Published in final edited form as:
Acad Pediatr. 2009 ; 9(6): 433. doi:10.1016/j.acap.2009.09.003.

Addressing Children's Oral Health in the New Millennium: Trends in the Dental Workforce

Elizabeth Mertz, MA and
Center for the Health Professions, University of California San Francisco, 3333 California Street, Suite 410, San Francisco, CA 94118, 415-502-7934, 415-476-4113, http://futurehealth.ucsf.edu

Wendy Mouradian, MD, MS
Professor Departments of Pediatric, Dentistry, Pediatrics and Health Services, Associate Dean for Regional Affairs and Curriculum, University of Washington Schools of Dentistry, Medicine and Public Health, Box 356365, 1929 NE Pacific Street, Seattle, WA 98105-6365, 206 543-0903, 206-616-2612

Elizabeth Mertz: bmertz@thecenter.ucsf.edu; Wendy Mouradian: mourad@u.washington.edu

Abstract

The Surgeon General's Report on Oral Health (SGROH) and the C*all to Action to Promote Oral Health* outlined the need to increase the diversity, capacity and flexibility of the dental workforce to reduce oral health disparities. This paper provides an update on dental workforce trends since the SGROH in the context of children's oral health needs.

Major challenges remain to ensure a workforce that is adequate to address the needs of all children. The dentist to population ratio is declining, while mal-distribution of dentists continues for rural and underserved communities. The diversity of the dental workforce has only improved slightly, while the diversity of the pediatric population has increased substantially. More pediatric dentists have been trained, and dental educational programs are preparing students for practice in underserved areas, but the impact of these efforts on underserved children is uncertain. Other workforce developments with the potential to improve children's oral health include: enhanced training in children's oral health for general dentists; expanded scope of practice for allied dental health professionals; new dental practitioners including the dental health aid therapist; and increased engagement of pediatricians and other medical practitioners in children's oral health.

The evidence for increasing caries experience in young children points to the need for continued efforts to bolster the oral health workforce. However, workforce strategies alone will not be sufficient to change this situation. Requisite policy changes, educational efforts and strong partnerships with communities will be needed to effect substantive changes in children's oral health.

Keywords

Dental Workforce; Workforce Trends

Introduction and Background

The 2000 Surgeon General's Report on Oral Health (SGROH) noted “concerns about a declining dentist-to-population ratio, an inequitable distribution of oral health care providers, a low number of underrepresented minorities applying to dental school, the effects of the costs of dental education and graduation debt on decisions to pursue a career in dentistry, the type and location of practice upon graduation, current and expected shortages in personnel for dental school faculties and oral health research, and an evolving curriculum with an ever expanding knowledge base.” [1] The C*all to Action to Promote Oral Health* outlines the need to increase the diversity, capacity and flexibility of the dental workforce in order to meet patients' needs and reduce disparities in oral health.[2] The purpose of this paper is to provide an update on dental workforce trends since 2000 and the implications for children's oral health.

Children's Needs and Workforce Adequacy

The ability of vulnerable populations such as children to access oral health care is a measure of the adequacy of the dental workforce. All children are entitled to preventive and other needed dental services from an early age to optimize their chance for good oral health and the development of health-promoting behaviors. [3, 4] Indeed, national dental and medical professional organizations call for a dental visit or oral health assessment by age one to initiate this care. [5, 6] This assumption removes demand from the equation of estimating requirements for the pediatric oral health care workforce: children require these services, even if caretakers do not “demand” the services or know how to access them due to a variety of barriers.

Thus we assume that *all* 75 million children in the U.S. need access to basic oral health services including regular oral health monitoring, timely access to preventive measures, and restorative dental treatment when needed.[7] Children from low-income families are at particular risk for poor oral health and difficulties accessing care.[1] Currently some 18% or 13 million of U.S. children live at or below the federal poverty level, while some 39% or 29 million are low-income and live at or below 200% of the federal poverty level. [8, 9] Most poor and low-income children are eligible for coverage under state Medicaid programs, that are mandated to provide medical and dental benefits under the Early and Periodic Screening, Diagnostic, and Treatment (EPSDT) service, or under the State Children's Health Insurance Plan (SCHIP).[10]

