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Dental Hygienists' Contributions to Improving the Nation's Oral Health Through School-Based Initiatives from 1970 through 1999: A Historical Review

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Purpose. The purpose of this literature review is to document the contributions dental hygienists have made over the past 3 decades to improve the nation's oral health. This historical review encompasses selected literature that acknowledged dental Hygienists' direct involvement in U.S. school-based or school-linked oral health programs from 1970-1999.

Methods. Five researchers independently searched MEDLINE, PubMed, and other electronic databases to identify relevant literature for the years 1970-1999. The search aimed to locate articles authored by or that documented dental Hygienists' involvement as "service provider" in U.S. school-based oral health programs. For the purpose of this review, service provider was defined as educator, administrator, clinician, examiner, or any other unspecified service performed by a dental hygienist.

Results. Fifty-seven articles were retrieved, of which 36 (63%) directly linked dental hygienists to U.S. school-based activities. Twenty-seven articles specifically identified dental hygienists as service providers. Dental hygienists were listed as either primary or contributing author on 19 of these articles.

Conclusion. The decade of the 1970s revealed very little literature documenting dental Hygienists' involvement in U.S. school-based oral health programs. The 1970s, however, were instrumental in laying the foundation for service in the years that followed. As public health initiatives expanded in the 1980s, dental hygienists were identified in the largest number of papers as key personnel in the areas of education, management, service provider, and author. The decade of the 1990s yielded less literature than the 1980s, yet recognized dental Hygienists' involvement in all aspects of oral health care delivery, program development and management, and authorship. The authors of this review theorize that dental hygienists were engaged in more school-based programs than reported and were involved in the authorship process more frequently than documented. Due to lack of credentials, or the omission of the words "dental hygienist," "RDH," or "LDH," in favor of "health care provider," "auxiliary," or "trained health care educator," it is unknown what portion of contributions made by dental hygienists remain undocumented.

Keywords: School-based programs, dental hygienists, community health, school-linked programs

Introduction

The purpose of this retrospective review was to document dental Hygienists' roles and contributions to improving the oral health of America. Step one in this process was to review what has been reported in the literature regarding school-based or school-linked programs-beginning in 1970 and progressing to 1999. This report was prepared by the 2003-2004 American

Dental Hygienists' Association (ADHA) Council on Research (COR) to provide an overview of dental Hygienists' involvement in expanding oral care in the United States utilizing public school-based settings. As a health-related organization, it is important to show where and how our profession has been able to affirm its fundamental commitment to better oral health for all people.

In a country where the best quality dental care is available, the delivery of this care is not well-distributed; therefore, utilizing school-based programs offers an approach for expanding health care delivery. Unfortunately, dental disparities among children still exist, along with the common misconceptions that children's poor oral health no longer presents a problem, and that all children have equal access to oral health services.[1-4] While tremendous progress has been made in improving the oral health of Americans (ie, community water fluoridation), not all people have benefited equally. The utilization of school-based health care provides comprehensive services in places where children normally congregate, in a nonthreatening environment. This eliminates some of the barriers that prevent individuals from receiving dental care, such as lack of transportation, parents taking time off from work, and lack of insurance coverage.

Community school-based programs are a public health measure that benefit children of all socioeconomic strata. The Surgeon General's Report, *Oral Health in America* (2000), stated "there are striking disparities in dental disease by income. Poor children suffer twice as much dental caries as their more affluent peers, and their disease is more likely to be untreated." However, the report recognized the "significant role that ...dental hygienists... played in the prevention of oral disease..."[5] as affirmation of our profession commitment. This review seeks to document the contributions that dental hygienists have made in improving the nation's oral health through school-based oral health programs.

The 1970s

The decade of the 1970s illustrated an effort to reduce the high prevalence of dental disease and caries through prevention. Caries reductions were achieved through water fluoridation, school-based fluorides, oral health and dietary education, and pit and fissure sealants. Research demonstrated that combining several approaches to "primary prevention" provided communities the most effective measures to prevent dental caries.[6-10] Several long-term studies took place throughout the 1970s to investigate the effectiveness of preventive interventions in school-based settings, utilizing dental hygienists as educators, coordinators, and clinicians.

