DENTAL TREATMENT RESOURCE AND GUIDELINES

PROTOCOL FOR THE FRAIL/ELDERLY/AND AGED LONG-TERM CARE (LTC) RESIDENT

The College of Dental Surgeons of Saskatchewan

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It is imperative to recognize that consequences of poor oral health among older individuals can be potentially devastating.

In determining an appropriate dental treatment plan, it is ideal and required to respect a senior's heterogeneity by realizing the elderly are a complex combination and expression of their genetic predisposition, lifestyle choices and experiences, socialization, and environment. It is imperative, prior to initiating treatment, that an evaluation occur of their cultural, psychological, educational, social, economic, dietary, and chronologically specific cohort experiences of influence. Concurrently, the treating practitioner must also consider social aspects, general health, and oral health conditions of our frail/elderly/aged LTC patients.[3(page1),4(page 447)]

In determining the oral health status, an assessment must occur of an individual's life experience with dental care, dental caries, periodontal disease, and iatrogenic disease, with the realization that different older adults have different needs and that the history of a person's behavioural attitudes and expectations regarding their own oral health will be reflected in his or her oral status.[4(page447)]

A completed dental/medical health form with a personal interview is imperative, including an evaluation of all potential modifying factors (including socioeconomic, psychological, and medical problems, along with side effects of their medications and the cumulative effects of dental diseases) that may influence eventual treatment.[3(page4)] Good communication is ideal with patients, significant others, and/or caregivers when assessing patients with complex social and medical/mental conditions in order to understand the complaint or the hidden meanings of their complaint.[1(page71)] It is ideal to obtain a written informed consent from the resident, if possible, or from those designated with the authority to make decisions for the patient/resident prior to commencement of dental treatment.

Above all, benefits of all treatment must outweigh the risk of adverse events, and provision of dental treatment must occur with the understanding of how patients are functioning in their environment and how their dental needs and treatment fit into their lifestyle and provide an improvement in their overall quality of life.[3(page4)]

Treatment plan decisions are based on the fact that a majority of oral diseases are chronic plaque-associated diseases, such as caries and periodontal disease which cause irreversible damage, and the need for treating the exacerbation of these two entities, including the influence of the patients' modifying factors. This forms the basis of our guidelines, Rational Dental Care (Diagnosis, Treatment Planning and Providing Maintenance).[5]

Resources on Geriatric Rational Dental Care will be subdivided to provide direct literature reference to scientific, evidence-based, peer-reviewed articles that will form the foundation of our recommended protocol for delivery of dental services to the frail/elderly/aged LTC resident. It is encouraged and recommended that the CDSS GP members form the basis of delivery of dentistry around the following parameters found within the articles cited. Any defense of treatment provided should be found within the current literature referred to below. The resources and references will be updated frequently as needed.

A. Rational Evaluation and Decision-Making Process of the Frail/Elderly/Aged/LTC Resident

1. OSCAR[1(page74), 3(page5)]
2. Berkey et al Questionnaire[3(page5), 1(page78)]
3. Ettinger Decision Making Process[1(page76-79)]
4. Decision Tree for the Dentate Senior[1(page80)]

B. Rational Risk Assessment

1. Rapid Oral Health Deterioration (ROHD)[3(page6), 2(pages2-8)]

A. Rational Treatment Planning

1. General Accepted Concepts[3(pages7-8), 1(pages78-83)]
2. Comprehensive Treatment Planning Considerations[7, 4(pages449-451)]

B. Rational Management Strategies

1. Caries Restorative Treatment and Minimally Intervention
2. Dentistry (MID)[2(pages13-14), 8, 9]
3. Treatment of Oral Problems [2(pages9-12), 10]
4. Prevention and Maintenance Strategies[2(pages8-13), 6]

C. LTC Related Oral Health Care Standards

1. Oral Health Care Standards for Residents in Long Term Care in Canada
2. CDA Position on Access to Oral Health Care for Canadians
3. Saskatchewan Seniors Oral Health and Long-Term Care Strategy

GUIDELINES FOR THE ORAL HEALTH CARE OF THE FRAIL/ELDERLY/AGED LTC RESIDENT IN SASKATCHEWAN

1. Assessment of overall medical health, its cause and effect on oral health (and conversely) and the implications on the overall quality of life is ideal and imperative. The assessment of medical health should be a cooperative contribution from medicine (e.g., family physician), family, and resident.

2. Following an Oral Health Assessment, utilizing the Resource Guide provided above as a decision-making framework, a customized formal/written/signed Oral Health Treatment Plan should be fabricated for our resident and updated in the same manner annually and/or as needed.

3. Ongoing prevention and maintenance are ideal components of the overall treatment process and should be addressed, including daily oral care.

4. Treatment provided should attempt to enhance the overall quality of life of the resident and should address undue hardships to the resident.

5. Oral Health Care Providers within these guidelines must fall within the parameters/requirements of the Saskatchewan

Health Authority as applicable for each resident.

REFERENCE LIST

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Treatment planning concepts for the ageing patient

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ABSTRACT

There is an ageing imperative in Australia as in many other industrialized nations, and these populations are extremely heterogeneous. In young adults, the factors which influence decision making for oral health care are whether the patient has the will, the time or the finances to pay for care, while for clinicians, the decisions are whether they have the skill and the resources to carry out the treatment plan. For older adults, the decision making includes all of the previous identified factors, but they are now complicated by the patient's medical and medication problems, the side effects of the medications they are taking, their cognitive status as well as the cumulative effects of a lifetime of physiological, traumatic and iatrogenic effects on the dentition and the oral cavity.
The decision-making process which has evolved has been called many names, from cost-effective care to minimal invasive dentistry to rational dental care. Fundamentally, they are similar. Rational dental care has been defined as the process of decision making, which develops a treatment plan that is in the best interest of the patient after evaluating all of the modifying factors. This article will discuss the various concepts, and the strengths and weaknesses of some of these systems. It will also illustrate some of the clinical problems as there is very little evidence-based data to support any of these concepts. However, treatment planning is still an art, which can only be carried out for an individual and not a group, and the result must serve the needs of the patient and enhance the quality of his or her life.

Keywords: Ageing, decision making, rational care, treatment planning.

Abbreviations and acronyms: CAMBRA = Caries Management by Risk Assessment; MAO = monoamine oxidase; MID = minimal intervention dentistry.

INTRODUCTION

The proportion of people aged 65 years and older in Australia has increased from 11.6% to 14.4% between 30 June 1993 to 30 June 2013.[1] This ageing imperative in Australia has been described in earlier articles in this supplement. It is important to remember that older adults are extremely heterogeneous and there is no such person as a typical older adult.[2] In fact, older adults range from the healthy to the frail, from the highly educated to the illiterate, from the affluent to the poor, from the dentate to the edentulous.[3] This heterogeneity has evolved because each person is influenced by their genetic heredity, their diet, their exercise programme, the history of their diseases, and the accidents they have sustained, as well as their lifestyle.[4] All of these factors influence their health literacy, which influences their motivation in regard to their general health as well as their oral health.[5]

The ageing population

The ageing population has usually been defined as a cohort of persons aged 65 years or older. If age is the only criterion used in dentistry, it is not very useful because of the significant heterogeneity of the ageing population. People of a similar age may have experienced great differences in physical health, medical problems, neurogenerative diseases, mental health, as well as differences in oral health.[2] Thus, from an oral health treatment planning perspective, a functional definition of ageing is more useful. In some ways, dentistry is more like surgery than medicine as we need our 'operating theatre' to carry out our surgical and reconstructive care of the oral cavity. In 1984, Ettinger and Beck[6] modified the Institute of Medicine's definition of geriatric medicine and suggested the ageing population could be divided into three broad functional groups, which would reflect their ability to seek dental services. These groups are functionally independent older adults, frail older adults and functionally dependent older adults.

Functionally independent older adults

Functionally independent older adults who live in the community unassisted and comprise about 70% of

the population over the age of 65 years. Many of these older adults have some chronic medical problems such as hypertension, type II diabetes, osteoarthritis, etc., for which they are taking a variety of medications. In terms of treatment planning, providing their dental practitioner takes a thorough medical and drug history and understands how their patients' medical issues and the effects of their medications can influence oral health care, their treatment will depend on the patients' or their significant others' perception of need and the amount of money they are prepared to pay for it. These older adults can access dental care independently using their own vehicles or public transportation, if it exists.

Frail older adults

Frail older adults are those people who have lost some of their independence but still live in the community with the help of family and friends or who are using professional support services such as Meals on Wheels, visiting nurses, home health aides, etc. They make up about 20% of the population over 65 years. These older adults can no longer access general dental services without the help of others. Their oral health needs require a greater understanding of medicine and pharmacology and a careful evaluation of their ability to maintain daily oral hygiene independently, as well as their ability to tolerate treatment.

Functionally dependent older adults

Functionally dependent older adults are those persons who are no longer able to survive in the community independently and are either homebound (about 5% of the population over 65) or living in institutions (another 5% of the population over 65). Some of these older adults can only access dental services if they are transported to a dentist's office and many may use wheelchairs, so dental offices need to be wheelchair accessible if the dentist wishes to treat these patients. If they cannot be transported, then the services need to be brought to them through mobile programmes. This means that the dental professional needs to have the will and the experience to access mobile equipment, if he or she wishes to visit the patient or the institution in which the older adult resides. If that institution has a dental facility, that is a bonus.

Treatment planning

Informed consent

The foundation of treatment planning is that the health care professional and a competent patient voluntarily exchange facts and discuss values so the patient can make an informed decision about their health care. In the past, the population, especially the elderly population went to health care professionals for advice and usually followed it, if they could afford it. It was a paternalistic relationship and it is still found amongst illiterate adults, especially immigrants and minorities.[7]

In the US, the National Adult Literacy Survey[8] found that half of the US adult population had some difficulty using print materials to accomplish everyday tasks. For people aged over 60, 71% of adults had a problem. This suggests that using written documents for informed consent may limit their understanding of the risks and benefits of treatment options that is an understanding of informed consent.[9] There are data to show that patients with limited health literacy may want and need information clarified but ask fewer questions and are at a greater risk for not understanding their options.[10] These patients often sign documents of informed consent without understanding what they are signing.[11] Loss of short-term memory can be a problem for a number of older adults. This loss can influence informed consent as a clinician may spend time with the patient, have them sign a document agreeing to a treatment plan, and after some time, the patient does not remember what has been discussed or what has been signed. Assessment of early cognitive losses is difficult and can seriously influence consent capacity.[12]

Good communication with the older patient, as well as their family or significant others, is essential. If the dentist is not skilled at communicating with older patients who have sensory deficits, the true nature of the patient's chief complaint may be missed. For example, a 68-year-old man seeks dental treatment. He is wearing a complete maxillary denture and a mandibular removable partial denture. The patient's older brother, a smoker, recently died from oral cancer. This patient, also a smoker, cannot openly vocalize his fears and comes to the dentist for an evaluation of his dentures. He cannot ask the dentist to check his mouth for oral cancer but hopes that during the oral examination of his denture, the dentist will say to him that he does not have oral cancer. If the dentist cannot find a problem with the dentures, has not taken a family history, does not read the patient's body language, there will be a failure in communications and the patient who came for counselling will not get the stress release he is seeking.

Decision making

The majority of diseases, which dentists treat on a daily basis, are chronic diseases which have no cure and cause irreversible damage. Some of the acute

diseases of the oral mucosa and pulp can repair themselves or be cured. In older adults, the majority of the need is to treat the acute exacerbations of caries or periodontal disease.

Problem solving that is decision making is an essential component of clinical diagnosis and treatment planning in geriatric dentistry.[13–15] In younger adults, the factors which influence decision making are whether the clinician has the skill and the resources to treat the particular problems of that patient, whether the patient has the will or the time to accept and pay for that treatment plan. In functionally independent older adults, the process of decision making becomes more complex. Apart from understanding the patient's psychological problems and side effects of the medications they are taking, there are other issues such as the cumulative effects of a lifetime of physiological, traumatic disease-derived problems, as well as iatrogenic effects on the dentition due to dental care.

Figure 1 shows restorations in varied states of disrepair, gingivitis, attachment loss, recurrent caries as well as wear and chipping of the dentition in an 82-year-old widow who is living independently in a community about an hour away from the dental surgery. She does not drive anymore and relies on the husband of her neighbour to get to dental appointments. She has two married children who live in different cities from her. Her medical problems include a history of hypertension and type II diabetes, arthritis and osteoporosis of the spine. She had a knee replacement three years ago. She has problems hearing in her right ear but does not wear a hearing aid. The patient was concerned because her right maxillary second premolar has fractured at the gingival margin. She has not seen a dentist in three years since her general dentist retired. The medications she is taking are listed below:

Hypertension	Hydrochlorothiazide 25 mg qd (diuretic) Atenolol 25 mg qd (selective B1 blocker)
Hypercholestraemia	Simvastatin 20 mg qd (antihyperlipidemic)
Diabetes	Glucotrol (glipizide) 2.5 mg bid (oral antidiabetic)
Arthritis	Ibuprofen 400 mg tid (NSAID)
Osteoporosis	Fosomax (Alendronate) 5 mg qd (bisphosphonate)

The knowledge base required to manage the oral problems of such a patient does not depend on the development of new technical skills but rather on the following:

(1) An understanding of normal ageing.
(2) An understanding of pathological ageing.
(3) An understanding of her medical problems and recognizing the oral implication of her systemic diseases.
(4) A knowledge of pharmacology and drug-induced dental disease.

Fig. 1 Intraoral photograph of an 82-year-old female showing restorations in various states of disrepair. The crown of her right mandibular premolar has fractured.

(5) The interpersonal skills needed to communicate with this patient, her family and her other health providers.
(6) Knowing special communication techniques required for older persons who have sensory deficits.
(7) Having practical experience in clinical decision-making for such a patient.

After evaluating all of her modifying factors, the following evaluations were done at this first appointment. Bitewing radiographs were taken of the posterior teeth which showed some early lesions in enamel. A periapical radiograph of the fractured second right premolar showed no visible pathology and pulp testing found a responsive tooth.

Because of the patient's transport problems, the following treatment plan was developed and approved by her: the teeth were scaled and cleaned; the second right premolar was excavated and sealed with a light-cured resin-reinforced glass ionomer. A 5000 ppmF toothpaste was prescribed with a modified handle on the toothbrush to help her clean her teeth, and a follow-up appointment was made for three months. This rational treatment plan fulfilled the patient's primary concern about the fractured second right premolar and also addressed the caries in her mouth. At three months it will be possible to re-evaluate her oral hygiene and oral health.

The bulk of dental care for frail older adults still remains reconstructive, i.e. the restoration of teeth and the restoration of function of the stomatognathic system with fixed and removable partial dentures.[16] The clinical techniques are usually similar to those needed for treating younger persons; however, more problems are encountered. For example, in recurrent caries, the margins of interproximal restorations will need to be placed subgingivally with all of the associated problems due to bleeding, marginal adaptation of restorative materials and finishing.[17]

Deciding what constitutes appropriate care may vary for an older cohort of individuals because those decisions must include the consideration of a variety of age-related and age-associated psychological, sociological, biological and pathological changes. Therefore, it is essential to identify modifying factors before a comprehensive treatment plan is formulated.

Bader and Shugars[18] reviewed dentists' clinical decision making and stated 'the extent to which differences in dentists' clinical decisions have been examined is limited'. They suggested that the differences were in the way dentists perceived dental diseases and their treatments, and not on factors such as known risk factors, rates of incidence, progress of disease or on outcomes. Braun and Markus[19] in a classic study sent study models and radiographs to dentists in private practice and asked them to develop treatment plans. They varied the age of the patients from under 40 to over 60. For the younger age group, teeth adjacent to a space were more likely to be used as abutments for fixed partial dentures. For those patients 60+ years old, the extraction rate increased and the dentists were more likely to prescribe a removable prosthesis.

For older adults, there have been discussions about the decision making process in the literature and some of these systems are discussed below. Shay[20] suggested a systematic approach to planning oral care for older adults, which he called OSCAR and which he used to determine the needs of a specific patient (Table 1). He believed that dentists could use OSCAR as a means of fully accounting for all of the factors that could impact an older adult's potential course of treatment. This is a useful tool for people beginning to treat older adults with complex medical problems.

Berkey *et al*.[21] proposed a similar but different conceptual model. They suggested that in clinical decision making for older adults, there were four domains of dental need that needed to be integrated and these were function, symptomatology, pathology and aesthetics (Table 2). To achieve these goals, the authors[21] suggested that a series of questions needed to be answered, which were:

(1) The patient's desires and expectations.
(2) The type and severity of dental need.
(3) The impact on quality of life.
(4) The probability of positive outcomes.
(5) Reasonable treatment alternatives.
(6) The ability to tolerate the stress of treatment.
(7) The capability to maintain oral health.
(8) Financial and other resources.
(9) The dentist's capabilities.
(10) Other issues.

Using the information gained from the patient, a dentist could weigh the impact of these findings and determine the patient's needs at five levels of care. These are very extensive care, extensive care, intermediate care, limited care or very limited care (Table 3).

In 1983, a decision-making algorithm, called the 'rational dental care model', was presented at a national meeting in Chicago.[6] Although the relative influence of the various modifying factors was unknown, the authors hypothesized that this was the mechanism by which dentists experienced in geriatric care made treatment planning decisions. The authors believed that this model could be usefully incorporated into dental education because it specified a thought process that would be helpful for diagnosis and treatment planning for all patients. The model was modified in 1984 (Fig. 2).[13]

To test this modified model, the authors evaluated the similarities and differences among five dentists who were experienced in caring for geriatric patients.[22] Each participating dentist individually

Table 1. OSCAR – a geriatric dental assessment

O = ORAL, which evaluates the teeth, the prostheses, the periodontium, the status of the pulp, the oral mucosa, the occlusion, and saliva.
S = SYSTEMIC, which evaluates normative age changes, medical diagnosis, pharmacological agents, and interdisciplinary communications.
C = CAPABILITY, which evaluates functional ability such as self care, oral hygiene, caregivers, and the need for transportation and mobility.
A = AUTONOMY, which evaluates the ability to give informed consent or dependence on others.
R = REALITY, which evaluates prioritization of oral health care, financial limitations, and anticipated life span.

(Source: Modified from Shay K. Identifying the needs of the elderly dental patient. The geriatric dental assessment. Dent Clin North Am 1994;38:499-523.[20])

Table 2. The four domains of dental need

A FUNCTION – Relates to the ability to chew and eat an adequate diet.
B SYMPTOMATOLOGY – Relates to comfort while chewing and being free of pain by having an adequate amount of saliva to speak, taste, swallow, etc.
C PATHOLOGY – Relates to not having any oral discomfort or lesions in the mouth.
D AESTHETIC – Relates to perceived needs to improve their appearance or smile.

(Source: Modified from Berkey DB, *et al*. The old-old dental patient: the challenge of clinical decision making. J Am Dent Assoc 1996;127: 321-332.[21])

Table 3. The five levels of care

No. 1: Very extensive care with complex needs, including rehabilitation of the dentition with fixed prosthodontics and the ability to accept this care.
No. 2: Extensive care, which may be solved by a combination of fixed and removable prosthodontics and the ability to withstand the care.
No. 3: Intermediate care, which requires some alternatives to traditional therapies.
No. 4: Limited care; these patients cannot tolerate extensive time in the dental chair and need short appointments and a simplified treatment plan.
No. 5: Very limited care; these patients should be treated for pain relief and infection control only.

(Source: Modified from Berkey DB, *et al*. The old-old dental patient: the challenge of clinical decision making. J Am Dent Assoc 1996;127: 321-332.[21])

examined the volunteer older adult patient and then planned a treatment for him. The dentists were videotaped as they interviewed and examined the volunteer patient. Later, the dentists were interviewed by an expert in communications while viewing the videotape of their examination. This interview was also videotaped. During the interview, the dentists were asked to stop the examination videotape and comment on any issue they wanted to discuss. The interviewer could also stop the tape during an interaction between the dentist and the patient, and ask the dentist to clarify his or her rationale for asking the patient a particular question. In particular, the authors wanted to know when the dentist decided on his or her treatment plan.

From the videotapes, it was clear that the patient was varying his response slightly from dentist to dentist and that he was not a reliable historian. In spite of that, it seemed that after initial contact with the patient and after looking at the dentition, the dentists knew what treatment they wanted to perform. The dentists then spent the remainder of the time with the patient developing the feasibility of their preferred option. It was clear that the patient assessment model used by these five dentists was based only on clinical experience and not on a step by step thought process. These findings support those of Feinstein[23] who stated, 'The way a clinician makes a prognosis for a new patient is to recall the results in a group of previous patients who resemble the current patient'.

It has been suggested that dentistry should model itself on medicine and that the future of dentistry is to be an oral physician.[24] However others do not believe that dentistry is like medicine because in medicine, it is important to make a diagnosis. Once a diagnosis is made, the treatment is usually well prescribed, often guided by evidence-based studies. Dentistry is more like surgery in that treatment includes removal of an infected part but there can be variations how that is carried out.[22] Like surgeons, dentists need an operating room (dental office) with specialized instruments to carry out treatment. Much of our treatment is based on anecdotal data and experience rather than evidence-based studies. It became clear to our group that a dentist treating geriatric patients needed experience and must be technically competent, and therefore he or she must be a good clinician.[25]

A discussion of treatment planning cannot be complete without evaluating the role of evidence-based dental care and geriatric minimal intervention. Evidence-based dentistry is the 'conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients'.[26] The treatment plan depends upon the clinician integrating the best available research evidence with the clinician's expertise.[27] After gathering this evidence, the risks and benefits of treatment are presented to the patient so that an informed decision can be made. The problem in clinical dentistry, especially in geriatric dentistry, is that there are few randomized clinical trials available to help with decision making. There is a need for research and more systematic reviews to help the clinician make evidence-based decisions.

In the 1970s, an evidence-based approach to caries management evolved, which became known as minimal intervention dentistry (MID).[28] The basic philosophy of the model was that dental diseases were chronic, infectious diseases and their treatment should be based more on a medical model than on a mechanistic one. The main components of MID are 'assessment of the risk of disease, with a focus on early detection and preservation; external and internal remineralization; use of a range of restorations, dental materials, and equipment; and surgical intervention only when required and only after the disease has been controlled'.[29–31] Using MID, the clinician needs to:[32]

(1) Control the disease by identifying and, if possible, manage the risk factors and allow an assessment of the severity of the disease.
(2) Detect the carious lesions as early as possible and try to remineralize the lesions without a need for restorations by the use of fluorides.
(3) Keep the necessary restorative procedures minimally invasive by removing only the 'caries infected' dentine but retaining the 'caries affected' dentine.
(4) If possible, repair defective restorations rather than replace them.

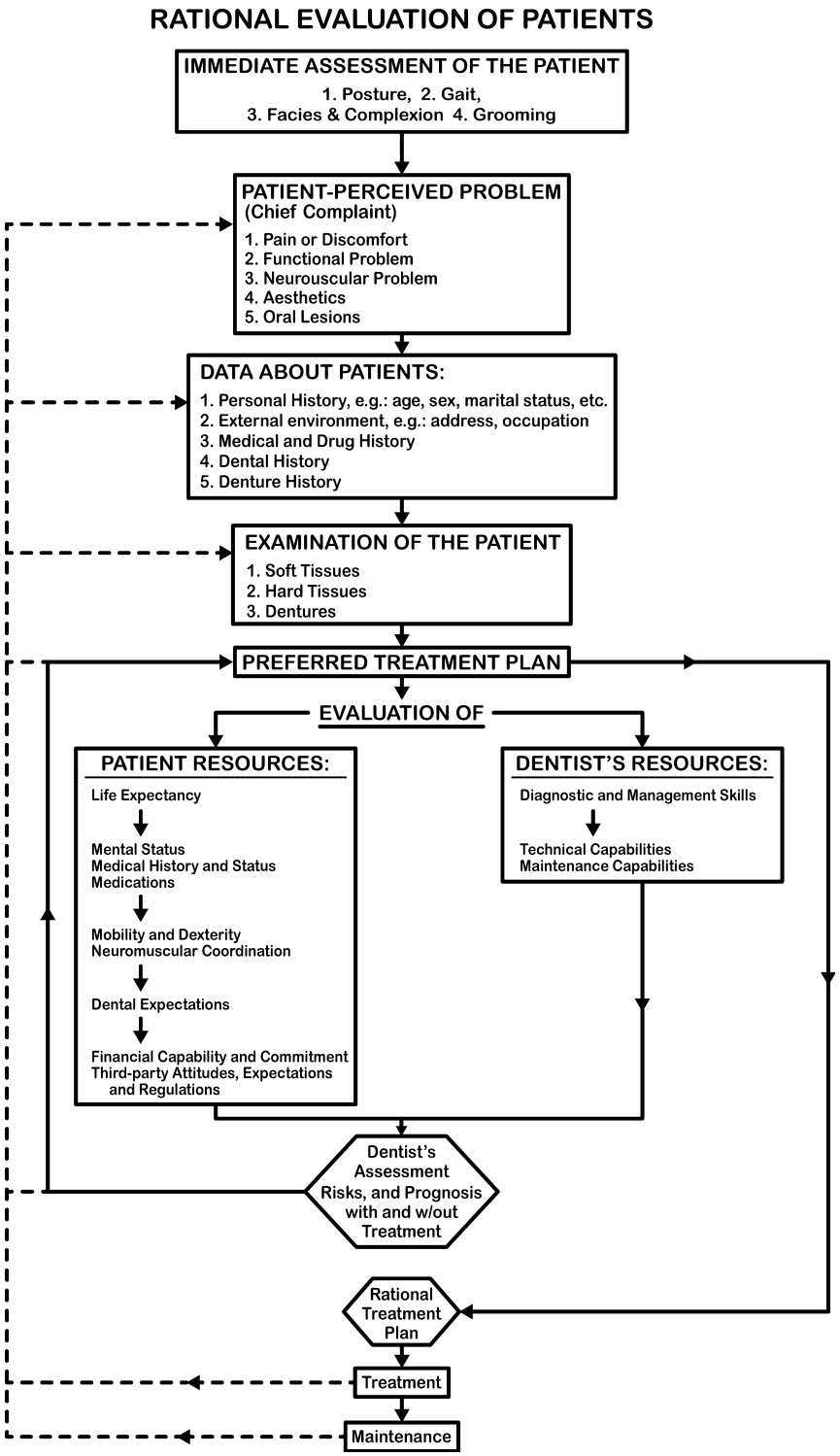

Fig. 2 A modified model of decision making for older adults developed by Ettinger and Beck.

(5) Try to change the patient's behaviours related to dietary habits, oral hygiene, antibacterial therapy and use of fluorides.
(6) Reinforce patient education by appropriate recalls to monitor the patient's oral health.

Ngo and Gaffney[33] presented an algorithm for oral disease management in MID, which included the assessment of some modifying factors, such as medical history, medications, socio-economic status, etc., followed by a number of primary factors, which influence the biofilm such as diet, saliva, fluoride, etc. These evaluations influence how the patient would be managed to convert the cariogenic biofilm to a healthy one. If this flow diagram is combined with the

rational care concept, it allows treatment to be more inclusive as shown in Fig. 3. Several risk management systems have evolved to look at risk assessment such as Caries Management by Risk Assessment (CAMBRA),[34] a form developed by the American Dental Association dentists (ADA),[35] one developed by the American Academy of Pediatric Dentistry (CAT),[36] and a cariogenic assessment system (Cariogram) in Sweden.[37] In a recent review paper, Teilez *et al.*[38] critically evaluated these four systems. They reported there was a wide variation among the systems in terms of defining what was a caries risk category. The Cariogram system was the only one in which there were good data for predicting caries in the permanent dentition and limited utility in preschool children and was moderately useful for elderly persons. They concluded 'there is an urgent need to develop valid and reliable methods for caries risk assessment'.

Strategy for decision making

Two conditions, which contribute to problems in decision making for older adults, are complexity and uncertainty. Decision making uncertainty occurs when there is insufficient knowledge relative to the significant variables and possible outcomes. The dentist may be uncertain about the nature of the dental problem and when, or even if, it should be treated. One example is an elderly woman who had recently relocated and was brought to the dental office by her son for a check-up. Routine radiographic evaluation revealed a central incisor that had had root canal therapy. This tooth had a well-circumscribed periapical lesion. When the patient was questioned, the tooth was asymptomatic but she was a poor historian. She was mildly confused and the son had power of attorney and could not remember when the tooth had been treated. It was not possible to contact her previous dentist, who according to the son was deceased. The dentist could not be sure if this was an active process or a healing lesion. If it were an active process, the treatment of choice might have been to redo the root canal therapy; however, if it were a healing lesion, the patient should be examined at regular intervals. Uncertainty about the possible therapeutic treatment alternatives and whether resources were available to carry them out was also a factor. If the patient was in good health, no particular problem would exist. However, as this patient had a history of early Alzheimer's disease, would it be more therapeutically correct to observe the tooth over a period of time? Since it is known that a patient with Alzheimer's disease will physically and mentally deteriorate over time, but have a limited lifespan, should the root canal therapy be redone or should the tooth be extracted? Specifically, the dentist may be uncertain about the prognosis for this patient.

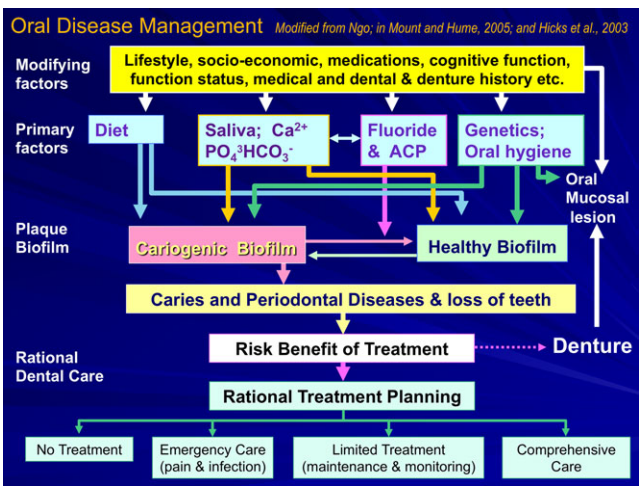

Fig. 3 Flow diagram of decision making for older adults.

Dentists who care for older frail adults face these kinds of decision problems on a daily basis. However, a decision needs to be made and the son needs to be offered guidance so he can make an informed decision as to what is in the best interests of his mother. The recommendation in this situation could be to do nothing except to emphasize the need for regular recalls. The reasons for coming to this conclusion are as follows:

(1) There are no apparent signs or symptoms that an active disease process exists.
(2) The site is easy to see and check and the son needs to be informed to look for signs of change, such as swelling or looseness of the tooth.
(3) The worst-case scenario for this condition is a periapical abscess, which can be dealt with by redoing the root canal or by doing an apicectomy or extracting the tooth.
(4) The mother has a limited lifespan, usually 7–10 years from the time the initial diagnosis of Alzheimer's disease is made, and the tooth seems symptom-free at this time.

Decision-making problem complexities occur when multiple relevant variables exist. These include consideration of a variety of treatment alternatives, as well as the criteria on which a decision will be based. Dental diseases are not always associated with a specific curative therapy and recent improvements in dental materials have resulted in more treatment options becoming available.

For instance, for a patient with root caries, the treatment of the lesions must include: an evaluation of the patient's ability to maintain daily oral hygiene as well as any xerostomic potential of the drugs they are using; the extent of the lesion; the status of the lesion, i.e. active or arrested; access to the lesion; ability to keep the tooth dry during restorative procedures; proximity of the lesion to

the cemento-enamel junction, whether it is subgingival; and aesthetics. An evaluation of these factors will determine which restorative approach should be used:

(1) remineralization with topical fluorides;
(2) recontouring to make the tooth self-cleaning;
(3) utilization of appropriate restorative materials, such as amalgam, glass-ionomer cements, or composite resin; or
(4) extraction of the tooth or teeth.

There needs to be consideration of patient-related factors, which can directly affect the prognosis of the dental treatment, such as health, neuromuscular ability, vision and motivation, which add to the complexity of treatment planning decisions. Since the dentist must choose the best therapeutic alternative and anticipate the consequences of that decision on later events, such as the deterioration in the health of the patient, the treatment planning situation can become even more challenging.

Ideal or rational treatment planning: a dilemma

The ideal treatment plan has been described by Barsh[39] as 'that leading to the best dental prognosis without taking modifying factors into account'. Traditionally, this has been based on the application of morphologic concepts; i.e. the dentist views the dentition and proceeds technically to evaluate how many teeth can be saved or replaced without evaluating any other limiting factors. This morphologically-based approach has been described by Levin[40] as 'the 28-tooth syndrome' and was usually compatible with healthy patients in a fee-for-service system. As stated previously more older adults are maintaining more teeth and the question becomes how much restoration of the occlusion is required for these older adults. Ramfjord and Ash,[41] while discussing the replacement of lost teeth, stated that 'clinical experience indicates that satisfactory function and occlusion, as well as neuromuscular stability, usually can be established if all bicuspids and anterior teeth are present, even if these teeth have lost a considerable amount of periodontal support'. The concept of the shortened dental arch was originally introduced by Kayser[42] who followed 118 subjects with different degrees of arch reduction and showed that there was sufficient adaptive capacity to maintain adequate oral function when at least four posterior occlusal units remained, preferably in a symmetric position. Since that time, there have been a number of studies,[43–45] which supported a positive outcome both financially[46] and functionally.[47]

Currently, if there is loss of a tooth or teeth, there are very few criteria or guidelines to replace the tooth or teeth. To answer that problem one needs to evaluate the patient and determine:

(1) How long has the tooth or teeth been missing? If the extractions are recent then it is important to look at the stability of the occlusion.
(2) Is there an antagonist and has it moved? If there has been movement then a replacement may be necessary to preserve or re-establish the occlusal plane.
(3) Is there an aesthetic problem? If the patient is severely cognitively impaired, replacement of anterior teeth needs to be evaluated in terms of the risks and benefits to preserving the remaining dentition.
(4) Can the patient chew comfortably and effectively, are there adequate numbers of chewing pairs of teeth?
(5) Are there any joint symptoms? If there are, there may be a need for posterior support of the occlusion.

