The Paradigm Shift to Prevention and Its Relationship to Dental Education


Abstract: The past seventy-five years have witnessed an extraordinary growth of scientific knowledge related to oral health and the development of evidence-based dentistry. The centrality of prevention to the control of oral diseases and the maintenance of good oral health has become increasingly recognized by the scientific community, dental educators, dental practitioners, and the public at large. Yet, despite significant improvements in the overall oral health of Americans, important disparities exist, and large segments of the population are disproportionately burdened by oral diseases. Despite the proven effectiveness of various preventive modalities, such as fluoridation and dental sealants, these have not been universally disseminated and implemented. This review will highlight the challenges remaining in completing the decades-long paradigm shift to prevention and the important role to be played by the dental education community in this process.

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The concept of a paradigm shift first gained popular attention fifty years ago with the publication of Thomas Kuhn’s classic work *The Structure of Scientific Revolutions*. In his treatise, Kuhn disputed the generally accepted model of scientific progress being represented by the steady and cumulative growth of evidence. Rather, he proposed that the history of science was characterized by dramatic and disruptive “revolutions” in which new models or “paradigms” are replaced by others. In this context, a “paradigm” has been defined as “a set of assumptions, concepts, values, and practices that constitutes a way of viewing reality for the community that shares them, especially in an intellectual discipline.” As applied to dentistry, one may consider whether the changing emphasis over the course of the twentieth century from a surgical model of corrective and reparative interventions to a medical model focused more on diagnosis, early intervention, and prevention represents a true paradigm shift in the sense meant by Kuhn.

It has become generally accepted that prevention is a foundational principle of the practice of modern dentistry. Education in prevention has become an integral component of the dental curriculum. The value of preventive self-care oral health behaviors and of professional preventive interventions has been recognized by the profession as well as by much of the public for decades. Even centuries ago, Pierre Fauchard (1678–1761), the father of dentistry, promoted the value of oral hygiene in the prevention of disease and maintenance of oral health. However, despite the explosive growth in high-quality scientific evidence, it may be surprising to recognize the extent to which evidence-based preventive practices have yet to be successfully disseminated and fully implemented. Two salient examples, among others, of such proven preventive modalities that we will explore in greater detail in this review are community water fluoridation and dental sealants. Thus, our aim in this contribution to the seventy-fifth anniversary issue of the *Journal of Dental Education* (JDE) is to briefly review the origins of the paradigm shift to prevention in dentistry and the science base in support of it, while also noting the extent to which this shift may be viewed as still being incomplete. That is to say, while the paradigm may be shifting, there has yet to occur the widespread transition to a true prevention-based practice of dentistry. We will thus make some recommendations regarding ways that dental education can contribute to driving the needed change to complete the paradigm shift. This may require a greater role for the dental education community in technology transfer and in the dissemination and implementation of new practice models. Given our recent experience in the promotion of lifelong learning and application of evidence-based approaches, the dental education...
community is ideally poised to take a leadership role in shifting the practice paradigm to prevention.

**Historical Origins of Preventive Practices**

It is remarkable to recognize that, from the earliest years of our Republic, the value of prevention appears to have been widely recognized and promoted. In his 1819 treatise, “A Practical Guide to the Management of the Teeth,” Levi Spear Parmly (1790–1859) emphasized the importance of daily preventive oral health behaviors to keep the teeth and gingiva free from oral disease. A New Orleans dentist, Parmly has also been credited as the “father of floss,” having advised his patients to use a silk thread to clean between their teeth. Many of the concepts and specific prevention practices he promulgated remain valid to the modern day. The value of prevention and oral self-care appears to have been widely recognized by the U.S. dental profession, if not universally promoted, for over 150 years.