In 1972, a long-term school-based program designed to prevent dental caries using student-administered methods of applying fluorides was initiated in Nelson County, Va, an area where the water was fluoride deficient.[10] A dental hygienist, serving as part of the research team, supervised students on a regimen of daily fluoride tablets and weekly rinses with a 0.2% neutral sodium fluoride, along with fluoride toothpaste and toothbrushes for use at home. Initially, the program was offered to all children in the 6 Nelson County elementary schools (first through sixth grade). When the county opened a kindergarten program in 1976, these children were added to the dental program. In 1978, the program was extended to the county's junior high schools, and by the 1979-1980 school year, seventh and eighth graders were participating. This program was designed to measure the total, long-term effects of a combination of student-applied fluoride, fluoride tablets, and fluoride toothpaste in school-aged children living in rural areas with low concentrations of fluoride in drinking water.

Eleven years after the program started, dental examinations were performed on 1007 children who had continuously participated in the program for 1 to11 years.[10] At the time, 6-year-old children had taken part in the program for one year, while most 17-year-old children had taken part in the program for 11 years. The investigators, one of whom was a dental hygienist, found reductions in caries prevalence as follows: 18%, 35%, 45%, 49%, and 65%, after 2, 4, 6, 8, and 11 years of the program, respectively.[10] By the time data were collected, nearly 39% of the school children in Nelson County experienced a caries-free permanent dentition.

In 1973, a 4-year school-based preventive dentistry demonstration project was initiated in an urban area of Michigan to test the combined effect of several preventive and therapeutic measures on dental caries.[6] This study involved approximately 1200 first and sixth grade children who had limited access to dental care. Dental hygienists served as educators and trained classroom teachers to serve as dental health educators in their classrooms. The children in the treatment group (1) consumed

fluoridated water, (2) received oral hygiene education, daily supervised brushing, and flossing, (3) dental examinations, prophylaxis, and topical fluoride, (4) sealants, and (5) necessary restorative care. Children in the comparison group consumed fluoridated water, were provided with oral hygiene education, supervised brushing and flossing, and received dental examinations, but no restorative care. Parents were notified if carious lesions were detected. The investigators found that after 1 year, decayed, missing, or filled teeth (DMFT) was significantly lower in the treatment group, thus demonstrating improved oral health.

In a 3-year follow-up, the treatment group was randomly divided to provide a cluster that did not continue with treatment and served as a comparison.[11] After 5 years, the researchers observed 3 groups: (1) treatment group that received the complete program for 5 years, (2) treatment comparison group that received the complete program for 3 years and discontinued for 2 years, and (3) comparison group that did not receive any treatment other than the oral hygiene program for 5 years and fluoridated community water. Results showed that the treatment group, which received the complete program for 5 years, received maximum benefit (ie, had the lowest incidence of caries). The treatment comparison group experienced less caries than the comparison group, but higher caries incidence than the 5-year treatment group. Caries reductions were not sustained in those children who discontinued care at 3 years. The researchers concluded that, to be successful, preventive programs should be continuous rather than limited to a few years. The health education component, coordinated by a dental hygienist, helped demonstrate that school-based programs effectively reduced caries incidence in children with a low to middle socioeconomic status (SES), mixed ethnicity, and limited access to care. This study, funded through National Institute for Dental Research (NIDR), suggested that with governmental and community support, oral health care services could be made available to individuals who lacked access to care in the traditional private practice setting.

In 1975, The National Caries Program (1971-1983), sponsored by NIDR, initiated one of the largest standardized community projects ever conducted, focusing on caries control through school-based fluoride rinse programs. Seventeen sites across the country were selected to participate in the Community Caries Prevention Demonstration program because they had little or no fluoride in the communal water supply.[12] While each of the sites could determine its own administrative scheme and staffing pattern, 6 sites hired a dental hygienist as central coordinator. The school settings varied from one site that included a single, large county school district with more than 30 schools and 7500 children, to a rural mountain school district that included 13 schools and fewer than 1500 children. The island of Guam was the single largest site, with more than 15 000 children participating. Approximately 75 000 children in more than 3500 classrooms (kindergarten through sixth/eighth grades) volunteered for the rinse program. The proportion of children participating was used as the primary indicator of community acceptance. Since over 82% of eligible children across all sites participated for the 4 years, the program was deemed successful in terms of community acceptance. Additionally, caries inhibition ranged from 11% to 54% across the sites. At the conclusion of the demonstration program, 5 state departments of health reported the incorporation of the models into larger community efforts or statewide programs; furthermore, 4 of the larger demonstration sites fluoridated their community water supplies as a result of their participation. On the basis of the participation rates, caries inhibition, community acceptance, and the expansion of the model programs, NIDR considered the Community Caries Prevention Demonstration program a success. This program demonstrated that utilization of dental hygienists in a school-based setting provided preventive oral health care services to large numbers of children, at a participation rate that would be difficult to duplicate in private practice settings.[12]