It also becomes important to assess the remaining teeth. For older adults, especially those with neurodegenerative diseases such as Parkinson's disease, dementia or people with tardive dyskinesia, the maintenance of some mandibular teeth is critical, because these people cannot adapt to complete mandibular dentures. Therefore all teeth need to be evaluated in terms of their value to the dentition and some are more valuable than others and have been described as 'key teeth'.

(1) A key tooth is one that can support itself or other teeth.
(2) A key tooth is one which, if lost, dramatically changes the treatment plan, e.g. from a fixed partial denture to a removable partial denture; from no removable partial denture to a removable partial denture; and from a tooth supported removable partial denture to a distal extension removable partial denture.
(3) A key tooth is one that is required to maintain an adequate chewing pair.

When caring for ageing populations who have modifying factors, which are often significant, a patient-oriented approach requiring rational decisions is essential. Berkey[14] has suggested that the dentist should begin by asking several basic questions, such as:

(1) What is the patient's dental problem?
(2) Why did it occur?
(3) What can I do about it?
(4) What will be the outcome?

Based on the assumption that as people age, they become increasingly compromised because of their various medical, social and psychological problems, a modification of the American Society for Anesthesiologists' evaluation system has been used to assess patients. Using the system as a reference, therapy modification and patient management approaches have been

suggested. This modified system provides guidelines for the dental treatment of medically compromised patients requiring anaesthesia.[48] Kamen[49] further modified the system by dividing the care provided into four broad categories. Although this system provides a useful concept, it has faults that Gordon and Kress[50] describe by stating, 'when applied to specific situations, the system is somewhat simplistic in that many patients fall between categories and many choices remain even within one category'. Little *et al.*[51] stated, 'this system is limited in that it does not provide specific information about how treatment may be modified'.

One of the difficulties encountered in treatment planning is that dental treatment options are continuously evolving and new information and techniques are becoming available to clinicians. Also, treatment planning is as much an art as it is a science. For example, an 81-year-old female (Mrs B) is brought to your office by her daughter-in-law. The daughter-in-law complains that the mother-in-law is not eating well and that she has oral discomfort. The patient has not been to a dentist in the past except to get teeth extracted. She understands some English but does not speak it well. She is illiterate in her own language.

Medical history

The patient has congestive heart failure and has a history of chest pain due to angina pectoris. The last chest pain was two days ago at home when she was doing some housekeeping. She has had hypertension for the last 10 years; her blood pressure is 160/95 mm Hg. She has cataracts, which will be surgically treated in a month, and she is hard of hearing. The patient has severe osteoarthritis of the knees and spine and is overweight. She had her right knee replaced just over two years ago.

Medication history

The daughter-in-law brought in Mrs B's daily medications as we had requested in our letter to the patient prior to the appointment. Her medications are listed in Table 4, which also identified their potential oral side effects and the management issues associated with them.

Oral examination

Right	Left
16 13 12 11	21 22 23 26
46 44 43 42	31 32 33 34 35

There was overeruption of #26 and #46. There was a periapical lesion on the distal root of #26 and on #31. There was condensing ostitis on tooth #46. There was a premature contact between #16 and #46, which created a forward slide in the occlusion. There were caries on the mesial of #35 and distal of #33 and #34.

Table 4. Daily medications

DRUG Trade name	DRUG Generic name	Potential oral side effects	Management issues
Lasix 60 mg qd	Furosemide (loop diuretic)	Xerostomia Lichenoid	**1** Monitor vital signs **2** Caries prevention **3** Artificial saliva **4** Orthostatic hypotension **5** Hypokalemia **6** Avoid alcohol
Slow-K 20 mgEq/day	Potassium chloride	None	**1** Cold extremities **2** Tingling **3** Muscle weakness
Inderal 30 mg qid	Propranolol (non-selective B-adrenergic blocker)	Xerostomia Altered taste	**1** Monitor vital signs **2** Caries prevention **3** Artificial saliva **4** Orthostatic hypotension **5** Limit saline **6** Limit vasoconstrictors **7** Short appointments
Nitro-Bid 0.4 mg prn	Nitroglycerin (inorganic, nitrate vasodilator)	Xerostomia Flushing of face	**1** Monitor vital signs **2** Orthostatic hypotension **3** Can use benzodiazepine for anxiety **4** Limit vasoconstrictors **5** Short appointments
Motrin 400 mg tid	Ibuprofen (non-steroidal anti-inflammatory)	Gingival bleeding Xerostomia	**1** Avoid aspirin **2** Avoid for patients with peptic ulcer or GI inflammation **3** Risk of nephrotoxicity **4** Semi-supine chair position

All teeth showed significant wear. The mouth was not very dry but the patient did report that she had a very dry mouth in the morning on awakening.

So how should one approach this patient's needs? There are some basic questions a clinician must answer in his or her mind to successfully diagnose and treat such an elderly patien:[21]

(1) What are the patient's oral problems?
(2) What is the patient's chief complaint?
(3) How and why are these problems occurring?
(4) What are the main modifying factors influencing the oral health care of the patient and has the right data been gathered?
(5) Can I solve these problems or do I need help from other health professionals or specialists?
(6) What will happen if I do nothing?
(7) Can I predict the outcome of this treatment plan that I think may help this patient and what treatment would increase the risk for the patient?

To answer these questions and to develop a rational treatment plan, a decision tree was used which is shown in Fig. 4. We also gathered answers to the following modifying factors:

1. What are the patient's desires and expectations?

Oral health is defined not only by objective signs but also by the subject's or patient's perceived symptoms.

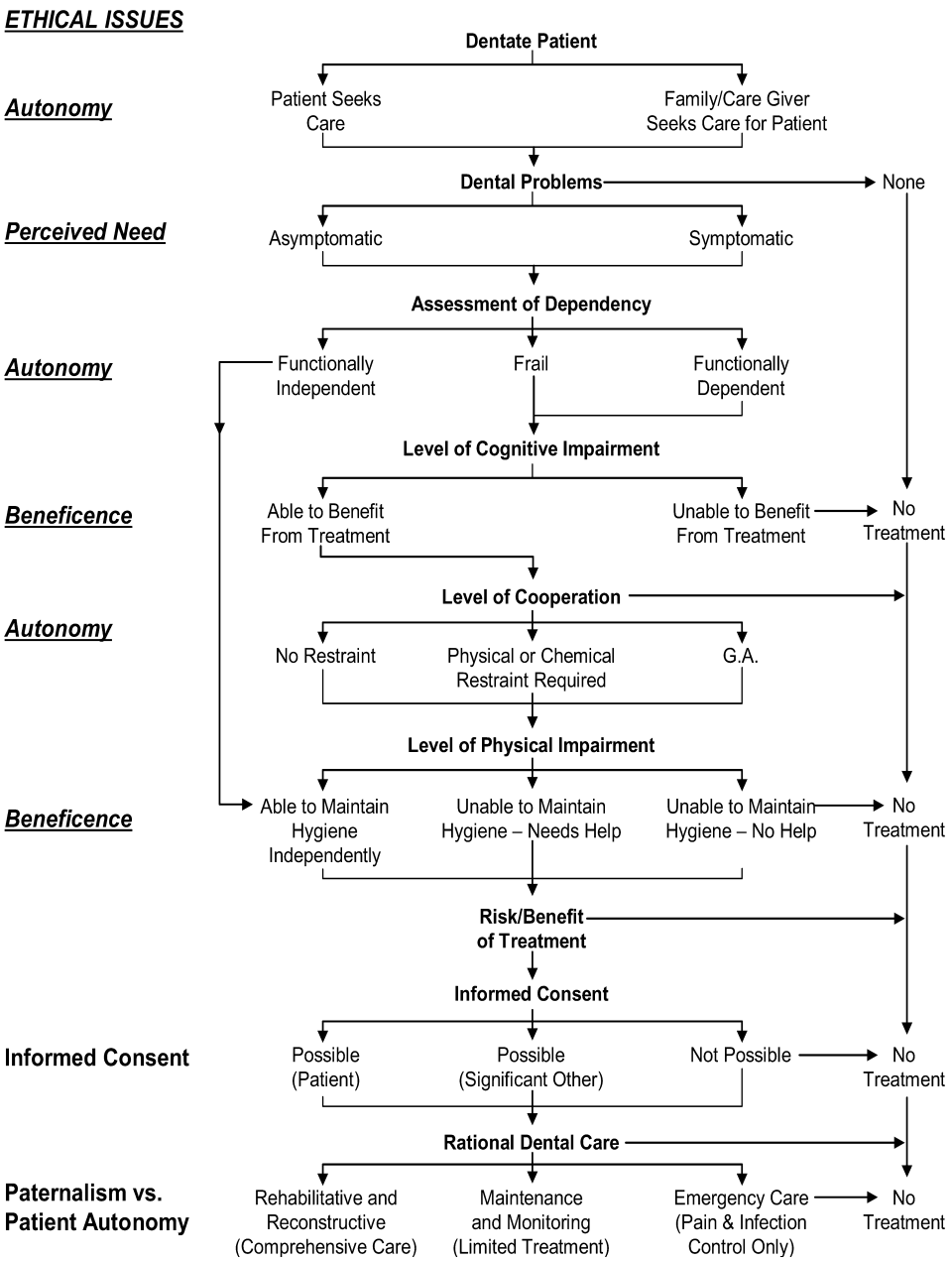

Fig. 4 Decision tree for a dentate person.

For Mrs B, we need to rely on the daughter-in-law to help with informed consent. The patient comes from a culture where whatever the 'doctor' says is right. We may need to have the son (who is in the health field) come and help with informed consent. The primary need is that the patient wishes to be comfortable and to have enough teeth to be able to chew her food.

2. ***What are the patient's dental needs and how complex are her problems?***

The patient is in discomfort so we need to identify where the discomfort is coming from and deal with that first. Tooth #26 is responsible for her discomfort and after discussion, there is agreement to extract it.

Her dental problems are: missing posterior teeth; heavily worn dentition with loss of vertical dimension; overerupted teeth; periapical pathosis #26 and #31; caries #33, #34, and #35; and plaque and calculus.

To ensure that she has enough chewing pairs of teeth, removable partial dentures may be necessary for both arches. How to manage #16 and #46 will need to be assessed.

3. ***What is the impact of her dental problems on her quality of life?***

The patient is in discomfort and having difficulty chewing. The pain is associated with tooth #26 and this tooth is overerupted and has a periapical lesion. Extraction of the tooth would alleviate the pain and then allow an assessment of the patient's masticatory needs. The question is how much treatment can this patient tolerate? How invasive can the treatment be? Can she maintain oral hygiene independently?

4. ***What is the impact of her medical problems on her dental treatment?***

Mrs B is living with her son and daughter-in-law and being supported by them. To evaluate her medical problems, we had to talk to her physician. He confirmed the patient's medical history and added that the patient had a mitral valve prolapse.

Chronic congestive heart failure

Mrs B became short of breath easily when experiencing mild stress such as walking from the waiting room down a corridor to the clinic. Therefore, stress reduction procedures were necessary during treatment[52] (Table 5). We will need to have oxygen available during treatment and monitor her vital signs. If she shows anxiety then a short-acting benzodiazepine could be used, such as lorazepam 1.0 to 2.0 mg one hour prior to the procedure or oxazepam 10 to 15 mg one hour prior to the procedure.[53]

Angina pectoris

Mrs B had chest pain two days ago when doing some light housework. The pain went away in a few minutes after she sat down and placed one 0.4 mg tablet of nitroglycerine under her tongue. To treat her, we will need to monitor her vital signs at all appointments and have nitroglycerine available as well as oxygen. In particular, if the appointment is deemed to be stressful or if she is susceptible to frequent angina attacks, she should take a prophylactic dose of 0.4 mg sublingually 3 to 5 minutes before beginning treatment.[53] For patients with cardiovascular disease, it is advisable to have short mid-morning appointments, adequate anaesthesia, and if required, sedation to reduce stress, which increases the oxygen demand of the myocardium.[52] It is standard procedure in our practice to record blood pressure and pulse rates for all new adult and older dental patients at the initial appointment.[52] If patients report a history of hypertension, even if it is controlled by medication, their blood pressure should be monitored and recorded before treatment and before patient dismissal, especially if local anaesthetics have been used.[52]

Hypertension

Her blood pressure (BP) seemed stable at her last appointment at 160/95 of mms of Hg. However, we need to monitor BP at each appointment. We would want to institute a stress-reduction protocol[53] and limit the amount of epinephrine used in local anaesthetics to follow the American Heart Association guidelines of no more than 0.036 mg of epinephrine at any one time. This translates to using no more than 2½ carpules of 1.7ccs of 2% xylocaine with 1:100 000 epinephrine. To prevent local anaesthetic entering directly into a blood vessel, a technique of deliberate aspiration is required before slowly depositing the local anaesthetic. Warming the solution prior to injection also reduces discomfort.[54–58] Due to the circadian stickiness of platelets the patient should not be seen between 6 am and 9 am.[59,60]

Table 5. Stress reduction protocol

- Short appointments preferably in the mid-morning, when the patient is well-rested and has a greater reserve;
- Stress and anxiety reduction with the establishment of good rapport;
- Premedication with a short-acting benzodiazepine or intraoperative conscious sedation, or both;
- Optimized use of epinephrine in local anesthetic – AHA guidelines: not more than 0.036 mg epinephrine;
- Monitoring of vital signs before and after the procedure;
- Good postoperative analgesia.

(Source: Modified from Rose LF, *et al.* Oral care for patients with cardiovascular disease and stroke. J Am Dent Assoc 2002;133 Suppl:37S-44S.[53])

The use of local haemostatic agents, such as an epinephrine-impregnated gingival retraction cord, is considered dangerous and is contraindicated for all older patients. Patients on propranolol should not be given epinephrine because unopposed vagal stimulation can produce bradycardia and hypotension.[52] For Mrs B, one would use carbocaine or citanest 3% with octapressin. The long-term inhibition of monoamine oxidase (MAO) has been shown to result in accumulation of norepinephrine, epinephrine, serotonin, dopamine, tyramine and tryptamine in various tissues. The use of local anaesthetic with epinephrine is contraindicated in persons taking monoamine oxidase inhibitors (MAO) because epinephrine may precipitate a hypertensive crisis.[61]

Osteoarthritis

The patient has difficulty walking because of the osteoarthritis in her knees, which is aggravated by her being overweight. We would want to make sure she had taken her pain medication before her dental appointment and we would want to give her a late morning appointment or an early afternoon appointment. This will allow her to stretch and get over the stiffness from sleeping. Her appointments should be short. Ideally, including time travelling to the appointment, it should be no more than 90 minutes.[52]

Mrs B had her right knee replaced two years ago. The guidelines agreed to by oral surgeons and orthopaedic surgeons in 2003[62] suggested that if a person did not have infection, revision, or replacement of the artificial joint for two years, then there was no need for prophylactic antibiotics (amoxicillin 2 gm, one hour prior to the invasive procedure). The 2013 consensus conference reported that the evidence is inconclusive that there is a benefit in using prophylactic antibiotics for patients with large joint replacements.[63]

5. What is the impact of her medications on her dental treatment?

The influence of Mrs B's daily medication on her oral condition and on her dental management is shown in Table 4.

6. What is her ability to maintain oral hygiene independently?

This is a key factor in decision making as plaque control is essential for the maintenance of natural teeth. The compliance with any preventive regimen will depend on the patient having:

(a) Adequate knowledge of why she needs to clean her teeth and to understand that her dry mouth puts her into the high risk category for caries and periodontal disease. Because of the language problems, we need to keep the explanations as simple and as practical as possible.
(b) Adequate motivation is needed if people are to change behaviours. In Mrs B's case, she told us that she wanted to keep as many teeth as possible so the prognosis for her cooperation is good.
(c) Adequate neuromuscular skills are necessary to hold a toothbrush. One must have adequate vision to see and enough hand-eye coordination to put the brush where it needs to be most effective. Mrs B has osteoarthritis of her hands. To help improve oral hygiene there are several options one could try. The simplest is to put a toothbrush through a small rubber ball to help hold the brush more easily or one could have the family buy her an electric toothbrush. Treatment of her cataracts will also help with vision during toothbrushing.

7. Are there any financial limitations on her treatment plan?

Mrs B is entirely dependent on her son and daughter-in-law for financial support. She has no dental insurance. Her daughter-in-law told us that her dental care would be financed at a 'reasonable level' by the family.

8. What is the ability of the dentist to deliver the care needed?

The dental care required for this patient is not technically difficult for a general dentist. It would be a combination of extractions, restorations, possible endodontics and prosthodontics. The difficulty is in the communication, informed consent, the diagnostics, and finally the decision making. To determine the patient's needs, one would have to decide on: what is the appropriate care; when should the treatment be done; how much treatment; and in what sequence should the treatment be done.

9. What is the probability of success for treatment?

Provided the patient's systemic health does not deteriorate further, we can treat her, however:

(a) Communications and informed consent will be a problem and we will need the help of her son to deal effectively with this problem.
(b) Transportation will not be a problem as the daughter-in-law has committed her time to help. However, because the patient gets out of breath, we need to give her time to recover from the stress of getting from the parking lot to the dental chair. A wheelchair would help, if she will accept it.
(c) Her xerostomia will increase the risk of caries and periodontal disease and cause problems with wearing dentures. It is important to avoid a complete denture, especially on the mandible.
(d) Determining the vertical dimension of occlusion will be a problem. The use of interim removable partial dentures will help us diagnostically.
(e) Her motivation seems to be good and her hand-eye coordination is adequate. The overall probability of success is fair and since the patient is in

pain, it is imperative to determine the cause of her pain and eliminate it as soon as possible. The overriding rule for the older patient, as with all patients, is that the treatment rendered must benefit the patient and do no harm.

Final treatment plan

The treatment plan was developed after evaluation of the modifying factors and following the concerns raised by the decision tree. Mounted study casts were made to help with the decisions on reconstruction of the dentition. The treatment could be divided into phases and each phase was a re-evaluation point in terms of the patient's tolerance of treatment:

A Emergency care
(1) Extraction of tooth #26 and #31.
(2) Have nitroglycerine and oxygen available.
(3) Prescribe oxazepam 15 mg one hour before the surgical procedures.
(4) No antibiotic prophylaxis is required for Mrs B.

B Disease control
(1) Clean and scale the teeth.
(2) Adjust occlusion between #16 and #46.
(3) Restore #16 and #33, #34, and #55 with composite resin.

C Reconstruction
(1) Do a diagnostic wax-up to estimate vertical dimension of occlusion.
(2) Do composite build-ups of the following teeth: maxilla #13, #12, #11, #21, #26, #23.
(3) Restore the tips and hollows of the following teeth: mandible #32, #33, #34, #35, #42, #43, #44.
(4) Deliver interim resin removable partial dentures with wrought wire clasps on the maxilla and mandible.
(5) Wait 3–6 months and evaluate if the patient is comfortable, if so replace the removable partial dentures, with cast removable partial dentures.

D Maintenance and monitoring

The treatment was completed within two months. After radical changes to the size of the maxillary restorations, the patient was happy with her appearance and able to chew comfortably. She did not wish for the partial dentures to be replaced. She returned on recall regularly for three years and then died in her sleep of a cardiac event.

DISCUSSION

Clinical decision making in dentistry tends to be based on qualitative, subjective estimates that the benefits of a specific treatment outweigh the possible alternatives. In dentistry, a clinician traditionally has collected useful pieces of evidence and synthesized them into a sequenced subjective treatment plan, which usually is based on his/her clinical experience. These decisions usually are based on the patient's age-associated psychological, social, biological, and pathological profile. Grembowski *et al*.[64] have indicated that clinical decision making should be a social process that includes the dentist, patient, and sometimes others.

CONCLUSIONS

This case history illustrates that it is possible to do restorative work for a frail at-risk patient, if one understands the influence social and medical problems have upon the oral cavity and dental treatment. It is imperative that a step-wise approach is used and that no irreversible step is taken until an adequate risk-assessment of potential for success has been made. It is important to maintain 'key teeth', especially in the mandibular arch. The fundamental concept for successful treatment is to understand how the patient functions in his or her environment and how dentistry fits into his or her overall needs.

DISCLOSURE

The author has no conflicts of interest to declare.

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Personalized Dental Caries Management for Frail Older Adults and Persons with Special Needs

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KEYWORDS

• Aged • Frail elderly • Developmental disabilities • Mental health • Dental caries
• Root caries • Oral health • Oral hygiene

KEY POINTS

- Frail older adults and persons with special needs include a diverse group of people with one or more disabilities that make them susceptible to rapid oral health deterioration (ROHD).
- The ROHD assessment helps practitioners determine the risk of oral health deterioration and identify how to deliver a personalized approach to dental care.
- ROHD risk factors are classified into three main categories: general health, social support, and oral conditions.
- ROHD risk levels are classified into four levels.

INTRODUCTION

The world's population is aging, and this trend is not only pronounced but also historically unprecedented.[1,2] In the next four decades, the world's older adults (customarily, older adults are persons older than age 65[a]) will increase from 800 million to 2

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[a] However, aging has been defined as a biologic process and therefore older adults could be any person 21 years or older who may be biologically old.

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billion people.[3] In general, the current cohort of older adults has been reported as healthier than previous ones. However, this progress has been unequal,[1,3] and older adults still have more extensive health problems that require more intense health care for longer periods of time than younger people. As a consequence, the number of people living with disabilities increases with age.[4] This poses an important challenge to health care systems around the globe.[1,3]

In conjunction with population aging, there is also an increasing number of younger adults living with disabilities, which occurred because of a reduced mortality rate among disabled children and adolescents. In the United States, 10.5% of people aged 18 to 64 had some type of disability in the year 2015.[4] The overall prevalence of people living with disabilities in the United States in 2015 was 12.6%, ranging from 9.9% in Utah to 19.4% in West Virginia.[4]

Oral diseases are still highly prevalent in the global and US aging population.[5] Because of population growth and aging, the cumulative burden of oral diseases has increased. Untreated caries in permanent teeth was the most prevalent chronic condition reported in 2015, affecting 2.5 billion people worldwide.[5] In industrialized countries, oral health has improved for older adults in the last few decades, resulting in lower prevalence rates of caries, periodontal disease, and edentulism when compared with previous cohorts.[6,7] However, the oral disease burden among older adults is still high,[6] and caries has been shown to be an active disease among this population[8] and even more so among frail older adults.[8,9] It is explained in part by the fact that more older adults retain their teeth into old age, and gingival recession exposes more tooth surfaces to the risk of root caries.[6,8,10] Thus, caries management among older adults should target preventing and controlling coronal and root caries, which has proved to be challenging.[10]

Adults living with disabilities are exposed to different risk factors that negatively impact their oral hygiene routines, and their ability to access dental care, and consequently increases their risk of caries. These risk factors include but are not limited to cognitive impairment,[11] dependence on caregivers,[12] polypharmacy,[13] poor manual dexterity,[14] financial constraints,[7] and xerostomia.[13,15] The influence of these risk factors makes controlling dental caries among this population even more challenging.

It is important to prevent the development of caries among frail older adults and persons with special needs to avoid infection, pain, and tooth loss. These consequences of caries have been shown to impact systemic health and quality of life.[16–19] To be successful in assessing and managing caries risk among these populations, one should consider all the patient modifying factors in a systematic way. In this article, the authors discuss how to provide a program of personalized and effective dental caries management for frail older adults and persons with special needs.

RAPID ORAL HEALTH DETERIORATION

Frail older adults and persons with special needs are composed of a wide diversity of people with different health problems, which require different types and intensities of care. In an initial attempt to help clinicians to determine the level of care necessary for different older adults, the aging population was classified into three groups: (1) functionally independent older adults, who can access oral health care on their own (70% of people older than age 65)[20]; (2) frail older adults, who can access oral health care with help from others (20% of people older than age 65)[20]; and (3) functionally dependent older adults, who benefit most if oral health care is provided in their place of residency (5% are homebound and 5% are nursing home residents).[20] This classification[b] proved to be important because each category requires a different philosophic

approach to care, depending on the patient's modifying factors, which may range from the most sophisticated and technical treatment available to no treatment at all. More recently, Chi and Ettinger[21] presented a more extensive approach encompassing six distinct life periods, from early childhood to older adulthood, when discussing oral health–related issues with regard to caries prevention for people with special needs. A unifying approach that considers all risk factors for the entire population of frail older adults and persons with special needs is still lacking.

Recently, a systematic approach to teach dental students how to assess the risk of rapid oral health deterioration (ROHD) was introduced.[22] This approach used education theory to develop a learning guide aimed at reproducing the expert's thought process when assessing frail older adults or persons with special needs, and is also used by more experienced dental practitioners. The strategy depends on evidence-based risk factors collected from the dental literature that have been shown to increase the risk of ROHD. It also includes a learning guide to help the practitioner to evaluate the risk, present customized treatment alternatives, and communicate plans to patients and/or their caregivers.[22] The most common evidence-based ROHD risk factors among frail older adults and persons with special needs are described next.

RAPID ORAL HEALTH DETERIORATION RISK FACTORS

Evidence-based risk factors for ROHD is classified into three categories: (1) general health, (2) social support, and (3) oral conditions. These risk factors are also referred to as modifying factors (**Box 1**), and influence treatment decisions either independently or are multifactorial.

General Health

The ROHD risk factors in this category are usually collected by oral health providers through health history forms, medication lists, and the initial interview with the patient. For example, there are multiple diseases that reduce patients' ability to maintain a proper oral hygiene routine, and thus increase patients' likelihood of experiencing ROHD, such as congenital (ie, cerebral palsy) and acquired physical (ie, rheumatoid arthritis) deficits.

Patients' ability to keep adequate oral hygiene routines are limited by cognitive deficits,[23,24] because patients may not be able to remember to perform oral hygiene, do not know how to do it, or are not able to appreciate the importance of having good oral hygiene. Developmental disabilities, such as Down syndrome[25] and autism spectrum disorders,[26] can cause cognitive deficits. Later in life, such diseases as Alzheimer disease and other dementias[27] can also cause cognitive deficits. Additionally, cognitive deficits can prevent patients from communicating oral pain or discomfort, providing informed consent, adapting to dentures, and adhering to treatment and maintenance plans.[28]

Keeping good oral hygiene routines can also be more difficult for patients with functional deficits,[14] such as patients who have had a cerebrovascular accident,[14] patients who are quadriplegic,[29] have cerebral palsy,[29] and advanced Parkinson disease,[30] and also patients with severe osteoarthritis or rheumatoid arthritis.[14] Although some of these conditions may also have a cognitive component, manual dexterity is compromised even if there is no cognitive deficit, reducing the patients' capacity to perform appropriate oral hygiene by themselves (**Figs. 1** and **2**).

[b] This classification is based on national US disability data, but is similar in many industrialized Western countries.[4]

Box 1
Rapid oral health deterioration risk factors

Risk Factors/Modifying factors
1. General health conditions
   - Cognitive deficits: Alzheimer disease and other dementias
   - Functional deficits: stroke, osteoarthritis, Parkinson disease, and so forth
   - Sensory losses: speech, sight, hearing, and taste
   - Medications: oral and systemic side effects, drug interactions
   - Manageable chronic diseases: hypertension, diabetes, osteoporosis, and so forth
   - Degree of dependence/autonomy: institutionalization, home care, dependence on caregivers, and so forth
   - Terminal diseases/palliative care
   - Life expectancy
2. Social support
   - Institutional support
   - Family/social support
   - Financial issues: private insurance, Medicare, Medicaid, social security, and so forth
   - Transportation
   - Access to care
   - Education and oral health literacy
   - Informed consent
   - Expectations
3. Oral conditions
   - Oral hygiene: independency or dependency
   - Periodontal condition
   - Caries
   - Number of teeth/restorations, number of chewing pairs
   - Prosthetic status: fixed, removable, implants
   - Oral lesions: inflammation, oral cancer
   - Stop seeing the dentist

Some conditions/diseases predispose patients to more aggressive oral disease. Immunocompromising conditions,[31] such as AIDS, patient taking immune-suppressant drugs, or anticancer chemotherapeutic agents, and uncontrolled diabetes[32] are examples of conditions that predispose patients to more aggressive oral disease, thus increasing patients' risk of ROHD. Polypharmacy used to control different diseases and/or its symptoms can also lead to reduced salivary flow, which

Fig. 1. Hands of a patient (67 years old) with rheumatoid arthritis showing the effects of the disease, which limits her manual dexterity.

Fig. 2. ROHD caused by patient's inability to brush her teeth because of her rheumatoid arthritis.

is another condition that has been frequently linked to more aggressive oral disease among frail older adults and persons with special needs.[13,33,34]

Sensory impairments (mainly sight, hearing, taste, and proprioception) can also reduce patients' ability to perform appropriate oral hygiene. If patients cannot see, plaque removal may be incomplete, or if patients do not hear well they may not adhere to treatment maintenance plans because they do not fully understand what has been discussed. Taste and proprioceptive changes can impact patients' ability to adapt to dentures. Patients with autism spectrum disorders often present with sensory challenges that can benefit from appropriate sensory adaptations when providing dental care.[35]

Mental health conditions have also been shown to impair patients' capacity of maintaining appropriate oral hygiene, providing informed consent, and adhering to treatment and maintenance plans. Some of the important factors that might impact oral health care for patients with serious mental health conditions are the type and severity of the illness; mood, motivation, and self-esteem; lack of oral health perception; lack of self-discipline to maintain daily oral hygiene; and side effect of medications.[36] Destructive habits, such as smoking, poor diet, and substance abuse, are also common issues associated with people with mental disabilities.[37] Although poor oral health findings are common among people with mental health problems and many barriers for appropriate oral health care have been identified, no current investigation has identified enablers to improve oral health care.[37]

Among the different mental health diseases, depression is of special interest because it is particularly prevalent among older adults and can increase the risk for ROHD not only by discontinuing daily oral hygiene, but also because of the strong xerostomic effect of the use of antidepressants.[38] Another group of mental health conditions associated with increased risk of ROHD are the eating disorders, which can cause dental erosion. Dental erosion is also often seen associated with gastroesophageal reflux disease, which is prevalent among individuals with developmental disabilities.[39]

Providers should be aware that multiple general health-related risk factors are often found in frail older adults and patients with special needs, for instance survivors of a cerebrovascular accident may have concomitant cognitive and functional deficits. Also, depression is common in early dementia and these cognitive impairments may be by aggravated polypharmacy-induced xerostomia.

Social Support

Social support–related risk factors for ROHD are most commonly overlooked by oral health practitioners. Nevertheless, ROHD risk factors related to the patients' social support may play an important role in facilitating or making it more difficult for patients to access appropriate oral health care, maintain daily oral hygiene, and adhere to a proposed treatment plan.

Lack of income has been reported as an important barrier for health care use.[7,37] The families of frail older adults and patients with special needs have a higher economic burden as compared with families without members with special care needs,[7] therefore discretionary finances may not be available to access health care. In addition to treatment cost, paying for transportation and parking is an added barrier. In addition, lack of dental insurance has also been cited as another important barrier to care.[7,40]

Another social support–related risk factor is patients' dependency on caregivers, which is considered the major barrier for receiving appropriate daily oral hygiene and accessing oral health care.[12] Caregivers are anyone from a family member to a nursing aid, who provides care at the patient's home or in a long-term care facility. The level of care provided varies depending on the severity of the disability and the willingness of the patient to cooperate. Many factors have been reported to influence the provision of this care, including the caregivers' level of training[41] and their oral health literacy.[42,43] Institutionalization is another important risk factor for ROHD, because most of the long-term care facilities lack appropriate oral hygiene routines[9,44] and have been resistant to many different strategies suggested to improve the provision of oral care.[9,45]

Community-level factors that should be considered as risk factors of ROHD include access to community water fluoridation, healthy foods (including buying, preparing, and eating), and access to dental providers with appropriate training.[21]

Other important risk factors related to social support are the stigma and prejudice against frail older adults and persons with special needs. Stigma related to people with mental conditions has been reported as a significant barrier for accessing adequate care.[37] Ageism (defined as "the stereotyping, prejudice and discrimination toward people based on age")[46] has also been described by the World Health Organization as one of the most important barriers for providing age-appropriate care for the growing number of older adults.[47] Ageism has been shown to be pervasive among health professions,[48] and dentistry is no exception.[49,50]

The lack of interprofessional collaborative practice among health care providers has been cited[37] as a barrier for receiving appropriate care for frail older adults and persons with special needs. For these patients, it is important to assess how they function in their environment and how dentistry fits into their lifestyle and overall treatment/management goals. To make these assessments requires interprofessional collaboration, which is necessary to integrate several different disciplines to achieve good outcomes. Because these patients often have a multitude of health conditions, each requiring unique therapies and different providers, communication between providers is necessary to understand the patient's needs and prevent overtreatment or undertreatment.

Oral Conditions

Some oral health conditions encountered among frail older adults and persons with special needs can also increase their risk for ROHD. Xerostomia is a common oral health condition that predisposes patients to oral health decline, and is usually caused

by polypharmacy.[13,33,34,51] Other causes for xerostomia include systemic diseases (eg, diabetes), psychoaffective disorders, head and neck radiation, and autoimmune diseases (eg, Sjögren syndrome).[51]

It is important to realize the difference between xerostomia, which is the subjective symptom of having a dry mouth reported by the patient, and salivary gland hypofunction, which is the reduced salivary flow that is measured by quantifying the amount of saliva produced in a given time.[34] It is advisable to measure xerostomia and salivary gland hypofunction in a patient where xerostomia is contributing to ROHD. Thus, a question about dry mouth sensation in the patient health history can help determine the need for assessing salivary flow output.[34]

Xerostomia prevalence among older adults ranges from 12% to 39%, with a weighted average of 21%, which shows xerostomia is a common condition in this population. The prevalence of xerostomia among younger adults is estimated to be about half of that compared with older adults. Xerostomia impacts patient speech, taste, swallowing, eating, and wearing dentures. Additionally, xerostomia can also contribute to halitosis, burning mouth sensation, and increases the caries risk.[34]

In addition to xerostomia, other oral conditions can also lead to an increased caries risk. Among older adults, the cumulative nature of gingival recession and consequent root surface exposure in later life is a major risk factor for root surface caries. Other risk factors include poor plaque control and previous experience with coronal and root caries.[15,52] Wearing partial dentures[53] and having a heavily restored dentition[10] are also risk factors for ROHD. Among younger adults with special needs, enamel defects, which is associated with some developmental disabilities,[54] have also been linked to increased caries risk and further ROHD.[55] Another local risk factor is the use of liquid medications with high sugar content for patients who are unable to swallow tablets.[56]

RAPID ORAL HEALTH DETERIORATION RISK ASSESSMENT

The ROHD risk assessment was designed on the premise that patients with disabilities can have a combination of risk factors, which can lead to a rapid decline in oral health. Because of the complexity of their health conditions, older adults and patients with special needs who have a high caries prevalence may not improve their oral health by simply instructing the patients to brush their teeth. It is only with a complete understanding of all the risk factors affecting a patient that caries risk can be improved, treatment can be effectively provided, and prevention can be improved. The assessment of the ROHD risk and selection of appropriate course of treatment to deter or manage the risk can be done in a systematic way.[22]

The first step is gathering information concerning ROHD risk factors. At this point, the oral health provider should be able to assess the completeness of the data gathered from the patient/caregiver interview, health history form, medication list, intraoral examination and radiographic evidence, and from the caries risk assessment. If any important information regarding one of the three categories of risk factors (ie, general health, social support, and oral conditions) is missing, it should be supplemented at this time.