Unfortunately, data available at the time of the SGROH indicated that fewer than one in five Medicaid-eligible children received preventive dental care, with lower rates for the youngest children.[1, 11] Children were 2.6 times more likely to lack dental coverage as medical coverage, and for all income levels, children from racial/ethnic minority backgrounds had higher levels of disease and untreated decay.[1] Of concern, newer data from the National Health and Nutrition Examination Survey indicate *increasing* levels of caries experience in young children, with persistent disparities by race/ethnicity and income.[12] Although measures of access to care in low-income children have improved since 2000 due to initiation of the SCHIP and other efforts, still more than half of children covered by Medicaid/SCHIP programs go without regular dental care, while many others remain uninsured.[13] (See Edelstein and Chinn[i] in this volume for more discussion of children's access to dental care). Meanwhile the population of children has become increasingly diverse: nearly half of children under age five are minorities, an independent risk factor for oral disease.[14] (For a discussion of the epidemiology of children's oral health see Tomar and Reeves[ii], in this volume.)

[i]Edelstein and Chinn. This issue
[ii]Tomar and Reeves, This issue.

For these reasons it is particularly critical to re-assess the adequacy of the workforce to meet the needs of children. In addition, the 2009 CHIP Reauthorization Act (CHIPRA) passed by Congress will increase the numbers of children with dental coverage, providing an opportunity to substantially improve children's access to oral health care– provided the workforce and delivery system can respond to this mandate.

Workforce Trends: 2000-2009

How has the workforce changed since the SGROH? Increased diversity, capacity and flexibility of the dental workforce have evolved due to new dental educational programs, innovative models for new practitioners, and expansion of roles for allied dental professionals (hygienists and assistants) and non-dental health professionals (physicians, nurse practitioners). The availability of dentists to treat children is dependent upon many factors beyond workforce supply -- including financing of care, dentists' training and willingness to see young children, disease levels and dental needs of the population across the life span, and changing practice patterns which may include reduced work hours and increased delivery of esthetic dentistry services.[15] Increasing utilization of allied dental providers, new practitioners and non-dental health professionals, advances in technology and science, and changing economic conditions may all impact workforce trends and adequacy. These considerations must be kept in mind when evaluating historical trends and projecting the dental workforce needs, particularly for children.

The Dentist Workforce

There were 179,594 professionally active dentists in the US in 2006, the majority of whom were in general practice (78.8%), with only 14.5% who were pediatric dentists.[16, 17] The supply of dentists varies widely across regions of the country and is predicted to be outpaced by population growth.[18] According to the American Dental Association (ADA) the 2006 dentist-to-population ratio was approximately 60:100,000, or about 1 dentist for every 1666 people. Future projections vary as to the extent and timing of a decline in this ratio; however the latest projections foresee a decline starting in 2015 with a drop to a ratio of 54:100,000 by 2030 or about 1 dentist for every 1850 people.[17] The optimal dentist-to-population ratio to ensure access to care has not been agreed upon, but the federal shortage designation threshold is 1 dentist per 5000 individuals.[19]

Geographic mal-distribution of dentists continues. The number of Dental Health Professional Shortage Areas (DHPSAs) has increased since the SGROH; there are now 4,091 Dental HPSAs with 49 million people living in them, a trend which may be partially attributable to more communities seeking the designation to be eligible for federal funding to attract dentists.[20, 21] It would require 9,579 dentists to fill the shortages in the current DHPSAs, and it is likely that there are many more areas with a shortage than are designated; for example, in California a study showed that only 37% of the communities eligible for shortage designation had actually achieved it. [21, 22] These shortages are likely to continue as older dentists in rural communities retire and new, younger graduates seek higher paying practices to pay off the increasingly large dental school debts.[23, 24] The average debt of all dental school graduates in 2007 was $158,810, up significantly from $145,465 in 2006. [23, 25] In comparison, median medical student debt was $140,000 for 2007 graduates.[26] At the same time the average net income of full-time solo private practice dental providers rose 117% between 1990 and 2004; and in 2006 independent general dentists earned $202,930 on average, surpassing many primary care physician specialty incomes (e.g. pediatricians earned between $140,000 - $202,000).[25, 27, 28]

Growth in the dental education sector will also impact future supply of dentists. Five new dental schools opened since 2000 (most of which were private with relatively high tuitions) and one closed its doors; several more are slated to open soon, many connected to osteopathic medical

schools, for a total of 58 fully-accredited dental schools in 2009.[29] The average dental school class size is just over 200.[30] Concurrently vacancies in full-time faculty positions have increased from 272 in 2000, to 365 in 2006. [31] New schools are likely to put increasing pressure on the already difficult task of recruiting new dental faculty. The number of graduates from U.S. dental schools intending to enter academic careers remains very low overall, posing a threat to dental education in the future.[23]

