

Perspectives on Innovations in Oral Health Care

R. Gary Rozier

A downward trend in dental caries in permanent teeth of children that began in the 1970s has leveled out at historic lows. Severe periodontal disease affects a small percentage of people, and tooth loss has plummeted so that complete tooth loss, once a common occurrence, now is almost nonexistent in upper socioeconomic groups. But not all people have benefited equally from these positive trends. Dental problems continue to affect the disadvantaged in society at unacceptable rates, and their disease burden is likely to increase because of trends in social determinants of oral diseases.

Personal dental care alone usually is unable to provide a sufficient buffer against these risks to maintain adequate oral health. Extensive disease in young children too often requires treatment in the hospital with a high chance of relapse. A national health goal is to “achieve health equity, eliminate disparities, and improve the health of all groups.” Achieving this goal in oral health requires that things be done differently.

This issue of the *North Carolina Medical Journal* highlights several approaches being tried here in North Carolina and elsewhere to address oral health problems. Initiatives fall into 4 categories: advocacy, workforce policies, integration of oral health and primary care, and the medical management of caries.

The prevention and control of oral diseases in populations is one of the more perplexing health challenges we face. Significant gains have been made in understanding disease processes, developing cost-effective preventive interventions, providing quality dental care, and reducing disease in many segments of the population. Yet, oral diseases are among the most common diseases in the world. Untreated caries in permanent teeth was the most prevalent condition among 291 diseases and injuries evaluated in the Global Burden of Disease 2010 Study, and severe periodontitis was the 6th most prevalent [1].

Many underlying causes of oral diseases are embedded in societies' ills, making the dental care system poorly equipped to address the underlying causes of the problem in patients. Community-based public health resources are often stretched much too thin to implement broad-based interventions that will reduce the effects of multiple determinants of disease.

The purpose of this Issue Brief is to provide an overview

of some of the new approaches being used to address oral health problems. These will be presented against a backdrop on trends in dental caries, periodontal disease, and tooth loss, using North Carolina-specific information where possible.

Trends in Oral Diseases in North Carolina

Notable reductions in the dental caries experience of permanent teeth in children and adolescents in North Carolina occurred over the 4 decades starting in the 1960s and 1970s [2]. Between 1960-1963 and 2003-2004, caries experience declined by 65% or more. The magnitude of the trend appears to have slowed in the 1990s and flattened out at these low levels during the first decade of this century. Its prevalence is projected to change little through 2040 without significant investment of resources or technological breakthroughs in caries prevention [3].

Dental caries experience in the primary dentition of preschool-aged children, already highly prevalent, increased each year between 2000-2001 and 2004-2005, and then declined over the next 5 years [4]. Figure 1 updates these trends through 2013-2014 using information about oral health from a subset of the North Carolina population. It displays the percentage of kindergarten students with any caries experience in their primary dentitions by poverty status of the county. The 10 counties with the highest percentage of children in poverty (mean = 40.8% in 2015) are compared to the 10 counties with the smallest percentage of children in poverty (mean = 20.9% in 2015), conditional on the availability of data provided by the North Carolina Oral Health Section surveillance system. The surveillance system provides robust estimates of disease trends for these 20 counties, based on clinical assessments of a total of more than 90,000 kindergarten students for the 4 time periods.

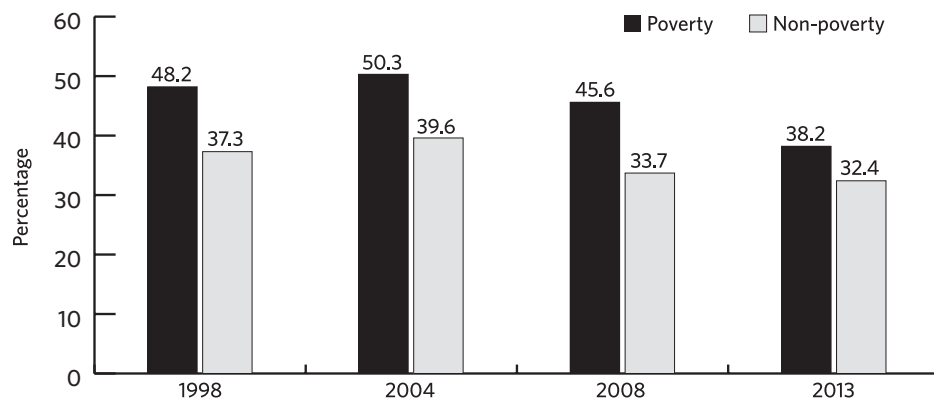
It appears that for these counties, the prevalence of dental caries continued to decline from a high point in 2004 through 2013. The decreases were greater in high-poverty counties, from 50.3% in 2004 to 38.2% in 2013, than in low-