The second step prioritizes the already gathered information. From all the general health conditions, social support factors, and oral health conditions presented by the patient, the clinician needs to decide which ones are more likely to contribute to ROHD progression and help determine the treatment plan. For example, if an adult patient with Down syndrome presents with controlled type II diabetes mellitus and is able to carry out his/her own daily oral hygiene at a reasonable level, it is less likely that diabetes will influence oral disease progression and modify the treatment plan. But if the

same patient presents with signs of early dementia, this information is likely to increase the patient's risk for ROHD and also influence the treatment plan to increase preventive measures and recruit future caregivers to help with oral hygiene, because self-care is expected to decline as the dementia progresses.

The third step categorizes the patient's current ROHD stage to predict the future oral health of the patient if no dental treatment is provided, or whether an alternative treatment approach may be needed. This step helps the provider to understand and manage the patient's disease as a continuum, and therefore there is a need to explain to the patient and the caregiver the importance of the dental treatment plan. As a guide for the oral health provider, ROHD is classified into four categories depending on the severity of the risk factors and the disease progression:

1. Risk factors are not present, therefore no ROHD is occurring
2. Risk factors are present, however, ROHD is not currently occurring
3. Risk factors are present, and ROHD is currently occurring
4. Risk factors are present, and ROHD has already occurred

This ROHD classification helps determine the preventive and restorative approaches needed in the treatment plan. However, there are often no clear demarcations between the stages, and patients may be transitioning from one stage to another. Therefore, thinking about risk factors as they relate to disease progression and how they impact treatment planning for a given patient is the emphasis of this step.

The fourth step identifies the treatment alternatives, recommending a specific intervention with a rationale, and then developing a communication plan for the patient, caregivers, and other members of the health care team. These topics are discussed in further detail in the next section of this article. **Box 2** summarizes treatment planning using the ROHD assessment.

RAPID ORAL HEALTH DETERIORATION MANAGEMENT STRATEGIES FOR CARIES PREVENTION AMONG FRAIL OLDER ADULTS AND PERSONS WITH SPECIAL NEEDS

Caries Prevention Strategies

Caries prevention is included in all four levels of ROHD. Caries prevention strategy should be in place for patients not experiencing ROHD, so they do not experience ROHD in their lifetime. For those experiencing ROHD, prevention should also be included to avoid further progression of ROHD. For patients for whom ROHD has

Box 2
Treatment planning using the ROHD assessment

Step 1. Gathering information concerning ROHD risk factors

Step 2. Prioritizing the information (What matters most?)

Step 3. Categorizes risk for ROHD
ROHD risk categories
1. Risk factors are not present, therefore no ROHD is occurring
2. Risk factors are present, however, ROHD is not currently occurring
3. Risk factors are present, and ROHD is currently occurring
4. Risk factors are present, and ROHD has already occurred

What will happen if I do nothing?

Step 4. Identify possible treatment alternatives

already happened but some teeth can still be used as abutments, caries prevention is crucial for maintaining these abutment teeth. For edentulous patients, caries prevention does not apply, but it is important to remember that oral hygiene is still needed to prevent local inflammation and infection. Therefore, the most important caries prevention strategies that relate to common risk factors in this population are described in the following paragraphs.

Impact of dry mouth and its management

Dry mouth can have a severe impact on caries risk, because the salivary protective system (including salivary buffers, antimicrobial activity, and calcium and phosphate replenishment) is reduced.[51] When treating patients presenting with dry mouth, the oral health provider should keep in mind the following aspects of dry mouth management: (1) hydration (dehydrated patients produce less saliva), (2) symptoms relief (relief of the discomfort caused by the lack of moisture and lubrication), (3) managing problems with dentures (saliva is important to retain and comfortably wear dentures), (4) monitoring the use of medication (medication reconciliation[c] may reduce the xerostomic effect of some drugs), and (5) preventing soft tissue damage and dental caries (**Figs. 3–5**).[34]

A broader approach should include maintaining appropriate hydration, using saliva stimulants or saliva substitutes (liquids or gel), and revaluating the patient's medications to reduce the xerostomic effect of their prescribed medications. These steps can help reduce the patients' oral discomfort caused by dry mouth and improve the quality of their lives.

Dehydration is prevalent among frail older adults and persons with special needs but there is a lack of awareness about this condition among patients and caregivers.[57] Unfortunately, patients when educated to sip liquids throughout the day may opt to use sugar-rich beverages or soda, increasing their caries risk. Therefore, it is important to educate patients and caregivers about the importance of drinking water, which has multiple benefits, such as keeping an adequate fluid intake, reducing the dry mouth sensation, and avoiding increased caries risk.[57]

Fig. 3. Patient (69 years old) presenting with dry mouth because of polypharmacy.

[c] "Medication reconciliation is the process of creating the most accurate list possible of all medications a patient is taking—including drug name, dosage, frequency, and route—and comparing that list against the physician's admission, transfer, and/or discharge orders, with the goal of providing correct medications to the patient" (http://www.ihi.org/Topics/ADEsMedicationReconciliation/Pages/default.aspx).

Fig. 4. Multiple carious lesions associated with dry mouth in the patient shown in Fig. 3.

For patients with residual secretory capacity, the use of saliva stimulants, such as chewing xylitol gums or using lozenges, and parasympathetic drugs can help improve salivary flow (eg, pilocarpine, bethanechol, and anethole trithione).[51] Saliva substitutes are usually presented as a gel, oral rinses, or sprays, and can help reduce dry mouth sensation and associated oral discomfort.[58] Oral discomfort can also be reduced by having a less spicy and less acidic diet, and using oral hygiene products, such as toothpastes and oral rinses specific for patients with dry mouth that have less flavoring agents (eg, peppermint and menthol) and are sodium lauryl sulfate–free.[59]

Frail older adults and persons with special needs are often taking multiple medications,[9,33] and most of the time xerostomia among this population is caused by polypharmacy.[51] Reconciling medication lists can help improve patients' health outcomes, reducing adverse drug reactions and reducing costs.[60] In an interprofessional collaborative practice where the dentist can present the effects of xerostomia on patients' quality of life, the xerostomic effects of drugs can also be considered when reconciling a patient medication list, potentially helping to reduce dry mouth.

Besides the broader aspects of dry mouth management, there are also some other strategies that are specifically designed to reduce caries risk among patients presenting with dry mouth. These strategies should be customized for each patient, depending on the patient's risk factors, and their ability to follow the prescribed therapies.

Fig. 5. Traumatic ulceration of the right border of the tongue related to lack of lubrication caused by dry mouth in the patient shown in Fig. 3.

Some of the tools that are deployed to help reduce caries risk for patients with xerostomia include remineralizing products, fluoride, and antibacterial products.

A remineralizing product often found beneficial for patients with xerostomia is Recaldent (casein-phosphopeptide–stabilized amorphous calcium phosphate nanocomplexes), which is the active ingredient of the MI Paste (GC America, Alsip, IL). MI Paste supplies calcium and phosphate to saliva, thus helping remineralization. It is easily applied to the tooth surface using fingertips after brushing. When applied at night, it also provides some moisturizing capacity because of casein. Although MI Paste does not contain fluoride, it has been added to MI Paste Plus (GC America).[61]

Fluoride exposure occurs from many sources, such as fluoridated water; self-applied sources, such as over-the-counter toothpastes, prescription/high-concentration (5000 ppm) toothpastes, and fluoridated rinses; and professionally applied sources, such as silver diamine fluoride (SDF), fluoride varnishes, and fluoride gel.[62] Patients with xerostomia can benefit from a higher fluoride exposure to reduce their caries risk. However, many toothpastes contain a detergent, sodium lauryl sulfate. This detergent can cause a burning sensation for those patients who have xerostomia. Therefore, over-the-counter fluoride toothpastes and prescription toothpastes without sodium lauryl sulfate should be recommended. A recommended approach that has been used in patients with xerostomia is a combination of prescribing 5000 ppm toothpaste to be used twice a day and have the patient returning for regular recalls every 3 months for fluoride varnish application.[51] It is critical to instruct patients and caregivers not to rinse after brushing with 5000 ppm toothpaste, but simply to spit. (See Margherita Fontana's article, "Non-restorative Management of Cavitated and Non-cavitated Caries Lesions," in this issue.)

Oral physiotherapy (aids for tooth brushing and flossing)

Daily mechanical removal of plaque is important for controlling bacterial load and reducing dental plaque. People who brush their teeth infrequently have higher incidence and increments of carious lesions.[63] However, many frail older adults and persons with special needs are not able to independently brush their teeth. Some patients are not able to brush because of cognitive deficits, and these patients need to be reminded to brush, or to be supervised while brushing; and some need a caregiver to brush for them. Another group of patients may be cognitively intact, but do not have the manual dexterity to brush by themselves. Depending on the severity of the patient disability, some patients in this group may benefit from larger toothbrush handles and/or electric toothbrushes, whereas other patients need help from a caregiver.

A larger toothbrush handle can allow patients with impaired manual dexterity to brush their own teeth, and several techniques have been described to fabricate customized toothbrush handles.[64] Toothbrush handles can also be improvised from bicycle handles, perforated rubber balls or a piece of swimming noodle. Power toothbrushes have larger handles in addition of being more effective for plaque removal,[65] particularly for frail older adults and persons with special needs.[66,67]

For caregivers who provide daily oral hygiene, the most appropriate tool will vary depending on patients' systemic conditions, cooperation and preferences. Regular toothbrushes with bent heads may help to hold the cheeks and lips apart, and provide better access. Some patients will benefit from caregivers using mouth props to help keep the patients' mouths open. Many patients can benefit from having a caretaker use a power toothbrush, although some patients with cognitive deficits are afraid/annoyed because of the vibration and/or the sounds.

Fluoride

(See Margherita Fontana's article, "Non-restorative Management of Cavitated and Non-cavitated Caries Lesions," in this issue.)

For patients with higher risk of developing caries, increasing their exposure to fluoride can help arrest caries progression and prevent new lesions. For these adult patients, a regimen of using 5000 ppm fluoride toothpaste twice a day and applying fluoride varnish every 3 to 6 months has been recommended.[68] Another protocol is daily use of 0.09% fluoride rinse followed by professional application of 1.23% fluoride gel every 3 to 6 months. However, the rinses are not as easy to use among frail older adults and persons with special needs because the rinse can be swallowed by patients with cognitive deficits and it is difficult for patients with physical deficits to swish and spit a rinse. Furthermore, the gel needs to stay into patients' mouth for 4 minutes, which is difficult for this population.

Another topical fluoride product is SDF, which has been used for a long time in many countries to arrest and prevent caries. This product has been available in the US market since 2014. The proportions of active ingredients in the SDF aqueous solution in the United States are 24% to 27% silver, 7.5% to 11.0% ammonia, and 5% to 6% fluoride.[69] Silver ions have an antibacterial effect, causing destruction of the cell wall, denaturizing cytoplasmic enzymes, and inhibiting DNA replication. Fluoride and ammonia have been linked to improved remineralization and formation of fluorapatite.[70]

For SDF application, targeted teeth should be isolated with cotton-rolls, dried with a triple syringe (or cotton pellet), then SDF is applied to the desired area using a microbrush for about a minute if possible, and the excess should be removed using cotton pellet.[71] Therefore, SDF application is technically easy, inexpensive, and has been proved to be safe[71] and effective for caries prevention and arresting caries among frail older adults[72,73] and persons with special needs.[74] One of the contraindications to use SDF is silver allergy, and the most negative side effect is darkening of the carious lesion, which may be important for some patients, mainly when involving anterior teeth.

Dietary changes for preventing caries

Meeting the diet and nutritional needs of frail older adults and persons with special needs is crucial for the maintenance of health, functional independence and quality of life. Persons with poor general health may experience difficulties in meeting their nutritional needs.[75] The existence of dental caries is strongly related to the consumption of sugar, and so by controlling the amount of sugar intake one can help reduce caries rates.[76] Also, oral health problems have been related to an inadequate diet among older adults,[77] and by improving diet quality it has been shown that root caries risk is reduced among older adults.[78] For instance, increasing vegetables and total grains intake has been shown to reduce root caries increments, whereas increasing consumption of sugar-sweetened carbonated beverages increases root caries increments.[78] Therefore, diet is an important factor to control caries risk among frail older adults and persons with special needs. Oral health care providers should educate patients and caregivers about the importance of having an adequate diet and reducing sugar consumption. However, just providing knowledge may not be sufficient to achieve behavior changes, because frail older adults and persons with special needs may lack the ability to apply the acquired knowledge to change their habits. In these circumstances, working with other members of the health care team may be necessary to induce behavior change. (See Teresa A. Marshall's article, "Dietary Implications for Dental Caries: a Practical Approach on Dietary Counseling," in this issue.)

Other preventive approaches

Replacing sugar with xylitol reduces caries risk by decreasing the amount of acid produced by acidogenic bacteria[51]; however, there is no strong evidence that xylitol-containing products can prevent caries.[79] Chlorhexidine in different formats has not been shown to be effective in caries prevention,[80,81] thus its use as the only method for caries control is not warranted.[51]

CARIES RESTORATIVE TREATMENT

(See Leo Tjäderhane and Arzu Tezvergil-Mutluay's article, "Performance of Adhesives and Restorative Materials after Selective Removal of Carious Lesions: Restorative Materials with Anti-Caries Properties," in this issue.)

Incomplete Caries Removal

International consensus has accepted the concepts of minimally invasive dental procedures, and it is considered the best practice to manage and control caries and to preserve hard tissues and keep the natural dentition.[82] This means that restoring a caries lesion should be done when it is not possible or desirable to arrest the existing lesion, and the focus should be on using all the preventive methods cited to control the disease and avoid further progression of existing lesions and/or the emergence of new lesions.

When a restorative approach is inevitable, the dentist's priorities should be to preserve healthy tooth structure, to remineralize natural tooth structure, and to obtain clear margins for a good restorative seal. This philosophy should stress the pulp as little as possible, and maximize the success of the restoration, and the survival of the tooth. Within this concept, infected or demineralized tissue does not need to be completely removed, whereas carious tissues are removed only to the extent needed to allow for a good seal of the restoration. In shallower lesions, distant from the pulp, selective removal to firm dentine should be carried out; whereas in deeper lesions, close to the pulp, selective removal to soft dentine has been shown to be successful.[82]

A range of different materials is used to restore teeth. Amalgam has been successfully used for a long period of time with some antibacterial properties against cariogenic bacteria.[82] However, resistance has emerged because of esthetic and environmental issues, and the use of composite resins has increased. Although composites in general have a similar longevity to amalgam,[83] composites are more susceptible to secondary caries in high-risk patients.[82]

When using composites, the dentist should keep in mind that bond strength is proportional to the area of the bonded surface to sound hard tissues, and therefore carious tissue that was left to protect the pulp from exposure should not be located at the margins of the preparation, which need to be on healthy tissue to allow for appropriate sealing.[82]

Glass ionomer cements (GIC) have been used as a third alternative for direct restorations. GICs were initially considered as a temporary material, but the most recent high-viscosity GICs have resulted in better longevity, comparable with composites or amalgams.[82] Glass ionomers are more biocompatible, release fluoride, adhere to dentine and enamel, and are becoming less technique sensitive. They are now commonly used as liners for deep restorations, and where moisture control is a problem. Resin-modified GIC has proved to be superior for use in cervical lesions.[84] GIC can also be used in combination with composite for open and closed sandwich techniques.[85] Because of its versatility, GICs are often used for frail older adults and

persons with special needs, where the conditions for placing restorations are technically difficult. For example, GICs are a good alternative for restoring root caries, which often spreads below the gingival margin (**Figs. 6** and **7**).[85]

In a recent assessment of the longevity of 9184 dental restorations after 15 years, placed in a clinic dedicated to caring for frail older adults and persons with special needs, the following was found. Failing restorations numbered 28.7%, and the overall restoration life span was 6.2 years. Multivariable regression models showed that the greater the number of restorative surfaces the shorter the life span, and that restorations placed earlier in a patient's life lasted longer than subsequent restorations.[86]

Atraumatic Restorative Treatment

Atraumatic restorative treatment (ART) usually consists of manual soft caries excavation followed by high-viscosity GIC restorations under cotton-roll isolation. Because of its simplicity, ART reduces patient anxiety and discomfort during dental treatment. Therefore, ART has been successfully used among frail older adults and persons with special needs, and survival rates of teeth restored by ART are similar to conventional restorative techniques.[87] ART is particularly useful when providing care outside the dental office for frail older adults and persons with special needs or to patients with limited cooperation in the dental chair. It also has been shown to be cost-effective[88] and well-accepted by patients.[89]

Behavior Management

Many frail older adults and persons with special needs, especially those with mental health issues and/or cognitive deficits, can have a difficult time sitting in a dental chair, or having their teeth cleaned at home. Combative and aggressive patients can pose a risk to themselves, their caregivers, and their health care providers. Multiple types of challenging behavior can happen, such as refusing oral care, inability to understand what is happening, inability to follow directions, and physical aggressions (kicks, hits, bites).

Basic communication techniques should always be used by the provider, and they include being patient, respectful, and gentle; using patient's name; smiling, keeping eye contact, and moving slowly; introducing yourself; using plain language and short sentences; explaining what is going to be done and why; repeating instructions if

Fig. 6. Preparation for restoring root caries, which has spread below the gingival margin, resulting in difficulties with moisture control. A cord was placed to allow access for subgingival restoration.

Fig. 7. Final restoration of the root caries shown in Fig. 6, with a high-viscosity glass ionomer.

necessary with neutral tone; and breaking down the instructions into single commands. It is important to always be polite, provide encouragement, and give positive feedback. If not successful, try a different time, because patients may react differently at different times of the day.[90]

More advanced techniques are presented in a mobile app (GeriaDental) that is downloaded for free, and can also be used by family and professional caregivers. The app is easily found in app stores for Apple and Android devices.

COMMUNICATION PLAN FOR THE PATIENT AND/OR CAREGIVER

Frail older adults and patients with special needs often present with a variety of comorbidities and functional impairments. Evaluating the needs of these patients requires thoughtful assessments from multidisciplinary health professionals. Therefore, providing the patient, caregivers, and occasionally other health care team members with a summary of the oral health findings, the proposed treatment plan with a rationale, and the strategies for the oral hygiene care required for maintaining patients oral health is of paramount importance for the long-term success of the therapy.[22]

The challenge of having multiple persons involved, who have different expectations and different perspectives, requires the oral health care provider to communicate effectively with all persons involved. The dentist needs to keep in mind how the perspectives of each individual may differ, and needs to determine who is responsible for the primary health care of the patient. The dentist needs to identify the various members of the health care team, understand their roles, and be part of the overall treatment goals. Therefore, information from all health care providers should be gathered during the initial interviews with patient and other members of the health care team. A multidisciplinary conference to assess the patient's needs would be ideal, but unfortunately rarely happens, except in certain institutions that are devoted to person-centered care.

Of particular importance is the communication with the patient's guardians/caretakers. If a patient is not able to provide informed consent, or even if he/she is capable but has an established guardian, the oral health care provider should also keep in mind that some patients may have a power-of-attorney for health and a different one for finances. Both parties must be consulted and their approval obtained before dental treatment. More about informed consent is found in the work by Kristen Flick and

Leonardo Marchini's article, "The Interprofessional Role in Dental Caries Management: From the Social Worker Perspective", in this issue, which is presented from a social worker's perspective.

SUMMARY

Frail older adults and people with special needs include a diverse group of people with different disabilities that make this group more susceptible to ROHD. Caries is a leading cause of ROHD. Therefore, it is important to consider the patient as a whole, and avoid a narrower, tooth-focused perspective.

To have a patient-centered perspective, it is necessary to consider each patient's personal characteristics. These include the patient's risk factors related to their general health, their social support, and their oral health. Gathering and analyzing these risk factors will help oral health providers to assess patients' risk for ROHD. Assessing the risk of ROHD helps determine how much preventive versus restorative treatment will be necessary, thereby helping providers think about the risk factors as they relate to disease progression and treatment planning. Some of the most important preventive caries management strategies for frail older adults and people with special needs include management of dry mouth problems, improvement of daily oral hygiene, use of different fluoride products, and dietary changes. Caries restorative treatment strategies commonly used among this group include incomplete caries removal, ART, and different techniques to help manage behavioral challenges.

Having a better understanding of the patient as a whole also can improve the oral health provider's ability to meaningfully communicate treatment and maintenance plans to the patient, his/her caregivers, and other members of the health care team. This is a necessary step, because patient adherence to appropriate maintenance is important for the long-term success of oral health treatment among frail older adults and people with special needs.

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Consideration in Planning Dental Treatment of Older Adults

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KEYWORDS

• Aged • Frail elderly • Mental health • Root caries • Oral health • Oral hygiene

KEY POINTS

- Frail and functionally dependent older adults include a diverse group of people with multiple disabilities, which are influenced further by their life experiences that complicate decisions related to clinical dental care.
- Furthermore, because they grew up prior to water fluoridation, most of them have maintained some of their teeth, but this puts them at higher risk for coronal and root caries, which complicates restorative care.
- The decision-making process, which has evolved, essentially has developed into a treatment planning philosophy that takes into account the best interests of the patient after evaluating all the modifying factors.

INTRODUCTION

In 2020, the total US population was approximately 330 million person and those aged 65 years and older made up nearly 16%, which is approximately 53 million persons.[1] There is greater heterogeneity among people aged 65 years and older than in any other age group.[2] Each older adult has a unique genome and has been influenced by a variety of environmental factors, such as social, cultural, economic, and cohort experiences, that have determined their lifestyle and health beliefs.[3] The oral health of these individuals also is affected by these same factors, so, when planning dental treatment of older adults, dentists must take into account the social aspects, general health, and oral health conditions prior to delivering care.[4]

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In geriatric medicine, it is important to make a diagnosis, and, once a diagnosis is made, there usually is enough scientific evidence to support a treatment plan. In geriatric dental medicine, it also is important to make a diagnosis, but often there are multiple treatment strategies, which often are not evidence based. Also, dentistry is unlike internal medicine and more like surgery, in that dentists need to remove infected tissue and restore shape and function, which require operating equipment.[5]

Therefore, if an older adult can drive or use public transport independently to access a dental office, this removes a significant complication associated with their treatment.[6] These persons have been defined as functionally independent older adults and comprise approximately 70% of persons over the age of 65 years. In general, they live in the community without assistance, but many may have 1 or more chronic medical problems, such as hypertension, type 2 diabetes mellitus, osteoarthritis, and so forth, for which they are taking a variety of medications.[3] To treat these older adults, dentists must take a thorough medical and drug history and understand how these diseases and medications influence patients' oral health conditions and dental treatment. The treatment such patients accept depends on their own and their significant others'/family members' perceptions of need for care as well as the amount of money they are prepared to spend on that care.[5]

A smaller group of older adults (approximately 20%) can be designated as frail older adults, because they have lost some of their independence.[3] They still are living in the community with the help of family and friends and may be using professional support services, such as Meals on Wheels, home health aides, visiting nurses, and so forth.[3] These frail older adults can access dental services only with the help of others if they are provided with transport. To treat this population, the dentist needs a greater knowledge of medicine and pharmacology as well as the skill to evaluate a patient's ability to maintain daily oral hygiene independently. Another important factor is the patient's ability to tolerate the treatment that has been proposed.[5]

The smallest group of older adults (approximately 10%) have been called functionally dependent older adults.[3] These persons are unable to survive in the community independently and either are homebound (5%) or living in a long-term care institution (5%). A minority of these older adults can be transported to a dental office provided it is wheelchair accessible, and a dentist is willing to care for them. The majority need to be cared for at their home or in their institution. To care for them, the dental professionals need either mobile dental equipment or a dental office in the long-term care facility.[5]

TREATMENT PLANNING

Patient Interview

The initial contact between older adults and their dentist begins with telephone contact between the patient/caregiver and the dental office receptionist. Therefore, a receptionist needs to have been sensitized to eliciting important information from potential patients, especially if they are frail or functionally dependent. To treat these patients safely, there is a need to know whether a patient needs help with transportation,[7,8] any specific accommodations for wheelchairs or oxygen tanks, the availability to come for an appointment, the chief complaint,[9] and current health issues,[9] including questions about symptoms of 2019 Coronvirus Disease (COVID-19).[10] The receptionist also ask the should patients/caregivers to bring a list of current medications or the medications themselves[5,9]; a list of their health care providers; and dental radiographs if they exist. The receptionist needs to be empathetic to the age-

associated sensory deficits of the patient, which can result in longer conversations to acquire the desired information and to schedule appointments.[11]

Teledentistry

The COVID-19 pandemic has thrust teledentistry to the forefront of dental practices. Teledentistry may be beneficial particularly for those who are considered at high risk of severe illness or mortality associated with COVID-19 infection, because efforts are being made to minimize Severe Acute Respiratory Syndrome Coronovirus 2 transmission to this vulnerable population. The use of teledentistry, however, will transcend this pandemic as a useful tool for dentists, the public, and especially at-risk populations. This vulnerable population includes but is not limited to persons of any age with multiple comorbidities, those over age 65 years, persons who are immunocompromised, and those residing in nursing homes.[10] A national survey has reported that older adults in the United States are interested in utilizing teledentistry but have expressed some concern with managing the technology needed to access virtual appointments.[12] Teledentistry is particularly useful, however, in evaluating nursing home patients because it allows the dentist and the nursing facility resident to remain in their respective locations while nursing home staff manage the technology needed to complete the visit.[13] Although these residents still may need an in-person dental appointment, the information gathered during these teledentistry visits can reduce the time in the dental office waiting room in order to complete forms and preappointment consent from the resident and/or person with power of attorney and, therefore, expedite treatment that minimizes the at-risk person's exposure time to the public. Teledentistry similarly can be advantageous for older adults living at home, but efforts should be made to select a simple technology that is easily accessible and overcomes any sensory deficits, such as hearing loss, either via synchronous (live video) or asynchronous (forwarding a still photo to the dentist) methods. Instances in which dentists will find teledentistry immediately helpful is when triaging a new or existing older adult patient prior to entering the dental clinic, diagnosing and treatment planning for existing dental patients, and postprocedural management of those patients.[14]

As patients come for the initial appointments, usually they are handed multiple forms about patient registration, finances, and health history. It is assumed that patients are literate, cognitively not impaired, and can understand the information being sought. The National Adult Literacy Survey reported, however, that 59% of the US older adult population had basic or below proficiency in health literacy, which means they would have difficult interpreting health-related printed materials.[15] Patients' age-associated impaired vision and slower cognitive processing of information exacerbate the problem of understanding printed materials, which often can slow the usual pace of a dental office.[15]

Consequently, when interviewing an older adult patient, the dentist should use the completed forms to begin the conversation with the patient/caregiver but extend the interview to include an evaluation of all the potential modifying factors. Good communication with patients and their significant others requires investigative interviewing when assessing patients with complex social and medical/mental conditions, in order to understand the hidden meanings of their complaints.[5] If dentists are not sensitized to understand the true nature of the implications of the chief complaint, they may miss important clues. For instance, a 72-year-old patient from a practice returns because she has lost the crown on her central incisor. Previously, she had returned for routine care regularly every 6 months, but she has been missing her appointments for more than 2 years. On careful questioning, she reported that 2 years ago her husband died unexpectedly, and her children live in distant states. Her health and overall

grooming have deteriorated visibly as has her oral hygiene. It is clear that she is suffering from severe depression associated with sustained grief due to the loss of her husband and her own health and mobility. She urgently needs counseling and mental health care. Merely treating her current dental problems does not address her essential needs. Therefore, focusing only on her current dental problem can lead to continuous oral deterioration or even more life-threatening consequences.

In assessing patient health histories, it is important to interpret the information provided by careful questioning. For example, if a patient reports a has a history of angina pectoris, what does this really mean? Does the patient experience spontaneous chest pain or by walking from the car to the office or by going up a set of stairs, or did the patient have chest pain 6 months ago and no episodes since then? Each of these scenarios requires the dentist to modify the management of the patient, due to the risk of precipitating potential medical problems. Possible modifications might range from using a stress-reducing protocol to postponing elective treatment until patients have been assessed by their physician.

HOW DO DENTISTS MAKE DECISIONS?

When examining how dentists make decisions, it should be that considered a majority of oral diseases are chronic plaque-associated diseases, such as caries and periodontal disease, which cause irreversible damage.[16] Some diseases of the oral mucosa and pulp can be cured, whereas a few, such as oral neoplasms, are life-threatening.[5,16] A majority of oral health needs in older adults are treating the exacerbations of caries and periodontal disease.[5,17,18]

Clinical geriatric dentistry requires problem solving and decision making to develop an appropriate treatment plan. In younger adults, the factors that influence the decision making related to treatment planning are simpler; for instance, Does the patient have the will and the time to accept the care? Does the patient wish to pay for the care? and Does the dentist have the resources and skills to carry out that care? In older adults, the factors may become more complex, and the dentist needs more skills and experience in decision making to develop an age-appropriate treatment plan. This treatment plan should take into account the multiplicity of modifying factors, which include but are not limited to patient's socioeconomic, psychological, and medical problems; side-effects of their medications; and the cumulative effects of dental diseases as well as the iatrogenic effects on the dentition due to previous dental care.[19,20]

The knowledge base to manage the treatment planning process for older adults does not require the development of new technical skills but rather the development of thought processes to understand the patient's modifying factors and how they may influence treatment. The aim of treatment is to understand how patients are functioning in their environment and how their dental needs and treatment fit into their lifestyle. When making these decisions, the benefits of treatment must outweigh the risks of adverse events. The thought processes that are required to develop this treatment protocol were developed by Ettinger and Beck,[21] and have been called, "rational treatment planning."

To make these decisions requires the gathering of information from and about the patient, in order to be able to make a diagnosis and a treatment plan. There have been several systems suggested in the literature on how to gather and process this information.[5] One of the most used systems is a modification of the American Society of Anesthesiologists evaluation scheme to assess patients' ability to tolerate treatment. This system has been used as a reference to modify therapy and patient management and provides guidelines for the dental treatment of medically compromised patients, especially those who need anesthesia.[22] This system was modified by

Kamen[23] into 4 broad categories (Fig. 1). Gordon and Kress[24] identified some of the faults of this system by stating, "when applied to specific situations, the system is somewhat simplistic, in that many patients fall between categories and many choices remain even within one category."

Another such system uses the mnemonic, subjective findings, objective findings, assessment, and plan (SOAP).[25] For older adults, subjective findings must include information on functional status, such as activities of daily living (ADLs) and instrumental activities of daily living (IADLs). Objective findings include an oral examination, radiographs, and other intraoral and laboratory findings. Using these findings leads a dentist to an assessment of the patient's expectations and needs, which evolves into a treatment plan.

Shay[26] has proposed another mnemonic, which he called OSCAR, especially designed for older adults. The O stands for oral factors, the S for systemic factors, the C for capability, the A for autonomy, and the R for reality. The oral factors include the condition of the dentition, restorations, periodontium, coronal and root caries, tooth loss, salivary function, mucosal health, oral hygiene, and the occlusion. Systemic factors should include an assessment of general health, available laboratory findings, the impact of medications, and communication between the dentist and the patient's physicians. Capability addresses the patients ADLs and IADLs as well as issues, such as incontinence. Autonomy relates primarily to a patient's ability to provide informed consent independently and maintain oral hygiene, which might be impaired as a result of stroke, dementia, or other diseases that affect cognitive function. Reality takes into account life expectancy and a patient's ability to access care and pay for the required treatment.

A similar but somewhat different conceptual model was suggested by Berkey and colleagues.[27] They proposed that decision making for older adults requires clinicians to take into account 4 domains, which are function, symptomatology, pathology, and esthetics. Function relates to the ability of the patient to chew and eat an adequate diet. Symptomatology assesses the amount of pain or discomfort when chewing

Fig. 1. Full mouth view of Mrs LL's dentition, showing multiple root caries lesions as well as generalized gingival recession. Plaque levels are limited to the lower one-third of the teeth, with relatively little gingival inflammation.

and having adequate amounts of saliva to speak, to taste and to swallow. Pathology evaluates oral discomfort and the presence of lesions in the mouth. Esthetics focuses on the patients' expectations to improve their appearance or smile. In order to achieve these assessments, the investigators[27] suggested that clinicians need to ask older adults the following questions:

1. What are the patient's desires and expectations with regard to dental treatment?
2. What are the type and severity of dental needs?
3. What is the impact of dental treatment on quality of life?
4. What is the probability of positive outcomes of dental treatment?
5. What are reasonable dental treatment alternatives?
6. What is the ability of the patient to tolerate the stress of dental treatment?
7. What is the capability of the patient to maintain oral health?
8. What are the patient's financial and other resources to pay for dental treatment?
9. What is the dentist's capability of achieving the planned dental treatment?
10. Are there any other issues?

Using the answers to these questions, the dentist then could determine what level of care was achievable for the patient, which could be very extensive care, extensive care, intermediate care, limited care, or very limited care. Very extensive care includes complex rehabilitation, such as fixed prosthodontics and implants. Extensive care may be a combination of fixed and removable prosthodontics. Intermediate care requires a modification of traditional therapies, such as an interim prosthesis. Limited care suggests that patients cannot tolerate extensive treatment time in the dental chair and require short appointments and simplified treatment. Very limited care focuses only on pain relief and infection control.