Between the fall of 1977 and the spring of 1982, the American Fund for Dental Health (AFDH) administered the largest comprehensive school-based preventive dentistry program in the world.[13-15] The National Preventive Dentistry Demonstration Program (NPDDP) was developed to determine the costs and effectiveness of several school-based preventive dental procedures. Initially, approximately 25 000 elementary and secondary school children (first through sixth grades), in 10 geographically distributed states, with both fluoridated and nonfluoridated water, participated in the study.[14] Children received sealants, prophylaxes, topical fluorides, and dental health education. Clinical staff at each site consisted of a 7-member team: a program director who was either a dental hygienist, nurse or teacher; 2 clinical dental hygienists; 2 dental assistants; a clerk; and a part-time supervising dentist. Final results were not available at the time the article was written; however, impressions based on program experience suggested that school-based clinical programs were well accepted by children, parents, and school personnel and that dental auxiliary personnel were able to provide high-quality care with minimal supervision. During a 4-year period, approximately 8500 children received 95 000 sealants, applied by

a team of dental hygienists and dental assistants, utilizing a mobile facility in school-based settings. It was reported that dental hygienists working in dental teams were able to effectively apply sealants.[14] Furthermore, investigators selected dental hygienists to place sealants during this project because "it had been demonstrated that they applied sealants as well as dentists and at a reduced cost."[14]

As a result of the NPDDP project, Bohannan et al emphasized the need to deliver oral health care to vulnerable populations in community-based settings in the most cost-effective and efficient manner possible.[16] Investigators concluded that the most realistic approach to extending resources would be the application of preventive measures targeted to specific populations. As a result of this study, researchers concluded that community-based programs should include sealants, and that dental hygienists possess the knowledge and skills necessary to determine which teeth should be sealed. Their recommendations, based largely on the NPDDP data, noted that the highest caries prevalence areas within communities were in neighborhoods of low SES, frequently populated by large numbers of minorities. This study concluded that in order to maximize operating efficiency, school-based preventive programs should include both sealants and fluorides to achieve optimal benefits for those most likely to experience disease.

By the mid 1970s, the American Dental Association (ADA) Council on Dental Materials and Devices had reviewed the status of pit and fissure sealants and published its supportive opinions.[17] Sealants were now recognized as an effective management strategy for occlusal pit and fissure caries, while fluoride was shown to have the least benefit on these surfaces. Based on a large body of research, school-based community programs were structured around combination therapies, which included education, fluoride sources, and pit and fissure sealants. During the decade of the 1970s, researchers continued to examine the effectiveness and economics of providing dental services for children.[18-20] The cost of care varied significantly among private practice, public-fixed clinics, and public-mobile clinics; delivery of oral health care to indigent children through mobile clinics; however, were the least expensive mode, while private practices were the most expensive. Researchers suggested that alternative practice models could meet the oral health needs of indigent children, demonstrating that there is a role for both public and private sectors.[18-19]

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The 1980s

The decade of the 1980s yielded more literature documenting school-based initiatives with dental hygiene involvement than the previous decade and the one to follow. In a review of primary health care delivery in American public schools from 1890-1980, Michael Kort suggested that the biggest challenge for the future would be to "find formulas that reconcile expanded needs and scarce resources to maximize the benefit to the nation's children."[21] With schools already overburdened and facing tight budgets, finding ways to expand the scope and efficiency of school-based programs became difficult. Yet, recognizing that not all individuals have equal access to oral health services, government and public officials investigated ways to improve access to care.

Houle, studied the impact of 5 years' exposure to school-based dental health education programs (grades K-5).[22] One hundred forty-seven children were screened and tested for oral hygiene behavior (plaque scores) and dental related cognitive knowledge. A 40-question multiple-choice examination, prepared by the American Dental Association (ADA), was administered to participants. Dental hygienists were utilized as health educators during this project. Researchers concluded that when reinforced on a long-term basis, a well-designed dental health curriculum resulted in better skill performance, as indicated by a better performance of overall plaque removal and higher oral health knowledge.