The Pipeline, Professions and Practice Program, with the initial funding of programs in 15 dental schools, has influenced dental education with a focus on recruitment of minority applicants, curricular changes to prepare students to care for underserved populations, and experiences in community-based clinical settings.[32] With additional funding from a Kellogg-American Dental Education Association partnership supporting financial aid for recruitment of minority students, this ongoing effort has helped increase the diversity of the dental students in the participating education institutions.[33, 34] However, the overall ethnic/racial composition of the incoming dental school classes remains far from parity with the population (See Table 1), although the number of female enrollees is approaching parity, at 44.9% of the graduating 2006 class.[23] Underrepresented minority graduates may be more likely to serve their own communities, but they continue to be a small percentage of graduates.[23]

While many dental schools have designed or participated in programs to develop dental graduates with a commitment to underserved and rural communities, the overall impact of these programs on the dental workforce has yet to be determined.[35] Despite this, the newly opened Arizona School of Dentistry and Oral Health has had preliminary success with an extensive community-based educational model, with the result that 25% of the first graduating class chose employment in community health centers (CHCs).[36] While all these efforts increase the capacity of dental providers to work with vulnerable populations, none of them are focused specifically on children.

Graduate training is one way to improve the capacity of the dental workforce to care for children including those with special health care needs (CSHCN). Residents trained in Pediatrics, Advanced Education in General Dentistry (AEGD) and General Practice Residencies (GPR) typically receive additional training in care of children, underserved and complex patients. The number of students trained in pediatric dentistry residencies has increased from 441 in 2000 to 686 in 2007; however, the number trained in GPR and AEGD programs declined slightly since 2000, from 1664 to 1651.[37, 38] In addition to increasing the number of individuals with this advanced training, enhanced capacity is also dependent upon external factors including financing streams and dental graduates' willingness to care for low income children and those with special needs.

Allied Dental Professions

Allied dental professions are essential members of the dental team; they complement the dentist's skills and improve the efficiency and effectiveness of dental care. Dental assisting and dental hygiene have been among the fastest growing occupations in the country, projected to see an approximate 30 percent increase between 2006 and 2016.[39] Nearly two-thirds of dentists employ at least one hygienist, and almost all dentists employ a chair-side assistant.[40] Dental hygienists provide preventive interventions and oral health education; in some states dental hygienists may receive additional training for expanded duties such as administering anesthesia and placing fillings *after* the dentist has performed necessary drilling. [41] In some states hygienists may practice in another location (i.e. public health program) under the general supervision of a dentist (meaning the dentist does not have to be physically present), while in other states dental hygiene has gained independent practice privileges (Oregon, California, and Colorado). [42,43] In all, 29 states allow direct access, meaning that the dental hygienist can initiate dental hygiene treatment based on his or her assessment of patient's needs without the

specific authorization or presence of a dentist, and can maintain a provider-patient relationship.[44]

Dental assistants tend to work under direct supervision of the dentist, but may also be trained in extended functions, depending on state statutes. Dental assistants' scope of practice and regulation vary widely across the country, and a 2006 study by the Dental Assisting National Board produced a position paper advocating for uniformity.[45] Dental assistants and dental hygienists are educated primarily at the associate degree level in community or vocational colleges. In 2004 there were 266 dental hygiene programs and by 2006 there were 287 accredited programs, 240 of which (84%) awarded an associate degree, and 53% of which were offered by a community college.[20, 46] The remaining 16% of the hygiene programs award baccalaureate or master's degrees. Between 2004 and 2008 the number of dental assisting programs increased from 256 to 273. [25]

The allied dental workforce is primarily female, and is racially/ethnically more diverse than the dentist workforce. A 2005-06 survey of dental hygienists in California found 97.5% of hygienists were female, and 76.6% of all hygienists were white, but of 18-30 year old hygienists only 67.0% were white, indicating an increasingly diverse workforce.[47]

Rethinking Professional Roles and Responsibilities

One way to improve children's access to oral health care and reduce disparities is to increase flexibility and capacity of the oral health workforce to meet children's needs through new arrangements of care delivery focused on early intervention, prevention, and health education. New models for the dental workforce have been tested long before the SGROH; yet renewed and heightened interest in new workforce strategies was evident in the February 2009 Institute of Medicine Workshop on the Oral Health Workforce in the US.[48] These approaches include both *new roles* for existing health professionals and development of *new dental providers*.