Various other models have been proposed to aid the clinician in decision making, especially with regard to the medically at risk and frail and functionally dependent older adults[9,28]. Recently, a teaching tool was created to provide a structured process to guide novice students when caring for frail and functionally dependent older adults. This teaching tool helps the students to process the overwhelming amount of information gathered from their patients and helps them to develop a decision-making process that would lead them to rational treatment planning. This concept, which has been called rapid oral health deterioration (ROHD) risk assessment, also may be useful for the practicing dentist.[4]

The concept was developed because more older adults are keeping their teeth into older age, which has complicated dental treatment.[29] There is evidence that as they age the risk of oral disease, which negatively affects their dentition or results in the deterioration of their general health, increases.[18] ROHD has been based on evidence based risk factors, which have been classified into 3 categories: (1) general health conditions, (2) social support, and (3) oral health conditions. Briefly, in the first category, there are multiple diseases, which influence a patient's ability to maintain oral hygiene, which would increase their risk of ROHD. Some of the concepts included in the social support category are lack of income or dental insurance, dependency on caregivers, transportation barriers, being institutionalized or homebound, and being able to access adequate nutrition as well as having had the benefit of lifelong community water fluoridation. The oral condition category encompasses factors, such as dry mouth and xerostomia associated with disease and polypharmacy, lesions of the oral mucosa, level of oral hygiene, number of heavily restored teeth, amount of coronal and root caries, degree of periodontal disease, and presence of fixed and removable prosthesis.[4] **Box 1** presents the detailed steps used for treatment planning based on the concepts of ROHD risk assessment.

RATIONAL TREATMENT PLANNING

After gathering and processing the data from the clinical assessment of the patient, the dentist needs to develop viable treatment alternatives that are compatible with a patient's lifestyle and modifying factors. The rational treatment planning philosophy can guide the development of these treatment alternatives, by using evidence-based data, where available, to make decisions.[21]

Caries is prevalent among frail and functionally dependent older adults who have teeth that have been treated and retreated over the years,[14] which makes restoring this dentition complex. Rational treatment planning evaluates the modifying factors to offer a realistic treatment plan that has the best potential outcome for the patient. For instance, the tooth may need to be extracted, the recurrent caries could be excavated and the existing restoration repaired with a glass ionomer, the whole restoration may need to be replaced, or the tooth may need to be crowned. The decision would depend on the patient's access to care, the systemic health of the patient, the extent of the carious lesion, and patient's ability to tolerate treatment and to maintain oral hygiene as well as ability to pay for care. A principle that could guide the decision is minimally invasive dentistry (MID), which contends that caries is a chronic infectious disease and should be treated using a medical model rather than a mechanistic one. The primary components of MID are assessment of the risk of disease, with a focus on early detection and preservation of dental tissue, external and internal remineralization, and using a range of materials with surgical intervention only when the disease has been controlled.[30,31]

Some of the alternatives to the treatment of caries in frail and functionally dependent older adults, especially those with severe cognitive impairment, that derive from MID is the use of silver diamine fluoride (SDF) only to arrest caries.[32] If the patient is relatively

Box 1
Steps in treatment planning using the rapid oral health deterioration assessment

Step 1. Gathering information concerning ROHD risk factors
a. General health conditions
b. Social support
c. Oral health conditions

Step 2. Prioritizing the information and developing an appropriate communication plan
a. What matter most for disease progression and treatment planning?
b. What will happen if the patient does not receive dental care?
c. An appropriate communication plan includes but is not limited to explaining the findings, the prognosis, the treatment alternatives, and the maintenance plan to the patient and care personnel.

Step 3. Categorizing the risk for ROHD
a. Risk factors are not present; therefore, ROHD is not occurring.
b. Risk factors are present; however, ROHD currently is not occurring.
c. Risk factors are present, and ROHD currently is occurring.
d. Risk factors are present, and ROHD already has occurred.

Step 4. Identifying possible treatment alternatives compatible with rational treatment planning
a. Comprehensive care
b. Limited care (maintenance and monitoring)
c. Emergency care (pain and infection control)
d. No treatment

Step 5. Developing a maintenance plan

uncooperative, then atraumatic restorative technique can be used to hand excavate the caries and restore the tooth with a glass ionomer.[33,34] Less cognitively impaired patients may tolerate the use of more traditional restorative techniques. Topical application of fluoride varnish on a regular basis is recommended for all patients.[35]

Although edentulism has declined, tooth loss still is a major oral health problem, especially among older adults.[29] Evidence-based guidelines to replace a missing tooth are virtually nonexistent.[5] Answering the problem, however, requires evaluating patients' dentition and determining several factors,[5] such as

1. How long has the tooth been missing? If the extractions are recent, then it is important to look at the occluding pairs of teeth, which determines the stability of the occlusion.
2. Is the extracted tooth an antagonist and has it moved? If there is an antagonist and if the extraction is recent, then a replacement may be necessary to preserve the occlusal plane.
3. Is there an esthetic problem? If the missing tooth is in the anterior of the mouth and the patient is severely cognitively impaired, replacement of that tooth with a prosthesis needs to be evaluated carefully. The decision requires a discussion with patients and person with power of attorney in terms of the risk of a prosthesis increasing plaque retention as well as on the preservation of the rest of the dentition.
4. Can the patient chew comfortably and effectively? Are there adequate numbers of occluding pairs of teeth, as suggested by Käyser.[36]
5. Is there any temporomandibular joint pain? If patients report temporomandibular dysfunction pain, they may need posterior support of the occlusion provided by a prosthesis.

When considering replacing posterior missing teeth, it should be kept in mind the concept of the shortened dental arch introduced by the studies of Käyser,[36] who showed that patients had sufficient adaptive capacity to maintain adequate oral function if they had at least 4 posterior occlusal units remaining, preferably in a symmetric position. They have been several studies that have supported the shortened dental arch concept, functionally,[37] financially,[38] and as it relates to quality of life.[39]

The maintenance of remaining teeth in older adults becomes important, especially for older adults with a variety of systemic diseases. Persons with neurodegenerative diseases, such as Parkinson disease, tardive dyskinesia, stroke, and dementia, are unable to adapt to complete dentures, especially on the mandibular arch. Therefore, the maintenance of some mandibular teeth is critical to maintain adequate oral function. Some of these teeth become more valuable than others, and these teeth have been described as key teeth (**Box 2**).

The available options for dental treatment have increased dramatically over time. As the total number of dental journals indexed by *Journal Citation Reports* available on the Institute for Scientific Information Web of Knowledge database has increased from 46 in 2003 to 83 in 2012, in the same time period, the number of publications in dental journals more than doubled, from 4727 to 10,102.[40] This number of publications is equivalent to more than 27 articles per day. These options include new restorative and preventive materials as well as new techniques, such as implants and digital dentistry. Treatment planning, however, still remains as much as art as science.

MRS LL CASE

For example, the authors were contacted by the director of nursing from a local nursing home about a 77-year-old woman (Mrs LL), who was avoiding certain foods.

Box 2
Characteristics of key teeth

A key tooth
1. Is one that can support itself or other teeth
2. Is one, which, if lost dramatically, changes the treatment plan, such as
   - From no prosthesis to a fixed partial denture
   - From a fixed partial denture to a removable partial denture
   - From a tooth supported partial denture to a distal extension removable partial denture
   - From a removable partial denture to an overdenture/complete denture
3. Is one that is required to maintain an adequate chewing pair

The patient had not seen a dentist in at least 2 years, and the staff were concerned that she might have some "dental problems." An appointment was arranged for the patient, who was wheelchair bound. Transportation and an escort were provided by the nursing home, who brought the patient's medical record and a list of her medication. The record showed that Mrs LL's son lived in a distant state and had power of attorney, but visited his mother several times a year. On contacting her son for permission to examine Mrs LL, he told the authors that he was financially responsible for her dental care. The escort told the authors that Mrs LL loves ice cream but recently has refused to eat it.

Medical History

The patient is allergic to dimenhydrinate (Dramamine). She has a history of hypothyroidism that was diagnosed 10 years ago, history of Parkinson disease with mild tremors (3 years ago), history of gastroesophageal reflux (3 years ago), dementia (2 years ago), depression (2 years ago), and insomnia (10 years ago). She also has chronic pain and muscle weakness.

Daily Medications

Mrs LL was taking multiple medications for her illnesses, many of which had significant systemic and oral side effects, as shown in **Table 1**.

Oral Health Findings

The patient was not concerned about esthetics; although she did not complain about any discomfort, the staff told the authors that she always loved ice cream and recently was avoiding it. On oral examination, Mrs LL is fully dentate, except for third molars and first premolars, which had been extracted for orthodontic purposes. A majority of teeth were covered with plaque at the gingival margins; however, there was little evidence of inflammation and no significant pocket depths. There was gingival recession and root surface caries on multiple teeth in both arches (see **Fig. 1**). The radiographic evaluation showed some bone loss in the mandibular anterior region. There was evidence of root canal treatments on teeth #9 and #10, with no visible periapical radiolucencies (**Fig. 2**). Although the patient did not complain of a dry mouth and the clinical examination did not suggest a lack of moisture, multiple root surface lesions suggest that there may be a change in the quality of the saliva. Mrs LL was able to follow directions, was able to cooperate during the oral examination, and had minimal tremors of the head and neck.

After examining the patient and gathering data (**Box 3**), the question was how should Mrs LL's oral health needs be approached? One approach would be to prioritize the risk factors that are more important for disease progression and treatment planning (see **Box 3**). When evaluating medical and social history, the impact of her

Table 1
Daily medications

Drug	Dosage	Commercial/ Generic Name	Use	Side Effects
Bisacodyl	5 mg qd	Dulcolax	Laxative	Gastrointestinal discomfort, cramps, semi-supine chair position
Diphenhydramine	25 mg q6h	Benadryl	Antihistamine	Somnolence, dizziness, hypotension, sedation, dry mouth, nose and throat
Guaifenesin	2 mg q4h	Robitussin	Expectorant	Dizziness, headache, nausea, gastrointestinal pain
Hydrocodone/ Acettaminophen	5 mg q6h	Vicodin	Opioid analgesic	Dizziness, sedation, bradycardia, risk of psychological and physiologic dependence, orthostatic hypotension
Levothyroxine	50 μg qd	Synthroid	Thyroid hormone	Hair loss, dry skin
Loperamide	2 mg qd (prn)	Imodium	Antidiarrheal opioid	Dry mouth, somnolence, semi-supine position
Miconazole	200 mg bid	Monistat-Derm	Imidazole antifungal	Rash, itching, dizziness, can increase bleeding with warfarin
MiraLAX	17 g qd	Polyethylene glycol 3350	Laxative	Bloating, dizziness, blood in the stool
Mirtazapine	7.5 mg hs	Remeron	Tetracyclic antidepressant	Somnolence, dry mouth, constipation, weight gain. dizziness, semi-supine position
Nystatin ointment	1000 U 4×/day	Mycostatin	Fungistatic antifungal	Rash
Omeprazole	20 mg qd	Prilosec	Proton pump inhibitor	Headache; nausea, cough, dry mouth
Quetiapine	25 mg bid	Seroquel	Antipsychotic	Headache, somnolence, dizziness, dry mouth, constipation, tachycardia, orthostatic hypotension, tardive dyskinesia, frequent recalls
Risperidone	2 mg bid	Risperdal	Antipsychotic	Agitation, anxiety, insomnia, constipation, rhinitis, orthostatic hypotension, dry mouth, extrapyramidal movements, limit vasoconstrictors, semi-supine position
Sinemet	0.5 mg bid	Carbidopa/ levodopa	Antiparkinsonian	Uncontrolled body movements, nausea, anorexia, depression, anxiety, confusion, dry mouth, orthostatic hypotension, photophobia (dark glasses)
Trazadone	25 mg hs	Desyrel	Antidepressant	Somnolence, dizziness, nausea, blurred vision, light headache, orthostatic hypotension, dry mouth
Tylenol	650 mg q6h	Acetaminophen	Nonnarcotic analgesic	Hypersensitivity, liver damage with dosage of 3000 mg/d

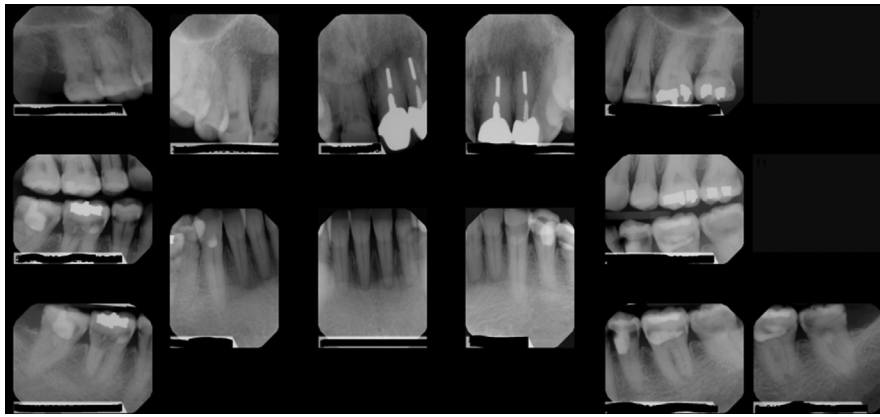

Fig. 2. Full mouth radiographs, including bitewing radiographs made at the initial appointment, showing multiple caries lesions and root canal treatment of teeth #9 and #10.

developing dementia and Parkinson disease suggests that she will need increasing help with her daily oral hygiene over time and dietary changes to reduce her sugar intake. An electric toothbrush has been shown to be beneficial in this population, provided patients can tolerate it.[41] Additional preventive measures will be needed, such as the use of topical fluoride varnish, a prescription for high-concentration daily fluoride toothpaste, and a return dental visit every 3 months.[42]

If the necessary preventive measures and treatment are not accepted, there will be further progression of root surface caries, with fracture of the teeth with possible local pain and infection, resulting in periapical lesions and loss of function. Consequently, there could be a possible deterioration of Mrs LL's systemic health and quality of life and the potential for aspiration pneumonia, which can be life threatening. Therefore, Mrs LL is presenting with multiple ROHD risk factors, and ROHD currently is occurring (see **Box 3**).

Considering the extensiveness of the current caries lesions and the patient's ability to cooperate, it is possible to choose multiple options to treat Mrs LL's dentition (see **Box 3**). For instance,

1. Comprehensive care, such as excavating the lesions to determine their depth. If they are shallow, complete caries removal is possible. If a lesion is deep, then

Box 3
Modified American Society of Anesthesiologists classification for frail and functionally dependent older adults[23]

Class I. Comprehensive dental treatment, including all necessary surgical, operative, prosthetic, and preventive services

Class II. Intermediate dental care, emphasizing preservation and maintenance of the existing dentition and prevention of further deterioration. This can range from restorative dentistry to a simple prophylaxis.

Class III. Emergency dental care only. This includes alleviation of pain, infection, and/or swelling. This is palliative care, applicable even for terminally ill patients.

Class IV. No dental treatment, a decision based on physical and mental contraindications for care, when treatment would do more harm than good.

partial caries removal should be considered, with glass ionomer applied to the deepest areas. The use of a sandwich technique may be appropriate, or, if the lesion is very large or very deep, it may be necessary to do a root canal treatment and/or to crown the tooth.

3. Limited care might include
   a. The use of atraumatic restorative technique to hand excavate the lesions and restore with glass ionomer, associated with home preventive measures and 6 month recalls
   b. The use of SDF to arrest the carious lesions and 6-month recalls with SDF reapplication
   c. The use of fluoride varnish in the office followed by the daily use of high-concentration fluoride toothpaste and recalls every 3 months
3. Emergency care (pain and infection control)

Emergency care may be the first step in a comprehensive care plan, or it could be the choice of a patient who seeks only comfort for the problem. If the patient presents with odontogenic pain or a dental abscess, however, it is important to define the source and treat the offending tooth or extract it. It may be necessary to support this treatment with oral antibiotics. If the pain is from a nonodontogenic source, then it is important to define the cause and treat the problem appropriately. It may be necessary to refer the patient to an appropriate medical or dental specialist for care.

4. No treatment.

If a patient seeks a consultation, is offered a treatment plan, and refuses treatment, the dentist needs to document this encounter in detail. If patients are so impaired that they cannot tolerate transfer to a dental office or any procedure in their mouth, however, a caretaker may help to reduce the bacterial burden by spraying chlorhexidine in the mouth on a daily basis.[43]

At this point, Mrs LL's son was contacted to inform him of his mother's oral health status and her treatment needs. In order to get informed consent (either verbally or in a signed document) to allow the authors to treat Mrs LL, the authors informed him about the different treatment options and their costs and suggested a rational treatment plan. This rational treatment plan included an evaluation of Mrs LL's cognitive status and ability to cooperate with the amount of dental treatment she needed as well as the

Box 4
Classification of patients with chronic unstable medical problems

Type I
Patients with chronic existing problem(s), for example, post–cerebrovascular accident, asthma, chronic bronchitis, coronary artery disease
These diseases progress but usually at a slow rate.
Time is *not* a problem, because treatment can be phased in a little at a time to keep stress low.

Type II
Patients with progressive medical problem(s), for example, dementia, cardiomyopathy, myasthenia gravis, scleroderma
These diseases progress at a relatively faster rate, and patients deteriorate with time:
- Need to maintain and preserve key teeth
- Need to remove questionable teeth
- If necessary, need to crown teeth

Time is a problem, because patients need to be treated while they are able to tolerate treatment.

Fig. 3. Full mouth view of Mrs LL's dentition, showing the completed glass ionomer restorations. Tooth #30 has been extracted, because it was deemed unrestorable.

authors' ability to deliver this care. An assessment of her chronic medical problems will help determine the need for phasing of her treatment, as shown in **Box 4**. Another important consideration was the nursing home staff's ability and willingness to commit to carry out daily oral hygiene in order to keep the appropriate maintenance regimen.

The treatment plan suggested and that her son accepted was as follows:

1. Scaling, cleaning, and polishing with fluoride varnish application, followed by customized oral hygiene instructions, including information for the nursing staff on how to maintain Mrs LL's daily care
2. A prescription for 5000 parts per million fluoride toothpaste, which should be sodium lauryl sulfate–free
3. Systematic restoration of the carious lesions using incomplete caries removal to determine restorability
   - In the maxilla: from teeth #2 to #4, #6 to #11, and #13 to #15: cervical glass ionomer restorations
   - In the mandible: from teeth #18 to #20, #23 and #27, #29 and #31: cervical glass ionomer restorations. Tooth #22 was deemed to be able to be remineralized with topical application of fluoride varnish
   - Teeth #24 to #26 did not require any restorations.
   - Tooth #30 was deemed unrestorable and was extracted.

   The completed dental treatment of Mrs LL after 4 weeks is shown in **Fig. 3**.
4. Patient was put on 3-months' recall and has returned consistently for the past 2 years, and recurrent caries occurred on tooth #14.

SUMMARY

The case of Mrs LL history presented illustrates the significant changes that have occurred in the aging population, that is, the maintenance of a natural dentition into old age. It also illustrates the problems and risks this presents for the patient and those

who care for them. The chronic medical problems of the patient, especially the dementia and Parkinson disease, which are progressive diseases, will cause limitations in the patient's ability to cooperate and follow instructions over time and put this patient's oral health at risk. Therefore, it was important to involve the family (son) and the care staff at the nursing home in the patient's restorative care as well as in the maintenance of her oral health.

In addition, modern restorative techniques need to be used, such as minimal invasive dentistry, including incomplete caries removal and sealing the lesions with glass ionomer, followed by a high concentration of topical fluoride to prevent further demineralization. The treatment followed the overall ethical principles, which are to do no harm and to do treatment that benefits the patient. This treatment was well tolerated and should improve the quality of her life (eg, allow her to enjoy her ice cream) and maintain function.

It is the authors' belief that the successful treatment of frail and functionally dependent older adults must include an understanding of how patients are functioning (medically, socially, and emotionally) in their environment and how the art and science of dental medicine fit into that environment.

CLINICS CARE POINTS

- Teledentistry should be considered when triaging new or existing older adult patients prior to their entering the dental clinic. Teledentistry also can be used for diagnosing and treatment planning for an existing dental patient as well as for postprocedural management.
- Good communication with patients and their significant others requires investigative interviewing when assessing patients with complex social and medical/mental conditions.
- In assessing patients' health histories, it is important to interpret the information provided by careful questioning.
- The aim of treatment is to understand how patients are functioning in their environment and how their dental needs and treatment fit into their lifestyle.
- Rational treatment planning philosophy can guide the development of treatment alternatives, by using evidence-based data, where available, and selecting alternatives that are compatible with a patient's lifestyle and general health-modifying factors.
- Some of the alternatives to the treatment of caries for frail and functionally dependent older adults, especially those with severe cognitive impairment, are incomplete caries removal followed by sealing the lesions with glass ionomer. SDF also can be used to arrest caries in this population.

DISCLOSURE

The authors have nothing to disclose.

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Rational Dental Care: Part 2. A Case History

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ABSTRACT

Treatment planning and managing the care of an elderly, frail patient can be complicated by a variety of modifying factors. To understand the patient's needs, one must understand the environment in which the patient functions. This second in a series of 2 articles presents a case history of a frail, older adult to illustrate some of the social, medical and community problems that are involved in caring for elderly persons.

MeSH Key Words: decision making; dental care for aged; dental caries/therapy; patient care planning

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The number and percentage of adults over the age of 65 in Canada has grown dramatically since the middle of the last century as a result of improvements in public health, medical care and methods of birth control. In 1951, people aged 65 and older made up about 8% of the population. By 2001, this proportion had grown to 12.5% and is expected to reach 20% by 2031 at which time 45% of elderly people be older than 85 years.[1] The fastest growth in the aging population is occurring in the 85 years and older group.[2]

The Canadian population is diverse, but heterogeneity is probably greater among those aged 65 and over than for any other age group.[3] Elderly people are a complex combination and expression of their genetic predisposition, lifestyle, socialization and environment. All of these factors influence their health beliefs and, therefore, their health-related behaviour and attitudes. Dentists need to evaluate the cultural, psychological, educational, social, economic, dietary and chronologically specific cohort experiences that may have influenced a patient's life. Determining oral health status must also include an assessment of an individual's life experience with dental care, caries, periodontal disease and iatrogenic disease. The history of a person's behavioural attitudes and expectations regarding their own oral health will be reflected in his or her oral health status. The skills, attitudes and philosophies of the various dentists that an older person has encountered during his or her lifespan will also affect their oral health status.[4–7]

Different older adults have different needs and their functional disabilities influence their ability to accept and receive dental treatment. This paper presents a case history that illustrates some specific oral needs and problems in the clinical oral care of a frail, older adult.

Case History

Mr. J.H., an 87-year-old widower, who had been moved into a long-term care facility about 12 months earlier as a result of a cerebrovascular accident (CVA), was brought to our office by his son, who thought his father was having trouble eating solid food. The patient had been a postman before he retired about 20 years earlier.

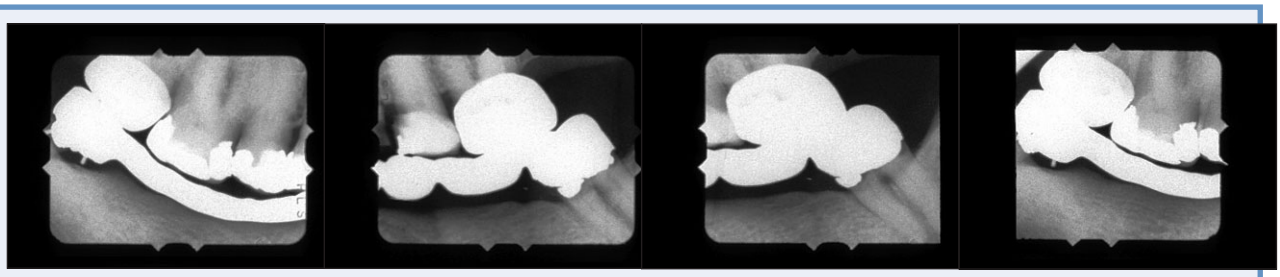

Figure 1: Bitewing radiographs of the patient showing the long-span fixed partial dentures with caries in the abutment teeth.

Table 1 Medications taken by our patient

Disease	Drug name and dose	Potential oral side effects	Management Issues
Chronic congestive heart failure	Digoxin (cardiac glycoside), 0.25 mg daily	Dry mouth Increased gag reflex	Need to monitor vital signs Patient has postural hypotension Patient is sensitive to light and has increased gag reflex Control use of vasoconstrictor
	Acetylsalicylic acid, 81 mg daily	Bleeding gums	Patient is at increased risk of bleeding
	Furosamide (loop diuretic), 40 mg daily	Dry mouth Lichenoid	Need to monitor vital signs Patient has postural hypotension Limit use of saline Avoid alcohol Take caries prevention measures Patient at risk for hypokalemia
Hypokalemia	Potassium chloride, 20 mEq		Patient may have cold extremities, confusion, muscle weakness
Depression	Fluoxetine (selective serotonin re-uptake inhibitor), 10 mg daily	Dry mouth Taste changes	Patient has postural hypotension Take caries prevention measures Avoid use of alcohol Patient is sensitive to light
Diverticulitis	Mesalamine (anti-inflammatory), 500 mg bid (suppository)		Use semi-supine chair Consult if need to use antibiotics
	Ranitidine (H2-receptor antagonist), 150 mg hs		Avoid aspirin if possible Use semi-supine chair Patient may have reflux symptoms, e.g., burning mouth
Seizure	Phenytoin (anti-convulsant), 2 50-mg chewable tablets hs	Gingival over growth Ulceration Taste loss	Frequent recalls necessary Keep appointments short Use stress reduction measures
Anemia	Ferrous sulphate, 325 mg bid	Stain on teeth	Counsel patient to take liquid iron through a straw to reduce staining
CVA	Warfarin (anti-coagulant), 5 mg daily	Gingival bleeding Stomatitis Salivary gland pain	Check international normalized ratio Encourage good oral hygiene to prevent bleeding

Note: bid = twice daily; CVA = cerebrovascular accident; hs = at bedtime.

Medical History

Mr. J.H. had suffered an acute CVA resulting in right-sided hemiplegia. He was aphasic and unable to communicate directly with us. His medical records from the nursing home stated that he had cardiomyopathy, chronic congestive heart failure, diverticulitis and a past history of prostate cancer, which had been treated with surgery and radiation 5 years earlier. The patient also suffered from depression. He had a seizure after the CVA. Because of his dysphagia, he was currently being fed via a gastric tube. He was allergic to nitrofurantoin.

Drug History

The list of Mr. J.H.'s medications was sent to us by the nursing home and is shown in **Table 1**. His most recent international normalized ratio (INR) was 2.40.

Oral Examination

The patient had generalized hard and soft deposits on all his remaining teeth.

Upper right							Upper left						
17	16	15	14	13	12	11	21	22		24	25	26	
47	FPD		44	43	42	41	31	32	33	34	FPD		37
Lower right							Lower left						

FPD = fixed partial denture

Overeruption of teeth in the posterior maxilla was evident, especially on the right side.

Teeth 11 and 21 consisted of root fragments only. Caries were present in teeth 12, 24 and 25.

In the mandible, fixed partial dentures (FPDs) spanned teeth 37 to 34 and 44 to 47. There was furcation involvement of all molars, with recurrent caries of the abutments resulting in movement of the FPDs. Caries were present in teeth 31 and 41 (**Fig. 1**). The mouth was dry.

Development of a Rational Treatment Plan

To develop a treatment plan for this patient, we followed a decision tree (**Fig. 2**), which required an evaluation of the modifying factors as well as answers to the following questions.

What are the patient's desires and expectations?

We did not know Mr. J.H.'s wishes as we were unable to communicate with him because of his aphasia. However, his son wanted his father to be able to chew hard foods again and to have the gastric feeding tube removed. The son believed his father was in pain or discomfort and wanted him to be pain free.

What are the patient's dental needs?

The FPDs had to be removed to evaluate the viability of the abutment teeth. Teeth 12, 11, 21 and 22 had to be extracted as they were not restorable. Caries had to be treated. The patient needed help with daily oral hygiene.

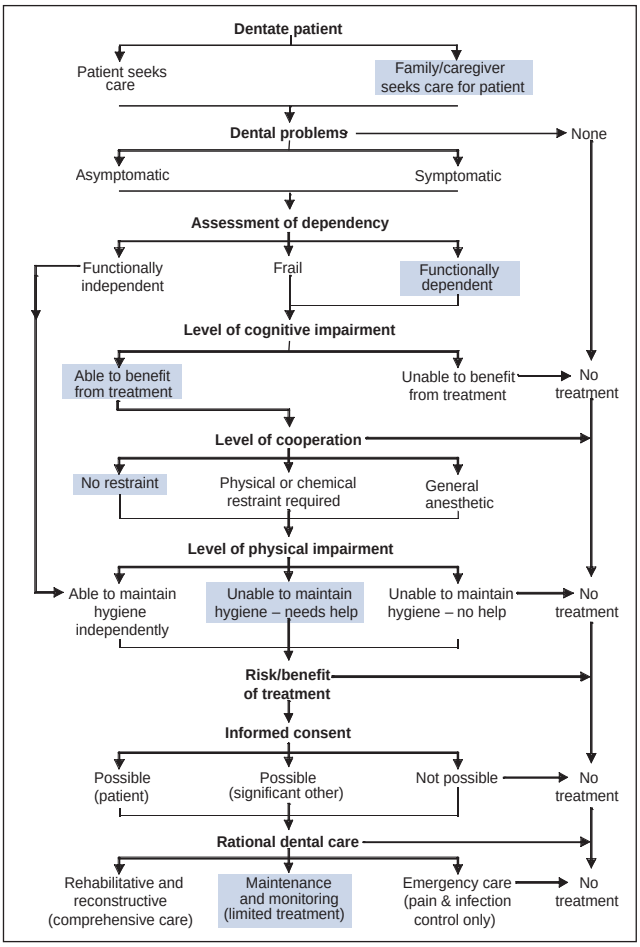

Figure 2: Decision tree for a dentate person.

To ensure enough chewing pairs of teeth, a removable partial denture might be necessary for the mandible. Some of the maxillary anterior teeth would have to be extracted and the importance of their replacement would have to be assessed.

What is the impact of his dental problems on his quality of life?

We had no measure of the severity of Mr. J.H.'s dental problems. The son believed that his father was in pain and that dental treatment would alleviate this and allow his father to eat. The son did not believe that esthetics was an issue for his father and replacement of the maxillary anterior teeth was not important.

What is the impact of his medical problems on his treatment?

Mr. J.H. was living in a nursing home and was dependent on others for all activities of daily living. To evaluate his medical problems, we had to talk to his physician.

Cardiomyopathy: The patient's blood pressure was stable at 110/60; however, it and other vital signs had to be

monitored at each appointment. Because of his cardiomyopathy, we had to limit the use of epinephrine to 0.036 mg or 2 carpules of local anesthetic with deliberate aspiration.[8–10] As there is a diurnal variation in the stickiness of platelets, the patient should not be seen between 6 and 9 a.m. to avoid a cardiovascular event.[11,12]

Chronic congestive heart failure: Mr. J.H. became short of breath easily when experiencing mild stress, such as that associated with being helped to stand and moved to a dental chair; therefore, stress reduction procedures were necessary during treatment. We had to have oxygen available during treatment and monitor his vital signs.

Acute CVA with right hemiplegia: Despite his aphasia, Mr. J.H. could follow instructions and, therefore, was able to benefit from dental treatment. We needed to take the same preventive measures as for his cardiomyopathy.

Depression: We consulted the nursing home to ensure that Mr. J.H. was receiving his medications.

Dysphagia: Improving the patient's chewing ability might help his nutrition and allow his physicians to remove his gastric tube; this was discussed with his physician who approved dental treatment.

What would the impact of his medications be on his treatment?

The effects of Mr. J.H.'s daily medications on his oral condition and dental management are shown in **Table 1**.

Would he be able to maintain oral hygiene?

This is a key factor in decision-making, as plaque control is essential to the maintenance of any teeth.[13] Compliance with this preventive behaviour depends on the patient's caregiver having:

- adequate knowledge of the reasons for cleaning the patient's teeth and understanding that his dry mouth puts him at high risk for caries and periodontal disease
- adequate motivation to clean his teeth (we know from experience that this is difficult)
- adequate neuromuscular skills to manipulate a toothbrush (the patient's right-sided hemiplegia meant he needed help with daily oral care).

As Mr. J.H. had a very dry mouth, we wanted him to receive a home care regimen for persons with high risk of caries. We suggested that he try an artificial saliva and use a high concentration fluoride toothpaste (Prevident 5000, Colgate, New York, N.Y.). We would have liked to use a chlorhexidine rinse as well, but at that time all commercially available products had an alcohol base. (Sunstar-Butler has now developed an alcohol-free rinse.) An effective way to deliver chlorhexidine rinse for a person who is unable to swish or rinse is by spray bottle. We wrote orders for the nursing home to clean Mr. J.H.'s teeth twice a day, using Prevident 5000 in the morning and spraying his mouth with chlorhexidine in the evening just before bed. We put Mr. J.H. on 3-month recall.

What is the patient's ability to withstand the stress of treatment?

The patient was in fragile health and his unstable medical condition limited treatment. His cardiomyopathy was progressive as was his congestive heart failure. It was not clear whether his depression was sufficiently treated or whether he had an interest in cooperating during treatment. If we were going to extract teeth or do deep scaling, we needed to consult his physician and ensure that his INR did not go above 2.5. We would be able to treat him in short late-morning appointments while monitoring his vital signs. The fact that his son brought him to appointments was a key to success as was the son's liaison with the nursing home to improve his daily oral hygiene.

Are there any financial barriers?

The son paid for his father's care and the planned treatment was not very expensive.

What is the probability of success?

Communication with the father was a problem because of his aphasia. The son's expectations were unrealistic because of his father's fragile health and unstable medical condition.

Mr. J.H.'s inability to walk or lift himself was a problem; however, his son helped us move him from the wheelchair to the dental chair.

