policies and practices that capitalize on the skills and experiences of all community members create the context in which health homes—and the people they care for—thrive.

PROMOTING HEALTH AND WELL-BEING

On January 1, 2011, the oldest members of the baby boom generation celebrated their 65th birthday. In fact, on that day, today, and for every day for the next 19 years, 10 000 baby boomers will reach age 65. The aging of this huge cohort of Americans (26% of the total US population are baby boomers) will dramatically change the composition of the country and indeed the world. At the time of this writing, just 13% of Americans are aged 65 years and older. By 2030, when all members of the baby boom generation have reached that age, fully 18% of the nation will be at least 65 years old, according to Pew Research Center population projections.[13]

The sheer numbers of baby boomers reaching older ages will require rethinking and restructuring many aspects of US society, including our systems of care. To us the choice is clear. The health home approach places the emphasis on promoting health and well-being. The current fragmented medical, dental, and social care systems are difficult to navigate and create needless pain and suffering for older patients and burnout for dedicated care providers.

One of the priorities we face as educators is to better ensure that future health care professionals—including dentists—obtain the requisite skill sets to function effectively in a health home. This entails crossing traditional boundaries and accepting a very different health care delivery structure. Indeed, creating a team-based, integrated, public health–oriented care delivery system is a monumental task, but well worth the long-term effort required. By building upon the formative programs already in place and the policy opportunities of the PPACA, this is a challenge that the oral health, general health, and public health communities need to work on together.[8] ■

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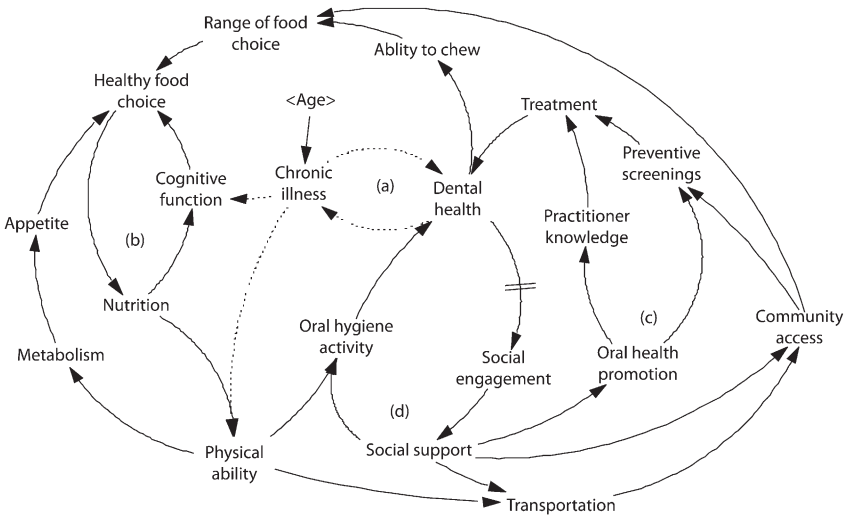
A Systems Perspective for Dental Health in Older Adults

As the population of older adults in the United States expands with the aging of the baby boom generation coupled with longer life expectancies, the need for coordinated and cost-effective health policies becomes more acute. Oral health promotion and care may help prevent potentially debilitating oral conditions that can cause significant discomfort, affect social interaction, and reduce the ability to properly masticate, thereby affecting nutrition. Nonetheless, developing effective oral health interventions for older adults is challenging, owing partly to the complex set of causal pathways that are involved and the time delays that accrue over a life course. Drawing upon the methodology of system dynamics, a causal map was developed and is presented here to illustrate how relationships at the individual and interpersonal scales influence dental health outcomes among older adults. Specifically, chronic illness and nutrition-related dynamics are implicated in dental health, as is the availability of social support and oral health promotion. This systems perspective reflects shared knowledge among an interdisciplinary research team about the dynamics of dental health through a set of reinforcing feedback loops that are likely to be induced with age.



Note. Dotted arrows indicate inverse relationships. The aging process may trigger a set of reinforcing feedback loops involving (a) chronic illness, (b) nutrition, (c) oral health promotion, and (d) social support. The hatched arrow from "dental health" to "social engagement" indicates a delay, or time lag, to allow for resulting shifts in behavior and activity.

FIGURE 1—Causal dynamics of dental health among older adults.

SYSTEMS THINKING

A systems science approach informs public health by providing mechanisms for modeling complex, dynamic problems. System dynamics is concerned with the identification and modeling of feedback relationships and delays that characterize a particular problem.[1,2] By linking the structure of complex systems to their behavior over time, system dynamics modeling helps policymakers assess the impact of different interventions in both the short and long term.

