3 falls under a medium risk category since there are three existing factors (out of 10 listed risk factors) with potential impact on the overall case. This patient is recommended to be seen every 6 months in order to undergo the assigned professional maintenance steps as well as to reinforce at-home maintenance practices. If the same patient's DFMI score improved to B1 at the following recall visit, this would indicate a favorable drop in the number of risk factors from 3 to 1 and that the overall status of the patient has improved over the 6 months period. However, this patient would still need to be seen every 6 months because of a persistent medium risk category (B).

In the proposed maintenance index, follow-up intervals were categorized into 3, 6, and 12 months timeframes. The interval assignment would be based on a combination of all respective guidelines from various dental disciplines and taking into consideration social and geographical factors related to the community of Saudi Arabia in this case. An example would be dental caries, which is a prevalent condition in Saudi Arabia as reported by Al-Ansari et al. in 2014 [43]. In this study, caries prevalence was reported to be at 95% among children with primary dentitions and DMFT (decayed, missing or filled teeth parameter) score of 7.34, 91% among children with mixed dentitions and DMFT score of 7.35 and 98% among adults (age range 30–45 years) and DMFT score of 14.53. Based on this data and other caries national epidemiological studies, follow-ups with shorter intervals were included in the current index to account for these epidemiological figures. Additionally, other factors such as simplicity and ease of application by dental providers were considered throughout the process of developing these guidelines. For other dental disciplines without existing maintenance protocols such as Oral Medicine, a customized protocol was developed based on expert's opinion and incorporated in DFMI.

Q2: What are the parameters considered for the proposed DFMI protocol?

Ten major components were carefully identified to determine the patient's dental risk category. These elements demonstrate the patient's most current oral and dental statuses which include 1) presence of systemic diseases based on American Society of Anesthesiologists (ASA)

classification; 2) patient compliance; 3) plaque Index; 4) bleeding on probing; 5) caries risk assessment; 6) root canal treated teeth; 7) fixed implant-borne prosthesis; 8) fixed tooth-borne prosthesis; 9) removable prosthesis; and 10) para-functional habits (Table 4). If a systemic disease is present, risk assignment should be made based on disease current status whether controlled or uncontrolled (category A: ASA I, category B: ASA II or category C: ASA III or more). In Addition, patient compliance was broken down into good, inconsistent or poor. At the same time, plaque index was classified into: category A < 30%, category B between 30 to 40 % and category C > 40%. Bleeding on probing was categorized into: category A when it is <10%, category B when it is between 10-20%, and category C when it is more than 20 %. Caries risk assessment was divided into low, moderate or high/extremely high as mentioned previously. If apical pathology was detected on a radiograph, assigning an asymptomatic or symptomatic status should follow. The presence and condition of fixed and removable prostheses must be recorded as described in the prosthetic-specific maintenance protocol. Para-functional habits were also included and divided into either absent, controlled or uncontrolled. Once the checklist is completed, the clinician should be able to categorize each particular patient and determine the most appropriate interval for maintenance index based on the entered data.

Q3: What are the in-office recommendation for each patient category?

In-office care is customized based on patient dental risk category (Table 5). In general, medical history and medications list should be updated at each maintenance visit for all patients' categories. In addition, patients who are current smokers should also be encouraged and offered smoking cessation guidance through official consultations with a specialist. Patients in category A (ASA I) are a low risk category in general without risk factors for oral cancer (e.g. never smoked, non- or social alcohol drinker) and have no or stable oral disease (e.g. stable and asymptomatic oral lichen planus, oral pemphigus vulgaris or oral mucous membrane pemphigoid), and would only require annual oral cancer screening and re-evaluation of the oral disease and possible tapering down of active medications if patient is asymptomatic/disease remission.

In addition, a thorough clinical and radiographic assessment of teeth, soft tissue, existing restorations and prosthesis, and abutments should be completed. Radiographic evaluation should be completed every 24 months (i.e. every other maintenance visit) and consists of obtaining bitewing radiographs for posterior teeth (provided the interproximal surfaces are not clinically visible) in addition to selective periapical radiographs as needed for each patient (e.g. assessment of an abutment tooth and endodontically treated tooth). Details on other disciplines of periodontics, restorative and endodontics are listed in detail in Table 5.