The Final Rational Treatment Plan

A treatment plan was developed after resolving the issues raised by the decision tree.

Emergency or Palliative Care

1. Cut FPDs distal to teeth 34 and 43.
2. Check INR with the help of his physician; maintaining it below 2.5, extract teeth 12, 11, 21, 34, 37, 44 and 47.

Disease Control

1. Clean and scale the teeth.
2. Restore teeth 24 (mesial aspect), 25 (facial aspect), 31 (facial), 41 (facial).

Reconstruction

1. Ensure maintenance of teeth 33 to 43, which are "key teeth" as Mr. J.H. could not adapt to a mandibular complete denture.
2. Construct an interim resin mandibular removable partial denture (RPD) to determine patient benefit and to keep costs down.
3. After discussion, the son chose not to have a maxillary RPD constructed as neither he nor his father was concerned about esthetics.

Maintenance and Monitoring

The treatment was completed after 2 months, and Mr. J.H. was able to chew some soft foods (**Fig. 3**). He had trouble wearing the mandibular denture because he could not place it in his mouth by himself and the staff at the home did not help him adequately. Also, the nursing staff did not do an adequate job of maintaining his daily oral hygiene. After 9 months, he had new caries on teeth 13, 25 and 34. He had occlusion only on teeth 14 and 13 with 43, and 22 with 33 and 32, and he was still being fed by gastric tube (**Fig. 4**).

Figure 3: The restored dentition of Mr. J.H. with the interim removal partial denture.

Figure 4: The dentition of Mr. J.H. showing his limited occlusion.

The patient died in his sleep 3 months after this last appointment or 14 months after we first saw him.

Discussion

Clinical decision-making in dentistry tends to be based on qualitative, subjective estimates that the benefits of a specific treatment outweigh the possible alternatives. In dentistry, a clinician traditionally collects useful pieces of evidence and synthesizes them into a sequential subjective treatment plan, which is usually based on his or her clinical experience.[14] Decisions are usually based on the patient's age-associated psychological, social, biologic and pathologic profile. Grembowski and others[15] have indicated that clinical decision-making should be a social process that includes the dentist, patient and sometimes others.

What was unique about Mr. J.H. was that he was very frail and unable to communicate directly, but had a son who wanted him to have treatment so that he could enjoy eating again. After consultation with his physician, it was agreed that we should try to do more than palliative care. It was clear that Mr. J.H. could not tolerate extensive restorative procedures and it was often necessary to shorten appointments and define achievable goals for each appointment.

Conclusions

This case history illustrates that it is possible to improve quality of life by improving the oral health of a frail, at-risk patient. To achieve this, one must understand the influence of social and medical problems on the oral cavity and dental treatment. It was imperative that we use a step-wise approach to treatment of Mr. J.H. and that no irreversible step was taken before adequate assessment of its potential for success. It was important to maintain key teeth, especially the 6 anterior teeth in the mandibular arch. The fundamental concept of successful treatment requires that the dentist understand how the patient functions in his or her environment and how dentistry fits into the patient's overall needs.

Rational dental care is a framework of decision-making that allows a clinician to develop a plan for the most appropriate care in the best interests of the patient after weighing all the underlying or modifying factors.

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Rational Dental Care: Part 1. Has the Concept Changed in 20 Years?

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ABSTRACT

The concept of "rational dental care" was developed 20 years ago when it became clear that idealized treatment plans for frail and functionally dependent older adults were often inappropriate. This first in a series of 2 articles reviews the reasons for developing the concept.

MeSH Key Words: decision making; dental care for aged; geriatric assessment; patient care planning

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Oral health has been defined as "a standard of health of the oral and related tissues which enables an individual to eat, speak and socialize without active disease, discomfort or embarrassment, and which contributes to general well being."[1] Oral health problems are among the most prevalent chronic problems that elderly people have to deal with.

In clinical geriatric dentistry, decision-making and problem-solving are essential components of clinical diagnosis and treatment planning.[2–4] The fundamental questions that the clinicians must answer are:

- What is the patient's dental problem? What is his or her primary complaint?
- How and why did it occur?
- What other modifying factors influence the problem? (**Box 1**)
- Can I, as the clinician, help to solve this problem or do I need help from other health care professionals?
- Can I predict the outcome of the treatment that I think may help the patient?

In young people, factors that affect decision-making are whether the clinician has the skill and resources required to treat the patient; whether the patient has the time and desire to accept the treatment plan; and whether the patient has the financial ability to pay for the treatment.

In older adults, the problem is much more complex. The dental needs of older people are more extensive and the patient may have a medical history that modifies or limits treatment. He or she may be taking medications to treat chronic diseases, and these may affect the oral cavity directly or require modification of treatment. The patient's physical frailty may limit travel or time of treatment. The patient may be cognitively impaired and, therefore, unable to understand a treatment plan or have the neuromuscular skills to clean his or her teeth or to wear dentures.

In 1984, Jim Beck and I published a paper[5] in which we defined our concept of geriatric dentistry and the treatment that some older, frail and dependent patients need; we called it

Box 1: Modifying factors that should be evaluated in preparing a rational treatment plan

- The patient's desires and expectations
- The type and severity of the patient's dental needs
- How the patient's dental problems affect his or her quality of life
- The patient's ability to tolerate the stress of treatment (his or her mental and medical statuses as well as mobility)
- The patient's ability to maintain oral health independently
- The probability of positive treatment outcomes
- The availability of reasonable and less-extensive treatment alternatives
- The patient's financial status
- The dentist's ability to deliver the care needed (skills and available equipment)
- Other issues (for example, the patient's lifespan, family influences and expectations and bioethical issues)

Source: Adapted from Berkey and others[22] and Ettinger[21]

"rational dental care" (**Fig. 1**). We explained that individualized care should occur only after all the modifying factors have been evaluated and that this approach is much more appropriate for older patients than "technically idealized dental care." The amount of stress involved in implementing an idealized treatment plan could pose health risks to some older medically compromised patients and limit the potential benefit of the treatment, thus making it inappropriate. Or a patient's medical or cognitive status might make it impossible to deliver such idealized care.

At that time, our thinking had been influenced by several occurrences. First, we were seeing more older adults who had kept some of their teeth, and evaluation of data from the 1983 Iowa State-Wide Dental Survey[6] made it clear that a younger group of elderly people had emerged, which could be called "the new elderly."[7] These older adult dental consumers were better educated, more politically aware and more demanding of health services and health care providers. They had one or more chronic medical condition, but were probably healthier than past cohorts and more actively involved in preventive behaviours. This group was less likely to be edentulous, and they were interested in keeping their remaining dentition, which required more complex care than in the past when emphasis had been on complete dentures. Although there are no national studies in Canada, data show the same trends in the aging of the population and in the reduction of edentulousness.[8–11]

Second, if an edentulous person with dentures has a problem, the dentures can be removed and the person can eat food prepared in a blender. However, a dentate person with an oral problem needs the services of a dentist. Further, to treat such a person requires the use of a local anesthetic; therefore, it is important to know the patient's medical and drug history and understand the possible drug interactions of the local anesthetic and the epinephrine used as a vasoconstrictor.[12–15]

Third, we noticed that some patients were coming to our dental school once and never returning. When we evaluated these patients, we found that age was not the issue; they were physically or medically frail and could not cope with the movement to and from the multiple clinics of a dental school.

Fourth, we realized that most older people are relatively healthy and ambulatory and have, possibly, 1 or 2 chronic medical problems. Treatment for such individuals is well within the realm of a general dentist who has received some additional training in patient management problems that may be related to the normal aging process. At that time, we defined that kind of dental care as "dentistry for the older adult" rather than geriatric dentistry.[5]

The fifth point was that dentistry is not like medicine. In medicine, it is important to make a diagnosis. Once a diagnosis is made, the treatment is usually well prescribed, often guided by evidence-based studies. Dentistry is more like surgery in that treatment includes removal of an infected part.[2] Like surgeons, we need an operating room with specialized instruments to carry out this treatment. Much of our treatment is based on anecdotal data and experience rather than evidence-based studies. It was clear that a dentist treating geriatric patients needs experience and must be technically competent and, therefore, must be a good clinician.[16]

The national data showed that most people (95%) aged 65 and older live in the community. Of these, 5% are homebound and approximately 17% have a major limitation in mobility because of some chronic condition. The rest of these 65+ year olds are relatively healthy and ambulatory. Thus, about 70% of people 65 years and older can travel to the offices of a general dentist independently, approximately 20% would have access problems unless a caregiver helped them, a further 5% are homebound and another 5%, who are institutionalized, might require a dentist to provide care for them at their place of residence.[17] The data from Canada are very similar; only 20% of elderly Canadians are restricted in their activities of daily living due to chronic health problems.[8]

The medical profession has been fairly specific about the definition of geriatric medicine. The Institute of

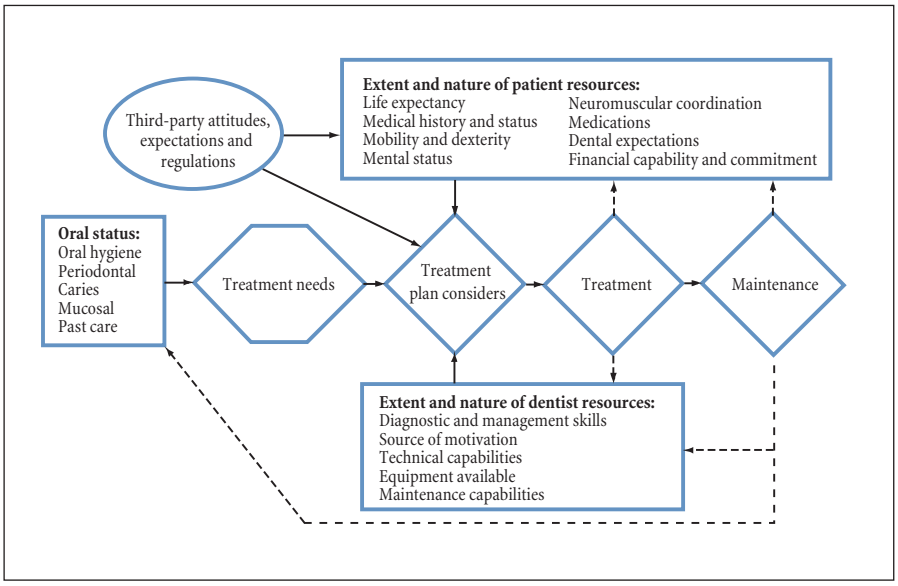

Figure 1: Model for rational dental care for older adults.

Medicine defines geriatrics as the "branch of general medicine concerned with the clinical, preventive, remedial and social aspects of illness in the elderly."[18] Thus, geriatrics in medicine is associated with illness, but how is that relevant to dentistry? We modified the Institute of Medicine's definition to delineate more than one geriatric population. Our definition was that geriatric dentistry was the provision of dental care for adults with one or more chronic, debilitating physical or mental illness with associated medication or psychosocial problems.[5]

We stated that, although many of these conditions were associated with increasing chronological age, they were not a direct consequence of the aging process. In our definition, the geriatric dental patient was a biologically compromised adult who may or may not be older than 65. However, most geriatric patients were older than 65 and could be separated into 2 groups: frail elderly people and functionally dependent elderly people.

In 1983, a flow diagram of decision-making, called the "rational dental care model," was presented at a national meeting in Chicago.[5] Although the relative influence of the various modifying factors was unknown, it was hypothesized that this was the mechanism by which dentists experienced in geriatric care made treatment planning decisions. It was suggested that this model could be usefully incorporated into dental education, because it specified a thought process that would be helpful for diagnosis and treatment planning for all patients. The model was modified in 1984.

To test our model, we evaluated the similarities and differences among 5 dentists who were experienced in caring for geriatric patients.[19] Each practitioner individually examined and planned treatment for the same older adult volunteer patient. The dentists were videotaped as they interviewed and examined the volunteer patient. Later, the dentists were interviewed while viewing the videotape of their examination. This interview was also videotaped. During the interview, the dentists were asked to stop the examination videotape and comment on any issue they wanted to discuss. The interviewer could also stop the tape during an interaction between the dentist and the patient and ask the dentist to clarify his or her rationale for asking a particular question. After the examination and interview, each dentist was asked to develop a treatment plan for the patient.

From the videotapes, it was clear that the patient was varying his response slightly from dentist to dentist and that he was not a reliable historian. In spite of that, it seemed that after initial contact with the patient and after looking at the dentition, the dentists knew what treatment they wanted to perform. Dentists spent the remainder of the time with the patient developing the feasibility of their preferred option.

The patient assessment model used by the 5 dentists was based on clinical experience. If most dentists follow this patient assessment model, the implications are obvious. The more limited the range of clinical experience with geriatric patients, the more restricted will be the ability of the dentist to conceptualize appropriate, rational treatment strategies. Thus, training in geriatric dentistry must provide a wide range of clinical experiences so that dentists feel comfortable with their diagnostic and treatment planning abilities.

Older adults do not tend to seek care unless they have a perceived problem.[20] Therefore, when older people seek care, it is important to try to resolve their chief complaints as quickly as possible when developing the treatment plan. This plan must take into account the patient's attitude, genetic predisposition to oral disease, lifestyle, socialization and the environments that influence his or her health beliefs and behaviours.[21] Berkey and others[22] identified 4 domains of dental need: function, symptomatology, pathology and esthetics. The modifying factors that challenge dentists when prioritizing treatment interventions for elderly people are illness and frailty. When planning the patient's restorative and oral rehabilitative treatment needs, dentists must recognize, prioritize and balance the influences of multiple age-associated

dental issues, the patient's changing systemic health and psychosocial factors.[22]

Berkey and others[22] used a case history to present the modifying factors (**Box 1**) that they believed must be identified to evaluate a rational treatment plan. If patients are physically disabled or cognitively impaired, dentists need to understand their wider needs, such as how they function in their environments with their medical problems, pharmacotherapy, their social support systems and the diverse sociologic variables, as well as how oral health care fits into their environment.[23,24]

Clinical decisions in dentistry tend to be based on qualitative, subjective estimates of the specific treatment needs of patients that will result in a net benefit to them. As we have shown, this subjective restorative treatment plan is often based on the dentist's personal clinical experiences rather than on evidence-based studies.[19]

Successful dental care depends on good communication between dentists and patients, their families or significant others, as well as other health care providers. Different older adults have different needs and their functional disabilities affect their ability to accept and receive dental treatment. Also, treatment plans change over time with these older adults due to their illnesses, their finances and their support systems.

Discussion

In 1984, when we defined the concept of rational dental care, it was to refute the idea that anything other than idealized dentistry was secondhand dentistry, other care was compromised and only "bad dentists" offered it. In the new millennium, the concept of rational dental care is still needed. However, we must ensure that rational care is appropriate by increasing its evidence base with longitudinal studies to show that it represents a high level of comprehensive dental care. In the last 20 years, the aging population and the number of frail older adults have increased and a majority of them have some natural teeth. Many do not want to lose their teeth; they value dental care and, over their lifetime, they have spent a significant amount of money to maintain their dentition. However, as this group of older adults ages and acquires more chronic diseases with more comorbidities and an increasing polypharmacy, they will challenge us with more and more complex problems to maintain their dentition.

The old idealized extension-for-prevention philosophy of care cannot solve their problems; it just results in more restorative work. To treat this population, we need rational thinking and so the concept of rational dental care today is more relevant for most general practitioners than it was 20 years ago. This means that we need to treat the causes of their oral diseases not just the acute manifestations. We need to better understand the onset and progression of oral diseases in older adults, especially those in some at-risk subcategories. We need to understand the oral disease process, how it is affected by salivary dysfunction and especially how biofilm changes affect oral tissues. We need to help change societal attitudes and government policies so that older adults have better access to care. And we also clearly need some new biocompatible materials that will make restorative care easier.

In summary, rational dental care is a framework of decision-making that allows a clinician to develop the most appropriate care in the best interests of the patient after weighing all the underlying or modifying factors. Although it applies to a patient of any age, because the number of modifying factors increases and their interactions become more complex as people age, it is particularly relevant for older adults.

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REVIEW ARTICLE

The Prevention of Infections in Older Adults: Oral Health

Patrick P. Coll, MD, Adam Lindsay, MD,† Joyce Meng, MD,‡ Aadarsh Gopalakrishna, DDS,§ Sree Raghavendra, DMD,§ Pooja Bysani, DDS,§ and Daniel O'Brien, MD†*

The oral cavity is exposed to the external environment and from a very young age is colonized by infectious agents. Under certain circumstances including poor oral hygiene, dry mouth, trauma, and the use of antibiotics, oral infections can occur. They can result in damage to the oral cavity including teeth and their support structures. Oral infections can also lead to the extension of infection into surrounding tissues and to systemic infections. Chronic oral infection is a recognized risk factor for heart disease. Older adults are at high risk for oral infections and associated complications. Tooth loss, for which infection is the most significant cause, leads to cosmetic changes and a decreased ability to masticate certain foods that can lead to malnutrition. Chronic oral infections and the manipulation of teeth and supporting structures can lead to the hematogenous spread of infection including the infection of artificial joints and endocardial implants. Good oral hygiene, the use of fluoride, regular dental care, and the appropriate use of antibiotics can all reduce oral infections and their associated complications. **J Am Geriatr Soc 00:1-6, 2019.**

Key words: oral health; dental caries; periodontitis; endocarditis; prosthetic joint infection

EPIDEMIOLOGY OF ORAL INFECTIONS AND INFECTIONS ASSOCIATED WITH ORAL HEALTH IN OLDER ADULTS

Extensive evidence indicates that poor oral health is more common with increasing age.[1] A strong relationship was found between increasing age and the presence of dental caries.[2] Data from the National Center for Health Statistics in the United States showed that the prevalence of root caries was more than twice as high in older adults (36%) when compared with younger adults.[3] The prevalence of periodontitis also increases with increasing age, with as many as 64% of older adults in the United States with moderate or severe periodontitis, compared with less than 38% for those who are younger.[4] Both dental caries and periodontitis contribute to tooth loss. Although complete loss of all teeth (edentulous) is less common in most high-income countries than in the past, it is more common with increasing age.[5] Tooth loss affects a person's ability to chew, with a possible negative impact on nutrition.[6] Poor oral health, dental infections, tooth loss, and socioeconomic status are strongly correlated.[7,8] Inadequate dental insurance coverage for dental hygiene and dental care is a major contributor to poor oral hygiene, dental infections, and tooth loss with increasing age.

Poor oral hygiene including periodontitis was demonstrated to be associated with a variety of medical conditions including cardiovascular disease and diabetes mellitus.[9] Improved dental hygiene was shown to be associated with improvement in surrogate measures of cardiovascular disease including a reduced progression of carotid intima-media thickness.[10] Several meta-analyses showed that improved oral hygiene reduces hemoglobin A1c levels.[11] High sugar consumption is associated with dental caries.[12]

It is well recognized that manipulation of teeth and their support structures can result in bacteria present in the oral cavity being released into the bloodstream.[13] This has resulted in the concern that this bacteremia, although transient, may lead to infections in parts of the body far removed from the oral cavity. The greatest concern in this regard has been the potential for these bacteria to infect various body implants including artificial joints and replacement heart valves that are both more common in older patients. Poor oral hygiene was also demonstrated to be a risk factor for aspiration pneumonia in adults.[14]

Because a growing number of older adults have native teeth and older adults with teeth are at high risk for dental caries, periodontitis, associated systemic infections, and tooth loss, all healthcare professionals who provide care for older adults should work to promote good oral hygiene for their older patients (Figure 1).

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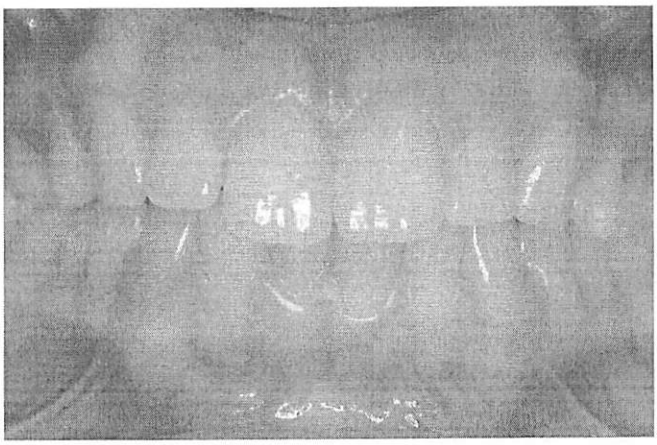

Figure 1. Good oral hygiene.

PREVENTING DENTAL CARIES IN OLDER ADULTS

Dental caries, commonly referred to as tooth decay, is a chronic disease with an infectious component that is prevalent worldwide. Although all age groups are at risk, older adults are more susceptible to dental caries.[15,16]

The pathogenesis of dental caries includes the presence of cariogenic bacteria, notably *Streptococcus mutans* and lactobacilli that using tooth biofilm as a substrate produce an acidic environment. A resulting imbalance in the physiologic equilibrium between tooth minerals and the oral microbial biofilm leads to the breakdown and destruction of susceptible dental hard tissues including enamel, dentin, and cementum.[17] Low pH by-products resulting from bacterial fermentation of dietary carbohydrates, especially sugars, also contribute to demineralization that eventually progresses to cavitation in the tooth structure.

Dental caries, if left untreated, leads to the extension of caries beyond the dental surface to the dental pulp, which is both vital to tooth integrity and more vulnerable to infection and damage than the more resilient tooth surface (Figure 2). Damage to the dental pulp may lead to pulp necrosis, pulp infection, and eventually dental root infections and root abscesses.[18] These deeper dental infections have the potential to spread to a variety of fascial spaces depending on the location of the tooth. Symptoms of a dental abscess include fever, dysphagia, trismus, and swelling. In severe cases, cellulitis, airway obstruction, and cavernous sinus thrombosis can pose life-threatening consequences for the patient. Untreated, dental caries results in tooth loss that leads to masticatory dysfunction and cosmetic changes that both have a negative impact on the patient's quality of life and overall health.[19] Tooth loss was shown to be associated with weight loss and a low serum albumen.[6]

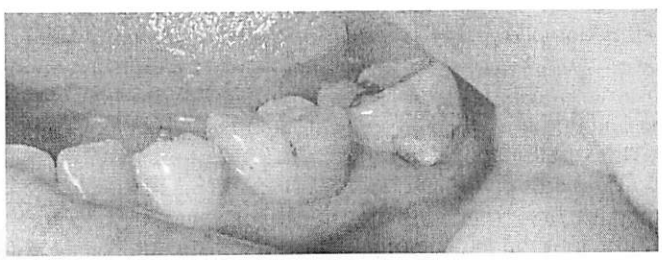

Figure 2. Dental caries.

Table 1. Interventions to Prevent Dental Caries and Periodontal Disease in Older Adults

Ask patients about oral discomfort or tooth pain during regular medical visits
Ask patients about dry mouth symptoms during regular medical visits
Recommend the avoidance of both smoking and chewing tobacco
Recommend xylitol-containing candy or chewing gum to stimulate saliva production for patients complaining of dry mouth[33]
Avoid the use of medications that cause reduced saliva production[34]
Recommend a dental evaluation for patients with chronic dry mouth symptoms
Recommend daily tooth brushing with a fluoride-containing toothpaste[35]
Recommend the use of an electric or battery-operated toothbrush, especially for patients with cognitive impairment[36]
Recommend daily dental flossing, Floss holders may be helpful for patients with limited dexterity
Recommend the avoidance of foods high in sugar, particularly sticky high-sugar foods that have prolonged contact with dentition
Consider prescription-strength fluoridated dentifrices such as fluoride mouth rinses and fluoride varnishes for patients with a history or recurrent dental caries and high-risk patients including nursing home patients[37-39]
Patients with existing periodontitis and patients at high risk for periodontitis may benefit from the regular use of a chlorhexidine-containing monthwash[39,40]
Provide educational material regarding the importance of oral hygiene and instructions on steps to promote good oral hygiene for patients and caregivers[41]

In addition to the presence of cariogenic bacteria, many additional factors including saliva production, fluoride exposure, diet, oral health literacy, socioeconomic status, and eating habits influence caries progression.

Healthcare providers who provide medical care for older adults can play an important role in the prevention and identification of dental caries (Table 1). This includes incorporating

Table 2. Medications That Can Contribute to Xerostomia

Class of medication	Example
Antihistamine	Diphenhydramine, chlorpheniramine
Decongestant	Pseudoephedrine
Antidepressant	Citalopram, sertraline, paroxetine
Antipsychotic	Haloperidol
Diuretic	Hydrochlorothiazide, furosemide
Muscle relaxant	Cyclobenzaprine, orphenadrine
Benzodiazepine	Alprazolam, lorazepam
Anticholinergic	Atropine
Bladder relaxant	Oxybutynin, mirabegron
Analgesic	Tramadol, codeine
Nonsteroidal anti-inflammatory drug	Ibuprofen, naproxen
Miscellaneous	Ipratropium, levodopa/carbidopa

a brief examination of the oral cavity as a part of an annual wellness visit, avoiding the use of medications that have a high propensity to reduce saliva production (Table 2), and providing advice regarding routine dental hygiene, the avoidance of high-sugar foods, regular dental cleaning (twice a year for most patients), and the use of fluoride-containing dental products.[20-22] For most patients, recommending the daily use of a toothpaste containing fluoride is sufficient. For patients with significant dental caries or a history of significant dental caries, their dentist may suggest additional fluoride treatments including fluoride varnishes.

PREVENTING PERIODONTAL DISEASE AND TOOTH LOSS IN OLDER ADULTS

Periodontal disease is a common oral chronic inflammatory disease often found in older adults (Figure 3). Left untreated, periodontitis results in damage to tissues that support teeth including the oral mucosa, surrounding connective tissue, and bone. These changes eventually result in tooth loss. Some gum recession can occur with increasing age, but poor dental hygiene results in excessive gum recession that exposes a vulnerable dental root to both environmental and infectious agents. Many of the same risk factors for dental caries are also risk factors for periodontitis. Besides pathogenic microorganisms in the plaque biofilm, genetic and environmental factors such as tobacco use also play an important role.[23] Although a causal mechanism is not established between periodontitis and systemic disease, shared inflammatory pathways could contribute to this association, and a bidirectional relationship may exist.[9] Periodontal disease has been associated with cardiovascular disease, hypertension, diabetes mellitus, rheumatoid arthritis, osteoporosis, Alzheimer's disease, and pneumonia.[24-32]

Healthcare providers who provide medical care for older adults can play an important role in the prevention and identification of periodontal disease.

PREVENTING ASPIRATION PNEUMONIA BY IMPROVING ORAL HYGIENE

Evidence indicates that routine oral hygiene, for instance brushing teeth and the oral cavity after each meal, can reduce the incidence of aspiration pneumonia in older residents of long-term care facilities.[42,43] Although it is not clear, it appears from the few studies that have been done that good oral hygiene may have as much of an impact on improved swallowing as it does on the biological flora of the patient's oral cavities.[44,45]

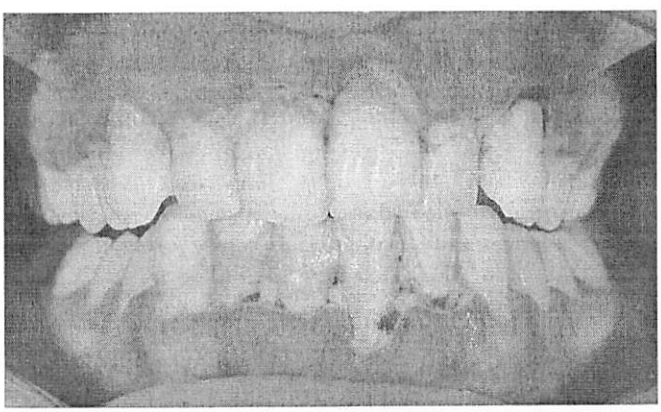

Figure 3. Severe periodontitis.

PREVENTING NONORAL INFECTIONS BY USING ANTIBIOTIC PROPHYLAXIS BEFORE DENTAL PROCEDURES FOR OLDER ADULTS

The Prevention of Endocardial Infections in Older Adults Following Dental Procedures

Age is a risk factor for developing infectious endocarditis.[46] Older patients also have a higher likelihood of having significant valve diseases, with one study showing that nearly 3% of people aged 76 to 85 years have critical aortic stenosis warranting a valve replacement procedure.[47] An increasing number of older patients, including those with multimorbidity, are now candidates for heart valve replacement procedures such as transcatheter aortic valve replacement.[48] As replacement valves become more prevalent in older adults, the prevention of endocardial infections in older adults is becoming an increasingly important issue.

Endocarditis is thought to occur following the deposition of blood-borne bacteria on an abnormal valve surface. Animal studies demonstrated that administering antibiotics after the injection of bacteria in laboratory animals with damaged heart valves prevents endocarditis.[49] Because transient bacteremia can develop following disturbance of the gingival surface, there have been recommendations to administer antibiotics before dental procedures to prevent endocarditis in patients with replacement valves. However no prospective randomized placebo-controlled trials exist on the efficacy of antibiotic prophylaxis to prevent infective endocarditis in patients who undergo a dental procedure.[50] Bacteremia can occur following brushing teeth and even from chewing food.[51] Because of a lack of proven benefit from using antibiotic prophylaxis and because it is now recognized that bacteremia can occur following routine daily activities, maintaining good oral hygiene is increasingly being emphasized as the primary means of limiting the development of this highly morbid disease.

After extensive evaluation of existing data and after extensive discussions among researchers and clinicians from diverse clinical backgrounds, a committee of the American Heart Association published guidelines on the prevention of infective endocarditis in 2007.[52] The committee's recommendations are listed in Table 3. Cardiac conditions associated with the highest risk of adverse outcomes from infective endocarditis include prosthetic cardiac valve or prosthetic material used for cardiac valve repair, a history of infective endocarditis, congenital heart disease, and cardiac transplantation recipients who develop cardiac valvulopathy. Similar guidelines were developed by clinical societies outside the United States.[53,54]

The committee also provides guidance on the timing of administration (30-60 min before the procedure) and choice of antibiotic, if antibiotic prophylaxis is indicated (Table 4).

Prevention of Prosthetic Joint Infections in Older Adults Following Dental Procedures

Total hip arthroplasty and total knee arthroplasty are common orthopedic procedures, with more than a million joint replacements performed annually in the United States. One

Table 3. American Heart Association Guidelines (2007) Regarding the Prevention of Infective Endocarditis

Only an extremely small number of cases of infective endocarditis might be prevented by antibiotic prophylaxis for dental procedures even if such prophylactic therapy were 100% effective
Infective endocarditis prophylaxis for dental procedures is reasonable only for patients with underlying cardiac conditions associated with the highest risk of adverse outcomes from infective endocarditis
For patients with these underlying cardiac conditions, prophylaxis is reasonable for all dental procedures that involve manipulation of the gingival tissue or the periapical region of teeth or perforation of the oral mucosa
Prophylaxis is not recommended based solely on an increased risk of lifetime acquisition of infective endocarditis
Administration of antibiotics solely to prevent endocarditis is not recommended for patients who undergo a genitourinary or gastrointestinal tract procedure

Table 4. Recommended antibiotics for patients with the highest risk of adverse outcomes from infective endocarditis

Situation	Agents
Able to tolerate oral medication	Amoxicillin 2 g
Unable to take oral medication	Ampicillin 2 g IM/IV, or cefazolin/ceftriaxone 1 g IM/IV
Able to tolerate oral medication but allergic to penicillin/ampicillin	Cephalexin 2 g+, clindamycin 600 mg, Azithromycin 500 mg, clarithromycin 500 mg
Unable to take oral medication and allergic to penicillin/ampicillin	Cefazolin/Ceftriaxone 1 g IM/IV+, clindamycin 600 mg IM/IV

Abbreviations: IM, intramuscular; IV, intravenous.
Note: Cephalosporins should not be given to people with a history of anaphylaxis, angioedema, or urticaria with penicillins or ampicillin.

of the most devastating complications of joint replacement is a periprosthetic joint infection (PJI). The treatment of PJI often involves surgical debridement of the joint, implant removal, and prolonged if not a lifelong course of antibiotics. The morbidity and economic burden of PJI are well documented.[55]

PJIs that are not clearly the result of contamination at the time of surgery are thought to arise from the deposition of blood-borne bacteria on the surface of the prosthetic joint.[56] As noted earlier, dental procedures can lead to transient bacteremia, and theoretically this could result in seeding of a prosthetic joint.[13] Although evidence indicates that a prophylactic antibiotic given before a dental procedure decreases the rate of transient bacteremia, there is no direct evidence that transient bacteremia is associated with PJI, or as is the case with the use of antibiotics to prevent endocarditis following dental procedures, that antibiotic prophylaxis before dental procedures decreases rates of PJI.[57,58] Because there are many more older patients with prosthetic joints than there are with replacement heart valves, the ramifications of unnecessary antibiotic administration are even greater in this population of patients.

In spite of a lack of clear data indicating a benefit, a variety of recommendations have been offered regarding the use of antibiotics before dental procedures for patients with prosthetic hip and knee joints. In 2003 the American Dental Association (ADA) and American Academy of Orthopaedic Surgeons (AAOS) released a consensus statement recommending against routine antibiotic prophylaxis for patients with orthopedic implants undergoing dental procedures.[59] In 2009, an updated information statement released by the AAOS stated, "Given the potential adverse outcomes and cost of treating an infected joint replacement, the AAOS recommends that clinicians consider antibiotic prophylaxis for all total joint patients prior to any procedure that may cause bacteremia."[60] In 2012, the AAOS and ADA again performed a systematic review and published a clinical practice guideline that once again recommended against routine antibiotic prophylaxis.[61] Given these competing recommendations, it is understandable that medical practitioners, dentists, and patients may still be confused about the indications for dental antibiotic prophylaxis for those with prosthetic joints.

