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

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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]

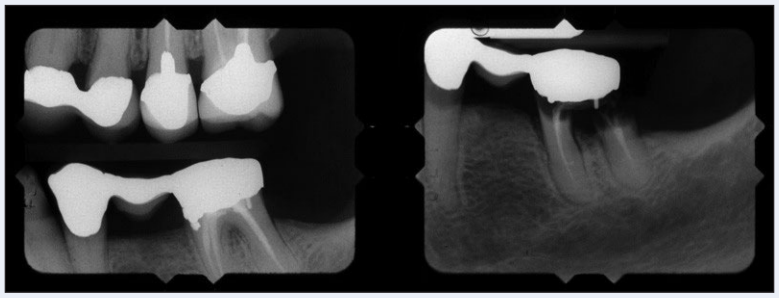

Figure 1: Multiple caries in an older woman who had not experienced this problem previously. Between 1999 (age 58 years) and 2005 (age 64 years), 3 chronic medical conditions developed in this patient, and 2 medications with oral anticholinergic adverse effects were initiated; the patient presented with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

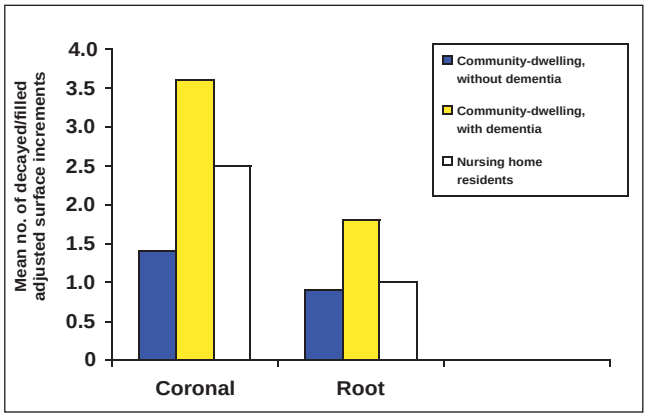

Figure 2: Annualized coronal and root adjusted caries increments in subgroups of older adults.[1] Sources: South Australian Dental Longitudinal Study, Oral Health of Community-Dwelling Older Adults with Dementia study, and Adelaide Dental Study of Nursing Homes.

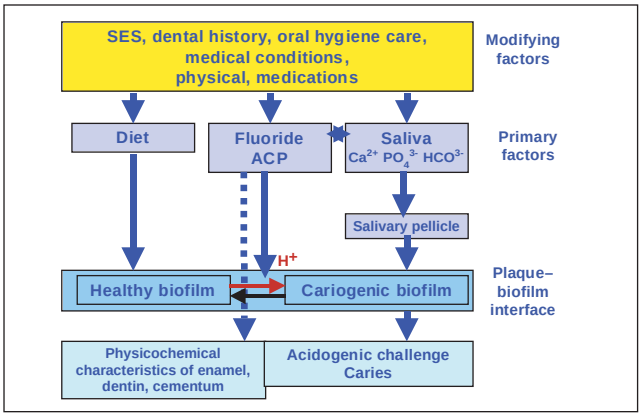

Figure 3: Caries management in minimal intervention dentistry. ACP = amorphous calcium phosphate, SES = socioeconomic status. Modified from Ngo.[11]

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.

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