Category B patients (ASA II) are expected to have low to moderate risk for oral cancer and would require oral cancer screening every 6 months and oral biopsies for suspicious lesions. Other patient population included in this category are patients with active oral disease which fluctuate between remission and symptomatic episodes. Other patients in this category may also require adjustment of their active medication doses and/or add new medications as needed. In general, patients in this category should receive assessment of existing prostheses and/or assessment of the stability of hard and soft tissue supporting any existing tooth-borne and implant-borne prostheses. For specific cases, adjustment, repair or professional cleaning of prostheses may have to be completed. When indicated, occlusal splints could be also constructed for better maintenance of existing prosthesis. Radiographic evaluation for this patients' category should be delivered every 18 months in the form of bitewing radiographs for posterior teeth (if the contacts are not visible clinically) in addition to selective periapical radiographs as needed for each patient.

The last category of patients, category C, who are at high risk for oral cancer (e.g. heavy smoker, previous history of oral cancer) who require oral screening every 3 months. In addition, oral biopsies may be obtained

regularly (e.g. at each visit) with further investigational imaging such as CT-scan, MRI or PET scan to rule out malignancies or metastases. This category of patients is the most advanced (ASA III or higher) and requires closer follow up due to the associated risk and probability of disease progression. In more medically challenging cases, the treating dentist may have to communicate with the patient's primary care physician or request a medical consultation to ensure patient safety and delivery of care. Patients with uncontrolled oral diseases are included in this category as well, including aggressive oral diseases, severe symptoms with no or low response to treatment. These cases will likely require special attention from the treating physician in a multidisciplinary approach (e.g. dermatology, rheumatology) and combination of topical and systemic therapy. In this category, existing dental prostheses should be assessed, adjusted, repaired or professionally cleaned as indicated. In addition, occlusal splints may be prescribed depending on patient's need. This category of patients is typically at high or extremely high risk for dental caries. Therefore, their radiographic evaluation interval is set at a range of 6–12 months based on clinician's judgement. Recommended images would include bitewing radiographs for posterior teeth as long as the proximal contacts are not visible clinically with selective periapical radiographs according to patient's needs.

Q4: What are the at-home recommendation included in this index?

Similar to in-office care recommendations, home oral care recommendations are tailored based on patients' risk category (Table 6). In general, patients in all risk categories are instructed to maintain routine oral hygiene with brushing twice daily, over the counter (OTC) fluoride toothpaste and anti-septic mouth rinse in addition to dental floss/super-floss. Prescription-grade fluoride toothpaste is recommended only in Category C (high risk) patients. Low risk patients (category A) may use chlorhexidine mouth rinse (CHX), or similar antiseptic mouth rinse of their preference. In addition, patients are instructed to continue using topical and/or systemic treatment for active oral mucosal disease and monitor medical condition/s as indicated. Also, patients are advised to maintain regular follow up on any existing and/or underlying systemic disease. Patients in category B are maintained on instructions similar to low risk patients in addition to few more. This include specific instruction for patients with removable prosthesis on how to clean, use and store their appliance. Occlusal splints are advised to be used at night and maintained clean regularly and optional use of CHX and fluoride mouth rinse. For category C patients, additional instructions may include the use of CHX

mouth rinse for 1 week each month, prescription-grade fluoride toothpaste, and fluoride rinse depending on CAMBRA guidelines. Finally, patients with systemic diseases should be followed up closely and may require regular laboratory tests for long-term follow-up.

Q5: What is the next step for the proposed DFMI protocol?

The current proposed DFMI protocol is yet to be validated in a clinical setting. In order to obtain a universal approval from international dental societies and organizations, the DFMI protocol will have to go through multiple phases of implementation, assessment then feedback from users. Considering that academic institutes are centers providing dental services following international standards most of the time, this setting would serve as a great environment to implement the proposed index for validation. In addition, the index layout could serve as a clinical evaluation form for academic teaching to guide students and facilitate assessment of patients for dental disease risk category. Application of such clinical tool by students should be followed by user feedback for improvement and modification. Additionally, DFMI protocol will be a useful tool to follow-up patients' compliance in implementing various recommended home care protocols.

Q6: Are there other considerations which could affect DFMI application?