In an attempt to clarify the situation, the AAOS published 2016 guidelines titled the "Appropriate Use Criteria for Prophylaxis Prior to Dental Procedures in Patients with Prosthetic Joints."[62] Using the RAND/UCLA Appropriateness Method, the AAOS convened two separate volunteer physician panels who completed two rounds of voting on 80 patient scenarios. Of the scenarios reviewed, there was only disagreement on 2%. Overall, antibiotics were voted "Appropriate" in only 10% of scenarios, "May be appropriate" in 24%, and "Rarely appropriate" in 66%. According to these guidelines, most patients with prosthetic joints should not receive an antibiotic before dental procedures. However, certain high-risk patient populations might benefit from antibiotic prophylaxis. These guidelines include a very helpful algorithm that practitioners can access for free to help them determine if a patient should have dental prophylaxis.[63] The algorithm is based on five patient considerations including the invasiveness of the planned dental procedure, immunocompromised status, time since joint implantation, history of prior joint infection, as well as the patient's diabetic glycemic control.[64]

For patients who are not immunocompromised, do not have diabetes, and do not have a history of joint infection, antibiotics are rarely appropriate. Because of this and because it is now recognized that bacteremia can occur following routine daily activities, emphasis is focused on maintaining good oral hygiene as the primary means of limiting the development of PJI. If a decision is made to prescribe dental prophylaxis, 2 g amoxicillin or cephalexin is commonly used for patients without a penicillin allergy, and 900 mg clindamycin can be prescribed in patients with a penicillin allergy.[65]

Special Populations of Older Adults and the Prevention of Oral Infections

Diabetes Mellitus

Patients with diabetes mellitus are at increased risk for developing oral infections including periodontal disease.[11] Evidence also suggests that periodontal disease is a risk factor for diabetes mellitus and that preventing and treating periodontal disease may have an impact on both the incidence and control of diabetes mellitus.[66,67] All older patients should be provided advice regarding oral hygiene and provided regular dental treatments

to promote good oral health and prevent oral infections. This is particularly important for older patients with diabetes mellitus. Promoting good oral health and preventing oral infections can be added to the long list of benefits that occur when patients with diabetes mellitus have good diabetic control.

Dementia

Patients with dementia, and particularly patients with advanced dementia, are at high risk for poor oral hygiene. Evidence also suggests that poor oral hygiene may be an independent risk factor for the development of dementia.[68,69] Patients with dementia may neglect their oral health and may be resistant to accepting help with their oral hygiene from others. They may be reluctant to see a dental hygienist or a dentist and may be unable or unwilling to allow dental cleaning or dental treatments.[70] Fluoride applications including fluoride-containing toothpastes should be used during daily oral hygiene. All patients with cognitive impairment should have at least an annual oral examination. Behavioral approaches that improve the patient's acceptance of routine oral care should be adopted.[71] Patients with cognitive impairment should not be sedated for dental hygiene procedures, although it may be necessary for the treatment of dental complications including tooth extractions and the treatment of dental abscesses.

Patients in Long-Term Care Settings

Although under federal law, US nursing homes are required to provide both routine and emergency dental care for their residents, many nursing home residents do not receive adequate dental care. High rates of poor oral hygiene, periodontitis, and dental caries were reported in nursing home patients.[72] Periodontitis may be present in as many as 43% of nursing home patients, and tooth caries may be present in as many as 38% of nursing home patients with teeth.[73] Poor oral hygiene in residents of long-term care may contribute to a variety of poor outcomes including increased risk of pneumonia.[74-76] Long-term care facilities should adopt risk assessment tools to identify patients at high risk for poor oral hygiene.[77] Long-term care facilities should educate their staff on the importance of good oral hygiene and how to provide it.[78]

In conclusion, good dental hygiene is a critical component of healthy aging. There is no substitute for toothbrushing after each meal and at least daily flossing. All older adults should have biannual dental cleaning performed by a dental hygienist and a biannual oral health assessment by their dentist. Medical practitioners should consider an oral examination during an annual wellness visit, especially for those patients who are not receiving regular dental care. Patients with replacement heart valves and prosthetic joints should be particularly fastidious regarding their oral hygiene.

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Treatment Planning Considerations in Older Adults

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KEYWORDS

• Treatment planning • Geriatric • Decision making • Informed consent • Dental • Oral health • Older adults • Elderly

KEY POINTS

- Treatment planning for geriatric care is a dynamically informed process culminating from comprehensive diagnostic evaluation and informed consent.
- Geriatric patients presenting with multiple chronic conditions, medications, and complex sociobehavioral histories require a strategic, stepwise plan for disease treatment and oral health maintenance.
- Flexibility and good communication with the patient and other involved parties during treatment planning for older adults may attenuate uncertainties and lead to successful outcomes.

INTRODUCTION

Treatment planning in a healthy, older adult is usually straightforward, varying little from the process clinicians typically follow. Normal changes in the aging dentition can require very little modification to the usual treatment-planning process. Often, though, developing dental treatment plans for older adults is complicated by their declining status in general health, cognitive function, and functional ability.

This article briefly describes the profile of older adults in the United States, and discusses the dynamic process of treatment planning and obtaining informed consent. Next, various models for formulating alternative treatment plans are described. Finally, a case is presented that illustrates treatment planning for multiple chronic conditions and polypharmacy.

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PROFILE OF OLDER ADULTS

Thirteen percent of the United States population is 65 years and older, with the young-old (age 65–74 years) comprising 7%, the old (age 75–84) 4%, and the old-old (age ≥85) 2%.[1] In large part because of the shift away from infectious diseases as the leading causes of death, Americans are living longer than ever before. In 1960, at birth Americans were expected to live 69.7 years; today they are expected to live at least 78 years. With a declining birth rate, the first group of baby-boomers reaching 65, and the increasing life expectancy, the United States is developing into an aging society (**Fig. 1**).[2,3] The life expectancy in 1960 for people age 65 was 14.3 years. Half a century later, life expectancy for older adults has increased to 19.1 years.

Although most people 65 years and older live in the community, only 3% at any given time live in a skilled nursing facility (SNF).[4] However, the percentage of elderly living in SNFs increases with age; in 2010, less than 1% of the young-old and 13.5% of the old-old lived in an SNF. In addition to being older, residents living in these facilities tend to be sicker and more functionally impaired.[5] An increasing need for long-term care combined with shortages in the workforce and physical space in nursing homes shifts the burden of disease toward the community at large.[6] Almost 20% of community-dwelling older adults suffer from a psychiatric disorder[7] while approximately 28% of older adults have 3 or more chronic diseases.[8] From 2007 to 2010, 89% of those aged 65 and older took at least one prescription drug in past 30 days, and 66.6% took 3 or more prescription drugs.[9] Despite improvement in maintaining functional status, in 2010 23% of older adults had at least one basic action difficulty or complex activity limitation.[3,9] Those persons most functionally impaired with loss of activities of daily living (ADLs) are increasing in proportion.[10] With an aging population, oral health needs, which can affect quality of life and overall health, remain a concern.

As the United States increasingly ages, older adults have retained more teeth than ever before. In 1965, every other man or woman older than 65 years in the United States had no natural teeth.[11] By contrast, in 2002 fewer than 25% of older adults were edentulous.[12] However, older adults with a chronic condition such as diabetes, arthritis, cardiovascular disease, or chronic obstructive pulmonary disease, experienced a higher rate of tooth loss and edentulism than those without a condition.[13] Furthermore, increasing numbers of elderly still necessitates fixed and removable complete dentures (CDs).[14] Sixty-four percent of older adults have either moderate or severe periodontitis.[15] Approximately 1 in 5 older adults have untreated coronal caries[13,16]; similarly, 1 in 5 report xerostomia.[17] Twelve percent of adults age 60 years and older have root caries.[12] The need for treatment exists.

In recognition of treatment needs, older adults continue to seek dental care. From 2000 to 2011, dental utilization among older adults increased from 38% to 42% (Medical Expenditure Panel Survey[18]). This trend is consistent with previous analyses of the same survey, which showed greater utilization among older adults than younger adults.[19] In 2007, 92% of dentists report treating vulnerable elderly patients.[20] In the same survey, dentists indicate a lack of information about managing patients with complex medical histories, xerostomia, and dementia. In the next sections, management of the treatment-planning process for older patients is discussed.

GOALS OF THE TREATMENT-PLANNING PROCESS

Treatment planning is the culmination of a comprehensive diagnostic process that usually precedes routine treatment.[21,22] A goal of treatment planning should be the development of a systematic means of action to eradicate dental disease, reestablish

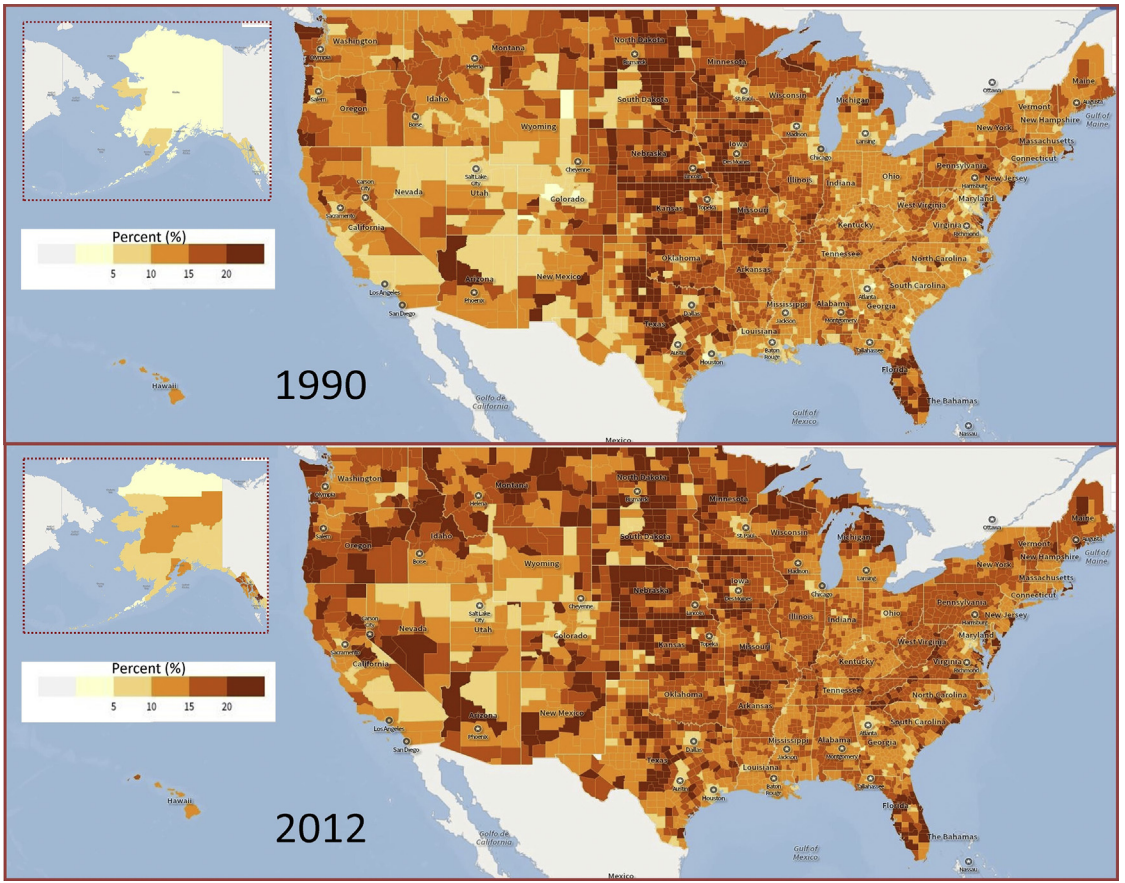

Fig. 1. Maps depicting percentage of people 65 years and older by county: 1990 and 2012. (*From* U.S. Census Bureau; American Community Survey, 2012. Available at: https://www.census.gov/acs/www/. Accessed December 20, 2013.)

and preserve as much function as possible, and enhance quality of life.[21,23] It should address the underlying disease process giving rise to signs and symptoms found on examination and elicited from patients.[22,24] Treatment plans should also attend to patients' chief complaints as quickly as possible, rely on individual needs, and prevent and manage tooth loss.[25,26] Furthermore, treatment plans should communicate the role of caregivers in maintenance and care, account for realistic circumstances, be continuously informed, make dental appointments as comfortable as possible, and emphasize continued monitoring of oral health and a functional dentition.[27] The most influential factors in comprehensive treatment planning are patients' disease status, followed by patients' requests, and lastly, patients' ability to pay.[21] The treatment-planning process facilitates diagnosis of disease(s) and results in a plan that accounts for patients' interests and expectations, treats diagnosed problems, and provides a stepwise strategy for maintaining oral health.

REVIEW OF CONVENTIONAL TREATMENT PLANNING

Treatment plans vary in the breadth of services required and the degree of comprehensiveness involved in treatment delivered. The simplest treatment plan consists of no treatment. On another level, limited treatment plans address only emergency and/or palliative care. Basic treatment plans are expanded in scope by providing for additional procedures such as scaling and root planing, denture relines, or minor operative interventions. Comprehensive treatment plans inherently address more complicated, multistep, sequenced procedures, which usually entail different disciplines such as endodontics and prosthodontics (**Fig. 2**).

With regard to comprehensive treatment planning, treatment considerations are incorporated through several phases dynamically informed by patient desires. Comprehensive treatment, as outlined in the treatment plan, is accomplished over these phases: diagnostic evaluation phase, priority and acute phase, disease control phase, restorative phase subdivided into preprosthetic and definitive prosthetic, and maintenance and prevention phase.[28]

Diagnosis of disease and resultant treatment plans culminate from a thorough diagnostic evaluation that assembles the following information: complete medical history, patient information and chief complaint, history of present illness, dental history, social history, family history, review of systems, intraoral/extraoral examination, laboratory results, vital signs, impressions and models, imaging such as radiographs, and photographs.[22,28] Additional information is often retrieved by a consultation with the patient's physician; the consultation may require follow-up conversations with multiple care providers in cases with a complicated medical history.[29]

Acute issues of an emergent or palliative nature are immediately addressed. Treatment of acute pain exemplifies a pressing issue requiring immediate attention. After an emergency or palliative phase, a disease-control component manages any extended conditions such as initial periodontal treatment, caries control activities, and prevention activities. The restorative and aesthetics phase following disease control may be further subdivided into a preprosthetic phase and definitive prosthetic phase. Critical sequencing in preparation for final restorations is planned during this phase. The preprosthetic phase often entails advanced treatment in oral surgery, endodontics, orthodontics, periodontal surgery, and implant placement. The final prosthetic phase involves certain types of permanent operative restorations, fixed and removable final prostheses. Finally, in the maintenance and prevention phase, all treatment is reevaluated and the patient is placed on a maintenance schedule. An appropriate prevention plan for the time interval between recall examinations is also determined.

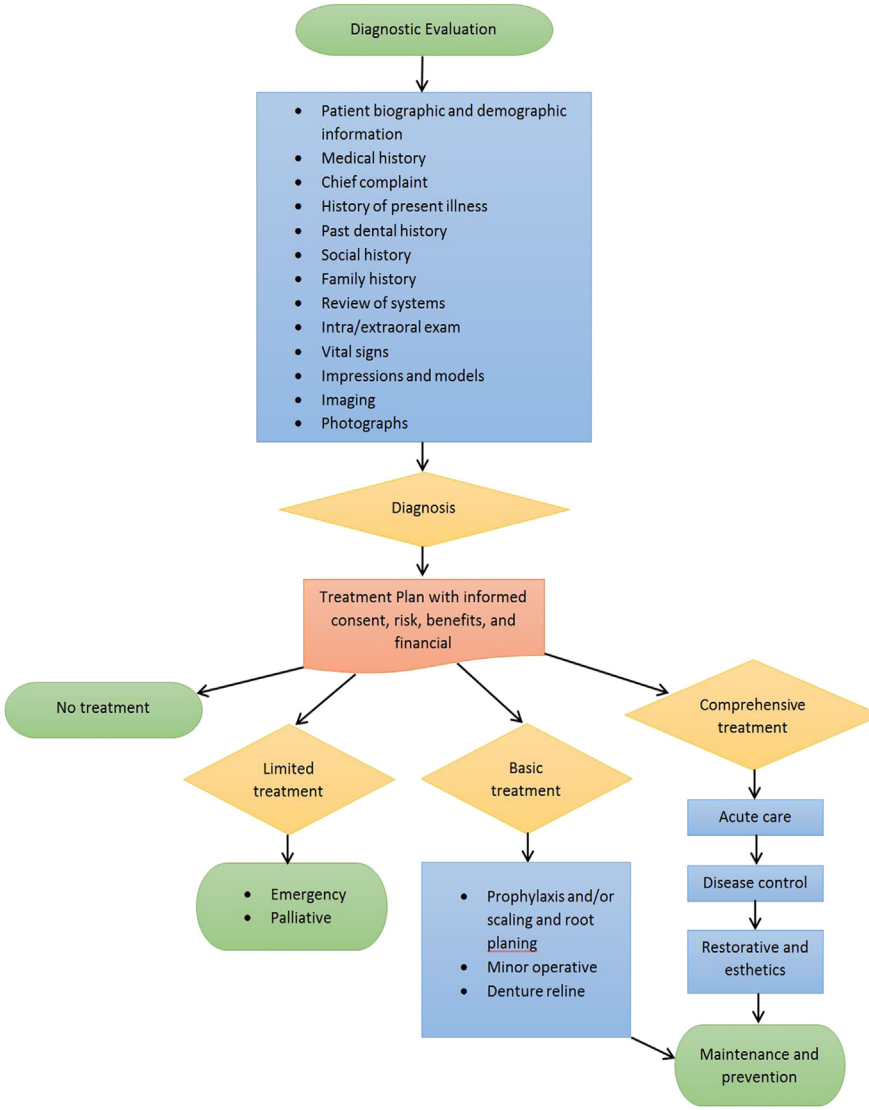

Fig. 2. Conventional treatment-planning process.

MODELS OF GERIATRIC DENTAL TREATMENT PLANNING

This section provides an overview of treatment-planning models that attempt to account for the myriad of considerations accompanying dental care for the elderly, and **Fig. 3** presents a diagram summarizing of the factors presented in these models. A straightforward yet comprehensive approach to treatment planning for older adults uses the familiar mnemonic SOAP (Subjective findings, Objective findings, Assessment, and Plan).[24] In geriatric patients, the subjective findings include additional information concerning functional status as described by the ability to carry out ADLs and instrumental activities of daily living.[24] Otherwise, objective findings and resultant assessment develop in the usual fashion. Finally, the plan section details any

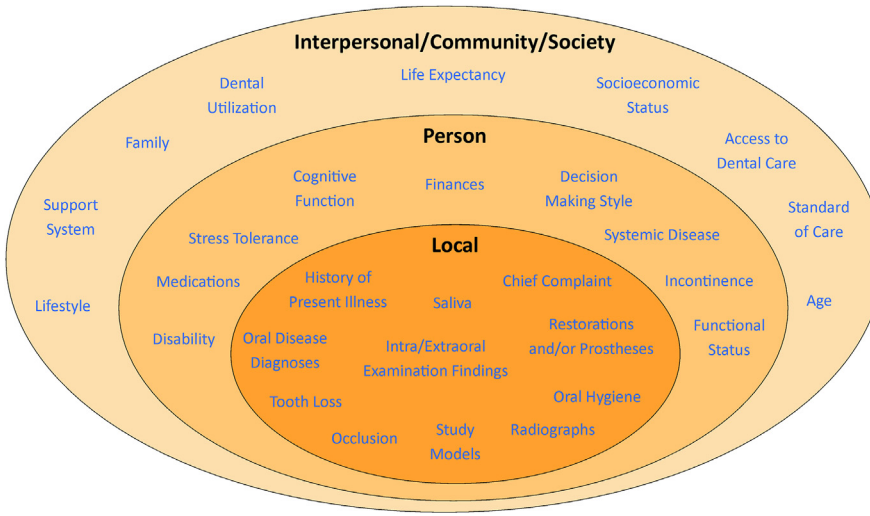

Fig. 3. Considerations in treatment planning grouped by proximity to oral health.

treatment performed and delineates a comprehensive, sequenced treatment plan, which may or may not take into account modifying factors.[22,24]

Another approach to treatment planning for older adults uses the easy to remember mnemonic OSCAR, which stands for Oral factors, Systemic factors, Capability, Autonomy, and Reality.[30] The assessment should follow the order of the mnemonic. Oral factors take into consideration the current dentition and restorations, periodontium, oral hygiene and root caries, salivary secretions, tooth loss, mucosal tissues, removable prosthesis, and occlusion. Systemic factors encompass normal changes related to aging and comorbidity, effect of medications, and communication between the dentist and physician(s) in managing the geriatric dental patient with a medically compromised health status. Capability refers to attributes such as the ability to carry out ADLs, walk with or without assistance, and control incontinence. Autonomy relates to the patient's ability to independently make health care decisions within the context of cognitive impairment stemming from a history of stroke, dementia, depression, or other conditions. Lastly, reality refers to financial issues and life expectancy.

The rational treatment model considers the influence of modifying factors on primary factors, which in turn alter the biofilm and, consequently, the development of oral diseases and conditions.[31,32] Modifying factors such as lifestyle, socioeconomic status, medications, cognition, disability, and medical and dental history alter the balance of diet, saliva, and genetics, and affects chemotherapeutics and oral hygiene. This model, adapted from a caries risk model, explains how etiologic factors affect the development of caries, periodontal disease, tooth loss, and mucosal lesions. Furthermore, risks and benefits of treatment also influence whether no treatment, emergency care, limited treatment, or comprehensive care is planned. In addition, an example of the rational treatment model depicts the utility of a decision tree in treatment planning for dentate adults.[33] The patient's desires, expectations, dental needs, quality-of-life expectations, stress tolerance, financial status, and oral hygiene capacity, along with the dentist's experience and skill level, direct the treatment-planning process.[25,32]

Another model uses a clinical reasoning sequence in decision making and resolution of dental problems.[32] In the model, 3 action sequences are presented in resolving

dental problems: (1) determine the cause, (2) choose an action, and (3) implement the plan. To determine cause, the problem must be defined, other possible causes considered, and possible causes tested. To help choose an action, goals in consultation with the patient must be established, alternatives examined, and adverse consequences considered. Finally, implementation of the plan involves anticipating potential problems, taking preventive actions, and setting up contingency plans. This systematic approach can be successful if the steps in the action sequences are effective.

Another approach addresses complexity and uncertainty in treatment planning in elderly patients, and provides a basis for prioritizing and weighing factors affecting the treatment-planning process.[34] More than 20 factors contribute to the process. Some important factors include: reliance on biological age rather than chronologic age; consideration of the useful life of dental interventions such as fillings and prosthetics in the context of life expectancy for older adults; and reconciliation of expectations between the patient, other involved parties, and the dentist through effective communication. To address uncertainties inherent to treatment planning, clear decisions should be made and treatment progress monitored. Careful documentation from evaluation to implementation protects from uncertainty.

Mulligan and Vanderlinde[35] present a geriatric care model that is intended to account for the factors precipitating successful treatment in any setting. The model depicts the interplay between 4 broad domains: dental/oral, medical, psychosocial, and behavioral. Examination findings, influence of systemic disease, physician consult, dental specialty referral, treatment plan modifications, and selection of appropriate treatment options constitute the factors within the dental/oral category. Suggested medical factors to consider include: systemic conditions; medications, including adverse effects and drug-drug interactions; laboratory values; special issues; and medical referral. Psychosocial factors influencing treatment plan include: informal assessment; basis of functioning such as cognition, recognition, reasoning, and commitment; and support system from the societal to the personal. Among behavioral factors, the areas of consideration are: decision-making style; ability to cooperate with treatment; sedation involving feasibility and need; understanding of one's own limitations; need for personal assistance; home-care capability; and adherence potential. This model guides the clinician in attenuating psychosocial, medical, and behavioral barriers.

Finally, a more specific approach to treatment planning addresses dementia and its role in planning.[27] In the early stage of dementia, when changes in cognitive function are minimal, changes to the treatment-planning process are minimal as well. However, if there is an accompanying degenerative disease diagnosis such as Alzheimer disease, the treatment plan should be designed to anticipate future loss of cognitive function, include aggressive prevention, and restore function with celerity. Treatment plans for middle and late stages of dementia may require considerations such as modifying appointment length, using sedation, and increasing the frequency of recalls. In the middle stages of dementia, it is suggested that limited treatment plans are designed with minimal changes, and should include aggressive prevention along with communication of prevention strategies with caregivers. Treatment of those at advanced and terminal stages may be basic, with palliative and emergency care aimed at maintaining the dentition. As described, many considerations are factored into treatment planning for the older adult. Nonetheless, throughout the treatment-planning process the patient's desires continually influence clinical decision making. However, communication between the dentist and an older patient can be complicated by competency and informed consent issues.

DECISION-MAKING CAPACITY, COMPETENCY, AND INFORMED CONSENT

Before any dental examination, the clinician must obtain a valid consent to treat or not treat. In general, informed consent requires a disclosure of the relevant risks of, benefits of, and alternatives to treatment that potentially affect the patient's decision on the treatment. However, proper disclosure by the clinician alone is insufficient to obtaining a valid consent. The patient must also possess decision-making capacity as defined by ability to comprehend, appreciate, and reason the contingencies of treatment or no treatment[36,37]; the ability to weigh the risks and benefits of treatment, no treatment, and alternatives; and the ability to communicate his or her choices.[37,38] In some instances, especially in the elderly, determination of capacity may be unclear and subject to bias.[36] The elderly with dementia and/or psychiatric illness, nursing home residents, and hospitalized elderly all have increased risk for reduced consent capacity.[39] In most cases when a patient is determined to lack capacity, the clinician assigns a health care proxy to consent for that patient. Dentists are legally bound by the same process and standards as physicians and other health care professionals in securing informed consent.[40] Therefore, dentists should know and comply with the legal obligation regarding capacity and informed consent for the state in which they practice.[41] The evaluation for capacity to consent for treatment should be a fluid process to be evaluated at each treatment decision. The patient should have self-determination of as much of their treatment as possible.

Although decision-making capacity and competency are similar; they are not synonymous. The legal determination of patient competency describes the ability of the patient to make informed decisions. However, patient competency differs in scope, determination, and purpose. Lack of capacity does not preclude a patient from making any decisions. Each decision varies in risk, benefits, and complexities, and should be independently assessed. When appropriate, patients should be empowered to make their own decisions. However, competency, formally determined by a court of law, concerns the individual's mental capacity to make autonomous decisions in general. At the time a person is determined incompetent, a court appoints a guardian who acts as a surrogate decision maker. In addition to health care decisions, the guardian handles decisions regarding contracts, finances, and other personal affairs. In this case, obtaining consent is straightforward; the guardian provides informed consent. A case is now presented that emphasizes many of the factors highlighted in this discussion of treatment-planning considerations.

AUTHORS' CASE REPORT

Presentation and Examination

A 73-year-old Greek American woman, Maria, was referred to our clinic by her internist. Her chief complaint was "I don't like the way my teeth look. It looks like I don't have teeth." She arrived with her 42-year-old niece. Maria suffered from osteoarthritis of the hips and knees, and had undergone total hip replacement on her right side 4 years ago. However, she still had some difficulty walking without the assistance of a cane. She was morbidly obese and experienced breathing difficulty on exertion. Maria's medical conditions and medications are listed in **Table 1**.

Maria immigrated to the United States from Greece as a teenager with her parents and one sister. She was a retired elementary school teacher, never had children, and lived alone with her 2 cats. At the time of treatment, Maria's sister and parents had been deceased. Her niece helped transport her to her medical and dental visits, and assisted with some daily chores. Her internist informed us Maria had intact ADL skills. Maria smoked cigarettes for more than 20 years and quit more than 10 years

Table 1
Medical status of the patient

Systemic Conditions	Mental Conditions	Medications
Arterial stents	Alzheimer disease (stage 1: early/mild)	Baby aspirin
Chronic obstructive pulmonary disease	Anxiety	Citalopram
Coronary artery disease	Depression	Donepezil
Diabetes mellitus type 2		Hydrochlorothiazide
Hypercholesterolemia		Ibuprofen
Hypertension		Lisinopril
Mild rheumatoid arthritis in hands		Lorazepam
Obesity		Lovastatin
Osteoarthritis with previous total joint replacement		Metformin
		Warfarin

ago. She denied use of alcohol. At her initial appointment, Maria was verbally coherent. She occasionally forgot words but her communication skills remained largely intact. Her dementia was mild and she had clear decision-making capacity. Photographs and radiographs from her initial visit are presented in Fig. 4.

Maria strongly preferred not to be left without teeth at any point during treatment. She remarked on how as a child her friends and family complimented her on her beautiful smile. She expressed feelings of depression over her deteriorating appearance and inability to chew. She was edentulous on the maxilla and partially edentulous on the mandible. Her existing natural teeth consisted of her 6 mandibular anterior teeth and one mandibular first premolar on her right side (see Fig. 4B). Findings from her examination showed generalized periodontal attachment loss with slight mobility of all her teeth, periapical radiolucencies, extensive root caries, and recurrent decay under existing crowns (see Fig. 4C). Her existing maxillary CD exhibited poor upper lip support and a collapsed vertical dimension (see Fig. 4A, D). In addition, she showed signs of Kelly combination syndrome: bilateral increase of her maxillary tuberosities, canting of the occlusal plane upward toward the anterior, and loss of anterior alveolar ridge support (see Fig. 4E).[2] Maria informed us that the maxillary CD was more than 10 years old, and she never wore her mandibular removable partial denture (RPD) because of discomfort.

Factors in Assessment

An important part of assessment is identifying what the oral health problems are, how they formed, and why they are present. The processes of examining the oral cavity, diagnosing oral diseases, and identifying local factors that cause diseases may be routine for clinicians. However, more distal factors that contribute to oral health problems may be more difficult to identify; such factors include financial, psychosocial, and behavioral problems (see Fig. 3).[42,43]

The following are some examples from Maria's case. First, Maria lacked dental insurance for nearly a decade. She was on a fixed income and thought that dental care was "too expensive." She sparingly visited the dentist and did not perceive any need. She only came to see us after her geriatrician made the referral when she complained about the appearance of her smile. Maria did not realize that her oral health was in decline, because of her lack of symptoms and perceived needs. Second, Maria's depression and anxiety likely negatively affected her hygiene habits, diet, oral health perception, and motivation.[44,45] Depressed elders are less likely to be interested in oral hygiene and more likely to consume a cariogenic diet.[46,47] A third example is the possible effects on Maria's oral health by her diabetes; diabetes, especially

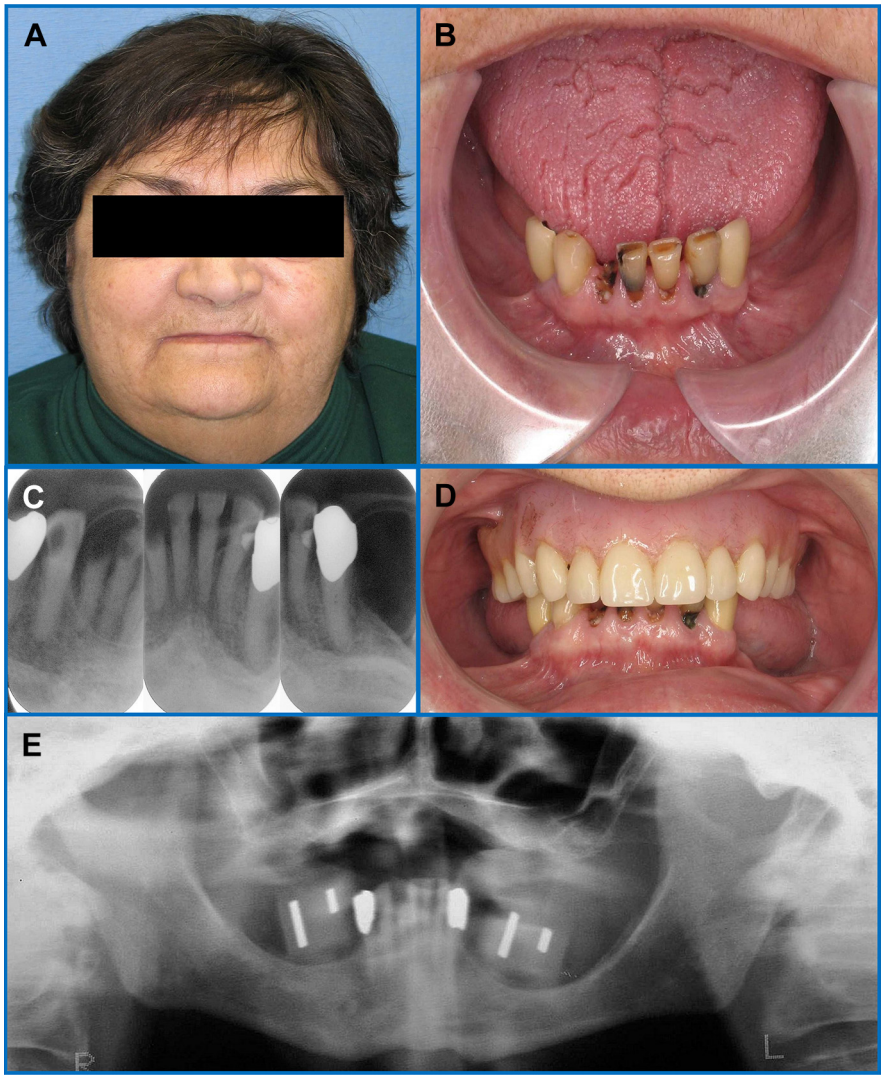

Fig. 4. Pretreatment photos and radiographs. (*A*) Face showing lack of lip support. (*B*) Remaining teeth. (*C*) Periapical radiographs. (*D*) Preexisting maxillary complete denture. (*E*) Panoramic radiograph.

when uncontrolled, has been identified as a risk factor for several diseases such as periodontal disease, caries, and endodontic infections.[47–50] Fourth, the link between cardiovascular disease and periodontal disease has been well documented, with nearly 500 peer-reviewed articles on the subject published between 1950 and 2011.[51] Maria's coronary artery disease (CAD) may have been associated with her periodontal disease and partial edentulism. Moreover, a history of periodontal disease may have contributed to her missing teeth. Finally, a side effect of nearly all of her medications is xerostomia. Xerostomia has been well documented to cause multiple oral health problems such as the root surface caries and periodontal disease that

were observed in Maria's mouth.[52] For a more detailed discussion about the effects of systemic diseases and medications on oral health, please refer to the article by Tavares and colleagues on systemic and oral health elsewhere in this issue. As demonstrated, the combination of Maria's lack of perceived need, financial barrier, comorbidities, and polypharmacy are likely to have contributed to the decline in her oral health.