As an inherently interdisciplinary and iterative process, the construction of a system dynamics model provides an opportunity for input from a variety of stakeholders. After articulating the problem, a causal map is drawn to visualize feedback relationships among the relevant variables shaping system behavior over time. Such a representation constitutes a dynamic hypothesis of plausible relationships that may be tested with a formal computer model. For practitioners who lack the resources needed to quantify and calibrate a simulation model, or who aim primarily to reflect group knowledge using visual iconography, the construction of a causal map may be the ultimate goal.[3] An orientation to the causal mapping process is called systems thinking[4,5] or feedback thought,[6] a necessary skill in system dynamics modeling. We employ a systems perspective to frame the problem of dental health among older adults.

CAUSAL DYNAMICS

From a systems perspective, dental health in older adults is attributed to the lifelong accumulation of advantageous and disadvantageous experiences at multiple scales, from the microscale of the mouth to the societal scale that involves US federal policy, which includes the lack of routine dental care coverage under Medicare. Unfortunately, the logic that "you can eat without teeth" is all too pervasive, including among budget-minded policymakers who may erroneously view dental health as a luxury. Instead, a systems perspective may reveal the accumulated effects of neglecting dental health and be used to motivate needed policy and practice reforms.

An unquestioned factor affecting dental disease progression and tooth loss is frequency and quality of dental care. That is, adults who receive regular dental care are more likely to have decayed teeth diagnosed and treated before pain and other symptoms develop. On the other hand, uninsured and underinsured adults are less likely to receive regular care and are thus more likely to have teeth that progress untreated into symptomatic states. Edentulism, or a complete absence of permanent teeth in the mouth, is one consequence. Implants and other forms of prosthetic teeth may be an unaffordable or otherwise unattainable expense in later life. Adequacy of dental health for an aging population therefore requires attention to conditions that affect tooth retention, notably periodontal disease and tooth decay.

The dental health of older adults is influenced by a complex set of health and social factors, including pathologic mechanisms associated with morbidity such as diabetes and cardiovascular disease, multiple medications for chronic illnesses, cognitive impairment, social isolation, and physical and mental disabilities that interfere both with oral hygiene activity and access to dental care. Figure 1 maps the causal dynamics involved in dental health. Because health issues tend to become compounded with age, the reinforcing feedback loops outlined in Figure 1 can trigger cycles of decline in dental health among older adults. While refinements are under way, this version is presented for illustrative purposes.

CHRONIC ILLNESS DYNAMICS

The central reinforcing loop (a) in Figure 1 is formed by the inverse and reflexive relationship between chronic illness and dental health. Chronic illness is more likely with increasing age, and frequently affects both physical ability and cognitive function. Deteriorating physical and mental health makes it harder for individuals to perform appropriate oral hygiene, leading to worsening dental health.

Despite the link between general and oral health, medical and dental disorders are too rarely treated as related conditions and thus are not comanaged. For example, periodontal disease is a risk factor for other chronic illnesses, notably diabetes and cardiovascular disease, and it has been proposed that dentists may perform screening tests for these conditions.[7] The mouth has been famously recognized as "the gateway of the body" in that it senses and

responds to the external world, yet reflects what is happening within.[8] Studies have examined the level of oral disease as an indicator of general health.[9]

NUTRITION DYNAMICS

In addition to its connection with chronic illness, the mouth is integral in maintaining proper nutrition. As a key contributor to both physical and mental health, nutrition plays an important role in the system dynamics of dental health (Figure 1, b). Missing or decayed teeth and ill-fitting prostheses reduce the ability to chew and enjoy foods thoroughly. These individual factors, along with interpersonal factors such as access to and consumption of fresh fruits and vegetables, can influence the sufficiency of the diet. Adequate nutrition improves both cognitive function and physical ability.[10] If nutrition is compromised, a frailty loop is triggered as metabolism slows from reduced physical activity, further decreasing appetite and worsening nutrition.[11]

ORAL HEALTH PROMOTION DYNAMICS

Consistent with the mission of patient-centered health homes,[12,13] oral health promotion involves enhancing dental practitioner knowledge regarding the unique considerations of older adults and how to effectively treat patients with concomitant chronic illness (Figure 1, c). Oral health promotion also encourages frequent screenings that lead to early identification of tooth decay and periodontal disease and any comorbid conditions. Community-based outreach programs such as the preventive screening and referral services offered through the ElderSmile program[14] of the Columbia University College of Dental Medicine generate useful opportunities to share critical information between participants and public health providers seeking to improve dental health. Nearly all of the participants of the ElderSmile program who were screened required dental treatment, and the majority of those referred have followed up with the treatment at neighborhood sites, demonstrating the effectiveness of the program as well as the widespread need for such services.[14]

SOCIAL SUPPORT DYNAMICS

An important incentive to maintain healthy teeth is to sustain the propensity to smile and interact with others. Dental problems such as missing teeth and foul breath inhibit social behavior. Conversely, freedom from dental pain and an esthetic smile signal an increased propensity for social engagement, as depicted in Figure 1. The strengthened social support (Figure 1, d) that results from increased social engagement with family and friends provides an impetus for engaging in oral hygiene activities such as brushing and flossing that further improve dental health.