New Roles for Dental Providers

Examples of new roles for existing dental providers includes enhanced training and support for general dentists to provide care for Medicaid-eligible infants and young children (for example the Access to Baby and Child Dentistry (ABCD) program initiated in Washington State), [49] and additional training for allied dental professionals. The latter includes scope of practice increases for dental assistants and dental hygienists, and independent dental hygiene practice as discussed above. These changes may increase the capacity and productivity of general and pediatric dental practices and community health clinics that serve children. In addition, dental hygienists working under general supervision or as independent practitioners can provide oral assessments, sealants and fluoride applications in schools, community centers, health fairs, etc. [42, 50] Many initiatives around the country have focused on using dental hygienists and mobile or school-based oral health programs for underserved children, although some have met with opposition from concerned local dental associations.[52, 53] In one study, those states with more permissive dental hygiene practice environments were also shown to have higher utilization of oral health services and better oral health outcomes.[51]

New Types of Dental Providers

The expansion of primary care medical services in rural and underserved communities was made possible in part by the creation of mid-level providers such as nurse practitioners, physician's assistants and community health aids. The potential for similar advances in access to dental care has motivated several recent proposals for new dental providers, including the Community Dental Health Coordinator (a community health worker), favored by the American Dental Association (being piloted), and the Advanced Dental Hygiene Practitioner, proposed

by the American Dental Hygienists' Association (with expanded ability to provide restorative dental care).[43]

The most innovative (and controversial) workforce effort to date has been the Dental Health Aide Therapist (DHAT) training program. Implemented by the Alaska Native Tribal Health Consortium, this program is based on the dental therapist (dental nurse) model currently utilized in more than fifty countries.[54] (See article on this topic by David Nash[iii] in this volume). These practitioners can provide restorative services, including drilling and filling teeth and simple extractions, after just two years of training post high-school and a limited period of close-supervision. Education and licensure of a dental therapist and an advanced dental therapist have recently been approved by the Minnesota legislature. [55] The final decision came as a compromise between a state workgroup proposal for the development of an independent mid-level "Oral Health Practitioner (OHP)," (patterned after the "advanced dental hygiene practitioner") and a subsequent proposal by the Minnesota Dental Association for an entry level dental therapist. [56] Unlike the DHAT which is a two year program, the basic dental therapist will be bachelor's-educated and work with a dentist on-site, while the advanced dental therapist will be master's educated and be able to provide restorative procedures in underserved communities under indirect supervision of a dentist. [55]

New Roles for Medical Providers

A number of efforts have targeted increasing physician attention to oral health as part of overall health. This strategy builds from the fact that children access medical care frequently in the early years of life when disease prevention and early identification are possible before extensive treatment needs develop. Pediatricians, family physicians, nurses and nurse practitioners have provided preventive services including oral health risk assessment and screening, application of fluoride varnishes, oral health education and referrals to dentists in many states. Indeed, more than half of states currently reimburse physicians for application of fluoride varnishes under the Medicaid program. [57] The "Into the Mouths of Babes" Program in North Carolina is the largest such program, and thus far has trained thousands of practitioners who provided some 134,000 preventive oral health services to children birth – 3 years in 2008 alone (and more than 600,000 visits since 2000).[58-60] Reimbursement for oral health services vary from state to state, and may be as high as the $55-70 range (North Carolina and Washington, respectively) if the full oral health services package is delivered.[61, 62] To date about 1000 physicians have been trained in Washington State; 11,700 oral health visits were billed in FY 2008.[62] In addition to financial incentives, engagement of medical practitioners has required addressing physician attitudes, knowledge and skills along with practical advice for office personnel on implementing such services.

Other efforts have targeted physicians in training within residencies or in medical school with curricula and accreditation mandates. (See Douglass[iv] et al in this volume on the role of physicians in oral health). Recent guidelines developed for dental care of pregnant women and interest in the oral health care of pregnant women have the potential to engage more medical providers (including obstetricians, family physicians and nurse midwives) in oral health education of patients.[63] New York University created an alliance between their dental and nursing schools to facilitate cross-training and help expand access to oral and general health care for underserved populations.[64] (See Hallas and Shelley[v] in this volume for a discussion of the role of pediatric nurse practitioners in children's oral health).