As mentioned earlier, social and behavioral considerations may have a significant impact on overall patient maintenance plans. Factors such as patient's demographic data (age, gender, occupation, educational level, marital status, and type and place of residence), barriers to access oral care (physical, medical, psychological/mental, sensory, transportation, language, financial, and others), acute or chronic stress, dental fear or anxiety, limited cooperativity or attitude issues, and patient's own perception of oral health importance should always be considered. The key for this maintenance index success, is customization to best suit the community, patient's lifestyle and social background. An example would be creating a maintenance plan for a patient with transportation or financial barrier which should prompt the clinician to adjust the recall interval or educate the patient to incorporate additional home care measures to help maintain good oral health until next visit and overcome the existing barrier. Another example is for patients with chronic stress and impact on oral health. In these particular cases, additional efforts are needed from the treating clinician to invest in home and dental office

Table 5. Professional maintenance protocol.

	Category A (Low)	Category B (Medium)	Category C (High)
History and examination	<ul style="list-style-type: none"> ○ Update medical history and dental history ○ Soft tissue examination (including oral cancer screening) ○ Periodontal charting ○ Dental charting 		
Radiographic assessment	<ul style="list-style-type: none"> ○ 24 months bitewings ○ Selective PA 	<ul style="list-style-type: none"> ○ 18 months bitewings ○ Selective PA (for endo; every 6 months in the first-year post-operative, then every 12 months) 	<ul style="list-style-type: none"> ○ 6–12 months bitewings ○ Select PA (for endo; every 6 months in the first-year post-operative, then every 12 months)
Oral hygiene instructions	Reinforcement		
Periodontal therapy (scaling)	Supragingival and polishing		Supra and subgingival and polishing
Periodontal therapy (chemical irrigation)	None	Chlorhexidine irrigation	
Fluoride therapy		Optional	Varnish application over susceptible areas
Prosthesis maintenance	<ul style="list-style-type: none"> ○ When indicated, adjust, repair, replace or remake any or all parts of a prosthesis or prosthetic components ○ Prescription/construction of occlusal splints when indicated, to protect tooth-borne and implant-borne fixed prostheses 		
Special Considerations	<ul style="list-style-type: none"> ○ Smoking cessation support for smokers ○ Consult with physician and/or dental specialist as needed ○ Obtain lab tests (e.g. CBC, urine) as indicated 		

BW: bitewing radiograph; PA: periapical radiograph; CBC: complete blood count.

prevention strategies (e.g. high fluoride toothpaste, anti-microbial mouth rinses, and professionally applied fluoride).

The ability of a patient to have a pain-free chewing and speech experiences, provides great self-esteem and sense of satisfaction. However, a sub-population of dental patients suffer from a unique scope of oral diseases that falls under mucosal diseases, salivary gland diseases or premalignant and malignant lesions. These patients may present with a wide range of symptoms including pain, burning sensation, exudate/discharge, swelling and many more. Part of patient management includes prescription of topical and/or systemic therapy, minimal surgical procedures or combination of more than one in order to treat the oral condition and have it under remission. Typically, these patients require continuous follow up which may last for several years. Part of patient management is patient education which should focus on disease observation, the two-way relation between systemic diseases and oral health as well as following the assigned treatment protocol by physicians and dentists. Patients are expected to monitor their oral and/or systemic disease activity, consume their medications regularly and as prescribed and seek medical/dental help whenever needed.

One of the advantages of the proposed index is the built-in flexibility where creative thinking allows for a patient-centered maintenance plan with maximum benefit in addition to applicability within different communities all around the globe.

6. Discussion

Clinicians are faced daily with dental cases of various levels of complexity based on many factors including financial, social, behavioral, and even geographical factors. Throughout dental educational years, dentists are trained to evaluate dental cases separately and generate a treatment plan that best fits each patient which may vary in length and cost. Following completion of dental treatment, patients are typically assigned to a maintenance program based on case complexity, treatment rendered as well as the dentist's training experience and most importantly specialty background of the dental provider. Such practice ignores the comprehensive approach of dentistry recommended for managing patients. As many dental patients commonly suffering from more than one dental condition, application of a single dental discipline maintenance guidelines and ignoring the others may result in unfavorable potential complications. In addition, attempt to apply more than one dental discipline guidelines can be confusing, overwhelming and time-consuming for dental practitioners. Other factors such as social and behavioral barriers will further complicate oral health maintenance planning process. As such, the current proposal to develop a multi-specialty comprehensive maintenance protocol was created and shaped in the current format.