In 1860, in the inaugural issue of the professional periodical *Dental Cosmos*, an editorial appeared on “Brushing Teeth,” and prevention-oriented articles and editorials continued to appear regularly over the years. Similarly, the *Journal of the American Dental Association* promoted the importance of prevention to the practice of dentistry. However, although there was a clear awareness of the importance of prevention, it was also noted that there were gaps in the transfer of such knowledge to the everyday practice of all dentists. In reviewing the history of dental hygiene, Mingee has noted, “in 1845, the American Journal of Dental Science criticized U.S. dentists for neglecting the preventive part of dentistry, opting instead to focus on mechanical dentistry and surgery.” This criticism appears to have been a recurring one. Dummett and Dummett write that in 1911 a popular article appeared that criticized American dentists and their education for a lack of scientific knowledge: “he goes about his work in the densest ignorance of such things as therapeutics or infection. He is no scholar and in no sense a man of science.”

In the early twentieth century, Charles C. Bass, M.D. (1875–1975), building on the work of Parmly, developed a philosophy of prevention, as well as a brushing technique, that became widely popular. Bass’s efforts were professionally recognized and became integrated into dental education and practice. They even came to the attention of Sir William Osler (1849–1919), who, referring to Bass, reportedly declared that “there is not one single thing more important to the public in the whole range of hygiene than the hygiene of the mouth.” Importantly, such opinions became widely disseminated beyond just the dental and medical professions. “Osler said it—and the dentists are doing it” was the headline in an advertisement by Bristol-Myers Co. for its Ipana toothpaste in the January 1928 issue of *Oral Hygiene*, continuing: “Every good dentist is giving his patients preventive advice and instruction of incalculable value. And as research develops further the practice of ‘preventive dentistry,’ the dentist has been quick to do his part in spreading information.”

Two other key pioneers in prevention in the twentieth century deserve special mention. Charles Edwin Bentley, D.D.S. (1859–1929), has been referred to as the “Father of the Oral Hygiene Movement in the United States.” A leading African American dentist based in Chicago, Bentley established a new model for dental care delivery based on a public health perspective and community-based needs. It is not an exaggeration to say that our current growth in community-based dental education has its origins in the work of Bentley, begun a hundred years earlier. Arising from a deep interest in the oral health of the disadvantaged, he launched school-based oral health programs in Chicago. These efforts went beyond the goal of treating disease but also encompassed a focus on community-based needs assessments, education in oral hygiene, and disease prevention. Dummett has written that Bentley also called for the “awakening of the dental profession to its social and public responsibilities.” However, Bentley’s views were not universally shared by his dental colleagues, and his public health programs met with some resistance.

Another great American leader in prevention and education, and a major force in the dental hygiene movement, was Alfred C. Fones (1869–1938). Fones led the development of professional dental hygiene care and education in the early years of the twentieth century. The term “dental hygiene” itself is attributed to Fones, who founded the world’s first School of Dental Hygiene in Bridgeport, Connecticut, in 1913 (now at the University of Bridgeport). As with Bentley, Fones’s ideas met with resistance from many dental professionals. His vision for the important role of dental hygienists in the promotion of oral health and prevention of disease was not uni-
versally shared. If there is a common thread to these historical examples that we have briefly reviewed, it may be that while prevention in dentistry has long been recognized to play an important if not central role, such a perspective has not been one universally adopted by practitioners nor universally incorporated into patient care.

**Prevention in Dental Education, 1936–2011**

The past seventy-five years since the founding of the *JDE* have seen a dramatic growth in the scientific basis of dentistry. The rise of modern biological science and the development of epidemiology over the twentieth century have greatly enhanced our understanding of disease causality and have built the evidence base that dental educators now use to train future generations of practitioners. Yet, to this day, there has been a gap in the transfer of such knowledge into practice, despite what appear to be the best efforts of the dental education community. However, this should be no surprise given the historical record summarized above. What this gap does highlight is that it is likely to be a major challenge to create a true paradigm shift to prevention in dental practice and that while efforts by dental educators may be essential, they may by themselves be insufficient to achieve the desired results.