[iii] Nash. This issue.
[iv] Douglass. This issue.
[v] Hallas and Shelley. This issue.

Monitoring Workforce Trends

While consistent sources of data are available for monitoring the traditional dental workforce, it is more difficult tracking the efforts of non-dental clinicians and the myriad of local programs focusing on improving oral health of children. An exception is states where physicians are now providing services reimbursed by Medicaid programs, since it is possible to monitor claims data. As noted in the SGROH, "…data regarding the contributions to oral health care made by the medical and public health components are not nearly as available," and that continues to be the case today. [1]

One system providing dental care for underserved children for which data are available is the network of community and migrant health centers. The Health Center Initiative of 2002 helped to fund expansion of dental services in health centers, almost doubling the number of medical and dental co-located services.[65] The National Association of Community Health Centers (CHCs) reports a 92.3% increase in dental patients and a 104.4% increase in patient visits for dental care between 2000 and 2006.[66] Yet, CHCs reported an 18.5% vacancy rate for dentists in 2004, with a 26.7% vacancy rate for rural CHCs.[67] The yearly placement of recent dental school graduates who have loan repayment obligations to the National Health Service Corps does not come close to meeting the needs of the Dental Health Professional Shortage Areas.[20]

Monitoring of certain other state level dental public health efforts important for children is provided by the National Oral Health Surveillance System (essentially new since the SGROH), sponsored by the Centers for Disease Control and Prevention. An update on data available from this resource as well as an updated commentary on the dental public health infrastructure as a whole, including dental public health workforce, is provided by Tomar and Reeves[ii] in this volume.

Summary and Conclusions

Overall our assessment is that only modest gains have been achieved in workforce goals of increased diversity, capacity and flexibility since the SGROH. In particular, the following trends and developments are discernible:

1. A projected decrease in the overall dentist to population ratio with continued or aggravated mal-distribution of dentists, and high vacancy rates in safety-net systems
2. Only modest gains in diversity of the dental workforce, despite national programs aimed at achieving this goal
3. The launching of 5 new dental schools – and potential opening of up to seven more - often affiliated with osteopathic medical schools - oriented to training public health-minded dentists in community-based settings
4. Increasing shortages of dental school faculty and continued low numbers of graduates seeking academic careers
5. New educational efforts to improve dental student and practitioner capacity to care for vulnerable populations and provide culturally sensitive care, with uncertain impact on children's oral health
6. An increase in numbers of pediatric dentists and residency training capacity with an uncertain impact on access to care for underserved children and those with special needs
7. Advances in the flexibility/capacity of oral health dental workforce including a) enhanced scope of practice for existing dental providers, b) models for new dental practitioners, including especially the implementation of Dental Health Aid Therapist

(DHAT) in Alaska and the Dental Therapist and Advanced Dental Therapist in Minnesota, and c) increased engagement of medical practitioners in promoting and addressing children's oral health.

8. A significant expansion of community health center dental services
9. Numerous new community-based prevention and education programs, with difficult-to-quantify impact

Major challenges remain to ensuring a workforce that is adequate to address the needs of children. With evidence for increasing caries experience in young children and continued disparities in oral health and access to care, we prioritize strategies that will prevent disease early or ensure early identification. This includes training of general dentists in care of young children, mobilization of the pediatric dental workforce to care for underserved children, engagement of medical practitioners and nurses in oral health preventive interventions, and development/evaluation of mid-level practitioner models with promise. Finally, all elements of the workforce must have the capacity to care for an increasingly diverse population.

The fact that high levels of a preventable disease persist in underserved children and that the majority of these children still do not access dental care provides a strong argument for enhanced efforts to address this important health problem. Workforce strategies are necessary, although not sufficient, to change this situation. Requisite policy changes, educational efforts, and most of all - valuing of children and all components of their health and well-being –are needed to reverse this situation for the next decade's update of the SGROH. Addressing the oral health care needs of the pediatric population in the future will require regulatory flexibility, community-based education, and innovations in care delivery -- extending outside of traditional professional silos to build a strong partnership commitment between professionals and communities to finding local solutions.