In the dental literature, several follow up and maintenance protocols exist and have been in use for daily dental practice for many years now. However, these guidelines categorize patients according to their

respective specialty and thus recommendations are made following the same approach. For example, CAMBRA guidelines for caries risk assessment divide patients into four different groups based on their caries risk only and recommend recalls at intervals ranging between 3 and 12 months. At the same time, PM categorizes patients according to periodontal disease severity following Merin's post treatment classification. Each post treatment category has a different recall interval according to respective periodontal statuses and needs. The same approach exists for other prosthodontics, endodontics and other dental disciplines. Therefore, the proposed DFMI overcomes these challenges and combines all dental maintenance protocols in a single user-friendly system.

During the process of developing DFMI, several factors were considered. Time is one, which has a significant value for dental practices today. Any attempt to modify the way we evaluate dental patients with potential to slow down the regular practice flow will face major resistance by dental providers. At the same time, modifying existing protocols to speed up the maintenance visit to a more efficient approach will be much more accepted. However, maintenance of patients separately for each discipline of dentistry is time consuming in general and impractical for dental providers. For example, the average periodontal maintenance visit was reported at 76 min divided into three segments of examination, treatment, and patient's education [53]. If the same average time is needed for other dental disciplines, comprehensive maintenance of patients will eventually result in significant utilization of resources as well as costs for dental practices. Therefore, a single compact protocol may be more appealing and efficient for daily application (Figure 1).

In the last several years, the focus of scientific research has shifted towards the connection of medicine with dentistry. Emerging evidence suggests for a relation between systemic diseases and oral conditions which has led to new dental recommendation to provide a more comprehensive evaluation of dental patients including medical status [54, 55, 56]. Hence, dentists are now expected to consider the patient's general health in the overall treatment plan as well as within the maintenance component. Therefore, patients' medical status and oral medicine components were included in the proposed DFMI protocol. Considering medicine and dentistry connection as a two-way relationship, patients with stable systemic diseases (e.g. diabetes) have better oral prognosis specifically in the periodontium. In addition, these patients will have a wider range of dental options compared to their counterpart with uncontrolled systemic disease statuses.

Several barriers may exist for dental patients which were considered for individualizing DFMI protocols. These barriers vary in weight and fall under behavioral or psychosocial components. Fear, anxiety, physical or language barriers are examples of factors which should be considered to modify patient's frequency of fluoride application, radiographic assessment, and use of chlorhexidine mouth rinse. A list of common barriers should be identified during the planning process and provided to dental practitioners as a guide for customization of DFMI protocols (Table 7).

Table 6. At-home maintenance protocol.

	Category A (Low)	Category B (Medium)	Category C (High)
Brushing with OTC fluoridated toothpaste	2 times per day		3 time per day OTC fluoride toothpaste OR twice per day prescription fluoride toothpaste
Fluoridated mouth wash	None	Once per day	Once per day if extremely high caries risk
Flossing	Dental flossing/superfloss		
CHX mouthwash	Optional		One week each month
OTC antiseptic	OTC antiseptic mouthwash		
Prosthesis care	None	<ul style="list-style-type: none"> o Clean removable prosthesis at least 2x/day with professional denture cleaning agent o Store in prescribed cleaning solution o Reinforce prosthesis usage instructions 	
Special considerations	<ul style="list-style-type: none"> o Continue using topical and/systemic treatment for oral disease as indicated o Continue monitor medical condition/s as indicated 		

OTC: over the counter; CHX: chlorhexidine.