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Address correspondence to Dr. R. Gary Rozier, Department of Health Policy and Management, Gillings School of Global Public Health, University of North Carolina at Chapel Hill, 1106K McGavran-Greenberg Hall, CB#7400, Chapel Hill, NC 27599-7411 (gary_rozier@unc.edu).

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FIGURE 1.
Trends in Dental Caries Experience (% dmft>0) of North Carolina Kindergarten Students by Poverty Status of County



Note. dmft, decayed, missing and filled teeth.

Poverty counties: Northampton, Scotland, Richmond, Edgecombe, Robeson, Washington, Halifax, Vance, Warren, Lenoir.

Non-poverty counties: Davie, Mecklenburg, Lincoln, Catawba, Onslow, Granville, Pender, Alexander, Stokes, Gates.

Counties ranked by percent children ages 0-17 in poverty (2015) and 10 with the highest and lowest percentages included if surveillance data available for all 4 cycles.

Source. Data derived from the North Carolina Division of Public Health, Oral Health Section. Poverty estimates for county are from United States Department of Agriculture, Economic Research Service.

poverty counties, which declined from 39.6% to 32.4%.

A substantial decrease in the prevalence of untreated caries in the primary dentition is apparent in Figure 2. This trend was particularly obvious in children living in those counties with the highest percentage of children in poverty. By 2013, the absolute inequality in untreated caries had been reduced to only 5.2 percentage points compared to 18.4 percentage points in 2004.

Less information on the oral health status of North Carolina adults is available than for children. The prevalence of periodontal diseases is unknown, not having been assessed statewide since 1976-1977. Nationally, the prevalence of periodontitis for adults was 46% in 2009-2012, with about 8.9% having severe periodontitis [5]. Projections for periodontal diseases are uncertain because of the lack of an obvious trend in national surveys.

Tooth loss, an important population-based outcome measure of the effectiveness of our collective efforts to achieve optimal oral health, dropped precipitously over the last 50 years. In 1960-1963, 58% of 60-69-year-old whites in North Carolina were edentulous and about 45% of people of other races [6]. In 2016, 18% of those 65 years of age and older reported that they had lost all their teeth because of dental problems [7]. Based on the research by Slade and colleagues [8], the projected prevalence in the United States will decline, but more slowly, reaching 2.6% in 2050.

Tooth loss provides a revealing example of socioeconomic disparities in oral health indicators. According to the Behavioral Risk Factor Surveillance System (BRFSS) conducted in North Carolina in 2016, complete tooth loss was almost non-existent in those in the highest income bracket (>\$75,000) at 1.6%, compared to 12.6% in the lowest income bracket (<\$15,000) [7]. In the "Running the Numbers" col-

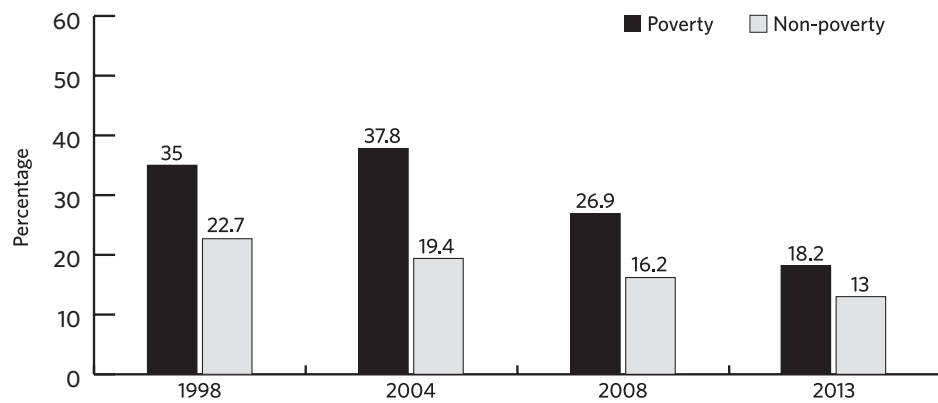
umn of this issue, Howell [9] provides an analysis of tooth loss using the last 3 cycles of the BRFSS (2012, 2014, and 2016). Overall, a majority of adults in North Carolina (52.4%) have never had a permanent tooth removed because of dental disease, but percentages differed by socioeconomic status. For example, adults who were college graduates compared to those with less than a high school education were 2.7 times more likely to have retained all their teeth (71.0% vs 26.2%).