In the mid 1970s, through a cooperative effort between with the school district of Juniata County and the University of Pennsylvania School of Dental Medicine, the Rural Dental Health Program (RDHP) was initiated. A study of 1859 children (K-6) compared the effects of delivering children's dental care utilizing school-based programs and community-based private dentists.[23] Two "professionally trained health educators" developed and delivered the dental health education component. Based on the data collected by the RDHP, investigators concluded that children who participated in the school-based delivery mode "were more likely to utilize dental services in a pattern which could lead to improved oral health." Being assigned to school-based programs that offered enriched dental health education "significantly increased the probability children would have regular preventive and restorative care."[23]

Seven years after the RDHP ended, a follow-up study conducted by Feldman et al measured the long-term effects of the 2 dental delivery systems-school-based and community-based.[24] Clinical examinations were conducted on the original participants who were in grades K-2 during the RDHP program. Based on the 406 children located, findings suggested that children who utilized community-based delivery programs were higher users of professional dental services. Researchers postulated that children in school-based programs had to seek out new patient-doctor relationships, whereas those in community-based settings had already established this relationship, yet long-term oral health effects might not be apparent for many years. Even though school-based programs meet community needs, once programs end or children are no longer eligible, they remain less likely to seek dental services than children in nonschool-based programs. The composition of the dental health teams providing services were not clearly defined, listed only as "professionally trained health educators."

Incorporating findings from large national studies conducted throughout the 1970s, New Mexico began programs that provided dental sealants for children in school-based settings.[25-28] The state of New Mexico utilized dental hygienists to apply pit and fissure sealants to children in areas of the state with limited or no access to private dental care. Calderone and Davis published a progress report on this initiative. They found that sixth graders who received sealants as first, second, or third graders, had 6% of the occlusal surfaces of their first permanent molars either decayed, missing, or filled (DMF). Their classmates who had not received sealants in the program had 27% DMF of the same tooth surfaces.[27] Retention rates for completely retained sealants placed in first molars were compared, revealing 67% after 6 years, 79% after 5 years, 79% after 4 years, and 94% after 1 year.

In a follow-up study, the New Mexico program researchers were able to obtain data from 482 high school students who participated in the New Mexico project during the 1980-1981 school year.[28] Brown, Calderone, and Mueller found that of the 813 sealants placed in permanent first molars, 460 (57%) of the sealants were completely retained, and 53 (7%) partially retained, with an overall retention rate of 63% after 10 years. The researchers concluded that a preventive public health program, utilizing dental hygienists in field settings, could achieve long-term results comparable to those found in a controlled practice environment.

In 1983, controversy arose over the utilization of dental hygienists to place pit and fissure sealants in the New Mexico project. The New Mexico Board of Dentistry ruled that the New Mexico Health and Environment Department's sealant program violated rules and regulations concerning the supervision of dental hygienists. For that reason, the state was forced to reduce the number of children served by the program to comply with this decision.[29] Initial attempts to secure a revision of the rules and regulations to accommodate the needs of public programs were unsuccessful. As a result of an extensive legislative effort involving the New Mexico Dental Hygienists' Association and the Health and Environment Department, general supervision became law in April 1985. Despite controversy, the programs illustrated dental Hygienists' ability to provide oral health care services to individuals with limited access to care through community based programs, in a cost-effective manner. Since that time, New Mexico has implemented a collaborative practice act allowing dental hygienists to practice in less restricted settings.

Most studies had evaluated sealant placement in the permanent dentition. Because of limited information for primary teeth, researchers studied children enrolled in Tennessee Head Start during the 1984-1985 academic year to evaluate the retention of pit and fissure sealants on primary molars, 6 to 24 months post-eruption. Using portable dental equipment at several Head Start centers, a team of dentists and dental hygienists placed sealants in 1871 children.[30] One year after application, regional retention rates varied from 74% to 95%, with an overall combined retention rate of 88%. Researchers concluded that sealants properly placed on primary teeth had a retention rate comparable to permanent teeth. They suggested that

application of sealants in Head Start centers provided a positive nonthreatening atmosphere where students did not have to be transported to unfamiliar surroundings.

In the late 1980s, the Washington State Department of Social and Health Services funded a pilot study to determine whether sealants could be effectively incorporated into a school-based dental health program directed at first, second, fifth, and sixth graders.[31] A team of dentists and one dental hygienist placed sealants in 403 teeth. One hundred seventeen children received sealants. The dental hygienist placed sealants in 68 of the children, while dentists placed sealants on the teeth of 49 participants. Six months after the sealants were placed, 85% of the children were available to be examined for sealant retention. Much like the New Mexico study, the majority of the children (98%) had retained the sealants. Nickerson, a dental hygienist and the author of this paper, concluded that sealants could be effectively incorporated into a school-based preventive program.