References

1. US Department of Health and Human Services. Oral Health In America: A Report of the Surgeon General. Rockville, MD: US Department of Health and Human Services, National Institute of Dental and Craniofacial Research, National Institutes of Health; 2000.
2. US Department of Health and Human Services. National Call to Action to Promote Oral Health. Rockville, MD: US Department of Health and Human Services, Public Health Service, National Institutes of Health, National Institute of Dental and Craniofacial Research; Spring. 2003
3. American Academy of Pediatric Dentistry. 2008-09 Definitions, Oral Health Policies and Clinical Guidelines; Core Values p4.; Ethical Responsibilities, p83. 2009 [July 21]. http://www.aapd.org/media/policies.asp
4. Mouradian WE. Ethics and leadership in children's oral health. Pediatr Dent Jan-Feb;2007 29(1):64–72. [PubMed: 18041515]
5. Mertz, E. Registered Dental Hygienists in Alternative Practice: Increasing Access to Care. San Francisco: Center for the Health Professions; May. 2008
6. American Academy of Pediatric Dentistry. 2008-09 Definitions, Oral Health Policies and Clinical Guidelines on Infant Oral Care. 2009 [July 21]. http://www.aapd.org/media/Policies_Guidelines/G_InfantOralHealthCare.pdf
7. US Census Bureau. State and County QuickFacts. 2008 [July 21, 2009]. http://quickfacts.census.gov/qfd/states/00000.html
8. National Center for Children and Poverty. Child Poverty. 2009 [July 21, 2009]. http://www.nccp.org/topics/childpoverty.html
9. DeNavas-Walt, C.; Proctor, BD.; Smith, JC. Income, Poverty, and Health Insurance Coverage in the United States: 2007 Current Population Reports P60-235. Washington DC: US Government Printing Office; 2008.

10. Centers for Medicaid and Medicare Services. Overview. 2009 [July 21, 2009]. http://www.cms.hhs.gov/medicaidearlyperiodicscrn/
11. US Inspector General. Children's Dental Services Under Medicaid: Access and Utilization. San Francisco: US Department of Health and Human Services; 1996. OEI 09-93-00240
12. Dye B, Tan S, Smith V, et al. Trends in oral health status: United States, 1988-1994 and 1999-2004. Vital Health Statistics 2007;11(248)
13. Manski, RJ.; Brown, E. Dental Use, Expenses, Private Dental Coverage, and Changes, 1996 and 2004. Rockville (MD): Agency for Healthcare Research and Quality; 2007.
14. US Census Bureau News. Census Bureau Estimates Nearly Half of Children Under Age 5 are Minorities Estimates find nation's population growing older, more diverse. 2009 [July 21, 2009]. http://www.census.gov/Press-Release/www/releases/archives/population/013733.html
15. Walton SM, Byck GR, Cooksey JA, Kaste LM. Assessing differences in hours worked between male and female dentists: an analysis of cross-sectional national survey data from 1979 through 1999. J Am Dent Assoc May;2004 135(5):637–645. [PubMed: 15202758]
16. American Dental Association. Distribution of Dentists in the United States by Region and State, 2006. Chicago: American Dental Association; Sep. 2008
17. American Dental Association. 2008 American Dental Association Workforce Model: 2006-2030. Chicago: American Dental Association; Jun. 2008
18. Valachovic RW, Weaver RG, Sinkford JC, Haden NK. Trends in Dentistry and Dental Education: 2001. Journal of Dental Education June;2001 65(6):539–561.
19. Orlans, J.; Mertz, E.; Grumbach, K. Dental Heatlh Professional Shortage Area Methodology: A Critical Review. San Francisco: Center for the Health Professions; Oct. 2002
20. ADEA. Dental Education At-A-Glance. Washington, DC: ADEA; 2004.
21. Health Resources and Services Administration. Shortage Designations: HPSAs, MUAs, & MUPs. 2009 [July 23, 2009]. http://bhpr.hrsa.gov/shortage
22. Mertz, E.; Grumbach, K.; MacIntosh, L.; Coffman, J. Geographic Distribution of Dentists in California. San Francisco: Center for California Health Workforce Studies at UCSF; Jan. 2000
23. Chmar JE, Harlow AH, Weaver RG, Valachovic RW. Annual ADEA survey of dental school seniors, 2006 graduating class. J Dent Educ Sep;2007 71(9):1228–1253. [PubMed: 17948617]
24. Harrison JP, Daniel RC, Nemecek V. The growing importance of dental services in rural America. Health Care Manag (Frederick) Jan-Mar;2007 26(1):34–42. [PubMed: 17314625]
25. American Dental Education Association. Trends in Dental Education. 2009 [July 13, 2009]. Online Presentation]http://www5.adea.org/tde/mainindex.htm
26. Jolly P. Diversity of U.S. Medical Students by Parental Income. Analysis in Brief. 2008 8(1)
27. By the numbers. Physicians. Physician compensation survey. Mod Healthc Dec 22;2008 (Suppl):76, 78, 80. [PubMed: 19227405]
28. American Dental Association. 2007 Survey of Dental Practice: Income from the Private Practice of Dentistry. Chicago: American Dental Association; Apr. 2009
29. American Dental Education Association. Personal Communication. Washington DC: 2009.
30. ADA Division of Education. Total US Dental School Enrollment by Ethnic/Race and Gender, 2006-2007. Chicago: American Dental Association;
31. Chmar JE, Weaver RG, Valachovic RW. Dental school vacant budgeted faculty positions, academic years 2005-06 and 2006-07. J Dent Educ Mar;2008 72(3):370–385. [PubMed: 18383641]
32. Pipeline Profession and Practice. Pipeline, Profession and Practice Fact Sheet. 2008 [July 22, 2008]. Website]http://www.dentalpipeline.org/
33. American Dental Education Association. ADEA Strategies to Enhance Diversity. 2009 [July, 2009]. http://www.adea.org/policy_advocacy/diversity_equity/Pages/ADEAStrategiesto.EnhanceDiversity.aspx
34. Andersen RM, Friedman JA, Carreon DC, et al. Recruitment and retention of underrepresented minority and low-income dental students: effects of the Pipeline program. J Dent Educ Feb;2009 73 (2 Suppl):S238–258. S375. [PubMed: 19237360]
35. University of Washington School of Dentistry. Regional Initiative in Dental Education. 2008 [July 29, 2008]. http://www.dental.washington.edu/ride