The requirement for dental education to be well grounded in science and scholarship was one of the key outcomes of the changes spurred by the 1926 Gies report on dental education of the Carnegie Foundation for the Advancement of Teaching. A contemporary reflection of that shift in focus may be found in the current movement to integrate evidence-based approaches into dental education and practice. Concomitant with this foundation in science, the past two decades have been marked by the recognition that innovations in dental curricula are critically important in order to prepare practitioners who have the skills to incorporate evidence-based approaches into dental care and to be lifelong learners.

The Pew National Dental Education Program, from 1984 to 1989, aimed to bring about such long-term change in U.S. dental education. It sought to affect the basic delivery model of dental care, historically grounded in the solo private practice model, as well as to understand the effects of epidemiologic trends in the U.S. population’s dental disease burden and anticipated shifts in treatment needs. A key contribution was to highlight dental schools’ critical role in serving as innovation leaders. The program validated the need for innovation in the predoctoral dental curriculum and in continuing professional education and the important role of research in dental schools. Subsequently, in 1995, the Institute of Medicine report *Dental Education at the Crossroads: Challenges and Change* identified similar needs and opportunities. Most recently, the Macy Study report, *New Models of Dental Education*, refocused national attention on the critical value of community-based approaches to education and care delivery, reflecting a prevention-oriented and public health perspective that had heretofore received somewhat limited attention in most dental school curricula.

Over the past several decades, the *JDE* has brought increased attention to the role of prevention in dental education. Examples include assessments of the prevention content of the dental curriculum, proposals for curricular innovation and continuing professional education, and evidence-based critical reviews on prevention. A key question that remains unanswered is whether there is sufficient time and attention given to prevention in the curriculum. In a survey of dental students’ opinions and knowledge regarding caries management and prevention, Autio-Gold and Tomar found that the majority of respondents felt that training and practice on caries prevention should be increased.

In their 1989 review of U.S. dental school curricula, Solomon and Brown categorized the area of “preventative dentistry” within the major curricular area of Behavioral Sciences. In addition to prevention, other components of the Behavioral Sciences area that they included were “behavioral principles, community dentistry, DAU [Dental Auxiliary Utilization], practice administration and public health.” They reported that, in 1987, the percentage of curricular time devoted to the area of Behavioral Sciences was 5.9 percent. This represented approximately 250 clock hours (of the total 4,689). Despite fluctuations in the intervening decades, this proportion was similar to what it had been fifty years earlier, when in 1934 a total of 5 percent of curricular time was devoted to Behavioral Sciences (approximately 218 hours of the total 4,367).

In 1995, Tedesco reviewed dental school curricula and reported that a mean of sixty-six hours was devoted to “prevention” in the 1991–92 survey of dental schools, with a range from four to 218
hours across fifty-five U.S. schools. These figures had grown somewhat over time, with a mean of fifty-five hours in 1981–82 and sixty-eight hours in 1985–86. Tedesco also noted the impact of the earlier Pew National Dental Education Program on dental school curricula.

More recent data suggest the curricular time devoted to prevention and related areas has remained quite modest and a small percentage of the total educational effort. An important but unanswered question is whether this amount of time is sufficient to educate the prevention-oriented practitioner the profession needs? And if it is not, then how does the dental curriculum provide the requisite time given the many competing demands? Given the increased focus on the merits of curricular reform and the importance of the accreditation process in influencing the curriculum, a critical step towards ensuring the necessary balance may be to construct new Commission on Dental Accreditation (CODA) accreditation standards for the appropriate inclusion of prevention in the dental curriculum (Figure 1).