In Kansas, a study examined the oral health knowledge and practices of 284 students who received caries preventive procedures during a 4-year school program.[32] The purpose of this project (not directly connected to the NPDDP) was to examine the oral health knowledge and practices of sixth graders in Wichita. This study was initiated as a result of health objectives outlined for the nation by the US Department of Health and Human Services (1980), which stated that by 1990, at least 95% of all US schoolchildren and their parents should be able to: (1) identify the principal risk factors related to dental diseases, and (2) be aware of the importance of fluoridation and other measures in controlling these diseases.[33] Participants were divided into 2 groups: (1) those who completed a 4-year regimen as part of the NPDDP, and (2) a control group without NPDDP training. The investigators found no differences in oral health knowledge or practices between those children who had participated in the NPDDP and those who had not. Findings related to oral health knowledge revealed that neither the NPDDP nor the regular Wichita dental education lessons stressed the uses and benefits of fluorides and sealants. Findings related to fluoride revealed that few students who had used fluoride tablets during the 4 years of the NPDDP reported using them at the time of data collection. The researchers, one of whom was a dental hygienist, noted that the continued use of fluoride tablets at home, following the termination of the NPDDP, would have been appropriate since the drinking water in Wichita at the time was not fluoridated.[32]

In 1985, data were collected from a large sample of public schools across the United States to examine the sustainability of fluoride mouthrinse programs (FMRP).[34] Dental hygienists, school administrators, and school nurses were part of the research teams. Researchers found that districts that abandoned the FMRP over time generally did so due to the lack of strong support from advocates, not as a result of weighing the pros and cons. Several variables were associated with adoption of the program. First, when school officials were approached with information about the FMRP program by a "health-related person" versus a "nonhealth professional," the district was more likely to have adopted the FMRP. Second, districts with large proportions of low-income children were slightly more likely to have adopted the FMRP. Lastly, districts lacking strong external support may not have been able to continue the FMRP.

In New York, researchers evaluated the combined use of sealants and fluoride mouthrinsing in children who participated in weekly school-based fluoride rinse program since kindergarten and had sealants applied to their first permanent molars while in the second and third grades.[35] This program, originally started as part of the nationwide NIDR National Caries Program, continued under the auspices of the Department of Children's Dentistry, State University of New York at Stony Brook, and the Bureau of Dental Health of the New York State Department of Health. The treatment group consisted of 95 students who had their 4 first permanent molars sealed and received weekly supervised fluoride mouthrinses. The control group consisted of 131 students who did not have sealants placed but received the mouthrinse regime. After 2 years, examination of 84 of the original 95 sealant/fluoride mouthrinse participants revealed only 3 lesions and 96% remained caries-free. Examination of the available children from the control group (n=51) revealed 24 surfaces were decayed or restored, and 78% of these children were caries-free. Investigators suggested that the combination of fluouride mouthrinses and sealants dramatically reduced caries incidence. Although the service provider was unspecified in this study, a dental hygienist served as the research field coordinator and coauthor.

The economics and effectiveness of school-based oral health programs were studied throughout the 1980s.[10,35-47] The cost-benefit and effectiveness of 4 hypothetical dental preventive interventions were analyzed: (1) community water fluoridation, (2) school-based water fluoridation, (3) weekly school-based fluoride mouthrinses, and (4) school-based

sealant programs.[44] Analyses for labor costs were calculated utilizing a team of dental hygienists and dental assistants to place sealants. Although analyses were performed on imaginary communities, general conclusions were derived from this report. Community water fluoridation provided the greatest benefits, with school-based water fluoridation and mouthrinse programs yielding the next most cost-effective results. In this study, sealant programs yielded negative net-benefit results, although favorable cost-benefit analyses were obtained when dental hygienists were service providers.

Research conducted by Doherty and a team of investigators examined the costs associated with wages and labor productivity in school-based mouthrinsing programs.[45-47] Results revealed that costs varied within such programs because of many factors; however, the selection of paid versus unpaid volunteer labor seemed to play an important role. Implications from these studies provided a framework for community planning and supplied useful information on mouthrinse program costs.