Factors in Planning and Implementation

At first glance, Maria's primary complaint may indicate a straightforward denture remake. However, after gathering more information, several factors arise that add complexity to the planning and implementing process. Her multiple chronic conditions may limit her tolerance for treatment and increase likelihood for fragmented and multiprovider medical care.[53] Moreover, the effects of her numerous medications would necessitate modifying her dental treatment. The following are several examples of how these factors influence treatment.

First, Maria's progressing Alzheimer disease may warrant a more aggressive treatment approach in anticipation of decline.[27] For example, early extractions and implants may be good options. Second, if a removable prosthesis is planned, it should be designed for easy removal because of the rheumatoid arthritis in her hands, yet it should still be retentive and stable in the mouth, enabling her to chew, speak, and smile. Third, one should consider having Maria sit upright for dental treatment because of breathing difficulties exacerbated by her chronic obstructive pulmonary disease (COPD) when lying supine. Fourth, epinephrine in local anesthetics should be limited to 0.036 mg per visit because of Maria's CAD.[54,55] Moreover, short appointments later in the morning are recommended for patients with cardiovascular disease.[54,56] Fifth, arterial stents do not require antibiotic prophylaxis[57]; however, as of this publication date, antibiotic prophylaxis before certain dental procedures may be required for patients with total joint replacement beyond the previously recommended period of 2 years after replacement.[58] A consult with the patient's orthopedic surgeon is recommended. Details for joint replacement antibiotic prophylaxis recommendations are discussed in an article by Tavares and colleagues elsewhere in this issue. Sixth, Maria's xerostomia and COPD increase her risk for dysphagia and aspiration pneumonia.[59,60] Treatment modifications such as nonalcoholic chlorhexidine treatment, fluoride treatment, frequent recall, or, in the extreme case, extractions may help to reduce the presence of bacteria and plaque in the mouth.[52,61,62] Lastly, Maria's internist or cardiologist should be consulted to manage her anticoagulation medications during her dental treatment. For invasive procedures such as extractions, implants, and periodontal and endodontic surgeries, the international normalized ratio (INR) should ideally be recorded on the day of surgery and no more than 48 hours before surgery.[63] Most instances of dental surgery will not require cessation of warfarin therapy if the INR is kept below 4.0.[64] If the INR is near the higher range, the dentist should be prepared to manage bleeding peri-/postoperatively. Moreover, when a patient like Maria is on multiple anticoagulant medications, it may be necessary to stop 1 or more of the medications before surgery. These examples illustrate a few of the management considerations that must take place during treatment in a patient presenting with multiple chronic conditions and medications.

Treatment

A challenging component of planning for Maria's treatment and that for other elders, especially those who are frail, is the uncertainty with prognosis and outcomes of the various treatment modalities resulting from multiple influencing variables and the

lack of good evidence. Therefore, development of a rational treatment plan becomes a subjective process biased by a clinician's experience.[1] Maria's case is no different. The treatment presented herein is one of several rational treatment options that could have effectively addressed her chief complaint and dental needs.

Maria wanted more natural-looking teeth but also wanted to be able to chew her food and speak without her dentures "flopping around." Although she presented with multiple chronic conditions, Maria was functioning highly with intact ADLs at the start of her treatment. She could tolerate most dental procedures including endodontic and implant procedures. However, cost was a major limiting factor for Maria and she had no desire to have fixed prosthetics. Therefore, we considered removable prosthetic options that would meet her aesthetic and functional needs in consideration of her limited financial resources, physical limitations, and impending disease progression.

Her remaining 7 mandibular teeth were extracted. Antibiotic prophylaxis was administered before surgery on the orthopedic surgeon's recommendation. During the same extraction surgery, 2 implants were immediately placed in the mandibular canine regions to serve as overdenture abutments. Thus we avoided separate surgeries for each procedure. Immediate maxillary and mandibular CDs were fabricated before surgery (**Fig. 5**A, B) and delivered immediately afterward (see **Fig. 5**D). After discussion with her cardiologist, we maintained warfarin treatment but stopped aspirin 10 days before surgery. Her INR was identified to be 2.8 at 4 hours before surgery with a quick capillary finger-stick test. Bleeding was well controlled during and after surgery with hemostatic techniques and good suturing (see **Fig. 5**C).

Alternative Treatment Comparisons

An alternative to extractions would have been to undergo caries control, endodontic and periodontal treatment, and crowns. Aesthetic correction would be much more challenging if mandibular teeth were left in place. For example, **Fig. 5**A, B shows the wax-up of the immediate CDs and illustrates the excessive overjet present.

In Maria's case the benefits of implants outweighed attempting to restore her teeth: there was a significant cost saving; implant abutments would be much easier to maintain as her dementia would lead to increased disability and frailty; the prognosis for the alternative endodontic and periodontal treatment may be worsened by her comorbidities[47–50]; her risk for dental decay for the future would be eliminated; and the simultaneous fabrication of the maxillary and mandibular CDs allowed for an immediate improvement in aesthetics. Implant-supported mandibular overdenture has become the standard of care for completely edentulous patients.[65,66] Moreover, improvements in oral health–related quality of life have been well documented.[67–69] However, the evidence comparing mandibular RPDs and implant-supported overdentures is lacking.

Less costly options for her remaining teeth might involve no treatment or a minimalist approach, more appropriate for end-of-life care, consisting of denture remake/reline, interim therapeutic restorations for caries, antibiotics for symptomatic endodontic infection, and chlorhexidine swabs for periodontal infections. These options were ruled out because of her high function and life expectancy of more than 12 years. Maria was happy with the aesthetics of the immediate CDs. Unfortunately, she was disappointed in the function of the mandibular CD for the first 6 months while awaiting osseointegration. After 6 months, we exposed the implants and placed overdenture abutments (see **Fig. 5**E). We retrofitted her mandibular CD to the new abutments, after which she felt an immediate improvement, and was happy with the final results (see **Fig. 5**F).

Fig. 5. Treatment photos. (*A*, *B*) Wax-up to dentures with appropriate vertical dimension and good support of facial muscles and lips. (*C*) After extractions and immediate implant placements, showing adequate hemostasis despite warfarin therapy. (*D*) After surgery, with immediate complete dentures (CDs) in mouth. (*E*) Six months postoperatively, overdenture abutments were placed. Mandibular CD was modified and retrofitted to abutments. (*F*) Six months postoperatively, with final modified CDs.

SUMMARY

The older patient often presents with clinically challenging dental problems and complex medical, social, psychological, and financial barriers to oral health. With careful consideration, the clinician must design a thoughtfully sequenced treatment plan that addresses the dental condition and facilitates improved oral health. This article presents several models and a summary of treatment-planning considerations that serve to guide the clinician in this endeavor.

As the case of Maria evinces, age alone does not dictate the course of dental disease. She required several alterations to her treatment stemming from a compromised medical condition, disability, and impending cognitive decline. The combination of

these factors may well put her at greater risk for frailty, and thus precipitate the need for greater modifications during future treatment. Flexibility and good communication during the treatment-planning process ameliorated her aesthetic concerns and ultimately led to a successful outcome.

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Minimal Intervention Dentistry: Part 1. Strategies for Addressing the New Caries Challenge in Older Patients

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ABSTRACT

The aging of the population combined with increased retention of natural teeth into old age means that clinicians now face a new caries challenge in older dentate patients. An increase in the onset of dental caries is evident among patients who may not have had high levels of caries in the past and who may have undergone extensive restorative procedures during their lifetimes. Minimal intervention dentistry (MID), a modern evidence-based approach to caries management in dentate patients, uses the medical model, whereby disease is controlled by the "oral physician" and an affiliated dental team. The main components of a geriatric approach to MID are assessment of the risk of disease, with a focus on early detection and prevention; external and internal remineralization; use of a range of restorations, dental materials and equipment; and surgical intervention only when required and only after disease has been controlled. This first in a series of 2 articles describes and illustrates oral disease management in geriatric MID, which involves the assessment and management of a diverse range of primary and modifying factors, integrated with an evaluation of the plaque–biofilm interface and the resultant dynamic oral disease process.

MeSH Key Words: bacterial infections/prevention & control; dental caries/microbiology; dental caries/prevention & control; tooth remineralization

The aging of the population, combined with increased retention of natural teeth into old age, means that clinicians now face a new caries challenge in older dentate patients. Many patients are living longer with more chronic medical conditions for which they are taking more medications. A resulting increase in the onset of dental caries is evident among patients who may not have had high levels of caries in the past and who may have undergone extensive restorative procedures during their lifetimes (**Fig. 1**). There is increasing longitudinal evidence of these changing caries patterns in adult and older adult cohorts, with rampant caries often occurring in relatively short time periods.[1–3] At any one point in time, not all older adults will have significant oral disease. However, many older adults will eventually experience significant oral disease as they become more frail, more dependent and more cognitively impaired. Longitudinal epidemiological and clinical research is enabling refinement of estimates of the time of onset of significant oral disease, which appears to be well before people move to nursing homes and other long-term care facilities, when they are still living in the community (**Fig. 2**).[1–3]

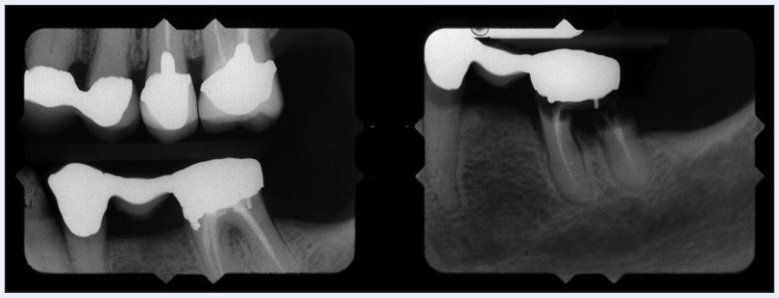

Figure 1: Multiple caries in an older woman who had not experienced this problem previously. Between 1999 (age 58 years) and 2005 (age 64 years), 3 chronic medical conditions developed in this patient, and 2 medications with oral anticholinergic adverse effects were initiated; the patient presented with both xerostomia and salivary gland dysfunction.

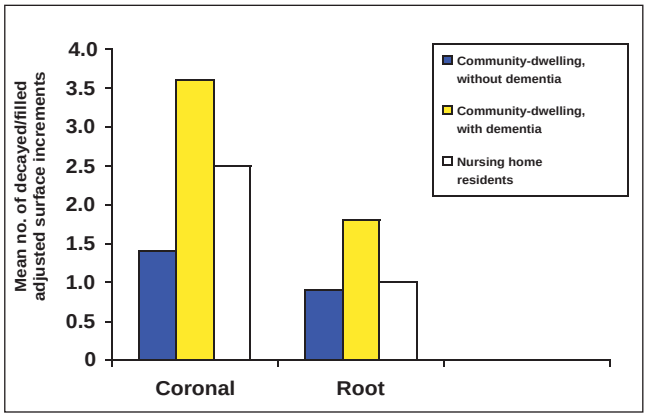

Figure 2: Annualized coronal and root adjusted caries increments in subgroups of older adults.[1] Sources: South Australian Dental Longitudinal Study, Oral Health of Community-Dwelling Older Adults with Dementia study, and Adelaide Dental Study of Nursing Homes.

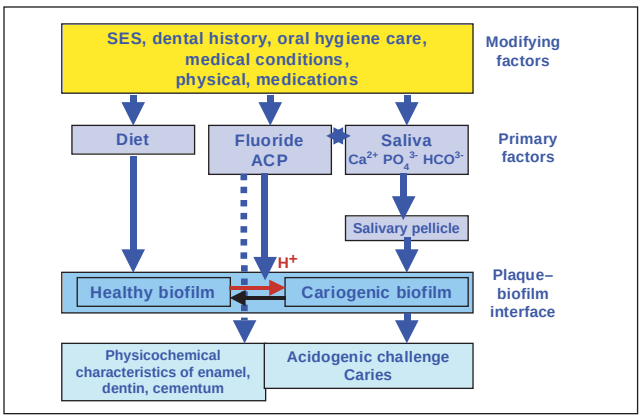

Figure 3: Caries management in minimal intervention dentistry. ACP = amorphous calcium phosphate, SES = socioeconomic status. Modified from Ngo.[11]

Traditionally, the management of dental caries in adult and older adult patients by the dental surgeon used an "extension for prevention" surgical approach, with G.V. Black cavity designs specified for each lesion type.[4] Up to 75% of dentists' time has been spent replacing such restorations.[5–7] Black was also visionary with regard to patients' susceptibility and immunity to dental caries: "Observations already made render it certain that caries of the teeth has its beginning only when the conditions of the oral secretions are such that the micro-organisms causing caries form gelatinous plaques, by which they are glued to the surfaces of the teeth."[8] On the basis of the early observations by Black and others and the emergence of atraumatic restorative technique in the 1970s, a more modern evidence-based approach to caries management has evolved: minimal intervention dentistry (MID). MID uses the medical model whereby disease is controlled by the "oral physician" and an affiliated dental team.[5–7,9–11] The main components of MID are assessment of the risk of disease, with a focus on early detection and prevention; external and internal remineralization; use of a range of restorations, dental materials and equipment; and surgical intervention only when required and only after disease has been controlled.[5–7,9–11]

Oral disease management in MID involves the assessment and management of a diverse group of primary and modifying factors (diet, saliva, and fluoride or amorphous calcium phosphate [ACP]), integrated with an evaluation of the plaque–biofilm interface and the resultant dynamic oral disease process. **Figure 3** illustrates this model for dental caries.[12] A variety of paper and electronic formats are available for systematically conducting this assessment, including CAMBRA[13] and Ngo's Traffic Light system.[12] During the assessment, all modifying factors and life characteristics are reviewed with the patient, including past and present socioeconomic status, demographic characteristics, medical conditions, medications, physical and functional status, cognitive status, dental history and oral hygiene. For older patients, the practitioner may need to assess other modifying factors such as those discussed by Ettinger and Beck in the concept of rational dental treatment planning: social support, transportation, fear and anxiety, consent, restraint and perceived need.[14] This review and the identification of which modifying factors have an effect on the primary factors is key to the use of MID in the clinical management of oral diseases. In particular, it is essential to assess the clinical pattern of demineralization and caries in the context of all

Table 1 The Xerostomia Inventory[15]

For each row, please circle the answer that best applies to you during the last year					
1. I sip liquids to aid in swallowing food					
Never	Hardly ever	Occasionally	Fairly often	Very often	Don't know
2. My mouth feels dry when eating a meal					
Never	Hardly ever	Occasionally	Fairly often	Very often	Don't know
3. I suck candy to relieve dry mouth					
Never	Hardly ever	Occasionally	Fairly often	Very often	Don't know
4. My lips feel dry					
Never	Hardly ever	Occasionally	Fairly often	Very often	Don't know
5. I have difficulties swallowing certain foods					
Never	Hardly ever	Occasionally	Fairly often	Very often	Don't know
6. My mouth feels dry					
Never	Hardly ever	Occasionally	Fairly often	Very often	Don't know
7. I get up at night to drink					
Never	Hardly ever	Occasionally	Fairly often	Very often	Don't know
8. My eyes feel dry					
Never	Hardly ever	Occasionally	Fairly often	Very often	Don't know
9. I have difficulty eating dry foods					
Never	Hardly ever	Occasionally	Fairly often	Very often	Don't know
10. I have difficulty swallowing					
Never	Hardly ever	Occasionally	Fairly often	Very often	Don't know
11. The skin of my face feels dry					
Never	Hardly ever	Occasionally	Fairly often	Very often	Don't know

modifying, primary and biofilm factors. Because the processes of demineralization and remineralization are continuous, the mouth of an older adult who has active or rampant caries will exhibit areas with a range of demineralization, from low to high, and various degrees of cavitation.

Primary Factors

Saliva

A variety of terms are used and confused for problems related to dry mouth. Xerostomia is a person's subjective perception of a dry mouth.[15,16] An observable change in the quality or quantity of saliva is known as salivary dysfunction or salivary gland hypofunction (SGH).[15–18] Xerostomia can be assessed only by direct questioning of the patient, whereas SGH can be determined clinically.[19,20] When the salivary flow rate drops "below a designated clinical threshold [patients] are categorized as having SGH."[21] The clinician can ask patients to complete the Xerostomia Inventory (XI), for which higher scores indicate worsening xerostomia (**Table 1**).[16,18] Salivary function can be assessed systematically by a simple method described by Ngo[12] and Walsh.[20] Several testing kits are available commercially, including GC Saliva Check (GC America, Alsip, Ill.), which assess unstimulated and stimulated saliva flow rates and pH, as well as buffering capacity. Effective treatment of xerostomia and SGH is difficult and multifaceted. Results from the Xerostomia Inventory and saliva testing help the clinician in choosing between saliva substitutes and stimulants (secretagogues) or recommending other strategies (**Table 2**).[17,21]

Diet and Xylitol

It is essential to minimize the consumption of fermentable dietary substrates, including those in foods, drinks and medications.[20] Nonfermentable dietary sweeteners, such as xylitol, sorbitol, aspartame or saccharine, are recommended wherever possible.[20] Polyols such as xylitol are "anticariogenic," as shown by decreased acid fermenta-

Table 2 Treatment of xerostomia and salivary gland hypofunction

General treatment
Change medications to classes that are less anticholinergic and lead to less fluid retention
Increase water intake (if not contraindicated by medications and medical conditions).
Avoid dental products with additives (e.g., sodium lauryl sulfate) or alcohol (e.g., mouthrinses)
Use a room humidifier during the day and at night.
Saliva substitutes and oral lubricants[a]
Oral Balance Gel, Denture Grip, Biotene Range (mouthrinse, toothpaste and gum) (Laclede Inc, Rancho Dominguez, Calif.)
MI Paste (GC America, Alsip, Ill.); not for use by people with allergy to IgE casein; appropriate for those with lactose intolerance
Range of other products such as Moi-Stir (Kingswood Laboratories, Indianapolis, Ind.), MouthKote (Parnell Pharmaceuticals Inc, San Rafael, Calif.), XeroLube (Colgate Oral Pharmaceuticals, Canton, Mass.)
Saliva stimulants[b]
Sugar-free gum and candy several times daily (e.g., xylitol gum and candy products, Trident White with Recaldent gum (Cadbury Adams USA LLC, Parsippany, N.J.)
SalivaSure tablets (Scandanavian Formulas, Sellersville, Penn.)
Place near major salivary ducts several times daily and suck. Contains fruit acid which is pH buffered.
Systemic sialogogue therapy with pilocarpine or cevimeline; watch for adverse effects.

[a]*Use several times daily as needed, including before meals and bedtime*
[b]*Useful only if salivary gland tissue remains*

tion by *Streptococcus mutans*.[22] The findings of evidence-based reviews of xylitol have varied and are not conclusive.[22,23] However, the use of polyols in chewing gum and candy has greatly increased since research indicated reduced mother-to-child transmission of *S. mutans*. Xylitol produces some gastrointestinal adverse effects.[24] It is incorporated in dental products intended for use by older patients, although its concentrations can be difficult to ascertain. In recent research involving the use of xylitol for a geriatric population living in an institution, *S. mutans* counts were reduced to a level better than that achieved by the use of chlorhexidine.[25]

Fluoride and Amorphous Calcium Phosphate

Fluoride, a cornerstone of modern preventive dentistry, acts in 3 ways: (1) it inhibits demineralization, (2) it increases the resistance of enamel to acid attack and increases remineralization by formation of fluoride-enriched apatite, and (3) at high concentrations it can inhibit bacterial metabolism.[26] Frequent exposure to fluoride achieves optimal low-level loading of the salivary fluoride reservoir.[27] In older patients, sodium fluorides are generally recommended because of the detrimental impact of stannous and acidulated fluorides on restorative materials (e.g., staining, removal of glaze from ceramics, roughening of composites and glass ionomers).[26] Sodium fluorides are also less irritating to oral soft tissues. A variety of topical sodium fluorides are available for use by older adults. Those with low caries risk can use a 1,100 ppm toothpaste, which can be supplemented or replaced as caries risk increases with a 5,000 ppm toothpaste or gel (available by prescription). The use of sodium fluoride mouthrinses is decreasing with the introduction of the 5,000 ppm toothpastes. Fluoride foams (placed in trays) at 12,300 ppm are challenging for older patients to use, and the use of these foams has decreased with greater use of 22,600 ppm (5%) fluoride varnishes. These varnishes may be used annually for older patients with low caries risk or more frequently for those with high caries risk. Caries reduction has been observed in the following studies of adult patients[28–33]:

- 1,100 ppm vs. nonfluoridated toothpaste
- 5,000 ppm vs. 1,100 ppm toothpaste
- 5,000 ppm or 12,300 ppm toothpastes or gels vs. sodium fluoride (NaF) 0.5% rinses
- NaF 22,600 ppm varnish (increased therapeutic effect when used in combination with other lower concentration fluorides and chlorhexidine)

Although the use of topical fluorides has reduced the frequency of caries for many adults and older adults, some patients experience high caries rates despite the use of fluoride.[26] Such patients need additional adjunctive therapies, including chemoprophylactics, amorphous calcium phosphates and therapies for saliva dysfunction.

Calcium phosphate products in various forms have been tested for many years. However, maintaining calcium and phosphate in an amorphous state in the product and in the oral environment has been a challenge. Recently, carriers for calcium and phosphate, such as the casein protein molecule and bioactive glasses, have been developed. Remineralization from fluoride ions is more superficial than that from calcium, phosphate and fluoride ions in combination. However, the 3 ions together can remineralize in depth, "virtually eliminating white spot lesions and restoring full esthetics to enamel and resistance to further acid attack."[34]

As alluded to above, one method for stabilizing calcium and phosphate ions is through application of casein phosphopeptides (CPPs), which stabilize nanoclusters of amorphous calcium phosphate (ACP) in supersaturated

Table 3 Examples of oral hygiene protocols for older patients

Patient characteristics	Toothpaste application	Recaldent product (MI Paste or Trident White Gum)	Chlorhexidine gluconate 0.12% mouthrinse (rinse or spray bottle)	Fluoride varnish (22,600 ppm)
Low caries risk and hypersensitivity	1,100 ppm 2 times daily	Use paste and/or gum several times daily (including after toothbrushing) for hypersensitivity	Not needed	1 or 2 times annually
Low caries risk and gingivitis	1,100 ppm 2 times daily	Not needed	Once daily after lunch for 4 weeks and then review gingivitis	1 or 2 times annually
High caries risk and saliva dysfunction	5,000 ppm 2 times daily (morning and night)	Use paste and/or gum several times daily (including after toothbrushing) for saliva dysfunction and caries	Once daily after lunch for 4 weeks and then review oral bacteria and caries rate	Several times annually as patient attendance permits

solution, thus preventing growth of clusters to the critical size required for phase transformations.[35] CPP–ACP becomes localized at the tooth surface by binding to dental plaque (to the microorganisms and in extracellular matrix) and by binding to exposed dentin.[34] CPPs are soluble at acid pH and so are activated in the acidic oral environment; they also buffer plaque pH to produce calcium and phosphate ions, in particular the neutral ion pair $CaHPO_4^O$. The presence of this neutral ion pair is highly correlated with the rate of remineralization of enamel subsurface lesions and with prevention of demineralization.[34] CPP–ACP also interacts with localized fluoride ions to produce a novel amorphous calcium fluoride phosphate (ACFP) phase $Ca_8(PO_4)_5FxH_2O$. Evidence to date has highlighted a several-fold increase in remineralization through the additive effects of fluoride, calcium and phosphate.[34] CPP–ACP has been commercially developed as Recaldent (Bonlac Bioscience International Pty Ltd, Melbourne, Australia), which is sold for professional use as MI Paste (10% CPP–ACP) (GC America, Alsip, Ill.) and for consumer use as a range of chewing gum products (e.g., Trident White with Recaldent, 0.6% CPP–ACP; Cadbury Adams USA LLC, Parsippany, N.J.). Because of the casein content, it is essential to question all potential users of Recaldent products as to any possible IgE-mediated casein allergies (by posing the question "Do you ever have any allergic reactions when you drink milk?") For older patients who do not drink milk and have never liked drinking milk, it may be better to avoid recommending this product. However, older patients with lactose intolerance can use Recaldent products, as they do not contain lactose. Recaldent products are recommended for use several times daily. Patients can use the MI Paste, the gum or both. MI Paste is easily applied: a pea-size amount on a fingertip is rubbed all over the teeth and soft tissues. Clinical indications for Recaldent products in older adults are hypersensitivity, bleaching and periodontal scaling (used before and after the procedures to help reduce sensitivity), erosion and incipient caries, for prevention of caries and dry mouth.[34] In older adults with SGH, application of MI Paste either by professional application during prophylaxis or on the finger before topical fluoride varnish is applied will help to produce an even film of fluoride. Application of MI Paste can also help lubricate and comfort a dry mouth before commencing dental treatment.

A second method for stabilizing calcium and phosphate ions is with bioactive glasses. Novamin (Novamin Technology Inc, Alachua, Fla.) is a sodium calcium phosphosilicate glass that releases calcium and phosphate ions in water or saliva.[36] The exposed dentin acts as a nucleation site for the ions to form a hydroxycarbonate apatite. Several Novamin products that focus on hypersensitivity are sold for professional use by Sunstar Butler (Sunstar Americas Inc. Chicago, Ill.), Omnii (3M ESPE Omnii Oral Pharmaceuticals, West Palm Beach, Fla.) and other

companies. Evolving research is also highlighting the possible antimicrobial effects of Novamin.[37]

Plaque–Biofilm Interface: Chemoprophylactics

The management of oral microorganisms with chemicals has historically focused on plaque control, especially for periodontal diseases, more than on the prevention of caries.[38] Products have generally been approved by regulatory bodies for on-label plaque-control use, with off-label use for dental caries. Chemoprophylactic agents are those most commonly used for oral disease management and can be categorized by their ionic status: cationic, including chlorhexidine gluconate (CHX), cetylpyridinium chloride (CPC), benzalkonium chloride, hexetidine and metal salts; anionic, specifically sodium lauryl sulfate; and nonionic, specifically phenolic compounds (essential oils) and triclosan. Additional categories include oxygenating agents (e.g., hydrogen peroxide) and surface-modifying agents (e.g., delmopinol).[38] Most studies comparing CHX with the other agents such as essential oils, CPC and delmopinol have demonstrated the clinical superiority of CHX.[38] Thus, CHX is the most widely accepted and most widely used chemoprophylactic agent, because of its substantiveness in the oral cavity and low toxicity (it is poorly absorbed by the gastrointestinal tract). In North America, the most common CHX product is the 0.12% mouthrinse with alcohol. A 0.12% CHX mouthrinse without alcohol has recently been marketed in North America by Sunstar Butler. Evidence has substantiated that non-alcohol CHX products are as effective as those with alcohol.[39,40] The use of a small spray bottle is an effective alternative application method for CHX mouthrinse for older patients, especially those who exhibit behavioural problems and need assistance with oral hygiene.[41] Although not readily available in North America except if formulated by a dispensing pharmacist, CHX gel (1% or 2%) has been documented as more efficacious than the mouthrinse.[42] CHX varnishes are used in Europe but are not approved for use in North America.[43]

Recommendations for application of CHX in the management of dental caries may range from daily to weekly use. The duration will vary depending on the results of monitoring for oral microorganisms and the appearance of new caries. In older patients, CHX has potential adverse effects, especially if the patient has dry mouth; in this situation, use a formulation that does not contain alcohol and reduce the frequency of application. Although past recommendations have often specified the use of CHX twice daily, periodontal disease and caries management may be achieved in older patients with once-daily use.[44,45] Potential interaction with fluoride is possible, especially with toothpastes containing sodium lauryl sulfate.[46] Application regimens can take this into consideration: apply CHX after lunch and apply fluorides in the morning and evening, or apply CHX in the morning and fluoride at night (or vice versa). Although clinicians are limited to the use of the chemoprophylactic agents listed above, a recent review highlighted that all of these agents have limited effectiveness with respect to oral microbial ecology.[47]

Which Product First?

Achieving good compliance is a challenge, especially when care givers are involved in oral hygiene care.[44,47] In addition, financial considerations will be influential. In deciding which preventive or therapeutic dental product to prescribe, the clinician must (1) review the oral diseases present and the greatest modifying factors, (2) try one product first, (3) add other products as needed over time, and (4) review and adjust the oral hygiene protocol as appropriate. In many older patients, the 2 main product categories to try first are those for saliva dysfunction and chemoprophylactics. Recaldent products may be helpful for dry mouth and prevention of caries. If the patient has high caries experience, then the use of a 5,000 ppm toothpaste or gel together with regular professional application of fluoride varnish is advised. **Table 3** presents examples of oral hygiene protocols for older patients with low and high caries risk.

Conclusions

Geriatric MID offers the dental professional working with older patients realistic, rational, evidence-based options for treating oral disease. Oral physicians and their dental teams must monitor the literature to stay up to date with new preventive and restorative approaches in geriatric MID, for all primary and modifying factors, for factors at the biofilm level, and for efficacious combinations of therapeutic products.

THE AUTHOR

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Minimal Intervention Dentistry: Part 2. Strategies for Addressing Restorative Challenges in Older Patients

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ABSTRACT

Minimal intervention dentistry (MID), a modern, evidence-based approach to caries management in dentate patients, uses a medical model whereby disease is controlled by the "oral physician" and an affiliated dental team. Geriatric MID helps clinicians to address the ever-increasing restorative challenges presented by older patients, including erosion, abrasion, demineralization, rampant coronal and root caries, retained roots, recurrent caries (necessitating crowns and other repairs), subgingival caries, "wet" oral environments, salivary dysfunction, disruptive behaviours, poor compliance with preventive care, high plaque levels, and financial and other restrictions on care options. The main components of a geriatric approach to MID are assessment of the risk of disease, with a focus on early detection and prevention; external and internal remineralization; use of a range of restorations, dental materials, and equipment; and surgical intervention only when required and only after disease has been controlled. This second in a series of 2 articles describes direct restorative strategies to address the challenges of geriatric caries management, including choice of material, placement of glass ionomers, sandwich technique, techniques for the management of erosion and abrasion, tunnel and slot preparations, techniques for "wet" subgingival environments, vital pulp therapy and geriatric atraumatic restorative technique.

MeSH Key Words: dental bonding; dental caries/prevention & control; dentistry, operative/methods; glass ionomer cements/therapeutic use

The "extension for prevention" surgical approach to oral disease management, with G.V. Black cavity designs specified for each lesion type, has been the cornerstone of 20th century dentistry.[1] Of great importance has been the design of the cavity preparation to include a self-cleansing outline form, resistance form, retention form, convenience form, removal of caries, and finish of the enamel walls, margins, and toilet of the cavity.[1] The resulting "lifetime cycle of restoration" involved a substantial loss of tooth structure, weakening of cusps and undermining of crowns. In particular, use of the mesio-occlusodistal amalgam has resulted in a large number of cusp fractures.[1] Unfortunately, this traditional restorative approach does not help to address the ever-increasing number of complex restorative challenges in older patients, which include erosion, abrasion, demineralization, rampant coronal and root caries, sound and decayed retained roots, recurrent caries (necessitating crowns and other repairs), subgingival caries, "wet" oral environments,

Table 1 Caries classification and treatment options for geriatric minimal intervention dentistry (based on Mount and Hume,[4] modified by Chalmers)

	Size				
Site	0 (no cavity)	1 (minimal)	2 (moderate)	3 (enlarged)	4 (extensive)
1 (pit and fissure)	1.0 External remin, sealant	1.1 Caries removal, sealant or GI	1.2 Caries removal, internal remin with GI, GI or composite or amalgam (lamination)	1.3 Caries removal, internal remin with GI, GI or composite or amalgam (lamination)	1.4 Vital pulp therapy, internal remin with GI, review for GI or composite or amalgam (lamination)
2 (contact area)	2.0 External remin	2.1 Caries removal, open access (GI or composite), tunnel (GI), box or slot (GI or composite or amalgam)	2.2 Caries removal, internal remin with GI, GI or composite or amalgam (lamination)	2.3 Caries removal, internal remin with GI, GI or composite or amalgam (lamination)	2.4 Vital pulp therapy, internal remin with GI, review for GI or composite or amalgam (lamination)
3 (cervical)	3.0 External remin	3.1 External and internal remin and/or caries removal, GI or composite	3.2 Caries removal, internal remin with GI, GI or composite or amalgam (lamination)	3.3 Caries removal, internal remin with GI, GI or composite or amalgam (lamination)	3.4 Vital pulp therapy, internal remin with GI, review for GI or composite or amalgam (lamination)

GI = glass ionomer, remin = remineralization

salivary gland hypofunction, disruptive behaviours, poor compliance with preventive care, high plaque levels, bleeding and swollen gingival tissues, and financial and other restrictions on care options.

Minimal intervention dentistry (MID) is a philosophy that offers useful strategies for managing these restorative challenges. Geriatric MID uses a broad range of dental materials and instruments as appropriate for tooth preparation and restoration. The materials used are classified by their method of clinical placement: direct or indirect.[2] In-depth discussion of MID restorative techniques is presented in several texts and articles.[2–9] A new caries classification by Mount and Hume[4] describes dental caries by site (1 = pit and fissure, 2 = contact area, 3 = cervical) and size (from 0 to 4) (**Table 1**).[4] This classification has been modified in Table 1 for older patients, with various MID strategies recommended for each type of caries; for example, a carious lesion in a contact area without cavitation can be externally remineralized, whereas a cavitated deep carious lesion in a contact area might need internal remineralization with a glass ionomer and composite sandwich (lamination) restorative technique. This article focuses on the use of direct restorative materials in older patients and on several aspects of MID that can be routinely used in geriatric dentistry: choice of material, placement of glass ionomers, sandwich technique, techniques for the management of erosion and abrasion, tunnel and slot preparations, techniques for dealing with "wet" subgingival environments, vital pulp therapy and geriatric atraumatic restorative technique.