Most of what we know about trends in oral health status in North Carolina is derived from information provided by the surveillance system maintained by the Oral Health Section of the North Carolina Division of Public Health, the oldest state dental public health program in the United States. Next year, it will celebrate the 100th anniversary of its founding. The surveillance system has been redesigned and expanded to provide statewide clinical assessments of special population subgroups, including the frail elderly, pregnant women, 3rd grade school children, preschool children, and high school students, in addition to the long-standing annual assessments of kindergarten students used in this paper for the analysis of trends in caries experience of primary teeth by county income. Authors in this issue provide information about 2 components of the redesigned and expanded surveillance system [10, 11].

Oral Health Inequities and Interventions

The prevalence of oral diseases follows a stepwise social gradient with the smallest amount of disease in upper socioeconomic groups and with incrementally larger amounts in successively defined lower socio-economic groups [12]. Social, economic, political, and environmental factors are considered major determinants of oral health.

FIGURE 2.
Trends in Untreated Dental Caries (% dt>0) of North Carolina Kindergarten Students by Poverty Status of County



Note. dt, decayed (and untreated) teeth.

Poverty counties: Northampton, Scotland, Richmond, Edgecombe, Robeson, Washington, Halifax, Vance, Warren, Lenoir.

Non-poverty counties: Davie, Mecklenburg, Lincoln, Catawba, Onslow, Granville, Pender, Alexander, Stokes, Gates.

Counties ranked by percent children ages 0-17 in poverty (2015) and 10 with the highest and lowest percentages included if surveillance data available for all 4 cycles.

Source. Data derived from North Carolina Division of Public Health, Oral Health Section. Poverty estimates for county from United States Department of Agriculture, Economic Research Service.

Oral health status differences resulting from most social determinants are considered inequitable because they are avoidable and deemed unfair and unjust [13, 14]. The acknowledgment of the importance of social determinants of disease and that they are not equitable has important implications for strategies to move forward the oral health agenda in North Carolina. What matters now is that we set goals and develop strategies in which we consider the oral health conditions among disadvantaged groups.

In designing interventions, there are those focused on the health of the general population, others focused on the disadvantaged within the population, while still others focused on the general population but with the goal of reducing the inequitable gaps in oral health status. One of our national health goals for 2020 is: "To achieve health equity, eliminate disparities, and improve the health of all groups" [15]. This goal implies that health promotion and disease prevention strategies need to consider everyone, but with different levels of intensity proportional to the level of disadvantage [16].

Articles in this issue review activities underway by the North Carolina Oral Health Collaborative (NCOHC) and Youth Empowered Solutions (YES!) to better understand and address oral health inequities in North Carolina. The commentary by Oh and Santiago [17] from the NCOHC and the sidebar by Le [18] from YES! describe detailed methods used to assess the personal dental experiences of people from around North Carolina. Both organizations are advocating for changes that will reduce the influence of social determinates on oral health, which is essential information in providing decision makers with knowledge and options to improve oral health.

Eyes and Warren [19] of the Blue Cross and Blue Shield

of North Carolina Foundation and The Duke Endowment, respectively, highlight in their paper the 3 major areas that their organizations consider important for investment in oral health innovation. They long for "new approaches to dramatically increase access to affordable preventive care" and lament "...despite multiple statewide task forces and long-standing consensus that improvements in oral health are achievable and necessary, much of the change needed in North Carolina has yet to be realized." Hopefully, articles in this issue provide useful information to help understand what can be done to reduce inequities in oral health.