The Massachusetts Department of Public Health (MDPH) has utilized dental sealant programs since 1984.48 Dental hygienists, acting as assistant project directors and service providers, played an integral role in statewide programs designed to provide sealants to school children. When the MDPH conducted a survey of 9000 school children from 1978-1981 to assess their level of oral health, the results suggested that by the age of 17 these children had a decay rate that was 30% higher than the national average. Recognizing that underutilization of sealants was a public health issue, the "*Save Teeth: Seal Them*" program was designed to increase sealant use in Massachusetts. Researchers recommended that placement of sealants be conducted by dental hygienists, rather than dentists, to ensure cost-effectiveness and success of the project.

School-based prevention programs were extensively studied during the 1980s. Although most programs were deemed a success, some researchers questioned the effectiveness of school-based fluoride preventive programs.[49-50] The decade of the 1980s yielded the greatest amount of literature related to school-based oral health preventive programs and initiatives. While dental Hygienists' involvement was documented more than in the previous decade, it was clear that the unmet oral health needs of the nation's children would worsen unless public health measures were put into place to create alternative delivery models.

The 1990s

Since 1913, the Bureau of Dental Health Services of the New York City Department of Health has provided dental services to public school children. In 1990, the bureau initiated an extensive network of school-based dental clinics. A 6-year analysis of the program built a strong case for the effective utilization of portable delivery modes that in many ways surpassed the effectiveness and capacity of "fixed-state" school programs.[51-52] As an alternative to conventional dental care, the portables were able to deliver "total patient care" in a cost-efficient manner within schools presenting the highest need. To promote the utilization of sealants in New York, the health department implemented several school-based programs to identify high-risk children so sealants could be placed in newly erupted first and second molars. A 1997 evaluation of this program revealed that 1122 sealants were applied by a team of dental hygienists and assistants under the general supervision of a dentist.[53] After 4 years, sealant retention rates ranged from 65% to 82%. The Bureau concluded that the program provided a feasible method for identifying high-risk children who would benefit from sealant placement in a school-based situation.

Utilization of school-based preventive programs continued to contribute to improved oral health, but not without controversy. In 1995, Nowjack-Raymer, a dental hygienist, and her team of researchers dispelled concern over the presence of dental fluorosis in children participating in school-based programs.[54] Reporting for the NIDR, Nowjack-Raymer reiterated the safety of school-based fluoride programs (mouthrinses, tablets, or combinations) in communities with fluoride-deficient water supplies, thus supporting their implementation.[54]

Additionally, in 1996, the Oral Health Program at the CDC established a Fluoride Work Group to review the role and benefits of fluorides. Adair concluded that fluoride mouthrinses are a safe mode of providing caries protection and suggested that school-based programs should be utilized in communities with children who are at high-risk for caries.[55] Horowitz reviewed the role of dietary fluoride supplements, noting that fluoride supplements are highly effective in reducing dental

caries; yet many parents do not administer home-based fluoride and choose to enroll their children in school-based fluoride programs.[56]

Doherty evaluated the resource productivity and returns of school-based mouthrinse programs in the United States.[57] Comparative cost analyses of fluoride mouthrinse programs varied by: (1) program size, (2) method of administration, (3) wage rates, and (4) types of personnel utilized. Data were obtained from 14 federally-supported mouthrinse programs during their second and third years in operation. Implications from the Doherty report concluded that the viability of programs differ depending on the organizational framework, as well as direct and indirect costs. One of the biggest concerns was labor expenditures. Many school-based programs depended on "free labor" or volunteers as a way to reduce costs, yet difficulties in obtaining and coordinating volunteers led to utilization of paid workers, thus increasing program costs.

In the early 1990s, Cohen and Horowitz conducted a national survey to determine the current status of community-based sealant programs in the United States, as well as to identify general program characteristics.[58] Data were gathered through surveys mailed to all state dental directors. Results revealed that 29 states (57%) had active dental sealant programs in the early 1990s, although 8 states had programs that were discontinued within the preceding years. The number of sealant programs in each state ranged from 1 to 25. All but 3 respondents reported that dental hygienists were permitted to place sealants; dental assistants were allowed to place sealants in 15 states. Fifty-seven percent of the states required a dentist to be present when allied dental personnel placed sealants in school-based programs. While the number of states with sealant programs increased from 21 in 1983 to 29 at the time of the survey in 1991, based on the number of programs operating in each state and the number of children served, it was concluded that only a small proportion of children receive the benefits of sealants from community-based programs. One-hundred percent of respondents reported a need for additional community sealant programs in their state.