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**Dental Education and Translating Scientific Evidence for Training, Practice, and Policy**

The improvement in the oral health of Americans over the past fifty years is a public health success story, founded on discovery and evolution of the scientific basis of prevention in dentistry. However, despite the great progress made in the scientific understanding of oral disease causality and prevention, as Slavkin has summarized, there remain important challenges in translating science into practice. In this section, we will briefly discuss two examples, water

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The terms “prevention” and “preventive” are mentioned just three times (bolded below) in the new Commission on Dental Accreditation (CODA) standards approved in 2010:

2-13 In-depth information on abnormal biological conditions must be provided to support a high level of understanding of the etiology, epidemiology, differential diagnosis, pathogenesis, prevention, treatment, and prognosis of oral and oral-related disorders.

2-23 At a minimum, graduates must be competent in providing oral health care within the scope of general dentistry, as defined by the school, including:

  d. health promotion and disease prevention;

**Community-based experience:** Refers to opportunities for dental students to provide patient care in community-based clinics or private practices. Community-based experiences are not intended to be synonymous with community service activities where dental students might go to schools to teach preventive techniques or where dental students help build homes for needy families.

At their August 6, 2010, meeting, CODA adopted a resolution to approve the new Accreditation Standards for Dental Education Programs. The required implementation date is July 1, 2013.


**Figure 1. Prevention in the CODA standards**
fluoridation and dental sealants, and consider the role of dental education in promoting prevention in practice.

**Community Water Fluoridation**

The pioneering studies leading to the discovery of the use of fluorides for caries prevention and implementation of community water fluoridation are a classic example of research and scientific evidence leading to a great public health achievement. Consequently, fluoridation of drinking water has been recognized one of the ten great public health achievements in the United States during the twentieth century.

The scientific evolution of community water fluoridation (CWF) started with Dr. Frederic McKay’s investigation of brown staining on teeth, a seemingly unrelated topic to dental caries prevention. McKay’s observations led directly to the demonstration of fluoride as the etiologic agent for “Colorado brown stain” and its caries preventive effects. Beginning in the late 1930s, Dean, through a series of epidemiological studies known as the 21-Cities Study, conclusively demonstrated that drinking water naturally containing fluoride was associated with lower prevalence and severity of dental caries. The results suggested a concentration of 1.0–1.2 ppm of fluoride in drinking water as optimal to achieve maximum caries prevention with an acceptable level of fluorosis. Results of subsequent field trials of CWF showed a sharp decline (about 60 percent) of caries prevalence and severity in fluoridated communities compared to the control communities where the fluoride level was negligible.

Since its early days, community water fluoridation has faced various challenges. However, its efficacy, effectiveness, cost-effectiveness, and safety have endured the challenges and test of time. Yet, to this day, almost one-third of all Americans who could benefit from CWF (i.e., Americans who use public water systems) still lack the benefits. Is dental education doing enough to ensure that the future dentists of America are fully conversant with the science underlying the effectiveness and safety of CWF and aware of the scientific rationale supporting the most recent federal recommendations for CWF? And are our students fully capable of countering the often specious arguments being made against CWF?

**Dental Sealants**

Epidemiological data have shown that pit-and-fissure surfaces are the most vulnerable to caries. While the action of fluorides is more protective on the smooth surface, it has become apparent that there is a need for additional protection for pit-and-fissure surfaces. Dental sealants were developed for this purpose. In theory, properly placed dental sealants can almost completely prevent caries development of the targeted pits and fissures as long as the sealant remains in place. The caries preventive efficacy of dental sealants has been clearly demonstrated through numerous well-conducted clinical trials and has more recently been confirmed with systematic reviews and meta-analyses.