Workforce Policies In and Outside North Carolina

Workforce projections are important but often imprecise, inconsistent, and subject to decisions and events outside of dentistry. The potential variability in projections of workforce needs is exemplified by the polar opposite conclusions of 2 recent efforts to assess dental workforce needs for the United States. As part of a study of dental education in the 21st century, Eklund and Bailit [20] project a surplus of dentists in 2040 of 32% to 110%. Official projections by the Health Resources and Services Administration [21], the agency in the federal government responsible for workforce, estimate about an 8% shortage of dentists in 2025.

A comprehensive study with the aim of quantifying the need for dentists in North Carolina has not been completed recently. But several aspects of dental workforce planning are clear. First, using relative statistics, North Carolina persistently ranks 47th among states in the number of dentists per 10,000 civilian population [22]. However, dentists are concentrated in one-fifth of the state's counties. The gap in dentists per 10,000 population between North Carolina's

most underserved and not underserved counties defined by Primary Health Professional Shortage Areas status has been slowly widening over the years.

Second, previous workforce assessments for the state have relied heavily on interpretation of statewide population growth, which far exceeded changes in dentist supply. The state's population is projected to gain 2.1 million new residents between 2015 and 2035, but two-thirds of that growth is expected to occur in the Triangle and Charlotte [23]. Thirty-three counties are projected to have no growth or a loss of population in the next 20 years. More than half of counties (54) are projected to have fewer children in 2035, and 53 counties are expected to have fewer working adults. Trends in social determinants of oral diseases suggest a growing socioeconomic divide in North Carolina, which will present a major challenge for workforce planning.

Finally, North Carolina has among the most restrictive regulations for the scope of practice for dental hygienists in the nation. According to an analysis by the Oral Health Workforce Research Center (OHWRC) at the University of Albany, North Carolina is 1 of only 4 states that does not permit any of 8 services the Center included in their analysis or has no law pertaining to the service [24]. The American Dental Hygienists' Association has identified 40 states, so called direct-access states, in which dental hygienists can initiate treatment based on their assessment of a patient's needs and provide treatment without the specific authorization of a dentist or presence of a dentist [25]. Eighteen states have practice act provisions that allow dental hygienists to be reimbursed directly by Medicaid [26]. According to research by the OHWRC, a broader scope of practice for dental hygienists is associated with improved oral health [27].

In response to the lack of access to treatment services, some workforce models for mid-level providers new to the United States have emerged [28]. The models differ mainly in the degree of supervision required by a dentist, the amount of education required, and whether a dental hygiene license is required or not. The Advanced Dental Hygiene Practitioner (ADHP) is a model proposed by the American Dental Hygienists' Association. This provider can offer simple restorations and extractions without the direct supervision of a dentist. It currently exists in Minnesota only.

Dental therapists, similar to physician assistants in medicine, can provide preventive services, routine restorative care, and extract teeth. First introduced in the United States by Alaska tribal communities in 2003, dental therapists are now providing oral health services in Minnesota and Alaska, are supported by approved legislation in Maine and Vermont, and as of May 2017, at least 11 states were exploring the authorization of dental therapy practice [28, 29].

In her invited commentary, Grover [30] describes the Community Dental Health Coordinator (CDHC), a new member of the dental workforce promoted by the American Dental Association. She emphasizes the case management

and care coordination competencies taught in the 18-month curriculum, along with other competencies needed for public health and community activities. As Grover points out, the CDHC can fill an important role in helping people navigate primary care, oral health, and social services. Currently, a little over 100 students have graduated, so experience with this model is limited. Further experience will provide more information about appropriate roles for the CDHC, their effectiveness, and how they fit within existing financial systems and dental practice acts.