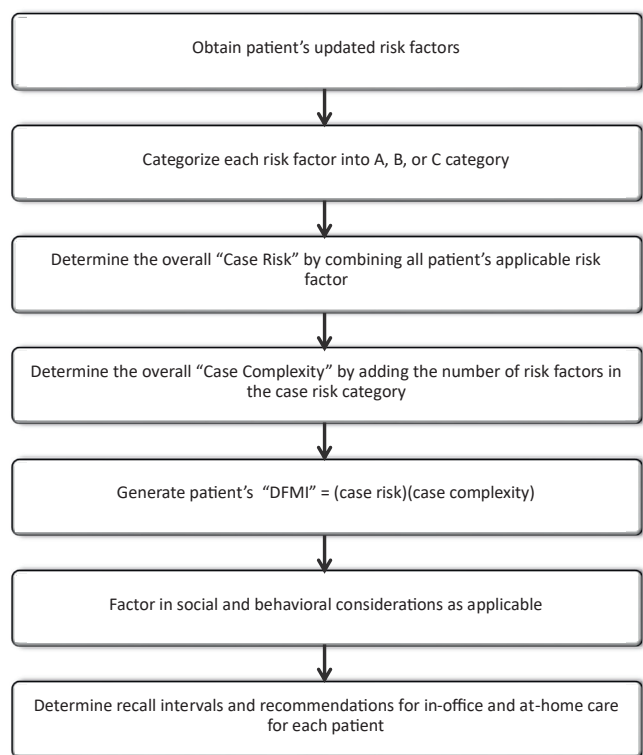


Figure 1. A flowchart illustrating the required steps to generate a customized Dental Follow-up and Maintenance Protocol (DFMI) for each patient using the corresponding form (Table 4), in-office (Table 5) and at-home recommendations (Table 6).

The current proposal was structured to provide a comprehensive, yet simple and practical guideline for long-term patient maintenance. We anticipate that, on average, it will take a general dentist 5–7 min to complete all parameters included in the DFMI protocol. As mentioned earlier, to be able to implement DFMI in every dental clinic's daily practice, this proposal has to go through multiple validation levels. The first phase of validation has been already initiated at KAU-FD where the DFMI is being implemented, taught and used in the pre-doctoral students' clinic. To serve this validation step, the existing dental records systems were modified to include a comprehensive assessment of the social and behavioral aspects of the patient. The main purpose will be to use it as a

Table 7. Patient's barriers to receive optimum dental care.

Behavioral Barriers:	<ul style="list-style-type: none"> • Dental fear and anxiety • Limited cooperation • Challenging patient attitude
Psycho-social Barriers:	<ul style="list-style-type: none"> • Medical barriers • Psychological/mental barriers (e.g. depression, bipolar disorders, fibromyalgia) • Sensory barriers (e.g. blindness, deafness) • Physical barrier (e.g. handicapped patient) • Language barrier • Access to health care facility (e.g. financial, transportation) • Sudden family or social disturbance (acute stresses) • Current ongoing stressors (chronic stresses)

❖ **Note on how to incorporate the barriers to care:** A general statement will be used to direct the attention of practitioners to the presence of any of listed barriers to care. For example: “in case your patient has any of the listed barriers to care, then use your clinical judgment to suggest any or all of the following: frequent fluoride application, frequent radiographic assessment, use of chlorhexidine mouthwash etc”.

teaching tool for better understanding of the multispecialty and comprehensive care of patients. In addition, it will be used to assess students' perception of the protocol and to collect feedback from both students and faculty members. Any modification to the index will be implemented and validated again. Once completed, the second phase of validation will include collaboration with other national and international dental centers to further validate the index. Along with this process, data will be collected and analyzed to provide the best evidence available to support the DFMI protocol feasibility.

This comprehensive maintenance index has several limitations. First, no data is currently available to support this proposal yet; however, the main core of the index was based mostly on existing and validated maintenance programs from different dental entities. Second, the index in its current format may not fit every dental patient. Due to a variety of factors considered and included in this protocol, we anticipate dentists to modify the DFMI protocol using the built-in flexibility and user-friendly features to match each patient needs. Third, the protocol was designed for adult patients and has to be modified for pediatric patients prior to implementation if needed. Keeping this in mind, we believe DFMI in its current status will provide a solid foundation to develop a simple profound multidisciplinary guideline for dental patients' recall and maintenance with more predictable outcome.

7. Conclusion

Up to our knowledge, this is the first proposal for a comprehensive patient maintenance index including all dental disciplines in the literature. Even with some built-in components were designed to match patient demographics of Saudi population, the proposed DFMI can be easily modified to match different patients' communities. Considering its potential positive impact on every dental patient, we believe the application of such index in the dental setting would be beneficial for both, dentists and patients. We anticipate the application of DFMI to change the paradigm of maintaining dental patients. Future prospective, longitudinal studies are needed to validate the proposed index.

Clinical significance

The newly suggested maintenance index will allow dentists to simplify and streamline the follow up process of their patients. It will ensure that follow up appointments are comprehensive and efficient in order to improving patient care while conserving resources.

Declarations

Author contribution statement

H. Nassar, N. Al-Dabbagh, R. Aldabbagh, M. Albahiti, F. Jadu, A. Qutob and Hani Mawardi: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Additional information

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