Choice of Material

In geriatric MID, the choice of the direct restorative material to be used cannot be made until caries removal is complete and field control has been evaluated. Conventional hand instruments, rotary handpieces and, if available, air abrasion or lasers are used for removing caries.[10–12] Other factors affecting choice of restorative

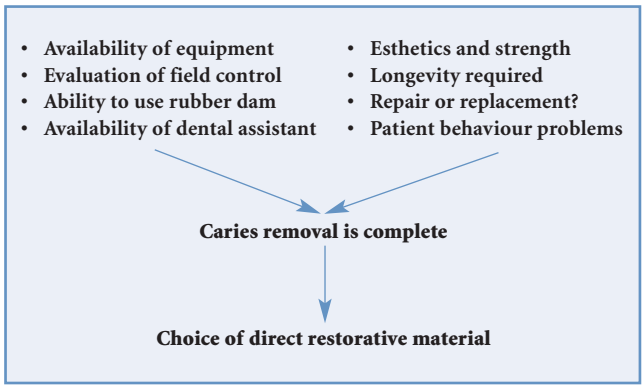

Figure 1: Factors influencing choice of direct restorative material in geriatric minimal intervention dentistry.

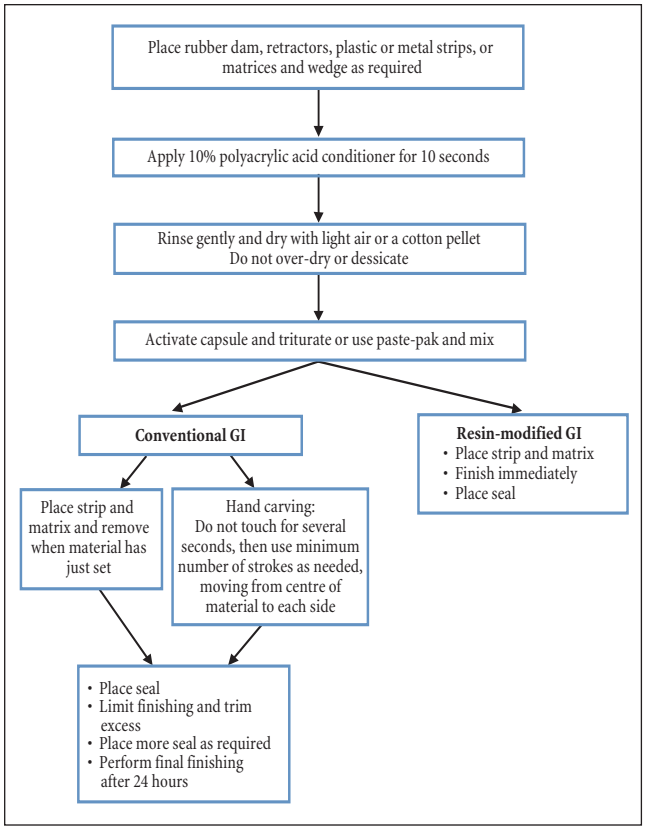

Figure 2: Placement of glass ionomers (GI).

material are esthetic requirements, required longevity and whether the restoration is being repaired or replaced (**Fig. 1**). Caution is needed when probing root surfaces, as probing has been shown to increase the progression of caries.[13] The use of a blunt or periodontal probe is advocated for exploring root-surface caries in older adults.[13]

In clinical situations where field control is excellent, traditional MID techniques involve using the most appropriate amalgam, composite resin or glass ionomer direct restorative material.[10–12] For example, in carious lesions that are not deep, but where esthetics and strength are important, composite resins may be the material of choice. In a similar situation but where esthetics are of less concern, or where cusp protection is indicated, then amalgam may be the material of choice.[11,12] If an erosion or abrasion lesion is being restored, then a conventional or resin-modified glass ionomer may be selected, as is described below.[14] In clinical situations where field control is less than optimal (even with the use of gingival retraction techniques), the restorative material of choice will be an amalgam or a conventional glass ionomer,[11,12] especially for subgingival areas and areas that are difficult to access, such as molar bifurcations and root areas around crowns. For deep carious lesions, the use of glass ionomer will aid internal remineralization, which is especially important if subgingival visibility is poor.[8,15] Where strength is also needed posteriorly, the stronger glass ionomers, with a higher liquid-to-powder ratio, can be used (e.g., Fuji IX, GC America, Alsip, Ill.; Ketac Molar, 3M ESPE, St. Paul, Minn.). Where the highest fluoride release and recharge is needed, Fuji Triage (GC America) will be the material of choice.

Placement of Glass Ionomers

As with composite resins, use of a rubber dam, retractors and/or plastic or metal matrices and strips is recommended to ensure optimal placement of glass ionomers.[14,16] Following the basic principles of glass ionomer placement, use cavity conditioner (10% polyacrylic acid) for 10 seconds to remove the smear layer, and do not over-dry or desiccate (a clean cotton pellet, rather than water and air, is optional for removing the conditioner) (**Figs. 2** and **3**). Note that different companies use different capsule activation systems. After triturating for the required time, squeeze the glass ionomer into the deepest part of the preparation and slowly back-fill, and then place a matrix or hand-carve the material. When hand-carving conventional glass ionomers, do not touch the material for several seconds, then use the minimum number of strokes needed, moving from the centre of the material to each side (for a total of at most 3 to 5 strokes). As a helpful guide to the setting time, place a small amount of glass ionomer from the applicator onto your glove, or try to squeeze the remaining glass ionomer out of the applicator. Both conventional and resin-modified glass ionomers require a seal; either a varnish or a light-activated resin enamel bond can be applied. Conventional glass ionomers need to be sealed as soon as the material is set, to limit immediate water exchange. A small amount of finishing to trim excess can be completed, with another layer of sealant added if required. Final polishing should not be performed for at least 24 hours. Resin-modified glass ionomers can be finished immediately, and a seal

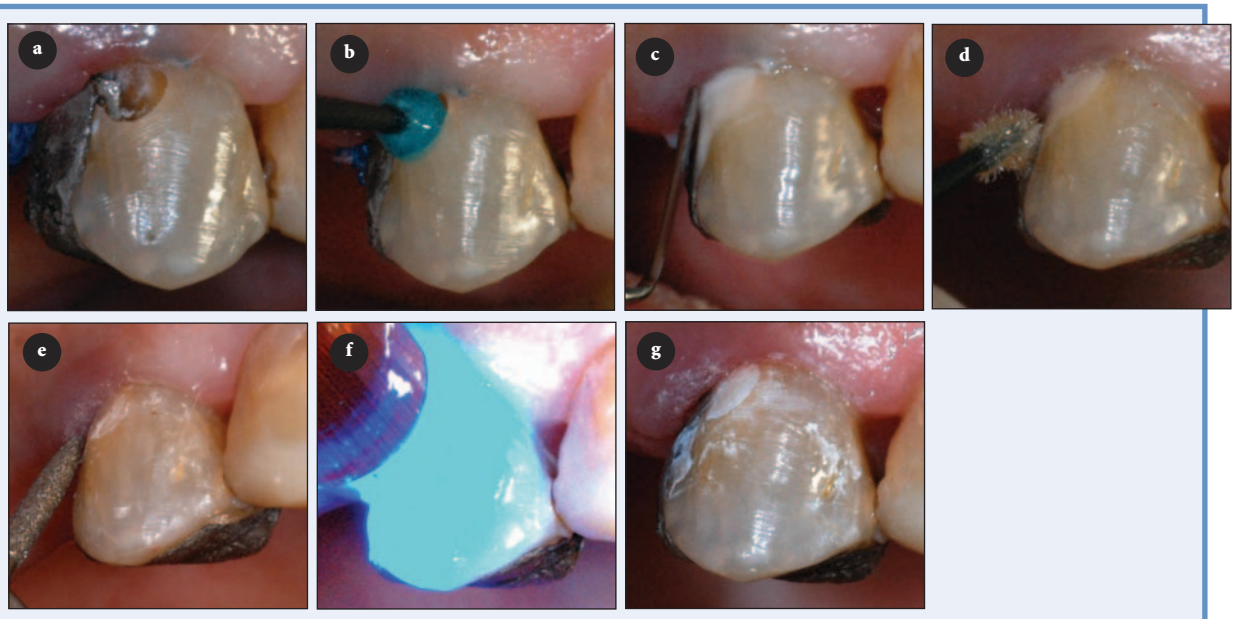

Figure 3: Placement of a Fuji Triage glass ionomer restoration in a "wet" subgingival location in a patient with dementia, whose behaviour made treatment difficult: **(a)** placement of retraction cord and removal of recurrent caries using high- and low-speed handpieces and hand instrumentation; **(b)** application of cavity conditioner; **(c)** hand carving; **(d)** placement of light-cured seal; **(e)** completion of limited finishing; **(f)** placement of another light-cured seal; and **(g)** completed restoration.

is recommended to prevent water uptake over the next 7 days.[14,16]

Sandwich Technique

As described by Mount[14] a lamination or "sandwich" technique with 2 direct restorative materials can be used to "make the most of the biological, physical and/or aesthetic properties of each material, and in the presence of adhesion, to achieve as close as possible to a single monolithic reconstruction of a tooth." This technique is especially useful in situations when strength and pleasing esthetics are essential. The strongest glass ionomer material (i.e., that which releases the most fluoride) is placed and allowed to fully set and is then covered with the final restorative material (amalgam or composite resin).[14] Composite resin bonds micromechanically to set glass ionomers and chemically to hydroxyethylmethacrylate (HEMA) in resin-modified glass ionomers.[14] Thus, if a composite resin is being placed over a conventional glass ionomer, then both glass ionomer and enamel are etched with 37% orthophosphoric acid before placement of the bond and composite resin. If a composite resin is being placed over a resin-modified glass ionomer, then it is not necessary to etch the resin-modified glass ionomer, because of the chemical HEMA bond. However, if the etching material does contact the resin-modified glass ionomer, "it will do it no harm."[14] Contact areas should be built in composite resin but not glass ionomer, and sufficient space should be allowed for an adequate thickness of composite resin.[14] With the full sandwich technique, the internal glass ionomer is completely covered by the overlaying restorative material, whereas with the partial sandwich technique, the internal glass ionomer is only partly covered.[14]

Remineralization and Restoration to Counteract Erosion and Abrasion

Erosion is defined as the loss of dental hard tissues by chemical action from intrinsic and extrinsic sources not involving bacteria; abrasion is the loss of tooth substance because of factors other than tooth contact.[17] Erosion and abrasion lesions vary in shape and size but are most often located on the buccal tooth surface. It appears that erosion and abrasion contribute in combination to cervical tooth wear.[17] Patients with these lesions often complain of hypersensitivity. Cervical tooth wear can occur around any type of dental restorative material. In many cases, caries are not present initially, but many cervical carious lesions develop over time on eroded and abraded root surfaces. In addition to treating the cause of the erosion or abrasion, it is essential to monitor the progression of cervical lesions over time.[18] There are 2 main treatment choices for cervical lesions: remineralization and restoration. Remineralization involves the use of products such as topical fluorides and amorphous calcium phosphates. Topical fluorides must be used at home and must be supplemented with regular professional application of fluoride varnish. Adjunctive use of amorphous calcium phosphates

will increase remineralization; MI Paste (GC America) in particular has shown impressive clinical results in reducing hypersensitivity[19–21] (please see Part 1 of this series on p. 427). Restoration of cervical lesions may be undertaken when esthetics is an issue or when soft caries and cavitation have occurred. The use of glass ionomers and composite resins either alone or in combination (with a sandwich technique) is generally recommended.[20] Glass ionomers will adhere to the dentin and assist in reducing hypersensitivity and enhancing internal remineralization.[14] The resin-modified glass ionomers were designed for use in these situations and have a wider colour range than traditional glass ionomers.[14]

Tunnel and Slot Preparations

Access to and conservative restoration of interproximal carious lesions can be challenging. Tunnel and slot preparations are conservative preparations that can be used effectively in older patients. Slot preparations are indicated for lesions that are less than 2.5 mm from the marginal ridge.[11,12] Glass ionomer, composite or amalgam can be used, and indeed slot amalgams have proven as successful as traditional Class II amalgams.[22] If needed, a preventive resin or glass ionomer restoration can be placed over the occlusal surface.[23] In certain carefully chosen cases where the lesion is more than 2.5 mm from the marginal ridge, a tunnel preparation can be used. In-depth description of this technique is provided elsewhere.[11,12,24] In general, initial access is gained through the fossa immediately medial to the marginal ridge.[14] This entry area should not be under occlusal load. A small tapered cylinder bur is aimed at the lesion, after which a long-shanked bur, held in a more upright position, is used to increase visibility. Small round burs and hand instruments are used to complete the preparation. Glass ionomer is the material of choice, as some of the demineralized interproximal areas will not be removed, and the interproximal enamel cannot be bevelled.[14]

Techniques for "Wet" Subgingival Environments

In many older patients, especially those with poor oral hygiene, it can be extremely challenging to control bleeding and saliva during restoration of subgingival carious lesions, which tend to recur around large restorations and crowns. The use of a rubber dam, electrosurgery, periodontal surgery and retraction techniques may not be feasible for some older patients and in some geriatric dental settings. Behaviour and communication problems can further increase the need for a quick and efficient method for restoring such lesions.[25] Because it may be difficult to penetrate these deep subgingival areas with a curing light, the materials of choice are amalgam or conventional glass ionomer. A glass ionomer such as Fuji Triage works well in these "wet" environments because it has low viscosity and does not "run" (**Fig. 3**). As with all conventional glass ionomers, the clinician must wait several seconds before carving, and the gingiva should be used to guide subgingival carving.

Vital Pulp Therapy

For deep carious lesions in older patients, vital pulp therapy, a conservative MID technique involving stepwise remineralization and biocompatible dental materials, can be used.[11,12] Vital pulp therapy provides an optimal clinical result, especially when finances, time and behaviour problems limit the clinical treatment options. Whenever possible, it is advisable to have a periapical radiograph of the tooth being treated to ensure the absence of periapical abnormalities; however, obtaining such radiographs may be a challenge in some geriatric dental treatment settings. If radiographs are not available, the clinician must determine the extent of bacterial infection in the pulp and the feasibility of vital pulp therapy. The lower layers of dentin may not be infected and can often be retained during caries removal.[11,12,16] The following stepwise excavation technique is used: remove only as much marginal enamel as necessary to gain access to the carious lesion and remove the infected dentin (additional dentin should only be removed around the complete circumference of the lesion to enable bonding of restorative material and minimization of microleakage.[11,12,16] In the traditional stepwise technique, a "temporary" restoration is placed at this stage, with a note in the patient's record that the tooth is not caries-free; the material of choice is glass ionomer to encourage internal remineralization. The temporary restoration is left in place for 3 to 6 weeks, but no longer than 6 months.[11,12,16] Pulp vitality is reassessed, and the clinician has the option of removing all or some of the temporary restoration to place a permanent restoration. It is advised to leave some glass ionomer material in the deepest part of the lesion as a base for the final restoration.[11,12,16] It has been shown that the number of bacteria decreases during stepwise excavation procedures and that deep lesions become clinically arrested after restoration.[14,16,26] The stepwise excavation of caries will change the cariogenic environment and will also limit the removal of carious dentin close to the pulp to reduce the risk of an iatrogenic pulp exposure.[14,16,26]

In rational treatment planning for older patients, a modification of this vital pulp therapy technique is often required, whereby stepwise excavation may be limited to the initial stage and the restoration that is placed is not temporary but permanent. This method is required in cases of ringbarking of root caries (circumferential caries), palliative care, behaviourally difficult patients, patients seeking emergency care and patients who can visit a dentist only intermittently. It is also an option when patients and their caregivers refuse to have "unsavable" teeth extracted, when a "repair" is the only reasonable option

and when extensive subgingival restorations are needed around complex restorations such as crowns and bridges.

Geriatric Atraumatic Restorative Technique

In some clinical settings where access to rotary handpieces is limited, such as in nursing homes or patients' homes, only hand instruments may be available for removing caries. In these settings, an atraumatic restorative technique using glass ionomer may be appropriate.[14] The choice of glass ionomer material will be limited only by the clinician's access to a triturator and a curing light. The diversity of conventional glass ionomer materials is increasing and provides choice among hand-mixed materials, paste-pak and triturated capsules. At present, resin-modified glass ionomers are available in the latter 2 forms, which require use of a curing light. As discussed previously, both conventional and resin-modified glass ionomers require a seal, and in these settings a varnish or a light-activated resin enamel bond can be applied.

Conclusions

Geriatric MID offers the dental professional working with older patients realistic, rational, evidence-based options for treating oral disease. Geriatric MID restorative techniques will continue to evolve with the development of more biocompatible restorative materials to help address the ever-increasing challenges encountered with dentate older patients.

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The Treatment of Oral Problems in the Palliative Patient

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ABSTRACT

Palliative care patients require special dental attention, ranging from operative and preventive care to support for emotional needs. The dentist's role in palliative care is to improve quality of life of the patient. This paper describes some common problems encountered in palliative care dentistry for adults with terminal cancer and the appropriate treatment of these problems.

MeSH Key Words: dental care for chronically ill; mouth diseases/therapy; palliative care; quality of life

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Palliative care dentistry has been defined as the study and management of patients with active, progressive, far-advanced disease in whom the oral cavity has been compromised either by the disease directly or by its treatment; the focus of care is quality of life.[1] This approach not only involves the provision of support for the patient's physical needs but also extends to support of the patient's and family's spiritual needs. This article presents some common problems encountered in palliative care dentistry in relation to adults with terminal cancer and the appropriate treatment of these problems. The oral problems associated with palliative care are illustrated in **Fig. 1**.

Mucositis and Stomatitis

Mucositis and stomatitis are common in patients who receive chemotherapy and radiotherapy (**Fig. 2**) Chemotherapy acts on tissues that have a high rate of mitosis, and the oral cavity is frequently affected. An estimated 40% of chemotherapy patients suffer from mucositis.[2] Reducing mitosis causes atrophy of tissues leading to ulceration, which may be further complicated by microbial invasion.[3] Mucositis occurs within 5–7 days of chemotherapy with drugs such as 5-fluorouracil and methotrexate, which are potent mucositis agents. Radiotherapy to treat cancers of the head and neck result in xerostomia due to destruction of the salivary tissues within the treatment zone. The decrease in lubrication and the protective agents in saliva render the tissues more susceptible to trauma and invasion by pathogens. The tissues become ulcerated and erythemic.

Treatments for mucositis and stomatitis are primarily aimed at relieving pain (**Box 1**). Xylocaine and dyclonine topical anesthetics provide comfort but must be used with caution as they will block the gag reflex and increase the risk of aspiration. Dyclonine has been shown to have anti-inflammatory activity in addition to its anesthetic qualities.[4] The use of diphenhydramine hydrochloride 5% (Benadryl, Pfizer Inc., New York, N.Y.) and loperamide (Kaopectate, Pfizer Inc., New York,

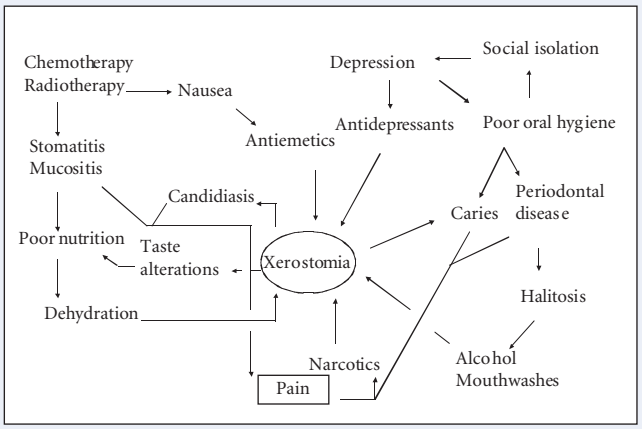

Figure 1: Oral problems in palliative care

Figure 2: Oral mucositis

N.Y.; Maalox, Novartis Consumer Health Canada Inc., Mississauga, Ont.) as a rinse to relieve pain has been used for herpetic stomatitis.[5] Milk of Magnesia (Rougier Pharma, Mississauga, Ont.) should not be used as a substitute as it will dry the mouth.

The use of sucralfate suspension to palliate radiation-induced mucositis has had mixed results.[6–8] Sucralfate should be used on a case-by-case basis, and the clinician must not only assess the clinical signs of mucositis but also seek the patient's evaluation of his or her status.

Many oncologists prescribe a concoction termed "magic mouthwash." It contains many ingredients, often varied; it has been known to contain antihistamines, antifungals, topical anesthetics and even antibiotics. I believe that these products should not be used as a panacea, but instead treatments should be prescribed to remedy specific symptoms.

Benzydamine (Tantum, 3M Pharmaceuticals, London, Ont.) is a nonsteroidal analgesic with anti- inflammatory properties. It has been reported to relieve radiation-induced stomatitits[9]; however, its benefit in the treatment of burning mouth syndrome has not been demonstrated.[10]

Box 1 Treatments for stomatitis and mucositis

- Viscous xylocaine 2%
- Xylocaine spray 10%
- Diphenhydramine hydrochloride 5% and loperamide in equal parts (dyclonine 0.5% may be added to increase potency)
- Dyclonine hydrochloride 0.5% or 1%
- Magic mouthwash
- Sucralfate suspension, 10 mL 4 times a day, swished and swallowed or expectorated
- Benzydamine, 15 mL 3–4 times a day, rinsed and expectorated
- Morphine 2%
- Reduction of potential localized factors

After teaching patients to expectorate completely by practising with saline solution, a 0.2% morphine solution can be used topically to relieve the discomfort associated with mucositis. Patient selection is important, as they must be able to follow directions carefully to prevent overdosing.[11]

Before any of the above measures is initiated, it is important to identify local traumatic factors such as fractured restorations or teeth, or an impinging removable prosthesis. Patients should also be advised to avoid spicy foods, smoking and alcohol.[11]

Nausea and Vomiting

Nausea and vomiting in palliative care patients may have many causes, including chemotherapy, opioid use, bowel obstruction, pancreatitis and electrolyte imbalance, or they may be movement induced or even an emotional reaction. Vomiting has a caustic effect on the hard tissues and can also increase the morbidity of mucositis. It may also delay healing if the patient cannot consume nutrients essential for tissue repair. Many of the drugs prescribed to control nausea and vomiting have oral side effects (**Table 1**), the most notable being tardive dyskinesia and xerostomia. Tardive dyskinesia usually occurs with long-term dosing and its presentation may affect denture wear. Xerostomia affects nutrition, communication and oral tissues. Although the oral effects of the antiemetics are great, the inability to consume foods and medications orally has more serious implications. Emotional outbursts are treated by the palliative care team by listening to the patient's concerns and suggesting relaxation techniques.

Table 1 Oral side effects of antiemetics prescribed to control nausea and vomiting

Agent	Oral side effect
Haloperidol	Tardive dyskinesia
Metoclopramide	Tardive dyskinesia
Hyoscine butylbromide	Xerostomia
Promethazine	Xerostomia

Table 2 Treatments for candidiasis

Topical
Nystatin suspension, 200 000–500 000 IU, swished and swallowed 3–5 times a day
Nystatin suspension frozen (200 000–500 000 IU) in sugarless fruit juice
Nystatin vaginal suppository, 100 000 IU 4 times a day
Clotrimazole vaginal suppository, 100 mg/day for 7 days
Clotrimazole troche, 10 mg, 5 times a day for 14 days
Clotrimazole vaginal cream 1%, applied to denture 3–4 times a day for 7 days
Systemic
Ketoconazole, 200–400 mg orally for 7–14 days
Fluconazole, 100–200 mg on day 1, then 50–100 mg/day orally for 7–14 days
Itraconazole, 100–200 mg/day orally for 7–14 days
Amphotericin B, 0.25–1.5 mg/kg a day intravenously

Figure 3: Pseudomembranous candidiasis

Figure 4: Angular cheilitis

Candidiasis

The incidence of candidiasis in palliative care patients has been estimated to be 70% to 85%. Predisposing factors for fungal infections include poor oral hygiene, xerostomia, immunosuppression, use of corticosteroids or broad-spectrum antibiotics, poor nutritional status, diabetes and the wearing of dentures. *Candida albicans* is the most common infectious organism encountered in candidiasis. It is a natural inhabitant of the oral cavity whose overgrowth is normally suppressed by other nonpathologic microorganisms and natural host defense mechanisms. The mere presence of a positive culture without clinical symptoms is not indicative of *Candida* infection.[13]

Candida infections are manifested as pseudomembranous, erythematous or hyperplastic candidiasis or angular cheilitis. Pseudomembranous candidiasis (thrush) is characterized by small white or yellow plaques with surrounding erythemic areas (**Fig. 3**). These lesions can be rubbed off, revealing raw mucosa. Erythemous (atrophic) candidiasis appears as red lesions, frequently on the hard palate and dorsal surface of the tongue. Hyperplastic candidiasis is similar to pseudomembranous; however, the plaques do not wipe off. Angular cheilitis appears as white and red fissures emanating from the corners of the mouth. It commonly has a bacterial and fungal component (**Fig. 4**).[14] In palliative care patients, candidiasis is primarily a result of xerostomia.

Higher salivary *Candida* levels are more frequently encountered in denture wearers than in dentate patients.[15] The use of commercial hydrogen peroxide releasing agents has been found to be ineffective in the disinfection of the denture.[16,17] Soaking the denture in bleach (15 mL) and water (250 mL) for 30 minutes will help rid the denture of odours. Partial dentures should not be soaked in bleach solution, as it will lead to metal fatigue. Dentures can also be soaked in benzalkonium chloride (1:750) for 30 minutes. Benzalkonium chloride should be formulated daily as Gram-negative bacteria can proliferate within 24 h.[17] Boiling the denture will cause denture base distortion[18]; however microwaving it in water at high power for 5 minutes can disinfect the denture base. Repeated microwaving can result in hardening of PermaSoft denture linings.[19] Dentures should be stored in well-identified vessels in solutions of water, mouthwash, 0.12% chlorhexidine, Listerine antiseptic (Pfizer Canada, Toronto, Ont.) or 100 000 IU of nystatin suspension.[20]

Candidiasis may be treated by a combination of topical and systemic applications (**Table 2**).

One topical agent is nystatin, which can be administered via different methods. The fungicidal activity of

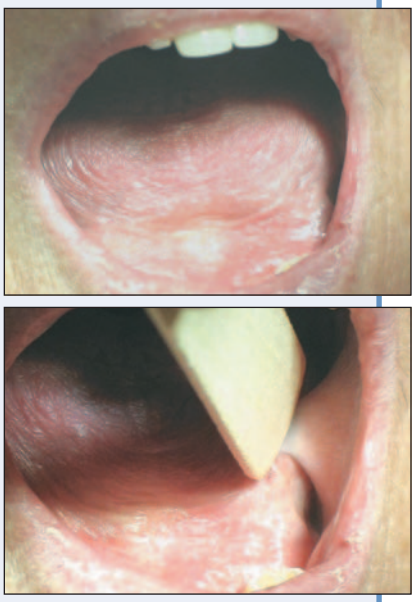

Figure 5: Xerostomia

nystatin depends directly on contact time with the oral tissues, and this is generally minimal with the suspension as most patients swallow it rapidly. Nystatin suspension also has a high sugar content and must, therefore, be administered cautiously in the xerostomic dentate patient. Nystatin may occasionally cause gastrointestinal effects such as nausea, vomiting and diarrhea.[20]

Freezing nystatin with sugarless fruit juice yields nystatin popsicles or ice chips. As some patients with fungal infections complain of a sore burning mouth, the dual effect of cryotherapy and antimycotic therapy may relieve pain and provide additional hydration for the patient. In addition, oral contact time is increased.

A nystatin vaginal tablet or clotrimazole vaginal tablet can be dissolved slowly in the mouth. Although this procedure increases contact time, it is difficult for patients with xerostomia to dissolve these tablets. These products are not sweetened and are reported to have a chalky taste.

Angular cheilitis can be treated with a cream made up of 0.5% triamcinolone and 2% ketoconazole. Due to the likelihood of a co-existing bacterial infection, washing the area with an antimicrobial soap before applying the therapeutic cream is advised.

Clotrimazole troches (Mycelex Troche, Roxane Laboratories, Columbus, Ohio) may be dissolved slowly in the mouth; however, they contain sucrose, which can increase caries. Troches are more efficacious than suspensions due to their longer oral contact time.[21,22] Clotrimazole vaginal cream may be applied as a thin coat on the tissue side of the denture.

Systemic medications (**Table 2**) should be reserved for cases in which topical agents are ineffective, as they are expensive and may have renal or hepatic toxicity. The treating dentist should note the drug interactions of these antifungal agents. Absorption of ketoconazole is decreased by antacids, which increase gastric pH. Ketoconazole increases the half-life of benzodiazepines. Fluconazole, ketoconazole and itraconazole interact with anticoagulants such as coumadin, leading to an increase in the international normalized ratio. Itraconazole can increase plasma levels of midazolam and triazolam and it reduces the efficacy of oral contraceptives. Amphotericin B should be reserved as a final treatment when all other antifungals are ineffective as its therapeutic index is low and it should be prescribed in consultation with an infectious disease specialist.

Comparison of the efficacy of a topical (nystatin) and a systemic (fluconazole) agent resulted in no significant difference in fungicidal effect.[23] However, as the dose frequency for fluconazole is much lower, it was speculated that compliance would be greater with this drug.[23] A comparison of the efficacy of fluconazole (100 mg daily) with clotrimazole troches (10 mg 5 times daily) revealed a statistically equivalent clinical response; however, fluconazole was more effective than clotrimazole in eliminating *C. albicans* from the oral flora.[24]

Fluconazole works against most oral fungal species. If fungal growth is persistent, then mycologic culturing may be necessary, as resistant species have been isolated from the mouths of terminally ill patients.[25] In this case, switching to itraconazole may be a good option.

Nutrition, Hydration and Taste Disorders

Palliative care patients are unable to consume food or fluids if their oral cavity is compromised. These patients do not generally expend large numbers of calories and usually eat lightly.

Vomiting, diarrhea, fever, swallowing difficulties and anorexia may cause dehydration, which in turn can lead to xerostomia. Palliative care patients should be gently encouraged to drink as much as possible. During winter months, a room humidifier can help reduce oral dryness, especially for mouth breathers.

Chemotherapy or head and neck radiotherapy causes dysgeusia in many palliative care patients.[26] This can be corrected by zinc supplementation.[27] To improve the patient's appetite, suggest that foods be served with gravy, which aids in swallowing for the xerostomic patient. Monosodium glutamate can be used to improve the taste of food.

Xerostomia

As noted above, xerostomia is common in palliative care patients, mainly as a result of medication or radiotherapy to the head and neck (**Fig. 5**). The simplest test for

assessing xerostomia is to ask the patient if his or her mouth feels dry. Dry mouth or xerostomia does not always correlate with salivary gland hypofunction, but the clinician should respond to the patient's chief complaint. In a recent survey of 25 palliative care patients (unpublished data by author), all complained of xerostomia. A chart review of their medications revealed that the average patient was taking 5 medications (standard deviation, 3) in the following xerogenic classes: anticholinergics, bronchodilators, narcotic analgesics, diuretics, antihypertensives, antipsychotics, antiemetics, antidepressants and anxiolytics. Water-soluble lubricants should be used to lubricate the oral tissues. These can be found under a variety of trade names. Oral Balance gel (Laclede Professional Products, Gardena, Calif.) is an excellent water-soluble agent and an alternative to the typical lubricants as it contains lactoperoxidase, lysozyme, glucose oxidase, lactoferrin and no glycerin. Nursing staff should be instructed to apply the product thinly all around the mouth using a foam brush. These products do not have an unpleasant taste. Petroleum-based products such as Vaseline (Unilever Canada, Toronto, Ont.) are anhydrous and hydroscopic, absorbing water from the tissues. They may also occlude harmful bacteria, preventing them from being eliminated from the oral cavity by saliva. For patients on oxygen, petroleum-based products are a potential combustible material.

Mouth rinses that contain alcohol should be avoided as they will further desiccate the mouth. Alcohol-free rinses are available, e.g., Oral B anticavity rinse (Gillett, South Boston, Mass.). Saliva substitutes are beneficial for the patient and should be used before eating to improve swallowing. Examples of these products are Moi-Stir (Kingswood Laboratories, Indianapolis, Ind.), MouthKote (Parnell Pharmaceuticals, San Rafael, Calif.), Oral Balance (Laclede) and Xero-Lube (Colgate Oral Pharmaceuticals, Canton, Mass.). Chlorhexidine is currently being formulated as an alcohol-free product (Sunstar-Butler, Chicago, Ill.) and will be available shortly in Canada.

The use of the cholinergic-mimetic drugs pilocarpine and cevimeline in palliative care has not been explored in depth. Topical use of malic acid, vitamin C and citric acids can stimulate saliva; however, their low pH contributes to tooth demineralization.

Depression

Depression is not uncommon in the terminally ill patient. The palliative care dentist must take time to listen to his or her patient. The dentist should not stand next to the patient's bed, but rather sit next to the patient. Demonstrate empathy by eye contact and gentle touching of the patient's hand or shoulder. It is also important to acknowledge family and significant others who may be present in the room. These people require as much emotional support as the patient.

Many patients who become depressed are prescribed antidepressants, and these drugs are also used for pain palliation.[28] Many of these medications cause xerostomia. The dentist should guide the physician in choosing a saliva-sparing antidepressant; for example, amitriptyline (Apo-Amitriptyline, Apotex, Weston, Ont.) is more xerogenic then citalopram (Celexa, Lundbeck, Montreal, Que.).[29]

Patients who are depressed may forego regular oral hygiene activities, which may increase the severity of periodontal disease, caries and halitosis. Faced with these conditions, some friends and family may shorten their visits or stop visiting at all and, as a result, the patient may become further depressed. Therefore, it is imperative for the palliative care dentist to promote good oral hygiene.

Oral Hygiene

As mentioned, oral hygiene is very important in palliative care patients. Some patients with xerostomia find toothpastes containing sodium lauryl sulfate difficult to tolerate. Children's toothpastes or Oral Balance toothpaste (Laclede) may be more tolerable. A soft toothbrush should be used, as the oral mucosa is very sensitive to trauma.

Conclusion

Palliative care patients require special dental attention. This extends from operative and preventive care to the concept of total patient care covering both the physical and emotional aspects of well-being. The dentist's role in palliative care is to improve the quality of life of the patient.

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