Physical ability, social support, and availability of transportation foster community access for older adults to preventive screenings and treatment centers (Figure 1). Conversely, a loss of social support (e.g., through the death of a spouse or friend) can restrict transportation options and community access to nutritious food, interfering with cognitive function and resulting in another cycle of deterioration (Figure 1, b).

WHOLE SYSTEMS

As exemplified by Figure 1, ongoing efforts to refine and reform systems of health care for older adults may be meaningfully abetted by modeling that explicitly links dental health to the broader health care agenda, including chronic disease management and social support. A complex systems perspective for oral health in older adults helps to identify interventions as leverage points that impact interconnected components and domains. Through the process of articulating causal relationships between elements, dental practitioners and social scientists engage in a participatory process of knowledge sharing to develop a joint sense of how resources ought to be allocated to improve oral health and health care for older adults. As illustrated in the causal map, a number of reinforcing dynamics that deteriorate oral health are induced with age. Inadequate dental insurance coverage and limited resources, cultural beliefs, and daily routines often preclude oral health care, and may be investigated in future iterations of the model. The reinforcing nature of the feedback loops indicates their capacity to destabilize the system. To counter this tendency, a systems perspective underscores the value of coordinated interventions that provide both locally based public health and health care services for older adults, including transportation, community access, innovative care models, and closer integration of dental, medical, and social services. ■

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The Dental Profession in Transition

During the 20th century, dentistry has evolved as a profession, one offering a full range of services, from effective prevention to complex oral and maxillofacial surgery and from basic restorative care to full rehabilitation of severely compromised dentitions. Our understanding of the underlying pathology that accounts for oral diseases and our knowledge about the interaction between oral diseases and diseases and disorders of different organ systems has been significantly enhanced through basic, translational, and clinical research. The dentist is well respected by the public,[1] and the 2000 Surgeon General's report[2] on the oral health of the nation stated that the oral health of the nation over the past century has greatly improved. On the other hand, the same report indicated a silent epidemic of oral disease was impacting low-income individuals as well as racial/ethnic minorities. These groups have limited access to dental services. Reports of children dying because of neglected oral disease have heightened public and professional, as well as legislative and governmental awareness of this problem.[3]

Some have called this time period (i.e., the 20th century into the beginning of the 21st century) the best of times and the worst of times for dentistry. Presently, the profession is able to offer a high level of care to approximately 75% of the public through the private practice system. By contrast, at least 25% of the public—or 75 million Americans—have either limited or no access to oral health care. Furthermore the profession must seriously discuss its future as it pertains to the new health care environment. According to many, dentists—with an undergraduate degree, four years of dental school, and with additional postdoctoral training—are overeducated for much of what they routinely do (more than 60% of recent graduates opt for one or more additional years of postdoctoral training).[4] The dental profession needs to address the issue of scope of practice, which will allow the profession to both define itself in the context of primary health care while also providing services to a greater proportion of the public.

A November 2010 US Government Accountability Office (GAO) report[5] to Congress showed that there were still 4377 dental Health Professional Shortage Areas (HPAs) and a limited involvement of dentists treating Medicaid and Children's Health Insurance Program (CHIP) children, with 25 of 39 states reporting fewer than half of the dentists treating any children in those programs. Some limited progress has been made over the past four or five years to increase the number of dentists and hygienists providing dental services in health centers (from 1912 to 2577 practitioners) through federal grant programs, but these centers only provide care to 3.4 million patients. Although we applaud the effort to increase the dental workforce in health centers that dedicate themselves to the underserved, finding ways to provide access to the millions who cannot receive treatment will require fundamental shifts in how the profession at large approaches the problem.

Since 1981, Columbia University College of Dental Medicine has addressed various issues in dentistry from the broad perspective of society. In November 2010, the 15th Dunning Symposium—named in memory of James Dunning, a 1930 graduate of the dental school and a founder of the field of public health dentistry—hosted discussions on the practice of dentistry for the 21st century. The invited speakers considered the health care reform, the access-to-care challenge, as well as a vision for dental education and future practice. We believe that a careful reading of the five articles in this issue (representing the Symposium topics) will point to new ways in which dentistry can play a stronger role in the primary care health system and can improve access to care for those left behind.

In our view, an important message garnered from these articles is a call for the profession to "scope up," that is, to become a stronger part of the primary care workforce by screening for chronic disease in their patients. Many of these diseases affect the presentation of oral disease or a patient's ability to tolerate dental treatment. Dental schools can prepare their graduates to integrate into the primary care workforce through offering a wider range of courses,