However, despite the extensive scientific evidence, private practitioners’ adoption of dental sealants has been rather slow, in varying parts due to skepticism over effectiveness, fear of sealing over caries, and preference for surgical treatment with amalgam restorations. By the 1990s, while sealants appear to have been adopted by a majority of general dentists in many states, some reservations appear to have remained as over two-thirds of American children were not receiving sealants. Nationwide, prevalence data over the past decades have shown a slow, gradual increase in sealant treatment: from 7.6 percent of five- to seventeen-year-olds in 1986–87 to 30 percent of six- to eleven-year-olds in 1999–2004. The current Healthy People 2020 goals include a 10 percent improvement in dental sealants coverage among six- to nine-year-old children (from 25.5 percent to 28.1 percent). While this increase in sealant use is promising, it also has been recognized that efforts for expanded coverage need to be more targeted for maximum benefit, i.e., sealants need to be placed in those children most likely to develop caries (to be at high risk). Children from disadvantaged backgrounds have higher caries risk and are also far less likely to receive dental sealants due to their limited access to dental care. Public health initiatives, such as school-based or school-linked sealant programs, have been implemented in many states to provide targeted sealant services to such high-risk children. Based on a systematic review of available scientific evidence, the U.S. Task Force on Community Preventive Services gave school-based or school-linked sealant programs a “strongly recommended” score for their caries prevention effectiveness. A recent expert review of systematic reviews...
confirmed the effectiveness of such school-based sealant programs.\textsuperscript{49}

An expert panel convened by the American Dental Association (ADA) Council on Scientific Affairs recently presented evidence-based clinical recommendations for dental sealant treatment based on an extensive analysis of systematic reviews and clinical trials.\textsuperscript{60} The recommendations not only re-affirmed the strong evidence for sealants in caries prevention among children and adolescents but also importantly showed that there is strong evidence that sealants placed over early (non-cavitated) caries lesions significantly reduce progression.\textsuperscript{61} Unfortunately, a recent survey of U.S. dentists found that less than 40 percent indicated they were following the ADA’s evidence-based recommendations for sealing non-cavitated carious lesions.\textsuperscript{61}

\section*{Incorporating EBD into Dental Education and Practice: Opportunities and Challenges}

Evidence-based dentistry (EBD) aims to incorporate current best evidence with clinical decision making in order to provide best care for patients. The ADA has defined EBD as “an approach to oral health care that requires the judicious integration of systematic assessments of clinically relevant scientific evidence, relating to the patient’s oral and medical condition and history, with the dentist’s clinical expertise and the patient’s treatment needs and preferences.”\textsuperscript{62}

In order to provide evidence-based care, practitioners need to be able to critically assess current best scientific evidence and incorporate it into their clinical decision making. Since EBD is not about providing a standard of care as in a “cookbook” approach,\textsuperscript{63} it is crucial for practitioners to become lifelong learners and active self-learning consumers of information (including current best scientific evidence). The foundational knowledge, skills, and attitudes necessary for this lifelong learning endeavor need to be developed during students’ dental education.

Dental education faces many competing forces, internally and externally, calling for change and reform.\textsuperscript{64,65} There clearly are a strong rationale and many opportunities to infuse EBD into the dental curriculum. The American Dental Education Association (ADEA) has already incorporated the concept of evidence-based dentistry into the core competencies expected of new dentists.\textsuperscript{66} Accordingly, many dental schools have undergone or are in the process of undergoing curriculum reform to require that their graduates satisfy new competencies that include EBD concepts. However, resistance to change seems inherent to both individuals and organizations. Incorporating EBD into dentistry, as with other new paradigms, has faced skepticism and resistance, including fear of third-party control over the doctor-patient relationship in clinical decision making.\textsuperscript{67} In dental schools, incorporating EBD has also faced challenges including faculty members’ unwillingness to change,\textsuperscript{68} shortage of faculty members trained and knowledgeable in EBD, and the curriculum being too tight and inflexible.\textsuperscript{27}

Incorporating EBD into the dental curriculum cannot be achieved by just adding a few didactic courses; it requires integration of EBD across the curriculum including preclinical and clinical training—a profound change in how we provide dental education, i.e., a paradigm shift. It requires fundamental changes in how we evaluate students’ learning and competencies within the dental school\textsuperscript{69} and eventually in the professional licensure examination process.\textsuperscript{70}

\section*{Moving Forward}

In 2011, the ADEA Section on Community and Preventive Dentistry had more than 1,360 members.\textsuperscript{71} This section has developed and disseminated innovative prevention education programs, including its recent development of a “Smoking Cessation Training Program in Dental School Settings” for which they received ADEA Council of Sections Project Pool funds. The section has conducted productive collaborations with other health professions through the Association of Teachers of Preventive Medicine and other groups. Clearly, the intellectual, organizational, and financial resources are in place to truly achieve a paradigm shift to prevention in dental education. Perhaps a harder challenge remains the translation of what we teach and inculcate in our students to their eventual professional practice.