36. AT Still University. Arizona's first dental school graduates second class. 2008. http://www.atsu.edu/communications/news_releases/Arizonasfirstdentalschoolgraduatessecondclass.htm
37. ADA Survey Center. 2000-2001 Survey of Advanced Education. Chicago: American Dental Association;
38. ADA Survey Center. 2007-2008 Survey of Advanced Education. Chicago: American Dental Association;
39. Dohm A, Sniper L. Occupational Employment Projections to 2016. Monthly Labor Review. November;2007
40. Valachovic RW. Dental workforce trends and children. Ambul Pediatr Mar-Apr;2002 2(2 Suppl): 154–161. [PubMed: 11950387]
41. American Dental Hygienists' Association. Dental Hygiene Practice Act Overview. 2009 [July 12, 2009]. http://www.adha.org/governmental_affairs/downloads/fiftyone.pdf
42. Mertz, E. Registered Dental Hygienists' in Alternative Practice: Increasing Access to Care in California. San Francisco: UCSF Center for the Health Professions; May. 2008
43. McKinnon M, Luke G, Bresch J, Moss M, Valachovic RW. Emerging allied dental workforce models: considerations for academic dental institutions. J Dent Educ Nov;2007 71(11):1476–1491. [PubMed: 18030710]
44. American Dental Hygienists' Association. Direct Access States. 2009 [July 12, 2009]. http://www.adha.org/governmental_affairs/downloads/direct_access.pdf
45. Dental Assisting National Board. Job Title Excerpt: Position Paper of the ADAA/DANB Alliance: Addressing A Uniform National Model for the Dental Assisting Profession. 2007. http://www.danb.org/PDFs/JobTitles.pdfJuly 21, 2008
46. Association ADH. Dental Hygiene Education Program Director Survey, 2006. Chicago, IL: American Dental Hygienists' Association; 2008.
47. Mertz, E. Survey of Registered Dental Hygienists. San Francisco: Center for the Health Professions; Mar. 2007
48. Institute of Medicine. The US Oral Health Workforce in the Coming Decade: A Workshop. 2009. http://www.iom.edu/CMS/3809/55302/55352.aspx
49. ABCD Program. Access to Baby and Child Dentistry Program. 1994 [July 30, 2008]. http://www.abcd-dental.org/
50. Battrell AM, Gadbury-Amyot CC, Overman PR. A qualitative study of limited access permit dental hygienists in Oregon. J Dent Educ Mar;2008 72(3):329–343. [PubMed: 18316537]
51. Wing P, Langelier MH, Continelli TA, Battrell A. A Dental Hygiene Professional Practice Index (DHPPI) and access to oral health status and service use in the United States. J Dent Hyg Spring; 2005 79(2):10. [PubMed: 16208778]
52. Moller J. Feds oppose limits to school-based mobile dental clinics. The Times-Picayune. May 4;2009
53. Niederman R, Gould E, Soncini J, Tavares M, Osborn V, Goodson JM. A model for extending the reach of the traditional dental practice: the ForsythKids program. J Am Dent Assoc Aug;2008 139 (8):1040–1050. [PubMed: 18682618]
54. Nash DA, Nagel RJ. A brief history and current status of a dental therapy initiative in the United States. J Dent Educ Aug;2005 69(8):857–859. [PubMed: 16081565]
55. Fox, K. Minnesota Governor Signs Dental Therapist Legislation. Minnesota Dental Association]. 2009 [July 12, 2009]. http://www.mndental.org/client_files/documents/OHP_Articles/OHP_June_3_ADA_NEWS.pdf
56. Minnesota Department of Public Health. Oral Health Practitioner Recommendations: Report to the Minnesota Legislature. St Paul: Minnesota Department of Public Health; 2008.
57. Deinard A, Johnson B. Ending an epidemic: physicians' role in primary caries prevention. Minn Med Mar;2009 92(3):38–39. [PubMed: 19400385]
58. North Carolina Academy of Family Physicians. Into the Mouths of Babes. 2008 [July 24, 2008]. http://www.ncafp.com/imb/index.html
59. Rozier, G.; Close, K. Personal Communication with Wendy Mouradian. University of North Carolina; Jul. 2009