In another article, the Health Policy Institute of the American Dental Association presents a measure of geographic proximity of the public and dentists at a sub-county level (Census tract) for each state. This method provides a more sophisticated way to think about dental shortage areas than previously available for use in workforce planning. Dr. Marko Vujicic, Vice President of the Institute, provides some results for North Carolina in this issue [31]. The analysis for North Carolina demonstrates, among other results, that 90% of publicly-insured children live within 15 minutes driving time of a dentist enrolled in Medicaid. If a policymaker chose to define shortage areas using the data presented by Vujicic, he would conclude that 17% of publicly-insured children and 29% of the overall population in North Carolina live in dental shortage areas. Vujicic makes no claim that living in close proximity to a dentist enrolled in Medicaid is associated with dental use or whether the rather robust estimates for geographic proximity in this study implies an adequate supply of dentists.

In addition, Kranz and colleagues [32] completed a geospatial analysis of dental offices and Medicaid-enrolled children in 17 counties in North Carolina. They calculated driving time from the home address of young children enrolled in Medicaid to the nearest dental practice providing oral health services paid for by Medicaid as documented by claims. On average, children lived only 7 minutes from the nearest dental practice. Greater distance to care was associated with decreased probability of dental visits. Even with this very close proximity, however, use was less than 50%; therefore, factors other than proximity appear to be affecting use.

What if Dental Caries Prevention Fails? A New Strategy for High-Risk Patients

Substantial scientific evidence and practical experience supports the prevention of dental disease and the promotion of oral health. The science supporting collective personal, professional, and public health strategies for the prevention of dental caries in children is particularly well-developed. A recent review of prevention methods identified 30 systematic reviews on prevention of dental caries supporting those strategies recommended for use in the United States [33]. Yet, thousands of people in North Carolina lack access to a comprehensive set of recommended preventive services throughout life. Further, clinicians and scientists acknowledge that clinical strategies effective in preventing dental

caries in the average-risk child sometimes can have little effect on those children at extreme risk [34].

Increasingly, young children receive extensive surgical dental treatment (remove and replace decayed tooth structure or extract teeth) for dental caries in the hospital operating room or ambulatory care center under general anesthesia at high costs and anguish to other family members. National estimates suggest that as much as \$450 million in avoidable Medicaid expenditures for hospital care occur in a single year [35].

Wright and White [36] from the UNC-Chapel Hill Schools of Dentistry and Public Health provide an overview of silver diamine fluoride (SDF) in their invited commentary. SDF is a chemotherapeutic agent first made available in the United States in 2015 that stops the progression of caries when applied topically to the carious lesion. It promises to make unnecessary some of the now standard-of-care surgical treatment for dental caries provided in hospitals, ambulatory care centers, and private offices. Even with acceptance as a treatment option and wide-spread adoption by dentists in North Carolina, access to SDF application, like other dental services, will remain a problem for some children. We already are hearing calls for its use in non-dental settings, including primary care, as a means to increase access [37, 38].

Integration of Primary Care and Oral Health Care

The dental and medical primary health care systems historically have operated separately with little integration of their education programs, clinical practices, organizational structures, regulatory agencies, or policies [39]. Separate systems contribute to disparities in oral health status because of missed opportunities to provide services in primary care locations where patients might seek care. Physicians can provide preventive oral health services in their offices, dentists can provide preventive health services in their offices, and community-based health professionals can provide preventive oral health services in multiple non-health care settings like Early Head Start programs and long-term care facilities. Four contributions in this issue address different aspects of the integration of oral health and primary care [40-43].

Most of the focus of early work in integration of primary care and oral health was on the expansion of the scope of practice for primary care physicians and allied professionals to include preventive oral health services such as screening and enhanced dental referral activities, counseling, and fluoride therapies [44, 45]. This work was motivated largely by the growing awareness of the high dental need, particularly among very young disadvantaged children and their poor access to dentists [46]. Well-child visits for infants and toddlers provide multiple opportunities for preventive oral health services for children who are unlikely to have access to or make a visit to a dentist.

Into the Mouths of Babes (IMB) in North Carolina,

reviewed in the article by Eason and colleagues [41], was one of the initial efforts in the United States to integrate clinical preventive oral health services into primary care. Evaluations of IMB show that this type and degree of integration can reduce the need for dental caries-related treatment services, promote early entry into the dental care system for those children in greatest need, reduce hospital use, and help control costs [47-49]. Eason and colleagues highlight the continued commitment of partners in North Carolina to the oral health of young children and identify strategies to move integration forward, specifically expanding the age for eligibility for IMB services to be consistent with national guidelines and increasing medical providers' promotion of the age 1 dental visit and its effectiveness.