In an effort to learn more about the diagnostic reliability of different examiners, Katz, conducted a study to evaluate a dental hygienist, dentist, and nondental personnel, in a caries study of 375 children enrolled in Head Start programs in St. Thomas, U.S. Virgin Islands.[59] Because approximately 450 000 children were enrolled in Head Start programs in the United States, at that time, researchers believed that a significant amount of vital information could be obtained. The results of multiple examinations revealed that there was a strong-to-good (0.87 to 0.93) diagnostic correlation between the dentist and dental hygienist, but only a good-to-fair (0.80 to 0.89) agreement between the dentist and nondental personnel.

In 1988, the dental hygiene program director at Youngstown State University and the clinical director of Child and Family Health Services (CFHS) partnering with Area Health Education Centers (AHEC), implemented a pilot study to provide educational and preventive care.[60] This program was a community-based approach to meet the oral health needs of women and children in a low-income rural population. It also provided dental hygiene students with experience treating patients in a nontraditional setting. According to Burger, a dental hygienist and lead author, there are many challenges facing dental hygienists who choose to work in public health settings. In addition to removing barriers to alternative practice settings, the profession struggles to be recognized by other health care professionals for the services they provide.[60] The Columbiana County Dental Health Task Force was established as an integrated community-based approach to help address the lack of access to dental care to economically disadvantaged individuals. The task force, which initially included 2 dental hygienists, 2 dentists, and various service agencies, received funding to hire licensed dental hygienists and dentists to provide educational, preventive, and restorative dental care to help address the community oral health needs.

In a review of preventive dental programs at Louisiana's state schools for the mentally handicapped, lead author, Connick, a dental hygienist, concluded that it was beneficial to have onsite dental clinics at the schools because of lower costs, and that the burden of transporting clients was removed.[61] These schools allowed time for continual oral health assessment of clients, and placed a high priority in identifying poor oral hygiene. Although dental hygiene involvement in the project was unclear, the Dental Health Resource Program (DHRP) office review revealed that the schools had very successful preventive dental programs; however, most facilities were understaffed and could benefit from additional health personnel.

In rural Northern California, several unique community-based models helped to address the access to care problem for individuals with developmental disabilities.[62] A coalition was formed to coordinate resources and community agencies to provide preventive and therapeutic oral care to the population at risk. Many of these individuals have been moved from

institutional settings into community living situations, further compounding the unmet medical and dental needs. For a problem of this magnitude, an alliance was formed with a team of: (1) dental and dental hygiene faculty from the University of the Pacific School of Dentistry (UOP); (2) faculty and students from the Department of Special Education at San Francisco State University; (3) key staff members from local agencies; and (4) local private physicians, dentists, dental hygienists, and dental assistants. A team of dental hygienists and physicians conducted all initial and end of project interviews with parents, caregivers, case managers, dental personnel, and other administrators, to determine barriers, care needs, and future requirements of the program. Dentists and dental hygienists assessed community needs by providing over 300 dental screenings during the first 2 years of the program. The most significant client need was for oral prophylaxis (n = 78), compared to small fillings (n = 20), and extractions (n = 26. By working together through combined efforts of dental school faculty, community officials, and personnel, a model was implemented to address the long-standing problem of access to dental care for persons with developmental disabilities in rural California. This program demonstrated that through a consortium of agencies, in a community-based approach, preventive and therapeutic dental services can be provided to the population in need.

The decade of the 1990s revealed the continuous effort to provide preventive oral health care services to the underserved. Throughout the nation, school-based and school-linked programs were initiated utilizing dental hygienists as key personnel. Yet, a report from the Center for Health and Health Care in Schools concluded that dental decay remained the most prevalent chronic infectious disease among children, and that more than 51 million school hours were lost due to dental-related illnesses.[63] Furthermore, a report in the CDC's weekly publication documented that a school-based program could increase dental sealant utilization among high-risk children, thus helping reduce racial and economic disparities in children.[64]

Results

A summary of dental Hygienists' involvement in U.S. community school-based oral health programs from 1970 to 1999 is depicted in Table I. Of the 57 articles retrieved, 36 (63%) specifically cited dental Hygienists' involvement as a "service provider," author, or both. For the purpose of this review, "service provider" was defined as educator, administrator, clinician, examiner, or any other unspecified duty performed by a dental hygienist. Of the 36 articles, 27 (75%) cited a "dental hygienist" as a service provider, while 19 (53%) listed a dental hygienist as an author.