One approach that bears crucial attention is to apply evidence-based health policy as a lever for
changes in the ways that health professionals are educated and health care is delivered. It is becoming evident that the current model of dental practice is insufficient to meet all the oral health care needs of an increasingly diverse U.S. population with worsening oral health inequities leading to high-risk underserved population groups bearing a disproportionate burden of disease. In addition, with the increasing focus on the nation’s need to contain health care costs, it is also becoming evident that efforts aimed at preventing disease are likely to be the most cost-efficient approaches we can take.

One example of the related recent work of the ADEA Section on Community and Preventive Dentistry is its role on the Healthy People Curriculum Task Force, formed to promote the Healthy People 2010 objective of increasing the preventive content of clinical health professional education within the broader national goals of achieving better health outcomes. The Healthy People Curriculum Task Force, founded in 2002, was convened by the Association for Prevention Teaching and Research (APTR) and represents eight national health professions education associations including ADEA. The task force developed the Clinical Prevention and Population Health Curriculum Framework. This framework provides recommendations for curricula to integrate clinical prevention and population health into the education of students across the health profession disciplines. The academic community is encouraged to apply this framework to curriculum design, evaluation, and accreditation efforts. The Healthy People Curriculum Task Force has continued to work collaboratively to implement the educational objectives of Healthy People 2020. A key component, Education for Health, is an educational roadmap to achieve the Healthy People 2020 goals. One could view this as a good example of how the predoctoral dental curriculum is being used as a basis for creating changes in dental practice and eventually in oral health outcomes.

Another leverage point at which dental education institutions and ADEA are ideally positioned is in the design and implementation of innovative programs to produce new types of dental practitioners, or the so-called “mid-level providers.” It is clear that new dental workforce models and related reforms in the delivery of oral health services are needed in order to achieve equity in health care access and to eliminate oral health disparities. The dental education community can provide the expertise to develop and deliver new curricula and to conduct the science needed to evaluate new models, as well as providing the venues for testing and demonstration and the integrated settings to educate future dentists within a team of diverse providers. We already had similar successes in dental education several decades ago. However, without the committed leadership of an organization like ADEA, its members, and its journal, we will not be able to complete the paradigm shift to prevention that remains urgently needed.

We have benefited from decades of scientific advances in building the evidence base for prevention-oriented oral health care. However, it is doubtful that, by itself, additional science will lead to a true paradigm shift. Rather, any major shift will likely result from an externality, such as societal change in how health care is organized and paid for. In large part, such change may be driven by the Patient Protection and Affordable Care Act of 2010 (ACA). Once fully implemented, the ACA is expected to result in major reform in payment methodologies for medical and dental care (at least, of all persons up to age twenty-one) through the creation of accountable care organizations, use of global payments, and payment for outcomes-based performance rather than payment for procedures. Prevention-oriented, evidence-based care is likely to be prioritized and rewarded. New dental workforce models and related reforms in the delivery of oral health services may also be a consequence. With oral health recently included as one of the twelve major topics of the U.S. Leading Health Indicators for the coming decade, it is increasingly evident that national health reform will significantly affect oral health care.

We can hope that change comes more quickly than in the past and that our current generation can achieve a true paradigm shift to prevention in the practice of dentistry. If nothing else, we may always take solace from physicist and Nobel laureate Max Planck (1858–1947), whose Planck’s Principle holds that “A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die and a new generation grows up that is familiar with it.”

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