Still with a goal of providing access to oral health services in the location where most individuals receive their primary care, another model is the co-location of dental hygienists in the primary care setting, either with separate administrative functions or as a fully-integrated member of the medical practice [50]. An example of this model is the Colorado Medical-Dental Integration Project (CO MDI) in which independent dental hygienists are co-located in several primary care practices with dedicated rooms with dental equipment [50, 51].

Other approaches to integration maintain separate dental and medical delivery systems but create linkages through treatment protocols for medical and dental services, financing mechanisms, and linkage services such as care coordinators. Integration models in which physical location of clinical services, patient records, practice management, accountability, and policies are integrated are rare, but some examples include the Department of Veterans Affairs, Kaiser Permanente of Oregon, and some Federally Qualified Health Centers [52].

Another notable development in the integration of oral health and primary care is the chairside screening in the dental office for medical conditions such as hemoglobin A1C for glycemic control in diabetes or BMI for obesity [53, 54]. Several feasibility studies have shown the dental office to be a promising health care environment to deliver these services. Economic studies show that treatment of dental problems such as periodontal disease can reduce expenditures for medical problems. One analysis estimated savings of \$64 billion over 10 years from insurance coverage of periodontal disease [55].

A final integration strategy is to include community-based agencies in efforts to link patients to comprehensive health services [56]. These 3 trends—the integration of oral health services into medical care, the integration of medical services into dental care, and the integration of social service agencies with either—provide the opportunity for greater population coverage of preventive services, access to care, and improved overall health.

Atchison and Weintraub [40] identify some of the barriers to integration of oral health and primary care. Among

them is the lack of access by all providers to Electronic Health Records, also consistently identified in the literature as a barrier [57]. Burris [42] provides a commentary on the North Carolina Health Information Exchange (HIE), known as NC HealthConnex. State law will require dentists and other health care providers who are paid funds from Medicaid, HealthChoice, or other state sources to be connected to the HIE and submit patient information. Implementation dates are pending as is the structure for dentists' participation, but the current deadline for implementation is by June 2019 for most providers. Among the many advantages of NC HealthConnex is the opportunity to coordinate care in integrated care models, particularly an already functioning one like IMB where the need for coordination is documented. NC HealthConnex will permit physicians and dentists who might be seeing the same child on multiple visits during the early years of life to coordinate preventive oral health services like fluoride varnish application and confirm adherence to the recommended visit schedule.

The contribution by Moss [43] about including oral health as a core benefit in Medicare Part B reminds us that integration strategies need to consider multiple levels, from the delivery of individual clinical services to the development of regulations and policies that allow and facilitate these efforts. General advancement and awareness of scientific knowledge about the bi-directional relationship of oral health and general health, along with the high prevalence of oral diseases in cohorts of adults born before the preventive dentistry era and dental insurance have contributed to support for a dental benefit in Medicare. Two bills to include dental, vision, and hearing services in Medicare have been introduced in Congress [58]. Although some recommendations have been made, a national consensus on strategies for including these benefits in Medicare is lacking [59]. While policymaking at the national level plays itself out, approaches to increasing access to care for elderly adults in North Carolina need debate. Moss presents 2 delivery system options for consideration.

Conclusion

Substantial progress has been made in improving oral health outcomes in North Carolina, but further progress will require strategies that not only maintain these gains, but also develop creative ways to consider social determinants of dental problems, some of which are beyond the traditional boundaries of existing dental and public health systems.

The priority we place on the oral health of young children continues to yield positive results. Although based on limited data, the percentage of children enrolled in kindergarten who are affected by dental caries and the proportion with untreated caries continued the decline that started in 2004. These benefits likely carry over to older children.

The deep divide in North Carolina counties, according to poverty and population density, makes workforce planning challenging. Promising workforce and integration models

for prevention and treatment are evolving in the state and nationally; however, dental practice act rules and regulations prevent adoption of some of these models in North Carolina. Experience with them in other states should be monitored for their application to North Carolina. **NCMJ**

R. Gary Rozier, DDS, MPH research professor, Gillings School of Global Public Health, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina.

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