Table I. Dental Hygienist Involvement in U.S. School-Based Articles

Decade	Total articles retrieved	Articles with RDH as service provider, author, or both	Articles with RDH as service provider only	Articles with RDH as author only
1970 - 1979	7	3	3	1
1980 - 1989	36	26	19	12
1990 - 1999	14	7	5	6
Total	N = 57	36	27	19

Discussion

Looking back over 3 decades of school-based oral health programs, it is apparent that dental hygienists have been engaged in community initiatives on many levels; moreover, the extent of involvement has grown from the role of educator, examiner, and assistant to that of program administrator, director, researcher, and author. However, as a profession, dental hygiene needs to expand its roles and increase its visibility within the health community. Reasons for the probable under

representation of dental hygienists in the literature remain unclear, but may be due in part to the "silent" partnerships established, or not utilizing professional credentials in publications. On the other hand, dental hygienists have been, and continue to be, involved in school-based oral health programs throughout the nation, and are making substantial contributions to a population at serious risk for oral disease.

Following publication of the Surgeon General's Report and the Healthy People 2010 objectives, the need to remove barriers and establish community partnerships to reach the underserved children of our nation with effective interventions remain key issues.[2,5] The "hidden epidemic" of dental disparities among school children suggests that school-based programs and community partnerships are critical to helping resolve the continuing problem.[65-67] In the face of questions regarding the cost-effectiveness of community school-based oral health programs,[68] current wisdom suggests that even with increasing program costs, the elimination of existing programs addressing the dental needs of the underserved would only discourage new program development, thus widening the "gap" and increasing disparities.

In spite of major improvements over the years, "profound and consequential oral health disparities exist, especially among the poor."[2] Dental hygienists are well positioned to lead the efforts to equalize this disparity and serve unmet community needs. The significant role that dental hygienists play in improving the oral health of the nation has been based on safe and effective measures, which include interventions such as dental sealants and lifestyle behavioral changes.

Research suggests that the best way to reduce dental disparities in children is through school-based programs. Bohannan et al discussed dental sealant use in school and community-based programs, stating, "certainly most dental hygienists possess or can be trained to exercise sufficient diagnostic skills to render the necessary judgments as to which teeth should be sealed."[16] Currently, the number of states that allow dental hygienists to work in school-based programs varies depending on how states define "settings." Thirty-seven states clearly specify that dental hygienists may work in school-based practice settings, 6 states do not put limits on practice settings, and 9 states limit practice settings outside of the dental office to "public" institutions.[69] In states that have authorized unsupervised dental hygiene practice, many hygienists have seized opportunities to provide oral care in nontraditional settings. For dental hygienists residing in states with more practice restrictions, providing services in school-based settings can be more difficult, thus limiting the amount of oral care that is pro vided.

Conclusion

Over the decades, the literature with respect to dental hygienist's involvement in school-based programs was episodic. However, with the initiatives and goals of the Surgeon General's Report and Healthy People 2010, there is an opportunity for community engagement and research, and a concomitant requirement to produce literature documenting the contributions of the dental hygiene profession.

While dental hygienists were specifically identified as authors on numerous publications, the authors of this review theorize that many other articles involved dental hygienists in the authorship process, yet credentials such as RDH or LDH were omitted from the authors' name. Additionally, articles mentioned "dental auxiliaries" or a "trained dental professional" performed services, yet it was unclear who actually conducted the activity. The authors of this review speculate that the service provider was often a dental hygienist, but no professional recognition occurred.

As the dental hygiene profession moves forward, it needs to expand its scope of practice, become more engaged in community-based oral health care initiatives and policy making, and increase public awareness of the profession. The challenges facing dental hygienists working in public health settings are apparent, yet, if there is a lesson to be learned from history, it is that reaching some of our most vulnerable citizens may be best achieved by collaborating with others to remove existing barriers. This step would allow dental hygienists to work in less restricted practice settings. As dental Hygienists' involvement increases, there is a concomitant need to be more "visible" in the literature and in the health care community. Partnering with other professions, such as medicine, social science, and economics, provides opportunities to expand research activities and increase publications in a variety of peer-reviewed journals. Utilizing professional credentials can increase awareness of the dental hygiene profession, as well as educate and influence policy-makers about

the roles of the dental hygienist. Documenting the ways that dental hygienists have contributed to improving the oral health of America further establishes a place for the dental hygiene profession.

For additional information on practice laws in your state, contact the governmental affairs division at http://www.adha.org/govermental_affairs.

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Notes

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