60. Rozier RG, Sutton BK, Bawden JW, Haupt K, Slade GD, King RS. Prevention of early childhood caries in North Carolina medical practices: implications for research and practice. J Dent Educ Aug; 2003 67(8):876–885. [PubMed: 12959161]

61. Casey, M. Personal Communication with Wendy Mouradian. North Carolina Department of Health and Human Services; Jul. 2009 DDS MPH Division of Medical Assistance.

62. Riter, D. Washington Dental Services Foundation. Personal Communication with Wendy Mouradian. Jul. 2009

63. Kumar, J.; Iida, H. Oral Health During Pregnancy: A Summary of Practice Guidelines. Washington DC: National Maternal and Child Oral Health Resource Center; 2008.

64. NYU College of Dentistry. NYU College of Dentistry, A Special Place. 2008 [July 22, 2008]. http://www.nyu.edu/dental/index.php

65. HRSA. The Health Center Program: The President's Health Center Initiative. 2002 [July 22, 2008]. http://bphc.hrsa.gov/presidentsinitiative/

66. National Association of Community Health Centers. A Sketch of Community Health Centers - Chart Book 2008. 2008 [July 21, 2008]. http://www.nachc.com/client/documents/Charbook%202008%20FINAL.pdf

67. Rosenblatt RA, Andrilla CH, Curtin T, Hart LG. Shortages of medical personnel at community health centers: implications for planned expansion. Jama Mar 1;2006 295(9):1042–1049. [PubMed: 16507805]

Table 1

Race/Ethnic Characteristics of Dental School Students, the Dental Workforce and US Population.

	Dental School Enrollment 2000-01	Dental School Enrollment 2006-07	Dental Workforce 2006	US Population 2006*
White	63.4%	61.3%	86.0%	74.1%
Black	4.8%	5.8%	3.5%	12.4%
Hispanic	5.3%	5.9%	3.5%	*14.7%*
Native American	0.6%	0.6%	0.1%	0.8%
Asian/Pacific Islander	24.8%	22.4%	7.0%	4.4%
Missing/Other	1.1%	3.9%	n/a	8.3%

Sources: ADA Division of Education. Total US Dental School Enrollment by Ethnic/Race and Gender, 2000-2001. Chicago: American Dental Association; ADA Division of Education. Total US Dental School Enrollment by Ethnic/Race and Gender, 2006-2007. Chicago: American Dental Association; American Dental Education Association. Trends in Dental Education. Online Presentation]. 2009; http://www5.adea.org/tde/mainindex.htm. Accessed July 13, 2009; US Census Bureau. American Community Survey Data Profile Highlights. 2006; http://factfinder.census.gov/servlet/ACSSAFFFacts?_submenuId=factsheet_1&_sse=on. Accessed July 29, 2008.

* Does not add up to 100% as “Hispanic” is a separate category in the Census than race. Race categories add up to 100%.